Black River Watershed Management Plan

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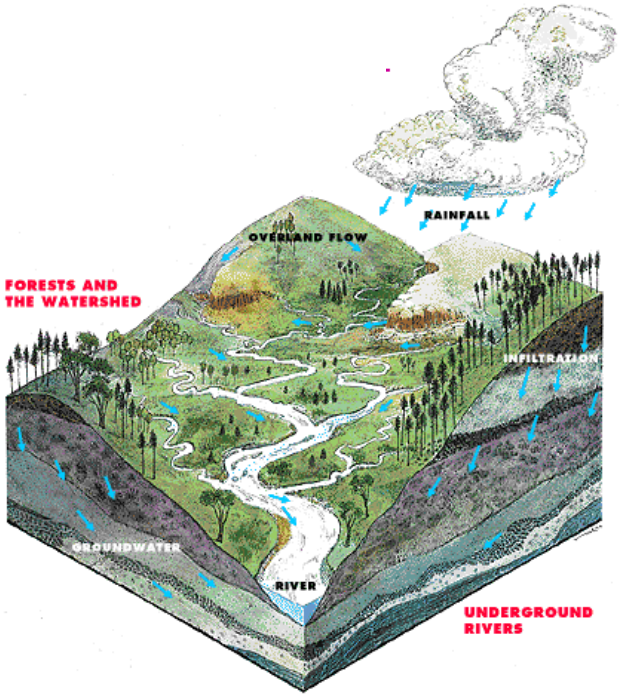
1 Project Overview and Introduction

A watershed is defined as all of the land area that drains into a common low point such as a lake or river. Rainwater and snowmelt run over the land and carry pollutants into those lakes and rivers. This form of pollution is referred to as nonpoint source, since it originates from a variety of sources. Watershed management takes a holistic approach to natural resource protection, focusing on all the activities within the watershed boundaries that can impact water quality. This requires working across township, county, and sometimes state and international boundaries. The watershed management planning process also relies heavily on input from stakeholders within the watershed.

This Watershed Management Plan has been completed through a Section 319 grant from the U.S. Environmental Protection Agency and administered by the Michigan Department of Environmental Quality. This grant was awarded to the Van Buren Conservation District in the fall of 2002. Before this, a locally driven group of individuals and organizations known as the Black River Watershed Assembly had united in efforts to improve and protect the natural resources of the Black River Watershed.



This plan focuses specifically on nonpoint source pollution, a form of pollution that is generally not regulated. The primary aim of this plan is to protect and improve surface water quality in the Black River Watershed. Other goals include educating watershed residents on how they can work to improve and protect water quality, improving recreational opportunities on the river, and developing land use strategies that will protect water quality in the future. In particular, this plan serves to restore and protect the designated uses of the Black River (see section 6.5).

The Black River is a shared resource: people swim in it, and canoe in it; farmers use it for irrigating their crops; people build houses along it to take advantage of picturesque views. South Haven is full of marinas for boaters who moor in the Black River. All of these interests depend to some extent on clean, unpolluted water. The river empties into Lake Michigan, and therefore any pollution problems in the Black River have the potential to impact the Great Lakes. Thus, the citizens of the Black River Watershed have an obligation to do their best to protect and improve the water quality of the Black River, and by extent, Lake Michigan.

2 Literature Review

Water quality is important to people, perhaps more so than any other natural resource protection goals (Weigel et al. 2004, Schueler 2000). The public is concerned with protecting drinking water quality, improving and protecting water quality in lakes, rivers and streams, and protecting watersheds (Weigel et al. 2004). Other complementary concerns include the creation of greenways, waterfront improvements, neighborhood revitalization, and protection from flooding (Schueler 2004).

> Watershed management involves identifying and prioritizing problems, promoting involvement by stakeholders, developing solutions and measuring success through monitoring and data collection.

Rivers are extraordinarily complex systems. Not until relatively recently did scientists begin to fully understand the interrelationships of the processes that occur in a healthy river system (Ward and Tockner 2001). For example, in the past, there was little consideration of floodplains and groundwater as part of the system (Ward and Tockner 2001).

Thus, the overall health of a river system is difficult to determine. Rivers that meet quantitative water quality standards may be lacking in other ways. For example, a waterway that meets water quality standards for chemical criteria may be devoid of mayflies, which are an important food source for trout (Palmer 1994). All portions of the system must be taken into account when researching the condition of a river.

Significant improvements have been made to water quality in many rivers due to point source controls on industrial and municipal discharges (Wolf and Wuycheck 2004). Nonpoint source pollution, on the other hand, remains a problem in many watersheds. Nonpoint source pollution is caused by pollutants that are carried into water bodies through runoff from roads, parking lots, farms, lawns, and other sources. This form of pollution is difficult to trace due to the diversity of originating sources. One method of managing nonpoint source pollution is through watershed management.

Watershed management is the process of managing land-use activities on upland areas so that impacts on water quality are minimized. Inherent in this process is the recognition of the interrelationships between land use, water, and soil, as well as the connection of upstream and downstream areas (Brooks et al. 1991, Ffolliott et al. 2002). Watershed management recognizes the array of uses of a watershed, including agriculture, wildlife habitat, recreation, and industry (Brooks et al. 1991, Satterlund and Adams 1992), and works to balance the demands that are placed on our water resources. One challenge of watershed management is to protect or improve water quality while maintaining these uses.

Watershed management has been attempted for at least fifty years in the United States, but the science continues to evolve. Thus, many current watershed management efforts are, at least in some part, experimental (National Research Council 1999). In the 1990s, watershed management became the new paradigm for resolving local environmental problems (Schueler and Holland 2000). Other relatively recent trends in environmental management relevant to watershed management include: a change from end-of-the-pipe pollution control measures to prevention of pollution; increased concerns about 'invisible' threats and chronic effects of pollution; awareness that nonpoint source pollution is now the major contributor to water pollution; and an increase in reliance on education programs to change behavior as it relates to environmental issues (Heathcote 1998).

Watersheds make an ideal planning unit when planning for the protection of ecological processes and habitats (Brody et al. 2004, Schueler and Holland 2000). Ecological processes, like watersheds, generally cross political boundaries. Improvements in downstream water quality can be undone by pollution upstream. However, due to the many political units that may be involved, the watershed boundary may be less useful for political and funding purposes (National Research Council 1999).

Because watershed management occurs across political boundaries, it requires buy-in from diverse agencies. No single entity has jurisdiction over all facets of the watershed, and thus watershed management requires effective collaboration from all of the political units within the watershed as well as state environmental agencies, non-profit organizations, and others. Though watershed management takes a broad geographic view, it is implemented at the local level through local land use policies. Furthermore, many factors that contribute to ecosystem degradation (such as habitat fragmentation and stormwater runoff) arise due to decisions made at the local level. On the other hand, decisions made at the local level to protect and improve ecosystems may be more effective and less expensive than those made at the state or federal level. Local land use decisions that are not made collaboratively have the potential to have a cumulative negative impact on the ecosystem (Brody et al. 2004).

Watershed management can focus on restoring degraded areas, but it can also set forth guidelines that will prevent future degradation to our water resources (Brooks et al. 1991). Beyond preventing future pollution, the most ambitious form of watershed management seeks to *improve* water quality conditions (Schueler 2004). This proactive, rather than reactive, approach will in most cases be more cost effective in the long term (Satterlund and Adams 1992). Additionally, watershed protection tools generally have a positive impact on the local economy (Schueler 2000).

A regulatory approach to an issue like watershed management is often punitive in nature and is costly to administer and enforce. Thus, some researchers feel that regulatory controls should only be used as a last resort after other programs (such as research, education, and technical assistance programs) have failed to achieve improvements (Satterlund and Adams 1992). On the other hand, the threat of future regulatory action is often an important motivator in encouraging collaboration to solve environmental problems in the present. Rather than treating environmental protection from a regulatory standpoint, watershed management strives to facilitate consensus and cooperation and ultimately solve problems relating to nonpoint source pollution and habitat loss (Lubell 2004).

Lubell (2004) argues that support from grassroots stakeholders is crucial to successful collaborative management. Grassroots stakeholders are those such as the fishers, farmers, and tourists: those who actually use the resource, not just elected officials and staff. Similarly, the National Research Council (1999) found that much watershed management in the mid- to late-20th century had been a "top-down" process, but that that approach had left out local-level decision makers. Their recommendation, therefore, was for watershed management to be driven by local stakeholders in a "bottom-up" approach.

Satterlund and Adams (1992) argue that education (particularly of policy makers, resource managers, and landowners) is essential to successfully implementing changes to improve watershed management. The growing population exacts a growing demand on water resources at the same time tourism and outdoor recreation are increasing. This points up the need for educating an urbanizing public about natural resources and rural land use (Satterlund and Adams 1992). Even rural landowners with access to technical assistance or subsidies (such as through programs administered by the Natural Resources Conservation Service) need to be educated about their options and the impacts on natural resources of their management. A study of landowners in Wisconsin found that educational programs had the most significant and long-lasting influence on management (Satterlund and Adams 1992).

The ultimate product of the watershed management planning effort is a watershed management plan. This plan should be a dynamic and flexible document, and should be updated as conditions in the watershed change (Schueler and Holland 2000). Thus, to be successful, plans should be reviewed and updated regularly (Satterlund and Adams 1992, Heathcote 1998). In reality, however, many watershed management plans, once completed, are never read or updated again (Schueler and Holland 2000).

Despite the array of benefits that watershed management can produce, not all planning efforts are successful. These efforts are often constrained by lack of funding, lack of technical expertise, or limited availability of water quality data. Schueler and Holland (2000) interviewed a variety of watershed stakeholders, including municipal officials, environmental planners, consultants, and watershed researchers about the effectiveness of watershed management plans. The general consensus was that many plans had ultimately failed to protect their watersheds. The following were the reasons cited for this failure:

- plan was conducted at too great a geographic scale
- plan was a one-time study rather than a long-term and continuous management commitment
- lack of local ownership in the watershed management process
- plan skirted real issues about land use change in the watershed.
- budget for watershed plan was poor or unrealistic
- plan focused on the tools of watershed analysis rather than their outcomes
- document was too long or complex
- plan failed to critically assess adequacy of existing local programs
- plan recommendations were too general
- plan had no regulatory meaning
- key stakeholders were not involved in developing the management plan

Additionally, the Indiana Department of Environmental Management (2003) noted that watershed partnerships can fail due to conflicts, lack of a clear purpose, vague goals, lack of commitment, and a failure to include all stakeholders.

Schueler and Holland (2000) also made recommendations for creating effective watershed management plans:

- create a watershed management institution
- plan at the subwatershed scale
- commit to a continuous watershed management cycle
- accurately measure and forecast land use
- shift the location and density of future development
- produce integrated resource map for subwatershed
- devise specific criteria to guide subwatershed development
- emphasize strategic resource-based monitoring
- audit effectiveness of local watershed protection programs
- incorporate priorities from larger watershed management units
- actively engage stakeholders and include public early and often
- promote intra- and inter-agency coordination

Brody et al. (2004) also recommended that watershed management plans must have a factual basis (including a thorough inventory of natural resources and human impacts to these resources), must have clearly specified and measurable goals and objectives, and must define the actions that need to be taken. The plan "conceptualizes a commitment to implementing the final plan… [and] articulates mechanisms and procedures to implement the plan once it is adopted" (Brody et al. 2004, p. 37).

Some of these recommendations may be difficult to implement in real world situations, given the realities of tight budgets, development pressures, and political situations (Schuler and Holland 2000). However, these recommendations have great potential to improve watershed management plans in the future.

Though watershed management planning may be flawed in some cases, the potential benefits are significant. Beyond identifying steps to be taken to improve water quality, a plan can also be used to leverage grant funds, empower the community, and leverage agency support (Indiana Department of Environmental Management 2003). Collaborative relationships built during watershed management planning can carry over into other areas of environmental management. In many instances, collaborative watershed management may be the only method by which to address nonpoint source pollution.

3 Watershed Description

3.1 Geographic Scope

The Black River Watershed encompasses approximately 183,490 acres, or 287 square miles in Allegan and Van Buren Counties in southwestern Michigan. 43.8% of the watershed lies in Allegan County, and 56.2% lies in Van Buren County. A map of the watershed is shown in Figure 1, and a map displaying subwatersheds is shown in Figure 2. The primary townships encompassed by the watershed are listed in Table 1.

Table 1: Townships in the Black River Watershed

Townships in Allegan County	% of Township in the Black River Watershed	Townships in Van Buren County	% of Township in the Black River Watershed
Casco	92%	Arlington	77%
Cheshire	23%	Bangor	65%
Clyde	78%	Bloomingdale	53%
Ganges	59%	Columbia	100%
Lee	94%	Covert	22%
		Geneva	100%
		South Haven	40%
		Waverly	11%

The watershed boundary also encompasses small portions of Manlius, Saugatuck, and Valley Townships in Allegan County. However, no streams enter the watershed from these townships. There are also several cities and villages in the Black River Watershed. These are listed in Table 2.

Table 2: Cities and Villages in the Black River Watershed

City or Village	County
Fennville*	Allegan
Bangor	Van Buren
Breedsville	Van Buren
Bloomingdale	Van Buren
South Haven	Van Buren

*Though the boundaries of Fennville are technically within the Kalamazoo River Watershed, the cities' storm sewers drain to the Black River (G. Tuhacek, personal communication, February 17, 2004).

Other unincorporated communities in the watershed include Grand Junction, Pullman, and Lacota.

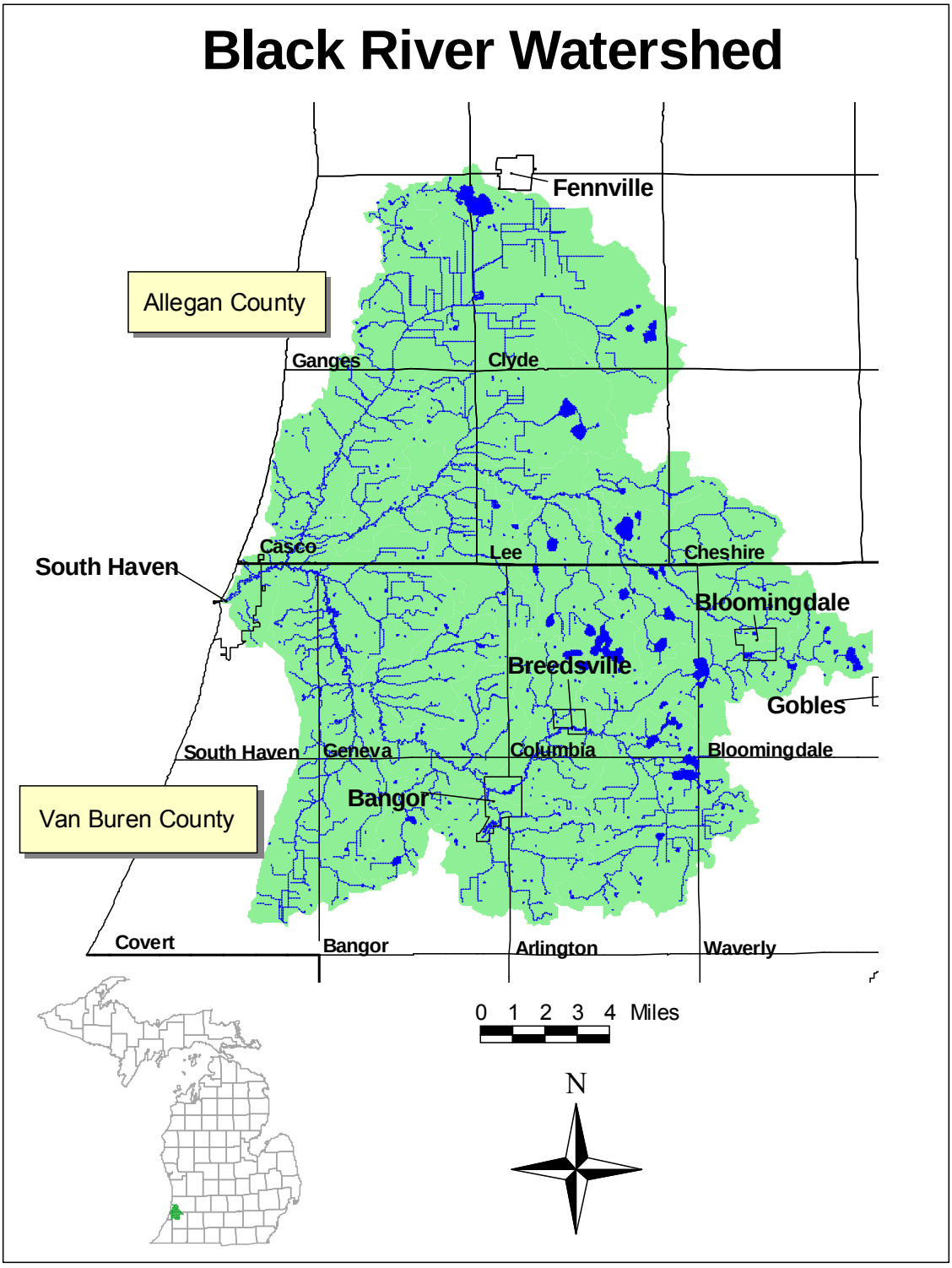


Figure 1: Black River Watershed map

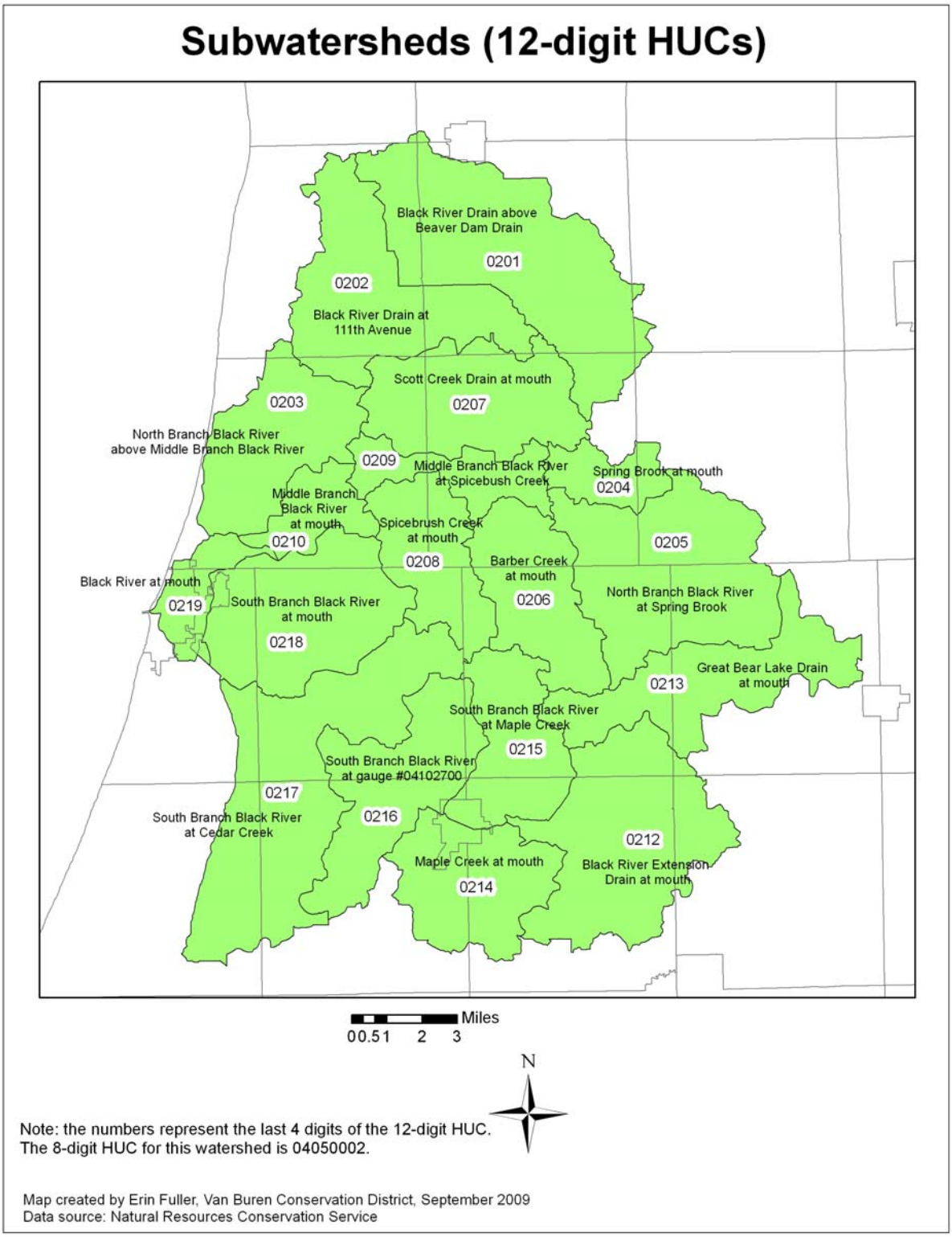


Figure 2: Subwatersheds of the Black River Watershed (12 digit HUCs)

3.2 Topography

Glaciers shaped the landscape of Michigan, and the Black River Watershed is no exception. The surface (or quaternary) geology map (Figure 3) of the area shows that the landscape of the watershed is dominated by lacustrine sand and gravel, fine-textured glacial till, glacial outwash, and end moraines (MNFI and MDNR 1998). The bedrock of the watershed is primarily Coldwater shale, with a small area of Marshall Formation (MDEQ 1987). This bedrock is generally covered with 50 to 350 feet of glacial deposits (Albert 1995). The landscape tends to be flat to gently rolling with some steeper ravines.

Relief varies across the area. The highest elevation in the watershed is 836 feet above sea level, in the far southern portion of the watershed in Arlington Township (Van Buren County). The lowest elevation is representative of local base level, which at the western shores of Lake Michigan is 577 feet above mean sea level. Topographic variations are not significant in Allegan County (USGS 1985).

3.3 Soils

The principal soil associations in the watershed are Capac-Riddles-Selfridge and Gilford-Maumee-Sparta (Figure 4 and Table 3). The most prevalent soil series (in terms of area) in the watershed are Oakville fine sand, Selfridge loamy sand, Capac loam, Pipestone-Kingsville complex, Glendora loamy sand and Chelsea loamy fine sand. The Oakville series is usually well- or moderately well-drained and is found on outwash plains, lake plains, moraines, dunes and beach ridges. It can be poorly suited for crops due to droughtiness and erosion by wind (Knapp 1987). The Selfridge series is a nearly level and somewhat poorly drained soil. It is found on convex plains, knolls and side slopes. This soil is well suited for cropping with corn and soybeans (Bowman 1986). The Capac series is nearly level to undulating and somewhat poorly drained, and is found on flats, low ridges, knolls and foot slopes. These soils are well suited to cropland for corn, soybeans, small grain, hay, apples and pears (Knapp 1987). The Pipestone-Kingsville complex consists of nearly level, somewhat poorly drained soils. They are found on slight knolls, depressions, and natural drainageways. They can be frequently ponded. They are suited mostly for specialty crops, and if drained are well suited for blueberries (Bowman 1986). The Glendora series consists of nearly level, poorly drained soils and is usually found in floodplains. Due to periodic flooding, this soil is typically not used for crops (Knapp 1987). The Chelsea series is found in level to hilly areas on low ridges, knolls, flats and side slopes. It is usually excessively drained, and is typically unsuitable to cropland due to droughtiness and wind and water erosion. Some crops (such as corn, small grain, soybeans, hay, peaches, cherries, potatoes and asparagus) can be grown (Knapp 1987). Tables of the individual soil units are located in Appendix A.

Table 3: General Soil Associations in the Black River Watershed

General Soil Associations	Acres
Capac-Riddles-Selfridge	81,618
Coloma-Spinks-Oshtemo	11,393
Gilford-Maumee-Sparta	34,712
Houghton-Carlisle-Adrian	1,527
Kingsville-Pipestone-Covert	20,277
Marlette-Capac-Spinks	4,790
Oakville-Covert-Adrian	20,540
Urbanland-Parkhill-Capac	8,629

Soils are classified by the Natural Resources Conservation Service for their runoff potential (Table 4). Analysis of these hydrologic soil groups can help determine which portions of the watershed are most important for groundwater recharge. Soils in group A have smallest runoff potential and those in group D have the highest runoff potential. Protection of areas with high infiltration capacity (group A soils) is important for maintaining hydrology and temperature regimes in the watershed. The majority of the watershed (about 67%) has soils with high or moderate infiltration rates. See also Appendix N, Figure 7 for a map of soil hydrogroups.

Table 4: Hydrologic soil groups

Hydrologic Soil Group	Description	% of watershed
A	Sand, loamy sand or sandy loams with low runoff potential and high infiltration rates	37.6%
B	Silt loam or loams with moderate infiltration rates	29.5%
C	Sandy clay loams with low infiltration rates	11.0%
D	Clay loam, silty clay loam, sandy clay, silty clays with high runoff potential and low infiltration rates	20.3%
Water		1.6%

Another aspect of soils is their suitability for septic tank absorption fields. This watershed is primarily rural, and many homeowners rely on septic systems. The Natural Resources Conservation Service rates different soil types as "not limited," "somewhat limited," or "very limited" for their use as septic tank absorption fields. "Not limited" indicates that the soil has features that are very favorable for septics; good performance and low maintenance can be expected. "Somewhat limited" indicates that the soil has features that are moderately favorable for septics. Limitations can be overcome or minimized by special planning, design, or installation; fair performance and moderate maintenance can be expected. "Very limited" indicates that the soil has one or more features that are unfavorable for septic tank absorption fields. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected. The majority of soils in the Black River Watershed are considered very limited for use as septic system absorption fields (Figure 5), and, in fact no soils are considered "not limited."

3.4 Ecosystem and Climate

The Black River Watershed is in the Berrien Springs (VI.3.1) and Southern Lake Michigan Lake Plain (VI.3.2) sub-subsections of the Southern Lower Michigan regional landscape ecosystem. This ecosystem has been highly modified by agriculture and development. In addition, the proximity of Lake Michigan and prevailing westerly winds moderate the climate and produce lake effect snow. The climate is influenced by the Maritime Tropical air mass, which tends to be a relatively warm and humid air mass (Albert 1995).

The watershed lies within the Southern Michigan, Northern Indiana Till Plains ecoregion. Ecoregions are delineated by their climates, soils, vegetation, land slope, and land use (Wolf and Wuycheck 2004). Rivers within this ecoregion tend to be of good quality in their headwaters, are typically slow flowing, and are sometimes bordered by extensive wetlands. Drainage ditches and channelized rivers are common in this ecoregion where land is too wet for agriculture or building (Wolf and Wuycheck 2004).

Total annual rainfall is approximately 37 inches. Average winter temperature is 25.6° F and average summer temperature is 69.4° F. Average seasonal snowfall is 85.6 inches (Knapp 1987 and Bowman 1986).

