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Upper Grand River Watershed Management Plan

TETRA TECH MPS

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Prepared by:

Tetra Tech MPS
for the

Grand River Inter-County Drainage Board

Geoffrey Snyder, Jackson County Drain Commissioner
Patrick Lindemann, Ingham County Drain Commissioner
William Word, Hillsdale County Drain Commissioner
Janis Bobrin, Washtenaw County Drain Commissioner
Andrew Raymond, Michigan Department of Agriculture

With guidance from the

Upper Grand River Watershed Planning Initiative Steering Committee:

And technical assistance from:

Tetra Tech MPS
Space Imaging Solutions
Jackson County Conservation District
Region 2 Planning Commission
Dahlem Environmental Education Center
Jackson County Health Department
Grand River Environmental Action Team

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Eaton Rapids Township
Eaton Township
Grand River Environmental Action Team
Grass Lake Charter Township
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Hanover Township
Henrietta Township
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Ingham County Drain Commissioner
Ingham County Health Department
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Jackson County Conservation District
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EXECUTIVE SUMMARY

The Upper Grand River Watershed is approximately 700 square miles in size, and is headwaters to one of the largest river basins in Michigan with its outlet into Lake Michigan. Though the river and its watershed provide a variety of recreational lands and uses, much of the watershed's value as a recreational asset is unrealized. Despite significant efforts to improve water quality, portions of the river system still fail to meet water quality standards.

In an effort to improve water quality in the Upper Grand River Watershed, the Grand River Inter-County Drainage Board (GRICDB) convened a group of watershed stakeholders (the Upper Grand River Watershed Planning Initiative Steering Committee) in 2000. In October 2001, the Steering Committee was successful in obtaining a Clean Water Act, Section 319, Nonpoint Source Planning Grant from the U.S. Environmental Protection Agency (U.S. EPA) and Michigan Department of Environmental Quality (MDEQ). A key component of the planning grant is the development of this Watershed Management Plan. Previous watershed efforts and parallel projects are detailed in the Introduction of this plan.

One critical measure of success is the amount of community involvement and public input obtained throughout the development of the plan. Two press releases were issued inviting the public to attend specific steering committee meetings. A front-page article ran in the Jackson Citizen Patriot describing this project to watershed residents. Also, this project involved many partners including individual agencies and organizations who reviewed existing water quality information and other relevant documents, conducted additional water quality sampling at select locations, reviewed and interpreted paper maps, aerial photographs, and digital geographic information system (GIS) data, interviewed municipal planning officials and reviewed existing land use policies, and evaluated ideas for new initiatives.

Data on pollutant loading calculations, risk analysis, and prioritization analysis were conducted on the sub-watershed level. Many of these charts are included throughout the watershed management plan, although more detailed information can be found in Appendix C, GeoBook Analysis Report, and Appendix D, Jackson County Conservation District Reports. Two different reports were

prepared. The first analyzed the Portage River Subbasin for wetland restoration and preservation potential, along with current levels of riparian buffers and need index. The second report is a wetland inventory report which examined 335 distinct wetlands totaling over 11,000 acres and rated each wetland on its potential for preservation, restoration, or if it had been completely degraded. The need for riparian conservation practices was also evaluated on over 81,000 linear feet of riparian corridor.

Overall, the large size of the Upper Grand River Watershed planning area (700 square miles) did not allow developing detailed source control strategies, specific costs for implementation, schedules or mechanisms to evaluate the effectiveness of detailed strategies. A subwatershed level of analysis was performed to evaluate land cover and flow impacts on the Grand River. The categories of analysis included impervious cover, stream flow, biota, riparian buffers, wetlands, streambank and shoreline erosion, agricultural soil erosion, septic tank failures, nitrogen loads, and phosphorus loads. The information provided in this plan will provide a procedure for communities and stakeholders developing detailed action plans, schedules, costs, and Measurables. In addition, this document will guide Phase II communities with developing a more detailed plan for the urbanized portion of this watershed.

This watershed plan summarizes land cover and flow impact analyses and used the results to develop a set of watershed management recommendations. The categories of plan recommendations included an institutional strategy, public awareness, land use policy, water resource policy, wetland protection, streambank protection, Best Management Plan (BMP) recommendation by subwatershed, and TMDL BMPs. Highlights of the recommended actions include the following:

- Develop a dual purpose, not-for-profit, watershed management institution to (1) coordinate further watershed management planning and implementation activities and (2) to serve as a land conservancy for protection and management of unique and valuable lands; (A copy of the resolutions used to establish this institution is provided in Appendix I.)

- Create and disseminate public education materials, designed to raise citizen awareness of the Upper Grand River and its watershed, in a coordinated, multi-media campaign (described herein);
- Change local land use plans and ordinances to protect and improve water quality;
- Adopt local water and infrastructure use policies providing local governments additional powers to govern cross-watershed boundary wastewater discharges and/or withdrawals of surface or groundwater in their natural state;
- Implement specific recommendations to safeguard existing, and restore degraded wetlands; and
- Address detailed recommendations for each of seven major subbasins regarding agricultural, residential, and/or urban best management practices based upon the predominant land use(s) in each of these subbasins, as well as the estimated risk for specific water quality issues.

This plan is intended to guide the efforts of the newly initiated creation of a formal Upper Grand River Watershed Council. The development of this plan has led to a host of implementation efforts; to which this council formation is a prime example. Other efforts include the development of a K-12 curriculum, the development of an educational brochure about the Upper Grand Watershed, and coordination with the National Resource Conservation Service (NRCS) and Jackson County Conservation District to enroll wetlands into the Wetland Reserve Program.

The Steering Committee formally adopted this watershed management plan in March 2003. Currently, there is good momentum within the partner agencies to begin work implementing the recommendations and also applying for additional Section 319 and Clean Michigan Initiative (CMI) funding for plan implementation.

INTRODUCTION

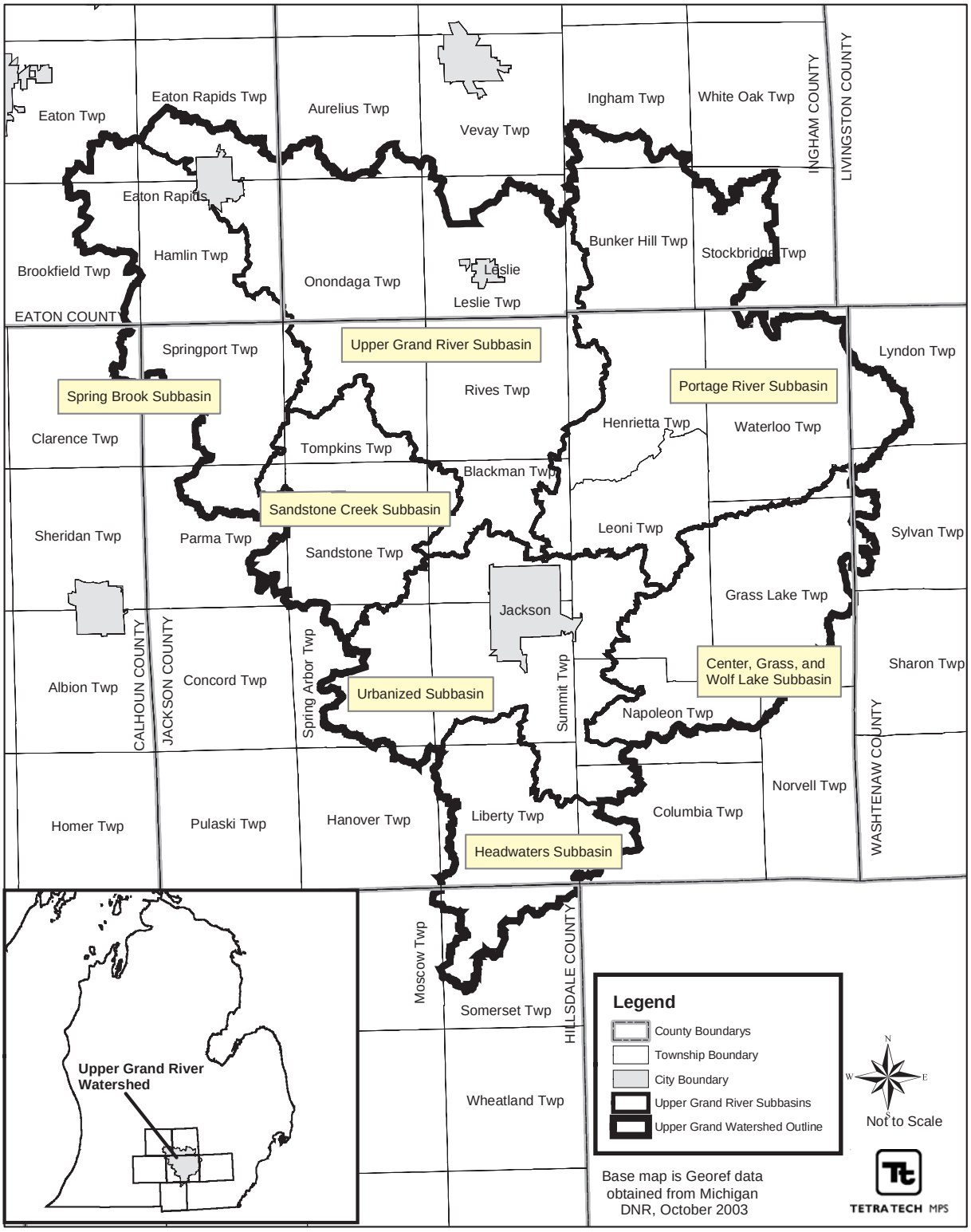
The Upper Grand River Watershed (Figure 1), headwaters to one of Michigan's largest river basins, is both beautiful and troubled. The river was once studied for possible inclusion in the State's Natural Rivers system, its watershed contains critical wetlands for thousands of migrating sandhill cranes (*Grus canadensis*) and other waterfowl, and the river and it's watershed provide a variety of recreational lands and uses. Yet, much of the watershed's value as a recreational asset is unrealized. Despite significant efforts to improve water quality, portions of the river system still fail to meet water quality standards.

Of approximately 390 river miles in the Upper Grand River Watershed assessed by the Michigan Department of Environmental Quality (MDEQ) (not including the Looking Glass River), 56 river miles fail to meet water quality standards. Another 116 river miles are categorized as highly (hydrologically) modified due to past, and current, practices of dredging and damming. Segments of the river system receive untreated sewage discharges, exhibit poor fish and macroinvertebrate communities, and fail to meet water quality standards for pathogens, dissolved oxygen, mercury in lakes, and polychlorinated biphenyls (PCBs). Pollutants contributing to these water quality problems come from both urban and rural sources, both point source discharges and nonpoint source polluted runoff (MDEQ 2002).

PREVIOUS EFFORTS

Since at least the 1960s, municipal agencies and local organizations in the Upper Grand River Watershed have made concerted efforts to identify and correct sources of impairment in portions of the river system. The Michigan Grand River Watershed Council was one of the State's first regional watershed management organizations working to coordinate planning and protection of resources across the river basin.

Figure 1 - Upper Grand River Watershed



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In 1997, the Grand River Inter-County Drainage Board (GRICDB) initiated two studies to identify water quality, erosion, and conveyance problem areas on designated inter-county drain portions of the Grand and Portage Rivers. These studies evaluated river channel and corridor characteristics including areas of sedimentation, areas of stream bank erosion, hydraulic conditions, and potential nonpoint sources of pollution. Both studies identified sedimentation and other geomorphologic changes, which have resulted in log jams and channel restrictions (GRICDB, 1999a, 1999b).

In 1999, with a grant from the Michigan Great Lakes Protection Fund, the GRICDB initiated another study to determine the impact of catch basin cleaning and street sweeping on storm water quality. This study provided important information for making management choices that will be used to meet Federal storm water pollution prevention requirements.

In 2001, the City of Jackson "day-lighted" a section of the Grand River in downtown Jackson, removing the cap that had been built over the river, thereby making the resource visible again. The city also completed a massive effort to separate its sanitary and storm sewer systems in order to eliminate combined sewer and sanitary sewer overflows of untreated sewage to the river.

PARALLEL EFFORTS

Communities in the Jackson urban area, which includes all or portions of Blackman, Leoni, Napoleon, Rives, Summit, and Spring Arbor Townships, the City of Jackson, and Jackson County agencies with storm water conveyance systems within the urban area (e.g., the Jackson County Drain Commissioner, Jackson County Road Commission) are required by the U.S. Environmental Protection Agency (U.S. EPA) to develop storm water pollution prevention plans in accordance with Federal Phase II Storm Water Regulations.

These communities have worked together to develop strategies to pursue compliance with forthcoming Phase II Storm Water Regulations. During the winter of 2002, they jointly submitted a grant application for Clean Michigan Initiative funding to identify and correct illicit connections to their respective storm sewer systems, and in March 2003, they submitted applications for watershed-based storm water permits.

Nineteen communities that make up the Greater Lansing Urbanized area are also regulated under the U.S. EPA Phase II Storm Water Regulations and are pursuing the development of a watershed management plan for the portion of the Upper Grand River from a point beginning just north of the City of Eaton Rapids and ending at Oneida Township.

Municipalities in Jackson County, with assistance from the Region 2 Planning Commission (R2PC), Michigan State University, and LSL Planning, are developing a Comprehensive Countywide Master Plan to guide development, land use, and protection priorities in Jackson County. This is a tremendous effort involving all of the municipalities in the County.

The Jackson County Regional Trailway Committee is developing a countywide vision for connecting existing and proposed recreational paths in Jackson County and surrounding counties. This plan is intended to "provide the county with a tool to plan for future land acquisition and trailway development, thus providing Jackson County with continually improved non-motorized transportation and recreation opportunities" (Jackson County 2002).

Yet another committee representing municipalities and County agencies is working to develop a Jackson County Wellhead Protection Plan to protect the County's drinking water aquifers. Both the Wellhead Protection Plan and this Watershed Management Plan are to be incorporated, by reference, into the Jackson County Comprehensive Master Plan.

A WATERSHED PLAN FOR THE UPPER GRAND RIVER

In an effort to coordinate some of the activities in the Upper Grand River Watershed and to layout an action plan to more fully realize the rivers potential, the GRICD Board convened a group of watershed stakeholders in 2000. This group was dubbed the Upper Grand River Watershed Planning Initiative Steering Committee. In October 2001, the Steering Committee was successful in obtaining a Clean Water Act, Section 319, Nonpoint Source Planning Grant from the U.S. EPA and MDEQ. A key component of the planning grant is the development of this watershed management plan.

The Process for Developing this Plan

This watershed management plan has been developed in accordance with guidance provided in: *Developing a Watershed Management Plan for Water Quality: An Introductory Guide* (Brown, et al., 2000), as recommended by MDEQ. Other guidance documents used in developing this plan include:

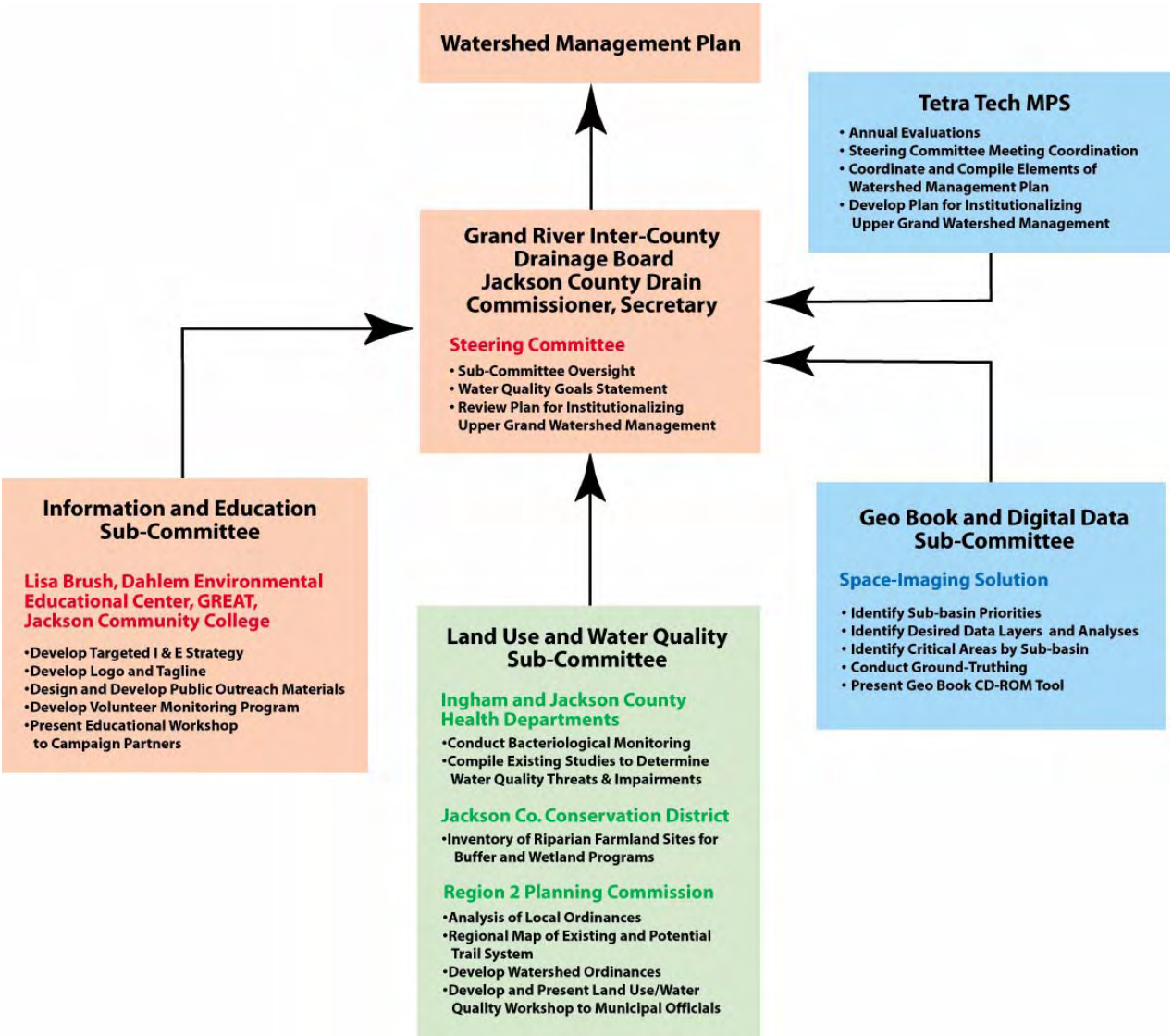
- *Checklist for an Approved Watershed Management Plan, DRAFT* (MDEQ, 1999),
- Michigan's Watershed-Based MS4 Voluntary General Permit (MDEQ, 1997), and
- The Lower One Rouge River Subwatershed Management Plan (Lower One Subwatershed Advisory Group, 2001).

Following award of the Section 319 Planning Grant, the Upper Grand River Watershed Planning Initiative Steering Committee was expanded to provide broader representation and community and individual involvement. Members of this committee provided input and feedback as various aspects of the plan were developed. In addition to the Steering Committee, three subcommittees were formed, each made up of members of the Steering Committee and staff of different agencies and/or consulting firms charged with development of portions of the plan and analyses. The following three subcommittees were formed:

- Information and Education Subcommittee,
- Land Use and Water Quality Subcommittee, and
- GeoBook and Digital Data Subcommittee.

A schematic diagram of the tasks of these subcommittees, the lead agency or agencies for each subcommittee, their tasks, and their relationship to the overall Steering Committee is provided as Figure 2.

Figure 2 - Watershed Management Planning Process



To develop this plan, individual agencies and organizations reviewed existing water quality information and other relevant documents, conducted additional water quality sampling at select locations, reviewed and interpreted paper maps, aerial photographs, and digital geographic information system (GIS) data, solicited information from municipal planning officials and reviewed existing land use policies, and brainstormed ideas for new initiatives within the structure of either the subcommittees or the overall Steering Committee previously described.

A wealth of information was developed in conducting these analyses. This watershed plan summarizes portions of these analyses and results viewed as central to developing a set of watershed management recommendations. The full reports for these analyses are included as appendices to this plan.

Goals and Desired Uses

Specific goals for the watershed management plan identified in the original grant proposal included identifying ways to:

- Reduce nonpoint source inputs of pathogenic and oxygen-depleting materials to the Upper Grand River to meet full-body contact health and water quality standards.
- Reduce other nonpoint source pollutants, particularly phosphorous, nitrogen, eroded soil, and metals.
- Improve aquatic habitat and increase the abundance and diversity of native fish, aquatic macroinvertebrates, and other aquatic flora and fauna.
- Identify critical wetland resources within the watershed.
- Restore, develop, and promote the Upper Grand River as a recreational asset through development of river corridor and canoe trail systems.
- Foster a stewardship ethic among watershed residents.
- Develop institutional capacity for continued watershed management plan implementation and monitoring.

Other goals identified in subsequent discussions of the Steering Committee included the following:

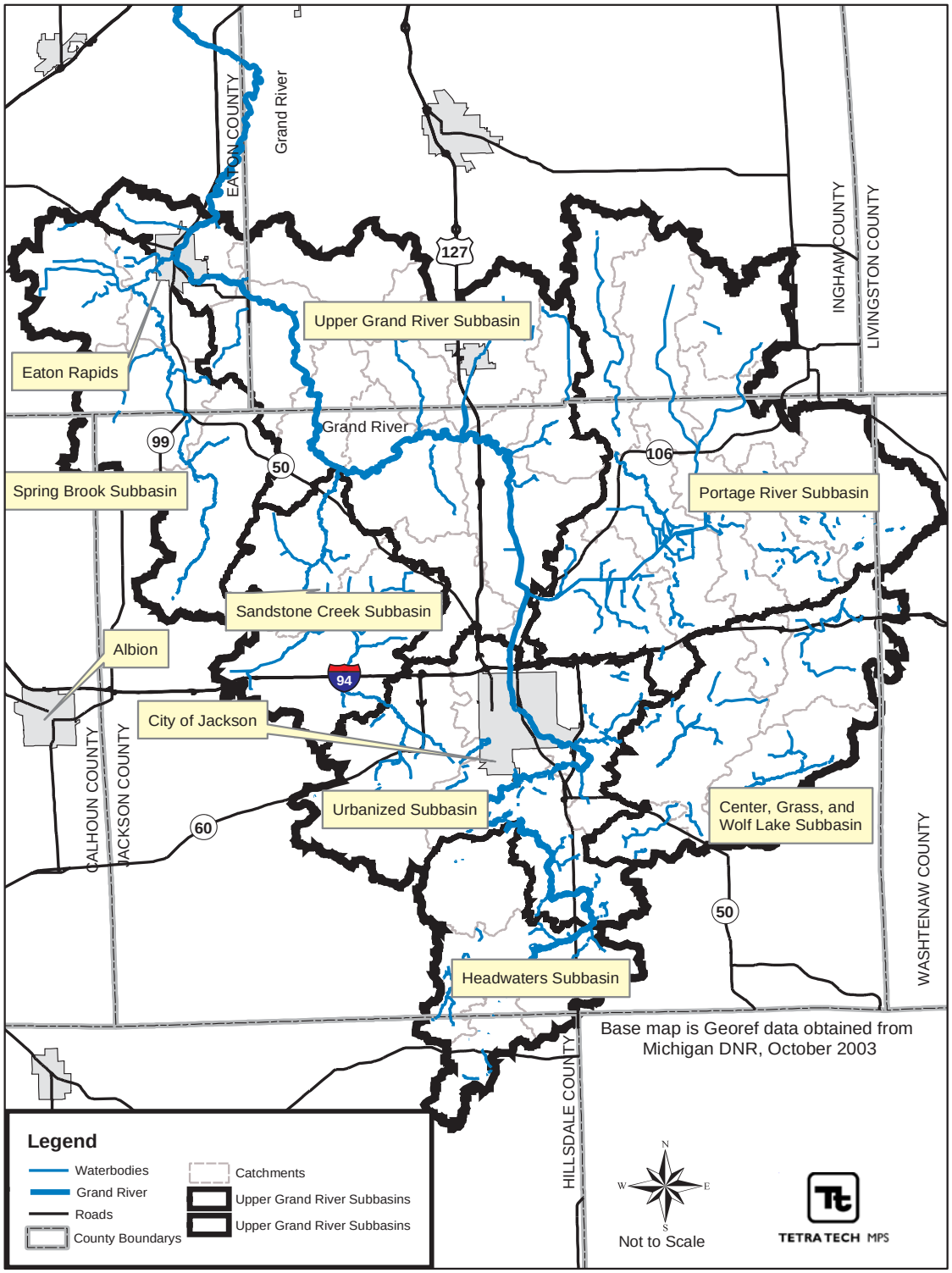
- Increase storm water conveyance in portions of the river system that serve as designated county or inter-county drains.
- Protect threatened and endangered species.
- Preserve and restore wetlands.
- Protect the State-designated uses of waters in the Upper Grand River Watershed.
- Develop plans for storm water quality and quantity management and pretreatment.
- Conduct targeted stream restoration.
- Update sewer ordinances.
- Coordinate the Watershed Management Plan with other plans and programs (e.g., Jackson County Wellhead Protection program, the Jackson County Master Plan).
- Map wetland resources within the Upper Grand River Basin.

Watershed Planning Area

The planning area for development of this watershed management plan includes a portion of the Upper Grand River Watershed as recognized by MDEQ. This subset of the Upper Grand River Basin is shown in Figure 3, Upper Grand River Watershed Planning Area. As mentioned previously, a group of 19 communities in the greater Lansing urban area have formed a working group to develop Phase II storm water permit applications and to conduct watershed planning for their portion of the Upper Grand River and its tributaries. To avoid duplication with that effort, the planning area for this watershed management plan was delineated to link with the Lansing area work, and includes the headwater areas of the Upper Grand River in Hillsdale, Jackson, Washtenaw, Calhoun, Ingham, and Eaton Counties to a point on the Grand River just downstream of the City of Eaton Rapids.

This portion of the Upper Grand River Watershed was further subdivided into seven major subbasins. Specific recommendations were developed for each of these. The planning area for this Upper Grand River Watershed Management Plan, divided into these seven major subbasins, is shown in Figure 3, Upper Grand River Watershed Major Subbasins.

Figure 3 – Upper Grand River Watershed Major Subbasins



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Watershed Plan Contents

The following management plan for the Upper Grand River Watershed is broken into two main sections: (1) a description of analyses conducted to identify and prioritize problem areas within the watershed as well as analyses of policy and educational needs within the watershed, and (2) recommendations stemming from the principle findings of those analyses. In general these sections include the following:

Analyses:

Review of existing water quality information and water quality sampling conducted in conjunction with this planning effort.

Land cover analyses to identify and prioritize those subbasins at risk of surface water contamination or other environmental degradation.

Analysis of existing land use planning policies.

Analysis of potential models for an organization(s) to oversee long-term watershed management implementation.

Discussions to develop a framework for public education concerning watershed protection and restoration.

Recommendations:

Recommendations for creation of a new watershed management organizational structure.

Recommendations for public education campaigns.

Recommendations specific to wetland protection.

Recommendations specific to riparian buffer management to limit stream bank erosion and resulting sedimentation.

Recommendations for improved land use policies.

Recommendations for continued watershed planning and evaluation of implementation success.

WATERSHED DESCRIPTION

WHAT IS A WATERSHED

Throughout this Watershed Management Plan, the terms *watershed, river basin, subbasin,* and *subwatershed* are used to describe the drainages of all or portions of the Upper Grand River. A watershed is any area of land that drains to a common point. That point may be a lake, the outlet of a river, or any point within a river system.

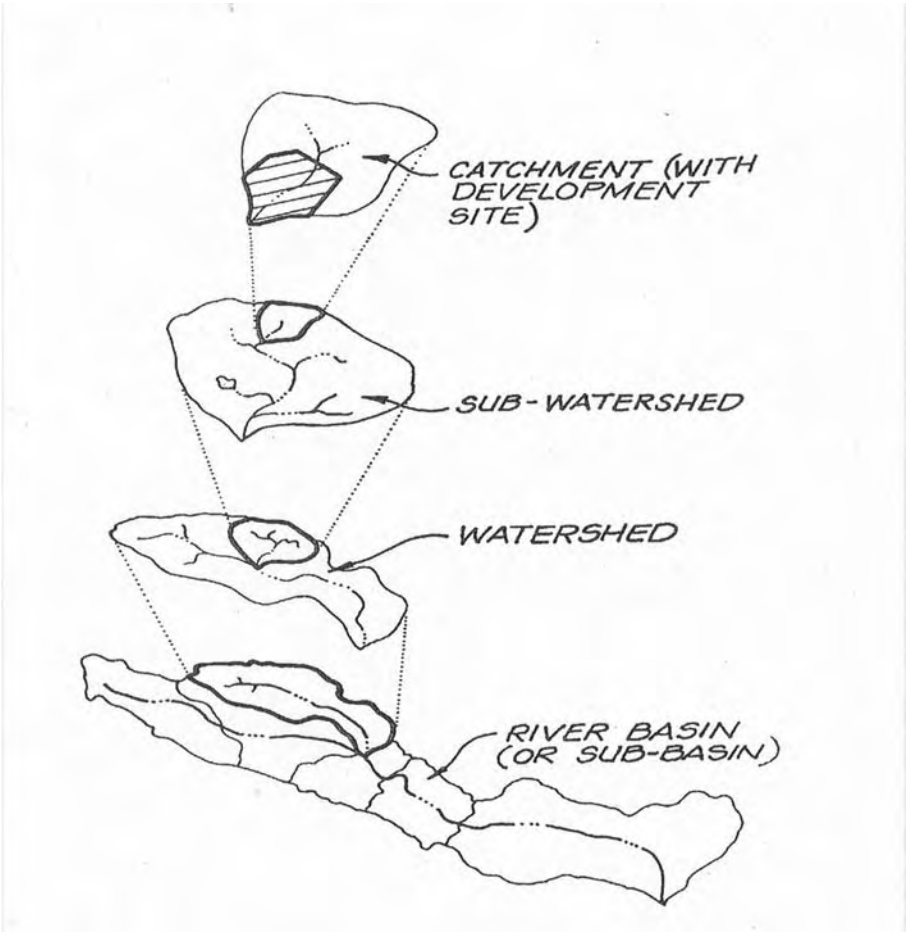
Using the Grand River as an example, a storm drain along a subdivision street in Ingham County may carry storm water and associated pollutants to Batteese Creek. Batteese Creek drains to the Portage River, which is a tributary to the Grand River. The Grand River Watershed ultimately drains to Lake Michigan. Each of these areas are considered watersheds at differing scales and may be referred to as catchments, subbasins, subwatersheds, or watersheds. Smaller watersheds within larger watersheds are called nested watersheds (see Figure 4). Each watershed is nested in the next size larger watershed. The water quality in the last river or lake is dependent on the quality of water being delivered to it by all the watersheds nested within.

THE UPPER GRAND RIVER WATERSHED

The Grand River originates in Somerset Township, Hillsdale County and outlets into Lake Michigan approximately 260 miles downstream at Grand Haven. It drains the second largest watershed in Michigan (Figure 1). The watershed is bounded on the north by the Muskegon River and Saginaw River watersheds, and on the south by the Kalamazoo River, St. Joseph River, and River Raisin watersheds, and to the east by the Huron River watershed. The watershed has a drainage area of 5,572 square miles and includes all or part of 19 counties (USACE, 1972).

As mentioned previously, the planning area for this Watershed Management Plan is defined as starting in northern Hillsdale County and terminating just north (downstream) of the City of Eaton Rapids, an area of approximately 700 square miles. This area is referred to as the Upper Grand River Watershed throughout this plan.

Figure 4 - Watershed Management Units (Center for Watershed Protection, 1998)



A soil surface texture map is provided in section 5, page 13, of the GeoBook, located in Appendix C of this plan. The map shows the distribution of soil surface textures throughout the Upper Grand River Watershed and surrounding area.

Land use in the watershed is mixed. The Grand River Watershed was predominately wilderness up until the 1830s. The few European-Americans in the area conducted fur trading and farming. With improved transportation in the 1830s, the timber industry took hold and flourished between 1840 and 1870. With the removal of timber, the land was largely converted to agricultural uses (USAED, 1972). Agriculture is still a significant land use in the Upper Grand River Watershed,

but the urban areas surrounding the cities of Jackson and Lansing are growing, replacing agricultural lands and open space as the watershed population grows.

Current land cover/land use in the Upper Grand River Watershed was compiled from the following sources and is presented in Table 1 below:

- Hillsdale and Calhoun County areas: MIRIS (1978).
- Washtenaw County areas: SEMCOG (1995).
- Eaton and Ingham County areas: Tri-County Regional Planning Commission (1999).
- Jackson County areas: MIRIS (1978) with updates made for urban change as of 2000, imagery by Veridian and Michigan State University.

Table 1 - Land Use in the Upper Grand River Watershed (Acres)

Sub-watershed	Agriculture	Commercial /Industrial	Forested Land	Rangeland	Residential	Urban Green Space	Water	Wetlands	Total (acres)	Total (mi.^{2})
Center, Grass, & Wolf Lake	21,329	785	4,241	2,316	7,369	460	2,391	10,574	49,465	77.3
Grand River Headwaters	13,397	160	4,533	2,073	3,760	253	1,178	6,021	31,376	49.0
Portage River	44,351	1,139	18,516	7,709	7,684	524	1,885	24,633	106,441	166.3
Sandstone Creek	17,398	556	3,607	3,047	2,252	221	128	8,040	35,249	55.1
Spring Brook	29,648	431	5,452	3,939	3,086	87	178	9,301	52,121	81.4
Upper Grand River	58,436	2,444	10,118	9,850	12,801	100	661	16,614	111,024	173.4
Urbanized	12,659	7,264	6,761	4,161	17,181	1,779	1,281	11,160	62,246	97.3
Total by Land Use	197,218	12,779	53,228	33,095	54,134	3,424	7,702	86,343	447,923	699.9
Percentages	44.0%	2.9%	11.9%	7.4%	12.1%	0.8%	1.7%	19.3%	100%	100%

People and Communities

The Upper Grand River Watershed is home to approximately 204,000 people, of which over half live in the City of Jackson or the urbanizing townships surrounding the City (U.S. Census Bureau, 2002). Thirty-eight (38) local units of government in six counties lie wholly or partially within the Upper Grand River Watershed. Of these, 21 local governmental units are located in Jackson County, 9 in Ingham County, 4 in Eaton County, 2 in Hillsdale County, 2 in Washtenaw County, and 1 in Calhoun County (see Table 2).