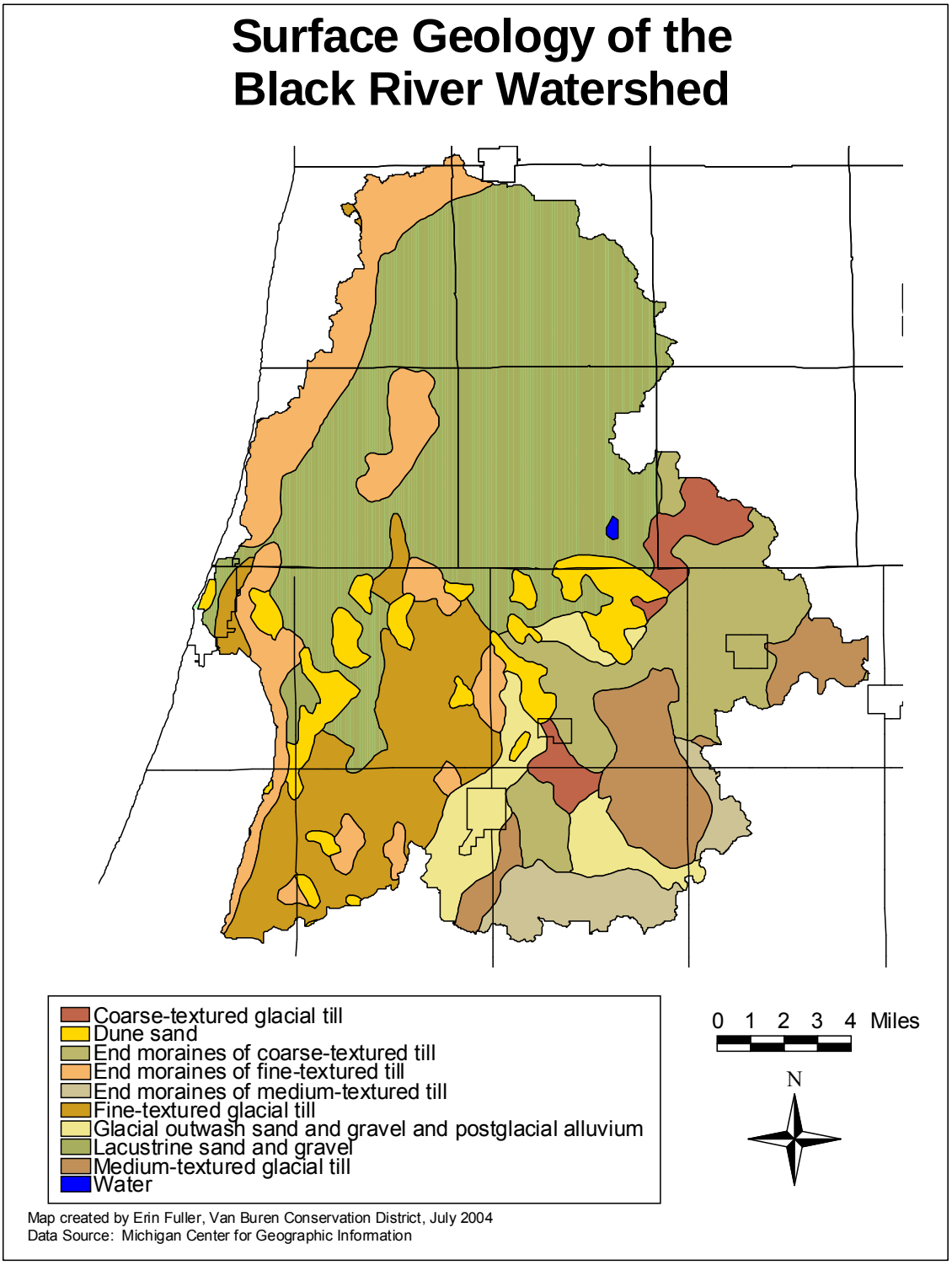


Figure 3: Surface Geology of the Black River Watershed

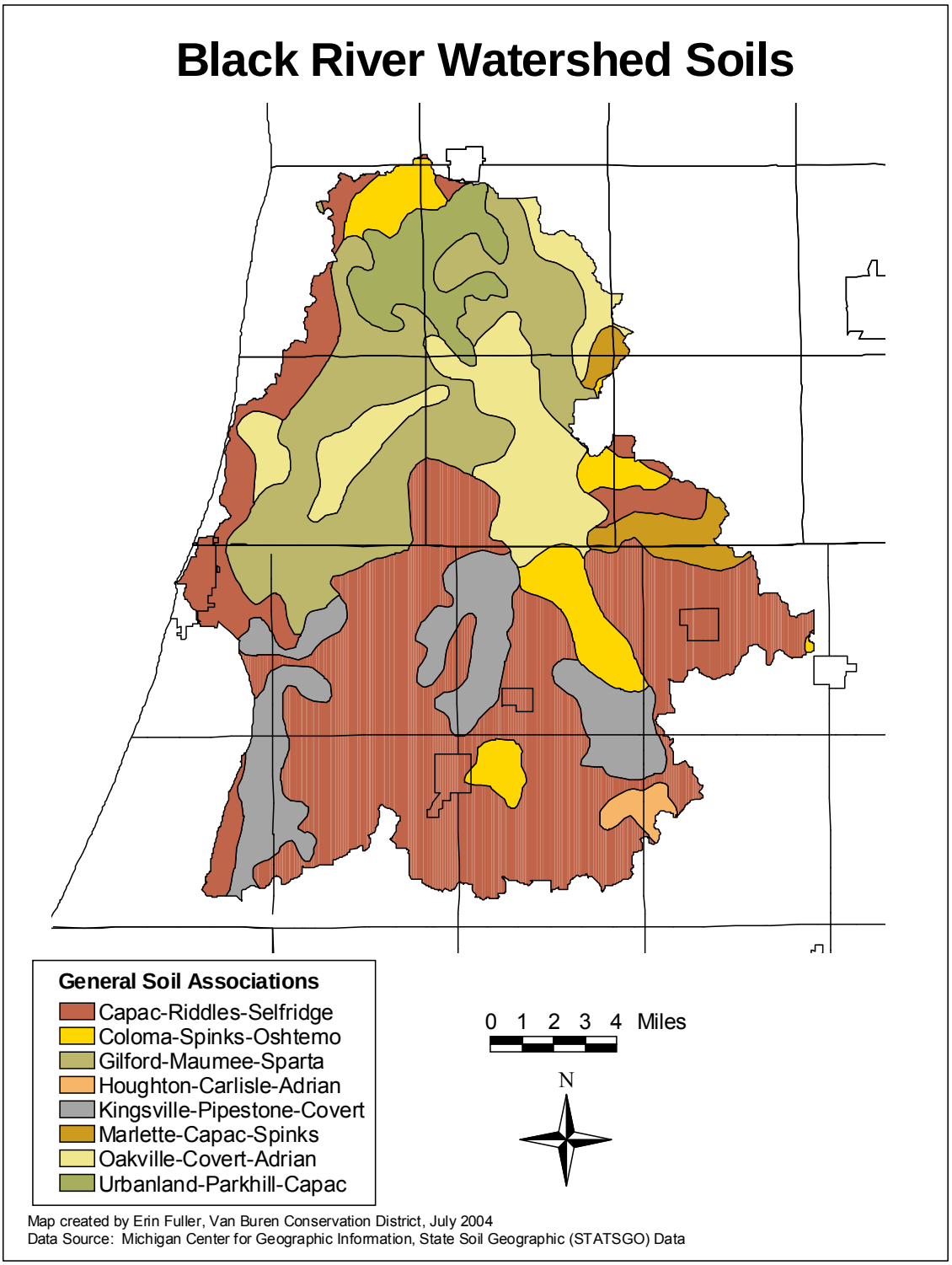


Figure 4: Black River Watershed soil associations

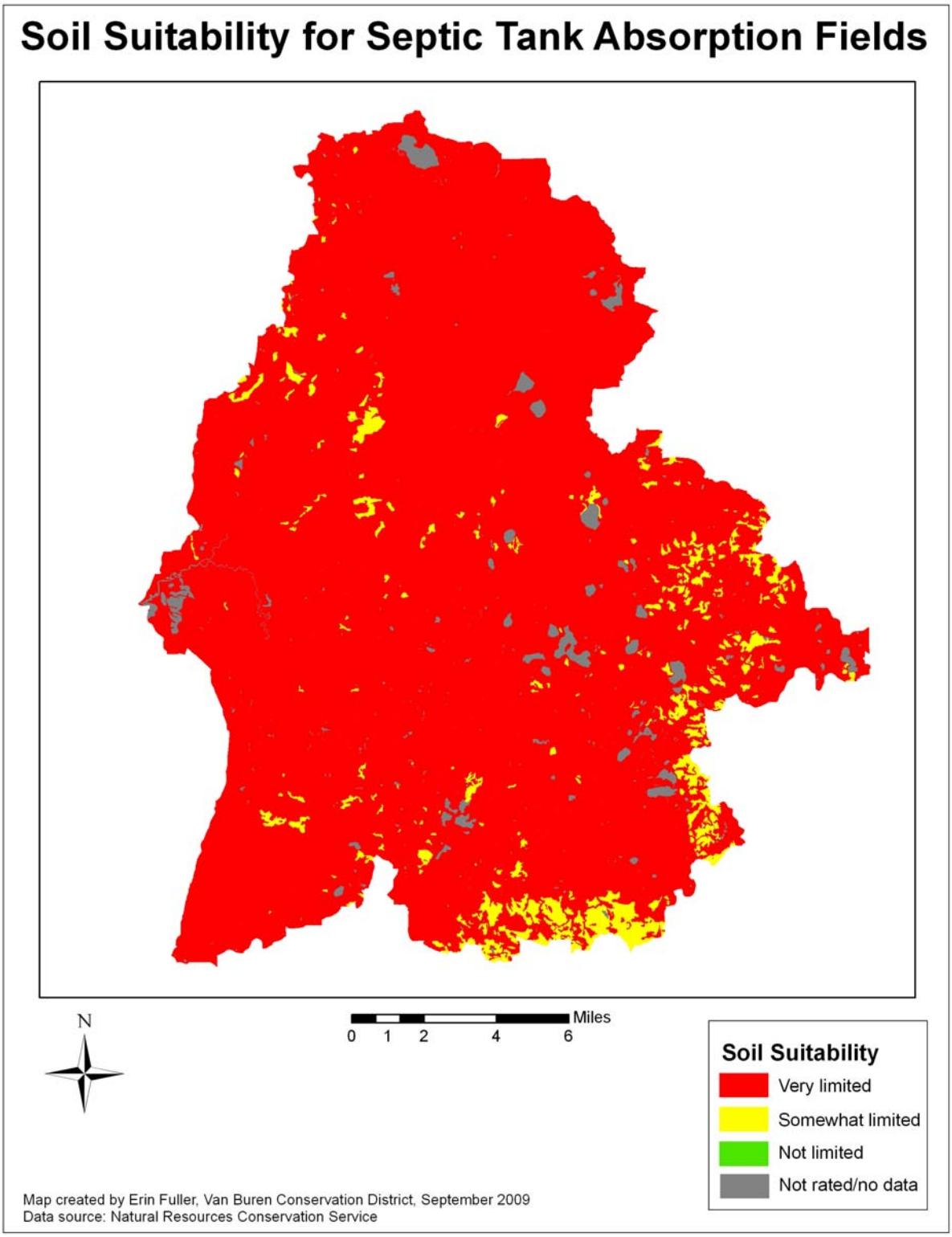


Figure 5: Soil suitability for septic tank absorption fields

3.5 Land Use and Land Cover

Prior to European settlement of the area in the 1800s, the Black River Watershed was primarily forested (Figure 6). The dominant forest type was Beech-Sugar Maple forest. The complete list of pre-settlement land cover types is shown in Table 5. The forest was used for lumbering beginning in the mid 1800s and continuing until the 1890s. (Pahl n.d.). As soon as the land was cleared of trees, land was cultivated for agriculture (Knapp 1987).

Table 5: Black River Watershed 1800s Land Cover

Land Cover Type	Acres	% of total
Beech-Sugar Maple Forest	98276.2	53.6%
Beech-Sugar Maple-Hemlock Forest	22226.2	12.1%
Mixed Conifer Swamp	19736.5	10.8%
Mixed Hardwood Swamp	12805.5	7.0%
White Pine-Mixed Hardwood Forest	10257.8	5.6%
White Pine-White Oak Forest	7476.4	4.1%
Black Ash Swamp	3382.8	1.8%
Lake/River	3039.0	1.7%
Hemlock-White Pine Forest	2936.8	1.6%
Oak/Pine Barrens	1754.8	1.0%
Shrub Swamp/Emergent Marsh	1031.4	0.6%
Muskeg/Bog	413.1	0.2%
Cedar Swamp	149.7	0.1%
TOTAL	183486.3	100.0%

Source: Michigan Resource Information System 1978

The most current land use/land cover data for the Black River Watershed is from 1992 (Michigan Center for Geographic Information 2002). This shows agriculture (herbaceous planted/cultivated) as the dominant land use, followed by forested upland (Figure 7). The complete list of land cover types in the 1992 land cover map is shown in Table 6.

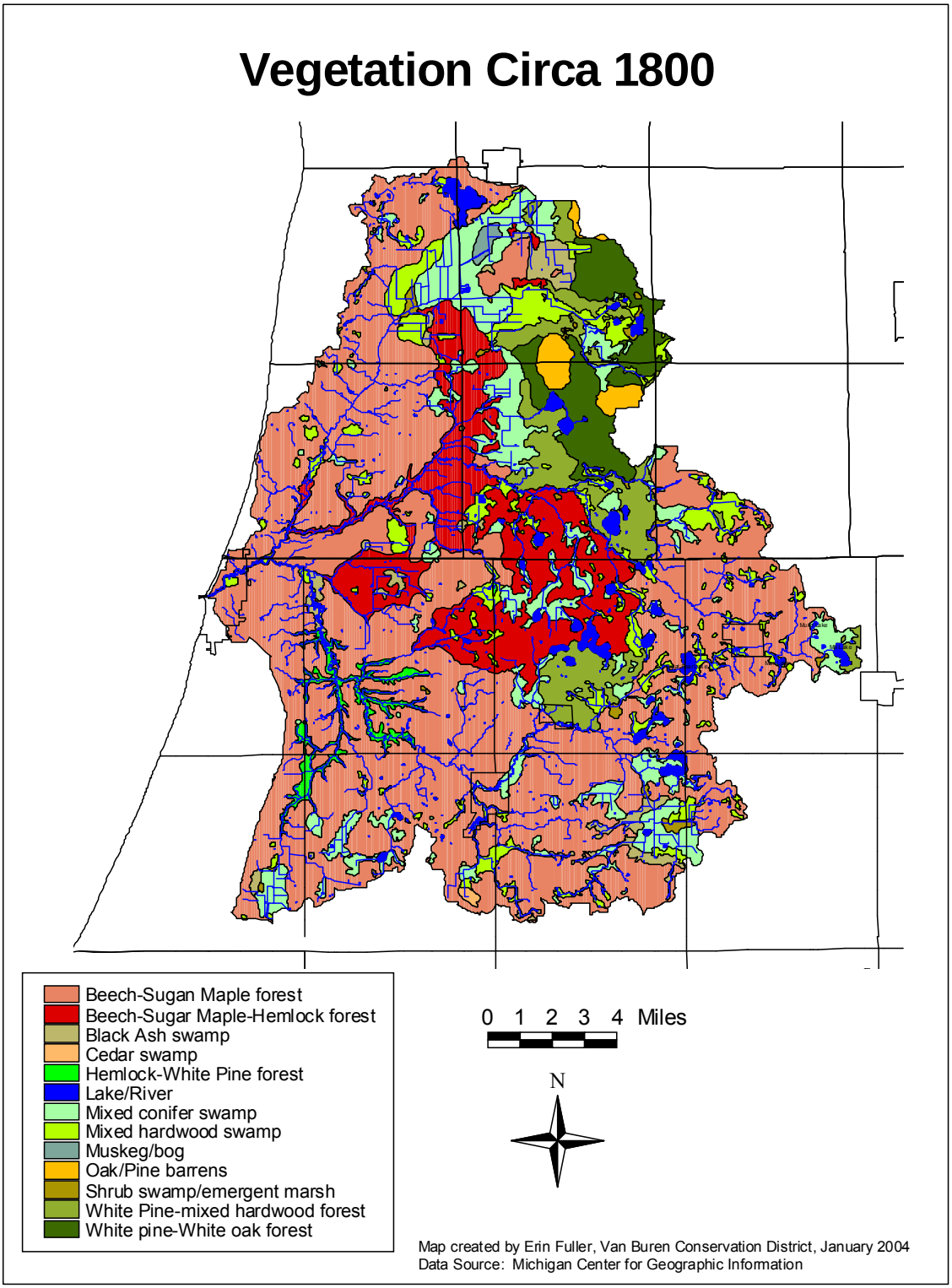


Figure 6: Presettlement vegetation in the Black River Watershed

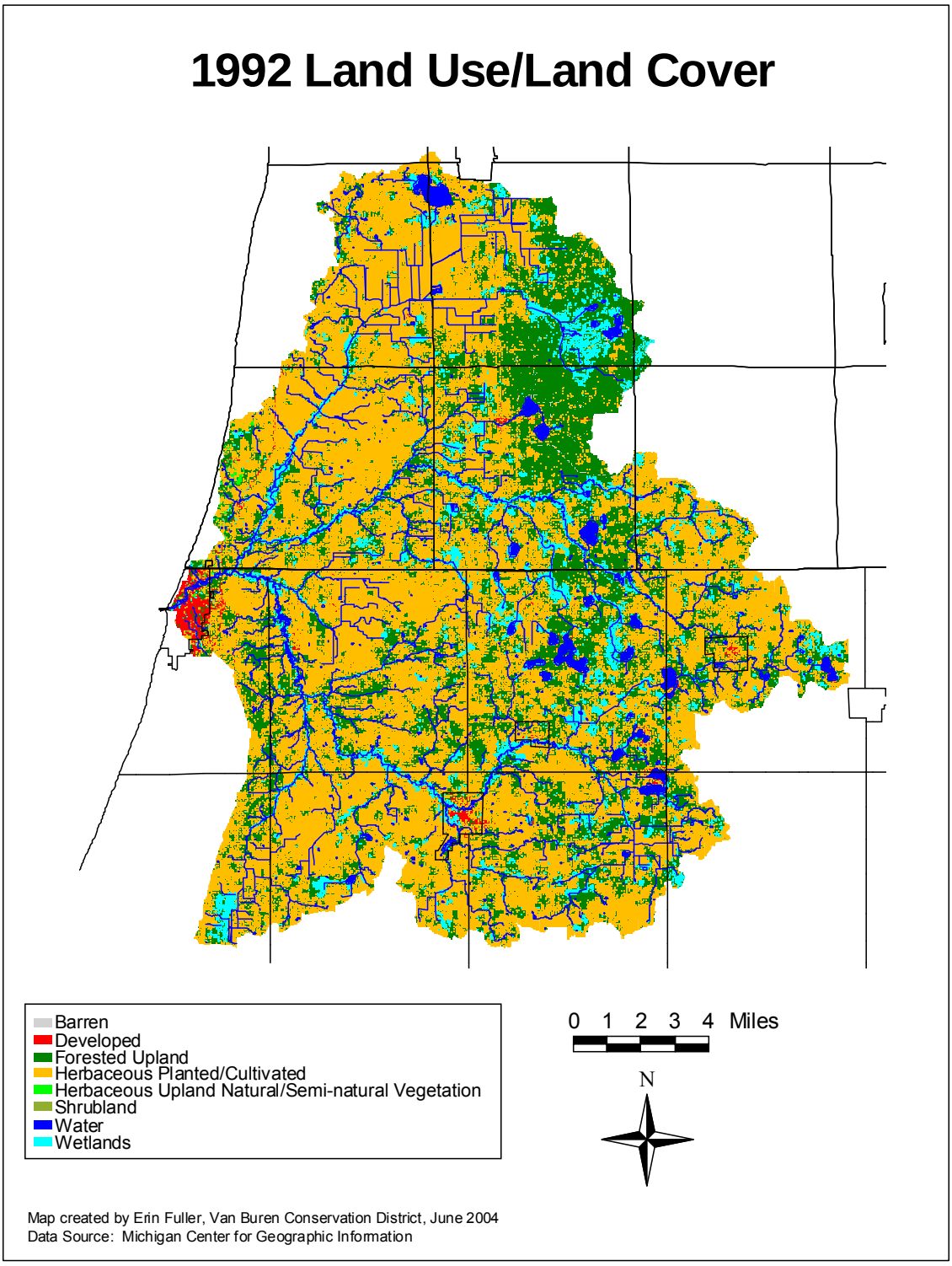


Figure 7: 1992 Land Use

Table 6: Black River Watershed 1992 Land Cover

Land Cover Type	Allegan Acres	Van Buren Acres	Total Acres	% of watershed
Herbaceous Planted/Cultivated	44385.5	60894.8	105280.3	57.4%
Forested Upland	28015.2	32426.1	60441.3	32.9%
Wetlands	5950.2	6374.5	12324.7	6.7%
Water	1160.6	1608.4	2769.0	1.5%
Developed	409.1	1742.3	2151.3	1.2%
Barren	250.1	2.1	252.2	0.1%
Herbaceous Upland Natural/Semi-natural Vegetation	173.2	34.5	207.7	0.1%
Shrubland	61.2		61.2	0.0%
Total	80405.1	103082.7	183487.8	100.0%

Source: Michigan Center for Geographic Information 2002

Land use/ land cover data is also available from 1978 (Michigan Department of Natural Resources 1999) (Figure 8). There is no clear trend in land use change available from an analysis of these two data layers, due to the different methods by which these data were derived. The 1978 data was derived from a visual interpretation of aerial photographs, while the 1992 data was compiled from Landsat satellite Thematic Mapper imagery. A summary of the results of these surveys is shown in Table 7.

Table 7: Black River Watershed Land Use/Land Cover in 1978 and 1992

Land Cover Type	1978	1992
Agricultural Land	54.42%	57.38%
Forested Land	36.51%	32.94%
Developed Land	4.71%	1.17%
Wetlands	2.83%	6.72%
Water	1.48%	1.51%
Other	0.06%	0.28%
Total	100.00%	100.00%

Sources: Michigan Department of Natural Resources 1998 and Michigan Center for Geographic Information 2002

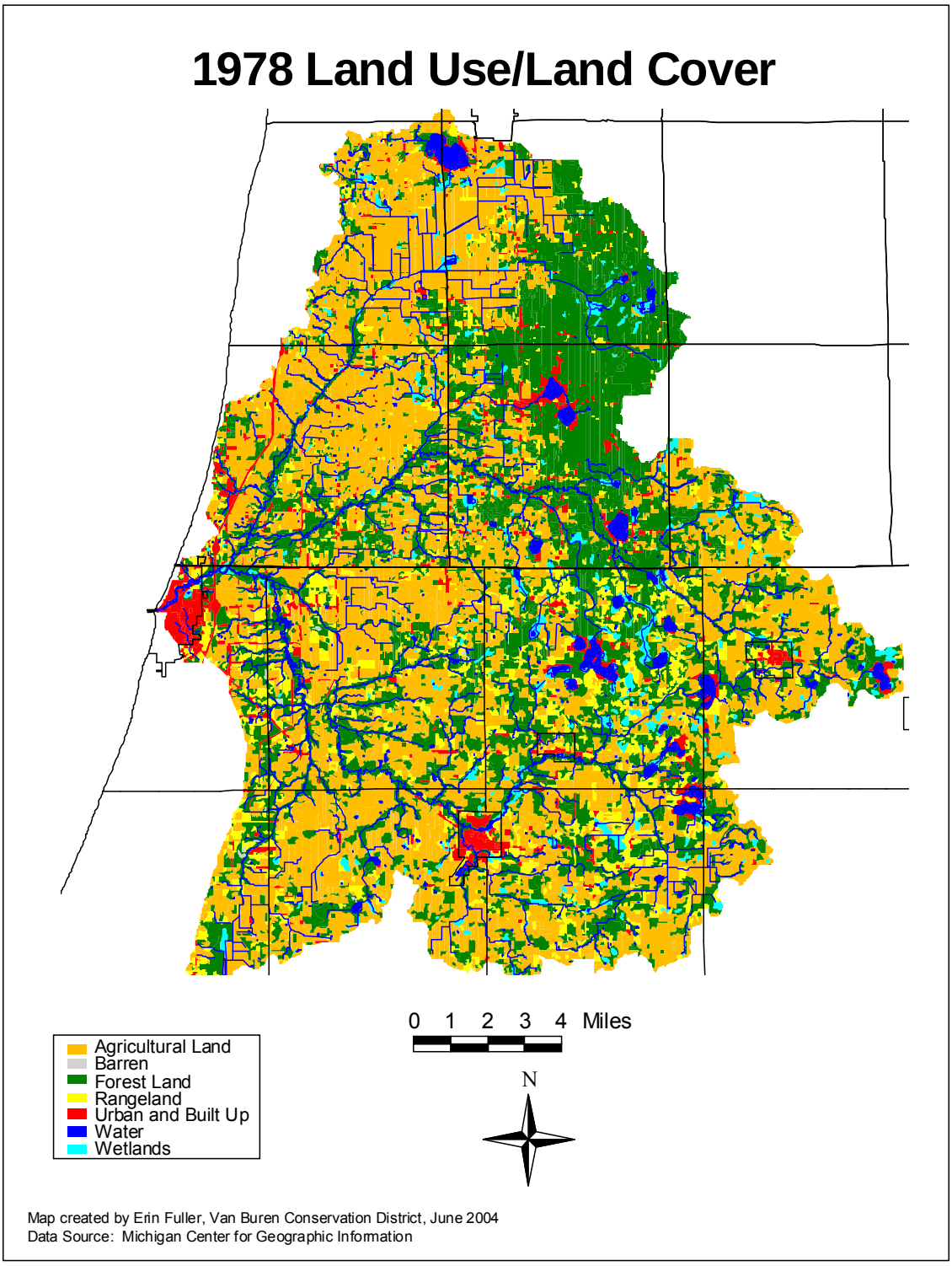


Figure 8: 1978 Land Use

3.6 Hydrology

The Black River Watershed contains approximately 530 miles of rivers, streams, and drains (this number does not include intermittent streams and likely under-represents county drains). The watershed also contains 43 named lakes and numerous (over 500) small, unnamed lakes and ponds. The named lakes are listed in Appendix B. The largest lake in the watershed is Hutchins Lake in Clyde and Ganges Townships (Allegan County), at 379 acres. Other large lakes in the watershed include Saddle Lake in Columbia Township (Van Buren County) at 283 acres, Osterhout Lake in Lee Township (Allegan County) at 172 acres, and Great Bear Lake in Bloomingdale and Columbia Townships (Van Buren County) at 166 acres. Most of these named lakes (and many of the smaller, unnamed ones) are connected by surface water to the Black River through streams and drains.

- Lakes in the watershed are generally either mesotrophic (having moderate nutrient levels) or eutrophic (having excessive nutrients)
- 65%-85% of the watershed's wetlands have been converted to other uses
- Sandy soils in the watershed make groundwater vulnerable to pollution

Based on studies by the Michigan Department of Environmental Quality, lakes in southern lower Michigan tend to have moderate to high nutrient levels, while lakes with lower nutrient levels tend to be located in northern Michigan. This is likely due to the fertility of soils along with higher population density in southern Michigan. The lakes in the Black River Watershed that have been assessed have been determined to be either mesotrophic (lakes with a moderate level of nutrients) or eutrophic (lakes with excessive nutrient levels that are often subject to algal blooms and overgrowth of aquatic plants, leading to low oxygen levels). Lakes listed as eutrophic in the watershed are Lake Fourteen (Columbia Township), Lower Scott Lake (Lee Township), and Saddle Lake (Columbia Township) (Wolf and Wuycheck 2004). Great Bear Lake (Columbia and Bloomingdale Townships) is considered high-eutrophic (Walterhouse 2004).

There are 17 dams on the Black River and its tributaries. Of these dams, 11 are privately owned, 4 are owned by local governments, and 2 are state-owned. Most of these are impassable to fish. The full list of these is shown in Appendix C.

Much of the wetland area in the watershed was drained during settlement to provide land for agriculture (wetland inventory, wetland loss, and potential wetland restoration area maps are shown in section 4.7). Many drains were dug, or streams were straightened in the late 1800s and early 1900s to improve the drainage of water. The majority of the drains are located in the headwaters of the North Branch of the Black River, though drains also exist in the headwaters of both the Middle and South branches. Approximately 65% to 85% of this watershed's wetlands have been converted to other uses since European settlement of the area. Maps of wetland change created by the Michigan Natural Features Inventory (MNFI n.d.) indicate that the area with the most wetland loss is the headwaters area of the North Branch in Ganges and Clyde Townships. The area around inland lakes has also experienced a considerable amount of wetland loss.

Groundwater supplies much of the water in the main stem and tributaries of the Black River. Groundwater seeps are visible along the banks in several locations. This helps keep water temperatures relatively cold, even in the summer. Groundwater and surface water are clearly closely linked, and any contamination of the former has the potential to significantly impact the latter. The predominance of sandy soils and the shallow water table in many portions of the watershed make the groundwater particularly vulnerable to pollution. Sources of groundwater pollution include leaking underground storage tanks and abandoned wells.

Much of the Black River and its tributaries are low gradient (or low slope). The profile is fairly typical, being steeper in the headwater regions and flatter near the mouth (Fongers 2004). Elevation changes between the headwaters and the mouth generally are not more than 5 feet per linear mile (though some headwaters have higher gradients). Water velocity is generally relatively slow. These factors contribute to the vulnerability of the system to sand and sediment deposition. Sand and sediment is deposited into the stream channel from eroding streambanks, and the stream lacks the energy to flush the deposits from the stream channel (Cooper 1999).

3.7 History of the Region

The rivers in this region of Michigan were the principal source of food and travel for the Native Americans that first inhabited the area. Europeans explorers and fur traders arrived in the early 1600s but the area was not settled until the late 1820s (Pahl n.d. and Bowman 1986). At that point lumbering became a major industry and sawmills and dams (to provide water power to the mills) were located on most of the rivers. This major clearing of land likely contributed a great deal of silt to the Black River. Mrs. A.B. Chase arrived in South Haven as a child in 1852. She recalls:

> We used to go out on the bank and watch the boats until they reached South Haven. We children crossed many a times on the dry sand bar at the mouth of the river, and when the wind went down, Old Mr. Bundy would come down with an ox team and plow through the sand, and in a few hours the river would flow again into the lake (excerpted in Appleyard 1996, p. 76).

The Black River (probably the South Branch) was cleared and widened for a 25-mile stretch to accommodate logs being floated down (Appleyard 1996). An early settler, Agnes Sheffer, recounted some of this history in "The Early History of South Haven":

> A saw mill was built in 1853 on the north side of the river. The river had been dragged for nearly 25 miles. The river was much wider and deeper than at the present time, which made it an easy run for logs from the pines lands up the river (excerpted in Appleyard 1996, p. 8).

By the 1860s, South Haven was a town of approximately 200 people, with a hotel, flour mill, lumber mills, tannery and several stores (Appleyard 1996). The piers at the mouth of the Black River in South Haven were first built in 1861, and a lighthouse was built on these piers in 1871 (Stieve 1977). The building of the piers gave rise to a busy harbor. Many ships were built in South Haven even before the turn of the 20th century. These ships were used for the transportation of products such as lumber, fruit, produce, wood pulp as well as passenger travel. In 1932, South Haven was the busiest foreign port on the Great Lakes (Stieve 1977). Much of the freight was wood pulp and other supplies for paper mills in the Kalamazoo area (Appleyard 1984).

The area was thickly forested and full of game when the settlers arrived. The January 8, 1855 edition of the Paw Paw Free Press contained the following advertisement:

> TO SPORTSMEN!
> All who take pleasure in hunting, will find plenty of amusement here. The woods on Black River and its branches are literally filled with game. Deer, Bear, Wolves and Turkeys are often met with. A good home will be found at the "FOREST HOUSE," which has lately changed hands, and is now kept by Mr. J.F. Withey who is ready and willing at all times to accommodate travelers and make them comfortable and happy.
> South Haven, Van Buren Co., Dec. '54

After the land was cleared during logging it was quickly cultivated for agriculture (Pahl n.d.). By 1921, most of the active logging had ended, and the fruit industry was on the rise (Appleyard 1984). The soils and climate of the region made it especially good for growing specialty crops like blueberries, apples and peaches.

The South Haven area has been a center for a variety of industries, including shipbuilding, tanneries, sawmills and commercial fishing. Fish species such as whitefish, perch and lake trout were all plentiful in the mid- to late-1800s. Sturgeon were also plentiful (Appleyard 1984). Oil was discovered in Bloomingdale in 1938, leading to the drilling of 108 oil wells and the building of two refineries. The oil boom lasted only a few years, and the oil business ended completely in 1963 (Van Buren Community Center n.d.).

The South Haven area became a resort destination in the late 1800s. Visitors arrived via lake steamer and lodging was available in a variety of hotels, farm resorts, family homes and summer cottages. Several parks and resorts arose along the Black River, including Riverside Park, Midway Park, Crescent Park, and Oakland Park. Launches carried resorters up and down the river.

The Bangor area has also been the center for several industries, many of which depended upon the Black River in some way. The first industry in Bangor was a sawmill built in 1846 on the banks of the Black River. Other mills soon followed, including a grist mill and a woolen mill. The Bangor Furnace Company was built in 1872. This blast furnace burned wood into charcoal for the manufacture of pig iron. This industry consumed a significant amount of the local virgin timber: approximately one square mile of local forest was cleared per year. The Bangor Chemical Works was built in 1877 to work in conjunction with the Bangor Furnace Company, producing chemicals that were derived from the furnace operations, including acetate of lime, wood alcohol, and acetic acid. By the mid-1880s both the furnace and chemical company were affected by the dwindling supply of local timber and lack of demand for iron. Both industries had ceased operations in Bangor by 1890. All the land that had been cleared for

the operations of the blast furnace was potential farmland, and agriculture became the next major industry in the Bangor area (Emmert 2004).

All of these industries certainly impacted the Black River. The clearing of forests for the furnace and agriculture likely left the banks of the river unvegetated and unstable. Chemical pollutants from the industries were likely discharged into the river, as were pesticides (such as arsenate of lead) (Emmert 2004) and fertilizers from agricultural operations.

4 Natural Features of the Black River Watershed

4.1 Introduction

The landscape of the Black River Watershed has changed dramatically since the 1800s, prior to European settlement. The watershed was at that point nearly entirely forested (including both upland and lowland forest types), while the current forest cover is closer to 35% of the landscape. Wetlands (including marshes and swamps) were also a significant portion of the pre-settlement landscape (20.4 %). Current wetland land cover is between 2.8% and 6.7% of the watershed, representing a 65% to 85% loss from pre-settlement times.

Most of the native habitat remaining in the Black River Watershed consists of a variety of forest types. Most of this forest is deciduous, though there are also areas with evergreen and mixed forests as well. Of the wetlands remaining in the watershed, most consist of woody vegetation (i.e. swamps), though a few contain herbaceous emergent vegetation (i.e. marshes).

Table 8: Existing native habitat types in the Black River Watershed

Habitat type	Acres
Central Hardwood	46,846.4
Lowland Hardwood	16,294.5
Pine	3,098.5
Shrub/Scrub Wetland	2,940.4
Lakes	2,606.9
Wooded Wetland	1,472.8
Emergent Wetland	371.2
Aquatic Bed Wetland	255.6
Lowland Conifer	101.5
Aspen, Birch	31.5

Source: MDNR 1999

Many stretches along the Black River have intact riparian forest habitat. A study of bird communities in forested riparian wetlands in southern Michigan (Inman et al. 2002) found that this type of habitat is important breeding habitat for bird species that are not always found in upland areas. Species composition, species richness, and densities of individual species varied markedly between forested wetlands and adjacent uplands. Loss of this type of habitat would thus have a major impact on those bird species that depend upon river corridors for food and nesting. Riparian forests also play a critical role in water quality. Deforestation of riparian areas leads to reduced stream habitat for benthic macroinvertebrates (animals without a backbone that live on the bottom of streams) and increased pollutant runoff. Forested stream channels are also more stable than deforested channels (Sweeny et al. 2004).

4.2 Species in the Black River Watershed

As of September 2004, a total of 471 species of plants, 130 species of birds, 70 species of fish, and 67 species of other wildlife (insects, reptiles, etc.) had been recorded for the Black River Watershed. This list was compiled from observations of the watershed coordinator, watershed technician, and other volunteers, as well as from species lists kept by the Southwest Michigan Land Conservancy for four properties under their ownership in the watershed (Appendix D). There are certainly many more species (especially invertebrates) that simply have not been catalogued for the watershed. Fish species were compiled by Kregg Smith, MDNR Fisheries biologist (Appendix E).

4.3 Unique Natural Features

A variety of rare species have been documented in the Black River Watershed. The Michigan Natural Features Inventory (MNFI) maintains a database of threatened and endangered species as well as species of special concern. This should not be considered an exhaustive inventory. For the Black River Watershed, this list contains 14 species of animals, 30 species of plants, one community (Coastal Plain Marsh), and one “other” element (Great Blue Heron Rookery). The Great Blue Heron Rookery is especially interesting because it may have existed as early as 1875. A

journal article from 1895 recounts a visit to a heron rookery in Van Buren County at the approximate latitude of 42º 20 (Pericles 1895), which is the same latitude as the present rookery. This may also be the largest heron rookery in southwest Michigan.

The watershed contains one species that is federally endangered, the Karner Blue butterfly (*Lycaeides melissa samuelis*). The Eastern Massasauga (*Sistrurus catenatus catenatus*) is a candidate for federal listing under the Endangered Species Act of 1998. Species in the watershed that are listed at the state level as endangered include the migrant Loggerhead Shrike (*Lanius ludovicianus migrans*), Small-fruited Spike-rush (*Eleocharis microcarpa*), and Swamp or Black Cottonwood (*Populus heterophylla*). Other rare species that exist in the watershed include Red-shouldered Hawk (*Buteo lineatus*), Box Turtle (*Terrapene carolina carolina*), and Swamp Rose-mallow (*Hibiscus moscheutos*). A full list of these rare species can be found in Appendix F.

A population of state threatened Sessile Trillium (*Trillium sessile)* (also known as "toadshade") occurs along the South Branch of the Black River. This population is the northernmost population of this species yet discovered, and is one of the largest (B. Martinus, personal communication, May 1, 2004). This species is considered to be rare or uncommon in the state and possibly imperiled due to rarity.

4.4 Biological Surveys

The Michigan Department of Environmental Quality has performed a number of biological surveys in the Black River Watershed. These surveys are examined in more depth in section 6.1. A 1988 survey of the Black River in Bangor found that aquatic habitat quality was low due to the amount of sand and silt, and that discharges into the river may have also contributed to poor habitat quality. Low macroinvertebrate species diversity was discovered downstream of these discharges (Hull 1989). PCBs were also detected in fish in this area in a 1989 study (Gashman 1990).

A 1992 survey determined that biological quality ranged from acceptable to excellent throughout the watershed (though one site above Bangor rated as poor). A lack of cobbles, boulders and woody debris in the substrate, as well as sand and silt eroding from stream banks were cited as contributing to an in-stream habitat rating of 'fair' for much of the watershed (Heaton 1997).

The conclusions were similar in a 1997 survey. In-stream habitat was again reported as being threatened by sediment deposition. This survey reported that "…channelization from various historical dredging events had removed channel diversity, reduced bank stability, and generally contributed to conditions that reduce the quality and quantity of stream biota" (Cooper 1999, p. 2).

The most recent biological survey of the watershed occurred in 2002. Its conclusions were similar to previous surveys:

> In summary, water quality throughout the Black River Watershed was adequate to support acceptable biological communities at locations with suitable riparian and in-stream habitat. Unfortunately, historic channelization and dredging of many streams, wetland drainage, sandy soils, and the current land management activities of riparian owners provides the aquatic biota of streams in the Black River Watershed with limited stable habitat (Walterhouse 2003, p. 2).

4.5 Fishery

Descriptions of the original fish communities for the Black River watershed prior to European settlement are not available. However, currently there have been seventy species of fish identified in the watershed (Appendix E). Nine species of fish have been introduced through management practices or inadvertently by human development in the Great Lakes Basin. Non-native species such as sea lamprey, alewife, and round goby use the Black River for spawning (Goodyear et al. 1982) and have a strong influence on fish communities through predation or competition (K. Smith, personal communication, September 20, 2004).

The Michigan Department of Natural Resources routinely stocks fish in the Black River. These include brown trout, steelhead, chinook salmon, northern pike, rainbow trout, walleye, and muskellunge. Tiger muskellunge were stocked historically, but are no longer stocked (K. Smith, personal communication, September 17, 2004). Stocking locations include the Black River in South Haven, Osterhout Lake (Lee Township), North Scott Lake (Arlington Township), Barber Creek (Lee Township), Three Legged Lake (Bloomingdale Township), and Hutchins Lake (Ganges and Clyde Township) (Michigan Department of Natural Resources 2004).

Portions of the river are designated coldwater streams (Figure 9). These reaches are classified as coldwater streams by the MDNR because they are stocked with coldwater fish species. However, they do not necessarily

contain reproducing populations of coldwater (salmonid) species. The fine substrate of North and Middle Branch is not conducive to the reproduction of these species. The coarser substrate of the South Branch has more potential to provide habitat for a reproducing population of salmonids (K. Smith, personal communication, March 2, 2004). However, much of this habitat is currently covered by sediment. Thus, management approaches on this branch need to address these sediment issues.

Other species that inhabit the Black River include longnose suckers and white suckers that enter the river to spawn (Goodyear et a. 1982), as well as common carp, largemouth bass, and rock bass (Gashman 1990). Non-native species such as sea lamprey and alewife have also been known to spawn in the Black River (Goodyear et al. 1982).

A fish consumption advisory exists for carp, northern pike and white sucker in the river below the Bangor Dam due to contamination from PCBs and chlordane (Michigan Department of Community Health 2004). For the most recent information on fish consumption advisories, visit www.michigan.gov/mdch-toxic and click on "Michigan Fish and Wild Game Advisories."

4.6 Invasive Species

Invasive species are species that are not native to the habitat that they inhabit, and can out-compete native species. They can destroy habitat for native plants and animals as well as have economic impacts. Invasive species in the wetlands and waterways of the Black River Watershed include Purple Loosestrife (*Lythrum salicaria*), Eurasian Milfoil (*Myriophyllum spicatum*), and Zebra mussels (*Dreissena polymorpha*). Several other invasive species inhabit upland habitats in the watershed, including Garlic Mustard (*Alliaria petiolata*), Spotted Knapweed (*Centaurea maculosa*), and Autumn Olive (*Elaeagnus umbellata*).

Zebra mussels have been found in at least two of the inland lakes in the watershed, Hutchins Lake and Saddle Lake (Michigan Sea Grant 2004). They have also been found in several other lakes outside of the Black River watershed in Allegan and Van Buren Counties. Recent research indicates that beyond clogging water intake pipes and competing with native species for food, these mussels may promote the cyanobacterium (or blue-green algae) *Microcystis aeruginosa* in lakes with low levels of total phosphorus (Raikow et al. 2004). These algae produce a toxin (microcyctins) that can be dangerous to humans, pets, and wildlife. Thus, zebra mussels may contribute to a degradation of water quality in low-nutrient lakes.

Prevention of infestation is the only known method of controlling zebra mussel populations (Hart et al. 2002). Experts expect that most inland lakes in Michigan will eventually be invaded by zebra mussels.

4.7 National Wetlands Inventory

The National Wetlands Inventory is a record of wetlands location and classification as defined by the U.S. Fish & Wildlife Service. These maps were created by interpreting aerial photographs. As such, they are not as accurate as on-the ground wetland delineation. However, they do provide general information on wetlands in the area. The wetland classes identified in the National Wetland Inventory for the Black River Watershed are aquatic bed, emergent, forested, scrub-shrub, unconsolidated bottom, and unconsolidated shore (Figure 10). Some of these wetlands are adjacent to the lakes and rivers in the watershed, while others are geographically isolated from any apparent surface water connection. Forested wetlands are the largest class of wetlands in the watershed, followed by emergent wetlands.

Wetland Functions

Wetlands play a crucial role in protecting water quality. They trap and filter pollutants and sediment out of surface and groundwater. They also absorb floodwaters, protecting downstream areas from flooding impacts. Wetlands provide habitat for a variety of species, and wetland vegetation helps stabilize shorelines that would otherwise be vulnerable to erosion caused by waves (Cwikiel 1996). Management measures need to be taken to protect remaining wetlands in the watershed. Not all wetlands are regulated at the state or federal levels; these can be protected at the local level, thorough planning and zoning.

Wetland Loss

For the period 1986 to 1997, wetlands were estimated to be lost at the rate of 58,500 acres annually in the United States (Dahl 2000). While this is a large improvement over the past, the goal of no net wetland loss has not been met (Dahl 2000). Forested wetlands have experienced the greatest declines, leaving the U.S. with the least amount of forested wetlands in the nation's history (Dahl 2000). Analysis of wetland loss indicates that urban and rural development, agriculture and silviculture are primarily responsible (Dahl 2000). It has been estimated that Michigan has lost 50% of its original wetland habitats (Cwikiel 2003).

Significant wetland loss has occurred in the Black River Watershed. A model of wetland loss by subwatershed was prepared by comparing the 1998 National Wetland Inventory with a hydric soils map (per guidance from MDEQ, Pete Vincent, personal communication). The results of this model are shown in Figure 11. Loss per subwatershed ranged from a low of -2.79% (indicating a slight gain of wetland area) to a high of 31.03% of wetlands lost. Further loss should be prevented, and any wetland restoration or reconstruction should be encouraged.

Wetland Restoration

MDEQ staff has prepared a map of potential wetland restoration areas in the watershed (Figure 12). This map displays areas of the watershed that are not currently wetland, but have wetland soils and were mapped as wetland on a presettlement vegetation map. This map can help guide efforts on where wetland restoration efforts may be most successful. Recommendations regarding wetlands can be found in section 8.2.8 of this plan, as well as in Table 24.

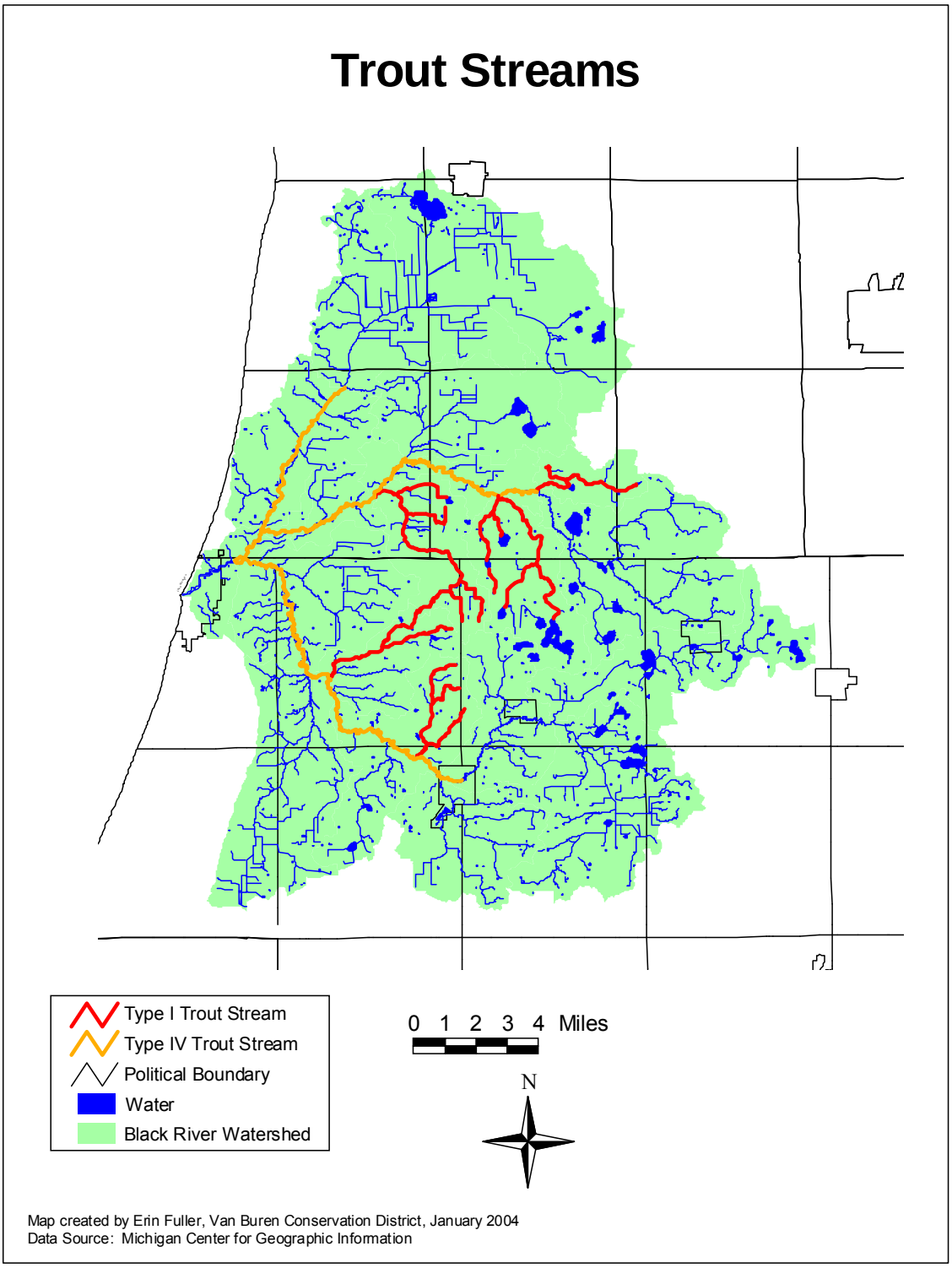


Figure 9: Trout streams in the watershed

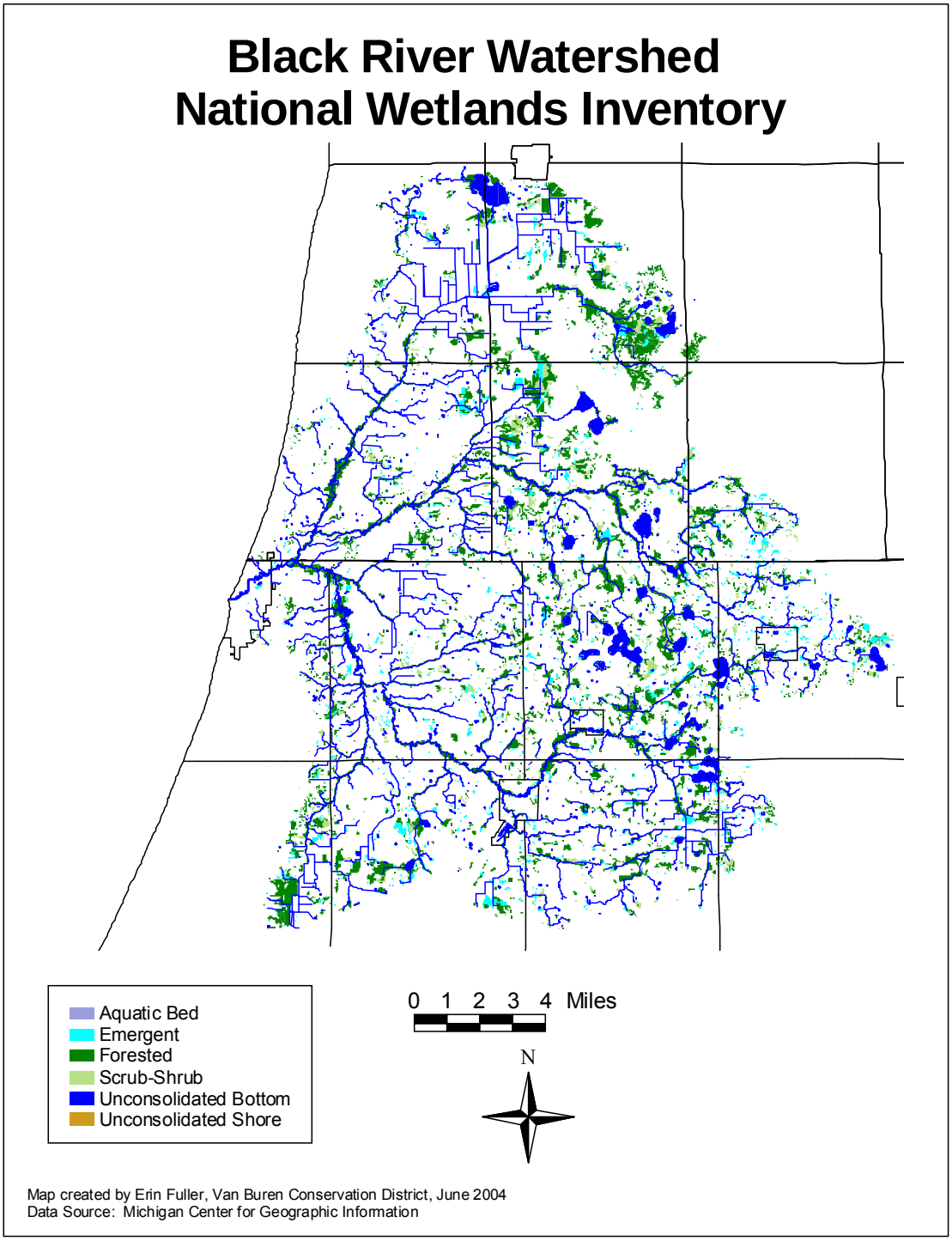


Figure 10: National Wetlands Inventory

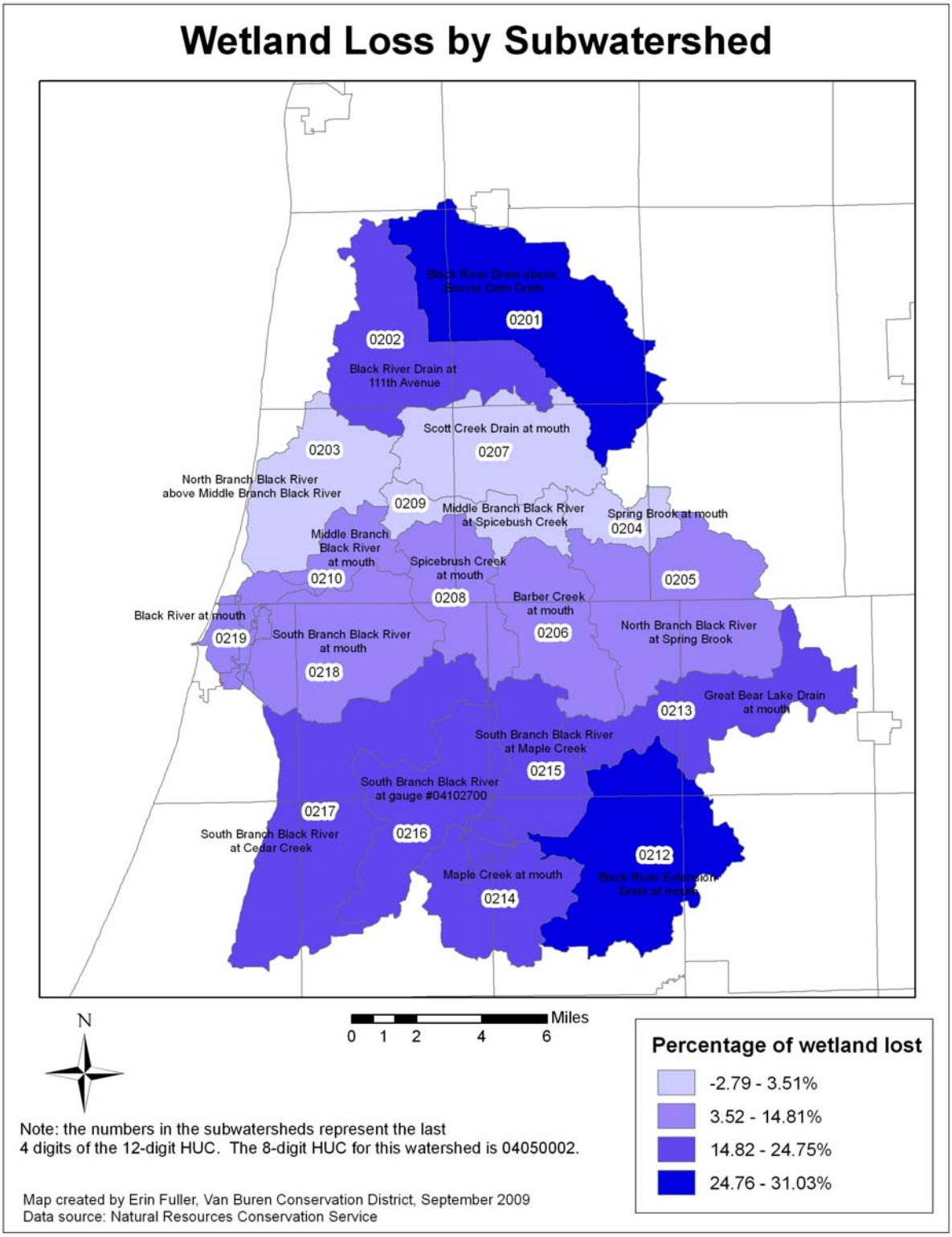


Figure 11: Wetland loss by subwatershed

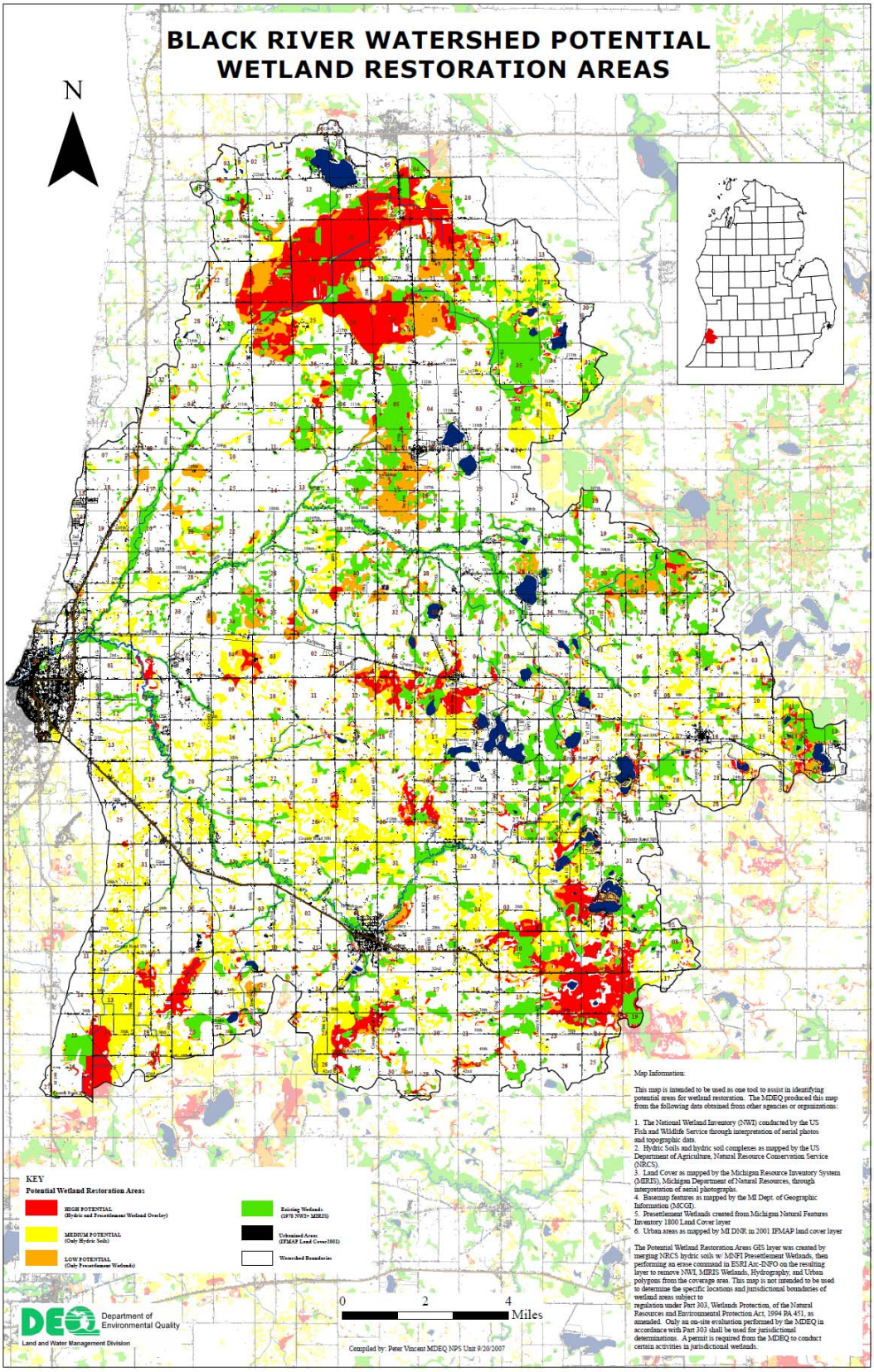


Figure 12: Potential Wetland Restoration Areas

4.8 Farmland

The U.S. Department of Agriculture's 2002 Census of Agriculture (Preliminary Data) shows that Michigan had a 0.5% decrease in its number of farms between 1997 and 2002. However, the amount of land in farms has had a steeper decrease: 3.5% between 1997 and 2002. The average size of a farm in Michigan has decreased by 6 acres in the same time period. This contrasts with the national figures. Nationally, the number of farms decreased 4% and the amount of land in farms decreased 1.6%, while the average size of farms increased by 10 acres (from the period between 1997 and 2002) (USDA 2004).

Farms within the Black River Watershed account for the vast majority of fruit/berry/nut production within Southwest Michigan, which ranks #1 in the state for fruit production. Van Buren County is ranked #1 in the nation for blueberry and cucumber production and second in the state for grape production. Allegan County ranks #1 in the state for total market value of agricultural production, and also ranks highly for fruit production. Southwest Michigan ranks highest in the state for acres of greenhouse and nursery operations.

Conversion pressures are an especially grave concern to the state of agriculture in the Black River Watershed, as Allegan and Van Buren Counties rank 2nd and 3rd respectively as the most agriculturally vulnerable counties between now and 2020 in the state (*MSU Land Transformation Analysis*.) Farmland loss and conversion threaten to erode the agricultural base in the watershed and ultimately devastate Michigan's #1 economic industry. Considering growth projections, lack of funding for purchase of development rights efforts, and inadequate zoning and subdivision regulations in the areas comprising the Black River Watershed, direct agricultural preservation through conservation easements and PA 116 enrollment is critical to this region's agricultural prosperity. Communities should work to find sustainable funding for purchase of development rights programs.

University Outreach (UO) at the University of Michigan-Flint, on behalf of the Southwest Michigan Land Conservancy (SWMLC), developed an Agricultural Lands Inventory for the Black River Watershed. This inventory uses a multi-criteria scoring approach to identify agricultural lands throughout the Black River Watershed that are highest priority for perpetual conservation. See Appendix G for more details on this inventory, and for maps of land protected under PA 116 and priority areas for protection.

4.9 High Quality Natural Areas

Several high quality natural areas exist in the Black River Watershed, including one property owned by the Michigan Nature Association and four properties owned by the Southwest Michigan Land Conservancy. These properties include a variety of habitats, such as wetlands, floodplains and upland forests, and support a diversity of plant and animal life. Additional high quality natural areas likely exist in private ownership.

The State of Michigan also owns a considerable amount of land in the watershed. Most of this is a part of the 45,000 acre Allegan State Game Area (of which approximately 12,200 acres are located in the Black River Watershed, with the remaining acreage located in the Kalamazoo River Watershed). The game area is highly diverse, containing over 800 plant species, and 30 threatened or endangered species (Michigan Department of Natural Resources 1993).

A map showing the approximate locations of lands owned by the State of Michigan, the Southwest Michigan Land Conservancy, and the Michigan Nature Association is shown in Figure 13 (the State ownership data is specific only to the quarter-quarter section).

The Southwest Michigan Land Conservancy created a Land Protection Priority Model (Figure 14) focusing on water quality protection. This model was created using a Geographic Information System with input from a committee of stakeholders. The attributes that were considered when computing conservation values in the model were land cover, hydrology (presence of lakes or streams), presence of designated trout lakes or streams, groundwater recharge rate, species rarity index, proximity to existing protected areas, presence of a nature trail, and presence of a corridor or bottleneck. The full report on methodology can be found in Appendix G. The Southwest Michigan Land Conservancy will use this model to help target land for protection in the future. Communities can also use this model to locate parks or open spaces, or provide protection measures at the local level through planning and zoning for these high quality natural areas.

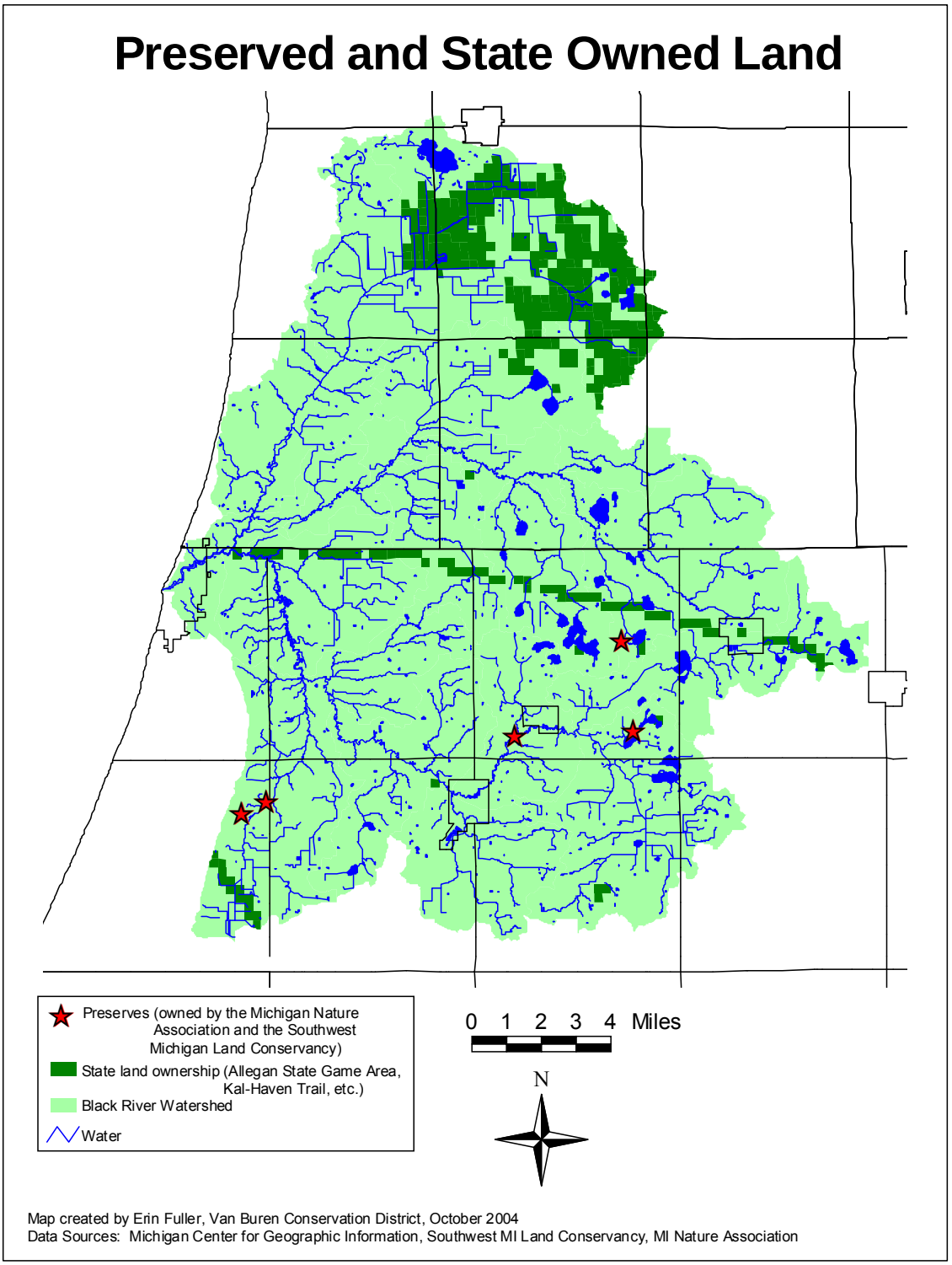


Figure 13: Preserved and state-owned land in the Black River Watershed

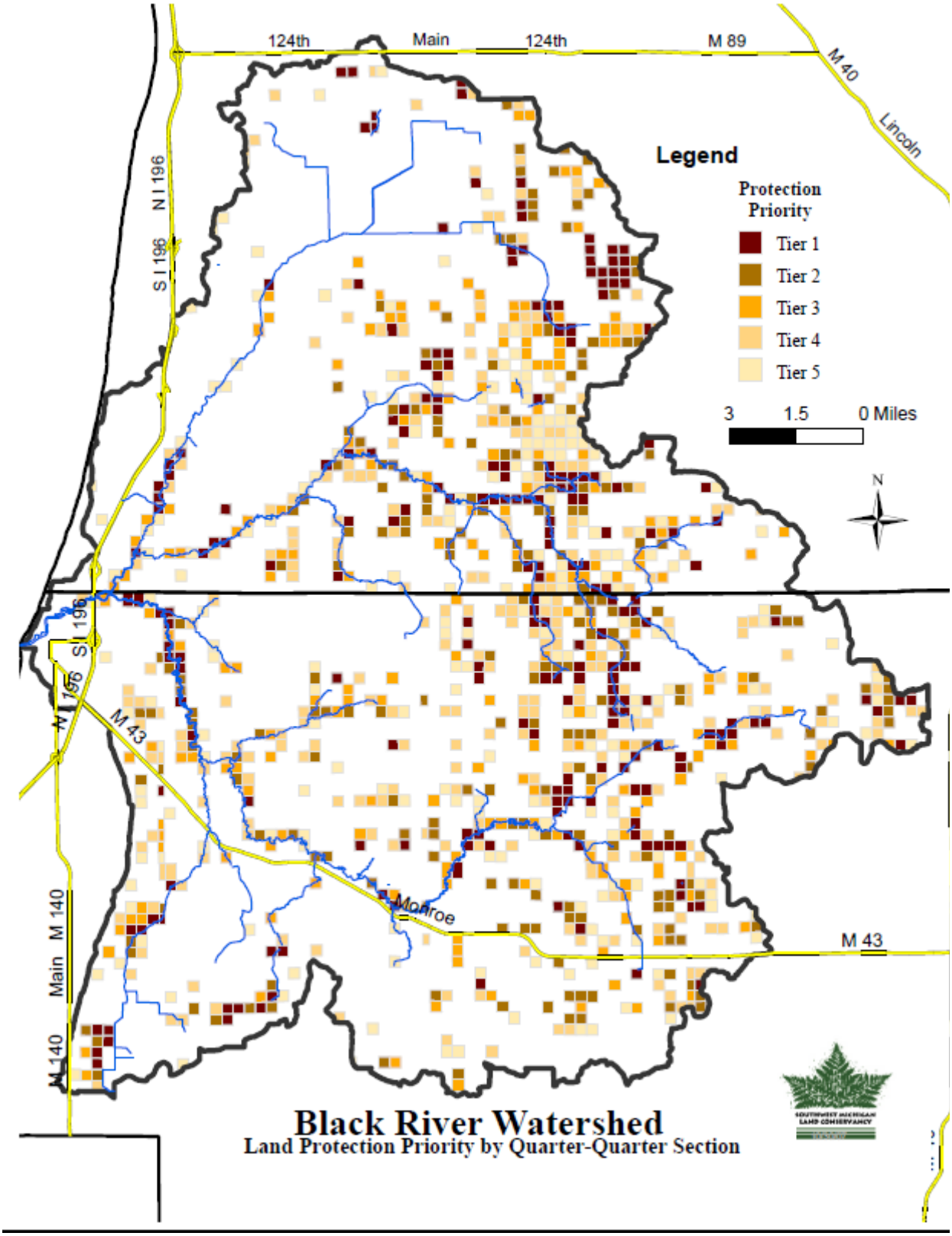


Figure 14: Land Protection Priority Model

5 Community Profile

5.1 Demographics

The Black River Watershed is primarily a rural area. The population is increasing, however (Table 9). The median income in most townships tends to be less than the Michigan average (Table 10).