Table 2 - Local Governments and Subwatersheds of the Upper Grand River

Local Governments and Subwatersheds	SUBWATERSHEDS			
	Spring Brook	Upper Grand River	Portage River	Grand River Headwaters
Calhoun County	X			
Clarence Township	X			
Eaton County	X	X		
City of Eaton Rapids	X	X		
Brookfield Township	X			
Eaton Township	X			
Hamlin Township	X	X		
Hillsdale County				X
Moscow Township				X
Somerset Township				X
Ingham County	X	X	X	
City of Leslie		X		
Aurelius Township		X		
Bunkerhill Township			X	
Ingham Township			X	
Leslie Township		X		
Onondaga Township		X		
Stockbridge Township			X	
Vevay Township		X		

Local Governments and Subwatersheds	SUBWATERSHEDS						
	Spring Brook	Upper Grand River	Sandstone Creek	Portage River	Center, Grass & Wolf Lakes	Grand River Headwaters	Jackson Urbanized Area
Jackson County	X	X	X	X	X	X	X
City of Jackson			X			X	X
Village of Grass Lake					X		
Village of Parma			X				
Village of Springport	X						
Blackman Township		X	X	X		X	X
Colombia Township						X	
Grass Lake Township				X	X		
Hanover Township			X				
Henrietta Township		X		X			
Leoni Township				X	X	X	X
Liberty Township						X	
Napoleon Township					X	X	
Norvell Township					X		
Parma Township	X		X				
Rives Township		X					
Sandstone Township	X	X	X				
Spring Arbor Township			X				X
Springport Township	X						
Summit Township			X			X	X
Tompkins Township	X	X	X				
Waterloo Township				X	X		
Washtenaw County				X	X		
Sylvan Township				X	X		
Lyndon Township				X			

As shown in Table 3, some communities in the watershed lost population between 1990 and 2000, while other communities are experiencing modest or rapid growth. Overall, the region gained 10,755 people between 1990 and 2000; a growth rate of 5.5 percent (the growth rate for Michigan as a whole was 6.9 percent). Although this may appear to be a rather low growth rate, the perception of watershed residents is that a great deal of development is occurring. The average number of people per household decreased during the same period, helping to explaining continued development with only modest population growth. The preparation of this plan and the parallel planning activities being conducted in Jackson County are, in part, a reaction to the changes residents are seeing within the river basin.

Table 3 - Populations of Upper Grand River Watershed Municipalities

Location	1990	2000	% Change	Location	1990	2000	% Change
Calhoun County				**Jackson County**			
Clarence Township	2,051	2,032	-1	City of Jackson	37,446	36,316	-3
				Village of Grass Lake	903	1,082	20
Eaton County				Village of Parma	809	907	12
City of Eaton Rapids	4,695	5,330	14	Village of Springport	707	704	0
Brookfield Township	1,331	1,429	7	Blackman Township	20,492	22,800	11
Eaton Township	3,003	4,278	42	Colombia Township	6,308	6,028	-4
Hamlin Township	2,351	2,952	26	Grass Lake Township	3,774	3,504	-7
				Hanover Township	3,710	3,368	-9
Hillsdale County				Henrietta Township	3,858	4,483	16
Moscow Township	1,353	1,445	7	Leoni Township	13,435	13,549	1
Somerset Township	3,416	4,277	25	Liberty Township	2,452	2,903	18
				Napoleon Township	6,273	6,939	11
Ingham County				Norvell Township	2,657	2,922	10
City of Leslie	1,872	2,044	9	Parma Township	2,491	2,445	-2
Aurelius Township	2,686	3,318	24	Rives Township	4,026	4,725	17
Bunkerhill Township	1,888	1,979	5	Sandstone Township	3,300	3,145	-5
Ingham Township	1,942	2,061	6	Spring Arbor Township	6,939	7,577	9
Leslie Township	2,436	2,327	-4	Springport Township	2,090	1,478	-29
Onondaga Township	2,444	2,958	21	Summit Township	21,130	21,534	2
Stockbridge Township	2,971	3,435	16	Tompkins Township	2,321	2,758	19
Vevay Township	3,668	3,614	-1	Waterloo Township	2,830	3,069	8
				Washtenaw County			
				Sylvan Township	5,827	6,425	10
				Lyndon Township	2,228	2,728	22

WATER QUALITY ASSESSMENT

Both published water quality reports and water quality sampling results collected as part of this planning effort were reviewed and summarized to identify water quality issues and trouble spots within the watershed.

STATE DESIGNED USES

The State of Michigan has developed standards against which streams are measured to determine the health of the stream. These water quality standards are contained in Part 31 of the Natural Resources and Environmental Protection Act, (P.A. 451 of 1994). Act 451, Part 31, Rule 100 states that all surface waters in the Upper Grand River Watershed shall be protected for the following designated uses:

- Agriculture
- Industrial Water Supply
- Public Water Supply at the point of intake
- Navigation
- Warm Water Fisheries
- Other Indigenous Aquatic Life and Wildlife
- Partial Body Contact Recreation
- Total Body Contact Recreation between May 1 and October 31

Each of these designated uses is represented in the watershed, with the exception of the public water supply at the point of intake. Groundwater is used as the primary source of drinking water for each of the communities within the watershed. In addition to the designated uses listed above, Mackey Brook (approximately 1/2 mile long), a tributary to Sandstone Creek in Parma and Sandstone Townships, Jackson County, is designated for use as a cold-water fishery.

PUBLISHED WATER QUALITY DATA

The Upper Grand River, from the City of Jackson downstream to Berry Road (8 miles), is listed in Michigan's 305(b) Report (MDEQ, 2002) for failure to attain designated stream uses. This stretch of river exhibits poor aquatic habitat, with correspondingly poor macroinvertebrate and fish communities, and violates Michigan water quality standards for pathogens and dissolved oxygen. Additionally, the section of the Grand River from the river's mouth at Lake Michigan upstream to the City of Jackson, is listed due to PCB contamination; for violations of PCB water quality standards near the river's mouth and for fish contaminant advisories upstream. In a biological and chemical survey conducted in 1991, Michigan Department of Natural Resources (MDNR, now MDEQ) staff found elevated levels of nutrients and metals, especially total phosphorus, zinc, chromium, copper, lead, arsenic, and cadmium, downstream of the City of Jackson (MDNR, 1992). Fish and invertebrate assemblages and aquatic habitat exhibited degraded conditions extending beyond the 8 miles listed in the State's 305(b) report.

Dissolved oxygen (DO) monitoring was conducted in 1988 and 1991 at Lansing Avenue, approximately seven miles north of the Jackson city limits (MDEQ, 2002). Both studies documented severe DO depressions following rain events. The 1988 monitoring was prompted by a fish kill at Lansing Avenue occurring in the summer of 1988. Wet weather chemistry sampling conducted in 1991 at locations on the Portage River and on the Grand River upstream of the Portage River confluence, indicated that combined sewer overflows (CSOs) in the City of Jackson were the likely cause of the DO depressions. As mentioned previously, the City of Jackson undertook a program to separate their sanitary and storm sewer systems, and the last of the CSOs were eliminated in 2000 (Limno-Tech, 2003).

To determine if sewer separation had eliminated the water quality standards violations, MDEQ conducted a more extensive study of the Grand River in the summer of 2001. The objective of this monitoring was to identify specific point and non-point sources (NPS) of oxygen-demanding wastes, low-DO inflows, and total dissolved solids (TDS) to the Grand River. Sampling results of this study are summarized below, a copy of the report narrative is provided in Appendix B.

North Branch Grand River at Falahee Road

Monitoring conducted at Falahee Road, east of the City of Jackson on the North Branch of the Grand River just upstream from the confluence with the Grand River and downstream from the Leoni Township WWTP, showed DO concentrations ranging from 0.0 to 20 mg/L, with an average of 6.08 mg/L. DO concentrations dropped below 5.0 mg/L on a daily basis and 50 percent of the measurements were below the minimum standard of 5.0 mg/L.

This location was observed to have extremely thick aquatic vegetation. The large diurnal variation, especially in the drier portion of the monitoring period, could be due to shallower river depths allowing more sunlight. This could increase photosynthesis and possibly respiration rates.

Grand River at Jackson State Prison (Parnall Road)

This station, located at the back of the Jackson State Prison property, along the Grand River just north of the Jackson city limits and downstream of the Jackson WWTP, exhibited DO concentrations ranging from 0.0 mg/L to 10.0 mg/L, with an average of 6.0 mg/L. This is above the minimum warm water DO standard of 5.0 mg/L. 8.34 percent of the measurements at this location were below 5.0 mg/L. The average daily variation in concentrations was 2.0 mg/L. Wet weather monitoring indicated that precipitation did not appear to have a significant impact on dissolved oxygen concentrations.

Portage River at M-106

Continuous monitoring conducted on the Portage River at M-106, just upstream of the Grand River confluence, showed that DO ranged from 0.2 mg/L to 10.0 mg/L, with an average of 4.58 mg/L. This is the only continuous monitoring station to have the average over the monitoring period below the minimum standard of 5.0 mg/L. Sixty-seven (67) percent of the measurements were below 5.0 mg/L. The average daily variation in concentrations was 2.73 mg/L. The daily minimum DO concentration recorded at this station was below the minimum standard on all but three days. The maximum daily DO recorded was below the minimum standard on 15 days. Wet weather monitoring indicated that sags in DO concentrations followed precipitation events.

Grand River at Churchill Road

Continuous monitoring conducted on the Grand River at Churchill Road, the most downstream and the most rural continuous monitoring station, recorded DO concentrations ranging from 0.7 mg/L to 9.19 mg/L, with an average of 5.59 mg/L, which is above the minimum warm water DO standard of 5.0 mg/L. Twenty-three (23) percent of the measurements were below the minimum standard. DO concentrations at this location were impacted by precipitation with significant drops in DO with each rainfall. The cause of these oxygen sags is believed to be from non-point source polluted runoff.

Instantaneous DO Monitoring Sites

Instantaneous DO measurements collected on the Grand River at Francis Road, Meridian Road, High Street at US-127, and High Street, all located within the City limits of Jackson, and instantaneous measurements at Falahee Road on the North Branch Grand River, Hawkins Road and Wooster Road on the Portage River, and Territorial Road on Huntoon Creek north of Jackson, all exhibited average morning DO concentrations below the minimum standard. Average afternoon concentrations at all locations exceeded 5.0 mg/L.

Summary

Monitoring data collected during this most recent study indicate that DO concentrations in the Grand River downstream of the City of Jackson; in the Portage River and in the Grand River downstream of the confluence with the Portage River; and in the North Branch of the Grand River downstream of the Leoni WWTP continue to violate Michigan water quality standards. DO concentrations on the Grand River main stem appear to rebound between the City and the Jackson WWTP, then exhibit a second sag downstream of the confluence with the Portage River.

Poor DO concentrations in the Grand and Portage Rivers are thought to result from high oxygen demand created by concentrated sediment deposition from both urban and agricultural runoff. In the Portage River, this effect is exacerbated by low stream gradient, which limits the potential for reaeration (Erik Sunday, MDEQ, pers. comm.). Hubbell, Roth, and Clark (1999a, 1999b) had identified several locations of deep sediment deposits in their analysis of the Grand and Portage River Inter-County Drain segments. Poor early morning DO concentrations in the North Branch

of the Grand River appear to be caused by plant respiration from the abundant rooted macrophyte growth present at that location and other locations upstream (Erik Sunday, MDEQ, pers. comm.). Nutrient loading to this tributary may exacerbate this problem.

BACTERIOLOGICAL WATER QUALITY SAMPLING AND ANALYSIS

To augment studies conducted by MDEQ, the Jackson and Ingham County Health Departments collected weekly water quality samples over the course of four months in the spring and summer of 2002 (May through August),. Samples were analyzed to quantify the number of *E. coli* bacteria colonies. Data collected by the Jackson County Health Department (JCHD) and Ingham County Health Department (ICHD) are summarized here. The full report of their sampling and analysis was compiled by JCHD and is provided as Appendix B.

Samples were collected from 12 sites located near the confluences of the Grand River and tributary streams; 2 sites in Ingham County, 1 site in Eaton County, 1 site in Hillsdale County, and 8 sites in Jackson County. Sample locations were chosen in an attempt to measure the effect of large tributaries on the main branch of the Grand River. Sites were located at or near the confluences of the tributaries and the main branch, as well as the upper stretches of the tributaries. Each site (except Somerset/Lake LeAnn) was sampled at three locations; upstream of the confluence on both branches and downstream of the confluence where the tributaries or branches mix, for a total of 35 sampling locations. Sampling sites are described in Table 4.

Of those locations sampled, a number showed elevated concentrations of *E. coli* bacteria on various dates. The following language from the Michigan Water Quality Standards regulates the allowable limits of *E. coli* bacteria in surface waters of the State:

> "R 323.1062 Microorganisms.
> *Rule 62. (1) All waters of the state protected for total body contact recreation shall not contain more than 130 Escherichia coli (E. coli) per 100 milliliters, as a 30-day geometric mean. Compliance shall be based on the geometric mean of all individual samples taken during 5 or more sampling events representatively spread over a 30-day period. Each sampling event shall consist of 3 or more*

samples taken at representative locations within a defined sampling area. At no time shall the waters of the state protected for total body contact recreation contain more than a maximum of 300 E. coli per 100 milliliters. Compliance shall be based on the geometric mean of 3 or more samples taken during the same sampling event at representative locations within a defined sampling area.

(2) All waters of the state protected for partial body contact recreation shall not contain more than a maximum of 1,000 E. coli per 100 milliliters. Compliance shall be based on the geometric mean of 3 or more samples, taken during the same sampling event, at representative locations within a defined sampling area."

The sampling conducted by JCHD and ICHD was not designed specifically to calculate the geometric mean over five sampling events per month, nor were three or more samples taken at any given location on the same date. In general, samples were collected on less than five different dates per month. However, the data do allow the identification of trouble spots and key times in the spring and summer when water quality conditions may be poorest.

Table 5 provides a summary of the bacteriological analysis data for each sampling location and month. Tetra Tech MPS (TTMPS) calculated the geometric mean of all samples collected during each month from raw data provided by JCHD. Only those geometric mean values that exceeded 130-colonies/100 ml are presented in Table 5. Where two values appear for a specific location and month, they represent locations and dates where more than one sample was collected on a given day.

Further review of the data indicates that, for the most part, geometric mean concentrations of *E. coli* are below 130-colonies/100 ml during the month of May, and lower in June than in July and August. This is perhaps due to a combination of generally lower temperatures and higher stream flows in May and June. A notable exception to this is Leslie Village where bacteria counts in May were high at all three locations. The highest geometric mean concentration for a given month was found at the McCreedy Creek confluence. The Leslie Village concentrations are of concern particularly due to the high concentrations across the entire sampling period. The

confluence of Springbrook Creek and the Grand River at Dimondale exhibits the best water quality in terms of this bacteriological analysis.

Table 4 - Bacteriological Water Quality Monitoring Locations

Site Code	Sample Site Location	Latitude and Longitude
A-1	Brown's Lake Road, upstream Sharp Creek	N42º10.808, W084º24.733
A-2	Hague Road, upstream Grand River	N42º10.603, W084º23.603
A-3	Brown's Lake Road, Bridge between Vandercook and	N42º11.425, W084º24.671
B-1	Falahee Road, upstream Michigan Center Lake	N42º13.784, W084º20.731
B-2	Meridian Road, upstream Grand River	N42º12.956, W084º21.901
B-3	High Street, downstream Grand River	N42º13.639, W084º21.796
C-1	Cooper Street, upstream Portage River	N42º18.741, W084º23.243
C-2	Parnell, upstream Grand River	N42º17.475, W084º24.349
C-3	Maple Grove Road, downstream Grand River	N42º20.493, W084º24.125
D-1	Roth Road, upstream Sandstone Creek	N42º22.759, W084º32.284
D-2	Rives/Eaton Road, upstream Grand River	N42º24.230, 084º29.169
D-3	Tompkins Road, downstream Grand River	N42º23.454, W084º32.497
E-1	Knight Street, upstream Spring Brook (Eaton)	N42º30.695, W084º39.407
E-2	Island Park, upstream Grand River	N42º30.677, W084º39.246
E-3	Petrieville Road, downstream Grand River	N42º32.096, W084º37.484
F-1	Brouhell Road, upstream of Rives Junction, drain	N42º22.280, W084º27.295
F-2	Churchill Road, upstream Grand River	N42º24.204, W084º26.530
F-3	Wood Street, downstream Rives Junction Village drain	N42º23.170, W084º27.817
G-1	Coonhill Road, upstream Batteese Creek	N42º21.572, W084º17.529
G-2	Dunn Road, upstream Portage Creek	N42º21.029, W084º15.847
G-3	Wooster Road, downstream Portage Creek	N42º19.899, W084º18.392
H-1	Fitchburg Road, upstream Portage Drain	N42º24.048, W084º16.185
H-2	Territorial Road, upstream Plum Orchard Creek	N42º24.297, W084º15.357
H-3	M-106, downstream Portage Drain	N42º23.568, W084º15.861
I-1	US 12, upstream Lake LeAnn	N42º03.052, W084º24.751
I-2	Vicary Road, between Lake LeAnn and Grand Lake	N42º04.374, W084º25.630
I-3	South Jackson, downstream Grand River	N42º06.063, W084º24.129
J-1	Weatherby, upstream McCreedy Creek	N42º08.216, W084º23.411
J-2	Reed Road, upstream Grand River	N42º08.350, W084º21.183
J-3	Loomis Street, downstream Grand River	N42º09.300, W084º22.920
K-1	Kirby Road, upstream of Leslie Village	N42º27.562, W084º25.170
K-2	Churchill Road, upstream of Leslie Village	N42º26.954, W084º26.617
K-3	Baseline Road (off Churchill), Downstream Leslie Village	N42º25.303, W084º26.485
L-1	Waverly Road, upstream Dimondale Village	N42º37.324, W084º36.174
L-2	Bridge Road, center of Dimondale Village	N42º38.665, W084º39.029
L-3	Creyts Road, downstream Grand River	N42º40.298, W084º38.534

Rives Village, at Location F-1 (Tables 4 and 5), exhibited mean concentrations greater than 130-colonies/100 ml across the sampling season similar to the Leslie Village sites. This is likely due to the failed septic systems in the Village that discharge to the river. Rives Village has received a rural development grant to address this issue and is working with the Jackson County Drain Commissioner to provide sanitary waste treatment for homes currently discharging untreated sewage.

STREAM BANK EROSION AND SEDIMENTATION

Hubbell, Roth, and Clark, Inc. (1999a,b) assessed the Inter-County Drain portions of the Grand and Portage Rivers in 1999 for the Grand River Inter-County Drainage Board. They noted visual observations regarding log jams, stream bank erosion, the depth of unconsolidated sediment, and notable litter and trash in the river. They assessed these physical characteristics for a 47,872-foot section of the Grand River from Ganson Street in the City of Jackson downstream to Berry Road, and for an 110,537-foot section of the Portage River from Ewers Road downstream to the Portage River confluence with the Grand River.

They identified a number of locations on the Grand River that exhibited general stream bank erosion and several locations on the Portage River that exhibited stream bank scour, scour at the toe of the banks, and/or bank failure due to erosion. Several sites on both river sections were noted where unconsolidated sediments were in excess of 6 feet in depth. The physical characteristics of the worst sites are summarized in Appendix B.

Table 5 - Bacteriological Sampling Geometric Means in Excess of 130 Colonies/100 ml

Sampling Site Name	Sample Location Code	Geometric Mean (Colonies/100 ml) May	Geometric Mean (Colonies/100 ml) June	Geometric Mean (Colonies/100 ml) July	Geometric Mean (Colonies/100 ml) Aug.
Sharp/Grand	A-1	---	140.0	397.4	244.1
	A-2	---	---	148.8	196.4
	A-3	---	---	---	---
Michigan Center	B-1	---	---	---	---
	B-2	---	---	204.9	207.6
	B-3	---	---	150.0	---
Portage Confluence	C-1	---	---	---	137.6
	C-2	---	---	---	141.9 (119.9)
	C-3	---	---	133.0	210.7 (96.4)
Sandstone Confluence	D-1	---	---	181.0	---
	D-2	---	---	161.7	206.6
	D-3	---	---	146.2	---
Springbrook	E-1	---	---	---	---
	E-2	---	---	---	---
	E-3	---	---	---	132.5 (96.1)
Rives Village	F-1	133.5	206.0	304.5	191.9
	F-2	---	---	240.9	164.8
	F-3	---	216.4	381.3	217.5
Batteese/Portage	G-1	---	---	221.8	152.6 (279.8)
	G-2	---	139.5	237.6	327.5
	G-3	---	---	222.9	138.2
Portage Drain	H-1	---	203.7	290.8	246.6
	H-2	---	278.0	201.1	244.8
	H-3	---	230.5	225.2	234.4
Somerset/Lake	I-1	---	130.6	401.0	---
	I-2	No Samples Taken	No Samples Taken	No Samples Taken	No Samples Taken
	I-3	---	---	---	---
McCreedy	J-1	---	342.2	812.3	173.0
	J-2	---	---	371.2	297.1
	J-3	---	---	283.9	194.4
Leslie Village	K-1	209.1	154.6	266.1	327.0
	K-2	272.3	179.4	173.5	---
	K-3	310.9	152.5	251.3	149.3
Dimondale Village	L-1	---	---	---	---
	L-2	---	---	---	---
	L-3	---	---	---	---

Calculations by TTMPS from data provided by the Jackson County Health Department (Appendix B).

FISH CONTAMINANT ADVISORIES

Advisories to limit the consumption of certain fish species and sizes (fish contaminant advisories [FCAs]) have been published by MDEQ and the Michigan Department of Community Health for portions of the Portage and the Grand Rivers due to PCB contamination. All inland lakes, reservoirs, and impoundments within the State of Michigan, including those within the Upper Grand River Watershed, are also under a fish advisory for mercury contamination. The latter is a general advisory applied to all inland lakes in Michigan since not all inland lakes, reservoirs, and impoundments have been tested or monitored. Table 6 lists the FCAs published for the Upper Grand River Watershed.

OTHER OBSERVED WATER QUALITY CONCERNS

The Upper Grand River Watershed Planning Initiative Steering Committee was asked to contribute to a list of water quality concerns. The following water quality concerns were identified by the Steering Committee:

- Soapsuds in Sandstone Creek at Minard Mill.
- Illegal dumping along the river.
- Loss of wetlands due to filling and development, both historically and currently
- Failing septic systems.
- Agricultural runoff and sedimentation.
- Potential impact on river due to change in Michigan Biosolids Program.
- Loss of open space.
- Rapidly developing landscape.
- Increasing urban runoff.
- Sedimentation and channel restrictions in the Portage and Grand Rivers.
- PCB contamination in the Grand River.
- Impaired fisheries.
- Receiving treated wastewater discharges from other watersheds.
- Diversion/export of groundwater or surface water from the Grand River Watershed to other river basins.

Table 6 - Fish Advisory Information

Water Body	Location	Fish Species	Restricted Population	Restriction
Grand River	Entire	Channel Catfish	Women and children	12-18 inches - One meal per week, 18-30+inched One meal per month
Grand River	Entire	Carp, Redhorse Sucker	Women and children	One meal per week
Grand River	Entire	Northern Pike	Women and children	22-30+ inches One meal per week
Grand River	Above Webber Dam	Walleye	Women and children	14-30+ inches One meal per week
All inland lakes, reservoirs, and impoundments	Entire watershed	Crappie	General population	8-22inches - One meal per week
			Women and children	8-22 inches - One meal per month
All inland lakes, reservoirs, and impoundments	Entire watershed	Largemouth and Smallmouth Bass	General population	14-30+ inches - One meal per week
			Women and children	14-30+ inches - One meal per month
All inland lakes, reservoirs, and impoundments	Entire watershed	Muskellunge	General population	30+ inches - One meal per week
			Women and Children	30+ inches - One meal per month
All inland lakes, reservoirs, and impoundments	Entire watershed	Northern Pike	General population	22-30+inches - One meal per month
			Women and children	22-30+ inches - One meal per month
All inland lakes, reservoirs, and impoundments	Entire watershed	Rock Bass	General population	8-18 inches - One meal per week
			Women and children	8-18 inches - One meal per month
All inland lakes, reservoirs, and impoundments	Entire watershed	Walleye	General population	14-30+ inches - One meal per week
			Women and children	14-30+ inches - One meal per month
All inland lakes, reservoirs, and impoundments	Entire watershed	Yellow Perch	General population	8-18 inches - One meal per week
			Women and children	8-18 inches - One meal per month

* Michigan Department of Community Health, 2001. Michigan 2001 Fish Advisory.

IMPAIRED USES

Table 7 lists the designated uses protected by State law and the attainment status for portions of the Upper Grand River and its tributaries. Designated uses are considered impaired if State water quality standards (WQS) are not met. These waters are listed in the State of Michigan's 305(b) Report and 303(d) List and require the development of a total maximum daily load (TMDL) allocation.

On April 21, 2003, the Michigan Department of Environmental Quality released draft Total Maximum Daily Load (TMDL) allocations for portions of the Upper Grand and Portage Rivers. Three TMDLs were prepared for the Upper Grand River, addressing issues of low dissolved oxygen (DO) concentrations, the restoration of healthy and diverse communities of warm water fish and other aquatic life (biota), and elevated concentrations of *Escherichia coli* (*E. coli*) bacteria (Alexander 2003, Sunday 2003, Wuycheck 2003). The DO and biota TMDLs cover an area tributary to 41.4 miles of the Upper Grand and Portage Rivers within Jackson County. This includes 33.7 miles of the Upper Grand River, including approximately 16 miles within the City of Jackson. The *E. Coli* TMDL covers 25 miles of the river in Jackson and Ingham Counties, from the City of Jackson downstream to Tompkins Road, and the Portage River from the confluence with the Grand River upstream to Wooster Road. Waters within the Upper Grand River Watershed requiring the development of TMDLs are listed in Table 7.

Table 7 - Michigan Section 303d TMDL Water Bodies

Water Body	Observations and Conditions	Pollutants	Suspected Pollution Source	Expected TMDL Date
Albrow Creek, Jackson Co.		Pathogens	Untreated Sewage Discharge	2007
Grand River, Red Cedar River Ottawa/Jackson Co.	Fish consumption advisory for entire river to Lake Michigan	FCA, PCBs	Industrial	2009
Grand River, City of Jackson to Thompkins Rd., and Portage River from the Grand River confluence to Wooster Rd.	Fish and macroinvertebrate communities rated poor	Pathogens, Low D.O. WQS violation	Urban runoff, agricultural runoff, sediment loads, nutrient enrichment	2003
Grand River and Red Cedar, Ingham Co.	CSO, pathogens , WQS exceedances for D.O., fish kills	Pathogens, Low D.O. WQS violation	Untreated Sewage Discharge	2011
Portage Lake, Jackson Co.	Mercury Lake	Mercury	Atmospheric	2011
Vandercook Lake, Jackson Co.	Mercury Lake	Mercury	Atmospheric	2011

The draft TMDLs were presented in a public meeting held in the Jackson County Commissioner's Chambers on May 7, 2003. Pollution reduction requirements established in the three TMDLs are summarized briefly here. Copies of the complete Upper Grand and Portage River TMDLs are included as Appendix H to this Watershed Management Plan, "Total Maximum Daily Load Allocations for the Upper Grand River Watershed."

Total Maximum Daily Load and BMPs for E. Coli *Bacteria*

The TMDL for *E. coli* bacteria does not establish specific load or concentration reductions for bacteria, but instead reinforces existing water quality standards governing bacterial contamination. The *E. coli* TMDL identifies several potential sources for elevated bacteria concentrations, including both urban and rural sources. Sampling conducted by the MDEQ in 2002, demonstrated that previous efforts in the City of Jackson to eliminate sanitary sewer overflows (SSOs), while improving water quality in the Upper Grand River, have not completely eliminated bacteria concentrations in excess of State Water Quality Standards (WQS). MDEQ sampling indicates that agricultural sources, such as manure runoff, also contribute to the water quality problems. Monitoring data collected in 2002 exhibited WQS exceedances at all but one of the twelve stations sampled. The results of sampling conducted by both the MDEQ and the results of sampling conducted by the Jackson and Ingham County Health Departments, presented

previously in this Watershed Plan, will provide useful information for development of a targeted program(s).

TMDL for Dissolved Oxygen and Aquatic Life (Biota)

Both the TMDLs for DO and biota establish numeric pollution reduction targets to improve dissolved oxygen concentrations and aquatic habitat in the Upper Grand and Portage Rivers. The TMDL for biota sets numeric targets for improvement in Procedure 51 (MDEQ 1999) bioassessment scores for fish, macroinvertebrates, and aquatic habitat. Specifically, fish and macroinvertebrate scores must improve to an "acceptable" rating, and habitat scores must increase to a score of 65. This represents a 40 to 55% improvement over previous habitat quality assessments. A mean annual concentration of 80 mg/l TSS during wet weather events (rain and snowmelt runoff) was established as a “secondary” target to assess progress toward TMDL goals. In reviews of the scientific literature, concentrations of approximately 80 mg/l TSS appear to be a threshold, beyond which fishery values are impacted (Wuycheck 2003).

Both the DO and biota TMDLs focus upon reducing sediment loads, measured as Total Suspended Solids (TSS), to the river. Sediment Oxygen Demand (SOD) is believed to be a principal factor in the consumption of available oxygen within the Upper Grand River system and the lack of oxygen, high turbidity, and sedimentation are all factors contributing to poor aquatic habitat. Successful reductions in both TSS and bacteria will address other pollutants and water quality issues as well. Suspended solids, principally suspended sediments from erosion, carry nutrients, metals, and other contaminants adsorbed to soil particles. Reduction of soil erosion and sedimentation, therefore, reduces nutrient enrichment as well as TSS loads. Reducing nutrient enrichment further reduces the growth of nuisance algae and plant growth, thereby reducing oxygen demand.

Overland annual loads of TSS were estimated from Michigan Resource Inventory System (MIRIS, 1978) land use/land cover data, published land use related pollutant export coefficients, and use of the Simple Method (USEPA 2001). The current annual load of TSS, to the biota and DO TMDL portions of the Grand and Portage Rivers, is estimated to equal 16.47 million pounds (per year) from overland sources. This includes 9.4 million pounds from the Grand River watershed and 7.07 pounds from the Portage River Watershed. An additional 1.76 million pounds of TSS is discharged from permitted point source discharges annually.

The DO and biota TMDLs call for a fifty percent (50%) reduction in overland loads, from 16.47 million pounds TSS per year to 8.25 million pounds per year, to attain compliance with Michigan water quality standards.

THREATENED USES

Designated uses are considered threatened when water quality is declining or conditions in the watershed indicate that water quality standards may not be met in the near future. Table 9 identifies segments of the Upper Grand River system that are deemed threatened based on MDEQ and MDNR biological surveys.

Table 8 - Designated Uses Attainment Status

Designated Use	Status (met/not met)
Agriculture	met
Industrial water supply	met
Public water supply at the point of intake	doesn't apply (1)
Navigation	not met
Warm water fishery	not met
Other indigenous aquatic life and wildlife	not met
Partial body contact recreation	not met
Total body contact recreation between May 1 and October 31	not met

(1) Doesn't apply but would meet water quality standards

Table 9 - Threatened Water Body Use Information

Water Body	Watershed Concern	Threatened or Impaired Use	Known or Suspected Pollutants	Suspected Sources
Batteese Creek, Thornapple Creek, Cahoagan Creek, Sections of the Grand River	Low species diversity, predominance of tolerant species	Warm Water Fishery	Arsenic Sediment Nutrients	Batteese Creek- Arsenic Hotspots Stream bank erosion Loss of wetlands and riparian vegetation Agricultural runoff Agricultural soil loss Soil erosion from construction sites Failing septic systems
Batteese Creek, Sections of the Grand River	Poor macroinvertebrate habitat communities	Warm Water Fishery	Arsenic Sediment Nutrients	Batteese Creek- Arsenic Hotspots Stream bank erosion Loss of wetlands and riparian vegetation Agricultural runoff Agricultural soil loss Soil erosion from construction sites Failing septic system
Batteese Creek, Thornapple Creek, Cahoagan Creek, Sections of the Grand River and Portage River	Stream Habitat - Moderate to Severe Impairments	Warm Water Fishery	Sediment Nutrients	Stream bank erosion Loss of wetlands and riparian vegetation Agricultural runoff Agricultural soil loss Soil erosion from construction sites
Portage River, Grand River	Logjams, Sedimentation	Navigation	Sediment	Stream bank erosion Loss of wetlands and riparian vegetation Agricultural soil loss Soil erosion from construction sites

LAND COVER AND FLOW IMPACT ANALYSIS

Land cover information was analyzed by Space Imaging Solutions (SIS), and separately by the Jackson County Conservation District (JCCD), to identify critical areas of the watershed that may contribute to current or future water quality concerns, pollution problems, and/or areas in need of conservation. Stream flow information was analyzed by TTMPS to determine if the hydrology of the Upper Grand River has changed over the period of available stream flow records and, if so, to determine whether changes in river discharge may, in turn, be driving changes in the composition in Upper Grand River fish communities.

APPROACH

SIS conducted land cover analyses using available geographic information system (GIS) data to identify areas of concern throughout the watershed and to create a GeoBook. A GeoBook is a highly accessible geographic information system designed to give the non-expert GIS user fast and easy access to complex GIS information. The GeoBook is used for both watershed analysis and digital presentation of the watershed data and recommendations. Intrinsic in the GeoBook approach is the embedding of spatial data and related query and analysis tools within the "pages" of the "book." The dual use of the GeoBook as an informational report and easy-to-use data access tool, and the ability to integrate descriptive and photographic information with spatial data, makes it much more useful than the conventional watershed management plan. The versatility of the GeoBook also allows other documents, such as manuals or guidelines, to be included in the book framework.

SIS analyzed existing GIS data for each of 37 minor subbasins in the Upper Grand River Watershed as shown in Figure 5 and Table 10. These analytical results were later aggregated for the seven major subbasins referred to previously, for purposes of developing specific action plans. The following issues of concern were identified by the Upper Grand River Watershed Planning Initiative Steering Committee and analyzed by SIS.

- Percent of riparian area that is grassland, wetland, or forest.
- Extent of the river valley bottom and land use within that valley bottom, including areas where agricultural flooding would be expected.
- Loss and fragmentation of wetlands compared to circa 1800.
- Characteristics of undeveloped land favorable for preservation or purchase including:
  - Areas of contiguous natural open space,
  - Areas with high potential for a rails to trails,
  - Areas along the Portage River linking Pinckney - Waterloo - Jackson.
- Estimates of potential peak flow.
- Potential for stream bank erosion, soil erosion resulting from high peak flows.
- Potential of soil erosion from agricultural fields.
- Biological integrity:
  - Records of historic fish communities within each subbasin,
  - Macroinvertebrate community health,
  - Threatened and endangered species.
- Potential impact of septic failure.
- Potential impact of manure application runoff.
- Potential nonpoint source nitrogen and phosphorus loads.

Summaries of some of these analyses, those that focus on potential sources of key pollutants in the Upper Grand River system (i.e., nutrient runoff, soil erosion, and bacteria), are presented in the following sections of this Watershed Management Plan. SIS's complete report is provided as Appendix C.