Table 9: Year 2000 Census data

Category	Allegan County	Van Buren County	Michigan
Population	105,665	76,263	10,079,985
Population, % change, 1990 to 2000	+16.7%	+8.9%	+6.9%
% White persons	93.5%	87.9%	80.2%
% Black or African American persons	1.3%	5.2%	14.2%
% American Indian and Alaskan Native persons	0.5%	0.9%	0.6%
% Asian persons	0.6%	0.3%	1.8%
% Persons reporting some other race	2.8%	3.4%	1.3%
% Persons reporting two or more races	1.3%	2.2%	1.9%
% Persons of Hispanic or Latino origin	5.7%	7.4%	3.3%
% Persons age 25+ who are high school graduates	82.3%	78.9%	83.4%
% Persons age 25+ who have a bachelor's degree or higher	15.8%	14.3%	21.8%
% Persons age 5+ who speak a language other than English in the home	6.8%	8.9%	8.4%
Homeownership rate	82.9%	79.6%	73.8%
Persons per household	2.72	2.66	2.56
Median household income	$45,813	$39,365	$44,667
% Persons below poverty	7.3%	11.1%	10.5%

Source: U.S. Census Bureau 2004 (derived from 2000 census)

Table 10: Demographic profiles for municipalities in the Black River Watershed

City/Township	Population	Sq. Miles	Median Income	% Employed over age 16
Arlington Township	2075	35.0	$36,847	66.8
Bangor Township	2121	33.7	$35,375	62.6
Bloomingdale Township	3364	34.1	$40,488	62.8
Casco Township	3019	38.9	$40,760	67.2
Cheshire Township	2335	34.9	$40,405	64.5
City of Bangor	1933	1.9	$28,165	60.8
City of South Haven	5021	3.4	$35,885	59.5
Clyde Township	2104	35.0	$42,717	66.9
Columbia Township	2714	34.1	$34,389	60.3
Covert Township	3141	35.0	$22,829	55.8
Ganges Township	2524	32.5	$47,143	66.1
Geneva Township	3975	35.3	$34,900	65.6
Lee Township	4114	35.3	$30,875	63.5

Saugatuck Township	3590	25.3	$43,771	64.8
South Haven Charter Township	4046	17.5	$35,000	68.2
Village of Bloomingdale	528	1.1	$35,715	63.6
Waverly Township	2467	34.4	$51,100	69.3

Source: U.S. Census Bureau 2000

5.2 Government Officials

A table of government officials in the watershed is located in Appendix H.

5.3 Planning and Zoning

A variety of different activities occur on the landscape, and these have varying degrees of impact on surface water quality. In attempting to improve and protect water quality, it is therefore necessary to locate these activities in areas where their impacts on water quality will be mitigated. From the watershed perspective, land use activities will not only affect the immediate area in which they occur, but also all downstream areas (Brooks et al. 1991). Thus, land use planning has significant to potential to positively affect water quality in the Black River Watershed.

An in-depth analysis of planning and zoning in the watershed needs to be completed. This would assist municipalities in making decisions that would affect water quality. Table 11 shows which communities in the watershed have zoning and master plans

A few municipalities have already adopted or proposed ordinances that are protective of water quality. These include an ordinance that requires inspection of septic systems when a property changes hands and an ordinance creating a resource development district that protects habitat for wildlife and native flora, as well as protecting natural water features. Through the Black River Watershed Implementation Grant (2006-2009), several communities in the watershed received assistance to update master plans and zoning ordinances to include language protective of water quality. A description of this project is available in Appendix I, and examples of this language are available at www.swmpc.org/ordinances.asp.

Table 11: Planning and Zoning in the watershed

Municipality	Zoning?	Master Plan?	Plan Date
Casco Township	Yes	Yes - Casco Township Master Plan	2005
Cheshire Township	Yes	Yes - Cheshire Township Land Use Plan	2001
Clyde Township	Yes	Yes- Clyde Twp. Master Plan	2005 (update/amendment)
Ganges Township	Yes	Yes - Master Plan, Ganges Township	2007
Lee Township	No	No	N/A
Arlington Township	Yes	Yes	2009
Bangor Township	No	Yes - Bangor Township Master Plan	2001
Bloomingdale Township	No	No	N/A
Columbia Township	Yes	Yes	2002
Covert Township	Yes	Yes	2004
Geneva Township	No	No	N/A
South Haven Township	Yes	Yes - Master Plan for Land Use: South Haven Charter Township	2008
Waverly Township	Yes	Yes	2001-2006
Bangor City	Yes	Yes - Parks, Recreation, Cultural, and Natural Areas Master Plan	2008-2013
Village of Breedsville	Proposed		
Village of Bloomingdale	No	No	N/A
South Haven City	Yes	Yes - City of South Haven Comprehensive Plan (there is also a 2003 Recreation Plan)	2003

6 Water Quality in the Black River Watershed

6.1 Previous Studies

The Michigan Department of Environmental Quality maintains a list of water bodies that do not attain water quality standards (the 303 (d) list). Many of the water bodies on this list are in southern lower Michigan. This is likely due to the higher population density and concentration of development, industry, roads, and prime agricultural lands in this portion of Michigan (Wolf and Wuycheck 2004). The most common causes of nonattainment status are habitat alteration, high concentrations of toxic organic chemicals (like PCBs), pathogens, sediment, and mercury. The most common sources of pollutants are hydromodification, inconclusive sources (such as atmospheric deposition), and agriculture (Wolf and Wuycheck 2004). The following summarizes the waterbodies in the Black River Watershed that were on the 2006 303(d) list. This information is excerpted from Edly and Wuycheck (2006). (Information on the most recent (2008) 303 (d) list is contained in Table 16.)

Category 2: Water Quality Standards Attainment List (some uses are met but there is insufficient data to determine if remaining uses are met)

- North Branch Black River
  County: Allegan
  Location: Black River confluence upstream to 111th Ave.

- Middle Branch Black River and tributaries
  County: Allegan/Van Buren
  Location: North Branch Black River confluence upstream to Little Bear Lake Drain and Melvin Creek confluence. Including Spicebush Creek, Scott Creek, Barber Creek, Spring Brook, and Little Bear Lake Drain, all inclusive and Melvin Creek to Deer Lake.

- South Branch Black River
  County: Van Buren
  Location: Bangor Dam upstream to Great Bear Lake Drain.

- Butternut Creek
  County: Van Buren
  Location: South Branch Black River confluence upstream

- Cedar Creek
  County: Van Buren
  Location: South Branch Black River upstream to 26th Ave.

- Eastman Creek
  County: Van Buren
  Location: South Branch Black River confluence upstream

- Haven and Max Lake Drain
  County: Van Buren
  Location: Great Bear Lake upstream to Max Lake

- Maple Creek
  County: Van Buren
  Location: Southwest of Bangor. South Branch Black River confluence upstream to 34th Ave.

Category 3: Water bodies requiring further evaluation (insufficient data to determine whether any uses are met)

- Lake Fourteen
  County: Van Buren
  Location: NE of Breedsville, SW of Berlamont

- Osterhout Lake
  County: Allegan
  Location: 5 miles SE of Pullman

- Peterson Drain (Scott Creek Tributary)
  County: Allegan
  Location: a tributary to Scott Creek from 111th Ave to 109th Ave.

Category 4b: Water Quality Standards Nonattainment List for Water Bodies with other control mechanisms (water quality standards nonattained; other corrective action used but unverified water quality standards restoration)

- Black River and South Branch Black River
  County: Van Buren
  Location: Lake Michigan confluence upstream to South Branch Black River confluence, thence, upstream the South Branch to Bangor Dam at Bangor at County Road 681.
  Problem: Fish Consumption Advisory-PCBs, chlordane
  Other corrective action: Sediment Remedial Action Plan (RAP) approved; sediments removed

Category 4c: Water Quality Standards Nonattainment List for highly modified water bodies

- Black River Drain, North Branch
  County: Allegan
  Location: 111th Ave. upstream (Black River Drain) including all tributaries to headwaters

- Black River Extension Drain
  County: Van Buren
  Location: South Branch Black River and Great Bear Lake Drain confluence (upstream of 52nd St.) upstream to Lake Fourteen outlet

- Cedar Creek
  County: Van Buren
  Location: West of Bangor; 26th Ave. upstream to headwaters

- Cedar Drain
  County: Van Buren
  Location: Tributary of South Branch Black River; upstream of 34th Ave., in the vicinity of Bangor upstream to headwaters.

- Great Bear Lake Drain
  County: Van Buren
  Location: South Branch Black River confluence upstream to Great Bear Lake outlet

- Melvin Creek
  County: Allegan
  Location: Lake Moriah confluence (just downstream of 4750th St.) upstream to 40th St.

- Silver Lake Inlet
  County: Van Buren
  Location: Silver Lake near Grand Junction

Category 5: Water Quality Standards Nonattainment list for water bodies requiring TMDLs (Total Maximum Daily Loads (water is impaired or threatened and a TMDL is required)

- Great Bear Lake
  County: Van Buren
  Location: Great Bear Lake proper
  Problem: Nuisance algal growths, phosphorus

See Appendix J for excerpts and summaries of previous studies that have been done in the watershed by organizations such as the Michigan Department of Environmental Quality and the Michigan Department of Natural Resources. These studies can help locate current problem areas in the watershed, but some information in them may be outdated (for example, areas in Bangor have undergone remediation for PCBs and heavy metals since these reports were completed). Updated reports will be added to this plan as they become available.

6.2 Watershed Analysis

The watershed inventory consisted of road-stream crossing inventories, "windshield" surveys, and canoeing, kayaking, or walking stretches of stream to identify potential problem areas. Aerial photographs were also studied extensively to help locate potential problem areas. A road-stream crossing inventory was performed by the Michigan Department of Environmental Quality in 2001. A follow-up survey was performed during the course of the Black River Watershed Project between 2002 and 2005.

6.2.1 Aerial Photograph Review

Aerial photographs were reviewed to determine the approximate number of houses around the lakes in the watershed. This was done to give an estimate of pollutant loadings from septic tanks. A residency rate of 3.5 individuals per dwelling was used, with an estimate of 0.25 pounds of phosphorus/capita/year. This estimate is the amount of phosphorus reaching the lake after treatment and discharge to the drainage field (Walterhouse 2004). This estimate may be off, since many of these lake homes are likely not occupied year round. However, some septic systems may be failing or inadequate and thus contributing greater amounts of phosphorus. County Health Department staff estimate that 1% of septic systems are actively failing, and 60% are not up to code (systems in heavy soils, not meeting isolation distance to water table, etc.) (M. Bjorkman, personal communication, 10 July 2007). The lakes with the greatest estimated phosphorus loads from septic tanks are those with the most adjacent houses, such as Saddle Lake, South Scott Lake (Van Buren County), Hutchins Lake, and Great Bear Lake (Table 12).

Aerial photographs were also reviewed to examine change in the river channel. Aerials of the watershed in 1938 were compared to more recent aerials of the watershed (1998 aerial photos for Allegan County and 2003 aerial photos for Van Buren County). The river is obscured by vegetation in some portions of these photographs, and thus, not all reaches of the river were analyzed. In general, the North Branch of the Black River has much the same pattern today as it did in 1938. Some portions were straighter in 1938 and are today showing signs of re-meandering, especially a portion in Casco Township north of 109th Avenue. Also, many more drains exist now than

in 1938. The Middle Branch has retained a similar pattern since 1938. It is a meandering river, and some meanders have cutoff since 1938. The South Branch has been the most dynamic branch since 1938. The river in Geneva Township especially appears to be straighter and less meandering than it was in 1938. From the confluence of the South Branch and Cedar Creek in southern Geneva Township to the City of Bangor, the river appears to have the same pattern (where it is visible on both sets of aerials). Upstream of Bangor, however, meander cutoffs and oxbows indicate more change.

Recent aerial photos (1998 for Allegan County and 2003 for Van Buren County) were also reviewed to locate areas that lack vegetative buffers along the riparian corridor. This review revealed 4595 linear feet lacking buffers in agricultural areas and 4326 linear feet of buffers lacking in residential areas. This is likely an underestimate, since smaller drains and streams are not clearly visible in these photographs.

Table 12: Estimated phosphorus loading from septic tanks around lakes in the Black River Watershed

Name	Township	Acres	Connected to Black River?	Number of houses within 300 ft. (estimated)	Lbs Phosphorus per year
Saddle Lake	Columbia	282.5	Yes	155	135.6
South Scott Lake	Arlington	118.1	Yes	154	134.8
Hutchins Lake	Ganges/Clyde	378.8	Yes	134	117.3
Great Bear Lake	Bloomingdale/Columbia	166.2	Yes	114	99.8
North Scott Lake	Arlington/Columbia	76.3	Yes	92	80.5
Lower Scott Lake	Lee	119.5	Yes	63	55.1
Osterhout Lake	Lee	171.9	Yes	56	49.0
Mill Lake	Bloomingdale	107	Yes	53	46.4
Upper Jeptha Lake	Columbia	58.8	Yes	42	36.8
Silver Lake	Columbia	50.1	Yes	41	35.9
Upper Scott Lake	Lee	94.4	Yes	29	25.4
North Lake	Columbia	60.6	Yes	25	21.9
S. Branch Black River (Breedsville Mill Pond)	Columbia	7.9	Yes	24	21.0
Munson Lake	Columbia	38.5	No	17	14.9
Lake Eleven	Columbia	53.9	Yes	16	14.0
Merriman Lake	Bangor	27.1	Yes	13	11.4
Lester Lake	Lee	60.4	Yes	12	10.5
Little Bear Lake	Columbia	46.1	Maybe/Wetland	9	7.9
Ely Lake	Clyde	27	Yes	4	3.5
Moon Lake	Geneva	14.6	Yes	4	3.5
Coffee Lake	Columbia	40.4	Yes	3	2.6
Crooked Lake	Clyde	96.9	No	3	2.6
Deer Lake	Columbia	30.4	Yes	3	2.6
Manitt Lake	Casco	0.7	No	2	1.8
Spring Brook Lake	Lee	15.3	Yes	2	1.8
Clear Lake	Lee	19.7	No	1	0.9
Lake Fourteen	Arlington	20.9	Yes	1	0.9
Max Lake	Bloomingdale	28	Yes	1	0.9
Munn Lake	Bloomingdale	12.3	Yes	1	0.9
Picture Lake	Geneva	5	Yes	1	0.9
School Section Lake	Bangor	36.1	Yes	1	0.9

Abernathy Lake	Waverly	4.1	Yes	0	0.0
Lake Fourteen	Columbia	69.5	Yes	0	0.0
Little Tom Lake	Clyde	18.1	Maybe/Wetland	0	0.0
Lower Jeptha Lake	Columbia	55.4	Yes	0	0.0
Max Lake	Waverly	4.4	Yes	0	0.0
Moriah Lake	Columbia	17	Yes	0	0.0
Mud Lake	Cheshire	3.9	Yes	0	0.0
Mud Lake	Clyde	4.4	No	0	0.0
Mud Lake	Columbia	23.4	Yes	0	0.0
S. Branch Black River (Bangor Mill Pond)	Bangor/Arlington	22.7	Yes	5	0.0
Skunk Lake	Bloomingdale	6.6	Yes	0	0.0
Stillwell Lake	Columbia	18.3	Yes	0	0.0

6.2.2 Road-Stream Crossing Inventory

A Road-stream crossing inventory was performed by Michigan Department of Environmental Quality staff in the spring and summer of 2001. These surveys were completed at approximately 80% of the road-stream crossings in the watershed. Investigators recorded a variety of information about each site, including physical characteristics and potential pollution sources. This data has been entered into a Geographic Information System (GIS) to facilitate the review of data. Figure 15 shows the rankings of all the sites visited. 212 road-stream crossings were visited in total. Six of these were considered to be in "poor" condition; ten in "fair" condition, and the rest were in "good" condition. Several of the "poor" sites were degraded due to unrestricted livestock access. While this information is certainly useful to help locate problem areas, it may not present an accurate picture of water quality. For example, data on turbidity may not be very useful, as some sites were visited after a rainfall and some were visited during dry periods. Furthermore, the dataset is now several years old and is somewhat incomplete. For example, problems with bridges or culverts were not recorded in this road-stream crossing inventory.

All sites were revisited between June 2003 and April 2004 to take photographs of the sites and note any problem areas. During this period, some road-stream crossings were identified as having problems (such as erosion around a bridge or culvert, or improper culvert sizing and placement). This list will be updated as new areas are found (or problem areas are remediated). Other problem areas were also discovered, including uncontrolled livestock access to streams, streambank erosion, incised stream beds, and areas lacking in a vegetative buffer along the stream.

6.2.3 Canoe and Kayak Trips

Sections of the watershed were visited via canoe, kayak, or by foot. The prevalence of snags and large woody debris makes canoe or kayak passage difficult to impossible in many portions of the river. In addition, the extremely silty substrate of some of the streams makes wading difficult. Thus, not all portions of the watershed were visited. Figure 16 shows the river reaches that were canoed, kayaked or walked during the course of the project. Photos and notes were taken in those reaches that were accessible by boat or foot.

Approximately 14 miles of the Black River were canoed or kayaked by the watershed coordinator and several volunteers. Much of the river is too shallow or is filled with debris dams, making canoeing and kayaking difficult. The sections that were canoed or kayaked were: the North Branch from the crossing at 68th St. downstream to the crossing at 103rd Ave; the North Branch from the confluence with the South Branch upstream to the confluence with the Middle Branch; the Middle Branch from 68th St. downstream to 70th St. in Casco Township; the South Branch from the crossing at CR 388 to the mouth; and the South Branch from Lion's Park in Bangor to approximately 1 mile downstream.

Most of the 14 miles that were canoed or kayaked had a wide buffer of natural vegetation. This buffer is primarily forest, though there are small portions of emergent wetland (Figure 17). The exception is the stretch

upstream of the river mouth (approximately 2 miles). The area in South Haven is very developed, with numerous marinas and residential developments to the edge of the river (Figure 18). Once upstream of this section, the river corridor is primarily forested and rural (however, condominiums are being developed along the river approximately 3 miles upstream of the mouth. A 151-slip marina may also be included in this development).

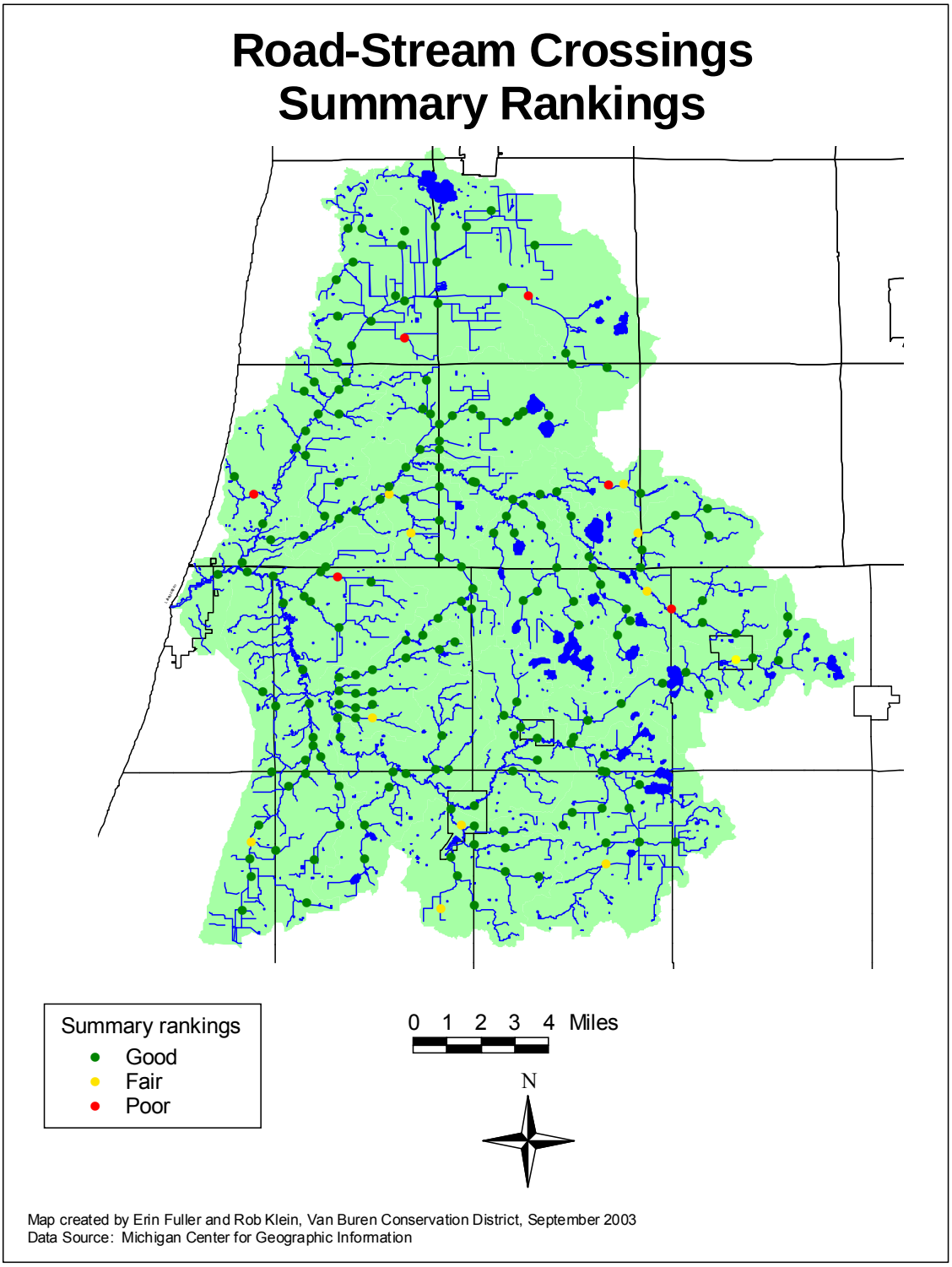


Figure 15: Rankings of Road/Stream Crossings

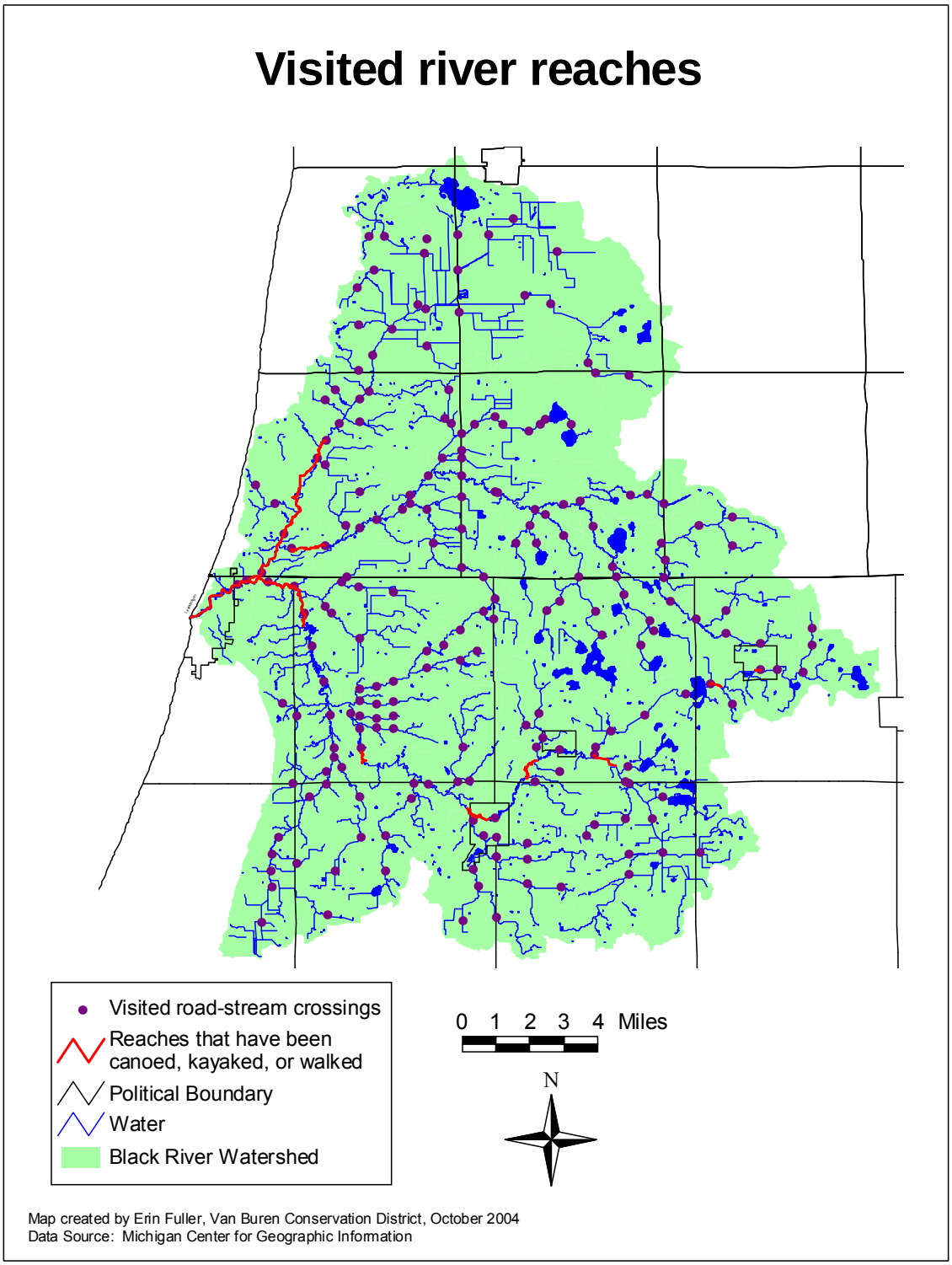


Figure 16: Visited river reaches

Figure 17: Natural vegetation buffer along the North Branch (Casco Twp.)

Figure 18: The Black River in South Haven, near the river mouth

The North Branch of the river downstream of 108th Ave. is primarily forested. Very few houses are visible along the river. The floodplain is wide, and woody debris is prevalent within the channel. The banks appeared stable and well-vegetated. There were a few small emergent wetlands along this stretch, dominated mostly by Reed Canary Grass (Figure 19).

Figure 19: Emergent wetland along the North Branch

The Middle Branch in Casco Township is primarily forested along the river corridor. Some bank erosion is occurring, but is not severe. Some tree roots are exposed along the river bank, but the trees are in many cases adapting to the erosion by growing straight (Figure 20). The substrate is primarily sand, with some gravel areas.

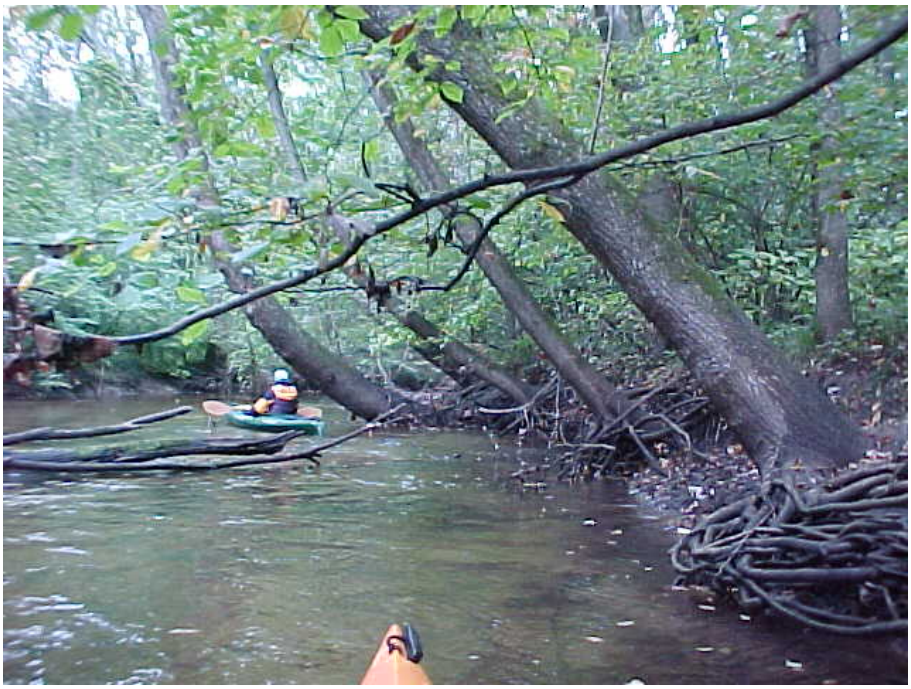


Figure 20: Trees responding to erosion along the Middle Branch

Upstream of the confluence with the North Branch, the banks of the South Branch are in some places quite high and eroding (Figure 21). This is in most cases not a result of current land use practices, as the river is forested along most of these sections.

Figure 21: High, eroding bank along the South Branch

The South Branch between Phoenix St. and 70th St. has high, somewhat unstable banks. Roots of many trees have been undercut, indicating that the channel of the river is changing faster than the vegetation can adapt (Figure 22).

Figure 22: Undercutting of tree roots along the South Branch

The South Branch downstream of Lion's Park in Bangor is very forested. The prevalence of woody debris makes this a slow and difficult paddle (Figure 23).

Figure 23: Canoeists negotiate a large tree across the South Branch, downstream of Bangor

Portions of the watershed were inventoried by foot if they were impassable by canoe or kayak. However, the nature of the river substrate made this difficult and at times impossible. Sections examined by foot (by wading or walking along the banks of the river) were:

- South Branch Black River downstream of Breedsville (Columbia Twp. Section 32).
- Haven and Max Lake Drain upstream of Great Bear Lake (Bloomingdale Twp. Section 19)
- Haven and Max Lake Drain downstream of CR 665 (Bloomingdale Twp. Section 17)
- South Branch Black River upstream of Breedsville (Columbia Twp. Section 34)
- South Branch Black River between Bangor and South Haven (Geneva Twp. Section 33)

6.2.4 Bank Erosion Study

Rates of bank erosion at 8 sites in the watershed were measured using erosion pins. The pins (sections of wooden dowel) were placed in the streambanks in June 2004 and measured throughout the summer to determine how much soil was eroding (or being deposited) around them. Though not enough sites were monitored to draw conclusions about the watershed, it was clear that at least in some areas, the river channel is actively changing. The full report is located in Appendix K.

6.2.5 Impervious Surface Analysis

Impervious surfaces are those surfaces such as roads, parking lots and rooftops that do not allow infiltration of rainwater and snowmelt. As impervious surface areas increase in a watershed, so does runoff. Runoff is usually warmer than groundwater and can carry a variety of pollutants into streams, such as sediment, fertilizers, pesticides, or oil. Recent research also indicates that potentially carcinogenic compounds may leach from asphalt-based and coal tar-based sealants that are used on paved areas (Perkins 2004). In addition, streams surrounded by a high percentage of impervious surfaces will have a "flashy" hydrological regime in which the stream receives floods after

rain events and snowmelt, but is deprived of water during the dry season due to decreased infiltration (Wyckoff et al. 2003). Studies have shown that as the land cover of a watershed becomes 8-10% impervious surface, water quality is negatively impacted. Above 10% impervious cover in a watershed, water quality typically begins to degrade (Wyckoff et al. 2003). High flows from storms scour the banks, causing erosion and loss of vegetation (Perkins 2004). A typical suburban development with homes on 1/3 acre lots is approximately 35% impervious (Perkins 2004).

An online land use analysis tool was used to estimate impervious surface cover in the watershed (Choi and Engel 2004). This model uses 1992 land use/land cover data and estimates the amount of impervious cover associated with that land use (Table 13). Using this model, an average of 2.19% of the Black River Watershed is composed of impervious surfaces. This is below the level at which water quality begins to degrade. However, this is important data to monitor. It is more cost effective to plan ahead to protect water quality by keeping the impervious cover under the 10% threshold than it is to try to restore the river system after it has already been degraded (Wyckoff et al. 2003). Additionally, within the watershed, impervious surface coverage varies widely. High-density areas may have impervious surface coverage of greater than 10% (unfortunately the model only works at the subwatershed level).

Table 13: Impervious cover percentage based on land use category

Land Use Category	Impervious Cover
Agriculture, Pasture/Grass, Forest	1.9%
Water/Wetland	0.0%
Low Density Residential	15.4%
High Density Residential	36.4%
Industrial	53.4%
Commercial	72.2%

Source: Choi and Engel 2004

6.2.6 Build-Out and Long-term Hydrologic Impact Analysis (L-THIA)

In 2009, Kieser & Associates completed a build-out analysis and long-term hydrologic impact analysis for the Black River Watershed. The purpose of this analysis was to calculate current runoff volume and pollutant load conditions and evaluate the impact of future land use changes on water quality (specifically runoff volume, total suspended solids, phosphorus and nitrogen). In the model, land use change was based on future land use maps from local municipal master plans. This report will be instrumental in working with governmental units on master plan and zoning ordinance updates to improve and protect water quality. The model was also used to determine current pollutant loading. Sources of non-point source pollutants in the Black River Watershed are primarily from agriculture and urban areas. Modeling results show that though agriculture is the largest non-point source of pollutants in the watershed, urban land uses contribute over 25% of the total pollutant load even though they only occupy about 5% of the land area. Additionally, the results of this model helped identify areas where future development is expected to threaten water quality. See section 6.7 for results of this study. Information contained in this report was used in the subwatershed matrix (Table 22). The full report can be found in Appendix L.

6.3 Watershed Inventory Sites of Concern

Sites of concern discovered during the watershed inventory were divided into four categories: road stream crossing sites of concern, streambank erosion sites of concern, agricultural sites of concern, and residential and municipal sites of concern.

6.3.1 Road-Stream Crossing Sites of Concern

The primary pollutant entering surface water at road-streams crossings is sediment. Sediment can enter the waterway as a result of erosion around bridges or culverts, or due to incorrect placement of a culvert. Culverts may also be undersized, which increases the velocity of the water as it travels through the culvert. This can increase erosion on the downstream side of the culvert. The slope of the road bed can also direct sediment-laden runoff directly into a waterway. Trash/debris is one pollutant that is found primarily at road-stream crossings, since these

are the primary public access point to the river and its tributaries. Much evidence of illegal dumping was found at road stream crossings during the course of the field inventory, and it is recommended that these points be the focus of future river clean-up days. Other pollutants that can be found at road-stream crossings include chemical pollutants like salts, gasoline and oil. Though these parameters were not tested for during the course of this study, it is likely that they are entering the surface water in at least small concentrations.

BMPs for road stream crossing problems include re-orienting culverts, replacing culverts with ones of the correct sizes, cleaning and maintaining blocked culverts, and adding bioengineering or riprap. However, there are few grant programs that cover costs of culvert and bridge replacement or repair. Numerous problem areas were found at road stream crossings. These sites are shown in Figure 24 and listed in Appendix M. Causes of pollution included gravel road grading, improper culvert sizing and placement, and erosion from/around bridges, culverts or roads.

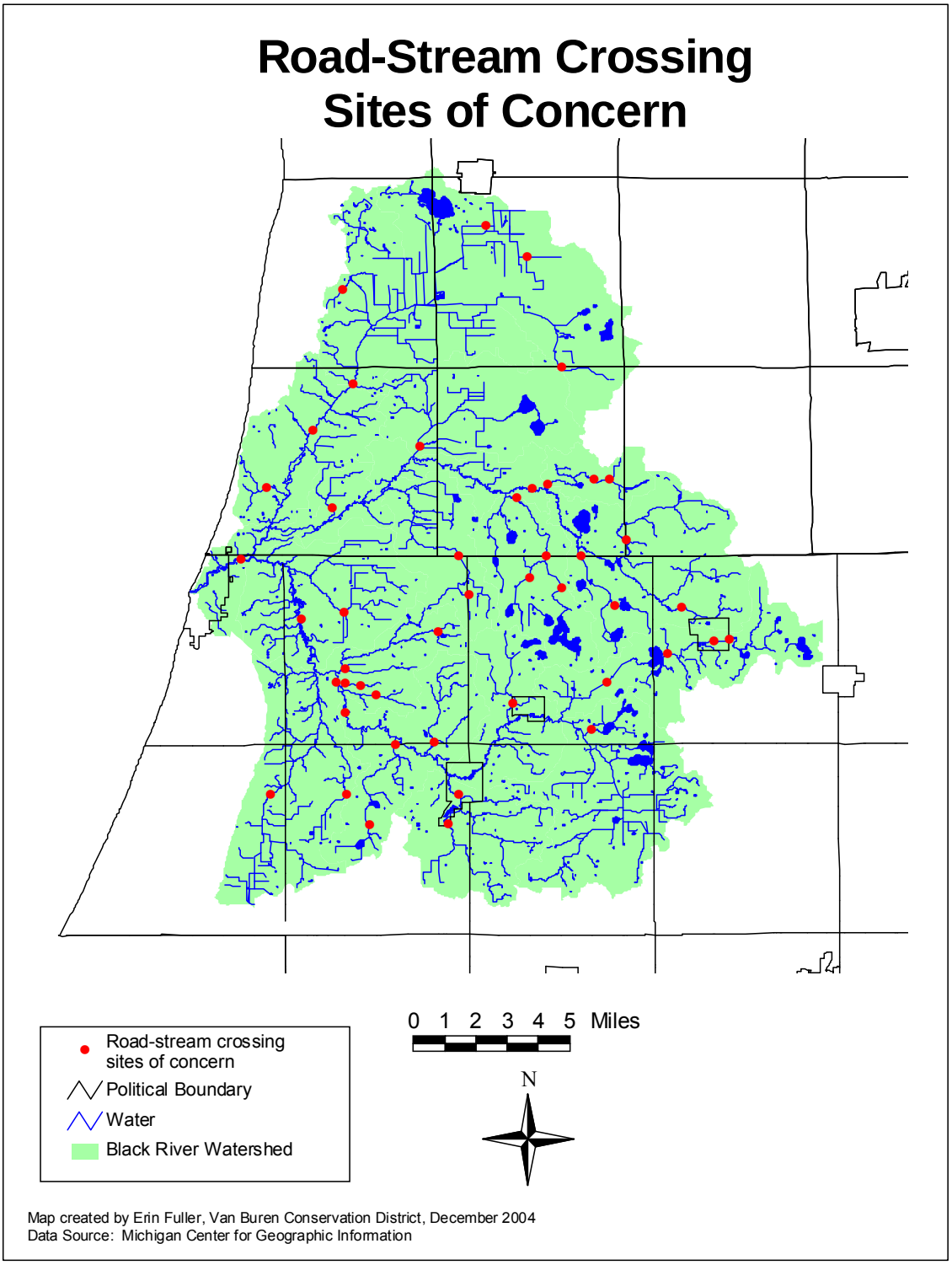


Figure 24: Road-stream crossing sites of concern

6.3.2 Streambank Erosion Sites of Concern

Sedimentation in the Black River Watershed is likely primarily a result of bank erosion. While there are certainly other sources of sedimentation, the banks appear to be eroding in many locations. This can be a result of the land use along the stream bank or changes in hydrology. For example, increased runoff from hardened surfaces results in a higher volume of water in the stream channel that is more erosive. Sediment can carry additional pollutants such as nutrients and heavy metals.

Sites with streambank erosion occurring are shown in Figure 25 and listed in Appendix M. Causes of erosion at these sites included human access, removal of streambank vegetation, and site development and construction. At some of these sites, the cause of the erosion was easily determined. At most, however, the causes are not immediately visible and are likely related to past changes in the hydrologic regime (such as channelization and ditching, loss of wetlands, and increase in hardened surfaces resulting in greater runoff). Streambank erosion sites can be addressed with a variety of bioengineering techniques (such as soil lifts, log crib walls and others). However, a more complete understanding of the hydrology of the Black River and the causes of the streambank erosion is necessary before BMPs are implemented at many of these sites. In addition, while most of the eroding sites listed are at road-stream crossings (because those sites are the most accessible and visible in the watershed), there are stretches of streams that are eroding away from road-stream crossings. Besides being difficult to properly inventory the river between road-stream crossings, it would not be feasible to "fix" all of these stretches with structural BMPs. Instead, steps should be taken to improve the hydrology of the river.

Other stretches of river exhibited streambank erosion for long stretches. These include:

- The South Branch, downstream of Phoenix Rd. in Geneva Township (BR-13), to approximately 70th St. (BR-05)
- Much of the Haven & Max Lake Drain
- Drains in Allegan

6.3.3 Agricultural Sites of Concern

Nonpoint source pollution from agricultural sources can include sediment, nutrients (from fertilizer runoff or animal waste), chemical pollutants (from pesticides), and bacteria/pathogens (from animal waste). In addition, silage leachate can have a significant impact on water quality. As little as one gallon of leachate introduced into a river or stream can lower the oxygen content of 10,000 gallons of water to a level at which fish cannot survive (Cropper and Dupoldt 1995). Many agricultural issues can be addressed through programs offered through the Natural Resources Conservation Service, as well as through education. Problem areas identified through the watershed inventory included areas in which livestock have uncontrolled access to streams (leading to eroded banks and livestock waste deposited directly into the waterway) and farm fields with little to no buffer along the waterway. It should be noted, however, that despite the large percentage of agricultural land use in the watershed, relatively few areas are degraded as a direct result of agricultural practices. The main stem (North, Middle and South Branches) of the river is for the most part surrounded by a wide vegetative buffer. Agricultural land use likely has more of an impact on the smaller designated drains.

Agricultural sites of concern are shown in Figure 26 and Appendix M. Pollutant loading from agricultural sites of concern is approximated at 2,602 tons/year of sediment, 3,225 lbs/year of phosphorus, and 6,470 lbs/year of nitrogen. Sources of pollution included livestock and a lack of vegetated buffer.

6.3.4 Residential and Municipal Sites of Concern

Nonpoint source pollutants from residential and municipal sources can include sediment, nutrients, bacteria/pathogens, temperature, chemical pollutants, and trash/debris. These are all potential pollutants, but the degree to which they actually pollute a water body varies greatly. Without extensive water testing of the Black River it is impossible to fully ascertain the pollutant load contributed by residential and municipal areas. However, generalizations can be made to locate potential problem areas. For example, lawns that are mowed to the edge of a waterway are indicators of several potential problems: the banks in these areas are not likely to remain stable (as

grass has a short root system that fails to provide bank stability), and there is no vegetative filter system in place to remove sediment, nutrients, or chemical pollutants before they reach the waterway.

Sites of concern in residential and municipal areas are shown in Figure 27 and listed in Appendix M. These sites were found during field surveys and may not include all problem areas. Pollutant loading from residential and municipal sites of concern is approximated at 412 tons/year of sediment, 1,331 lbs/year of phosphorus, and 11,896 lbs/year of nitrogen. Causes of pollution included removal of streambank vegetation, change in hydrology (increase in hardened surfaces) and poor stormwater management practices.

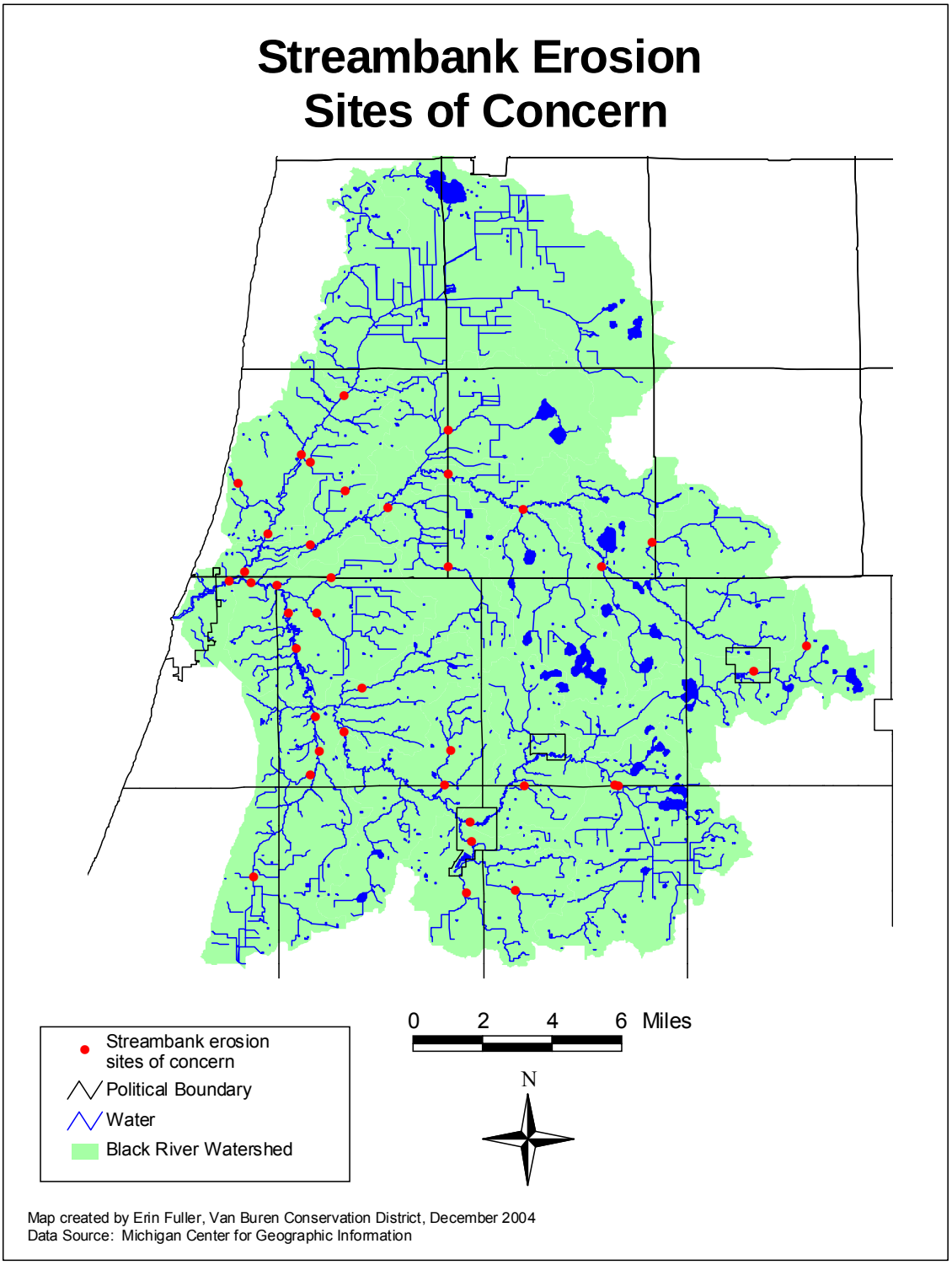


Figure 25: Streambank erosion sites of concern

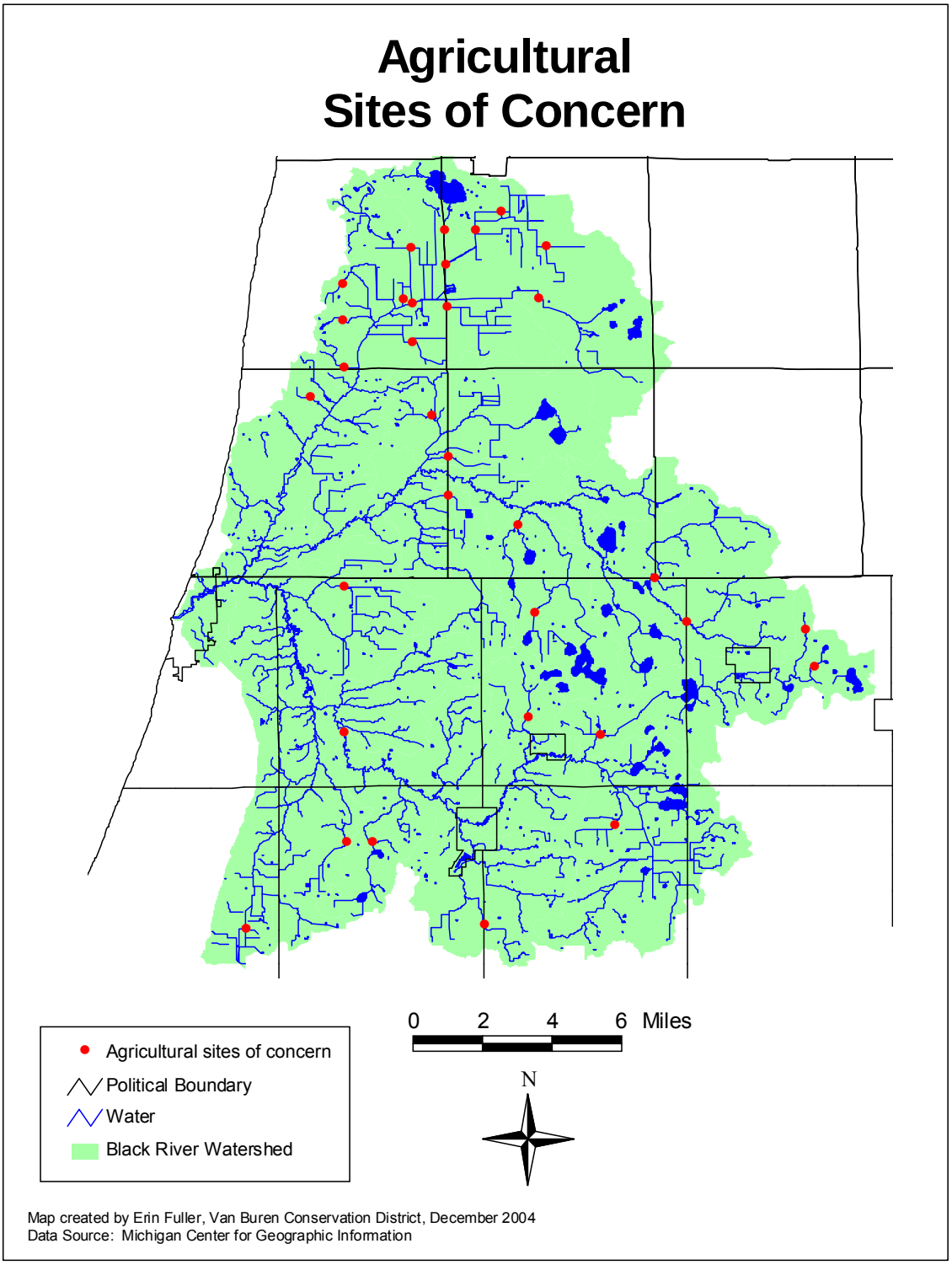


Figure 26: Agricultural sites of concern

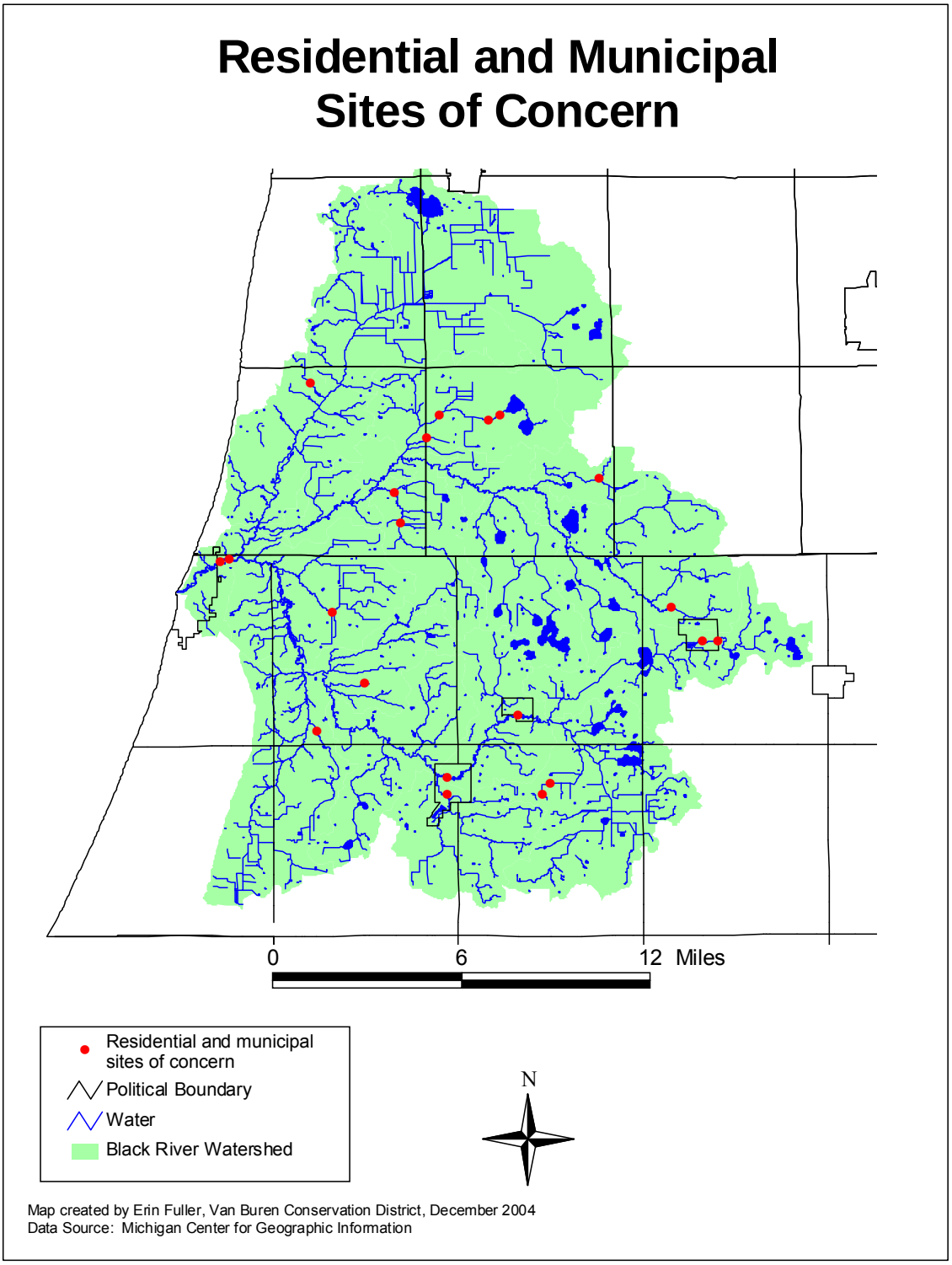


Figure 27: Residential and municipal sites of concern

6.4 Hydrology and Stream Morphology

Historically, many rivers and streams have been straightened and channelized. This was done primarily to increase drainage for the creation or improvement of agricultural land. This straightening results in a concentration of stream power which can lead to incision of the stream channel, leaving the riparian vegetation perched above the stream such that it may never be flooded (Malanson 1993). Thus, the value of flood protection for downstream areas is lost. The increased velocity also increases the river's erosive force (Palmer 1994). In 1984, the U.S. Fish & Wildlife Service estimated that 67% of the nation's degraded stream segments were degraded due to flow alteration (other causes of degradation included chemical pollution and habitat loss) (Palmer 1994).

6.4.1 Hydrology Study

A hydrologic model for the Black River Watershed was developed by the Michigan Department of Environmental Quality during the course of this project (Fongers 2004) (Appendix N). This model compares land use from a circa-1800s scenario with 1978. The model shows that there has been an increase in volume of runoff and peak flows since presettlement times (for both 2-year and 25-year storms). For the 25-year storms, this increase can cause or aggravate flooding. For the 2-year storms, channel-forming flows will increase, which can cause stream instability.

The flows of the three branches of the river were shown to peak at different times after a rain event. This helps to limit flooding effects downstream of the confluence of the three branches. Thus, any land use changes that would result in the branches peaking at the same time should be carefully evaluated for their potential downstream effects.

> Some streams in the watershed may have yields that are too high to support a trout fishery. Yield is the amount of peak flow divided by the drainage area.

This model can also be used to evaluate trout habitat based on yield (cubic feet per second per acre). Yields over a certain amount correspond with impaired or poor habitat for trout. Based on the 1978 land-use scenario, the Great Bear Lake Drain is classified as impaired for trout habitat, and habitat is classified as poor above Great Bear Lake. Six subbasins were above the target yield for fisheries (0.0075 cfs/acre): Haven and Max Lake Drain to Great Bear Lake, Maple Creek to mouth, S. Branch Black River to Confluence with Cedar Creek, Butternut Creek to mouth, Middle Branch Black River to mouth, and Black River to mouth. In studies of other rivers, streams with yields above 0.0105 cfs/acre have been shown to not have trout present. Subbasins with yields above this level include Haven and Max Lake Drain to Great Bear Lake, Maple Creek to mouth, S. Branch Black River to Confluence with Cedar Creek, and Butternut Creek to mouth.

6.4.2 Stream Morphology Study

An assessment of the morphology of the Black River was performed at several locations in the watershed (Appendix O). Kregg Smith, MDNR Fisheries Biologist, performed the assessment. The stream reaches were classified according to the methodology described by Rosgen (1996) (Table 14). Data collected on stream dimension, pattern and profile may guide the design criteria for structures to be used for restoring stream function.

Table 14: River delineation data collected at six stream reaches in the Black River Watershed

Waterbody	Location	Entrenchment ratio	Width/ depth ratio	Sinuosity	Slope	Channel Material	Stream type (Rosgen)
North Branch	68th St.	19.7	10.7	1.1	0.002	Glendora Loamy Sand	E5
Middle Branch	60th St.	>2.2	13.39	1.57	0.002	Glendora Loamy Sand	C5
South Branch	Hamilton St., City of Bangor	>2.2	14.83	1.2	0.002	Glendora Sandy Loam	C5

Haven/Max Lake Drain	42nd St.	>2.2	8.41	1.47	0.003	Algansee-Cohoctah	E5
South Branch	Phoenix Rd.	<1.4	6.2	1.13	0.0004	Algansee-Cohoctah	F6
Middle Branch	68th St.	<1.4	11.2	1.32	0.0013	Glendora Loamy Sand	F5

Source: Smith 2004

The E5 stream type is generally low-gradient, highly meandering, and is very stable and efficient with little deposition of materials. The C5 stream type generally has a broad floodplain, a low-gradient channel, and is relatively meandering. F stream types are generally deeply entrenched, meandering, and can experience high levels of bank erosion and sediment transport. F5 channels have a predominantly sandy substrate while F6 channels typically have a silt/clay substrate (Rosgen 1996).

More sites will be assessed in the future, and the previous sites will be revisited to track changes over time.

6.4.3 Channel Incision

Some stretches of the river were determined to be incised, included portions of Cedar Creek, the North Branch, the Black River Drain, the South Branch, and the Haven & Max Lake Drain. Incised channels have downcut their beds to the point at which the river is no longer connected to its floodplain. This results in more scouring of the channel because the water (and its energy) is confined to the channel and cannot escape onto the floodplain to dissipate the energy. It has been estimated that 75 to 80% of the sediment that is moved in the Black River comes from the streambanks as a result of channel incision and an overwide channel (C. Freiburger, personal communication, December 16, 2003).

6.5 Designated Uses

A designated use is a recognized use of water by state and federal water quality programs. All surface waters in the state of Michigan are designated and shall be protected for all of the uses listed below in Table 15 (R323.1100 of Part 4, Part 31 of PA 451, 1994, revised 4/2/99). The table also indicates whether the use is currently met, threatened, or impaired in the Black River Watershed. Designated uses in many water bodies in the Black River Watershed are threatened or impaired due to habitat loss or fragmentation, rather than any specific pollutants. For the designated use assessment, only pollutant-based impairments and threats are considered.

Table 15: Designated/Existing uses in the Black River Watershed

Designated/Existing Use	General Definition	Designated Use: Met, Threatened or Impaired
Agriculture	water supply for cropland irrigation and livestock watering	Met
Industrial Water Supply	water utilized in industrial processes	Met
Public Water Supply	public drinking water source	N/A*
Navigation	waters capable of being used for shipping, travel, or other transport by private, military, or commercial vessels	Threatened (for canoes and kayaks on stretches of the North, Middle, and South Branches, South Haven harbor)
Warmwater Fishery	supports reproduction of warm water fish	-Threatened (North & Middle Branches) -Impaired (South Branch)
Coldwater Fishery †	supports reproduction of cold water fish	Impaired (South Branch)
Other Indigenous Aquatic Life and Wildlife	supports reproduction of indigenous animals, plants, and insects	Impaired
Partial Body Contact	water quality standards are maintained for skiing, canoeing and wading	Threatened
Total Body Contact	water quality standards are maintained for swimming	Threatened (Insufficient data)

*No communities withdraw drinking water directly from the Black River. The South Haven municipal water intake is located offshore in Lake Michigan, and is rarely affected by flows from the Black River.