Figure 5 - Upper Grand River Watershed Subbasins for GeoBook Analyses

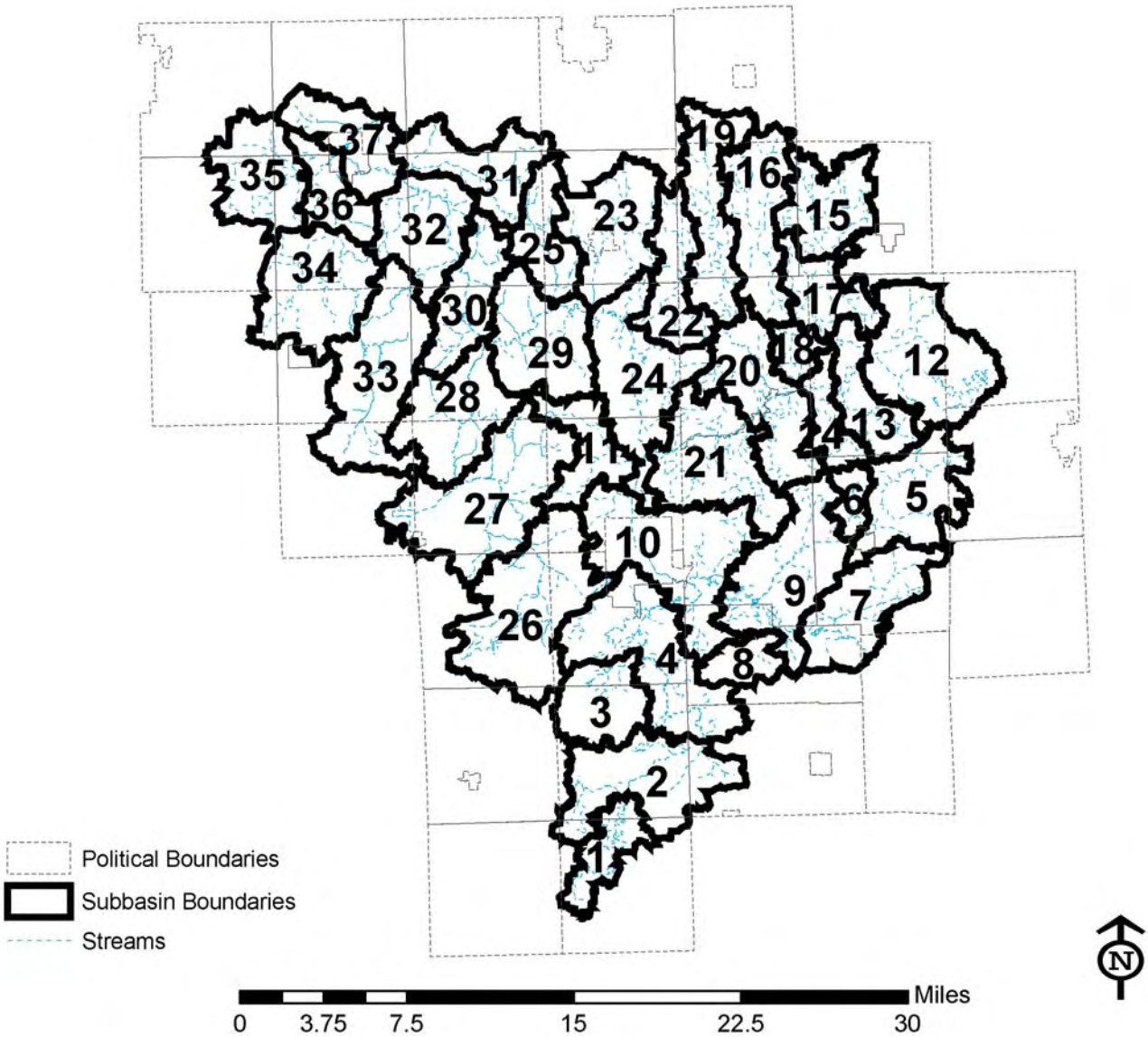


Table 10 - Upper Grand River Watershed Subbasin Names for GeoBook Analyses

1	Lake LeAnn	**20**	Portage River - Middle Branch 3 (St ID 1286)
2	Southern Liberty Township Drains	**21**	Portage River - Lower Branch (St ID 1319)
3	Sharp Creek	**22**	Western Creek
4	Pierce Drain	**23**	Huntoon Creek
5	Grass Lake Drain	**24**	Grand River Drain - Downstream
6	Grass Lake Outlet	**25**	Perry Creek
7	Wolf Lake and Drain	**26**	Sandstone Blackman Drain
8	Cranberry Lake Drain	**27**	Sandstone Creek - Middle Branch
9	Huttenlocker and Crittenden Drains	**28**	Sandstone Creek - Lower Branch
10	Grand River Drain - Upstream	**29**	Darling-Christie Drain
11	Tobin Snyder Drain	**30**	Bromly Tile Drain
12	Portage River - Source	**31**	Willow Creek
13	Portage River - Middle Branch 1	**32**	Baldwin and Puffenberger Drains
14	Portage River - Middle Branch 2	**33**	Spring Brook - Source
15	Pickett and Jacobs Drains (St ID 1227)	**34**	Spring Brook - Middle Branch
16	Cahaogen Creek (St ID 1221)	**35**	Mills and Post Drain
17	Wild Drain (St ID 1262)	**36**	Spring Brook - Lower Branch
18	Orchard Creek (St ID 1294)	**37**	Unnamed Tributary
19	Batteese Creek		

IMPERVIOUS LAND COVER

The physical, chemical, and biological integrity of a given stream system has been shown to be strongly correlated to the amount of impervious cover (the area covered by rooftops, streets, parking facilities, and other hard surfaces) in the subbasin or watershed (Schueler, 1994). Imperviousness appears to be one of the principal indicators of watershed "health," and analysis of stream systems across the country seems to indicate that there are thresholds at which watershed imperviousness results in degradation of water quality and physical stream processes.

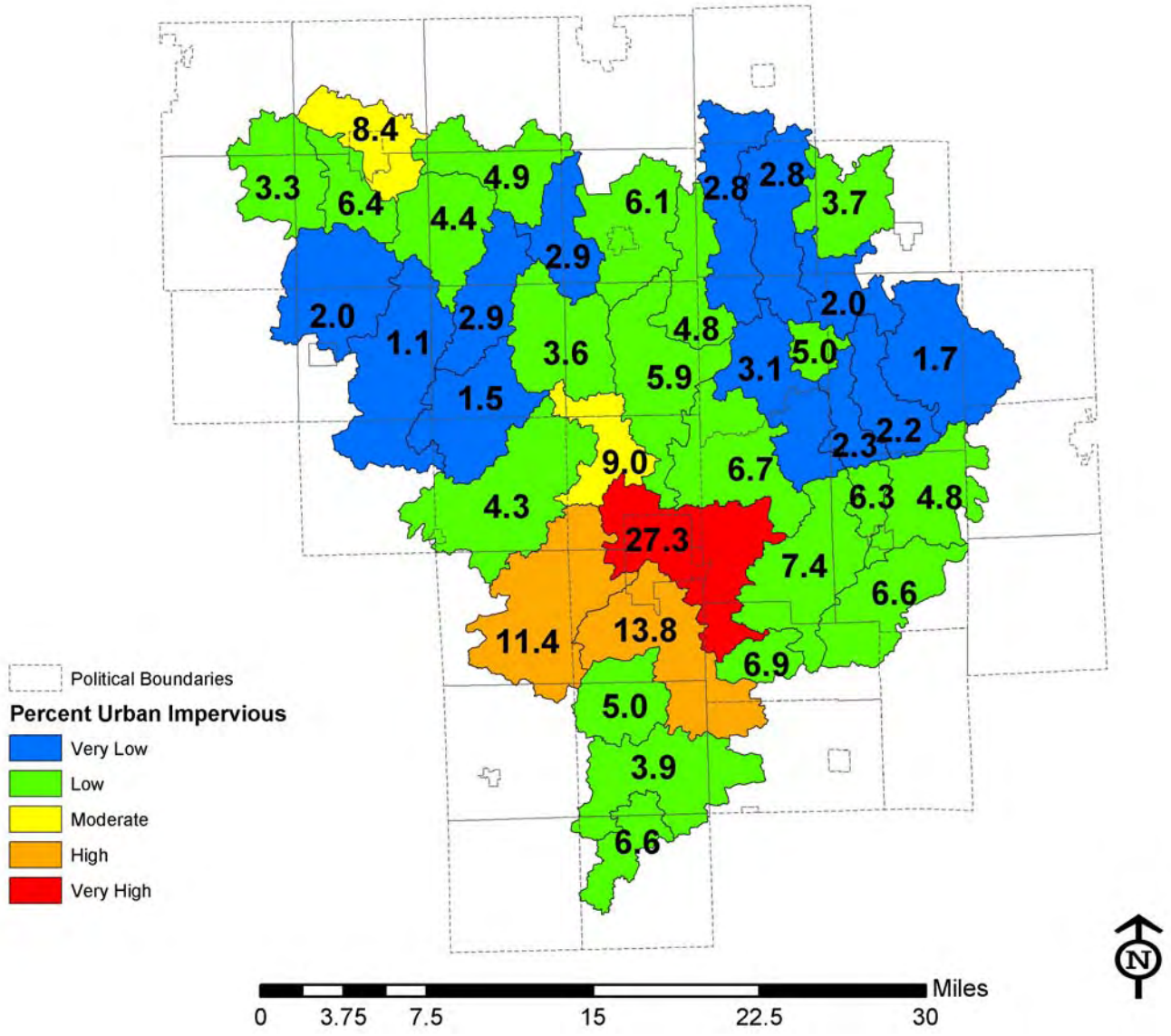
Watersheds with less than 10 percent imperviousness appear to exhibit natural chemical, physical, and biological quality. Between 10 and 25 percent imperviousness river systems show signs of degradation. Beyond 25 percent imperviousness, the damage to physical, chemical, and biological integrity may be irreversible (Schueler, 1994).

SIS estimated existing imperviousness based on existing digital land use and land cover data for the watershed. They categorized impervious cover according to the following classes. Average imperviousness values per subbasin are shown in Figure 6.

Class	**Relative to Mean (Std. Deviation)**	**Average Urban Percent Imperviousness**
Very Low	< -0.5	Below 3.2
Low	-0.5 - 0.5	3.2 - 7.8
Moderate	0.5 - 1.0	7.8 - 10.1
High	1.0 - 2.0	10.1 - 14.6
Very High	> 2.0	above 14.6

As may be expected, portions of the Jackson urban area exhibit the highest values of watershed imperviousness, and sections of the river immediately downstream of the City of Jackson exhibit some of the worst water quality and signs of hydrological modification due to urbanization. The area around the City of Eaton Rapids is also shown as approaching thresholds for stream degradation.

Figure 6 - Impervious Land Cover by Subbasin



STREAM FLOW

Stream flow dynamics, the volume of runoff, the peak runoff rate, the timing of runoff, and the resulting changes in sediment transport are perhaps the greatest factors driven by imperviousness, and further driving changes in water quality. In undisturbed river systems, storm water is intercepted by vegetation, stored temporarily on the land in wetlands or infiltrates into the ground to replenish groundwater supplies, and is then slowly released to the river system. As development occurs, naturally permeable land is converted to impervious roads, rooftops, and driveways.

As rain falls on developed land, it is directed to piped storm water conveyance systems which outlet directly to nearby streams and drains. Where once rain would slowly make its way primarily through the groundwater system to a river, under a developed scenario, it quickly "runs off" to nearby streams. As a result, there is an increase in quantity of rain flow and a decrease in time of flow to the stream. This is referred to as "flashiness." A flashy stream will provide unstable habitat due to low base flows and high peak flows for fish and other aquatic organisms. In addition, this increased runoff is often loaded with sediment, which is delivered to the streams, which can obstruct habitat and scour stream banks. Table 11 illustrates how increasing imperviousness can impact flow rates in a stream. Stream discharge (flow) is presented as cubic feet per second (cfs).

Table 11 - Flow Rate Comparison of Undeveloped and Developed Conditions

UNDEVELOPED CONDITIONS: WOODS IN GOOD HYDROLOGIC CONDITION				
Storm Frequency (years)	**24-Hour Rainfall (inches)**	**Estimated Runoff (inches)**	**Estimated Peak Discharge (cfs)**	**Runoff as % of Rainfall**
2	2.8	0.14	1	5%
10	4.0	0.53	5.6	13%
100	5.8	1.4	19.7	24%
DEVELOPED CONDITIONS: HALF-ACRE RESIDENTIAL LAND USE (25% IMPERVIOUS)				
Storm Frequency (years)	**24-Hour Rainfall (inches)**	**Estimated Runoff (inches)**	**Estimated Peak Discharge (cfs)**	**Runoff as % of Rainfall**
2	2.8	0.6	11.6	21%
10	4.0	1.33	27.4	33%
100	5.8	2.64	58.6	46%

Horner, R.R. 1994. Fundamentals of Urban Runoff Management: Technical and Institutional Issues Terrene Institute, Washington D.C., page 25.

The United States Geologic Survey (USGS) maintains stream gauges at:

- USGS Station 0410900 - Grand River at Jackson on the grounds of the City of Jackson Wastewater Treatment Plant (WWTP).
- USGS Station 04111000 - Grand River near Eaton Rapids (approximately 2 miles northeast of Eaton Rapids).

An analysis, by decade, of annual mean stream flow of recorded information indicates that the stream flow for the station at Jackson has increased. Table 12 presents the mean stream flow for the gauges at Jackson and Eaton Rapids per decade. As would be expected, average stream flows appear to be increasing over time with increases in population and impervious surface within the watershed.

Table 12 - Decade Stream Flow Comparison for USGS Stations 0410900 and 04111000 for the Period of Record

Decade	Decade Average Stream Flow at Jackson (cfs)	Decade Average Stream Flow at Eaton Rapids (cfs)
1930 – 1939	104.25	N/A
1940 – 1949	122.53	N/A
1950 – 1959	121.70	412.80
1960 – 1969	103.70	385.60
1970 – 1979	135.60	513.40
1980 – 1989	140.85	540.50
1990 – 1999	156.30	522.75

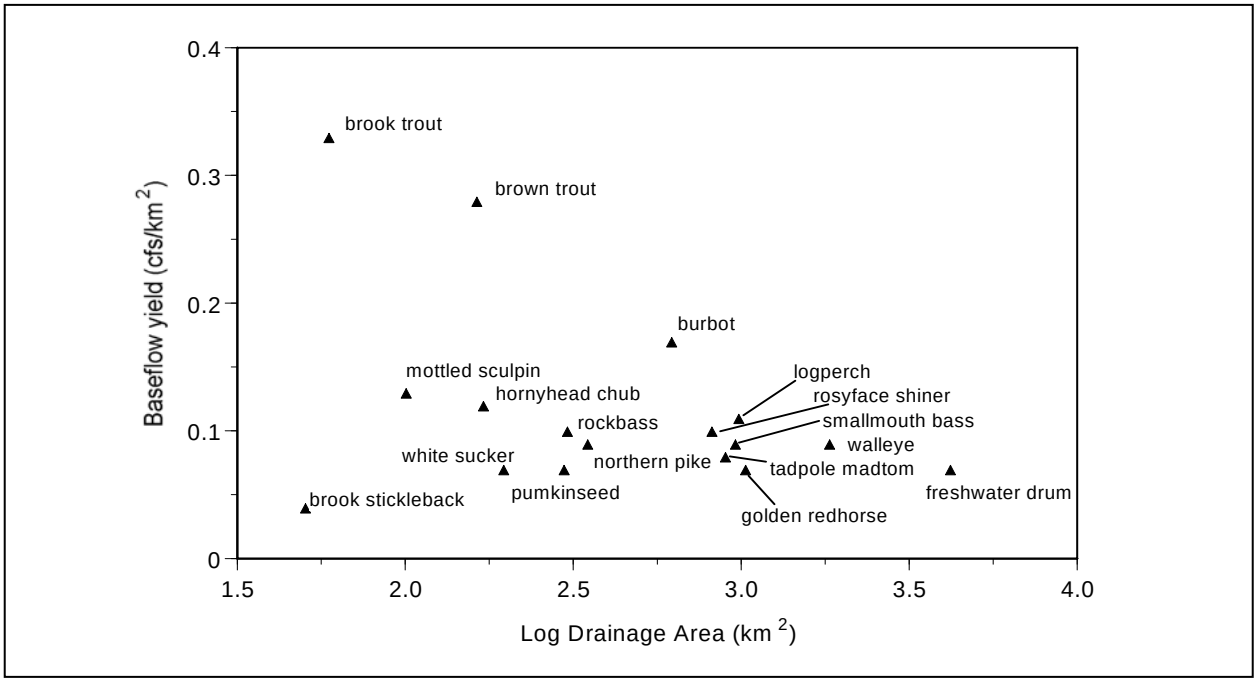
FLOW IMPACT ON BIOTA

Watershed urbanization can alter the hydrology of rivers and streams, generally resulting in lower summer base flows and higher, and more frequent flood flows. To evaluate whether drought and/or flood flows may be negatively impacting the biota in the Upper Grand River, flow duration curves for gauged sites near Jackson and Eaton Rapids were compared against target flow duration curves for different fish associations with distinct hydrologic preferences. This methodology and the target flow duration curves were developed by researchers at the University of Michigan, School of Natural Resources and Environment (UMSNRE), and the MDNR, and previously applied to assessment of the fishery potential of the Rouge River in southeastern Michigan (Wiley et al, 1998).

UMSNRE and MDNR researchers have developed a predictive model that can be used to identify potential species associations at a particular site based on watershed size and low flow yield (LFY). LFY, the 90 percent exceedance flow divided by watershed area (measured in square kilometers), is a measure of the contribution of groundwater to a river. As such, it is not only indicative of how stable or flashy a stream's hydrology is, but also describes a great deal of the variation in water temperatures among streams in glaciated settings such as Michigan – the higher the groundwater contribution to a stream (LFY), generally the colder the stream temperature and the more stable the temperature regime (Zorn et al, 1998, 2002). Figure 7 is a plot of species associations patterns developed from Michigan Rivers Inventory (MRI) data that

meaningfully reflect stream size and temperature preferences (reflected in LFY) of the constituent species of these associations. The species names appearing on the graph represent species associations, groups of species commonly found together.

Figure 7 - Species Association Dominance Relative to Mean Low Flow Yield and Catchment Area



(MDNR 2000)

Daily stream flow measurements, recorded by the U.S. Geological Survey at the Jackson and Eaton Rapids gauge sites were analyzed to develop spring and summer flow duration curves (lines marked with diamonds, Figures 8 through 11). Flow duration curves show stream discharge values plotted against the frequency of their occurrence in the hydrologic record (percent exceedance frequency refers to the percentage of time the river was greater than a given flow). In this case, to compare with State average target values, flow has been converted to watershed yield by dividing discharge values by the drainage area of the watershed.

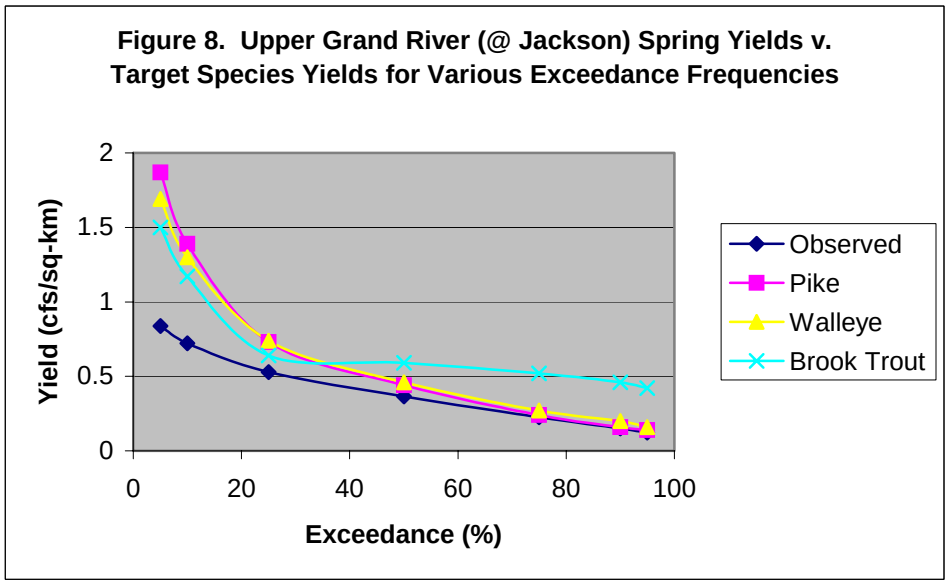


Figure 8. Upper Grand River (@ Jackson) Spring Yields v. Target Species Yields for Various Exceedance Frequencies
Yield (cfs/sq-km)
2
1.5
1
0.5
0
0
20
40
60
80
100
Exceedance (%)
Observed
Pike
Walleye
Brook Trout

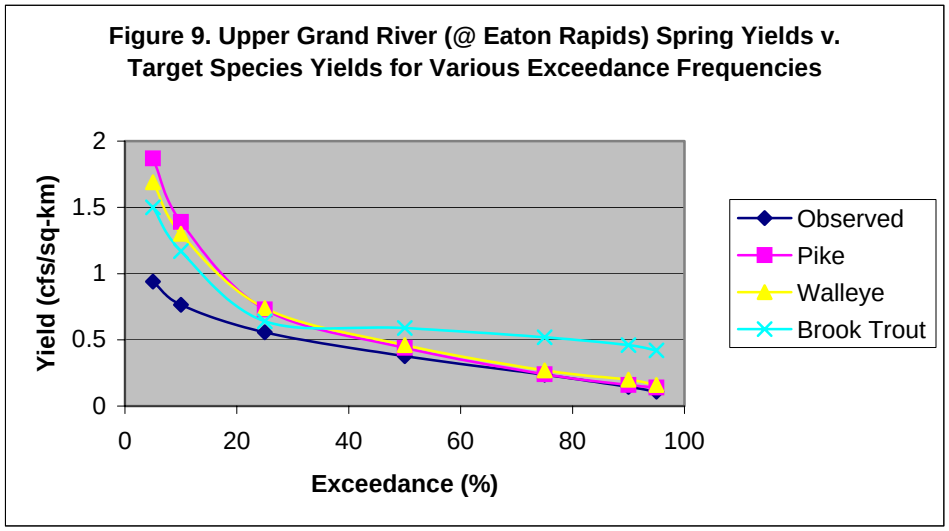


Figure 9. Upper Grand River (@ Eaton Rapids) Spring Yields v. Target Species Yields for Various Exceedance Frequencies
Yield (cfs/sq-km)
2
1.5
1
0.5
0
0
20
40
60
80
100
Exceedance (%)
Observed
Pike
Walleye
Brook Trout

Figure 10. Upper Grand River (@ Jackson) Summer Yields v. Target Species Yields for Various Exceedance Frequencies

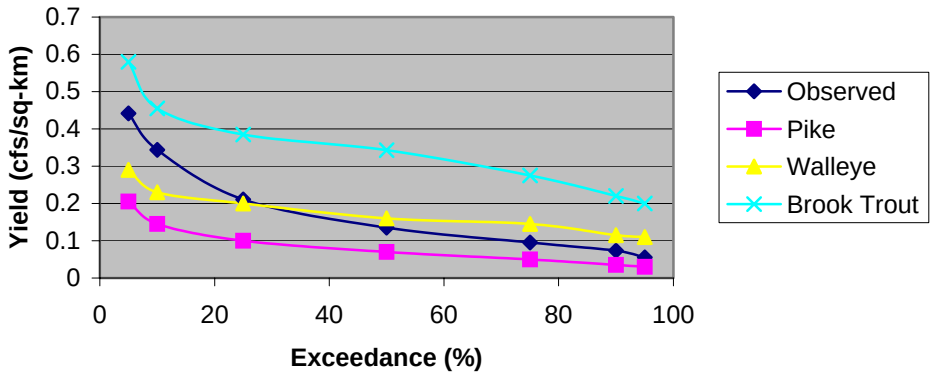
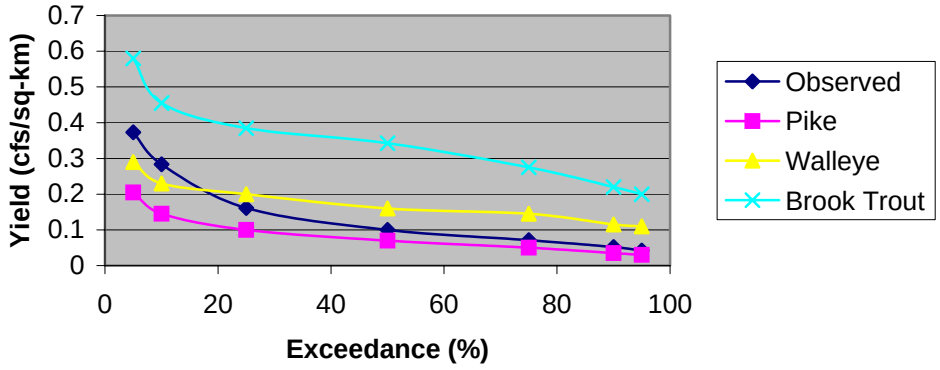


Figure 11. Upper Grand River (@ Eaton Rapids) Summer Yields v. Species Target Yields for Various Exceedance Frequencies



Flow duration curves for the Upper Grand River were compared against target hydrologic regimes for northern pike *Esox lucius*, walleye *Stizostedion vitreum*, and brook trout *Salvelinus fontinalis*, which were developed from MRI records by UMSNRE and MDNR researchers. USGS daily stream flow records for the period 1950 through 2000 were used in this analysis. These ecologically based target flow duration curves were developed by summarizing pooled discharge exceedence frequency values from subsets of MRI sites where selected target fishes were recorded as abundant.

Each fish species, or species association, has a distinct State average flow duration curve that varies by season. Although hydrologic conditions vary between rivers supporting healthy populations of these species associations, the statistical mean is interpreted as the target condition. The overall shape of the target flow duration curve can also be compared as an indication of the desired hydrologic habitat.

Mean summer flow duration curves were developed for three different species of fish with distinct hydrologic habitats. These curves are based on MRI reference sites where the selected taxa flourish. Note, for example, that northern pike and associated species have the lowest summer flow requirements of the three associations shown, whereas brook trout are found in streams that receive higher summer base flows from groundwater inputs.

The Jackson and Eaton Rapids gauge sites have 90 percent flow yield values of 0.091 and 0.069, and drainage areas of 450.66 and 1,711.98 square kilometers, respectively. Referring to Figure 10, these values place the Jackson site between points indicative of the rock bass *Amploplites rupestris*, northern pike, and rosyface shiner *Notropis rubellus* associations. The Eaton Rapids gauge site exhibits stream flows between plotted values representing walleye and golden redhorse *Moxostoma erythrurum* (Zorn et al, 1998, 2002). The biological survey of the Upper Grand River conducted by the MDNR in 1991, contained sites in close proximity to the gauged sites at Jackson and Eaton Rapids. Records of the fish collected at these sites reflect the species associations that might be expected from this plotting of low flow yield and drainage area. The Jackson sites sampled (sites No. 4 and No. 5, MDNR Report) yielded species within the rock bass and walleye fish associations (Zorn et al, 1998, 2002), as well as species from the creek

chub *Semotilus atromaculatus*, black bullhead *Ameiurus melas*, logperch *Percina caprodes*, brook stickleback, and smallmouth bass *Micropterus dolomieu* associations. The Eaton Rapids site contained species from the smallmouth bass association as would be expected from the plot of low flow yield versus drainage area, and also contained species from the brook stickleback, black bullhead, and rock bass associations. Monitoring station No. 5, downstream of the City of Jackson, however, exhibited only two fish species. Both of these indicative of smaller, low gradient or sluggish streams.

Comparisons of the observed flow durations curves for the Jackson and Eaton Rapids sites with the target species flow duration curves (Figure 8 and Figure 9) does not indicate that urbanization has created harmful hydrologic conditions for the species expected to occur within the Upper Grand River. The flow duration curve for the Upper Grand sites would be expected to fall between the statewide mean curves for northern pike and walleye. For the majority of summer flows, this is the case. Both the Jackson and the Eaton Rapids sites exhibit summer drought flows (the lowest summer flow) between the mean, those suitable for walleye and northern pike (Figure 10 and Figure 11). Neither site appears to be adversely impacted by excessive flood flows (high spring flows Figure 8 and Figure 9). Extreme event flood flows for the Upper Grand River sites actually are lower than the State means exhibited by rivers supporting any of the three species presented. Spring flood flows would not be expected, therefore, to be harmful to eggs or young of the year fish. Low spring flows may indicate an inability to adequately transport sediment through the river system or limited ability to flood riparian areas required for spawning of wetland/floodplain dependent species such as northern pike, but the data analyzed is insufficient to determine if this is indeed the case.

From this preliminary review, it does not appear that urbanization and sub-urbanization of portions of the Upper Grand River have resulted in sufficient hydrologic modification to negatively impact the fish community. Poor fish assemblage scores at sites in the Upper Grand would seem related more to poor aquatic habitat and/or water quality impacts.

RIPARIAN BUFFERS

Studies of impervious cover impacts to surface waters indicate that one of the key variables influencing watershed response is the presence or absence of an intact (wooded) riparian corridor or buffer. SIS examined the amount of intact, natural riparian buffer within each subbasin. The term "natural" is used for this grouping of "natural" land cover to differentiate it from intensively managed uses such as urban and agriculture. Two buffer widths, 100 feet and 500 feet, were examined for each subwatershed. Natural land cover was defined using the most current land cover dataset available.

Stream buffers were measured from the digitized stream lines in the Michigan Base Map files. Streams represented as a single line were buffered from the centerline of the stream. Streams represented as polygons were buffered from the edge of the polygon or the stream bank.

In order to calculate the percent of riparian area in natural land cover for each subbasin, riparian buffers strips of each width were overlain upon the land cover dataset. These data were then summarized by subbasin. The percent of natural land was used to rank the 37 subbasins from least disturbed to most disturbed.

Each subbasin was categorized with respect to the amount of natural land within the riparian buffer. Categories were determined by assessing the means and standard deviations of the resulting data from the 100-foot and 500-foot buffers and the river valley natural area analysis. The categories are:

- very low (0 to 45 percent),
- low (45 to 55 percent),
- moderate (55 to 65 percent),
- high (65 to 80 percent), and
- very high (80 to 100 percent).

The percentage land cover that is natural within a 100-foot riparian buffer in an individual subbasin ranges from 37 to 92 percent, with a mean of 69 percent (Table 13). The percentage of land cover that is natural within a 500-foot riparian buffer is less, with ranges from 32 to 82 percent and a mean of 58 percent (Table 14).

Rankings of individual subbasins were similar with both riparian buffer widths (Figure 12 and Figure 13). Many subbasins in Jackson County had a higher percent of natural area in the 100-foot riparian buffer than the 500-foot riparian buffer, indicating that although some natural riparian areas were left intact, the human disturbance increased with lateral distance from the stream.

Table 13 - Highest and Lowest Percent of Land Cover that is Natural within 100-foot Riparian Buffer

Rank	Subbasin Number and Name		100-foot Buffer Percent Natural Area
1	13	Portage River - Middle Branch 1	92
2	28	Sandstone Creek - Lower Branch	90
3	12	Portage River - Source	89
4	33	Spring Brook - Source	89
5*	2	Southern Liberty Township Drains	85
33	16	Cahaogen Creek	46
34	1	Lake LeAnn	46
35	23	Huntoon Creek	45
36	17	Wild Drain	39
37	15	Pickett and Jacobs Drain	37

* Table lists the top 5 and bottom 5 ranking subbasins. Subbasin locations are presented in Figure 5 and Table 10.

Table 14 - Highest and Lowest Percent of Land Cover that is Natural within 500-foot Riparian Buffer

Rank		Subbasin Number and Name	500-foot Buffer Percent Natural Area
1	12	Portage River - Source	82
2	13	Portage River - Middle Branch 1	82
3	33	Spring Brook - Source	77
4	28	Sandstone Creek - Lower Branch	75
5	14	Portage River - Middle Branch 2	74
33	18	Orchard Creek	41
34	16	Cahaogen Creek	39
35	23	Huntoon Creek	35
36	17	Wild Drain	33
37	15	Pickett and Jacobs Drain	32

* Table lists the top 5 and bottom 5 ranking subbasins. Subbasin locations are presented in Figure 5 and Table 10.