† The following water bodies in the Black River Watershed are also regulated as cold water fisheries (MDNR designated trout/salmon streams) (Figure 9):

- Black River Mainstream: From confluence of North and South branches down to Lake Michigan (Allegan and Van Buren Counties)
- Middle Branch Black River: From confluence of Spring Brook Creek (T1N, R15W, Section 22, Allegan County) downstream to confluence of Main Branch Black River
- North Branch Black River: From 111th Avenue (T1N, R16W, Section 3, Allegan County) downstream to confluence with Mainstream
- South Branch Black River: From Hamilton Stream Bridge (T2S, R16W, Section 1, Van Buren County) downstream to confluence with mainstream (T1S, R17W, Section 2, Van Buren County)

The different types of trout streams (shown in Figure 9) are related to stream regulations. For example, Type I streams have an open season from the last Saturday in April to September 30, while Type IV streams are open all year.

The Clean Water Act requires each state to prepare a biennial Integrated Report on the quality of the state's water resource. The 2008 Integrated Report (LeSage and Smith 2008) identifies watershed segments that are not supporting designated uses. Designated uses that are not supported in the Black River Watershed include "other indigenous aquatic life and wildlife" and "fish consumption." Causes include phosphorus, other anthropogenic substrate alterations, other flow regime alterations, and PCB in fish tissue. Table 16 and Figure 28 show the locations in which these designated uses are not met.

Table 16: Impaired segments in the 2008 Integrated Report

Impaired Designated Use	AUID	Location	Cause
Other Indigenous Aquatic Life and Wildlife	040500020201-03	Black River Drain, unnamed trib. To Black River Drain, unnamed trib. To Hutchins Lk.	Other anthropogenic substrate alterations
Other Indigenous Aquatic Life and Wildlife	040500020201-03	Black River Drain, unnamed trib. To Black River Drain, unnamed trib. To Hutchins Lk.	Other flow regime alterations
Other Indigenous Aquatic Life and Wildlife	040500020202-01	Black River Drain, unnamed tribs. To Black River Drain	Other anthropogenic substrate alterations
Other Indigenous Aquatic Life and Wildlife	040500020202-01	Black River Drain, unnamed tribs. To Black River Drain	Other flow regime alterations
Other Indigenous Aquatic Life and Wildlife	040500020203-04	Melvin Creek	Other anthropogenic substrate alterations
Other Indigenous Aquatic Life and Wildlife	040500020203-04	Melvin Creek	Other flow regime alterations
Other Indigenous Aquatic Life and Wildlife	040500020206-01	Great Bear Lake Drain	Other anthropogenic substrate alterations
Other Indigenous Aquatic Life and Wildlife	040500020206-01	Great Bear Lake Drain	Other flow regime alterations
Other Indigenous Aquatic Life and Wildlife	040500020206-03	Great Bear Lake	Phosphorus (total)
Other Indigenous Aquatic Life and Wildlife	040500020207-02	Lower Jeptha Lake Drain	Other anthropogenic substrate alterations
Other Indigenous Aquatic Life and Wildlife	040500020207-02	Lower Jeptha Lake	Other flow regime

		Drain	alterations
Other Indigenous Aquatic Life and Wildlife	040500020208-02	Cedar Drain	Other anthropogenic substrate alterations
Other Indigenous Aquatic Life and Wildlife	040500020208-02	Cedar Drain	Other flow regime alterations
Other Indigenous Aquatic Life and Wildlife	040500020209-02	Cedar Creek	Other anthropogenic substrate alterations
Other Indigenous Aquatic Life and Wildlife	040500020209-02	Cedar Creek	Other flow regime alterations
Other Indigenous Aquatic Life and Wildlife	040500020209-04	Unnamed trib. To Cedar Creek	Other anthropogenic substrate alterations
Other Indigenous Aquatic Life and Wildlife	040500020209-04	Unnamed trib. To Cedar Creek	Other flow regime alterations
Fish Consumption*	040500020208-01	Merriman Lk. Outlet, Bangor impoundment, School Section Lk. Outlet, South Branch Black River, unnamed tribs. to South Branch Black River	PCB in fish tissue
Fish Consumption*	040500020209-01	South Branch Black River, unnamed tribs to South Branch Black River	PCB in fish tissue
Fish Consumption*	040500020210-01	South Branch Black River, unnamed tribs to South Branch Black River	PCB in fish tissue
Fish Consumption*	040500020211-01	Black River	PCB in fish tissue

***** The impairment of fish consumption is not addressed in this plan, as it is not considered a nonpoint source pollution issue.

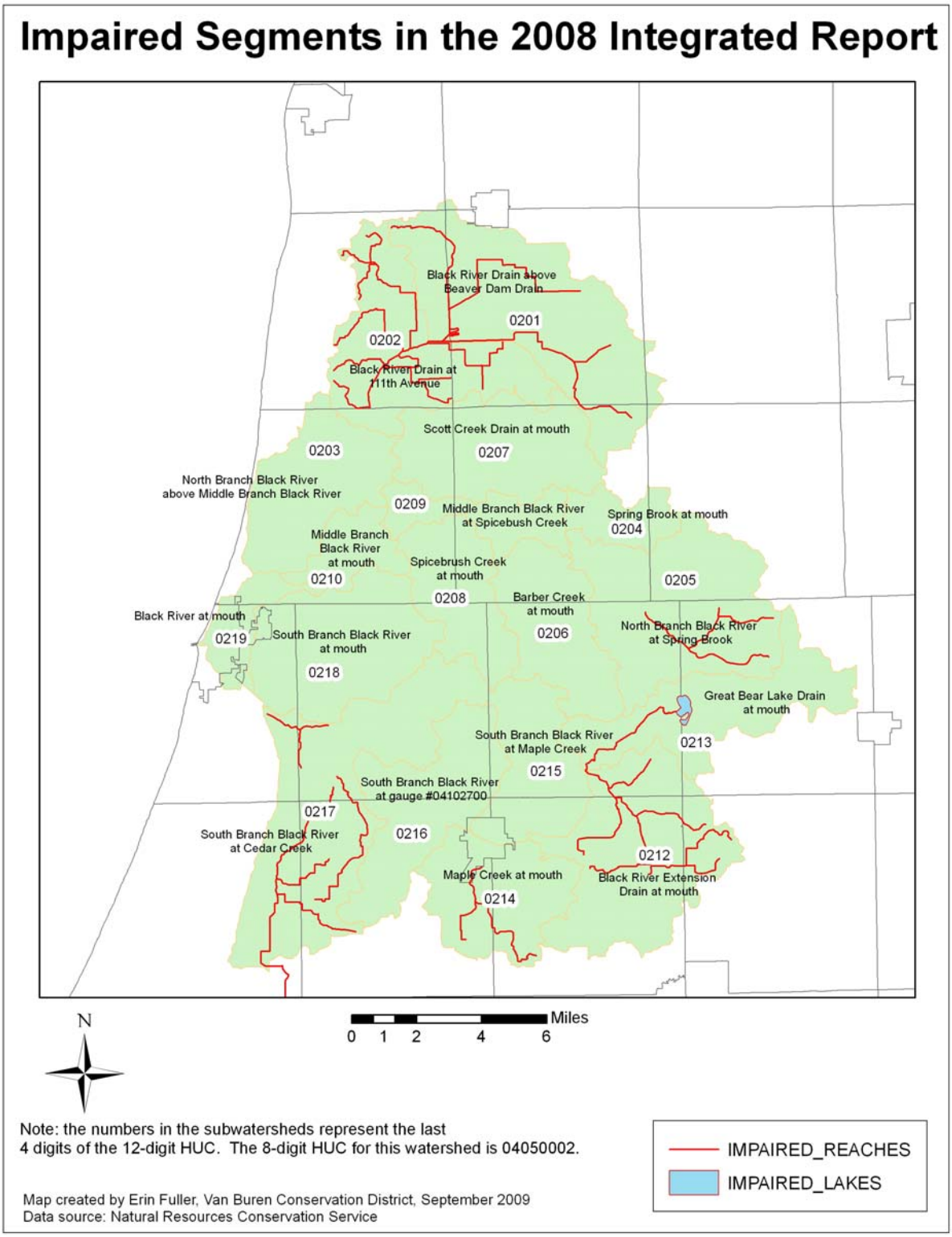


Figure 28: Impaired Segments in 2008 Integrated Report

6.6 Desired Uses and Stakeholder Concerns

Desired uses for the Black River Watershed have been identified through stakeholder meetings and public participation. The following desired uses are also designated uses (see Table 15) and are addressed through recommendations in this plan:

- Maintain the water supply for agricultural uses (cropland uses and livestock watering)
- Maintain the water supply for industrial uses (industrial processes)
- Improve and maintain warm and cold water fishery
- Improve and maintain the habitat for other indigenous aquatic life
- Improve partial body contact (water quality standards for water skiing, canoeing and wading)
- Improve total body contact (water quality standards are maintained for swimming)

The following are additional concerns brought up at public meetings that are indirectly related to water quality. Goals set forth in this watershed management plan also address these issues.

- Improve recreation infrastructure along river
  - Signage along river, access sites, remove log jams in portions for canoeing opportunities, canoe stops with bathrooms and picnic areas, remove litter and trash along banks
  - Establish trail/boardwalk along river in Bangor
- Maintain and protect wildlife habitat, specifically Great Blue Heron population near Breedsville
- Increase awareness and stewardship ethic in the Black River Watershed
  - Enhance public involvement (i.e. "Friends of the Black River")

Stakeholder concerns are shown in Table 17. These were identified through public meetings, interviews, and other forms of public participation.

Table 17: Stakeholder Concerns

Nutrients	Farms improperly spreading manure
	Farms with inadequate stream buffers
	Runoff from agricultural land
	Inadequate on-site septic systems
	Residential landscaping
	Overpopulation of Canada Geese in the Allegan State Game Area
	Waterfowl activity
	Excessive algae blooms
	Lake weed growth
Aquatic Wildlife	Lake weed growth impacting fish habitat
	Fish habitat lacking or degraded
	Dams and other barriers to fish runs
	Pollution has impacted fishery
	Exotic plants invading lakes and streams
	Largemouth Bass virus impacting bass and perch (Lower Scott Lake)
General Wildlife	Overpopulation of Canada Geese in Allegan State Game Area
	Exotic fauna such as zebra mussels and rusty crayfish may invade river and lakes
	Introduction of non-native species
	Reduction of biological diversity
	Loss of wildlife habitat
Development Issues	Wetland protection needed
	Lack of coordination between municipal governments and non-governmental economic development promoters
	Coordination of zoning regulations, incentives, etc. are necessary for watershed protection
	Lack of planning and zoning communication/coordination
	Headwater protection

	Areas of the watershed are in need of economic development
	Development needs to occur with river protection
	Region needs to capitalize on the amenity provided by the river for recreation and tourism
	Riverfront sites (esp. in Bangor) are available to residential or commercial development
	Impermeable surfaces and channelized waterways result in a pulse pattern of runoff and flow rather than even runoff sustained over a longer period of time
Recreation	Lack of canoeing opportunities
	Fisheries on the river are degraded
Sedimentation	Increase in sedimentation from short-sighted land-use practices
	Sediment from road runoff
	Sediment from Kal-Haven Trail
	Improper drain maintenance procedures
Chemical Pollutants	Possibility of cyanide from former Breedsville tannery
	Industrial runoff and dumping resulting in PCBs, cyanide and other toxins in the water and sediments
	Petroleum pollution from outboard motors and personal watercraft
	Road commissions using herbicides near/over water and culverts
Water Levels	River and lakes suffer from low water levels
	Wells and pumping diminishing the surface aquifers
Other	Garbage/debris entering river from dumping, littering and runoff

6.7 Sources and Causes of Pollution and Water Quality Impairments

Sources for water pollution are broken down into two categories: point source pollution and nonpoint source pollution. Point source pollution is the release of a discharge from a pipe, outfall or other direct input into a body of water. Common examples of point source pollution are factories and wastewater treatment facilities. Point source pollution discharges are monitored under the Clean Water Act and source discharges are required to obtain a permit to ensure compliance with water quality standards under the act. This permitting process assists in the restoration of degraded water bodies and drinking water supplies. Water quality has improved significantly in many areas due to point source controls on industrial and municipal discharges (Wolf and Wuycheck 2004). The National Pollution Discharge Elimination System (NPDES) is the permitting process for point source discharges. The facilities holding NPDES permits in the Black River Watershed are listed in Appendix P. These facilities are required to report to the Michigan Department of Environmental Quality on a regular basis.

Though not the focus of this plan, point source pollution has had significant impact on the Black River. A previous study identified contaminants such as arsenic, chromium, copper, mercury, nickel, lead, zinc, acetone, methyl ethyl ketone, tolulene, ethylbenzene and xylene in Scott Creek, a tributary of the Middle Branch (Heaton 1997). The Bangor Mill Pond area has also had chemical contamination as a result of point source discharges. Pollutants such as heavy metals, PCBs, oils, chlorides and dissolved salts have all been found in this area (Hull 1989, Gashman 1990, Heaton 1997, Wolf and Wuycheck 2004). A major clean-up of this area was undertaken to resolve this issue (Wolf and Wuycheck 2004, L. Nielsen, personal communication, June 15, 2004).

Nonpoint source pollution, the greatest water resource concern within the Black River Watershed, is not as easily identified. Nonpoint source pollution is caused when rain, snowmelt, wind, or gravity carries pollutants off the land and into the waterbodies. Roads, parking lots and driveways, farms, home lawns, golf courses, storm sewers, and businesses collectively contribute to nonpoint source pollution. Nonpoint source pollution is often overlooked because it can be a less visible form of pollution. Common forms of nonpoint source pollution are discussed in the next section.

> A pollutant load is the total amount of pollutants entering a waterbody.

Sources of non-point source pollutants in the Black River Watershed are primarily from agriculture and urban areas. Modeling results show that though agriculture is the largest non-point source of pollutants in the watershed, urban land uses contribute over 25% of the total pollutant load even though they only occupy about 5% of the land

area (Table 18, see Appendix L for the full report). Total watershed loading values for sediment, phosphorus and nitrogen are discussed in sections 6.7.1and 6.7.2.

Table 18: Percentage of pollutant load and runoff volume per land use for the Black River Watershed

		% of total load/volume			
Land Use Category (2001 land use)	2001 land use breakdown	Total Suspended Solids	Total Phosphorus	Total Nitrogen	Runoff
Agriculture	42.8%	65.6	62.0	77.2	58.4
Forest	22.0%	3.1	2.5	3.0	7.9
High density urban	0.5%	1.8	1.7	1.5	1.9
Low density urban	1.5%	0.9	2.4	1.8	1.6
Transportation	3.4%	26.0	29.4	14.0	23.8
Urban Open	0.1%	0.0	0.0	0.0	0.0
Rural Open	12.8%	2.5	2.0	2.5	6.4
Water	1.1%	0.0	0.0	0.0	0.0
Wetlands	16.0%	0.0	0.0	0.0	0.0

Source: Kieser & Associates 2009 (Appendix L)

6.7.1 Sediment

Sediment is soil, sand, and minerals that can take the form of bedload, suspended or dissolved material. The first problems with sedimentation within the Black River likely began during the logging period when the river was used for log transportation, and the land was deforested. This likely resulted in large amounts of sediment washing into the river. While logging is no longer the primary cause, sedimentation is still the greatest water pollution concern within the Black River Watershed (as well as the rest of the country).

Impacts:

- Sediment harms aquatic wildlife by altering the natural streambed and increasing the turbidity of the water, making it “cloudy”. Sedimentation may result in gill damage and suffocation of fish, as well as having a negative impact on spawning habitat. Increased turbidity from sediment affects light penetration that may result in changes in oxygen concentrations and water temperature that could affect aquatic wildlife.
- Sediment can also affect water levels by filling in the stream bottom, causing water levels to rise. Lakes, ponds and wetland areas can be greatly altered by sedimentation. As this occurs habitat for macroinvertebrates (as well as spawning habitat for fish) is covered.
- Certain pollutants, such as phosphorus and metals, can bind themselves to the finer sediment particles and will eventually enter the waterway or waterbody.

Pollutant Loading: According to the build-out analysis (see Appendix L), TSS loading for the watershed is currently 7,718,662 lbs/year. For a breakdown by both subwatershed and township, see the full report.

Related water quality standards:

Total Suspended Solids (TSS): Rule 50 of the Michigan Water Quality Standards (Part 4 of Act 451) states that waters of the state shall not have any of the following unnatural physical properties in quantities which are or may become injurious to any designated use: turbidity, color, oil films, floating solids, foam, settleable solids, suspended solids, and deposits. This kind of rule, which does not establish a numeric level, is known as a "narrative standard." Most people consider water with a Total Suspended Solids concentration less than 20 mg/l to be clear. Water with TSS levels between 40 and 80 mg/l tends to appear cloudy, while water with concentrations over 150 mg/l usually appears dirty. The nature of the particles that comprise the suspended solids may cause these numbers to vary.

6.7.2 Nutrients

Although certain nutrients are required by aquatic plants in order to survive, an overabundance can be detrimental to the aquatic ecosystem. Nitrogen and phosphorus are generally available in limited supply in an unaltered watershed but can quickly become abundant in a watershed under development. In abundance, nitrogen and phosphorus accelerate the growth rate of aquatic plants and speed up the natural aging process of a waterbody. This is referred to as "cultural eutrophication" when the addition of nutrients is related to human activities. Sources of these nutrients include fertilizers and organic waste carried within water runoff.

Impacts:

- Excessive nutrients increase weed and algae growth impacting recreational use on the waterbody.
- Decomposition of the increased weeds and algae lowers oxygen levels resulting in a negative impact on aquatic wildlife and reducing fishing opportunities.
- Exotic species can better compete with natural plants when nutrients are found in abundance.

Pollutant Loading: According to the build-out analysis (see Appendix L), total phosphorus loading for the watershed is currently 20,857 lbs/year and total nitrogen loading is 270,633 lbs/year. For a breakdown by both subwatershed and township, see the full report.

Related water quality standards:

Phosphorus: Rule 60 of the Michigan Water Quality Standards (Part 4 of Act 451) limits phosphorus concentrations in point source discharges to 1 mg/l of total phosphorus as a monthly average. The rule states that other limits may be placed in permits when deemed necessary. The rule also requires that nutrients be limited as necessary to prevent excessive growth of aquatic plants, fungi or bacteria, which could impair designated uses of the surface water.

Dissolved Oxygen: Rule 64 of the Michigan Water Quality Standards (Part 4 of Act 451) includes minimum concentrations of dissolved oxygen which must be met in surface waters of the state. This rule states that surface waters designated as coldwater fisheries must meet a minimum dissolved oxygen standard of 7 mg/l, while surface waters protected for warmwater fish and aquatic life must meet a minimum dissolved oxygen standard of 5 mg/l.

6.7.3 Temperature

Change in temperature is often a forgotten pollutant. Heated runoff from impermeable surfaces alters the normal temperature range for the waterways affecting the aquatic wildlife. Impermeable surfaces, such as parking lots and driveways, and reduced infiltration on other land use types (such as lawns) lead to an increased amount of runoff. In addition, removal of streambank vegetation decreases the shading of a waterbody and can lead to an increase in temperature. Impounded areas can also have a higher water temperature relative to a free-flowing stream.

Temperature was only measured in one previous study of the Black River. In that study (MI/DEQ/WD-03/067), temperature does not appear to be increased. In fact, temperature at all sites measured was within the parameters for a coldwater fishery.

Impacts:

- Surges of heated water during rainstorms can shock and stress aquatic wildlife that have adapted to the "normal" temperature conditions.
- A change in temperature can affect the rate of photosynthesis by aquatic plants as well as the metabolic rate of aquatic organisms (Earth Force 2004).

Related water quality standards:

Temperature: Rules 69 through 75 of the Michigan Water Quality Standards (Part 4 of Act 451) specify temperature standards which must be met in the Great Lakes and connecting waters, inland lakes, and rivers, streams and impoundments. The rules state that the Great Lakes and connecting waters and inland lakes shall not receive a heat load which increases the temperature of the receiving water more than 3 degrees Fahrenheit above the existing natural water temperature (after mixing with the receiving water). Rivers, streams and impoundments shall not receive a heat load which increases the temperature of the receiving water more than 2 degrees Fahrenheit for coldwater fisheries, and 5 degrees Fahrenheit for warmwater fisheries. These waters shall not receive a heat load which increases the temperature of the receiving water above monthly maximum temperatures (after mixing).

Monthly maximum temperatures for each water body or grouping of water bodies are listed in the rules. The rules state that inland lakes shall not receive a heat load which would increase the temperature of the hypolimnion (the dense, cooler layer of water at the bottom of a lake) or decrease its volume. Further provisions protect migrating salmon populations, stating that warmwater rivers and inland lakes serving as principal migratory routes shall not receive a heat load which may adversely affect salmonid migration.

6.7.4 Bacteria/Pathogens

Bacteria and pathogens may enter surface water from improper manure management, improper disposal of pet wastes, poorly maintained septic systems, or even from high populations of waterfowl. Fecal coliform bacteria are often monitored because they can be an indicator of high levels of pathogens. In the last study of fecal coliform bacteria in the Black River Drain (North Branch of the Black River), two sample locations had fecal coliform in excess of 550. However, this testing may now be outdated.

Impacts:

- High levels of pathogens can lead to human illnesses and diseases, and thus can impair body contact recreation in a waterbody.

Related water quality standards:

Bacteria - Rule 62 of the Michigan Water Quality Standards (Part 4 of Act 451) limits the concentration of microorganisms in surface waters of the state and surface water discharges. Waters of the state which are protected for total body contact recreation must meet limits of 130 Escherichia coli (E. coli) per 100 milliliters (ml) water as a 30-day average and 300 E. coli per 100 ml water at any time. The limit for waters of the state which are protected for partial body contact recreation is 1000 E. coli per 100 ml water. Discharges containing treated or untreated human sewage shall not contain more than 200 fecal coliform bacteria per 100 ml water as a monthly average and 400 fecal coliform bacteria per 100 ml water as a 7-day average. For infectious organisms which are not addressed by Rule 62, The Department of Environmental Quality has the authority to set limits on a case-by-case basis to assure that designated uses are protected.

6.7.5 Chemical Pollutants

Chemical pollutants such as gasoline and oil can enter surface water through runoff from roads and parking lots, or from boating. Other sources can be approved processes such as permitted application of herbicides to inland lakes to prevent the growth of aquatic nuisance plants. Other chemical pollutants consist of pesticides and herbicide runoff from commercial, agricultural, municipal or residential uses.

Impacts:

- Impacts of chemical pollutants vary widely with the chemical; however, chemical pollution can cause a variety of health risks to humans and wildlife.

Related water quality standards:

pH: Rule 53 of the Michigan Water Quality Standards (Part 4 of Act 451) states that the hydogen ion concentration expressed as pH shall be maintained within the range of 6.5 to 9.0 in all waters of the state.

6.7.6 Trash and Debris

Trash can enter the river through direct dumping from an uninformed or uncaring public. Natural debris such as trees fall into the river as part of a natural process. This natural debris is an important part of the ecology of a stream. However, too much natural debris in the river can cause impairments

Impacts:

- Trash can be hazardous to aquatic wildlife
- Trash and litter along the river is visually unappealing
- Debris jams can cause impairments to navigation
- Debris jams can cause streambank erosion if they divert the flow of water against the banks
- Debris jams can block flow and exacerbate local flooding

6.8 Designated Uses, Threats, and Pollutants

Rankings for Table 19, Table 20 and Table 21 were derived from meetings and discussion with stakeholders, the Steering Committee and the Technical Committee.

Table 19: Designated Uses, Threats, and Pollutants

Designated Use	Pollutants causing threat or impairment	Ranking
Agriculture	N/A	N/A
Industrial Water Supply	N/A	N/A
Public Water Supply	N/A	N/A
Navigation	Trash/debris	1
	Nutrients	2
	Sediment	3
	Invasive species	4
Warmwater Fishery	Sediment	1
	Nutrients	2
	Pathogens/bacteria	3
	Temperature	4
Coldwater Fishery	Sediment	1
	Temperature	2
	Nutrients	3
	Pathogens/bacteria	4
Other Indigenous Aquatic Life and Wildlife	Sediment	1
	Nutrients	2
	Temperature	3
Partial Body Contact	Pathogens/bacteria	1
	Nutrients	2
	Sediment	3
Total Body Contact	Pathogens/bacteria	1
	Nutrients	2
	Sediment	3

Table 20: Pollutants of concern and their sources

Pollutants* and Rankings	Source
Sediment (k) Rank: 1	Streambank Erosion
	Road-Stream crossings
	Storm water runoff
	Livestock access
Nutrients (k) Rank: 2	Storm water runoff
	Septic systems
	Direct inputs
	Streambank erosion
	Livestock access

	High waterfowl population
	Fertilizer use (residential, commercial, agricultural, municipal)
Bacteria/Pathogens (k) Rank: 3	Septic systems
	Storm water runoff
	Livestock access
	High waterfowl population
Temperature (s) Rank: 4	Storm water runoff
	Lack of vegetative buffer
Trash/debris (k) Rank: 5	Direct inputs
Chemical pollutants (Oils, pesticides, herbicides, salts, etc.) (k) Rank: 6	Storm water runoff
	Direct inputs
	Impervious surfaces (roads, parking lots)
	Storm drains
	Road-stream crossings
Invasive Species (k) Rank: 7	Non-native species' adaptability and lack of predators

**k = known and s = suspected*

Table 21: Sources and causes of pollutants of concern

Sources *	Causes	Rank
Stream Bank Erosion/Stream Channel Erosion (k)	Removal of streambank vegetation (k)	1
	Change in hydrology (channelization/ditching, wetland loss, etc.) (k)	2
	Lack of agricultural erosion control measures (k)	3
	Improper culvert sizing and placement (k)	4
	Site development and construction (k)	5
	Livestock access (k)	6
	Human access (k)	7
Road Stream Crossings (k)	Improper culvert sizing and placement (k)	1
	Erosion from/around bridges, culverts and roads (k)	2
	Gravel road grading (s)	3
	Poorly installed or lack of erosion control measures (k)	4
	Winter road salting (s)	5
Direct Inputs (k)	Improper disposal of grass clippings, brush (k)	1
	Boating (k)	2
	Poor pollution prevention practices (s)	3
	Improper boat fueling practices (s)	4
	Houseboat septage (s)	5
Stormwater Runoff (k)	Change in land use (increase in hardened surfaces causing higher volumes of runoff) (k)	1
	Insufficient land use planning (k)	2
	Poor storm water management practices (k)	3
Livestock (k)	Improper manure management practices (s)	1
	Unrestricted access (k)	2
Septic Systems (s)	Poorly maintained, designed, or sited septic systems (s)	1
	Lack of education (k)	2
High Waterfowl Population (k)	Management for Canada Geese in the Allegan State Game Area (k)	1
	Unrestricted access (k)	2
Lack of (or removal of) Vegetative Buffer (k)	Insufficient land use planning (k)	1
	Lack of education on importance of vegetative buffers (k)	2
	Poorly maintained vegetative buffers (s)	3
Impervious/hardened surfaces (k)	Decreased infiltration due to change in land use (k)	1
	Insufficient land use planning (k)	2
	Increase in roads and parking lots from development (k)	3
Fertilizer use (residential, commercial, agricultural, municipal) (s)	Improper application (s)	1
	Lack of vegetative buffer (s)	2
Pesticide use (residential, commercial, agricultural, municipal) (k)	Improper application (k)	1
	Lack of vegetative buffer (s)	2
Storm Drains (s)	Improper oil disposal and vehicle maintenance (s)	1
	Illicit connections (s)	2

**k = known and s = suspected*

7 Priority Areas

7.1 Priority Restoration Areas

Priority areas are those portions of the watershed that contribute, or have the potential to contribute the most pollutants that impact water quality. By identifying priority areas, implementation can be targeted to the areas where most benefit can be achieved. The watershed was prioritized at the subwatershed level. A subwatershed matrix was developed to incorporate several of the different studies that have been completed in this watershed. The matrix gives a score for each subwatershed based on waterbodies listed in the 2008 Integrated Report, pollutant loading in the L-THIA model (see Appendix L), increase in loading in a 25% build-out scenario (see Appendix L), yields over the fisheries target (see Appendix N), TMDL (Total Maximum Daily Load) developed or pending, and wetland loss. This matrix is found in Table 22, and a map is shown Figure 29. Subwatersheds were scored as follows:

Total maximum score available = 6 points

- Contains impaired segment in 2008 Integrated Report = 1 point
- TMDL developed or pending = 1 point
- High pollutant loading in L-THIA model* = 1 point
- Significant increase in nutrient & sediment loads and runoff volume in 25% build-out scenario = 1 point
- Hydrologic study: subbasin yields over fisheries target = 1 point
- Wetland loss: 0-10.0% = 0 points
  10.1-20.0% = 0.5 points
  20.1% and above = 1 point

TMDLs (Total Maximum Daily Loads) are developed for waterbodies that do not meet water quality standards. A TMDL represents the maximum loading of a pollutant that can be discharged to a water body while still allowing that waterbody to meet water quality standards.

*The top three loading (per acre) subwatersheds were chosen for the subwatershed matrix. The same three subwatersheds had the highest loadings per acre for TSS, phosphorus and nitrogen, and they were significantly higher than the rest of the subwatersheds for each pollutant. See Appendix L for the complete report on loading for all subwatersheds.

Once scored, the subwatersheds were divided into three levels based on their score: Priority area 1 (scores of 3 points and above), Priority area 2 (scores of 1.5 to 2.5 points), and Priority area 3 (scores of 0 to 1 points). Thus, Priority area 1 is the highest priority area to be addressed with action in the watershed action plan shown in Table 24. This methodology provided four subwatersheds in priority area 1. This oversimplifies the issues in each subwatershed, but does provide us with a method for prioritizing subwatersheds in which to focus best management practice implementation.

7.2 Priority Preservation Areas

Additionally, the Southwest Michigan Land Conservancy, along with local volunteers, completed a GIS-based land protection priority model for the watershed (see Section 4.9 and Appendix G). This model identifies both natural areas and agricultural areas for protection. See Appendix G for a full report on the methodology that was used to create these models. This model should be used to guide land protection efforts in the watershed. For the most part, these priority preservation areas are located in undeveloped, headwaters areas. Areas around the Allegan State Game Area scored highly, as did wetland complexes in the Pullman area, undeveloped river corridor, the area around Upper and Lower Jeptha Lakes, and many lakes with little development, including Lake 11, Lake 14, Little Bear Lake, Spring Brook Lake, and others that comprise the headwaters of the Middle Branch. Below are the subwatersheds that stand out as containing more areas of high conservation value. See Appendix G for a complete description and detailed maps.

- 040500020201 (Black River Drain above Beaver Dam Drain)
- 040500020204 (Spring Brook at mouth)
- 040500020205 (North Branch Black River at Spring Brook)
- 040500020206 (Barber Creek at mouth)
- 040500020213 (Black River Extension Drain at mouth)

Table 22: Subwatershed matrix

HUC 8	HUC12	Sub-watershed name	Contains impaired segment in 2008 Integrated Report?	TMDL developed or pending?	High pollutant loading in L-THIA model*	Significant increase in nutrient & sediment loads & runoff volume in 25% build-out scenario	Hydrologic study: subbasin yields over fisheries target	Wetland loss	Score	Priority area
04050002	0201	Black River Drain above Beaver Dam Drain	X (Black River Drain, unnamed tributary to Black River Drain, unnamed trib. to Hutchins Lake)					28.35%	2	2
04050002	0202	Black River Drain at 111th Ave	X (Black River Drain, unnamed tributaries to Black River Drain)					23.29%	2	2
04050002	0203	North Branch Black River above Middle Branch Black River				X		3.51%	1	3
04050002	0204	Spring Brook at mouth						-0.17%	0	3
04050002	0205	North Branch Black River at Spring Brook	X (Melvin Creek)					7.40%	1	3
04050002	0206	Barber Creek at mouth				X		12.01%	1.5	2
04050002	0207	Scott Creek Drain at mouth						-0.43%	0	3
04050002	0208	Spicebush Creek at mouth						14.81%	0.5	3
04050002	0209	Middle Branch Black River at Spicebush Creek						-2.79%	0	3
04050002	0210	Middle Branch Black River at mouth					X	8.41%	1	3
04050002	0212	Black River Extension Drain at mouth	X (Lower Jeptha Lake Drain)					31.03%	2	2

04050002	0213	Great Bear Lake Drain at mouth	X (Great Bear Lk Drain, Great Bear Lake)	X			X	19.75%	3.5	1
04050002	0214	Maple Creek at mouth	X (Cedar Drain)		X		X	20.88%	4	1
04050002	0215	South Branch Black River at Maple Creek				X		20.76%	2	2
04050002	0216	South Branch Black River at gauge #04102700			X			21.98%	2	2
04050002	0217	South Branch Black River at Cedar Creek	X (Cedar Creek, Unnamed trib. to Cedar Creek)				X	24.75%	3	1
04050002	0218	South Branch Black River at mouth				X	X	13.25%	2.5	2
04050002	0219	Black River at mouth			X	X	X	9.93%	3	1

*The top three subwatersheds were chosen for the subwatershed matrix. See Appendix L for the complete report on loading for all subwatersheds.