Figure 12 - Percent of 100-foot Riparian Buffer that is Natural Land

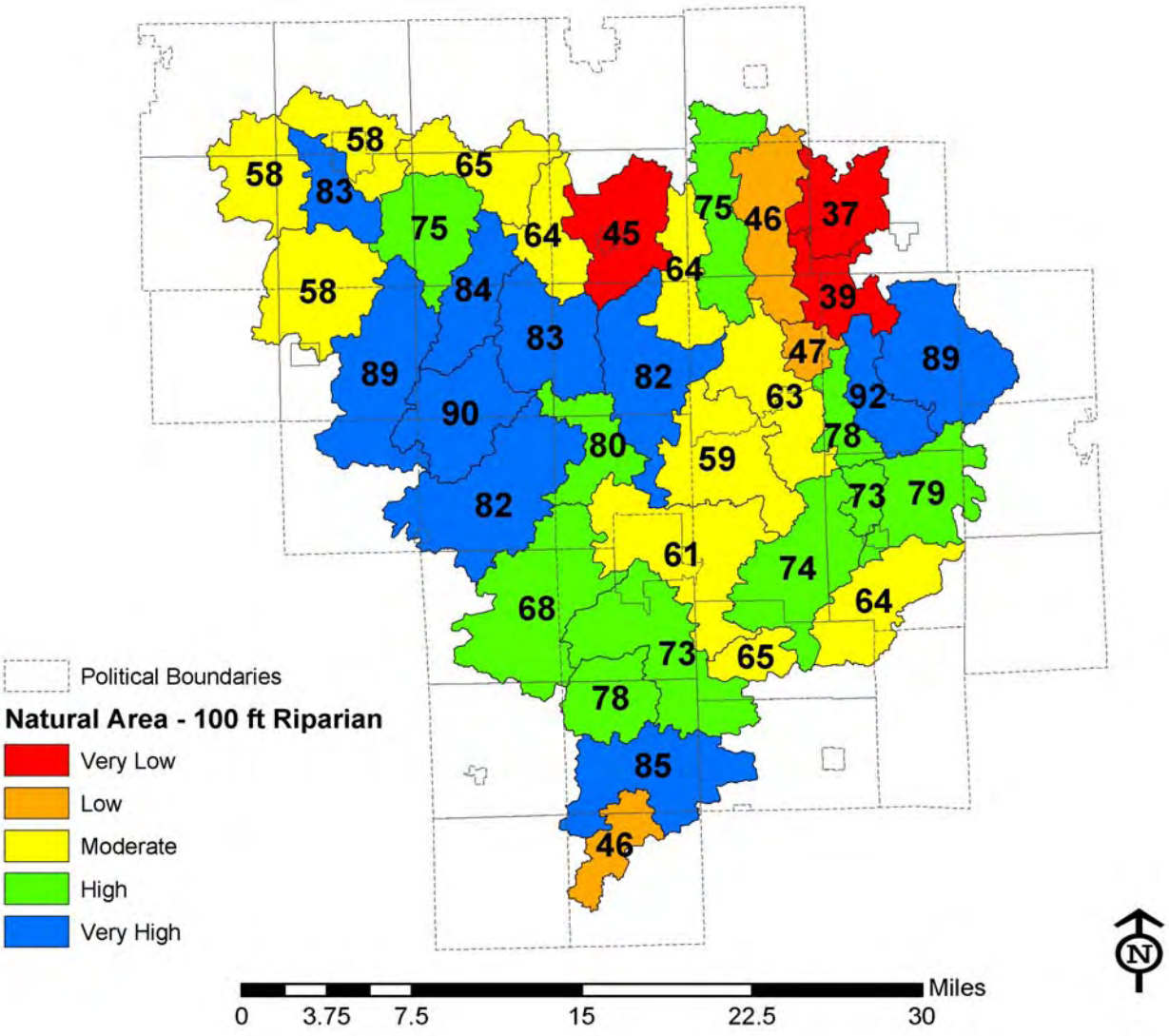
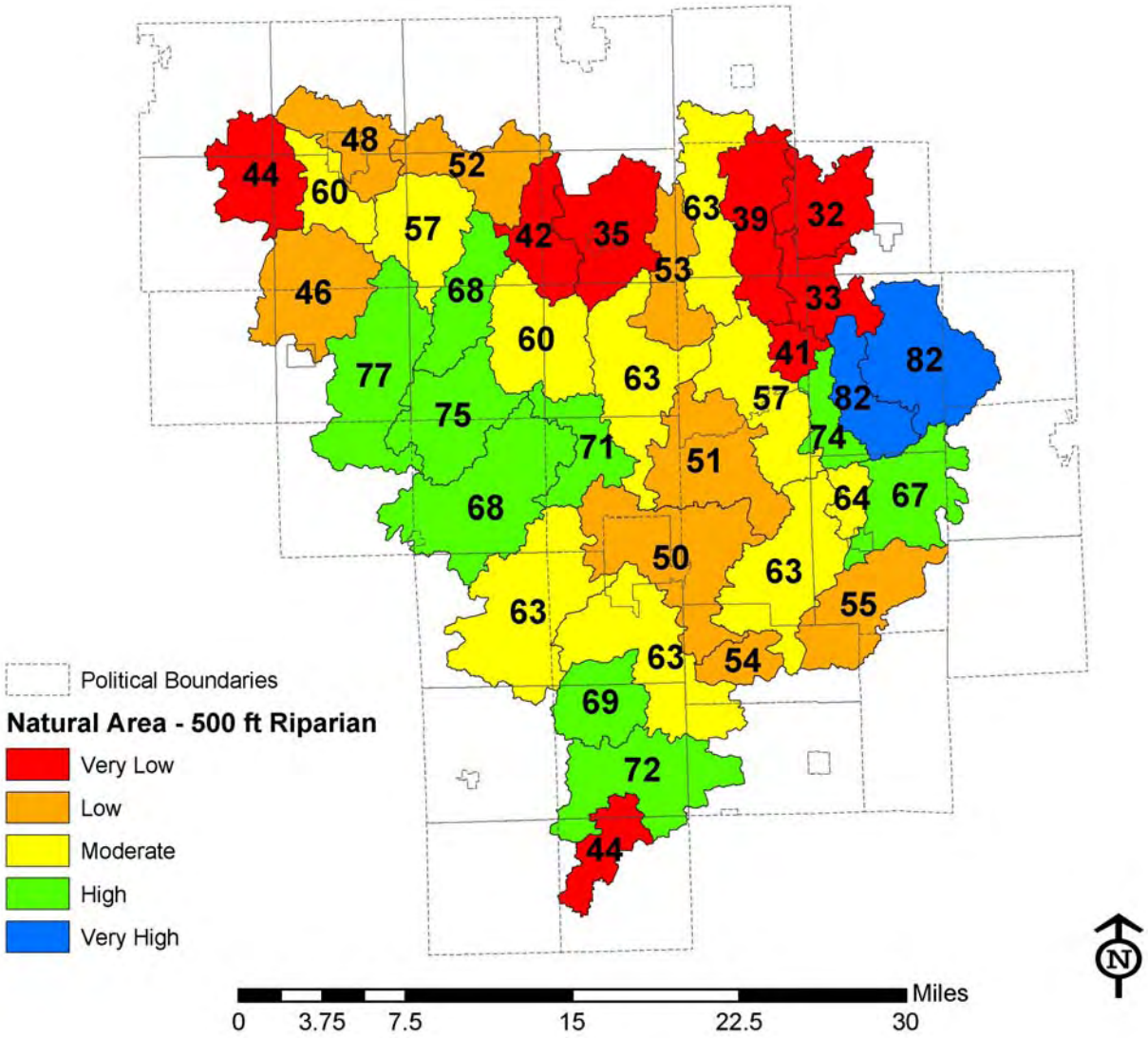


Figure 13 - Percent of 500-foot Riparian Buffer that is Natural Land



WETLANDS

The historic and future potential loss of wetlands in the Upper Grand River Watershed was identified by the Steering Committee as one of their key concerns. Wetlands can play critical roles in flood storage, nutrient transformation, and water quality protection and, as part of a healthy riparian corridor, may dampen the effects of impervious cover within the watershed. Important wetland functions and values include:

- Flood prevention and temporary flood storage, allowing the water to be slowly released, evaporate, or percolate into the ground and recharging groundwater.
- Sediment capture and storage.
- Wildlife habitat for a wide diversity of plants, amphibians, reptiles, fish, birds, mammals, and related recreational values.
- Water quality improvement by filtering pollutants out of water.
- The support of approximately 50 percent of Michigan's endangered or threatened species.

As such, wetlands with certain hydrologic and/or size requirements are regulated by the State of Michigan. The Jackson County Conservation District (JCCD) reviewed soil survey maps of hydric soils and aerial photos for two subbasins, the Portage River Lower Branch and Portage River Middle Branch 3, for the purpose of identifying candidate wetlands for restoration. A soil is considered hydric when it is saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in the upper part. The presence of hydric soils is one requirement for the determination of regulated wetlands. Hydric soils were used in this analysis as a surrogate indication of the presence of wetlands. Details of this analysis are included as Appendix D.

Wetlands in the Portage River Watershed have experienced dramatic changes during the past 180 years. Historically, the Portage River carried much of the water in northeastern Jackson County and southeastern Ingham County to the Grand River north of Jackson after filtering through extensive, complex of wetlands. Dramatic changes to these wetland complexes occurred when the Portage River was straightened and deepened in 1921-22, draining large areas of former wetland. With most of the wetlands drained, farmers were able to grow onions, lettuce, peppermint, sod, and a variety of other specialty crops on the rich muck soils.

In recent times, a combination of factors have reduced farming along the Portage River. Fallen trees, sediment, and other debris now clog not only the drain, but also the Grand River in many locations causing widespread flooding, especially in the spring (Hubbell, Roth & Clark, Inc., 1999). A U.S. Army Corps of Engineers 1972 study concluded that cleaning the Grand and Portage Rivers was prohibitive because the cost far exceeded agricultural benefits. Much of the farmland along the lower portions of the Portage River Drain is now abandoned because of flooding, late spring and early fall frosts, crop depredation by wildlife, and depressed crop prices. Restoring and preserving these former wetlands is a viable alternative to farming.

The JCCD categorized wetlands in these two subbasins as (1) destroyed, (2) degraded but candidates for restoration, or (3) relatively undisturbed and should be preserved. Hydric soil areas were considered degraded if there was evidence of drainage ditches, agricultural activity, or drainage tile. Field visits were made to more than half of the sites to confirm their classification.

Each wetland was evaluated for its potential restoration based on seven characteristics: wetland size, present land use, agricultural use in the last four years, uniqueness, proximity to other wetlands, location within the floodplain, degradation, and the number of landowners. Points were assigned to each of the seven characteristics based on a modification of the 2001 Wetland Reserve Program Michigan Ranking System (USDA NRCS, 2001).

The JCCD identified 335 wetlands in the Portage River Lower Branch and Portage River Middle Branch 3 subbasins. At least 17 areas, covering 120 acres, were once wetlands based on hydric soil locations and are now destroyed. Most were filled, leaving no trace that once a wetland was located at that site. Several of these destroyed wetlands are located on State of Michigan (prison) property.

The JCCD identified 198 wetlands (5,032 acres) that appeared to be in a relative natural state and, therefore, should be preserved. Seven of these wetlands, totaling 719 acres, that once were degraded have been, or soon will be, restored and preserved through either the Wetland Reserve Program (WRP) or the U.S. Fish and Wildlife Service Partners for Fish and Wildlife Program.

The Michigan DNR owns and protects 746 acres of wetlands, 299 acres of which are owned in partnership with other landowners. The Michigan Audubon Society, along with private landowners, protects an additional 541 acres. At least 34 percent of the 5,032 acres recommended for preservation are under protection currently.

The JCCD identified 120 wetlands (6,412 acres) categorized as degraded with the potential for restoration. The State of Michigan (prison) is the sole owner of the largest block of degraded wetlands (1,022-plus acres) with high potential for restoration. The State of Michigan (prison) shares ownership with one or more landowners of an additional 906 acres of wetlands. In 2002, two landowners applied to restore 1,134 acres as part of the WRP. WRP funds are available to restore that acreage and if accepted into the program, will further add to the wetlands that are preserved.

SIS conducted additional analysis of existing wetland acreage and compared current wetlands with the circa 1800 land cover data set for the watershed. The percentage of land area in each subbasin that was wetland in 1800 was compared with the percent of the subbasin area that was modeled to currently be wetland. Results from individual subbasins were categorized into the following based on the mean and standard deviation of the subbasin results:

- very low (0 to 24 percent),
- low (24 to 35 percent),
- moderate (35 to 56 percent),
- high (56 to 66 percent), and
- very high (greater than 66 percent).

The percent of the area in each basin that was wetland in 1800 compared with the percent of the area in each basin in the current wetlands model ranged from 11 to 97 percent, with a mean of 45 percent (Table 15). Subbasins with the greatest wetland loss since 1800 are those with the most agriculture. Subbasins in northwest Jackson County have experienced the least amount of wetland loss since 1800 (Figure 14).

Table 15 - Subbasin Rankings Based on Remaining Wetland Acreage

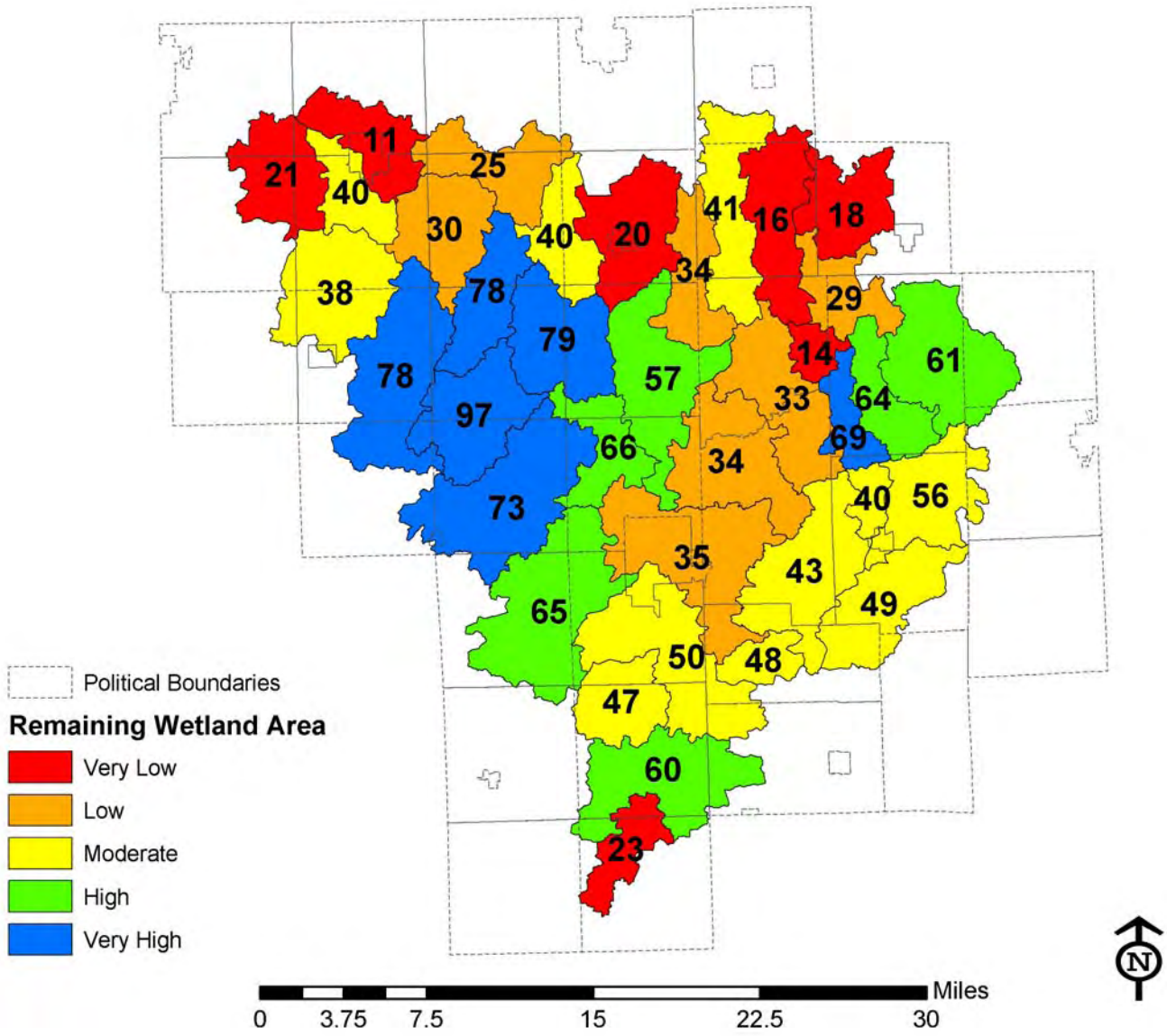
Rank		Subbasin Number and Name	% Remaining Wetland
1	28	Sandstone Creek – Lower Branch	97
2	29	Darling – Christie Drain	79
3	33	Spring Brook - Source	78
3	30	Bromly Tile Drain	78
4	27	Sandstone Creek – Middle Branch	73
33	23	Huntoon Creek	20
34	15	Pickett and Jacobs Drain	18
35	16	Cahaogen Creek	16
36	18	Orchard Creek	14
37	37	Unnamed Tributary	11

* Table lists the top 5 and bottom 5 ranking subbasins. Subbasin locations are presented in Figure 5 and Table 10.

The size distribution of wetlands was also examined to determine the portion of wetlands in the Upper Grand River Watershed likely to escape regulation. Each subbasin was evaluated to determine the extent of wetlands, as determined by the wetlands model, that fell into three size categories less than 5 acres, 5 to 50 acres, and greater than 50 acres.

MDEQ regulates all wetlands, regardless of size, that are contiguous with lakes and streams with at least one acre of surface water. Of those wetlands that are not contiguous with surface water, it regulates those larger than five acres. Regulation of noncontiguous wetlands less than five acres in size occurs only if MDEQ has determined the wetland is of ecological significance. Therefore, noncontiguous wetlands less than five acres in size are generally not regulated (protected). It was found that wetlands less than five acres comprise 10 percent of the entire wetland area in the watershed. These 7,855 wetlands totaled 5,165 acres in size. Eight subbasins in the watershed have greater than 20 percent of their total wetland area in wetlands less than five acres in size (Appendix B, Table 7).

Figure 14 - Percentage of Remaining Wetland Areas per Subbasin



Note: Remaining wetland area is defined as the percent of subbasin area currently in wetlands divided by the percent of subbasin area that was wetlands in 1800.

STREAM BANK AND SHORELINE EROSION

Studies by the Grand River Inter-County Drainage Board (Hubbell, Roth & Clark, Inc., 1999a, 1999b) identified significant areas of the Grand River and Portage River Inter-County Drains affected by stream bank erosion, sedimentation, logjams, and channel restrictions. Sediment in some locations was as much as 3 to 7 feet deep. Channel constrictions have, in turn, caused problem flooding along these drains (Abbey 1954, Anonymous 1954, USDA 1958, USDA 1968), which has damaged crops, and pasture lands.

Both SIS and JCCD conducted analyses to identify and prioritize areas at risk for stream bank erosion and sedimentation. SIS evaluated all subbasins within the Upper Grand River Watershed with the use of available GIS data. The JCCD evaluated two subbasins with a history of agricultural crop/land damage due to flooding within the Portage River Subwatershed using higher resolution aerial photographs and drain maps.

SIS calculated the potential for stream bank erosion within each subbasin based on runoff intensity, soil erodibility (K-factor), and riparian vegetation. Subbasin mean runoff classifications were used to assign base values that were then modified according to soil K-factor and the percentage of natural vegetation in the 500-foot riparian buffer. A detailed description of the scoring methodology is provided in SIS' full report in Appendix C.

Stream bank erosion potential final values ranged from 1 to 10. Based on their distribution, they were aggregated into the following categories: very low (1-2), low (3-4), moderate (5-6), high (7-8), and very high (9-10) (Figure 15). Subbasins with the highest and lowest predicted potential for stream bank erosion are summarized in Table 16.

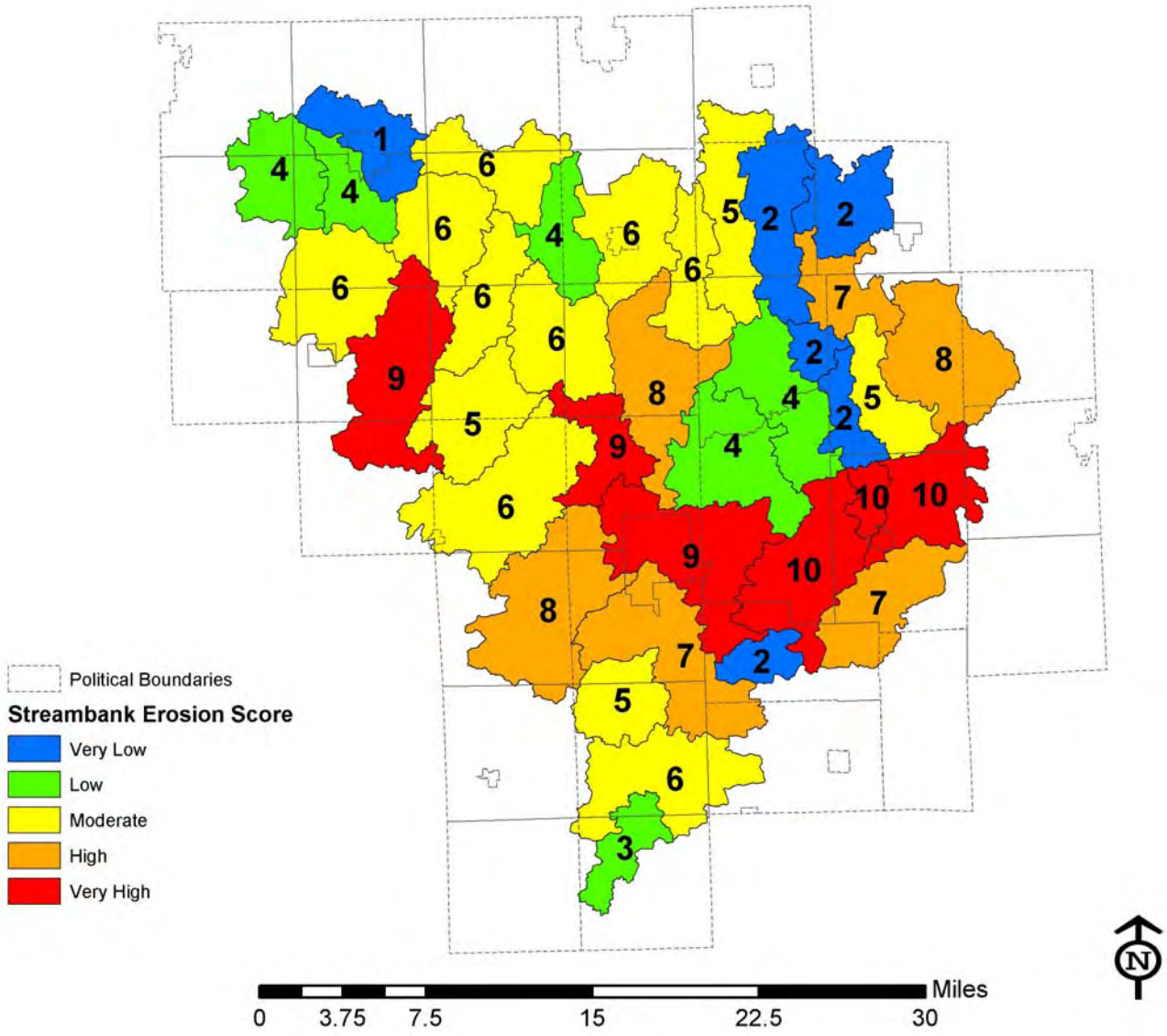
Relatively high runoff rates for subbasins in the eastern portion of the watershed and the addition of erodible soils suggest they have a high potential for erosion. Actual erosion rates may be lower in areas with intact riparian buffers. However, results pictured in Figure 15 emphasize that removal of these buffers would have a detrimental impact on the stream bank conditions.

Table 16 - Highest and Lowest Stream Bank Erosion Potential Scores for Subbasins

Rank	Subbasin Number and Name		Stream Bank Erosion Score
1	37	Unnamed Tributary	1
2	16	Cahaogen Creek	2
2	18	Orchard Creek	2
2	8	Cranberry Lake Drain	2
2	15	Pickett and Jacobs Drains	2
2*	14	Portage River - Middle Branch 2	2
9	10	Grand River Drain - Upstream	9
9	11	Tobin Snyder Drain	9
9	33	Spring Brook - Source	9
10	5	Grass Lake Drain	10
10	6	Grass Lake Outlet	10
10	9	Huttenlocker and Crittenden Drains	10

* Tables list the top 5 and bottom 5 ranking subbasins. Subbasin locations are presented in Figure 5 and Table 10.

Figure 15 - Stream Bank Erosion Potential by Subbasin



The JCCD assessed of the need for riparian conservation practices in the Cahaogen Creek and Orchard Creek subbasins based on three factors: soil slope, erosion factor K (USDA, 1981:76), and the width of vegetation within 180 feet of the stream bank. Their analysis focused on (1) farming activity near waterways, (2) unrestricted livestock access to waterways, and (3) stream bank erosion from disturbed areas. USDA 1993-94 black and white aerial photographs (scale 1 inch = 660 feet), USDA 2001 aerial color slides, Portage River Inter-County Drain 2000 maps (scale 1 inch = 250 feet), and soil maps were used to identify agricultural activity within 180 feet of four watercourses in the Portage River Watershed. Approximately one-third of the sites identified from photos and maps were visited to confirm the results of map and photo analysis. A detailed description of JCCD methodology is provided in Appendix D.

The JCCD found that 59,617 feet, of the total 81,256 feet of stream bank inventoried in the two subbasins (73 percent), exhibit a high or very high need for riparian conservation practices to reduce erosion and sedimentation (Table 17). The highest need occurs in the agricultural areas of Ingham County where crops on muck soils were commonly planted within 10 feet of the stream banks.

Table 17 - Portage River Subbasins in Need of Conservation Practices

	Riparian Area Need Index (Score, Class)				
Subbasin Name, Number	**14-17 Very High Length (ft.)**	**10-13 High Length (ft.)**	**6-9 Medium Length (ft.)**	**2-5 Low Length (ft.)**	**Total Length (ft.)**
Cahaogan Creek, 1221	23,345	28,493	5,306	2,045	59,189
Orchard Creek, 1294	2,902	4,877	8,249	6,039	22,067
Total	**26,247**	**33,370**	**13,555**	**8,084**	**81,256**

It should be noted that the JCCD analyses indicate that substantial lengths of stream bank within the Cahaogen and Orchard Creek subbasins are in need of riparian best management practices (BMPs) even though these areas ranked low in their potential risk for stream bank erosion according to the SIS analysis. This emphasizes the need for on-the-ground evaluation within those areas rated at moderate to high risk, and the overall need for improved stream course management throughout the Upper Grand River Watershed.

AGRICULTURAL SOIL EROSION

Off-field soil erosion was calculated for all agricultural areas in the contributing source area of the Upper Grand River Watershed. Annual soil erosion rates were calculated using the Universal Soil Loss Equation (Wischmeier and Smith 1965, 1978) for areas in the Upper Grand River Watershed that are classified as agriculture or pasture. Details of this analysis are included in Appendix C.

Potential soil loss calculations were averaged over the entire subbasin area, then divided by the contributing source area of that subbasin. These values (Table 18 and Figure 16) represent the average annual soil loss over the contributing source area within each subbasin. This information illustrates which subbasins are hot spots for potential off-field erosion.

Table 18 - Highest and Lowest Potential Annual Agricultural Soil Loss (tons/acre/year) Averaged over Subbasin Contributing Source Area

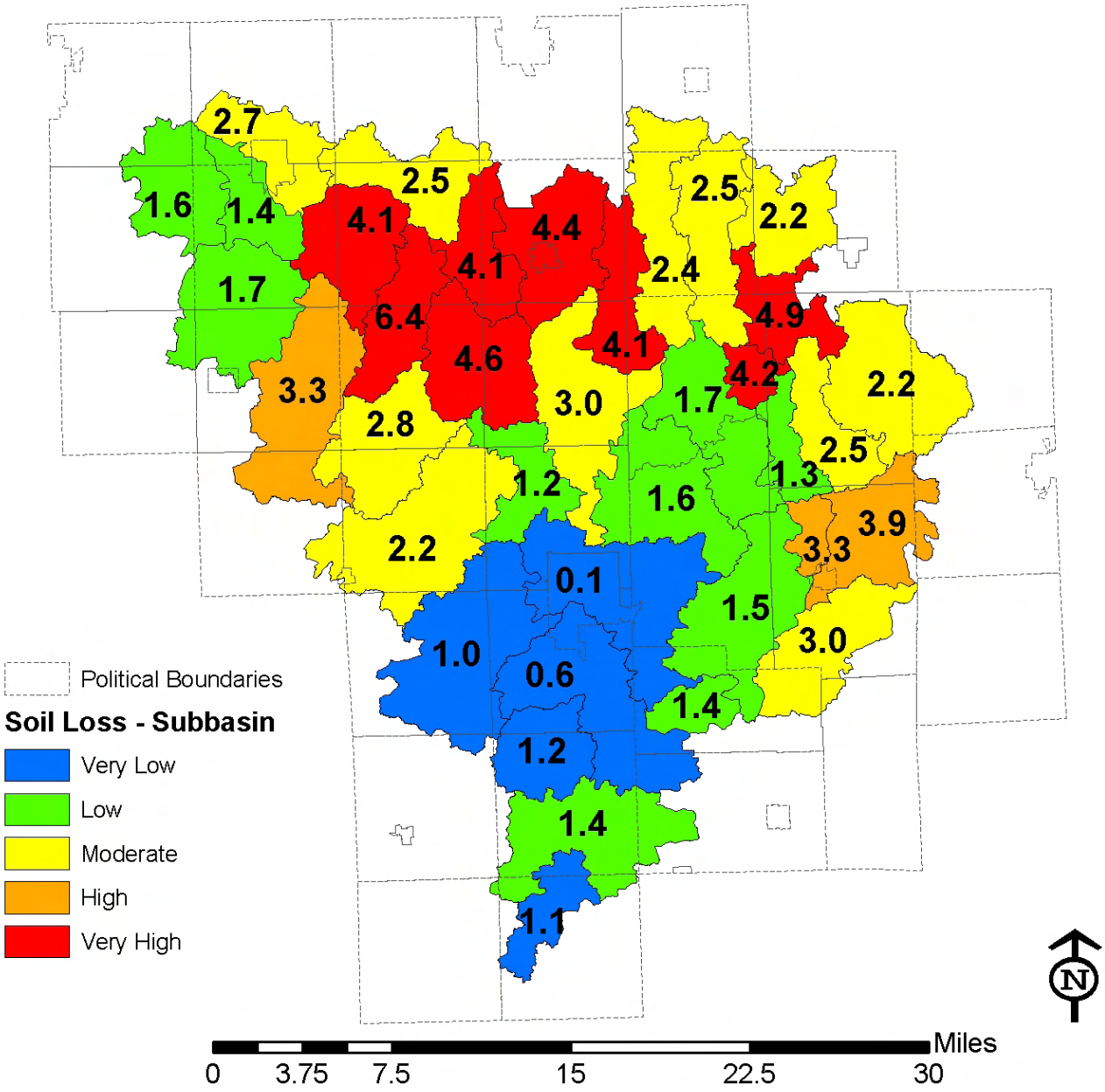
Rank	Subbasin Number and Name		Off-field Soil Loss Averaged by Subbasin Area (tons/acre/year)
1	10	Grand River Drain - Upstream	0.14
2	4	Pierce Drain	0.63
3	26	Sandstone Blackman Drain	0.92
4	1	Lake LeAnn	1.06
5*	3	Sharp Creek	1.16
34	18	Orchard Creek	4.19
35	23	Huntoon Creek	4.38
36	29	Darling - Christie Drain	4.57
36	17	Wild Drain	4.89
37	30	Bromly Tile Drain	6.36

* Table lists the top 5 and bottom 5 ranking subbasins. Subbasin locations are presented in Figure 5 and Table 10.

Annual estimated subbasin off-field erosion (tons/acre/year) from agricultural fields in the contributing source area (Figure 16) were placed into the following categories based on their mean and standard deviation:

Class	**Relative to Mean (Std. Deviation)**	**Average Soil Loss over Subbasin (tons/acre/year)**
Very Low	< - 1	below 1.16
Low	-1 - -0.5	1.16 - 1.84
Moderate	-0.5 - 0.5	1.84 - 3.21
High	0.5 - 1.0	3.21 - 3.90
Very High	> 1.0	above 3.90

Figure 16 - Annual Potential Agricultural Off-Field Erosion (tons/acre/year) Averaged over the Contributing Source Area of each Subbasin



RISK OF SEPTIC SYSTEM FAILURE

Water quality sampling conducted in the spring and summer of 2002 identified elevated concentrations of *E. coli* bacteria at a number of locations in the watershed, as described previously. Published water quality reports also identify areas of bacterial contamination, as well as areas impacted by nutrient enrichment. One potential source of both bacterial contamination and nutrient enrichment is the failure of on-site sewage disposal systems or septic tanks. Evidence of this potential was observed previously in the watershed as many lakeshore residences were converted from part-time to full-time occupancy. Nutrient loading to several local lakes increased due to overloaded septic systems. A number of the lakes now have sanitary sewer systems as a result and others are in the process of constructing sanitary sewer systems.

When a septic system fails, bacteria and nutrients may be released into groundwater supplies and local surface water. Failing septic systems present a risk to public health through increased nutrient and bacteria levels in the neighboring waterways.

As low-density development increases in the watershed, the number of on-site sewage disposal systems increases as well. The U.S. EPA (2002) has determined that risk of septic system failure is related to septic system density. The density of septic systems was computed from digitized locations of residences outside sanitary sewer service areas. This density dataset was calculated by determining the number of septic systems per acre within a 2,000-foot radius of a lake or stream. The U.S. EPA bases its risk categories on septic density as follows:

- Less than 0.016 septic systems per acre = low risk
- 0.016 - 0.063 septic systems per acre = moderate risk
- 0.063 septic systems per acre = high risk

The higher the density of the septic systems, the higher the likelihood that failure might contribute to surface water contamination. In the Upper Grand River Watershed, approximately 203,000 acres are categorized as low risk, approximately 199,000 acres are categorized as moderate risk, and approximately 44,000 acres are categorized as high risk. When averaged over the watershed, septic field density of potential failure ranged from 0.013 systems per acre to

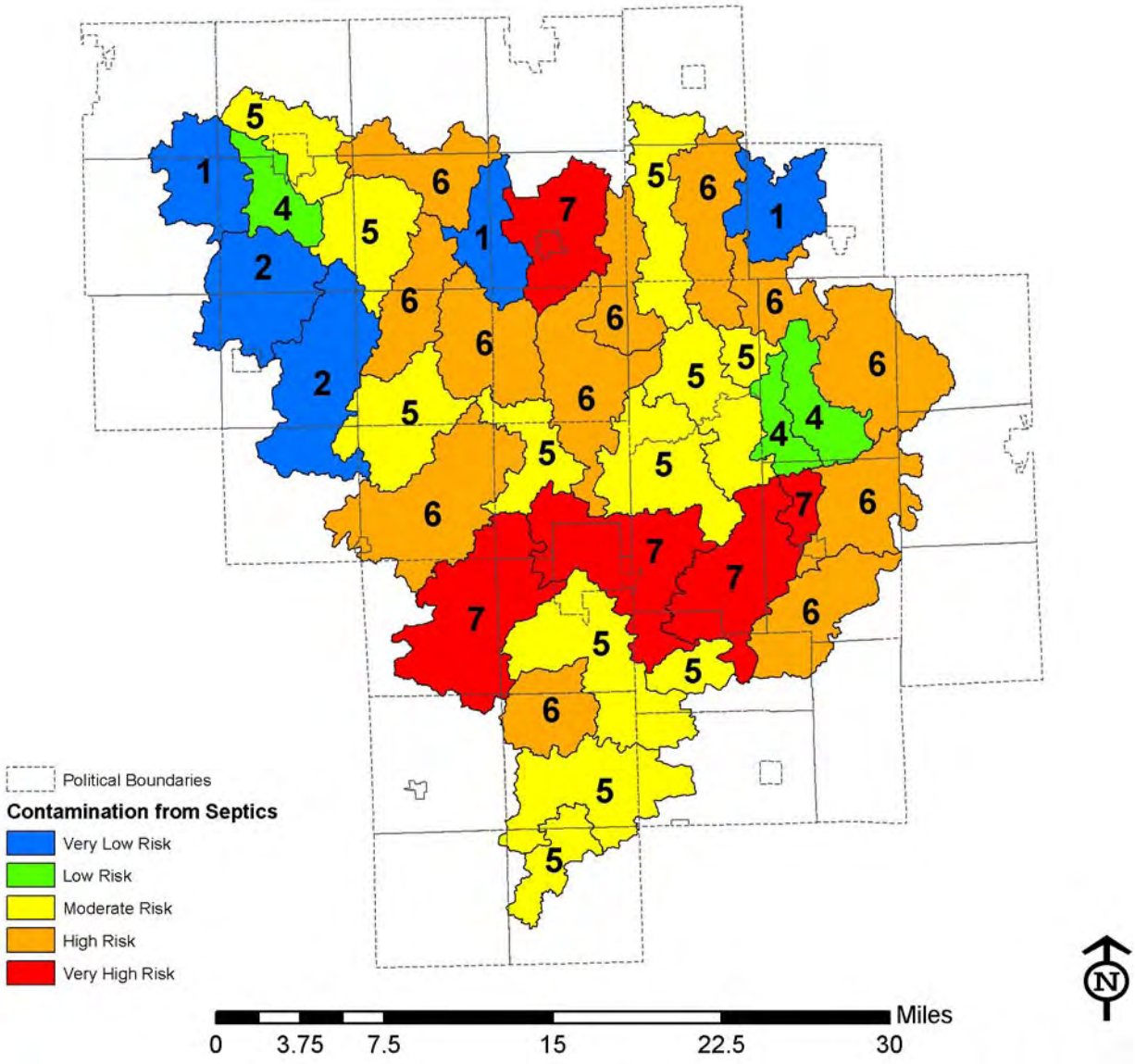
0.057 systems per acre. The highest and lowest ranking subbasins are shown in Table 19. The resulting values for all subbasins in the Upper Grand River Watershed are shown in Figure 17.

Table 19 - Highest and Lowest Septic Field Density per Acre Summarized by Subbasin for the Upper Grand River Watershed

Rank	Subbasin Number and Name		Number of Septic Systems per Acre
1	33	Spring Brook - Source	0.013
1	25	Perry Creek	0.013
1	34	Spring Brook - Middle Branch	0.013
2	35	Mills and Post Drain	0.015
2	15	Pickett and Jacobs Drains	0.015
33	24	Grand River Drain - Downstream	0.044
34	8	Cranberry Lake Drain	0.051
35	10	Grand River Drain - Upstream	0.053
36	22	Western Creek	0.054
37	18	Orchard Creek	0.057

* Table lists the top 5 and bottom 5 ranking subbasins. Subbasin locations are presented in Figure 5 and Table 10.

Figure 17 - Rankings for Risk of Surface Water Contamination from Septic System Failure



NUTRIENT CONTAMINATION RISK

Mean nutrient loads for each subbasin were calculated using runoff calculations based on a two-year recurrence (50 percent probability) storm event and mean concentrations of each nutrient over the duration of the event storm. Event mean concentrations were calculated based on land cover and a look-up table of nutrient values specific to the land cover classifications (Cave et al, 1994). The nutrient look-up table values were developed from a series of studies in southeastern Michigan's Rouge River Watershed (Cave et al, 1994) and modified for areas with tile drainage according to the specifications in Richards (1999). Nutrient load calculations were performed only within the contributing source area of the watershed. Separate calculations were performed for nitrites/nitrates ($NO_2 + NO_3$) and total phosphorus (TP).

Nitrite/Nitrate Pollutant Loads

Average NO_2 + NO_3 values measured over the potential contributing source area in each subbasin ranged from 0.33-lb./acre to 0.88-lb./acre (Table 20). NO_2 + NO_3 load classes of very low, low, moderate, high, and very high were determined by the mean and standard deviation (s.d.) as described below:

Class	Relative to Mean (Std. Deviation)	NO_2+NO_3 Average Loading from Contributing Source Area (lb/acre)
Very Low	< - 1	below 0.46
Low	-1 - -0.5	0.46 - 0.53
Moderate	-0.5 - 0.5	0.53 - 0.66
High	0.5 - 1.0	0.66 - 0.72
Very High	> 1.0	above 0.72

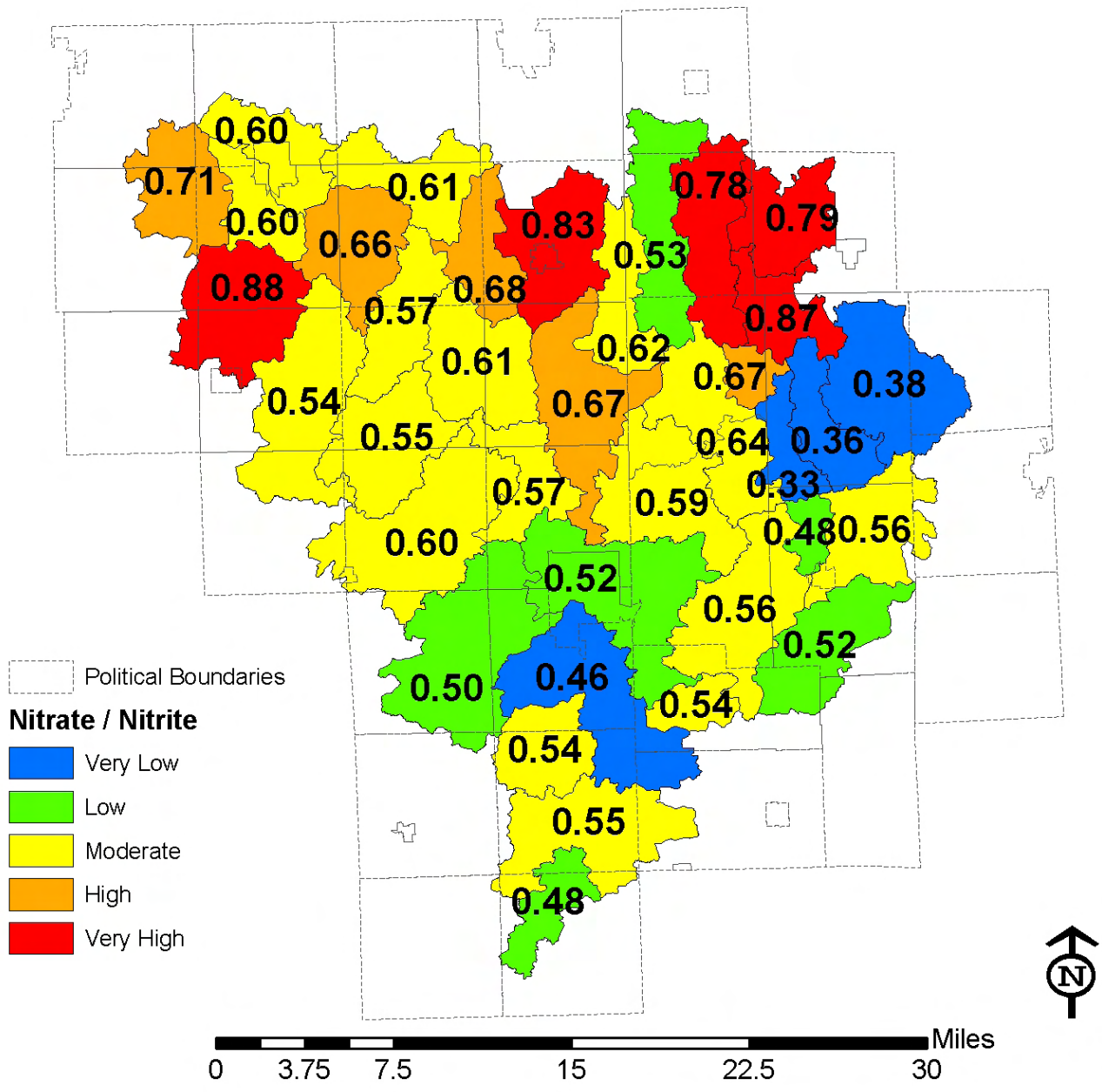
Table 20 - Highest and Lowest Average $NO_2 + NO_3$ Pollutant Loading Rates from Within the Contributing Source Area of each Subbasin for a 2-year Storm Event

Rank	Subbasin Number and Name		NO_2+NO_3 Loading Rate (lbs/acre)
1	13	Portage River - Middle Branch 1	0.33
2	14	Portage River - Middle Branch 2	0.36
3	12	Portage River - Source	0.38
4	4	Pierce Drain	0.46
5	1	Lake LeAnn	0.48
5	6	Grass Lake Outlet	0.48
33	16	Cahaogen Creek	0.78
34	15	Pickett and Jacobs Drains	0.79
35	23	Huntoon Creek	0.83
36	17	Wild Drain	0.87
37	34	Spring Brook - Middle Branch	0.88

* Table lists the top 5 and bottom 5 ranking subbasins. Subbasin locations are presented in Figure 5 and Table 10.

The subbasins with the highest average $NO_2 + NO_3$ within their contributing source area were all in the northern portion of the watershed (Figure 18), a trend that can be accounted for by soils and land cover. This area of the watershed had a considerable amount of agriculture on wetter hydric soils, which require artificial drainage (Julius Pigott, Jackson County NRCS, personal communication). These areas of artificially drained agriculture are modeled to contribute the highest event mean concentrations of $NO_2 + NO_3$ in storm runoff (Richards, 2000).

Figure 18 - Average $NO_2 + NO_3$ Pollutant Loads (lbs/acre) Within the Contributing Source Area of Each Subbasin for a 2-year Storm Event



Phosphorus Loads

Total phosphorus (TP) loads were modeled for the contributing source area of the Upper Grand River Watershed. Phosphorus loads were calculated within the contributing source area of each subbasin and compared across subbasins. Subbasin average phosphorus load values ranged from 0.04-lbs/acre and 0.12-lbs/acre, with a mean of 0.06-lbs/acre (Table 21). Load classes of very low, low, moderate, high, and very high were determined by the mean and standard deviation. These classes are outlined below:

Class	Relative to Mean (Std. Deviation)	TP Average Intensity from Contributing Source Area (lbs/acre)
Very Low	< - 1	below 0.05
Low	-1 - -0.5	0.05 - 0.055
Moderate	-0.5 - 0.5	0.055 - 0.065
High	0.5 - 1.0	0.065 - 0.07
Very High	> 1.0	above 0.07

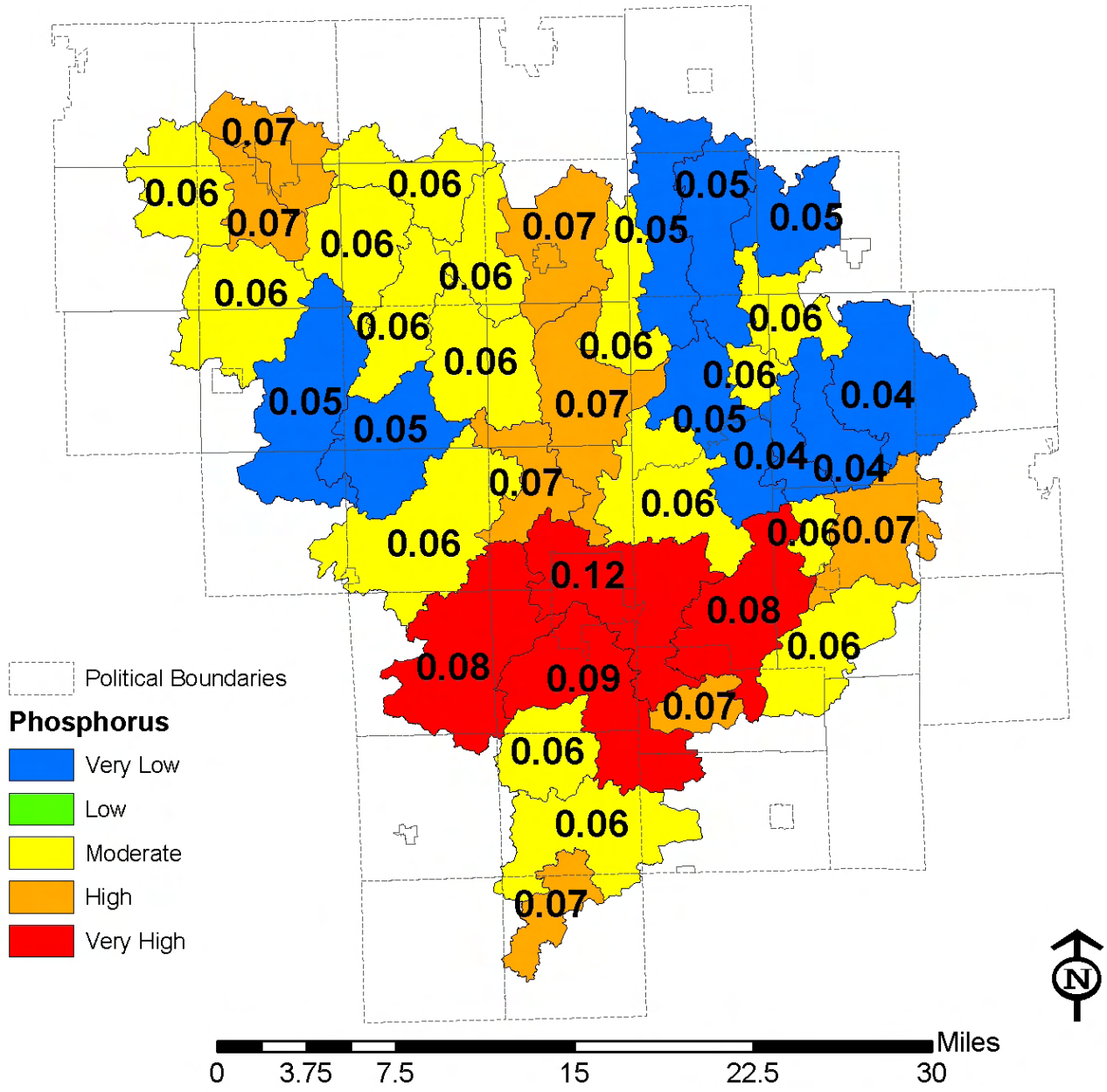
Table 21 - Highest and Lowest Average Phosphorus Loads from the Contributing Source Area of each Subbasin for a 2-year Storm Event

Rank	Subbasin Number and Name		TP Load (lbs/acre)
1	14	Portage River - Middle Branch 2	0.04
2	12	Portage River - Source	0.04
3	13	Portage River - Middle Branch 1	0.04
4	20	Portage River - Middle Branch 3	0.05
5	16	Cahaogen Creek	0.05
33	1	Lake LeAnn	0.07
34	9	Huttenlocker and Crittenden Drains	0.08
35	26	Sandstone Blackman Drain	0.08
36	4	Pierce Drain	0.09
37	10	Grand River Drain - Upstream	0.12

* Table lists the top 5 and bottom 5 ranking subbasins. Subbasin locations are presented in Figure 5 and Table 10.

The combination of tile drained agriculture and hydric soils exhibits the opposite effect on pollutant loads for phosphorus (relative to nitrogen) (Figure 18 and Figure 19). Many of the subbasins predicted to contribute very high and high average nitrate loads had low phosphorus loads and vice versa. For the most part, urban subbasins surrounding the City of Jackson were modeled as contributing the highest phosphorus loads (Figure 19). In studies elsewhere, urban lands have been shown to exhibit the highest event mean concentrations for total phosphorus (Cave et al, 1994).

Figure 19 - Average Phosphorus Load (lbs/acre) per Subbasin for a 2-year Storm Event



LAND USE POLICY ANALYSIS SUMMARY

LAND USE POLICY STATUS

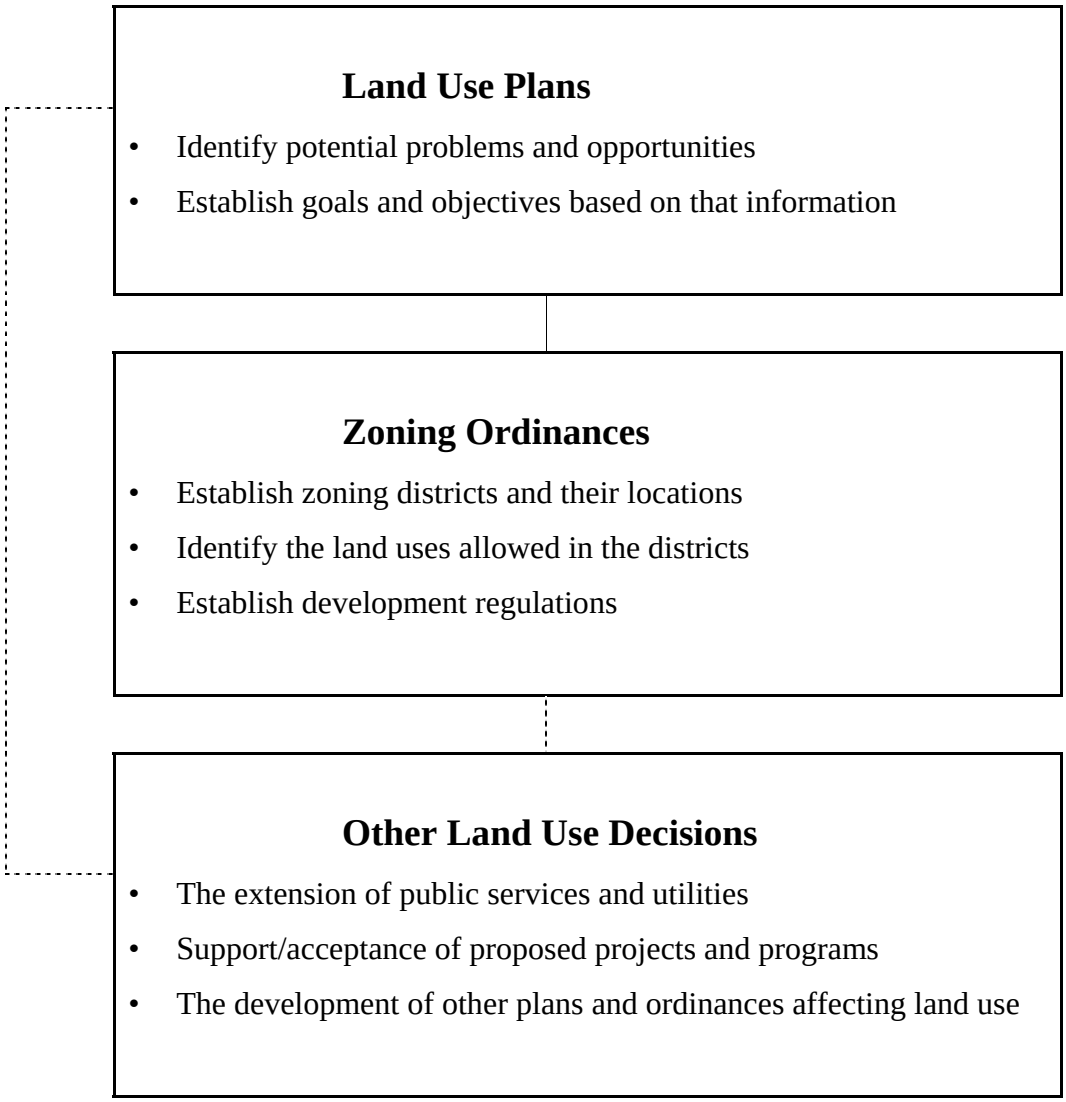
There are two main land use tools available to local governments: land use plans and zoning ordinances. Land use plans are used to establish local governmental policy. The zoning ordinance is the main regulatory document. It is utilized to implement the goals established within the land use plan. Local governments must also make other land use decisions. Those decisions are based on the goals of the land use plan. When pertinent, they are coordinated with the zoning ordinance. Figure 20 illustrates this relationship.

Staff of the Region 2 Planning Commission (R2PC) reviewed the land use plans and zoning ordinances of ten Jackson County municipalities and one Hillsdale County municipality as a representative cross-section of local governmental units within the watershed. They analyzed the policies and regulations for their potential effect on sources of nonpoint pollution and protection of water resources. The eleven municipalities, for which land use policies were reviewed, included two villages and a mix of nine rural and urban townships. A list of the specific municipalities and policies reviewed for each are presented in Table 22.

Table 22 - Review of Local Governmental Land Use Plans (LUP) and Zoning Ordinances (ZO)

Location	LUP	ZO	Location	LUP	ZO
Jackson County			**Jackson County (cont.)**		
Village of Parma	X	X	Sandstone Township	X	X
Village of Springport	X	X	Springport Township	X	
Blackman Township	X		Tompkins Township	X	X
Henrietta Township		X	Waterloo Township	X	X
Leoni Township	X	X	**Hillsdale County**		
Rives Township	X	X	Somerset Township	X	X

Figure 20 - The Relationship Between Important Land Use Planning Tools



Opportunities and policy strengths and deficiencies, identified by the R2PC, are summarized below. Their full report can be found as Appendix E.

- It is important to have up-to-date land use plans and zoning ordinances. The zoning ordinance should flow from the intent and conditions stated within the land use plan. Of the ten land use plans reviewed, only four of them had been enacted or updated within the past five years. The R2PC believes that this result is representative of conditions throughout the watershed. Only four of the eight communities with both land use plans

and zoning ordinances reviewed had enacted their zoning ordinance after developing a land use plan.

- The goals and objectives sections of land use plans reviewed include a wide variety of goals concerning environmental protection. Some of those goals are tied to quality of life objectives and open space and recreation preservation. Others are included under goals such as residential and industrial development.
- The "Purpose(s)" sections of some of the zoning ordinances reviewed often hint at or infer environmental protection, but do not come right out and state that purpose.
- Buffer strips were mentioned by at least one local unit of government as a way of reducing visual and noise impacts from adjacent land uses. Similar buffer strip requirements could be enacted to protect water quality where land and water meet.
- Several land use plans and zoning ordinances made a connection between agricultural and open space preservation and natural resource protection. Although interrelated, those goals would be more effective if they were not so intimately linked. Separate districts should be created for agricultural preservation and open space preservation. One of the reasons for zoning an area for open space preservation would be natural resource protection. The main objective for agricultural districts should be the preservation of prime and unique farmland.
- Many of the zoning ordinances attempt to regulate "intensive livestock feeding operations." However, the Michigan Right to Farm Act preempts this ability.
- Zoning ordinances reviewed listed single-family detached homes as a permitted use by right in agricultural districts. This permitted right perpetuates sprawl. In order to curb sprawl, single-family homes could be reduced to a conditional use in agricultural districts.
- R2PC reviewers observed that land use plans that included information designed to educate readers about the impacts of development and the importance of environmental protection were more interesting to read. This practice should include identifying pertinent laws, web sites, and other sources. These policies may make a greater impact if this information was included.

- A number of the zoning ordinances require information about the area surrounding the proposed site to be included in the information recorded on site plan maps. This information is very helpful to decision makers. Some of the zoning ordinances also addressed certain aspects of the environment as part of a site plan review. This action is also helpful.
- Land use plans should include background information on the number of households served by central water and sewer systems and the number of households served by individual wells and septic systems. This information can help local governments to establish appropriate density patterns.
- Follow-through from the land use plan to the zoning ordinance is often missing. Several local governments, however, included an implementation section in their plans.
- The effects that development can have on the health of lakes were included in the land use plan of at least one local government.
- The inventory of environmental features listed in land use plans should include environmentally sensitive corridors, groundwater recharge areas, open space, wetlands, floodplains, and soils.
- There seems to be a movement to protect natural resources through large lot development. This well-meaning practice can lead to greater land consumption. Open space developments and preserves may be better ways to preserve those resources.

R2PC staff also reviewed portions of the draft Jackson County Master Plan being developed. Key recommendations in that plan address the need to match the type of development with appropriate soils. Locating development on suitable soils can minimize construction costs and risks to the environment. Poor soils present problems such as foundation failure and septic tank limitations. Soil suitability is also critical for identifying productivity for agriculture and timberlands. The three major soil characteristics considered in the analysis of soil conditions are drainage, foundation stability, and septic suitability.

Drainage

Development on poorly drained soils increases development costs, maintenance costs, and may lead to sanitary problems. Development costs are increased due to additional foundation, road,

and septic preparation. Maintenance costs and problems are associated with septic field failures, flooded basements, and the deterioration of roads from frost action.

Foundation Stability

Soil types that do not provide stable foundations may experience shifting building foundations, cracked walls, pavement, and roadways. These problems often result in increased development and maintenance costs or, in extreme cases, structural failure.

Septic Suitability

Because there are many areas of the watershed that rely on individual septic systems, the location of septic systems on proper soils is extremely important. Septic system failure can result in areas of high-water table or excessive slope. Clay and silt soils do not allow wastewater to percolate readily, a high-water table prohibits adequate filtering, and excessive slope does not provide opportunity for adequate percolation.

Soils poorly suited for development include:

- Areas with little topographic relief that do not allow proper drainage.
- Areas with excessive slopes that are susceptible to erosion.
- Muck or peat soils and other soils with high organic material content.
- Silts and clays.
- Areas with high water tables.
- Soils generally found along lakes, creeks, and wetlands.

Soils well suited for development include:

- Areas sufficiently above the groundwater table.
- Loamy and sandy soils.

In addition to the land use policy analysis conducted by the R2PC, TTMPS reviewed County Drain Commissioner design standards for site developments for the counties within the Upper Grand River Watershed. Design Standards were reviewed for requirements relative to detention/retention basins, allowable outflow from developments, conveyance, and water quality

improvement. The purpose of this summary was to compare and contrast the rules governing construction and storm water conveyance in the different counties and identify where improvements might be made. A summary of this comparison is provided in Table 23. Design standards and construction standards that do not have an impact on water quantity/quality (e.g., required pipe materials) were not included in the summary table.

It should be noted that Washtenaw County's development standards have been developed to address both water quantity (flooding) and water quality concerns. They differ significantly in (1) providing treatment for the "first flush," the early runoff portion of a storm or snowmelt event that carries the most concentrated pollutant load, and (2) reducing the value associated with the pre-development runoff rate to 0.15 cubic foot per second (cfs) per acre. Because both runoff rate and the pollutant load in overland runoff contribute to degradation of area surface waters, other counties are recommended to incorporate similar changes in their standards.

SEWER SERVICE AREAS

As discussed above, soil composition is one of the most significant elements in land use planning. Since sewer and water infrastructure only serve a portion of the watershed, development should be promoted in areas where soils make it acceptable, and development dependent on septic systems should be limited in areas of unsuitable soils.

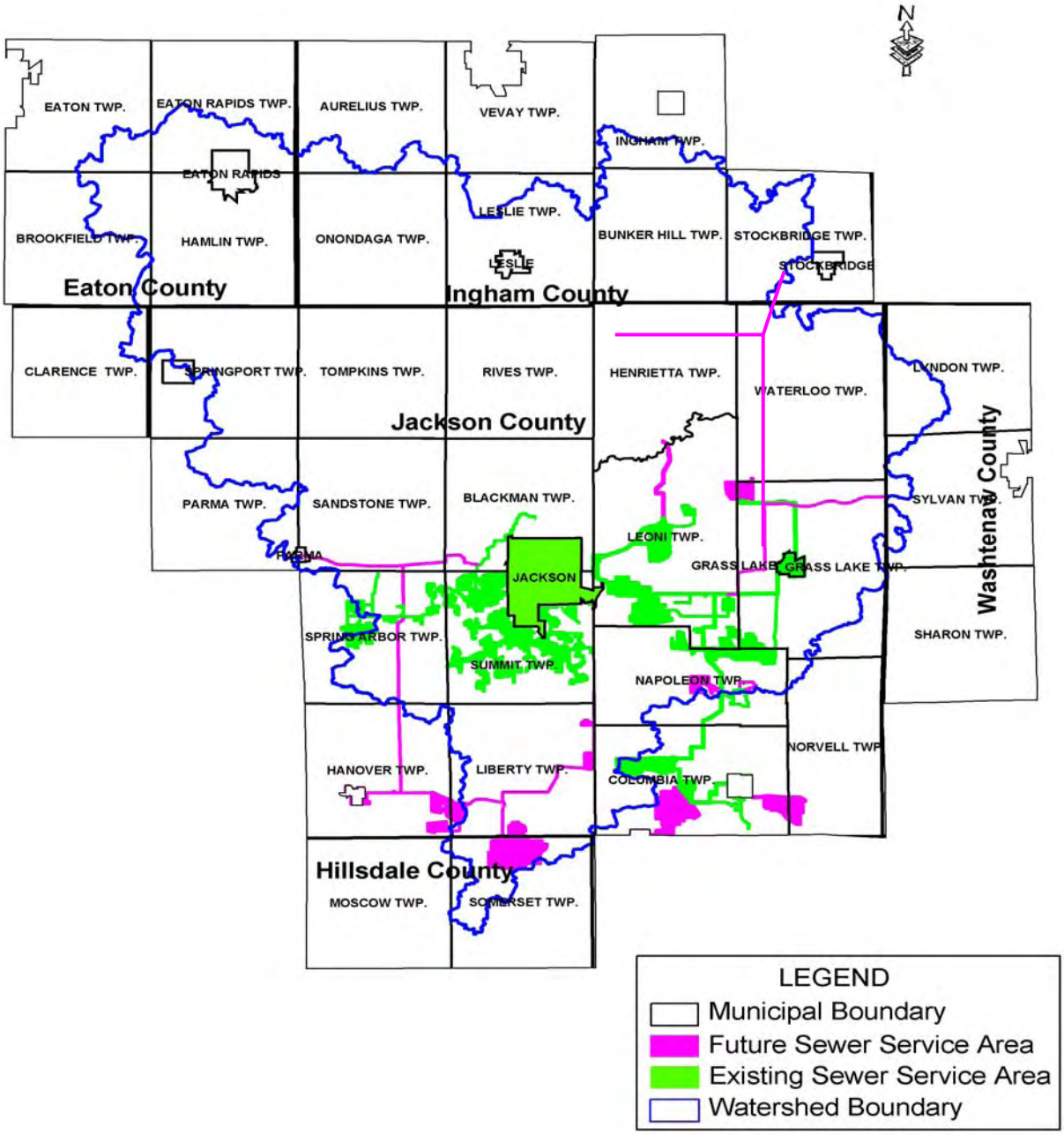
Likewise, it is valuable to identify those areas where sewer service is currently, or planned to be, available. Access to sanitary sewer infrastructure can dictate where higher density development will occur and may have the secondary impact of "opening-up" areas otherwise poorly suited for development to greater growth pressure.

Figure 21 identifies the current and proposed publicly owned sewer service areas in the Jackson County portion of the Upper Grand River Watershed. Municipal sewer service area maps within the other Upper Grand River Watershed counties were unavailable. This map can provide valuable information that local units of government can use when developing or revising their land use plans.

Table 23 - Comparison of County Development Standards

County	Detention	Retention	Maximum Allowable Outflow from Proposed Development	Conveyance	Water Quality	Soil & Erosion Control
Clinton	Volume difference between 10-year storm (present land use) and the 100-year storm (future land use)	None	0.39 cfs/ac	• 1 cfs/acre or an approved hydrologic calculation • Minimum 12" in DIA	None	CEA
Eaton	100-year, 24-hour storm event	None	Varies based on existing conditions	• Open channel – 100-year, 24-hour storm event • Closed pipe – 10-year, 24-hour storm event	None	CEA
Hillsdale	Awaiting information	Awaiting information	Awaiting information	Awaiting information	Awaiting information	CEA
Ingham	Awaiting information	Awaiting information	0.15 cfs/ac	10-year storm event (from previous work)	Awaiting information	CEA
Jackson	50-year, 1-hour storm	100-year, 3-hour storm	Any basin outlet: 10-year, 2-minute storm	None	None	CEA
Washtenaw	Capture and treat the following: • 100-year, 24-hour storm event • 1.5-year, 24-hour storm event • First flush (runoff from first 0.5" of rain)	Store two consecutive 100-year, 24-hour storms	0.15 cfs/ac	• Closed pipe – 10-year storm event (min. 12" DIA) • Open channel – 100-year storm	Multiple standards including ponds, wetlands, filters, channels, and swales	Not CEA

Figure 21 - Existing and Proposed Sewer Service Areas in the Jackson County Portions of the Upper Grand River Watershed



CURRENT LAND USE CHALLENGES

In order to minimize the possible negative impacts of development, potential problems must be identified. The following is a listing of those potential issues of high priority that most of the communities within the watershed have in common. All of the issues impact the quantity and/or quality of storm water runoff. The list is not in any particular order (unless otherwise noted), nor is it intended to be exhaustive.

SPRAWL

Perhaps the most important land use issue is the self-perpetuating problem of sprawl. The dispersed linear roadside nature of sprawl tends to land-lock their interiors, making the development of that land more costly. Sprawl results in a host of unintended problems such as (but not limited to):

- An increase in the percentage of land covered by impervious surfaces (e.g., wider roads and streets, large parking lots, and an increasing number of rooftops and driveways), increasing the quantity and quality of storm water runoff.
- The installation of sewer and water (when needed) is often economically infeasible, causing environmental problems to go unaddressed and endangering public health.
- The abandonment of existing urban places where water and sewer and other essential services are already in place.

REVITALIZING URBAN AREAS

The antidote to sprawl is the redevelopment of existing urban areas. By continually investing in existing urban areas – by making them attractive places to live and work – the pressure to develop rural areas should subside. This includes reintroducing natural features, such as wetlands, back into the urban environment. Those features can also be utilized to treat and store storm water runoff.

FLOODPLAINS

Floodplains serve as storage areas for floodwaters during times of flooding. Development within floodplains can be damaged during flooding and also impair the ability of the floodplain to store and absorb floodwaters. While current and future technological advances may make it feasible to develop in those areas, long-term damage to the environment and the development itself still make them undesirable.

- Municipalities should participate in the Federal Emergency Management Agency's (FEMA) National Flood Insurance Program. According to their website, flood maps "are the tool FEMA uses to determine the flood risk homeowners face. Prior to the enactment of the National Flood Insurance Program (NFIP), homeowners had no mechanism to protect themselves from the devastation of flooding and in many parts of the United States unchecked development in the floodplain was exacerbating the flood risk."
- At the very least, floodplains should be mapped. Development within those areas should be limited and dispersed. Permitted land uses should be reserved for agricultural, recreational, and open space residential uses.

WETLANDS

Wetlands serve as storage areas for surface water runoff. They also serve as filters which clean surface water as it becomes groundwater. Michigan currently regulates wetlands that are greater than 5 acres in size. Municipalities are urged to consider regulating smaller wetlands. At a minimum, wetlands should be identified and mapped.

SOILS

The limitations that soil types have when it comes to supporting certain types of development must play an important role in the determination of development patterns within the municipality. For example, areas that have sandy or gravely soils and which are situated adjacent to lakes or streams should not be considered suitable for intensive development due to the likelihood of phosphates and nitrates leaching into those bodies of water. Peat and muck soils are not suitable for septic systems. Development dependent on septic systems should be discouraged in areas where those soils predominate. The suitability of each soil type within the jurisdiction

should be mapped for different types of development using the county soil surveys (e.g., suitability for building and site development, sanitary facilities, etc.).

SOIL EROSION

Soil erosion continues to be a problem, impairing the health of water bodies due to an increase in turbidity. Construction sites are a major contributor to soil erosion. Each county has a soil erosion and sedimentation control officer. It is important that this individual be active in administering Part 91, Soil Erosion and Sedimentation Control, of the Natural Resources and Environmental Protection Act. Municipalities may also want to pass a local soil erosion and sedimentation control ordinance.

LAKES AND STREAMS

The water quality of water bodies is dependent, in part, on the type of development along its shores and banks. For example, effluent from septic systems can seep into water bodies, degrading water quality and the health of those in contact with it. Nutrient rich storm water runoff resulting from agricultural and lawn fertilization practices can accelerate eutrophication (the natural filling in of a water body).

Lakeshores are often very desirable for suburban development. Because lakeshore developments are often located away from urban centers, they are often served by wells and septic systems. This was less of an issue in the past when lake cottages were used seasonally. Conversion of those second homes into primary residences, however, can cause septic systems to fail.