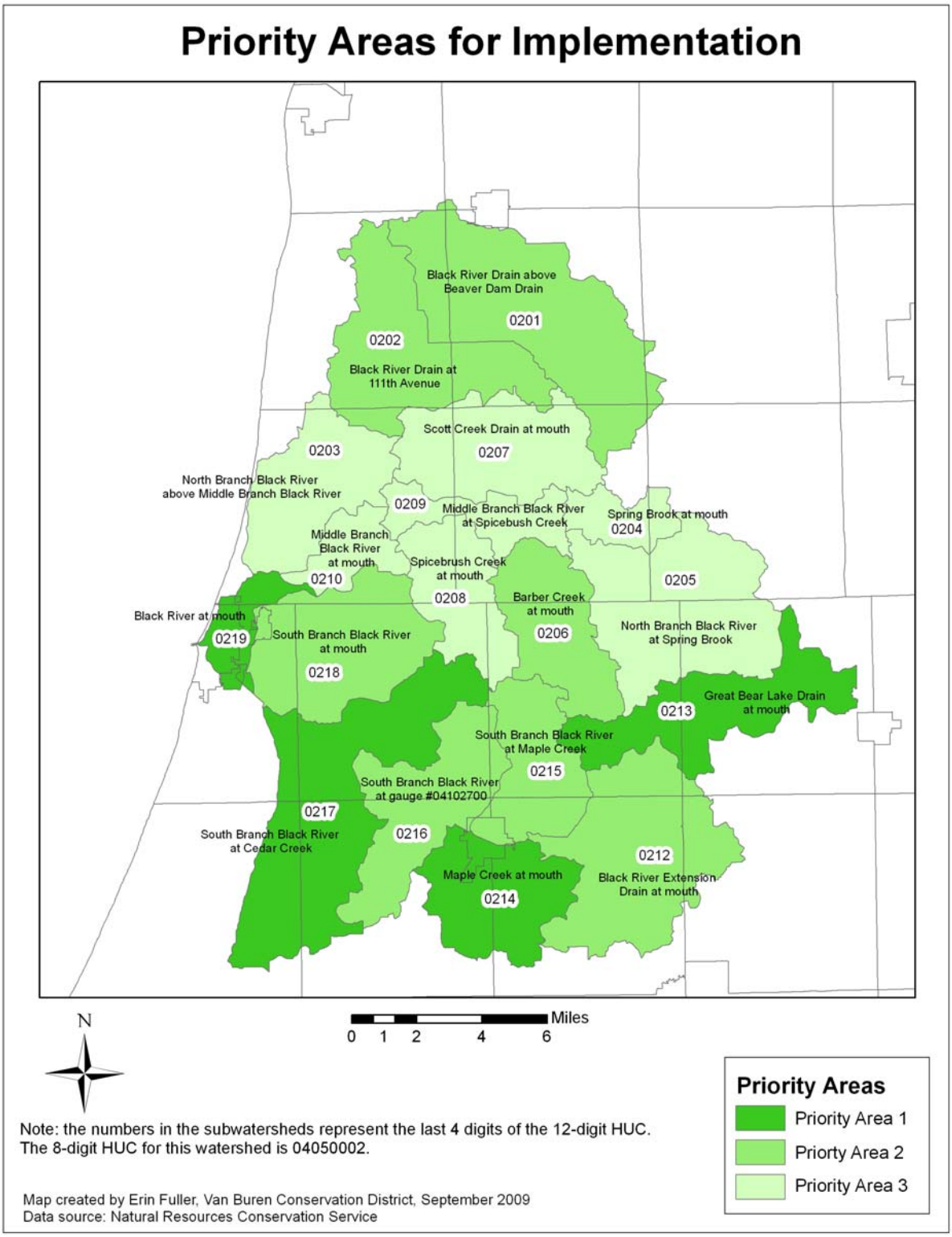


Figure 29: Priority areas for implementation

8 Implementation Strategies

Many of the water quality concerns in the Black River Watershed could be improved through education and land-use planning. Watershed residents need to be educated on how their actions can affect water quality. This education needs to be provided in a variety of formats: workshops for local residents, booths at local fairs and events, and presentations to township boards, lake associations, city and village councils, and other organizations. This education will help provide the foundation for long-range land use planning. Residents will need to understand the importance of master plans and ordinances for the protection of water quality for them to be effective. The themes of education and land-use planning are found throughout the goals and objectives for implementing this plan.

8.1 Goals and Objectives for the Black River Watershed

A variety of goals and objectives for the Black River Watershed have been identified through stakeholder meetings and meetings of the Steering, Technical, and Information and Education Committee (Table 23). Some of the objectives will accomplish more than one goal. For example, stabilizing priority streambank erosion sites will help achieve Goal 1, Goal 3 and Goal 4. Additionally, not all problem areas will be targeted for on-the-ground work. Instead, these areas may be addressed through other methods such as landowner education, or by creating ordinances that will address water quality issues. See Appendix R for tasks to help implement each objective.

The overall goals of this watershed management plan fall into four main categories (after Schueler 2004): water quality, hydrological and morphological condition, community concerns and biological diversity.

The action plan that defines how these objectives will be accomplished is displayed in Table 24. Each objective is given a priority of high, medium, or low. Objectives listed as high priority are generally those that would have more of an impact on water quality. If funding is limited, objectives listed as high priority should be undertaken first, and low priority ones last.

Table 23: Goals and objectives

Goals	Objectives
1. Improve water quality and habitat for fish, indigenous aquatic life and wildlife in the watershed by reducing the amount of nutrients, sediment, and chemical pollutants entering the system	1 A. Stabilize priority streambank erosion sites through the installation of corrective measures
	1 B. Establish a road/stream crossing improvement program to correct identified problems
	1 C. Work to limit or control direct livestock access to the river and tributaries
	1 D. Install corrective measures to reduce runoff at agricultural sites of concern
	1 E. Encourage farmers to participate in the Michigan Agriculture Environmental Assurance Program (MAEAP)
	1 F. Reestablish greenbelts/conservation buffers at sites in critical areas
	1 G. Work with communities to reduce polluted stormwater entering local waterways
	1 H. Identify and improve failing septic systems
	1 I. Encourage the creation of local sanitary sewer systems on densely populated inland lakes
2. Continue/increase watershed monitoring efforts and stewardship	2 A. Perform water quality monitoring for potential pollutants to monitor the current quality of the river as well as to monitor changes over time
	2 B. Continue monitoring stream bank erosion

	2 C. Continue geomorphologic assessments of river
	2 D. Perform hydraulic / hydrologic analysis of river
3. Improve the hydrology and morphology of the river	3 A. Reduce volume and rate of runoff using recommendations from hydrologic study (see Appendix N). BMPs include wetland creation, detention, bioretention, buffer strips and infiltration practices
	3 B. Restore river channel to stable condition
4. Provide long term protection of the Black River Watershed through improved local land use policies and conservation practices	4 A. Assess the current adequacy level of local community planning and zoning controls
	4 B. Develop model ordinances and language for adoption into existing master plans and zoning ordinances
	4 C. Assist local communities in updating master plans and/or adopting ordinances or "smart growth" techniques that will protect water quality
	4 D. Permanently protect identified sensitive areas through conservation easements, purchase of development rights, and land purchases
	4 E. Support efforts to protect prime farmland from development
	4 F. Promote Low Impact Development (LID) techniques
5. Improve the navigability of the Black River for canoes, kayaks, and other self-propelled watercraft, by reducing sedimentation and reducing excess woody debris	5 A. Remove or cut through downed trees that inhibit navigation by canoes and kayaks and increase bank erosion
	Stabilize priority streambank erosion sites through the installation of corrective measures (see objective 1 A)
	Establish a road/stream crossing improvement program to correct identified problems (see objective 1 B)
	Work to limit or control direct livestock access to the river and tributaries (see objective 1 D)
6. Enhance recreational access sites to prevent the degradation of water quality	6 A. Increase the number of legal access sites
	6 B. Provide educational kiosks and signage at launch sites that educate people about the watershed and good river etiquette
7. Increase knowledge and participation in programs regarding nonpoint source pollution and means of prevention	7 A. Hire staff to implement watershed management plan, including a project manager and a land use planner
	7 B. Implement Information & Education Plan (see Appendix Q)
8. Prevent or reduce the introduction and spread of invasive species	8 A. Establish or work with existing invasive species control programs to prevent the spread of exotic species in the watershed

Table 24: Black River Watershed Action Plan

(see Appendix R for tasks to help achieve each objective)

Goal 1: Improve water quality and habitat for fish, indigenous aquatic life and wildlife in the watershed by reducing the amount of nutrients, sediment, and chemical pollutants entering the system										
Priority area 1: subwatersheds -0213, -0214, -0217, -0219 Priority area 2: subwatersheds -0201, -0202, -0206, -0212, -0215, -0216, -0218 [See Figure 29] Priority area 3: subwatersheds -0203, -0204, -0205, -0207, -0208, -0209, -0210										
Objective	Pollutant	Location*	Priority	Coordinating agencies (partners)	Pollutants reduced	Estimated cost	Potential funding or partner programs	Timeline	Milestones (after implementation begins	Proposed evaluation method
1 A. Stabilize priority streambank erosion sites through the installation of corrective measures	Sediment, nutrients	Priority area 1	High	Conservation Districts (Drain Commissioners)	Sediment: 33 tons/yr, P: 32 lbs/yr, N: 63 lbs/yr [there are additional unidentified sites for which pollutant reductions have not been calculated]	$30/linear foot	MDEQ 319, Drain commissioner, Farm Bill	Ongoing	By 2009: 800 linear feet By 2014: 3000 ft By 2020: 6000 ft	Linear feet stabilized; estimate pollutant loading reduction
1 B. Establish a road/stream crossing improvement program to correct identified problems	Sediment, chemicals	Priority areas 1 & 2	Medium	Road commissions, MDOT (Conservation Districts, municipalities)	Potential to reduce sediment & chemical pollutants; not currently quantifiable	Agency staff time $14-$45/hour (varies)	Road commissions, MDOT	Ongoing	By 2012: 25% of problem areas corrected; by 2015: 50%, by 2020: 100%	Visual survey; before and after photos; estimate pollutant loading reduction
1 C. Work to limit or control direct livestock access to the river and tributaries	Sediment, nutrients, bacteria/ pathogens	Priority areas 1 & 2	High	NRCS	Sediment: 28 tons/yr, P: 24 lbs/yr, N: 48 lbs/yr	$3/ft for fencing; $6/sq. ft. for stream crossing; staff time	Farm bill	Ongoing	By 2009: 4 sites improved, by 2012, 8 sites improved	Visual survey; document number of sites improved; estimate pollutant loading reduction
1 D: Install corrective measures to reduce runoff at agricultural sites of concern (BMPs include no-till, filter strips, cover crops, fertilizer reduction, etc.)	Sediment, nutrients, bacteria/ pathogens	Priority areas 1 & 2	Medium	NRCS (Conservation Districts)	Sediment: 2578 tons/yr, P: 3201 lbs/yr, N: 6422 lbs/yr	$350/acre	Farm bill, MDEQ 319	Ongoing	By 2012: 4595 linear feet of buffers installed, 5500 acres converted to no-till/cover crops By 2020: 10,000 acres converted	Visual survey; before and after photos; track and report acres of corrective measures installed; estimate pollutant loading reduction
1 E. Encourage farms to participate in the Michigan Agriculture Environmental Assurance Program (MAEAP)	Sediment, nutrients, chemicals	All	Medium	Conservation Districts (MDA, NRCS)	Not currently quantifiable	Staff time (varies)	Conservation Districts, MDEQ 319	Ongoing	By 2009: 5 farms, by 2013: 20 farms, by 2020: 60 farms	Number of facilities environmentally assured

1 F. Reestablish greenbelts/conservation buffers at sites in critical areas	Sediment, nutrients	Priority areas 1 & 2	Medium	Conservation Districts (NRCS, municipalities)	Sediment: 108 tons/yr, P: 91 lbs/yr, N: 183 lbs/yr	$1-$50 per square foot for vegetation + design and labor; staff time	Conservation Districts, MDEQ 319, Farm bill	2010-2013	By 2013: 4326 linear feet of greenbelts/buffers installed	Before and after photos; estimate pollutant loading reduction
1 G. Work with communities to reduce polluted stormwater entering local waterways (BMPs include retention/detention ponds, vegetated swales, raingardens and constructed wetlands, etc.)	Sediment, nutrients, chemicals	Priority areas 1 & 2	Medium	Conservation Districts (municipalities)	Sediment: 304 tons/yr; P: 1,240 lbs/yr; N: 11,713 lbs/yr	Varies by practice, generally $1-$40/sq. ft. Rain garden: $5-40/ sq. ft., Swales: $0.05-$2.50/sq. ft.	MDEQ 319	2006-2020	By 2012: Develop maps, by 2015: BMPs installed at 25% coverage rate, by 2020: BMPs installed at 50% coverage rate	Before-and after survey; track and report reduction of stormwater outlets; estimate pollutant loading reduction
1 H. Identify and improve failing septic systems	Nutrients, bacteria/ pathogens	Priority area 1 & 2	High	Health departments (Conservation Districts)	P: 1lb/year/house	Staff time; educational materials; ≈ $92.50 per inspection	MDEQ 319, Health Departments	2006-2020	By 2012: Perform 15 free or discounted septic inspections By 2020: 100 septic inspections	Follow-up surveys to determine if change in practice has occurred; estimate pollutant loading reduction
1 I. Encourage the creation of local sanitary sewer systems on densely populated inland lakes	Nutrients, bacteria/ pathogens	Priority area 1 & 2	Medium	Health departments, Conservation Districts	P: 1lb/year/house	Staff time; homeowner assessments	Lake associations, Conservation districts	2006-2020	By 2010: Contact lake associations to assess interest/feasibility; next milestone dependent on level of interest/funding	Before and after knowledge surveys
Goal 2: Continue/increase watershed monitoring and stewardship efforts										
Priority area 1: subwatersheds -0213, -0214, -0217, -0219 Priority area 2: subwatersheds -0201, -0202, -0206, -0212, -0215, -0216, -0218 [See Figure 29] Priority area 3: subwatersheds -0203, -0204, -0205, -0207, -0208, -0209, -0210										
Objective	Pollutant	Location*	Priority	Coordinating agencies (partners)	Pollutants reduced	Estimated cost	Potential funding or partner programs	Timeline	Milestones (after implementation begins	Proposed evaluation method
2 A. Perform water quality monitoring to examine the current quality of the river as well as to monitor changes over time	NA	Priority areas 1, 2 & 3	High	MDEQ, MDNR (Conservation Districts, lake associations, Two Rivers Coalition)	N/A	Variable depending upon study method; staff time	MDEQ 319, Lake associations	2006-2020	By 2008: develop QAPPs, by 2010: complete data collection for 1 study; by 2020, have regular monitoring scheme	TMDL goal achieved; Success of studies will be determined in their final reports

2 B. Continue monitoring stream bank erosion	NA	Priority areas 1, 2 & 3	High	MDEQ, MDNR, Black River Watershed Assembly, Two Rivers Coalition	N/A	Staff time; minimal materials costs (≈ $100)	Grants	2006-2020	By 2012: Assess two sites per year By 2020: Entire watershed assessed	The success of this study will be determined in its final report
2 C. Continue geomorphologic assessments of river	NA	Priority areas 1, 2 & 3	High	MDEQ, MDNR	N/A	Staff time	MDNR, grants	2006-2020	By 2012: Assess two sites per year By 2020: Have 18 representative reaches assessed	The success of this study will be determined in its final report
2 D. Perform hydraulic/hydrologic analysis of river	NA	Priority areas 1, 2 & 3	Medium	Conservation District (MDEQ, MDNR)	N/A	Staff time; cost of hiring independent contractor ≈ $70,000	MDEQ, grants	2006-2020	By 2015: Perform hydraulic analysis By 2020: Repeat hydrologic analysis	The success of this study will be determined in its final report
Goal 3: Improve the hydrology and morphology of the river										
Priority area 1: subwatersheds -0213, -0214, -0217, -0219 Priority area 2: subwatersheds -0201, -0202, -0206, -0212, -0215, -0216, -0218 [See Figure 29] Priority area 3: subwatersheds -0203, -0204, -0205, -0207, -0208, -0209, -0210										
Objective	Pollutant	Location*	Priority	Coordinating agencies (partners)	Pollutants reduced	Estimated cost	Potential funding or partner programs	Timeline	Milestones (after implementation begins	Proposed evaluation method
3 A. Reduce volume and rate of runoff using recommendations from hydrologic analysis (see Appendix N). BMPs include wetland creation, detention, bioretention, buffer strips and infiltration practices	Sediment, nutrients, chemicals	Priority areas 1 & 2	High	Conservation Districts (MDEQ, MDNR, Ducks Unlimited)	Not currently quantifiable; these BMPs typically have treatment efficiencies ranging from 30-90%	≈ $20,000 per acre for wetland restoration	MDEQ 319, USFWS	2006-2020	By 2012: 50 acres restored, by 2016: 100 acres restored, by 2020: 200 acres restored	Acres of wetlands restored or recreated; hydrology study; estimate pollutant loading reduction
3 B. Restore river channel to stable condition	Sediment	Priority areas 1 & 2	Medium	Michigan Department of Environmental Quality, Michigan Department of Natural Resources, Conservation Districts	Not currently quantifiable	Undetermined	MDEQ 319	2014-2020	By: 2016,10 miles restored, by 2018:20 miles restored, by 2020, 50 miles restored	Stream morphology studies; estimate pollutant loading reduction

Goal 4: Provide long term protection of the Black River Watershed through improved local land use policies and conservation practices										
Priority area 1: subwatersheds -0213, -0214, -0217, -0219 Priority area 2: subwatersheds -0201, -0202, -0206, -0212, -0215, -0216, -0218 [See Figure 29] Priority area 3: subwatersheds -0203, -0204, -0205, -0207, -0208, -0209, -0210										
Objective	Pollutant	Location*	Priority	Coordinating agencies (partners)	Pollutants reduced	Estimated cost	Potential funding or partner programs	Timeline	Milestones (after implementation begins	Proposed evaluation method
4 A. Assess the current adequacy level of local community planning and zoning controls	All	Priority areas 1, 2 & 3	High	Conservation Districts (municipalities, county and regional planning agencies, MSU Extension)	N/A	Time & material: $5,997.73 per municipality (SW MI Commission estimate)	MDEQ 319	2006-2016	By 2009: 4 communities have been reviewed; by 2012; 10 communities, by 2015, all communities	Track number of communities reviewed
4 B. Develop model ordinances and language for adoption into existing master plans and zoning ordinances in the following areas: stormwater management, setback provisions, greenbelts, site plan review requirements, lot size, septic systems, funneling/keyholing, wetlands, etc.	All	Priority areas 1, 2 & 3	High	Conservation Districts (municipalities, county and regional planning agencies, MSU Extension)	N/A	Staff time and materials: $9,863.34 per municipality to develop and adopt ordinances (SW MI Commission estimate)	MDEQ 319	2006-2020	By 2009: Develop 3 model ordinances By 2020: develop model ordinances for all issues	Track total number of ordinances developed over the life of the project
4 C. Assist local communities in updating master plans and/or adopting ordinances or "smart growth" techniques that will protect water quality	All	Priority areas 1, 2 & 3	High	Conservation Districts (municipalities, county and regional planning agencies, MSU Extension)	N/A	Staff time; workshops ≈ $1,400	MDEQ 319	2006-2020	By 2009: Assist 4 communities with master plan/ordinance updates, by 2014, assist 17 communities By 2020, repeat review process	Track & report changes being made in communities; track # of master plans that include water quality provisions/number of water quality ordinances adopted in the watershed; track & report attendance at workshops & training sessions

4 D. Permanently protect sensitive areas through conservation easements, purchase of development rights, and land purchases	All	Parcels in tiers 1 & 2 of land protection priority model in priority subwatersheds in section 7	High	Southwest Michigan Land Conservancy, Conservation Districts, Michigan Nature Association, MDNR, etc.	Not currently quantifiable; Pollutants prevented/preventing future degradation. Once specific parcels are identified, calculations can be made.	$20,000/year for 3 years = $60,000	MDEQ 319	2006-2020	By 2010: 100 acres protected, by 2013: 300 acres protected, by 2020: 1000 acres protected	Track and report landowner contacts; track and report acreages that have been enrolled in land conservation programs
4 E. Support efforts to protect prime farmland from development	Limits changes in hydrology	All	Medium	Conservation Districts (MSU Extension, County Farm Bureaus, Allegan and Van Buren PDR programs, SWMLC)	Not currently quantifiable; Limits changes in hydrology	Staff time; educational materials	County PDR programs, Conservation Districts	2006-2020	By 2010: Provide education to municipalities and farmers; by 2020: educational efforts repeated at least biennially	Acreage enrolled in PDR programs; before and after knowledge surveys
4 F. Promote Low Impact Development (LID) techniques	Potentially all	All	Medium	SW Michigan Planning Commission (Conservation Districts)	N/A	Workshops ≈ $1350; Newsletters ≈ $2500	SW Michigan commission, Conservation Districts	2006-2020	By 2008: Newsletters distributed, by 2009: workshops given; by 2020, LID techniques installed in 4 communities	Before and after knowledge surveys; track and report LID techniques installed in the watershed
Goal 5: Improve the navigability of the Black River for canoes, kayaks, and other self-propelled watercraft, by reducing sedimentation and reducing excess woody debris										
Priority area 1: subwatersheds -0213, -0214, -0217, -0219 Priority area 2: subwatersheds -0201, -0202, -0206, -0212, -0215, -0216, -0218 [See Figure 29] Priority area 3: subwatersheds -0203, -0204, -0205, -0207, -0208, -0209, -0210										
Objective	Pollutant	Location*	Priority	Coordinating agencies (partners)	Pollutants reduced	Estimated cost	Potential funding or partner programs	Timeline	Milestones (after implementation begins	Proposed evaluation method
5 A. Remove or cut through downed trees that inhibit navigation by canoes and kayaks [See also: Goal 1, Objectives 1A, 1B and 1D.]	Trash/ debris, sediment	South Branch Black River from Bangor to South Haven/21 river miles	Medium	Bangor/South Haven Heritage Water Trail Association	N/A	≈ $4200 worth of staff and volunteer time	Bangor/South Haven Heritage Water Trail Association, grants	Ongoing	By 2008: 15 miles navigable by canoe or kayak, by 2012: 21 miles	Document river miles made accessible to canoe/kayak
Goal 6: Enhance recreational access sites to prevent the degradation of water quality										
Priority area 1: subwatersheds -0213, -0214, -0217, -0219 Priority area 2: subwatersheds -0201, -0202, -0206, -0212, -0215, -0216, -0218 [See Figure 29]										

Priority area 3: subwatersheds -0203, -0204, -0205, -0207, -0208, -0209, -0210										
Objective	Pollutant	Location*	Priority	Coordinating agencies (partners)	Pollutants reduced	Estimated cost	Potential funding or partner programs	Timeline	Milestones (after implementation begins)	Proposed evaluation method
6 A. Increase the number of legal access sites	Sediment	All	Low	Bangor/South Haven Heritage Water Trail Association (lake associations)	Not currently quantifiable; well-designed, stable access points will limit informal access points that lead to streambank erosion. Sites still need to be identified.	Varies; ≈ $1000 per site	TBD	2014-2020	By 2016: 3 new legal access sites	Number of legal access sites added
6 B. Provide educational kiosks and signage at launch sites that educate people about the watershed and good river etiquette	All	All	Medium	Bangor/South Haven Heritage Water Trail Association (lake associations, Black River Watershed Assembly)	Not currently quantifiable; this educational effort is expected to change behaviors in at least some of the targeted audience. This will reduce and prevent pollutants from reaching the Black River.	$300/sign	Bangor/South Haven Heritage Water Trail Association, lake associations	2010-2016	By 2016: signage at three launch sites	Track number of kiosks added
Goal 7: Increase knowledge and participation in programs regarding nonpoint source pollution and means of prevention										
Priority area 1: subwatersheds -0213, -0214, -0217, -0219 Priority area 2: subwatersheds -0201, -0202, -0206, -0212, -0215, -0216, -0218 [See Figure 29] Priority area 3: subwatersheds -0203, -0204, -0205, -0207, -0208, -0209, -0210										
Objective	Pollutant	Location*	Priority	Coordinating agencies (partners)	Pollutants reduced	Estimated cost	Potential funding or partner programs	Timeline	Milestones (after implementation begins)	Proposed evaluation method
7 A. Hire staff to implement watershed management plan, including a project manager and a land use planner	All	All	High	Conservation Districts	N/A	$40,000-$60,000/year	MDEQ 319	Ongoing	By 2006: Staff hired under grant By 2012: sustainable funding source determined	NA

7 B. Implement Information & Education Plan (see Appendix Q)	All	All	High	Varies (see plan); (Two Rivers Coalition)	Not currently quantifiable; this educational effort is expected to change behaviors in at least some of the targeted audience. This will reduce and prevent pollutants from reaching the Black River.	Varies (see plan)	MDEQ 319	2006-2020	Varies (see plan)	Varies (see plan)
Goal 8: Prevent or reduce the introduction and spread of invasive species										
Priority area 1: subwatersheds -0213, -0214, -0217, -0219 Priority area 2: subwatersheds -0201, -0202, -0206, -0212, -0215, -0216, -0218 [See Figure 29] Priority area 3: subwatersheds -0203, -0204, -0205, -0207, -0208, -0209, -0210										
Objective	Pollutant	Location*	Priority	Coordinating agencies (partners)	Pollutants reduced	Estimated cost	Potential funding or partner programs	Timeline	Milestones (after implementation begins)	Proposed evaluation method
8 A. Establish or work with existing invasive species control programs to prevent the spread of exotic species in the watershed	Invasive species	Priority areas 1 & 2	Medium	Conservation Districts (The Stewardship Network, MDNR, Southwest Michigan Land Conservancy, MSU Extension)	N/A	Staff time; materials; workshops ≈ $800	Conservation Districts, The Stewardship Network, lake associations	2010-2013	By 2011: Contact coordinating agencies and develop programs and materials	Number of brochures distributed; before and after knowledge surveys

* Individual sites are identified by priority area in Appendix M.

8.2 Recommendations for Implementation

The ultimate vision of this project is to better help people understand their impact on water quality and learn what they can do to improve and protect water quality. Many of the problems associated with current water quality are related to a lack of understanding about nonpoint source pollution and basic river morphology and hydrology. The problems that exist are primarily not ones that can be easily fixed with 'band-aid' Best Management Practices (BMPs). Instead, the focus should be on improved land use planning and a wide-ranging information and education plan. We will work with existing programs (through organizations such as the Natural Resources Conservation Service) to implement BMPs in some critical locations. We plan to also implement a few well-placed BMPs in critical areas that will be very visible to the public (e.g. in public parks in the watershed), and thus help enforce the educational goals of the project.

Due to limitations in the planning grant, additional studies will be needed to determine the best locations and scope of many of the recommendations contained within this plan. Objectives of this management plan are organized by area below.

8.2.1 Recommendations for Priority Area 1

- 1 A. Stabilize priority streambank erosion sites through the installation of corrective measures
- 1 B. Establish a road/stream crossing improvement program to correct identified problems
- 1 C. Work to limit or control direct livestock access to the river and tributaries
- 1 D. Install corrective measures to reduce runoff at agricultural sites of concern
- 1 E. Encourage farms to participate in the Michigan Agriculture Environmental Assurance Program (MAEAP)
- 1 F. Reestablish greenbelts/conservation buffers at sites in critical areas
- 1 G. Work with communities to reduce polluted stormwater entering local waterways
- 1 H. Identify and improve failing septic systems
- 1I. Encourage the creation of local sanitary sewer systems on densely populated inland lakes
- 2 A. Perform water quality monitoring for potential pollutants to monitor the current quality of the river as well as to monitor changes over time
- 2 B. Continue monitoring stream bank erosion
- 2 C. Continue geomorphologic assessments of river
- 2 D. Perform hydraulic / hydrologic analysis of river
- 3 A. Reduce volume and rate of runoff using recommendations from hydrologic analysis
- 3 B. Restore river channel to stable condition
- 4 A. Assess the current adequacy level of local community planning and zoning controls
- 4 B. Develop model ordinances and language for adoption into existing master plans and zoning ordinances
- 4 C. Assist local communities in updating master plans and/or adopting ordinances or "smart growth" techniques that will protect water quality
- 4 D. Permanently protect identified sensitive areas through conservation easements, purchase of development rights, and land purchases
- 4 E. Support efforts to protect prime farmland from development
- 4 F. Promote Low Impact Development (LID) techniques
- 5 A. Remove or cut through downed trees that inhibit navigation by canoes and kayaks
- 6 A. Increase the number of legal access sites
- 6 B. Provide educational kiosks and signage at launch sites that educate people about the watershed and good river etiquette
- 7 A. Hire staff to implement watershed management plan, including a project manager and a land use planner
- 7 B. Implement Information & Education Plan (Appendix Q)
- 8 A. Establish or work with existing invasive species control programs to prevent the spread of exotic species in the watershed

8.2.2 Recommendations for Priority Area 2

- 1 B. Establish a road/stream crossing improvement program to correct identified problems
- 1 C. Work to limit or control direct livestock access to the river and tributaries
- 1 D. Install corrective measures to reduce runoff at agricultural sites of concern
- 1 E. Encourage farms to participate in the Michigan Agriculture Environmental Assurance Program (MAEAP)
- 1 F. Reestablish greenbelts/conservation buffers at sites in critical areas
- 1 G. Work with communities to reduce polluted stormwater entering local waterways
- 1 H. Identify and improve failing septic systems
- 1I. Encourage the creation of local sanitary sewer systems on densely populated inland lakes
- 2 A. Perform water quality monitoring for potential pollutants to monitor the current quality of the river as well as to monitor changes over time
- 2 B. Continue monitoring stream bank erosion
- 2 C. Continue geomorphologic assessments of river
- 2 D. Perform hydraulic / hydrologic analysis of river
- 3 A. Reduce volume and rate of runoff using recommendations from hydrologic analysis
- 3 B. Restore river channel to stable condition
- 4 A. Assess the current adequacy level of local community planning and zoning controls
- 4 B. Develop model ordinances and language for adoption into existing master plans and zoning ordinances
- 4 C. Assist local communities in updating master plans and/or adopting ordinances or "smart growth" techniques that will protect water quality
- 4 D. Permanently protect identified sensitive areas through conservation easements, purchase of development rights, and land purchases
- 4 E. Support efforts to protect prime farmland from development
- 4 F. Promote Low Impact Development (LID) techniques
- 5 A. Remove or cut through downed trees that inhibit navigation by canoes and kayaks
- 6 A. Increase the number of legal access sites
- 6 B. Provide educational kiosks and signage at launch sites that educate people about the watershed and good river etiquette
- 7 A. Hire staff to implement watershed management plan, including a project manager and a land use planner
- 7 B. Implement Information & Education Plan (Appendix Q)
- 8 A. Establish or work with existing invasive species control programs to prevent the spread of exotic species in the watershed

8.2.3 Recommendations for Priority Area 3

- 1 E. Encourage farmers to participate in the Michigan Agriculture Environmental Assurance Program (MAEAP)
- 2 A. Perform water quality monitoring for potential pollutants to monitor the current quality of the river as well as to monitor changes over time
- 2 B. Continue monitoring stream bank erosion
- 2 C. Continue geomorphologic assessments of river
- 2 D. Perform hydraulic / hydrologic analysis of river
- 4 A. Assess the current adequacy level of local community planning and zoning controls
- 4 B. Develop model ordinances and language for adoption into existing master plans and zoning ordinances
- 4 C. Assist local communities in updating master plans and/or adopting ordinances or "smart growth" techniques that will protect water quality
- 4 D. Permanently protect identified sensitive areas through conservation easements, purchase of development rights, and land purchases
- 4 E. Support efforts to protect prime farmland from development
- 4 F. Promote Low Impact Development (LID) techniques
- 6 A. Increase the number of legal access sites

- 6 B. Provide educational kiosks and signage at launch sites that educate people about the watershed and good river etiquette
- 7 A. Hire staff to implement watershed management plan, including a project manager and a land use planner
- 7 B. Implement Information & Education Plan (Appendix Q)

8.2.4 Lakes

Many of the lakes in the watershed are facing (or will face in the future) cultural eutrophication, or aging that is caused by excessive nutrient input from human activities. Several steps can be taken to limit or slow this cultural eutrophication process. We recommend that lake associations promote techniques for landscaping for water quality, including improving shoreline buffers and limiting fertilizer use near lakes. We also recommend that lake residents have their septic systems inspected and pumped regularly. Lake residents should also attempt to maintain as much existing around lakes as possible, as wetlands act as natural filters of pollutants like sediment and nutrients.