Care must be taken to ensure that new residential development on the desirable land surrounding lakes and streams do not degrade the quality of those resources. Steps must also be taken to improve existing water quality. Included below are some potential tools:

- Delineate lake residential districts as a subset of the existing residential districts.
- Create targeted septic system regulations for those districts.
- Establish filter areas at appropriate places along lakeshores (e.g., low areas and other places where concentrated runoff flows into the water body).
- Construct municipal wastewater collection systems.

New industrial and commercial developments often create ponds and other impoundment areas into their designs for practical as well as aesthetic reasons. This practice should be encouraged. Care must be taken to ensure that new industrial and commercial development along streams and adjacent to ponds do not degrade the quality of those resources. Steps must also be taken to improve existing water quality. Included below are some potential tools:

- Prohibit the discharge of gray water into streams and other impoundments.
- Establish filter areas at appropriate places along stream banks and by ponds (e.g., low areas and other places where concentrated runoff flows into the water body).
- Do not zone property for industrial use unless central water and sanitary sewer systems serve it.

WATER AND SEWER

Public water, storm sewer, and sanitary sewer systems are often necessary to ensure that development in environmentally sensitive areas is benign. Those essential services also make more intensive development of an area feasible, possibly preserving other land from development.

The provision of central water, storm, and sanitary sewer systems can be used as a tool to guide development. They should not be extended to areas that a community wants to preserve. Municipalities should also be careful of extending water lines without complimentary sanitary and storm sewer service. Increased development could necessitate the extension of sewer lines in the future at an increased cost. In the meantime, that increased development could be harming water quality. Municipalities should consider the following:

- Include background information within the land use plan regarding the number of households that depend on water and sanitary sewer versus well and septic.
- Car washes and other enterprises that use a lot of water should dispose of water in a sanitary sewer or on-site in some type of detention/filtration system before entering a storm sewer, stream, or body of water.

ILLEGAL DUMPING AND LITTERING

Illegal dumping and littering can have an effect on water quality. Runoff and floodwaters can pick up trash and other contaminants when flowing through discarded materials, whether it is the occasional candy wrapper, old refrigerator, or a hazardous substance. Municipalities may want to consider enacting littering and dumping ordinances through which fines can be levied upon violators.

ANALYSIS OF POSSIBLE WATERSHED INSTITUTION STRUCTURE

From the outset, discussions concerning watershed planning for the Upper Grand River identified the need to identify or create a central entity that would provide continuity for watershed planning and implementation after the Watershed Management Plan was completed. Michigan has a long history of watershed management, and several previous studies exist describing the various options available and experiments that have been tried.

TTMPS reviewed information available from existing watershed management organizations in Michigan and elsewhere; previously published reports summarizing the pros and cons of various watershed management models in place in Michigan, elsewhere in the United States, and in Canada (Brenner et al 1998, Donohue 1993, MGRWC 1976, River Network 1999, USEPA 2001), and interviewed County Drain Commissioners and representatives of other organizations (e.g., GREAT, Dahlem Environmental Education Center, R2PC) within the watershed to identify their concerns and opinions regarding what was needed, and to identify which existing organizations/agencies may be interested in housing or becoming a watershed organization. The most promising of those, based on Michigan-specific success and/or enabling legislation, are summarized below.

POTENTIAL INSTITUTIONAL MODELS

Ad Hoc Act 200 Agreements

The Intermunicipality Committees Act of 1957 (Act 200, P.A. 1957) provides a mechanism by which two or more municipalities can formally convene "for the purpose of studying area governmental problems of mutual interest and concerns, including such matters as facility studies on sewers and sewage disposal, water, drains, roads, rubbish and garbage disposal, recreation and parks, ports, …" Such alliances, or intermunicipality committees, may formulate recommendations for review and action by member municipalities. Cities, villages, townships, and any other incorporated political subdivisions of the State are eligible to convene under this Act.

Act 200 agreements have been widely used within Jackson County to develop several components of this watershed management plan or related planning activities, including the creation of regional wastewater treatment systems, storm water management planning, wellhead protection, and development of the County's Comprehensive Master Plan. These arrangements have been used not only for planning, but also to pool funding for implementing projects of mutual interest. Even if another institutional arrangement for watershed management is developed for the Upper Grand River, Act 200 agreements may still be a useful tool for collective action and funding among watershed municipalities.

Partnership Agreement Model

Development of a "Partnership Agreement," as advocated in recent years by the Northwest Michigan Resource Conservation and Development Council (NWMRCDC) and the W.K. Kellogg Foundation, can serve as the principle vehicle for securing the support and involvement of policy makers and opinion leaders in the watershed. A Partnership Agreement, as defined by the NWMRCDC, is a "concise document that unifies diverse groups around a common cause or project." In-kind contributions from Agreement signatories and grants received by individual signatories provide the financial base for operations, which are largely coordinative, information-sharing, advisory, and public participation/education in nature. This was the form originally taken in the Traverse City area in creating the Grand Traverse Bay Initiative.

It is a somewhat fragile model in that it depends on the motivation and cooperative spirit of Agreement signatories. It provides a forum for discussion and information sharing, but is generally dependent on individual Agreement signatories for action. This model provides no institutional stature; funding support must be secured through other institutions that have other priorities and funding needs to address as well.

Actions to fine-tune the model might include clarification of the organizational structure. Formalizing a board of directors to be elected by the Agreement signatories, for example, is one means of raising the profile of watershed management efforts in the Upper Grand River basin and providing a sense of "ownership" for all Agreement signatories. Consideration may also be

given to expanded committees and committee activities. Requiring a base level of active support for, and involvement in, watershed management efforts could enhance actions conducted by the Agreement partners. An "action agenda" might be developed that explicitly identifies one or more goals in the Partnership Agreement vision statement that each signatory commits to implement.

Initiative Office Model

A further enhancement of the "Partnership Agreement" model, the "Initiative Office" model, establishes a distinct "Watershed Initiative Office" that lends a sense of identity, formality, and permanence to the initiative. The Partnership Agreement would remain the basis for Watershed Initiative efforts, and a committee structure populated by Agreement signatories would serve as the primary vehicle for addressing the Watershed Initiative's vision statement and goals.

A Watershed Initiative Office would be formed as the locus for coordinating watershed planning and management activities. The Office could be physically located with another local agency or organization to share costs, benefit from the affiliation with another organization, and share access to professional and support staff as needed. However, the Initiative Office should have its own identity, name, letterhead, logo, telephone number, core staff, and operating policies.

This option allows 501(c)(3) non-profit organization status, so that the Watershed Initiative Office would have access to competitive grant and philanthropic funding. A nominal membership dues arrangement with Partnership Agreement signatories could provide base support for a small staff and essential functions.

This model option lends itself primarily to the functions of coordination, information/education, and advisory services, as does the Partnership Agreement model. However, this model allows for programs specific to the Watershed Initiative Office to be developed since it provides opportunities to secure donation and grant funding. As such, the Office could develop specialized expertise in watershed planning, policy development, data analysis, etc., that could be provided on a fee-for-service basis or, at least, set the Watershed Initiative office apart as a vital entity.

This model does not provide for a truly independent, self-supporting institution. Sharing of space and/or staff with another agency or organization may be seen as problematic to other individual or potential Agreement signatories. The Initiative Office would have no regulatory authority or coercive power so its ability to address priority issues such as growth management, nonpoint source pollution, etc., would be a function of its persuasive powers and collaboration with individual member agencies that may have great enforcement powers.

The Initiative Office may be a useful transition model while laying the groundwork for Watershed Council or one of the other following models. In Michigan, an example of this model exists in the Grand Traverse Bay Watershed Initiative. The Grand Traverse Bay Watershed Initiative (now the Watershed Center Grand Traverse Bay) began under the Partnership Agreement model, later developed an Initiative Office, and still later incorporated as a private 501(c)(3) nonprofit organization that is now an affiliate of the national organization, Bay Keepers.

Independent, Private 501(c)(3) Nonprofit Organization

Creation of a nonprofit organization separate from existing agencies and organizations allows yet greater autonomy and a more independent organizational profile. Like the Initiative Office model, an independent nonprofit organization may develop specialized expertise in watershed planning, policy development, data analysis, or other services that local agencies/organizations might come to rely on. These services could provide a revenue stream for support of key staff and programs. Likewise, Internal Revenue Service designation as a 501(c)(3) nonprofit organization provides opportunities to secure grant funding and allows individual and corporate donors to receive tax benefits for charitable contributions. Private nonprofits, like most models for watershed management institutionalization, have no regulatory or coercive power to ensure protection of watershed resources. The ability of an organization to be involved in decision-making is ultimately dependent on their standing and respect in the community, built over time, and the services they provide.

Examples of private nonprofit organizations in Michigan that focus on watershed management include the Tip of the Mitt Watershed Council (TOMWC) based in Petoskey, and the Clinton River Watershed Council (CRWC) based in Rochester Hills.

The TOMWC is a highly successful nonprofit organization serving a three-county area, rather than a particular watershed. They provide technical assistance to landowners, water quality sampling, and public education. TOMWC, more than most other Michigan watershed organizations, also works outside of their immediate service area on a number of Statewide and Great Lakes Regional policy initiatives in the areas of land use planning, wetland protection, and other issues. They have even served as contract consultants providing municipal wetland ordinance oversight services to at least one community over two hundred miles from their core service area. The TOMWC was formed collectively by a number of local lake associations to provide technical services and to provide a greater voice for the protection of northwest Michigan water resources.

The CRWC was originally formed under the Michigan Local River Management Act (see following discussion on the Watershed Council model), but later reorganized as private not-for-profit, with a more diverse mix of governmental representatives, business interests, and interested individuals making up their Board of Directors.

Watershed Council/Coalition Model

Michigan's Local River Management Act (Act 253, P.A. 1964) was created as enabling legislation for watershed councils, districts, and authorities. These were conceived of as a sequence wherein an organization would grow in authority and powers from a watershed council with voluntary membership to a watershed district for which membership of all municipalities in a watershed would be required, to a watershed authority that could conceivably have limited regulatory powers and the ability to assess costs for specific projects. Of these levels, only watershed councils have been created since the law was enacted.

The Act allows local governmental units to "cooperate in planning and carrying out a coordinated water management program in the watershed in which they share." Originally, two or more governmental units could petition the Michigan Water Resources Commission (MWRC) for the creation of a watershed council. That power was passed to the Natural Resources Commission when MDNR and MDEQ were reorganized and the Water Resources Commission abolished.

Watershed Councils formed under this model are partnership-based, quasi-governmental organizations with core membership and base funding provided by member municipalities and counties. Voting power and funding responsibility are generally apportioned based on area within the watershed, population, or some mix of these factors. Watershed councils have their own separate identity like private nonprofit organizations with the ability to accept donations and grant funding or to provide services on a fee basis, in addition to receiving funding in the form of municipal dues.

The Huron River Watershed Council (HRWC) was the first watershed council in Michigan formed under the Local River Management Act. Its history actually pre-dates the Local River Management Act. It was first created in 1957 under the Intermunicipality Committees Act (Act 200, P.A. 1957). Municipal representatives active in that effort worked with the Michigan Legislature to craft the Local River Management Act and shortly thereafter petitioned the WRC to create the HRWC. The HRWC is a public, 501(c)(3) nonprofit organization. Membership in the HRWC was originally limited to municipalities on a voluntary basis, but they have subsequently opened both membership and board of directors representation to individuals and businesses in order to be more inclusive and to diversify involvement and funding.

Programs of the Council are similar to those listed for the TOMWC, with the exception that policy issues are generally confined to those directly applicable to the area bounded by the limits of the Huron River Watershed or to issues of State regulations that impact water resources of the Huron River Basin. Funding sources include grant funding from Federal and State sources and private foundations, fee-for-service/consulting services, individual and corporate donations/ membership dues, municipal government membership dues, and payroll deduction donations

through the Environmental Fund for Michigan. The HRWC has found that its quasi-governmental but independent status affords it the ability to propose projects and plans that inter-community rivalries would often prohibit if similarly proposed by an individual government or agency.

The CRWC also began under the Local River Management Act model but found, in the socio-political setting of the Clinton River Watershed, that this same quasi-governmental status was a limiting factor in its success and so reorganized as previously mentioned. The Michigan Grand River Watershed Council formed shortly after the HRWC in 1966, also under the Local River Management Act. It conducted regional planning initiatives, stream monitoring programs, soil erosion and sedimentation control education, and other services. It was disbanded in 1976 due to shrinking membership and the resulting budget constraints. These were driven in part by Federal 208 funding for regional planning being directed to regional planning groups based on county boundaries. The Michigan Grand River Watershed Council may also have been a victim of too much geography. The Council encompassed both the Upper and Lower Grand River Subbasins – a lot of land with many communities with differing dynamics, alliances, and issues.

PLAN RECOMMENDATIONS

Protection of water quality in the Upper Grand River Watershed and restoration of impaired uses will require implementation of numerous strategies and actions by many individuals and organizations. This section is the "plan" portion of this Watershed Management Plan. It contains a variety of recommended strategies based on the analyses presented in earlier sections of this report and other discussions of the work groups (subcommittees) charged with developing portions of this plan.

Recommended strategies include: (1) recommendations for the organizational model(s) for institutionalizing watershed management in the basin that may work best based on the experience and make-up of groups currently working on watershed management issues, (2) recommendations for new programs for watershed education, (3) recommendations for improved land use policies, (4) recommendations specific to wetland protection within the river basin, and (5) recommendations for best management practices to reduce nonpoint source pollution inputs to the Upper Grand River and its tributaries.

WATERSHED MANAGEMENT INSTITUTIONALIZATION STRATEGY

In our interviews on this subject, representatives of existing organizations and agencies suggested the Grand River Environmental Action Team (GREAT), the Dahlem Environmental Education Center (in partnership with Jackson Community College), or R2PC as possible entities to either provide watershed planning and management as a set of programs and services or to evolve into a watershed organization. Much of the existing and past watershed planning projects are being, or have been, conducted by the Grand River Inter-County Drainage Board or by communities working together under Act 200 agreements.

All of these organizations are indeed doing great and needed work within the Upper Grand River Basin. However, as they currently exist, they are limited in geographic scope, programmatic scope, and/or representation. As such, the WMP recommends the creation of an organization that

will encompass the entire watershed (the Upper Grand River Subbasin is recommended as the limit of geographic focus).

Based on review of the history and successes of different watershed management institutional models in Michigan and our interviews and work with existing organizations and agencies in the Upper Grand River Basin, TTMPS recommends that municipalities and organizations currently involved in watershed planning within the Upper Grand River Basin begin the process of creating an independent watershed council or nonprofit organization that would serve to coordinate the actions of individual organizations and agencies, as well as initiate programs of its own to protect the water resources of the basin. We suggest that this process be started following the Watershed Initiative Office model, using Act 200 agreements among interested communities to provide startup funding. This would allow continuity for implementing recommendations of this Watershed Management Plan while the organization applies for 501(c)(3) status, and watershed council creation under State statute, if the latter is deemed appropriate.

This entity could be designed as either a private or public nonprofit organization. The selection of either the private 501(c)(3) model or the watershed council model should be based on a reasoned analysis of local politics and resources. The Upper Grand River Watershed Planning Initiative Steering Committee has stated that this organization serve two primary purposes: 1) the facilitation of coordinated watershed management and 2) to serve as a land trust or conservancy for the protection of lands of ecological values and value in water quality protection (see wetland protection recommendations later in this section).

PUBLIC AWARENESS

While no surveys have been undertaken to assess the level of public understanding of water quality issues and related recreational activities, support for various river-related activities is evident throughout the watershed. In 1990, the Grand River Expedition, a flotilla of approximately 65 canoes carrying researchers, scouts, public officials, teachers, and interested individuals paddled from the headwaters of the Grand River at Grand Lake downstream to the river's outlet at Lake Michigan. At each stop, educational displays were exhibited and community and expedition members shared stories concerning the Grand River and what it

meant to their lives. Ten years later, a smaller expedition paddled the Grand River beginning at Wolf Lake to commemorate the anniversary of the first flotilla, evaluate improvements in water quality, and again, reach out to raise public awareness.

GREAT has sponsored annual river clean-ups in the Jackson area since 1987. These clean-ups attract an average of 60 interested citizens to volunteer in the clean up. These events have been well covered by the local media and have received occasional financial support in the form of corporate sponsorship or MDEQ grants.

Media coverage of the City of Jackson's many water quality improvement projects has also increased public awareness concerning the river. Day-lighting the river downtown and the development of the Farmer's Market adjacent to the restored river section have made the river visible once again in an urban setting. The separation of combined storm and sanitary sewer systems has played a significant role in improving water quality and has also received good media coverage.

Not all media coverage highlights improvement. In the spring of 2000, a gas line broke in Blackman Township spilling approximately 50,000 gallons of refined gasoline into Tobin Creek. This event and related media coverage highlighted the river's vulnerability to human impacts.

Other organizations in the watershed also provide programs designed to raise public awareness of the Grand River and its tributaries. The Dahlem Environmental Education Center (Dahlem Center) provides tours and workshops that focus on river-dependent species and their habitat. JCCD provides tree planting guidance and tree sales, and the Natural Resource Conservation Service offers cost-share programs to stabilize riparian areas. County-based Michigan State University Extension offices provide Master Gardener classes throughout the region, which focus on environmentally safe planting practices. County enforcing agencies, like the Ingham and Jackson County Drain Commissioners, work with developers, builders, and township officials to implement soil erosion and sedimentation control practices.

The Section 319 Watershed Planning Grant, which provided funding to develop this Watershed Management Plan, also provides funding for development, production, and dissemination of the first product in a watershed public education campaign. The Public Education Subcommittee with the consulting services of Lisa Brush developed that public education plan, consisting of both a marketing campaign and outreach programs. The process followed in developing the plan included identifying and prioritizing key water quality issues in the Upper Grand River basin, identifying and prioritizing target audiences whose behaviors contribute to these water quality problems or threats, identification of the messages needed to change behaviors of these audiences relative to key water quality, and prioritization of the messages to start off this campaign.

The design for the marketing campaign and initial thoughts on developing the accompanying outreach campaign are summarized below. The full report developed by Lisa Brush is provided as Appendix F.

Public Education Action Plan

Marketing Campaign

This piece of the public education campaign uses media strategies employed in the field of consumer advertising and marketing to provide coordinated educational messages to individuals in the watershed. The goal of the marketing campaign is to reduce nonpoint source pollution to the Upper Grand Watershed by seeking to reinforce and/or change key target audience behaviors.

Target Audiences and Behaviors

The Upper Grand River Watershed marketing campaign will target household residents. The determination to target households was based on the potential for this audience to impact non-point source pollution and on the probability of successfully reaching this audience through a marketing campaign. Other target audiences, agricultural producers, businesses, land developers, and local decision-makers, may be targeted through parallel outreach efforts. Households and the messages they will receive through this campaign will be further categorized and targeted as rural, urban, or riparian households as presented below:

- **Urban Residents:**
  1. Increase awareness of the Grand River Watershed community and the water cycle within it.
  2. Reduce the irresponsible use of, and increase the responsible use of, fertilizers and pesticides.

- **Rural Residents:**
  1. Increase awareness of the Grand River Watershed community and the water cycle within it.
  2. Reduce the irresponsible use of, and increase the responsible use of, fertilizers and pesticides.
  3. Proper septic system maintenance.

- **Riparian Residents:**
  1. Increase awareness of the Grand River Watershed community and the water cycle within it.
  2. Reduce the irresponsible use of, and increase the responsible use of, fertilizers and pesticides.
  3. Installation and maintenance of buffer strips along water bodies and changing mowing practices that will result in increased water quality.

Tactical Approach

This campaign will consist of a program utilizing the following media channels:

- Print advertising
- Direct-mail
- Radio advertising
- Point of contact
- Publicity

Materials Required

The following materials will be required in support of this campaign:

Print advertising pieces aimed at:

1. Increasing the awareness of the Grand River Watershed community and the water cycle within it.
2. Reducing fertilizer use, as well as increasing the proper use of fertilizer (for example, not fertilizing right before a rain, sweeping up and disposing of fertilizer spread on hard surfaces, applying the proper amount, finding out what fertilizer is needed by testing soil before application).
3. Proper septic system maintenance.
4. Installation and maintenance of buffer strips along water bodies and changing mowing practices that will result in increased water quality.

Direct-mail pieces aimed at:

1. Increasing the awareness of the Grand River Watershed community and the water cycle within it.
2. Reducing fertilizer use, as well as increasing the proper use of fertilizer (for example, not fertilizing right before a rain, sweeping up and disposing of fertilizer spread on hard surfaces, applying the proper amount, finding out what fertilizer is needed by testing soil before application).
3. Proper septic system maintenance.
4. Installation and maintenance of buffer strips along water bodies and changing mowing practices that will result in increased water quality.

Radio advertising aimed at:

1. Increasing the awareness of the Grand River Watershed community and the water cycle within it.
2. Reducing fertilizer use, as well as increasing the proper use of fertilizer (for example, not fertilizing right before a rain, sweeping up and disposing of fertilizer spread on hard surfaces, applying the proper amount, finding out what fertilizer is needed by testing soil before application).
3. Proper septic system maintenance.

4. Installation and maintenance of buffer strips along water bodies and changing mowing practices that will result in increased water quality.

Point of Contact/Sale

Opportunities exist to further the reach of the campaign by implementing a point of contact, or point of sale, campaign. This effort would target audiences in locations where residents conduct, or purchase materials for the targeted behaviors. For example, a program promoting soil testing to reduce the use of lawn fertilizers may be conducted through local fertilizer retailers (e.g., Lowes, Home Depot, etc.) in conjunction with Michigan State University Extension (MSUE). Print and radio advertising delivering the same or complimentary information would support information provided at the point of sale.

Web site

A Web site could provide invaluable support for the marketing campaign and could be used as an evaluation tool. A Web site should be developed that supports the information delivered through the above approaches. It may also contain a short survey that can be used for evaluation. For example, as the Web page opens, a survey could appear that would ask how the viewer learned about the Web site, and could query the viewer regarding their understanding of issues in the watershed.

Publicity

Public service announcements (PSAs) and press releases can be used to further disseminate campaign messages. Agencies involved in watershed planning efforts are encouraged to spend some time getting to know local reporters and radio station managers, and learning more about their preferences for information formats and deadlines. Developing these relationships will save time and help to ensure that information provided to these media outlets is disseminated to the public.

Services Needed

Professional Graphic Artist

An individual or firm should be contracted to create the materials required by this campaign. It is recommended that this be someone who can provide a full spectrum of design, writing, and editing services, and oversee the production process and delivery of print-ready materials.

Photography

A professional photographer should be contracted to provide photographs for use in the various advertising and collateral pieces.

Mail House

Given the quantities of materials to be disseminated in the campaign, a mail house should be contracted to address, post, and mail the direct-mail pieces for this campaign, and to assist the watershed initiative in developing materials that will take advantage of the lowest postage rate(s).

Web Designer and Master

A Web designer should be contracted to design a Web site. A Web master will also need to be designated (whether that is a staff person or a consultant) to maintain the Web site.

Additional Contractual Personnel

Additional contracting of specific personnel may be required depending on the expertise of the campaign staff. For example, staff may be able to write radio-advertising material and then seek feedback on it from radio station managers, or this may need to be contracted out to a professional.

Evaluation

Evaluation should take place on many levels. Examples include:

- Pre- and post-surveys via direct main and/or telephone.
- Tracking responses to phone number listed on educational materials.
- Tracking hits on website.

- Follow-up on point of contact/sale programs (e.g., the number of people participating in soil testing promotion).
- Focus groups.
- Photo monitoring points along water bodies that have been targeted for buffer installation.

Coordination

Development and dissemination of marketing and educational materials, as outlined in this plan, provide opportunities for coordination with the educational requirements of Federal Phase II Storm Water Program regulated communities in the watershed. These communities are required to develop and disseminate educational materials and programs regarding storm water management. Common programs among municipalities and agencies can provide cost savings as well as a more effective, coordinated message(s).

Outreach Campaign

Like the marketing campaign, the goal of the outreach campaign is to reduce non-point source pollution to the Upper Grand Watershed by seeking to reinforce and/or change target audience behaviors. While still under development, components of the outreach campaign are expected to target agricultural producers, businesses, land developers, local decision-makers, and watershed residents.

The Education Subcommittee of the Upper Grand River Watershed Planning Initiative Steering Committee will identify target behaviors and prioritize the list as was done for the marketing campaign. The outreach campaign will seek to open a dialogue with the target audiences and work with them to change and reinforce the identified behaviors. The outreach program may make use of:

- Community talks and a speaker's network,
- An "Adopt-A-Stream" volunteer monitoring program,
- Training and networking sessions,
- Needs assessments,

- Development of household hazardous waste drop-off days, and
- Special events (e.g., fairs, festivals, river trips, etc.).

Evaluation and assessment will be critical for the continual improvement of this program. The outreach strategy will need to include elements that examine the impact of the campaign on behavior change, and track the physical resources used to achieve the goal. It will be important to track information regarding activities, participation, reactions, changes in knowledge, skills, attitudes, and aspirations of the target audiences, and changes in behaviors.

Adopt-A-Stream Volunteer Monitoring Program

One anticipated element of an outreach campaign is a volunteer monitoring program patterned, in part, after the Huron River Watershed Council's Adopt-A-Stream Program. Such programs have been highly successful elsewhere in recruiting and training citizen volunteers to monitor and protect river tributaries.

The Dahlem Center, with similar programs already in place, is a natural entity to oversee such a program. Dan Ashton, Executive Director, developed an outline for an "Adopt-A-Stream" volunteer monitoring program. This program design is summarized below. Mr. Ashton's full report is provided as Appendix G.

The purpose of the program will be to recruit and train citizen volunteers to monitor the health of the Upper Grand River and its tributaries and to develop a database of long-term, coordinated, high-quality data for the Upper Grand River system. Goals of the program include the following:

- Increase public awareness of the watershed's non-point source pollution and water quality issues.
- Provide citizens with the tools and training to evaluate and protect their local waterways.
- Encourage partnerships between citizens and their local government.
- Collect quality baseline water quality data.

Three principle objectives in fulfilling these goals are:

Objective 1: Evaluate the benthic invertebrate communities in wadeable streams and rivers to assess ecosystem health and to inventory species and their distribution.

Identify and inventory the proposed sampling sites listed above.

Sample twice per year.

Identify potential indicator species for pollution.

Map distribution of species.

Objective 2: Improve water quality in the Upper Grand River and the entire watershed by eliminating sources of pollution.

Identify surface water sampling points at tributtary confluences with the Upper Grand River.

At each confluence, collect water samples at one to three sites near the confluence.

At each site test for:

- Dissolved Oxygen
- *E. coli* (to be conducted by Environmental Health Department)
- pH
- Biochemical Oxygen Demand (BOD)
- Temperature
- Total Phosphorus
- Nitrates
- Turbidity
- Total Solids

Objective 3: Develop a Citizen Riparian Network:

Provide hands-on, real life options for citizen action.

Provide activities to make a difference in the health of the adopted stream, river, lake, or wetland.

The Adopt-A-Stream program will target adult learners to monitor the health of streams in the Upper Grand River Watershed. Volunteers will be recruited to both participate in and help develop the Adopt-A-Stream Program. Initial volunteer training and data collection will focus on

the collection and analysis of benthic macroinvertebrate assemblages, with the sampling program growing over time to include collection and testing of water samples for chemical analysis.

Sampling locations will be coordinated with sites previously described regarding bacteriological monitoring in the Upper Grand River Watershed. However, it is likely that the program will need to start small with a subset (approximately eight) of these sites serving as a pilot for the program. These locations will be sampled twice per year for benthic macroinvertebrates. Additional sampling sites will be added as the program grows. Lakes could also be included in the sampling as the program grows.

A resource coordinator (RC) may need to be hired to coordinate and oversee implementation of the program. The RC's duties could include training in stream sampling (data collection), macroinvertebrate identification, visual stream monitoring, and chemical monitoring. Other duties could include updating a project website, development of the riparian network, coordination of Dahlem Center participation in the overall marketing and outreach campaigns, and development of other courses, workshops, and seminars.

Other Outreach Programs

The Dahlem Center is also involved in developing several other educational/training activities to begin in January 2003. A new Jackson Community College course, Environmental Science 142, will be offered at the Dahlem Center beginning in January 2003, and a watershed management short course was e held on the campus of Albion College in March 2003. A workshop on sampling and identification of benthic macroinvertebrates is planned for April/May 2003.

LAND USE POLICY RECOMMENDATIONS

Based on their review of local land use plans and policies, R2PC staff recommends that municipal governments in the watershed incorporate the following recommendations in their land use plans and zoning ordinances:

- Local governments are encouraged to update their land use plans and zoning ordinances every five years. State regulations mandate that land use plans be updated every five years.

- Land use plans should be developed before the zoning ordinance, and zoning ordinances should be updated after updates are made to municipal land use plans, making linkages between the two documents.
- Zoning ordinances should include an environmental protection provision to the "Purpose(s)" section.
- Buffer strips requirements should be incorporated in zoning or building ordinances where land and water meet to protect water quality.
- The purposes for zoning areas for open space and agriculture differ. Designation as open space is intended to preserve natural features and to protect water quality. The aim of agricultural districts is the preservation of prime and unique farmland. Likewise, the tools and policies used to protect these areas differ. As such, land use plans should establish separate districts for agricultural preservation and open space preservation.
- To reduce suburban sprawl, zoning ordinances listing single-family detached homes as a permitted use by right in agricultural districts should be revised to reduce single-family homes to a conditional use in agricultural districts.
- Land use plans should include background information on the impacts of development and the importance of environmental protection.
- Zoning ordinances should require information be placed on site plan maps regarding lands adjacent to the proposed site. Checklists concerning minimum environmental protection measures are also a useful for tool for site plan review.
- When developing or revising their land use plans, municipalities should include information regarding the number of households served by central water and sewer systems versus individual well and septic systems. Land use plans should also contain inventories of environmental features including environmentally sensitive corridors, groundwater recharge areas, open space, wetlands, floodplains, and an analysis of soils suitable for, and poorly suited for, new construction.
- The use of open space development design is encouraged in lieu of large lot single-family housing zoning to reduce land consumption, protect natural resources and farmland, and maintain the rural character of communities.

WATER RESOURCE POLICY RECOMMENDATIONS

Inter-Basin Wastewater Transfers

As mentioned previously in the section on Water Quality, several river and tributary segments or lakes in the Upper Grand River Watershed have been identified and scheduled for development of total maximum daily load (TMDL) pollutant allocations and reduction strategies. Likewise, waters in neighboring watersheds (e.g., the Kalamazoo and Huron River Watersheds) have had TMDLs developed and load restrictions placed on them.

Moratoriums on additional nutrient loads in adjacent watersheds have created water quality and land use planning issues that involve cross-watershed boundary transfers of waste discharges and the resulting impacts to receiving waters. For example, a mobile home park and accompanying wastewater treatment system were recently proposed in the western Huron River Basin. TMDL restrictions in the Huron River Watershed precluded MDEQ from issuing a permit to discharge treated wastewater to a tributary of the Huron. The permit was eventually issued allowing discharge across the watershed divide into waters tributary to the Upper Grand River. A second similar wastewater discharge to the Portage River system near Stockbridge is currently under review by the MDEQ and local communities.

With stringent phosphorus limits already in place in two neighboring watersheds, this is likely to occur with increasing frequency. Such trans-boundary discharges will only serve to heighten the restrictions placed on both current and future dischargers in the Upper Grand River Basin, including municipalities that may become responsible for reduction of nonpoint source pollutant reductions to meet TMDL limits currently under development.

Local communities have few tools with which to review these wastewater transfers and little, if any, recourse under their existing policies to halt such transfers if deemed necessary. As such, the Upper Grand River Watershed Planning Initiative Steering Committee recommends that:

- All inter-watershed wastewater transfers be directed to regional wastewater treatment facilities and prohibited from discharging directly to the Upper Grand River or its tributaries.

- Communities within the Upper Grand River Watershed should incorporate such language within their land use, drainage, or storm sewer use policies and require franchise agreements for the disposal of wastewater.
- Sewage should be treated to improve water quality through continuous implementation of better treatment technologies.

Extraction of Surface and Groundwater

Upper Grand River Watershed communities and individuals are not only concerned with the transfer of treated wastewater into the Basin, but are also concerned about the potential for large-scale removal of surface water or groundwater resources. The Upper Grand River Watershed is currently home to a spring water bottling plant, and the company has been studying the possibility of another plant to extract groundwater for bottling, distribution, and sale. Other Michigan communities have faced similar land use and water policy issues raised by water bottling plants in recent years.

Because existing water quality standard violations for dissolved oxygen in portions of the Upper Grand River system are exacerbated by low stream flows, any potential reduction in groundwater recharge to streams is a serious concern for Watershed communities. The Upper Grand River Watershed Planning Initiative Steering Committee adopts, as part of this plan, the stated policy of the Michigan Farm Bureau opposing diversion of water in its natural state from the Great Lakes Basin. The Steering Committee further requests that MDEQ and County Health Departments solicit the opinion of potentially affected municipalities, and other interest groups when reviewing permit applications for wells or water withdrawals of this kind.

RECOMMENDATIONS FOR WETLAND PROTECTION AND RESTORATION

Recommendations to restore and preserve wetlands presented here are general and apply to the watershed as a whole rather than for specific sites. The inventory conducted by the Jackson County Conservation District identified potential restoration sites, but recommendations for specific sites will require further analysis of site-specific conditions and discussions with individual landowners.

- Landowners should to be informed of wetland benefits and the problems caused by wetland degradation.
- Landowners should be encouraged to participate in restoration and preservation of wetlands.
- Land conservancies or trusts have proliferated across Michigan, but none is specific for Jackson County. A Jackson County or Upper Grand River land conservancy should be formed that would hold conservation easements on special interest lands (e.g., wetlands, farmland, forestland, etc.) to permanently prevent future development while leaving the land in private ownership.
- Landowners should be informed about opportunities to participate in wetlands programs and assistance that various agencies provide (e.g., USDA Wetland Reserve Program, U.S. Fish and Wildlife Service Partners for Fish and Wildlife, and Ducks Unlimited MARSH programs).
- Designating the Portage River Watershed a Conservation Enhancement Program (CREP) area would increase payments for the restoration, enhancement, and preservation of wetlands. Wetlands in additional subbasins should also be inventoried for restoration potential. Only two of 37 subbasins have been surveyed. Priority should be given to inventory subbasins with cropland subject to flooding (e.g., Unnamed Tributary, Orchard Creek, Cahaogen Creek, etc.).
- Local units of government are encouraged to adopt ordinances regulating wetlands smaller than five acres, which are largely unregulated by the State of Michigan.
- Wetland Mitigation - Michigan Wetland Protection law authorizes MDEQ to require actions to mitigate the loss of wetland area and function. Landowners with restorable wetlands can sell development easements for those wetlands to developers needing mitigation.
- Wetland Mitigation Banking - A wetland mitigation bank is a site where wetlands are restored, created, or in exceptional circumstances, preserved expressly for the purpose of providing an off-site alternative to compensate for authorized wetland loss. MDEQ may authorize the use of credits from an established mitigation bank.

Landowners with wetlands that qualify for banking may sell credits to developers. Last year, Jackson County applied for a grant to develop a wetland mitigation bank and banking system for new development. Communities in the Upper Grand River Watershed are encouraged to pursue this further as a land use planning tool.

Landowners are encouraged to implement conservation management practices (USDA, 2001) such as those listed below to help restore and enhance wetlands degraded by past activities.

- **Conservation Cover -** Planting herbaceous cover in uplands surrounding wetlands will improve and protect water quality by reducing the amount of sediment and other pollutants, and provide wildlife habitat where it is not feasible or desirable to establish woody vegetation. Warm-season grasses provide long-term vegetative cover but are slower to establish than introduced species. Native plants are usually better adapted to local conditions, are more resistant to diseases and insect problems, and provide better nesting and winter cover than introduced species. Introduced grasses and legumes (cool season) will live for 10 to 30 years, grow fairly fast, and are usually easier to establish than native grasses. Introduced species should be used only when there are no alternative native species and the introduced species are not invasive.
- **Riparian Forest Buffers -** Areas with trees and shrubs adjacent to water and up gradient from watercourses and wetlands that filter out pollutants, create shade, and provide wildlife habitat.
- **Tree and Shrub Establishment -** Establishing woody plants by planting or seeding will provide erosion control and wildlife habitat.
- **Wetland Enhancement -** Enhancement includes the modification or rehabilitation of an existing or degraded wetland where specific functions or values are modified for the purpose of favoring specific wetland functions or values. Examples include managing hydrology for waterfowl or amphibian use or managing plant community composition to favor native plants.

- **Wetland Restoration** - Rehabilitation of drained or degraded wetland where the soils, hydrology, vegetative community, and biological habitat are returned to the natural conditions to the greatest extent possible.
- **Wetland Wildlife Habitat Management** - Retaining, developing, or managing habitat for waterfowl, fur-bearers, or other wetland-associated flora and fauna.

RECOMMENDATIONS FOR SOIL EROSION AND SEDIMENTATION CONTROL WITHIN RIPARIAN ZONES

Reducing bank erosion and sedimentation with riparian conservation practices will improve water quality and reduce agricultural flood losses. Specific purposes of riparian conservation practices are to:

- Remove sediment runoff from croplands, grazing lands, and disturbed areas.
- Remove nitrogen, phosphorus, pesticide, and pathogen runoff from cropland, grazing land, and disturbed areas.
- Recharge groundwater and reduce flooding by increasing infiltration.
- Provide wildlife habitat.

The recommendations presented here to reduce soil erosion and sedimentation apply to the two sub-basins assessed in general rather than to specific sites.

- Landowners should to be informed of the extent and severity of soil erosion and sedimentation in the Portage River Watershed.
- Landowners should be encouraged to participate in riparian conservation practices that will control soil erosion and sedimentation.
- Soil Rental Rates approved for Conservation Reserve Program practices should be raised as an incentive for landowners to participate in cost-sharing practices. Soil Rental Rates are based on the average rental rate for cropland in a county. Then the rate is adjusted based on the productivity of the soil. Approved Soil Rental Rates for similar soils in Jackson County are lower than the rates in the surrounding counties. Present rates for

conservation practices cannot compete with income earned from farming erosion-prone areas.

- Designating the Grand River Watershed, or at least the Portage River portion, a Conservation Reserve Enhancement Program (CREP) area would increase payment rates for practices such as riparian buffers, filter strips, etc.
- Implementing conservation management practices (USDA, 2001) such as those listed below will significantly reduce erosion and sedimentation. Some of these practices deal with the stream channel, others with stream bank, and some with the area beyond the riparian zone, but all reduce soil erosion. Additional information regarding BMPs may be obtained from the USDA Natural Resource Conservation Service web site: www.nrcs.usda.gov/technical/efotg/.
  - **Cover Crops** – Grasses, legumes, forbs, or other herbaceous plants established for seasonal cover reduce the potential for erosion from wind and water.
  - **Conservation Crop Rotation** – Growing crops in a recurring sequence on the same field reduces erosion.
  - **Conservation Cover** – Establishing and maintaining perennial vegetative cover on land retired from agriculture reduces erosion and sedimentation and improves water quality.
  - **Critical Area Planting** – Planting vegetation such as trees, shrubs, vines, grasses, or legumes on high erodible or critical areas stabilizes the soil and thereby reduces damage from sediment and runoff to downstream areas.
  - **Cross Wind Trap Strip–Filter** – Herbaceous cover resistant to wind erosion, established adjacent to surface drainage ditches across the prevailing wind erosion direction will entrap wind-borne sediment to improve water quality.
  - **Filter Strips** – Narrow bands of grass or other permanent vegetation adjacent and parallel to streams will intercept undesirable contaminants from runoff before they enter a water body, thereby preventing pollution of surface water and groundwater.
  - **Grade Stabilization Structure** – A structure (earth embankments and mechanical spillways and full-flow or detention-type structures) used to control the grade in natural or artificial channels will stabilize the grade, control erosion, and prevent the formation or advance of gullies.

- **Grass Waterways -** Channels, usually constructed where natural watercourses occur, that are shaped and planted to suitable vegetation to protect soil from erosion, protect surface and groundwater and improve wildlife habitat.
- **Pasture and Hayland Planting** – Establishing and reestablishing long-term stands of adapted species of perennial, biennial, or reseeding forage plants will reduce erosion.
- **Residue Management, No-Till and Strip Till** – Managing the amount, orientation, and distribution of crop and other plant residue on the soil surface year-round, while growing crops in previously untilled soil and residue will reduce sheet, rill and wind erosion.
- **Residue Management, Mulch Till –** Managing the amount, orientation and distribution of crop and other plant residue on the soil surface year-round, while growing crops where the entire field is tilled prior to planting, will reduce sheet, rill, and wind erosion.
- **Residue Management, Seasonal –** Managing the amount, orientation, and distribution of crop and other plant residue on the soil surface during part of the year, while growing crops in a clean tilled seedbed, will reduce sheet, rill, and wind erosion.
- **Riparian Forest Buffers** – Areas with trees and shrubs adjacent to water and upgradient from watercourses will filter out pollutants, create shade, and provide wildlife habitat.
- **Riparian Herbaceous Cover** – Herbaceous cover will improve and protect water quality by reducing the amount of sediment and other pollutants, intercept solar radiation, create shade, and increase the depth-to-width ratio of streams where it is not feasible or desirable to establish wood vegetation. Planting native grasses will provide long-term vegetative cover, but are slower to establish than introduced species. Native plants are usually better adapted to our local conditions and are more resistant to diseases and insect problems. Introduced grasses and legumes will live for 10 to 30 years, grow fairly fast, and are usually easier to establish than native grasses. Introduced species should be used only when there are no alternative native species and the introduced species are not invasive.

- **Sediment Basin** – A basin constructed to collect and store debris or sediment will preserve the capacity of waterways, prevent undesirable deposition on bottom lands and developed areas, trap sediment originating from construction sites, and facilitate deposition and storage of silt, sand, gravel, stone, agricultural wastes, and other detritus.
- **Side Inlet Structures (Bubble Filter Strips)** – Rock riprap, grade stabilization structures, etc., trap pollutants before they can enter the stream. These are used where runoff is funneled into a water body by embankments, dikes, etc.
- **Stream Bank Protection** – Planting and maintaining trees, shrubs, and grasses, bank covers, riprap, etc., will help maintain the capacity of the channel, control channel meandering that may adversely affect downstream facilities, and reduce sediment loads.
- **Stream Crossing and Livestock Access** – A constructed stable area extending either into or across streams will minimize sediment and nutrient delivery where livestock gain access to streams.
- **Tree and Shrub Establishment** – Establishing woody plants by planting or seeding will provide erosion control.
- **Use Exclusion** – Excluding animal, people, or vehicles from sensitive riparian areas will reduce erosion.
- **Vegetative Barrier** – Permanent strips of stiff, dense vegetation along the general contour of slopes or across concentrated flow areas will reduce erosion, reduce gully erosion, manage water flow, stabilize steep slopes, and trap sediment.
- **Water and Sediment Control Basin** – An earth embankment or combination of a ridge and channel generally constructed across the slope of a minor watercourse to form sediment trap and water detention basin. Sediment control basins can reduce watercourse and gully erosion, trap sediment, reduce on-site and downstream runoff, and improve water quality.
- **Wetland Restoration** - Wetland acreage will improve ground and surface water quality, act as a flood control device by slowing water flow, and replenish groundwater and provide wildlife habitat.

NONPOINT SOURCE BEST MANAGEMENT PRACTICES

The following section is provided as guidance for local municipalities and agencies in each of the seven major subwatersheds of the Upper Grand River for the selection of appropriate water quality improvement BMPs. Appropriate BMPs recommended to address the key issues in each of the seven subbasins are identified, along with suggestions of who would be involved during implementation.

Storm water BMPs are activities, programs, or control methods used to protect and improve the environment, including water quality, habitat, and general quality of life. BMPs serve a wide variety of functions and can be structural, vegetative, managerial, and/or even chemical in nature. Erosion and sedimentation control, storm water infiltration and filtration, runoff control, stream bank stabilization, and public education are some of the ways BMPs can be implemented. BMPs provide a method for protecting our water environment. Many choices of BMPs are available for pollution prevention; the methodology described below offers a method to guide prioritization of BMPs for the Upper Grand River Watershed

Table 24 presents a list of general BMPs categorized by the three predominant land uses where BMPs are normally employed: (1) urban commercial/industrial, (2) residential, and (3) agricultural. These groupings aid in the assignment of potential BMPs to each of the major subbasins in the Upper Grand River. Development density, imperviousness, land use practices, and water quality concerns vary significantly between these three land uses. As a result, the selection of BMPs will also vary between the land uses. The BMPs in Table 24 have been assigned notations referring to their type: s, structural; v, vegetative; m, managerial; or c, chemical.

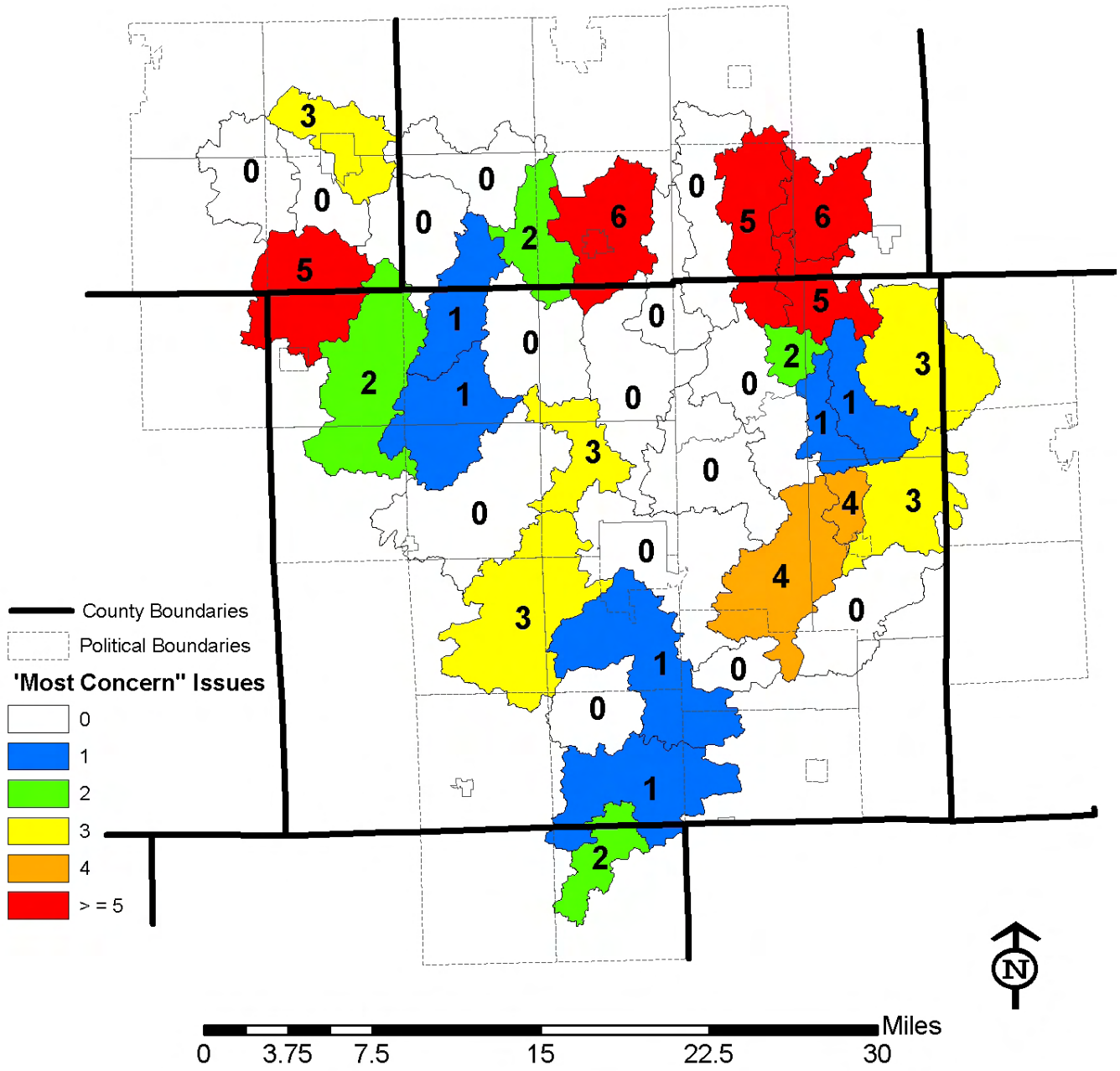
The GeoBook analysis of land use/land cover and the analysis of potential problem areas based on the land cover data was reviewed to determine the priority issues in each of the seven major subwatersheds. Mean values for each of the seven subwatersheds were calculated from the values assigned to the 37 smaller subbasins examined in the GeoBook analyses, weighted according to the land area of the individual minor subbasins. The following levels of concern were identified for each of the seven major subbasins and for each issue addressed in the

GeoBook analysis: very high, high, moderate, low, and very low. Figure 22 shows the number of "highest concern" rankings received by each of the 37 minor subbasins.

Table 24 - List of Potential BMPs

Agricultural	**Urban Residential (cont'd)**
Terraces (s)	Rooftop Storage (s)
Manure Management Systems (s)	Vegetated Roof (s)
Diversions (s)	Stream Bank Stabilization (s, v)
Stream Bank Stabilization (v)	Erosion Control Methods (s, v)
Erosion Control Methods (v)	Wet Ponds (s)
Constructed Wetlands (v, s)	Wet Basins (s)
Pocket Wetland (v)	without filtration systems
Pond/Wetland System (v)	with filtration systems
Buffers/Filter Strips (v)	Dry Ponds (s)
Grassed Swales (v)	without filtration
Grassed Waterways (v)	Dry basins (s)
Cover/Green Manure Crop (v)	on-line
Conservation Tillage (m)	off-line
Strip Cropping (m)	Infiltration Basin (s)
Contour Farming (m)	Infiltration Trench (s)
Nutrient Management (m)	Sand Filter/Filtration Basin (s)
Livestock Fencing (m)	Sand and Organic Filter (s)
Sediment and Water Control Basin (s)	Water Quality Inlet (s)
	with sand filter
Urban Commercial/Industrial	Inlet Devices (s)
Porous Pavement (s)	Baffle Boxes (s)
Concrete Grid Pavement (s)	Storm Water Filters (s)
Rooftop Storage (s)	Oil and Grit Separators (s)
Vegetated Roof (s)	Erosion Control Methods (v)
Inlet Devices (s)	Constructed Wetlands (v, s)
Baffle Boxes (s)	Pocket Wetland (v, s)
Storm water Filters (s)	Pond/Wetland System (v)
Oil and Grit Separators (s)	Buffers/Filter Strips (v)
Alum Treatment (c)	Grassed Swales (v)
	Grassed Waterways (v)
Urban Residential	Street Sweeping (m)
Bioretention Areas (s)	Downspout Disconnection (m)
Porous Asphalt Pavement (s)	Mulching (m)
Concrete Grid Pavement (s)	Sediment Control Polymers (c)

Figure 22 - Subbasins Compared by their Number of Issues of Most Concern



Potential BMPs have been recommended for each of the seven major subbasins based on predominant land use(s) and the applicability of each BMP to address those issues of highest concern for the subbasin.

Specific estimates of pollutant removal rates or costs for individual BMP implementation have not been developed. Development of this information will require additional information regarding site-specific conditions, landowner acceptance, etc. The following references provide valuable information, which can be used to identify costs and efficiencies of BMPs for various uses:

- Center for Watershed Protection Web site: www.stormwatercenter.net
- U.S. EPA (U.S. Environmental Protection Agency) Storm Water Phase II Menu of BMPs and Model Permits: http://www.epa.gov/npdes/menuofbmps/index.htm
- Tetra Tech MPS. 2002. Upper Huron TMDL: Storm Water BMP Prioritization Analysis for the Kent and Brighton Lake Subbasins, Oakland and Livingston Counties, Michigan.

BMP RECOMMENDATIONS BY SUBWATERSHED

Spring Brook Subwatershed

Predominant land uses in the Spring Brook Subwatershed are agriculture and rangeland, which account for over 50 percent of the land area. Less than 10 percent of the land area is urbanized. BMPs in this watershed should focus on agricultural land practices. The data in Table 25 identifies several issues of high concern. Encroachment on floodplains (river valley bottoms) and the 500-foot riparian buffers are significant issues within this subwatershed. The data suggests there is considerable use of the floodplains for agriculture and rangeland. These land uses may be sources of elevated nitrites and nitrates. Several hot spots exist within the subwatershed and are identified in the table footnotes. BMP usage in this subwatershed area should focus on agricultural land uses.

Table 26 identifies recommended BMPs, the target pollutants, and key municipalities and agencies that may be involved in BMP implementation for the Spring Brook Subwatershed. Please note that information stating which agencies or local governments might be involved in

implementation is simply based on which local and State governments and agencies are represented within the subwatershed; it does not indicate a commitment by these municipalities or agencies to implement these BMPs.

Table 25 - Spring Brook Subwatershed Issues of Concern

Issue of Concern	Average Measurable Value	Level of Concern
100-foot Riparian Buffers	68% Natural Land	Low
500-foot Riparian Buffers	54% Natural Land	High
Natural River Valley Bottoms	46% Natural Land	High
Agricultural River Valley Bottoms	41% Agricultural	Moderate[1]
Wetlands Remaining Since 1800	42%	Moderate[2]
Overland Runoff	3.5 in./any 100-year storm	Moderate[3]
Impervious Land Cover	2.8%	Very Low
Stream Bank/Shoreline Erosion Potential	6	Moderate[4]
Off-Field Soil Erosion	13 tons/ac/yr	Low
Off-Field Soil Erosion by Total Subwatershed Area	1.2 tons/ac/yr	Moderate
Nitrites + Nitrates	2.26 lbs/ac	High
Phosphorus	0.18 lbs/ac	Moderate

1. Significant amounts of agriculture are located in the floodplain in the eastern portion of the subwatershed.
2. The northern section of the subwatershed experiences significantly more wetland loss since 1800.
3. There is a high level of concern in the south section of the subwatershed regarding significantly increased overland runoff.
4. There is a very high potential of stream bank erosion in the southern section of the subwatershed.

Table 26 - Recommended BMPs - Spring Brook Subwatershed

Recommended BMP	Target Pollutants	Key Players							
		Jackson County	Eaton County	Calhoun County	Springport Township	Tompkins Township	Sandstone Township	NRCS	Landowners
Buffers/filter Strips	Sediment, Runoff, Nutrients	x	x	x	x	x	x	x	x
Grassed Swales	Sediment, Runoff, Nutrients	x	x	x	x	x	x	x	x
Grassed Waterways	Sediment, Runoff, Nutrients	x	x	x	x	x	x	x	x
Nutrient Management	Nutrients	x	x	x				x	x
Livestock Fencing	Nutrients	x	x	x				x	x

Portage River Subwatershed

In the Portage River Subwatershed, approximately 50 percent of the land area is agricultural in use, 8 percent is urban residential, and 1 percent is urban commercial/industrial. Table 27 provides a summary of each issue of concern for the subbasin.

Of highest concern within this watershed are the encroachment on floodplains and riparian buffers. There are, however, hot spots within the subwatershed that are footnoted in Table 27. The higher rates of erosion and loadings of nitrite and nitrate in the northeastern and eastern portions of the subbasin may be the result of a higher density of agriculture and rangeland uses in the floodplain.

Table 27 - Portage River Subwatershed Issues of Concern

Issue of Concern	Average Measurable Value	Level of Concern
100-foot Riparian Buffers	62% Natural Land	Moderate
500-foot Riparian Buffers	53% Natural Land	High
Natural River Valley Bottoms	55% Natural Land	High
Agricultural River Valley Bottoms	38% Agricultural	Moderate[1]
Wetlands Remaining Since 1800	36%	Moderate
Overland Runoff	3.3 in./any 100 year storm	Low
Impervious Land Cover	3.6%	Low
Stream Bank/Shoreline Erosion Potential	4	Low
Off-Field Soil Erosion	21 tons/ac/yr	Moderate[2]
Off-Field Soil Erosion by Total Subwatershed Area	1.5 tons/ac/yr	Moderate
Nitrites + Nitrates	2.09 lbs/ac	Moderate[3]
Phosphorus	0.15 lbs/ac	Low

1. The northeast part of this watershed poses a higher concern for the consumption of floodplains by agricultural land.
2. High rates of off-field erosion are experienced in the eastern portion of this watershed.
3. Nitrate/nitrites are a very high concern in the northeastern section of the watershed.

Table 28 identifies recommended BMPs, the estimated quantities required, the target pollutants, and key municipalities and agencies that may be involved in BMP implementation for the Portage River Subwatershed. The quantities are conservative estimates based on the 2002 survey conducted by the Jackson County Conservation District personnel. The survey identified potential sources of riparian erosion, but did not make site-specific recommendations so the quantities are estimated not actual. The recommendations are confined to the Portage Watershed because that area has the most data regarding the need for soil erosion control.

Table 28 - Recommended BMPs - Portage River Subwatershed

Recommended BMP	Estimated Quantities	Target Pollutants	Key Players									
			Jackson County	Ingham County	Washtenaw County	Henrietta Township	Waterloo Township	Blackman Township	Leoni Township	Grass Lake Township	NRCS	Landowners
Buffers / Filter Strips	20,000 ft.	Sediment, Runoff, Nutrients	x	x	x	x	x	x	x	x	x	x
Grassed Swales	Unknown	Sediment, Runoff, Nutrients	x	x	x	x	x	x	x	x	x	x
Grassed Waterways	10 ac.	Sediment, Runoff, Nutrients	x	x	x	x	x	x	x	x	x	x
Conservation Tillage	4,000 ac.	Sediment	x	x	x						x	x
Cover / Green Manure Crop	0 ac.	Sediment	x	x	x						x	x
Terraces	0 ac.	Sediment	x	x	x						x	x
Nutrient Management	5,000 ac.	Nutrients	x	x	x						x	x
Livestock Fencing	0 ft.	Nutrients	x	x	x						x	x
Wetland Restoration/Preservation	1,900 ac.	Nutrients									x	x
Stream bank Stabilization	100 ft.	Sediment									x	x

Sandstone Creek Subwatershed

Over 50 percent of the land use in the Sandstone Creek Subwatershed is agriculture. Less than 10 percent of the land use in this subwatershed is categorized as urbanized. Table 29 includes a summary of each issue of concern for the subbasin.

Table 29 - Sandstone Creek Subwatershed Issues of Concern

Issue of Concern	Average Measurable Value	Level of Concern
100-foot Riparian Buffers	84% Natural Land	Very Low
500-foot Riparian Buffers	70% Natural Land	Low
Natural River Valley Bottoms	52% Natural Land	High
Agricultural River Valley Bottoms	40% Agricultural	Moderate
Wetlands Remaining Since 1800	80%	Very Low
Overland Runoff	3.5 in./any 100-year storm	Moderate
Impervious Land Cover	3.5%	Low
Stream Bank/Shoreline Erosion Potential	6	Moderate
Off-Field Soil Erosion	18 tons/ac/yr	Low
Off-Field Soil Erosion by Total Subwatershed Area	1.3 tons/ac/yr	Moderate
Nitrites + Nitrates	1.87 lbs/ac	Moderate
Phosphorus	0.17 lbs/ac	Moderate

Land cover analysis indicates that a moderate amount of river valley bottoms in the Sandstone Creek Subwatershed have been consumed by agricultural land. These likely accounts, in part, for the moderate levels of overland runoff, nutrients, and erosion. Agricultural BMPs are recommended for this subwatershed. Table 30 identifies recommended BMPs, the target pollutants, and key municipalities and agencies that may be involved in BMP implementation.

Table 30 - Recommended BMPs - Sandstone Creek Subwatershed

Recommended BMP	Target Pollutants	Key Players							
		Jackson County	Tompkins Township	Parma Township	Sandstone Township	Blackman Township	Hanover Township	NRCS	Landowner
Buffers/filter Strips	Sediment, Runoff, Nutrients	x	x	x	x	x	x	x	x
Grassed Swales	Sediment, Runoff, Nutrients	x	x	x	x	x	x	x	x
Grassed Waterways	Sediment, Runoff, Nutrients	x	x	x	x	x	x	x	x
Conservation Tillage	Sediment	x						x	x
Cover/Green Manure Crop	Sediment	x						x	x
Terraces	Sediment	x						x	x
Nutrient Management	Nutrients	x						x	x
Livestock Fencing	Nutrients	x						x	x

Center, Grass, and Wolf Lakes Subwatershed

The Center, Grass, and Wolf Lakes Subwatershed are predominantly agricultural, but about 15 percent are urban residential. Table 31 includes a summary of each issue of concern for the subbasin.

Table 31 - Center, Grass, and Wolf Lakes Subwatershed Issues of Concern

Issue of Concern	Average Measurable Value	Level of Concern
100-foot Riparian Buffers	72% Natural Land	Low
500-foot Riparian Buffers	61% Natural Land	Moderate
Natural River Valley Bottoms	55% Natural Land	High
Agricultural River Valley Bottoms	28% Agricultural	Low
Wetlands Remaining Since 1800	48%	Moderate
Overland Runoff	3.6 in./any 100 year storm	High
Impervious Land Cover	6.5%	Low
Stream Bank/Shoreline Erosion Potential	8	High
Off-Field Soil Erosion	23 tons/ac/yr	Moderate[1]
Off-Field Soil Erosion by Total Subwatershed Area	1.2 tons/ac/yr	Moderate
Nitrites + Nitrates	1.6 lbs/ac	Low
Phosphorus	0.20 lbs/ac	Moderate

1. Northern portion of subwatershed has high levels of off-field erosion.

The data show that this subwatershed exhibits high potential for stream bank and shoreline erosion due to high modeled levels of overland runoff and relatively high off-field erosion. It appears that the potential concerns may be the result of both agricultural practices and urbanization within this subwatershed. Both agricultural and residential BMPs would be appropriate for this subwatershed**.** Table 32 identifies recommended BMPs, the target pollutants, and key municipalities and agencies that may be involved in BMP implementation.

Table 32 - Recommended BMPs - Center, Grass, and Wolf Lake Subwatershed

Recommended BMP	Target Pollutants	Key Players									
		Jackson County	Ingham County	Washtenaw County	Waterloo Township	Leoni Township	Grass Lake Township	Napoleon Township	Village of Grass Lake	NRCS	Landowner
Buffers / Filter Strips	Sediment, Runoff, Nutrients	x	x	x	x	x	x	x	x	x	x
Grassed Swales	Sediment, Runoff, Nutrients	x	x	x	x	x	x	x	x	x	x
Grassed Waterways	Sediment, Runoff, Nutrients	x	x	x	x	x	x	x	x	x	x
Conservation Tillage	Sediment	x	x	x						x	x
Cover / Green Manure Crop	Sediment	x	x	x						x	x
Terraces	Sediment	x	x	x						x	x
Stream bank Stabilization	Erosion	x	x	x	x	x	x	x	x	x	x
Bioretention Areas	Nutrients, Sediment, Runoff Detention	x	x	x	x	x	x	x	x	x	x
Constructed Wetlands	Nutrients, Sediment, Runoff Detention	x	x	x	x	x	x	x	x	x	x
Wet Ponds	Nutrients, Sediment, Runoff Detention	x	x	x	x	x	x	x	x	x	x

Upper Grand River Subwatershed

The Upper Grand River Subwatershed is approximately 53 percent agricultural, 9 percent rangeland, 12 percent urban residential, and 2 percent urban commercial/industrial. Table 33 includes a summary of each issue of concern for the subbasin.

Table 33 indicates high concern regarding encroachment on the riparian buffers and floodplains, and a high level of off-field soil erosion. The data from the GeoBook analysis also indicate hot spots in the northern portion of the subbasin may be the result of intense agriculture, and hot spots in the southern portion are likely due to urbanization. Table 34 identifies recommended BMPs, the target pollutants, and key municipalities and agencies that may be involved in BMP implementation.

Table 33 - Upper Grand River Subwatershed Issues of Concern

Issue of Concern	Average Measurable Value	Level of Concern
100-foot Riparian Buffers	68% Natural Land	Low
500-foot Riparian Buffers	56% Natural Land	High
Natural River Valley Bottoms	49% Natural Land	High
Agricultural River Valley Bottoms	42% Agricultural	Moderate[1]
Wetlands Remaining Since 1800	47%	Moderate[2]
Overland Runoff	3.4 in./any 100 year storm	Moderate[3]
Impervious Land Cover	5.3%	Low
Stream Bank/Shoreline Erosion Potential	6	Moderate[4]
Off-Field Soil Erosion	26 tons/ac/yr	Moderate
Off-Field Soil Erosion by Total Subwatershed Area	1.7 tons/ac/yr	High
Nitrites + Nitrates	2.07 lbs/ac	Moderate[5]
Phosphorus	0.19 lbs/ac	Moderate

1. A very high portion of the floodplain is agricultural in the northern part of the subwatershed.
2. A very high percentage of wetlands have been lost in the northern part of the subwatershed.
3. Higher levels of overland runoff are occurring in the southern portion.
4. A high potential for stream bank/shoreline erosion exists in the southern portion of the subwatershed.
5. Very high nitrite/nitrate loadings were calculated in the northern portions of the subwatershed.

Table 34 - Recommended BMPs - Upper Grand River Subwatershed

Recommended BMP	Target Pollutants	Key Players									
		Jackson County	Eaton county	Ingham County	Sandstone Township	Blackman Township	Tompkins Township	Rives Township	Henrietta Township	NRCS	Landowner
Buffers / Filter Strips	Sediment, Runoff, Nutrients	x	x	x	x	x	x	x	x	x	x
Grassed Swales	Sediment, Runoff, Nutrients	x	x	x	x	x	x	x	x	x	x
Grassed Waterways	Sediment, Runoff, Nutrients	x	x	x	x	x	x	x	x	x	x
Conservation Tillage	Sediment	x	x	x						x	x
Cover / Green Manure Crop	Sediment	x	x	x						x	x
Terraces	Sediment	x	x	x						x	x
Stream bank Stabilization	Erosion	x	x	x	x	x	x	x	x	x	x
Bioretention Areas	Nutrients, Sediment, Runoff Detention	x	x	x	x	x	x	x	x		x
Constructed Wetlands	Nutrients, Sediment, Runoff Detention	x	x	x	x	x	x	x	x	x	x
Wet Ponds	Nutrients, Sediment, Runoff Detention	x	x	x	x	x	x	x	x	x	x

Grand River Headwaters

The headwaters of the Grand River Subwatershed is predominantly characterized by agriculture and rangeland, which together account for approximately 50 percent of the land area. Urban residential area, representing approximately 12 percent of the land area, is also significant. Table 35 includes a summary of each issue of concern for the subbasin.

Table 35 - Grand River Headwaters Issues of Concern

Issue of Concern	Average Measurable Value	Level of Concern
100-foot Riparian Buffers	68% Natural Land	Low
500-foot Riparian Buffers	56% Natural Land	Moderate[1]
Natural River Valley Bottoms	49% Natural Land	High
Agricultural River Valley Bottoms	42% Agricultural	Moderate
Wetlands Remaining Since 1800	47%	Moderate[2]
Overland Runoff	3.4 in./any 100 year storm	Moderate
Impervious Land Cover	5.3%	Low
Stream Bank/Shoreline Erosion Potential	6	Moderate
Off-Field Soil Erosion	26 tons/ac/yr	Moderate
Off-Field Soil Erosion by Total Subwatershed Area	1.7 tons/ac/yr	High
Nitrites + Nitrates	2.07 lbs/ac	Moderate
Phosphorus	0.19 lbs/ac	Moderate

1. Very high encroachment on 500-foot riparian buffers has occurred in the southern portion (Lake LeAnn).
2. Significant loss of wetlands has occurred in the southern portion (Lake LeAnn).

The most significant impact in this area is encroachment on the river valley bottoms. It appears that the Lake LeAnn watershed in the southern portion of the area is a hot spot for loss of wetlands and encroachment on buffers and valley bottoms due to urbanization. Table 36 identifies recommended BMPs, the target pollutants, and key municipalities and agencies that may be involved in BMP implementation.

Table 36 - Recommended BMPs - Grand River Headwaters

Recommended BMP	Target Pollutants	Key Players											
		Jackson County	Moscow Twp.	Hillsdale County	Blackman Twp.	Leoni Twp.	Summit Twp.	Napoleon Twp.	Liberty Twp.	Columbia Twp.	Summerset Twp.	NRCS	Landowner
Erosion Control Measures	Sediment	x		x	x	x	x	x	x	x	x	x	x
Buffers / Filter Strips	Sediment, Runoff, Nutrients	x		x	x	x	x	x	x	x	x	x	x
Grassed Swales	Sediment, Runoff, Nutrients	x		x	x	x	x	x	x	x	x	x	x
Grassed Waterways	Sediment, Runoff, Nutrients	x		x	x	x	x	x	x	x	x	x	x
Conservation Tillage	Sediment	x		x								x	x
Cover / Green Manure Crop	Sediment	x		x								x	x
Terraces	Sediment	x		x								x	x
Stream bank Stabilization	Erosion	x	x	x	x	x	x	x	x	x	x	x	x
Bioretention Areas	Nutrients, Sediment, Runoff Detention	x	x	x	x	x	x	x	x	x	x		x
Constructed Wetlands	Nutrients, Sediment, Runoff Detention	x	x	x	x	x	x	x	x	x	x	x	x
Wet Ponds	Nutrients, Sediment, Runoff Detention	x	x	x	x	x	x	x	x	x	x	x	x

Urban Area Subwatershed

The Urbanized Subwatershed is approximately 28 percent urban residential and 12 percent urban commercial/industrial. The subwatershed does contain agriculture, but significantly less than other subwatersheds at 20 percent. Table 37 includes a summary of each issue of concern for the subbasin.

Table 37 - Urban Area Subwatershed Issues of Concern

Issue of Concern	Average Measurable Value	Level of Concern
100-foot Riparian Buffers	67% Natural Land	Low
500-foot Riparian Buffers	58% Natural Land	Moderate
Natural River Valley Bottoms	46% Natural Land	Very High
Agricultural River Valley Bottoms	14% Agricultural	Very low
Wetlands Remaining Since 1800	48%	Moderate
Overland Runoff	3.7 in./any 100 year storm	Very High
Impervious Land Cover	18.4%	Very High
Stream Bank/Shoreline Erosion Potential	8	High
Off-Field Soil Erosion	12 tons/ac/yr	Low
Off-Field Soil Erosion by Total Subwatershed Area	0.3 tons/ac/yr	Very Low
Nitrites + Nitrates	1.34 lbs/ac	Very Low
Phosphorus	0.25 lbs/ac	Very High

The data in Table 37 are characteristic of urbanized watersheds. The data illustrate a high degree of encroachment of impervious development, increased runoff, elevated stream bank erosion potential, and high levels of phosphorus loading. Table 38 identifies recommended BMPs, the target pollutants, and key municipalities and agencies that may be involved in BMP implementation. Table 39 presents published BMP installation and maintenance costs.

Table 38 - Recommended BMPs - Urban Area Subwatershed

Recommended BMP	Target Pollutants	Key Players						
		Jackson County	Blackman Township	Leoni Township	Summit Township	Spring Arbor Township	City of Jackson	Landowner
Wet Ponds	Urban Runoff	x	x	x	x	x	x	x
Constructed Wetlands	Urban Runoff	x	x	x	x	x	x	x
Grassed Channels	Urban Runoff	x	x	x	x	x	x	x
Engineered Dry Swales	Urban Runoff	x	x	x	x	x	x	x
High Efficiency Street Sweeping	Urban Runoff	x	x	x	x	x	x	x
Effective Catch Basin Cleaning	Urban Runoff	x	x	x	x	x	x	x
Infiltration Trenches	Urban Runoff	x	x	x	x	x	x	x
Bioretention	Urban Runoff	x	x	x	x	x	x	x
Catch-Basin Inserts	Urban Runoff	x	x	x	x	x	x	x
Porous Asphalt Pavement	Urban Runoff	x	x	x	x	x	x	x
Concrete Grid Pavement	Urban Runoff	x	x	x	x	x	x	x
Roof Top Storage	Urban Runoff	x	x	x	x	x	x	x
Storm water filters	Urban Runoff	x	x	x	x	x	x	x

Table 39 – BMP Installation and Maintenance Costs

BMP / Action	Unit Cost	Annual / Maintenance Cost
Bioretention Areas	6.80 / ft3	< 5%
Buffer / Filter Strips	$200 - $350 / acre	$4 / acre
Catch Basin Cleaning	$25 / cleaning	N / A
Catch Basin Inserts	$800 / per device	$3 / inspection
Concrete Grid Pavement	$80,000 - $120,000 / acre	$200 / acre
Conservation Tillage	$10 - $15 / acre	N / A - repeated every year
Wetland Preservation and Restoration	$700 - $1200 /acre	2 - 4%
Cover / Green Manure Crop	$225 / acre	$11.15 / acre
Engineered Dry Swales	$1,500 / acre of drainage area	$60 / acre of drainage area
Erosion Control Measures	variable - depends on practice	variable - depends on practice
Grassed Swales	$0.5 / ft2	.02 / ft2
Grassed Waterways	$3500 - $4500 / acre	$70 - $90 / acre
High Efficiency Street Sweeping	$100,000 - $200,000 / vehicle	$15 - $30 / curb mile
Infiltration Trenches	$5 / ft3	< 5%
Livestock Fencing	$3 / ft	$.10 / ft
Nutrient Management	$10 / acre	N / A - repeated every year
Porous Asphalt Pavement	$0.50 - $1.00 / ft2	$200 / acre
Rooftop Storage	$12 - $24 / ft2	minimal
Storm Water Filters	$5 / ft3	$0.54 / ft3
Stream bank Stabilization	$90 / ft	$1.80 / ft
Terraces	$.40 / ft along terrace	$.01 / ft along terrace
Wet Ponds	$1.30 / ft3	4%
Land Trust/Watershed Council	highly variable	highly variable
Public Education Marketing Campaign	variable - depends on activities	variable - depends on activities
Adopt-A-Stream Volunteer Monitoring	$10,000	$10,000
Consider Wetland Protection Ordinance	$500 - $1500	cost of enforcement
Conservation Reserve Enhancement Program.	highly variable	highly variable
Other Land Use Policy Changes	$2,000 / ordinance	cost of enforcement
Policies Against Inter-Basin Waste/Water Transfers	$2,000 / ordinance	cost of enforcement

Data obtained from: Mill Creek Subwatershed Management Plan, 2003; SWRPC, 1991; http://www.lid-stormwater.net/permeable_pavers/permpaver_costs.htm; http://www.fhwa.dot.gov/environment/ultraurb/3fs10.htm; and http://www.oznet.ksu.edu/BMP/BMP%20pages/Level%20terraces/Rev3_bmp_level_terraces_costsandbenefits.htm

TOTAL MAXIMUM DAILY LOAD (TMDL) BMP RECOMMENDATIONS

The three TMDLs, which affect the area within the Upper Grand River Watershed, will require the use of many of the BMPs discussed in the previous section. Since the goals of the TMDLs are closely aligned with the goals of the watershed plan, a list of BMP recommendations for the *E. coli* TMDL and the dissolved oxygen (DO) and Biota TMDLs have been prepared. The lists are not an inclusive, but highlight the more effective BMPs at reducing E. Coli, DO and improving biota.

Recommended Best Management Practices for E. coli TMDL Implementation

Recommended best management practices to reduce bacteria contamination to the Upper Grand River include the following:

1. Development and implementation of an Illicit Discharge Elimination Program (IDEP), including outfall sampling and chemical/bacteriological laboratory analysis, and follow-up, systematic investigation of area storm sewer networks.
2. Adoption of a countywide septic system inspection program. Washtenaw County has adopted a time-of-sale inspection program to identify failing and aging septic systems that may serve as an example program.
3. Continued efforts to fund, design, and construct sanitary sewer connections for homes in Rives Junction discharging sewage to Albrow Creek.
4. Higher efficiency street sweeping programs in urban centers.
5. Public education regarding the impacts and proper disposal of pet waste, and signage restricting the feeding of geese in area parks.
6. The creation and maintenance of buffer strips in agricultural areas bordering streams and rivers. This may include cost-share or rent programs for agricultural producers
7. Development of nutrient management plans for high priority livestock producers.
8. Fencing to limit livestock access to streams.

According to MDEQ sampling and analysis, the highest priority should be placed on programs targeting the greater Jackson urbanized area. The Phase II regulated communities of Jackson, Jackson County, and Blackman, Leoni, Napoleon, Rives, Spring Arbor, and Summit Townships

are required to develop and implement both IDEP and public education programs under their Storm Water Permits (forthcoming).

Agricultural BMPs should focus on the largest livestock producers adjacent to waterways and the sub-basins identified previously in the land cover analysis as having the highest potential for bacteriological contamination (SIS Prioritization Analysis Final Report (GeoBook), Appendix C). Specifically, the Lower Branch of Sandstone Creek the Grass Lake Drain, and the Portage River Source subbasins are located within the *E. coli* TMDL watershed, and were identified as having high potential for bacterial contamination based upon the numbers of animal units per acre. Additionally, though outside of the TMDL area, the Spring Brook- Source, and Southern Liberty Township Drains were also identified as having a high potential for bacterial contamination.

Recommended Best Management Practices for DO and Biota TMDL Implementation

Published storm water literature for pollutant removal efficiencies was reviewed, and eleven best management practices are recommended and include the following:

- Buffer Strips,
- Illicit Discharge Elimination
- Higher Efficiency Street Sweeping
- Detention Retrofits,
- Streambank Stabilization/Restoration,
- Flood Plain Storage,
- Public Education,
- Dredging of Accumulated Sediments,
- Conservation Tillage,
- Revised Development/Detention Standards, and
- Strengthen County SESC Program.

NPDES PHASE II STORM WATER REGULATIONS

It should be noted that, while participating as members of the Upper Grand River Watershed Planning Initiative Steering Committee, representatives of communities within the Jackson Urban Area Subwatershed have separately prepared to comply with Federal and State Phase II storm water discharge and permitting regulations. These regulations require communities within urbanized areas to develop programs and policies, and implement BMPs in the following "*six minimum control measures*:"

1. Public Education and Outreach:
   Distributing educational materials and performing outreach to inform citizens about the impacts polluted storm water runoff discharges can have on water quality.

2. Public Participation and Involvement:
   Providing opportunities for citizens to participate in program development and implementation, including effectively publicizing public hearings and/or encouraging citizen representatives on a storm water management panel.

3. Illicit Discharge Detection and Elimination:
   Developing and implementing a plan to detect and eliminate illicit discharges to the storm sewer system. This includes developing a system map and informing the community about hazards associated with illegal discharges and improper disposal of wastes.

4. Construction Site Runoff Control:
   Developing, implementing, and enforcing an erosion and sediment control program for construction activities that disturb one or more acres of land. Controls may include silt fences and temporary storm water detention ponds.

5. Post-Construction Runoff Control:
   Developing, implementing, and enforcing a program(s) to address discharges of post-construction storm water runoff from new development and redevelopment areas. Applicable controls could include preventative actions such as protecting sensitive areas (e.g., wetlands) or the use of structural BMPs such as grassed swales or porous pavement.

6. Pollution Prevention/Good Housekeeping:

Developing and implementing a program with the goal of preventing or reducing pollutant runoff from municipal operations. The program must include municipal staff training on pollution prevention measures and techniques (e.g., regular street sweeping, reduction in the use of pesticides or street salt, or frequent catch basin cleaning).

Communities in the Jackson Urbanized Area also previously took part in a study measuring the cost-benefit of improved street sweeping practices to reduce sediment (and associated pollutant) delivery to the Upper Grand River and its tributaries. Urban communities and agencies that have existing street sweeping programs are reviewing and evaluating the results of that study and considering changes in existing practices. As summarized earlier in the Water Quality section of this plan, sediment oxygen demand, from both the Jackson urban area and the Portage River, is believed to be the driving force in low oxygen concentrations in portions of the Upper Grand River and the corresponding violations of water quality standards.

UPPER GRAND RIVER ACTION PLAN

This action plan has been developed as a summary of all the recommendations that are discussed throughout this watershed plan. Input from the Watershed Stakeholders, MDEQ Representatives, and Community Players were critical in developing the recommended tasks in the action plan. Each task has a problem that is associated with it. Table 40 summarizes the Problems, Sources, and Causes found in the watershed based on stakeholder advisory group comments stated in the Water Quality Assessment Section of this plan and the data that was gathered in the SIS GeoBook Analysis (Appendix C).

Table 41 is the actual Upper Grand River Action Plan. Each Action Item is linked to the appropriate problem from Table 40, along with tasks, key players, level of effort, capital and annual costs, measure of success, schedule and resources if available. The recommended locations are linked to a critical pollutant in sub-basins identified in the SIS GeoBook Analysis and the Portage River Analysis completed by the Jackson County Conservation District. The strategies recommended in the Action Plan are not mandatory for watershed stakeholders, they are recommendations to meet the goals set forth in the watershed management plan.

Table 40: Problems, Sources, and Causes

Problem	Source	Known or Suspected Cause
Sedimentation, soil erosion	Streambanks	1. Lack of Vegetative Buffer Strips 2. Alteration of Hydrologic Regime
	Agricultural Runoff	1. Poor conservation practices
	Construction Sites	1. Lack of Soil Erosion Inspection and Enforcement 2. Lack of proper best management practices 3. Lack of maintenance after rain events
Low Dissolved Oxygen	Untreated Sewage Discharge	1. Combined Sewer Overflow 2. Illicit Discharges
	Stagnant Waters	1. Loss of hydrologic regime
	Agricultural Runoff	1. Poor conservation practices
	Temperature Alterations	1. Industrial Non-contact cooling water 2. Loss of Stream Buffer/Tree Cover 3. Stormwater Runoff
High Nutrient Load	Excess Fertilizer Use	1. Improper fertilizer application
	Failing On-Site Septics	1. Lack of Maintenance 2. Unsupporting Soil Types 3. Direct connection to River
	Agricultural Animal Waste	1. Lack of Nutrient Management Plan 2. Lack of streambank fencing 3. Improper Land Application
High E. Coli (Pathogens)	Untreated Sewage Discharge	1. Lack of treatment plant capacity 2. Combined Sewer Discharges 3. Illicit Discharges/Connections
	Agricultural Animal Waste	1. Lack of Nutrient Management Plan 2. Lack of streambank fencing 3. Improper Land Application
	Failing On-Site Septics	1. Lack of Maintenance 2. Unsupporting Soil Types 3. Direct connection to River
	Stormwater Runoff	1. Pet and wildlife waste
Illegal Dumping	Septic Waste	1. Human Behavior
	Toxic Waste	1. Human Behavior
	Trash/Litter	1. Human Behavior
	Used Tires	1. Human Behavior
Loss of Biota, Biodiversity and Habitat	Uncontrolled Development	1. Lack of Concise Ordinances to promote environmentally friendly development
	Wetland Development	1. Loss on incentives for protection 2. Lack of ordinance/State Protection
	Streambanks	1. Lack of Vegetative Buffer Strips 2. Alteration of Hydrologic Regime
	Agricultural Runoff	1. Poor conservation practices
	Wastewater Diversions from outside watershed	1. Input of wastewater into pristine sections of watershed
	Stormwater Runoff	1. Nonpoint Source Pollution
Human Behavior	1. Mixed Media Messages 2. Complicated Recycling Program 3. Lack of Watershed Stewardship	1. Lack of Awareness

Table 41: Upper Grand River Action Plan

Problem	Tasks	Key Players	Level of Effort	Capital Costs	Annual Costs	Measure of Success	Recommended Locations	Schedule	Resources (if available)
Sedimentation, High Nutrient Loading	Riparian Buffer	Private Landowners, State of Michigan	20,000 ft (46 acres)	$400/ac $18,400 total	$40-60/ac $1,840-2,760 total, dependent on rental rate	Number of acres installed	Portage River Sub-basins 15,16,17,18	Initiate 2004	USDA Programs, Technical Assistance from NRCS, JCCD
Sedimentation, High Nutrient Loading	Grass Waterways	Private Landowners	10 acres	$3,500/ac w/o title $4,000/ac w/title $35,000-40,000 total	$40-60/ac $400-600 total, dependent on rental rate	Number of acres installed	Portage River Sub-basin	Initiate in year 2	USDA Programs, Technical Assistance from NRCS, JCCD
Sedimentation	Streambank Stabilization	Private Landowners	100 ft.	$90/ft $9,000 total	$1.80/ft $180 total	Number of feet of streambank restored	Sub-basins with highest streambank erosion potential: 5,6,9,10,11,33	Identify in year 1, complete by year three	USDA Programs, Technical Assistance from NRCS, JCCD
Sedimentation	Conservation Tillage	Private Landowners	4,000 acres	$3-8/ac/yr for 3 yrs. $36,000-9,600 total	N/A	Number of acres installed	All	Initiate in year 1	USDA Programs, Technical Assistance from NRCS, JCCD
Sedimentation	Conservation Cover (Native Grass)	Private Landowners	450 acres	$150-300/ac $67,500-135,000 total	$10/ac maintenance	Number of acres installed	All, specifically in Schlee Waterfowl Production Area	Initiate in year 1	Programs: USDA, USFWS, Ducks Unlimited, Pheasants Forever: Technical Assistance from NRCS, JCCD
Sedimentation	Install Grit Chambers at critical outfalls to remove sediment from Grand River	Local Communities, County Drain Commissioners	25 City of Jackson, 25 other communities	$7,000 per site	5% per site	Number of Grit Chambers Installed, Amount of sediment removed from chambers per year, number of times maintenance was performed	City of Jackson, remaining TBD	Start summer 2004	
Sedimentation	Reduce amount of sand from road application runoff into surface waters	County Road Commissions, Local Communities, MDOT	Reduce the overall amount of sand entering the waterways by 25%	TBD	TBD	Estimate amount of sand reduction to waterways	Target TMDL areas first	Start December 2004	
Sedimentation	Increase the number of Certified Soil Erosion Agents in Jackson County	Jackson County Drain Commissioner and Road Commission	Hire six full time staff to run soil erosion program	Recruiting, Hiring, and Training Costs	Approx. $300,000	Number of Staff Hired, Number of Inspections Completed, Number of Maintenance Corrections	Staff assigned to specific sections of county	Hire three per year beginning Spring 2004	
Sedimentation	Increase Soil Rental Rates	Jackson County FSA Committee	All CRP	N/A	N/A	Increase of Rental Rates	Jackson County	Initiate in year 1	USDA
Sedimentation, Soil Erosion, High Nutrient Load, Low DO	Preserve Riparian Buffers by removing them from the County Tax Roll	Jackson County Drain Commissioner	20,000 ft (46 acres) in addition to JCCD efforts	TBD	TBD	Number of linear feet of riparian buffers preserved, number of homeowners participating in program	Sub-basins with lowest % of 100 and 500 ft buffers: 1, 15, 16, 17, 18, 23	Initiate in Year 1	
High Nutrient Load, Sedimentation, Low DO, High E. Coli	Evaluate existing storage facilities for water quality retrofit opportunities	Individual MS4 Operators	Community Specific	$1,500 per BMP evaluated	N/A	Number of facilities evaluated, recommended retrofits, amount of grant funding obtained	Phase II Urbanized Area including Grand River Drain, Pierce Drain, and Sandstone Blackman Drain	Evaluate existing BMPs within first two years of implementation	
High Nutrient Load	Nutrient Management for Ag	Private Landowners	5,000 acres	$10/ac average $50,000 total	Same-annual practice	11% of agricultural acres	Portage River Sub-basin, and Sub-basins with highest # of animal units: 2,5,12,28,33	Initiate in Year 1	USDA Programs: EQIP, CRP Technical Assistance from NRCS, JCCD
High Nutrient Load	Bioretention/Grassed Swales	Individual MS4 Operators	Reduce phosphorus loading to waterways by 25%	$6.80/ft3 Bioretention $0.5/ft2 Grassed Swales	<5%	Number of Bioretention and Grassed Swales systems installed	Sub-basins with highest phosphorus load, 1, 4, 9, 10, 26 (Urbanized Areas)	Initiate in Year 1	
High E. Coli	Link Health Department E. Coli and D.O. sampling sites to previous sampling sites used in WMP	Jackson and Ingham County Health Departments	1 Planning Meeting b/w both Health Departments and MDEQ	TBD	TBD	Track number of samples taken, keep database of results, compare results to MDEQ TMDL sampling reports.	Compare sites visited in WMP to sites MDEQ visited in TMDL. Standardize sites visited for future work.	Implement by December 2004	

Table 41: Upper Grand River Action Plan

Problem	Tasks	Key Players	Level of Effort	Capital Costs	Annual Costs	Measure of Success	Recommended Locations	Schedule	Resources (if available)
High E. Coli and High Nutrient Loading	Re-analyze Septic Contamination risk based on soils, water table, density, proximity to surface waters and location relative to existing sewer systems. Develop action item for follow-up work.	Jackson County Health Department and Jackson County Drain Commissioner	Mapping Exercise based on availability of staff	$15,000	N/A	Completed Map, Number of Failing Septic Systems inspected and repaired, Number of Septic System connected to available WWTPs	Non-sewer areas watershed wide	Six month effort	
Loss of Biota, Biodiversity, and Habitat	Preserve Wetlands by removing them from the County Tax Roll	Jackson County	Develop and present legal information to Jackson County Commissioners	TBD	TBD	Number of acres of wetland preserved, number of homeowners participating in program	Two tier program- 1. Work to Protect sub-basins with high remaining wetlands including 27,28,29, 30,33 2. Work to preserve wetlands in developing Phase II Urbanized Area including 4,9,10,26	Begin political process in Fall 2004, Implement Program by Fall 2006	Jackson County Drain Commissioner
Loss of Biota, Biodiversity, and Habitat	Develop a Model Ordinance to Protect Wetlands	Individual communities	Use existing model ordinances, include legal review	$10,000	N/A	Number of communities that adopt ordinance Goal to have 50% participation in first year	Watershed wide	Six month effort	
Loss of Biota, Biodiversity, and Habitat	Develop Technical Reference Manual for Low Impact Design Standards for New Development and Redevelopment	County of Jackson and Individual Communities/ Assistance from Region II Planning Commission	Each community adopt/use manual	$100,000	N/A	Number of communities that adopt ordinance changes Goal to have 50% participation in first year	Watershed wide	1.5 year effort	
Loss of Biota, Biodiversity, and Habitat	Address Inter-Basin Wastewater Transfers	County of Jackson and Individual Communities	TBD	TBD	TBD	TBD	TBD	TBD	Jackson County Drain Commissioner
Loss of Biota, Biodiversity, and Habitat	Provide funds to restore wetlands and establish native warm season grasses.	Ducks Unlimited and MDNR	2 acres of wetlands, 60 acres of native warm season grasses	$500-2,500/ac $950,000-4.7 million total	2-4% construction cost	Number of Acres restored	Selected locations within Waterloo Recreation Area	Concurrent with NAWCA grant	
Loss of Biota, Biodiversity, and Habitat	Provide limited funding (through NAWCA) and technical assistance to conserve and improve wetland and upland habitat in the Upper Grand River watershed.	Ducks Unlimited	Project Specific	TBD	TBD	Amount of funding and service provided	Watershed wide	Project Specific	
Loss of Biota, Biodiversity, and Habitat	Wetland Restoration	Private Landowners, State of Michigan	1,900 acres	$500-2,500/ac $950,000-4.7 million total	2-4% construction cost	30% of restorable wetlands	Portage River Sub-basins 20, 21		Programs: USDA, USFWS, Ducks Unlimited, MDNR Technical Assistance from NRCS, JCCD
Loss of Biota, Biodiversity, and Habitat	Conservation Easement	Private Landowners, State of Michigan	1,700 acres	$1,800-2,700/ac $3.06-4.59 million total	0.5% acquisition cost	15% of restorable wetlands	Portage River Sub-basins 20, 21		Programs: USDA, USFWS, Ducks Unlimited, MDNR Technical Assistance from NRCS, JCCD
Loss of Biota, Biodiversity, and Habitat	Purchase/Donate Development Rights	Washtenaw Potawatomi Land Trust, Henrietta Cons. & Recreation Conservancy, et.all	150 acres	$1,800-2,700/ac $270,000-405,000 total	TBD	Number of acres installed	Watershed wide	Initiate in year 1	Washtenaw Potawatomi Land Trust, Henrietta Cons. & Recreation Conservancy, USDA, et. Al
Loss of Biota, Biodiversity, and Habitat	Purchase Open Space	MDNR, Nature Conservancy, et. All	200 acres	$4,000-8,000/ac $270,000-405,000 total	TBD	Number of acres installed	Watershed wide	Initiate in year 1	Programs: MDNR, Nature Conservancy et.al. Technical Assistance: NRCS, JCCD
Loss of Biota, Biodiversity, and Habitat	Planting Open Space w/Native Plants	Private Landowners	200 acres	$150/ac $30,000 total	$10/ac maintenance	Number of acres installed	Watershed wide	Initiate in year 1	Programs: USDS, USFWS, Ducks Unlimited, Technical Assistance: NRCS, JCCD
Loss of Biota, Biodiversity, and Habitat	Conservation Enhancement Program (CREP) Designation	NRCS	106,441 acres	TBD	TBD	Number of acres installed	Portage River Sub-basin	Initiate in year 1	USDA
Watershed sustainability	Establish the Upper Grand River Watershed Council	Jackson County Drain Commissioner, Dahlem Center, Municipalities, GREAT	All Phase II and 80% of other Municipalities	N/A	TBD	Approval by State	Watershed wide	In progress, anticipated by June 2004	
Watershed sustainability, Illegal Dumping, High Nutrient Loading	Implement Upper Grand River Education Strategy	Local municipalities/counties, Dahlem Center, GREAT, NGOs	All Phase II and 80% of other Municipalities contribute to hire one staff member half time	$33,500	$96,260 1st Year, $50,000 2nd-5th Year	Evaluation Plan is to be developed as part of 1st Year Budget	Phase II Communities, Watershed wide	Begin work with in six months of formation of Watershed Council	

Table 41: Upper Grand River Action Plan

Problem	Tasks	Key Players	Level of Effort	Capital Costs	Annual Costs	Measure of Success	Recommended Locations	Schedule	Resources (if available)
Illegal Dumping	Conduct Yearly River Cleanup, Provide Watershed Education	GREAT	1 river clean-ups per year at 10 locations in watershed	$0	$10,000	Amount of trash removed, number of volunteers participating	Currently 10 locations are targeting in the Watershed	Ongoing	
Human Behavior	Educate municipal/county Staff on Watershed Stewardship and goals of WMP	local municipalities/counties, NGOs	2 workshops per year	$5,000	$3,000	Number of training sessions/workshops held, Number of Staff Trained	Watershed wide	Spring '04	
Human Behavior	Educate municipal/county Staff and boards on land use issues related to water quality	local and regional planning commissions	Integrate into monthly/quarterly meetings	$5,000	$35,000	Number of Staff Trained	Watershed wide	Spring '04	
Human Behavior	Implement volunteer water quality monitoring program	Dahlem Environmental Education Center, Health Departments, GREAT	9 sites, 3 samples per site, twice per year	$19,000	$12,000	Water Quality Monitoring Results, Number of Participants	Link Health Department E. Coli and D.O sampling sites to previous sampling sites used in WMP	Start Spring 2004, continue indefinitely	
High Nutrient Loading	Implement High Efficiency Street Sweeping Program (study conducted in 1999) to remove 75% of total solids	City of Jackson, County of Jackson, Phase II Municipalities	Increase catch basin cleanout schedule, increase frequency of street sweeping	Purchase of High-Efficiency Street Sweeper $220,000	$2325/acre /year	Pounds of Sediment Removed from Streets, Pounds of Sediment Removed from Catch Basins	Focus on Urbanized Area Streets	Purchase Machine and Implement Plan by 2006	
High E. Coli High Nutrients	Conduct IDEP	Phase II Communities	All PSDs within Phase II Communities	$500-$1500/point source discharge	Report every 5 years	Number of PSDs evaluated. Number of illicit connections found	Phase II Communities, TMDL Stretches	Complete within 5 years	
All	Conduct detailed subwatershed management plans to supplement watershed management plan	Local municipalities, Counties, NGOs, NRCS, JCCD	Detailed field evaluations, mapping, surveys and action plans	$50,000- $200,000/sub-watershed	N/A	Number of completed plans	Watershed wide; Focus on Sub-basins with issues of most concern outside the Portage River Watershed; 23,26,34,17,6,9,10		

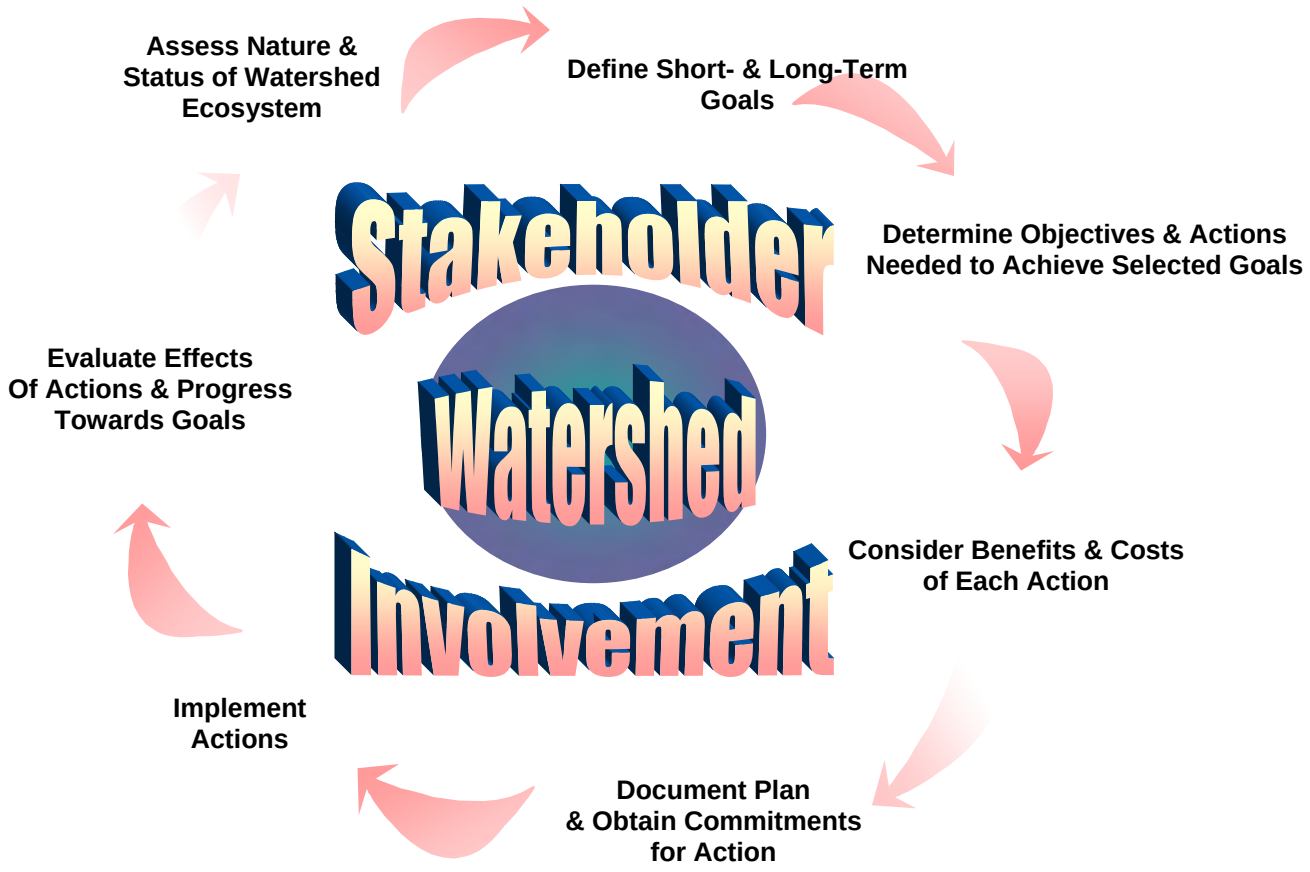
Acronyms	
CREP	Conservation Reserve Enhancement Program
CRP	Conservation Reserve Program
DO	Dissolved Oxygen
EQIP	Environmental Quality Incentive Program
FSA	Family Service Agency
GREAT	Grand River Environmental Action Team
JCDC	Jackson County Drain Commissioner
MDEQ	Michigan Department of Environmental Quality
MDNR	Michigan Department of Natural Resources
NAWCA	North American Wetlands Conservation Act
NGO	Non-Governmental Organizations
NRCS	Natural Resource Conservation Service
TMDL	Total Maximum Daily Load
WMP	Watershed Management Plan
WWTP	Wastewater Treatment Plant
N/A	Not Applicable
TBD	To Be Determined
IDEP	Illicit Discharge Elimination Plan
PSD	Point Source Discharge

Sub-basin Number	Sub-basin #	Sub-basin #	Sub-basin Name
1	Lake LeAnn	20	Portage River - Middle Branch 3 (St ID 1286)
2	Southern Liberty Township Drains	21	Portage River - Lower Branch (St ID 1319)
3	Sharp Creek	22	Western Creek
4	Pierce Drain	23	Huntoon Creek
5	Grass Lake Drain	24	Grand River Drain - Downstream
6	Grass Lake Outlet	25	Perry Creek
7	Wolf Lake and Drain	26	Sandstone Blackman Drain
8	Cranberry Lake Drain	27	Sandstone Creek - Middle Branch
9	Huttenlocker and Crittenden Drains	28	Sandstone Creek - Lower Branch
10	Grand River Drain - Upstream	29	Darling-Christie Drain
11	Tobin Snyder Drain	30	Bromly Tile Drain
12	Portage River - Source	31	Willow Creek
13	Portage River - Middle Branch 1	32	Baldwin and Puffenberger Drains
14	Portage River - Middle Branch 2	33	Spring Brook - Source
15	Pickett and Jacobs Drains (St ID 1227)	34	Spring Brook - Middle Branch
16	Cahaogen Creek (St ID 1221)	35	Mills and Post Drain
17	Wild Drain (St ID 1262)	36	Spring Brook - Lower Branch
18	Orchard Creek (St ID 1294)	37	Unnamed Tributary
19	Batteese Creek		

MEASURING SUCCESS AND REVALUATING THE PLAN

Watershed planning is meant to be an iterative process that is always being revised and updated (Figure 23). This Watershed Management Plan is a living document meant to be used, revised as new information becomes available, and altered to fit the changing needs of the watershed.

Figure 23 - Watershed Management Diagram



Watershed management is intended to be a tool in a comprehensive and systematic approach to balancing land uses and human activities to meet mutually agreed on social, economic, and environmental objectives in a drainage basin. This document should be reviewed periodically (perhaps every five years in concert with the State's watershed permit review cycle), and revised as needed. This process should include the following steps, all of which are intended to be done in the context of significant public participation:

- Assess the nature and status of the watershed ecosystem.
- Define short-term and long-term goals for the system.
- Determine objectives and actions needed to achieve selected goals.
- Assess both benefits and costs of each action.
- Implement desired actions.
- Evaluate the effects of the implemented actions and progress toward goals.
- Re-evaluate goals and objectives as part of an interactive process (MDEQ, 1997).

Development of this document has included Steps 1 to 3 above, and some elements of Step 4. As communities and agencies review this document, and opportunities arise, site- or program-specific information will be generated to develop greater detail regarding the costs and benefits of each recommendation and of select BMPs.

The Section 319 Watershed Planning Grant awarded to the Jackson County Drain Commissioner (JCDC) provides funding for some initial steps in the implementation of recommendations within this Plan (e.g., development of the first product in the Watershed Education/Marketing Campaign for a workshop to present land use policy recommendations, etc.). State budget changes will dictate if and when the JCDC and participating communities also receive awarded funding for investigations and improvement of storm water infrastructure in the Jackson urban area. No other funding has yet been earmarked to implement recommendations of this Watershed Management Plan.

Affected communities are encouraged to develop funding mechanisms on two fronts: (1) to develop a Section 319 and/or Clean Michigan Initiative (CMI) funding proposal(s) for watershed plan implementation, and (2) to discuss the development of Act 200 (P.A 1957) agreements that could also provide start-up funding for implementing recommendations contained herein.

Development of these proposals should involve the creation of detailed information regarding what BMPs are to be implemented, the locations of these BMPs, anticipated costs, and information regarding who will be responsible for implementation. Based on the additional detail provided in the proposals, relevant endpoints for evaluation can be identified. These proposals should include plans to evaluate progress against these endpoints.

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