8.2.5 Septic Systems

Septic systems may contribute a great deal of nutrient pollution to our surface waters. It is likely that more residents of the watershed utilize septic systems than public sewers, due to the rural nature of the watershed. However, it is difficult to determine how much pollution septics may contribute to the watershed, or how many septic systems may be failing in the watershed. Therefore, it is recommended that septic systems be inspected every three to five years and be pumped regularly. Some municipalities have (or are considering) ordinances that require septic systems to be inspected periodically (when a home is sold, e.g.). In addition, if hookup to a public sewer system is a feasible alternative, this should be given serious consideration, especially in lakefront communities.

8.2.6 Riparian Corridor

We recommend that efforts be made to maintain or restore forests along waterways in the Black River Watershed. Forests dominated the land cover of the watershed prior to European settlement, and much of the river corridor remains in a forested, natural state. This corridor serves to protect and improve water quality by filtering out pollutants, stabilizing streambanks, and providing habitat for a variety of species. A forested corridor keeps river temperatures cool, which benefits the fishery. Natural debris that falls into the river from overhanging trees provides food and habitat for aquatic organisms. Forest buffers help prevent nonpoint source pollution from reaching waterways, and forested streams are better able to process the pollutants that do reach them than deforested streams (Sweeney et al. 2004). Deforested stream corridors also often have increased temperatures and less beneficial woody debris (Sweeney et al. 2004).

This forested corridor is a key feature to protecting the water quality on the Black River. Any activities which would diminish or fragment this corridor should be discouraged. The generally shallow depth of the river and amount of natural debris has served to limit use of the river to self-propelled watercraft. This has maintained the tranquil and rural nature of the river, as well as protecting the banks from erosion caused by boat-wakes.

8.2.7 Stormwater Management

Given the rural nature of the watershed, stormwater pollution is likely not a great contributor to nonpoint source pollution. However, the small cities still certainly have some impact. The cities also have the potential to grow into larger cities with more complex stormwater pollution issues. Thus, we recommend that the cities and villages take a proactive approach to stormwater pollution. One method is to replace storm drains with ones that are imprinted with the message “Don’t dump—drains to stream.” As the municipalities replace old storm drains, these could be inserted. These are minimally more expensive than the traditional storm drains, and the cost could be considered local match for the Black River Watershed Project.

8.2.8 Wetland Protection

We feel that every effort should be made to protect the remaining wetland areas in the watershed. In addition, any effort to create additional wetland acreage would be encouraged. Wetlands provide a wide variety of benefits, from filtering pollutants to mitigating flooding effects. Much wetland acreage has been lost in the watershed. Though it is not feasible that all of the original wetland areas in the watershed will be restored, any increased

wetland acreage will benefit water quality in the Black River and its lakes and tributaries. Non-regulated wetlands should be of particular focus for protection efforts.

8.2.9 Low Impact Development

Low Impact Development (LID) is an innovative approach to land use planning. LID techniques focus on managing stormwater on-site to keep it from running off impermeable surfaces and carrying pollutants into nearby waterways. LID techniques can be used very effectively with new developments to reduce their impact on water quality. In addition, existing developments can use LID techniques during renovations, or to retrofit existing infrastructure. We recommend that these techniques be used whenever possible. Development will continue to occur in the watershed, but use of LID techniques will protect water quality. LID techniques include: rain gardens, porous pavement, green roofs, vegetative filter strips, and others.

8.2.10 Information and Education

Many water quality issues are traceable to a lack of education about water quality issues. For this reason, we hope to initiate a variety of water quality education programs. These programs will consist of classroom visits as well as workshops for adults. In addition, a variety of brochures and letters will be distributed targeting specific groups (see Appendix Q). A watershed newsletter will be sent to stakeholders to keep them informed and updated on the progress of the project. A website will also be maintained that will contain a variety of information about the project, including upcoming events, past successes, and ideas to help watershed residents protect water quality.

We recommend that informational packets be distributed to newcomers to the watershed. These packets would welcome residents to the watershed and would contain information about such things as riparian buffers, stormwater management, septic systems, etc. This would help not only educate new residents, but would encourage buy-in to the Black River Watershed project. These packets could be distributed through local realtors or through the county assessor's office when the affidavit of property transfer is distributed. Local Newcomer's Clubs could also be enlisted to help with this effort.

8.2.11 Long Term Land Use Planning

The importance of land-use planning cannot be overestimated. Many land use plans are outdated, or do not contain information relevant to protection of water quality. We hope that with the implementation of this plan, support can be provided to municipalities to undertake improvements to their master plans and/or zoning ordinances that will help improve water quality in the future.

9 Evaluation

9.1 Evaluation of Planning Phase

Evaluations forms were passed out at several public meetings and workshops during the planning phase. Responses on these forms were typically very positive. Attendees overwhelmingly felt that the meetings or workshops were useful, and many noted that they learned things that will change their behavior in the future.

A number of individuals and organizations have been crucial to the creation of this watershed management plan (Table 25). Many committed local match to the project and gave project support above and beyond expectations.

Not included in the following list are agencies and their staff that did not provide a written commitment of local match but nonetheless provided significant assistance to this project. These include: the Natural Resources Conservation Service (Jeff Douglas, Stacy Kimble and Jean Brokish), the Michigan Department of Natural Resources (Jay Wesley, Chris Freiburger and Kregg Smith), and the Michigan Department of Environmental Quality (Julia Kirkwood, Chris Bauer, Joe Rathbun, Pete Vincent and Dave Fongers). Patricia Bizoukas and Amy Lockhart of the Van Buren Conservation District were also crucial members of the planning process.

Table 25: Local partners

Name/Organization	Tasks
VBCD Directors	Attended monthly VBCD board meetings; general grant administration; read and commented on watershed management plan
Sauk Trails RC&D Council	Participated in committee meetings; gave grant for purchase of Information & Education (I & E) materials
Allegan Co. Road Commission	Participated in Steering and Technical Committee meetings
Allegan Co. Drain Commission	Participated in Steering Committee and Stakeholder meetings
MSUE - Allegan County	Participated in meetings
Allegan Conservation District	Participated in Steering Committee and Stakeholder meetings
Columbia Township	Provided meeting space; participated in meetings
MSUE - Van Buren County	Staff participated in I & E Committee meetings; attended Stakeholder meetings; donated prizes for photo contests; wrote articles for newsletter; printed newsletter
Watershed Assembly*	
Casco Township Hall	Provided meeting space
City of Bangor	Staff participated in I & E committee, Steering Committee, and Technical committee meetings; attended Stakeholder meetings; wrote articles for newsletter; attended trainings for water quality monitoring; participated in bank erosion study; provided publicity for the project
Bangor City Hall	Provided meeting space
Lee Township Hall	Provided meeting space
Michigan Lake and Stream Associations	Participated in Stakeholder and Steering Committee meetings; contributed to management plan
Van Buren Co. Land Management Dept.	Provided data for project Geographical Information System (GIS)
Volunteers	Helped with bank erosion study; created project website; helped create project GIS; data entry; office help
Steering Committee	Participated in Steering committee meetings
I&E Committee	Participated in I & E committee meetings; donated prizes for photo contests; wrote articles for newsletter
Technical Committee	Participated in Technical committee meetings
Watershed Assembly (general)	Attended public meetings; participated in committee meetings; provided meeting space; wrote articles for newsletter; donated prizes for photo contests; donated stream survey kit

* The Watershed Assembly was a catch-all category for groups that did not commit specific amounts of local match, but gave a great deal of time and support to this project.

9.2 Implementation Phase Evaluation

An evaluation process will determine if the implementation of this management plan is effective and if improvements in water quality are being achieved. Evaluation of a watershed can be a difficult and expensive endeavor. The level of evaluation and the methods utilized will largely depend on a sustainable watershed organization being able to carry out the evaluation methods, as well as on the availability of funding.

As this plan is implemented, we anticipate a variety of benefits to water quality. Tangible evidence of water quality improvements include: reduced need for dredging in South Haven Harbor, reduced need for dredging Great Bear Lake sediment trap, reduced algae blooms in inland lakes, the drafting and implementation of ordinances that are protective of water quality, and the establishment of a sustainable, non-profit group to advocate for continued improvement of water quality in the Black River Watershed. In addition, we anticipate that the fishery of the Black River will be improved. Furthermore, the goal from the Great Bear Lake TMDL of a spring overturn concentration of 0.030 mg/L of phosphorus will be obtained in Great Bear Lake.

Changes in water quality can also be documented through a variety of water quality monitoring methods. Periodic assessments of water quality in the watershed are conducted as part of federal and state water quality monitoring programs. Local efforts to monitor water quality include those of lake associations and drain commissioners. Goal 2 of this watershed management plan proposes to "continue/increase watershed monitoring and stewardship efforts." This goal includes continuing to monitor stream bank erosion, continuing geomorphologic assessments of the river and performing hydraulic/hydrologic analysis of river.

A method of monitoring stream bank erosion is the Bank Erosion Hazard Index (BEHI), which can be conducted at road stream crossings in priority area. A baseline BEHI could be conducted and then repeated every 5 years to assess changes in the watershed. A geomorphologic study could be repeated in the Bloomingdale and Bangor areas to assess improvements in the river channel over time. This could be repeated every 10 years. A hydrologic study could be repeated for the entire watershed every 10 years (or when new land use data is available). Phosphorus monitoring should be continued in the Great Bear Lake area to assess the implementation of the TMDL. This phosphorus monitoring should be repeated at least every 3 years (see Appendix S for previous study). Thermal monitoring is of importance for the coldwater streams in the watershed. Monitoring of temperature regimes will help evaluate if these coldwater streams are being protected. MDNR Fisheries sometimes conducts thermal monitoring. *E.coli* monitoring could be undertaken in heavily used swimming lakes as well as waterbodies running through the Todd Farm Unit of the Allegan State Game Area (where there is a known large concentration of waterfowl).

Evaluation methods for on-site improvements will include pollutant load reduction calculations, photographic documentation, visual surveys, bank erosion measurements, stream morphology studies, macroinvertebrate surveys, and embeddedness measurements. Table 24 contains a column listing the proposed evaluation method for each objective.

The progress of the Information and Education (I & E) campaign can be gauged through knowledge surveys, follow-up surveys (to determine if a change in practice has occurred), tracking production and distribution of I & E materials, tracking number of contacts generated by publicity in local media outlets, tracking number of students reached through classroom visits, and tracking attendance at meetings, workshops and training sessions. The proposed evaluation method for each activity in the Information and Education Plan is included in Appendix Q.

This implementation process should be reviewed at a minimum of every two years to determine if progress is being made on the objectives listed in Table 24, and to ensure that the pollutant load reductions listed in that table are being achieved.

9.3 Estimating Pollutant Load Reductions

A pollutant loading is a quantifiable amount of pollution that is being delivered to a water body. Pollutant load reductions can be calculated based on the ability of an installed BMP to reduce the targeted pollutant. Pollutant loading calculations are best used at specific sites where structural BMPs are installed and detailed data about the reduction of pollutants can be gathered. Specific pollutant load reduction calculations should be completed for structural BMPs when they are proposed and installed. It is hoped that with the implementation of this management plan, all of the pollutants affecting the Black River will be reduced. Sedimentation and nutrients were considered to be the two pollutants that have the greatest impact on the water quality of the Black River, so these pollutants will have the greatest reductions. Many objectives in this management plan deal with hydrological modifications or are

proactive and preventative measures. Estimating pollutant loads and load reductions for these types of practices is not feasible.

Pollutant load reduction estimates have been made for many of the objectives shown in section 8.1. These estimates were derived from methods described in the Pollutants Controlled Calculation and Documentation for Section 319 Watersheds (MDEQ 1999). To address impaired designated uses (warmwater fishery, coldwater fishery, and other indigenous aquatic life and wildlife) in the rural and agricultural areas of the priority subwatersheds, a reduction of an estimated 3,348 lbs/year of total phosphorus, 6,716 lbs/year of total nitrogen, and 2,747 tons/year in total suspended solids need to be recognized in the watershed. This will achieve the goal of a 29% reduction in phosphorus needed to achieve the TMDL for Great Bear Lake. These loading reductions were calculated for objectives 1A, 1C, 1D and 1F in Table 24. Loading reductions for agricultural BMPs were estimated from applying the BMPs at a 50% coverage on the cropland in the four priority subwatersheds. However, it must be emphasized that these pollutant reductions are estimates. Non point source pollution is, by definition, difficult to quantify. These estimates were based on a rough field survey, aerial photographs, and map layers in a Geographic Information System. Note that pollutant reduction estimates are reported to the nearest whole number, per guidance from the Michigan Department of Environmental Quality (MDEQ 1999). Further load reductions will also come from tasks in which reductions are not currently quantifiable, such as land use planning, enrolling farms in the MAEAP program, conservation easements, etc.

A build-out analysis utilizing the Long-term Hydrologic Impact Assessment model (L-THIA) was utilized to estimate load reductions in the urban portions of the watershed for sediment and nutrients with the installation of urban stormwater BMPs (including grass swale, extended dry detention basin, wet retention pond, rain garden and constructed wetlands). Among the five BMPs examined, the most cost effective for phosphorus is a wet retention pond and the most cost-effective for nitrogen is a dry detention basin. The most cost-effective BMP for total suspended solids are extended dry detention basins and wet retention basins.

To address impaired designated uses (warmwater fishery, coldwater fishery, and other indigenous aquatic life and wildlife) in the priority subwatersheds, urban stormwater BMPs should be implemented on urban lands at a 50% treatment coverage for grass swales, extended detention basins and wet retention basins (on all urban land uses, including low-density residential, high-density residential, commercial, industrial and roads/parking lots), 10% coverage for rain gardens (on low-density residential, high-density residential, commercial and industrial land uses) and 50% coverage for constructed wetlands (on low-density residential, high-density residential, commercial and industrial land uses). With those BMP implementation rates on urban lands, an estimated 1,240 lbs/year reduction in total phosphorus, 11,713 lbs/year reduction in total nitrogen, and 304 tons/year reduction in total suspended solids need to be recognized in the watershed. These reduction estimates were calculated by averaging the load reductions for each of the five urban stormwater BMPs modeled for the urban acreage of the watershed. For more information on this model, see Appendix L. This model also demonstrated that though agriculture is the largest non-point source of pollutants in the watershed, urban land uses contribute over 25% of the pollutant load even though they occupy only 5% of the land area. Thus, it will be crucial to focus on urban BMPs in the future, as build-out occurs.

9.4 Feasibility of Management Plan Goals and Objectives

The goals and objectives of this plan have been written with their feasibility in mind. The objectives that will likely be the most difficult to undertake are those that require significant outlays of resources, or will involve much research. For example, the goal of improving the hydrology and morphology of the river by decreasing incision and restoring wetlands will be a significant and costly undertaking, and one that will require a good deal of research before any work occurs. However, with meaningful participation from agencies like county drain commissions, the Michigan Department of Environmental Quality and the Michigan Department of Natural Resources, this goal could be achieved.

A major concern of any watershed stakeholder is that of the economics of watershed protection. However, a variety of studies have shown that despite the investment required in watershed protection efforts, there can be an overall net gain in terms of improved water quality, increased recreational outlets, higher quality of life, and even an increase in property values (Schueler 2000). In addition, a variety of grant programs are available to provide at least some of the funding necessary to undertake many of the proposed actions.

Resistance to planning and zoning in this region is significant, and may be a real barrier to implementing portions of this watershed management plan. Some municipalities may be more willing than others to implement progressive planning and zoning measures. If these efforts are successful and well-received, other municipalities may be more willing to attempt them. Furthermore, new grant opportunities may encourage advancements in local

planning and zoning initiatives (Partnerships for Change grant, e.g.). Regional planning agencies are also active in this watershed and will help facilitate this goal. The importance of education in implementing new planning and zoning techniques should not be overlooked.

Overall, the feasibility of implementing this plan depends on the ability of local stakeholders to truly collaborate and work for these goals. This will require strong leadership and significant time commitments.

10 Sustainability

The Black River Watershed Project has a long history. As long as twenty years ago, residents had concerns with water quality and began investigating solutions. Many entities have applied for grants to improve water quality and have continued to work for improved water quality even when those grants were not awarded. This tenacity speaks to the ability for this project to succeed in the future. In the past, a group of citizens known as the Black River Watershed Assembly, came together to try to keep the watershed management plan moving forward even when no funding was immediately available for an implementation phase. More recently a citizen-based group, the Two Rivers Coalition, has been formed with a mission of working to protect the health of the Black River and Paw Paw River Watersheds through conservation, education, and advocacy. This group arose out of visioning sessions for watershed project sustainability and as of 2009 has already successfully undertaken several water quality projects, fundraising efforts, and has received several grants to assist with their efforts. In addition, organizations like the Southwest Michigan Planning Commission, the Van Buren Conservation District, and the Southwest Michigan Land Conservancy will continue their efforts in this watershed. The educational aspects of this project will build the capacity of interested citizens to continue to advocate for water quality improvements in the Black River Watershed.

One aim of this watershed management plan is to provide information for stakeholders to take steps on their own to improve water quality. Municipalities and other groups interested in protecting the Black River will be able to use this plan to leverage funding for local projects.

This plan should be reviewed and updated as needed. This will ensure that as conditions in the watershed change, the plan will continue to be useful. At a minimum, review should include updating the following:

- Section 3.5, Land Cover – every 10 years
- Section 5, Community Profile – every 10 years
- Section 6, Water Quality in the Black River Watershed – every 2 years
- Section 7, Priority Areas – every 5 years
- Section 8.1, Goals and Objectives – every 5-10 years
- Education Plan (Appendix Q) – every 5 years
- Additionally, the TMDL for Great Bear Lake will be re-evaluated regularly. MDEQ will conduct annual monitoring, and assessments will continue until results from two consecutive years demonstrate attainment of the 0.030 mg/L spring overturn goal.

10.1 Other Projects and Programs

A variety of agencies have cooperated with and provided input to the Black River Watershed Project thus far, and it is our hope that they will continue to do so. These agencies include: Michigan State University Extension, Natural Resources Conservation Service, Conservation Districts, regional planning agencies, Southwest Michigan Land Conservancy, Michigan Association of Conservation Districts, county road commissions, county drain commissions, county health departments, the Michigan Department of Environmental Quality, the Michigan Department of Natural Resources, the Bangor/South Haven Heritage Water Trail Association, the Allegan County Math & Science Center, and municipalities within the watershed. In addition, we hope to work more in the future with the Michigan Department of Transportation, county Purchase of Development Rights programs, Intermediate School Districts, and the Michigan Groundwater Stewardship Program. All attempts should be made in the future to continue to build relationships with these and other organizations.

There are a wide variety of grant programs that may also be tapped into by local communities and organizations to support water quality protection efforts. This watershed management plan will provide background and support for other grant application efforts.

10.2 Long Term Project Goals

Certainly the overarching goal of this project is to improve water quality in the Black River Watershed. Furthermore, we hope to approach this task holistically, rather than relying on short-term “band-aid” solutions. Thus, the most emphasis is placed on long-term land use planning and education. On-the-ground restoration efforts will be implemented at a few highly visible public sites. Other best management practices will be implemented through coordination with existing programs, such as those offered through the Natural Resources Conservation Services.

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12 Glossary of Acronyms

BMP – Best Management Practice
GIS – Geographic Information System
GSP – Groundwater Stewardship Program
I & E – Information and Education
LID – Low Impact Development
MAEAP – Michigan Agriculture Environmental Assurance Program
MDA – Michigan Department of Agriculture
MDEQ – Michigan Department of Environmental Quality
MDNR – Michigan Department of Natural Resources
MDOT – Michigan Department of Transportation
MSUE – Michigan State University Extension
NRCS – Natural Resources Conservation Service
PDR – Purchase of Development Rights
SWMLC – Southwest Michigan Land Conservancy
USDA – United States Department of Agriculture
VBCD – Van Buren Conservation District

Appendix A: Soils in the watershed

Soils in the Allegan County portion of the watershed

Soil	Acres
Adrian muck	2432.7
Algansee loamy sand, protected, 0 to 3% slopes	1040.1
Aquents and Histosols, ponded	477.9
Aquents, sandy and loamy	61.2
Belleville loamy sand	228.7
Belleville-Brookston complex	54.7
Blount silt loam, 1 to 4% slopes	450.6
Brady sandy loam, 0 to 3% slopes	576.9
Brookston loam	140.0
Capac loam, 0 to 6% slopes	3462.7
Capac-Wixom complex, 1 to 4% slopes	339.3
Chelsea loamy fine sand, 0 to 6% slopes	5274.5
Chelsea loamy fine sand, 12 to 18% slopes	26.4
Chelsea loamy fine sand, 18 to 30% slopes	1.8
Chelsea loamy fine sand, 6 to 12% slopes	561.9
Cohoctah silt loam	191.0
Cohoctah silt loam, protected	289.8
Colwood silt loam	152.9
Corunna sandy loam	55.6
Covert sand, 0 to 4% slopes	3439.2
Glendora loamy sand	2628.8
Glendora loamy sand, protected	4126.1
Glynwood clay loam, 1 to 6% slopes	39.8
Glynwood clay loam, 6 to 12% slopes	2.7
Granby loamy sand	1987.2
Houghton muck	1999.3
Kibbie fine sandy loam, 0 to 3% slopes	191.0
Marlette loam, 12 to 18% slopes	53.5
Marlette loam, 18 to 35% slopes	14.4
Marlette loam, 6 to 12% slopes	395.7
Marlette-Capac loams, 1 to 6% slopes	1128.5
Martherton loam, 0 to 3% slopes	17.2
Martisco muck	110.2
Metamora sandy loam, 1 to 4% slopes	434.3
Metea loamy fine sand, 1 to 6% slopes	1589.5
Metea loamy fine sand, 6 to 12% slopes	174.3
Morocco fine sand, 0 to 3% slopes	4429.0
Morocco-Newton complex, 0 to 3% slopes	4605.6
Napoleon muck	54.4
Newton mucky fine sand	1796.6
Oakville fine sand, 0 to 6% slopes	16168.4
Oakville fine sand, 18 to 45% slopes	18.5
Oakville fine sand, 6 to 18% slopes	2663.0

Oakville fine sand, loamy substratum, 0 to 6% slopes	299.4
Ockley loam, 1 to 6% slopes	48.6
Ockley loam, 18 to 30% slopes	3.8
Ockley loam, 6 to 12% slopes	12.4
Oshtemo-Chelsea complex, 0 to 6% slopes	2081.4
Oshtemo-Chelsea complex, 12 to 18% slopes	94.2
Oshtemo-Chelsea complex, 18 to 35% slopes	70.2
Oshtemo-Chelsea complex, 6 to 12% slopes	527.1
Palms muck	216.7
Pewamo silt loam	48.2
Pipestone sand, 0 to 4 percent slopes	3154.6
Pits	67.8
Riddles loam, 1 to 6% slopes	119.4
Riddles loam, 6 to 12% slopes	1.4
Rimer loamy sand, 0 to 4% slopes	2877.6
Sebewa loam	109.9
Seward loamy fine sand, 1 to 6% slopes	1075.1
Sloan silt loam	64.1
Tedrow fine sand, 0 to 4% slopes	1053.7
Tekenink loamy fine sand, 12 to 18% slopes	6.5
Tekenink loamy fine sand, 2 to 6% slopes	351.9
Tekenink loamy fine sand, 6 to 12% slopes	76.9
Thetford loamy fine sand, 0 to 4% slopes	2982.2
Udipsamments, nearly level to gently sloping	53.6
Water	1129.5

Soils in the Van Buren portion of the watershed

Soil	**Acres**
Adrian muck	783.5
Algansee-Cohoctah complex	4376.2
Aquents and Histosols, ponded	628.1
Belleville loamy sand	1286.4
Blount silt loam, 0 to 4% slopes	2659.6
Brems sand, 0 to 2% slopes	4214.2
Bronson sandy loam, 0 to 3% slopes	763.3
Capac loam, 1 to 5% slopes	10208.2
Coloma loamy sand, 0 to 6% slopes	3843.3
Coloma loamy sand, 6 to 12% slopes	1743.4
Colwood silt loam	3340.2
Covert sand, 0 to 4% slopes	675.8
Edwards muck	346.5
Gilford sandy loam	2185.2
Glendora sandy loam	1787.0
Grattan sand, 0 to 6 percent slopes	218.7
Houghton muck	4757.0
Kalamazoo loam, 2 to 6% slopes	35.9
Kalamazoo loam, 6 to 12% slopes	98.8
Kingsville loamy sand	4839.5

Matherton loam, 0 to 2% slopes	634.1
Metea loamy fine sand, 1 to 6% slopes	2207.6
Metea loamy fine sand, 6 to 12% slopes	515.9
Morocco loamy sand, 0 to 2% slopes	2336.5
Napoleon mucky peat	277.1
Oakville fine sand, 2 to 12% slopes	33.7
Oakville fine sand, 25 to 60% slopes	1.4
Ormas loamy sand, 0 to 6% slopes	228.3
Ormas loamy sand, 6 to 12% slopes	27.2
Oshtemo sandy loam, 0 to 6% slopes	498.4
Oshtemo sandy loam, 6 to 12% slopes	183.2
Oshtemo-Coloma loamy sands, 12 to 18% slopes	438.4
Oshtemo-Coloma loamy sands, 18 to 25% slopes	248.8
Ottokee loamy fine sand, 0 to 3% slopes	1461.4
Palms muck	977.8
Pewamo silt clay loam	607.0
Pipestone-Kingsville complex, 0 to 3% slopes	8593.6
Pits	76.0
Plainfield sand, 0 to 6% slopes	3107.3
Plainfield sand, 6 to 12% slopes	633.0
Riddles sandy loam, 1 to 6% slopes	4083.0
Riddles sandy loam, 12 to 18% slopes	471.6
Riddles sandy loam, 18 to 25% slopes	141.9
Riddles sandy loam, 6 to 12% slopes	1887.5
Selfridge loamy sand, 0 to 3% slopes	12921.1
Sloan loam	2147.8
Spinks loamy sand, 0 to 6% slopes	1800.3
Spinks loamy sand, 6 to 12% slopes	372.6
Spinks-Oshtemo complex, 0 to 6% slopes	38.3
Spinks-Oshtemo complex, 6 to 12% slopes	229.1
Thetford loamy sand, 0 to 2% slopes	2692.1
Tuscola silt loam, 0 to 4% slopes	1674.5
Udipsamments and Udorthents, 0 to 4% slopes	383.7
Urban land - Brems complex, 0 to 4% slopes	301.0
Urban land - Coloma complex, 0 to 6% slopes	240.2
Water	1841.0

Appendix B: Lakes in the Black River Watershed

Name	Township	County	Acres	Connected to Black River?
Abernathy Lake	Waverly	Van Buren	4.1	Yes
Clear Lake	Lee	Allegan	19.7	No
Coffee Lake	Columbia	Van Buren	40.4	Yes
Crooked Lake	Clyde	Allegan	96.9	No
Deer Lake	Columbia	Van Buren	30.4	Yes
Ely Lake	Clyde	Allegan	27.0	Yes
Great Bear Lake	Bloomingdale/Columbia	Van Buren	166.2	Yes
Hutchins Lake	Ganges/Clyde	Allegan	378.8	Yes
Lake Eleven	Columbia	Van Buren	53.9	Yes
Lake Fourteen	Arlington	Van Buren	20.9	Yes
Lake Fourteen	Columbia	Van Buren	69.5	Yes
Lester Lake	Lee	Allegan	60.4	Yes
Little Bear Lake	Columbia	Van Buren	46.1	Maybe/Wetland
Little Tom Lake	Clyde	Allegan	18.1	Maybe/Wetland
Lower Jeptha Lake	Columbia	Van Buren	55.4	Yes
Lower Scott Lake	Lee	Allegan	119.5	Yes
Manitt Lake	Casco	Allegan	0.7	No
Max Lake	Bloomingdale	Van Buren	28.0	Yes
Max Lake	Waverly	Van Buren	4.4	Yes
Merriman Lake	Bangor	Van Buren	27.1	Yes
Mill Lake	Bloomingdale	Van Buren	107.0	Yes
Moon Lake	Geneva	Van Buren	14.6	Yes
Moriah Lake	Columbia	Van Buren	17.0	Yes
Mud Lake	Cheshire	Allegan	3.9	Yes
Mud Lake	Clyde	Allegan	4.4	No
Mud Lake	Columbia	Van Buren	23.4	Yes
Munn Lake	Bloomingdale	Van Buren	12.3	Yes
Munson Lake	Columbia	Van Buren	38.5	No
North Lake	Columbia	Van Buren	60.6	Yes
North Scott Lake	Arlington/Columbia	Van Buren	76.3	Yes
Osterhout Lake	Lee	Allegan	171.9	Yes
Picture Lake	Geneva	Van Buren	5.0	Yes
S. Branch Black River (Bangor Mill Pond)	Bangor/Arlington	Van Buren	22.7	Yes
S. Branch Black River (Breedsville Mill Pond)	Columbia	Van Buren	7.9	Yes
Saddle Lake	Columbia	Van Buren	282.5	Yes
School Section Lake	Bangor	Van Buren	36.1	Yes
Silver Lake	Columbia	Van Buren	50.1	Yes
Skunk Lake	Bloomingdale	Van Buren	6.6	Yes
South Scott Lake	Arlington	Van Buren	118.1	Yes
Spring Brook Lake	Lee	Allegan	15.3	Yes
Stillwell Lake	Columbia	Van Buren	18.3	Yes
Upper Jeptha Lake	Columbia	Van Buren	58.8	Yes
Upper Scott Lake	Lee	Allegan	94.4	Yes

Data source: Michigan Center for Geographic Information, 2003

Appendix C: Dams in the Black River Watershed

Dam Name	County	Owner	Year Built	Fish Passable?	River or stream name
Saddle Lk. Level Control Structure	Van Buren	Private	1932	No	Barber Creek
Great Bear Lk. Level Control Structure	Van Buren	Local Govt.	1964	Yes	Black River
Yacht Harbor Dam	Allegan	Private		No	Black River
Lower Scott Lk. Dam	Allegan	Private	1920	No	Lower Scott Lake Creek
Black River Dam (Hamlin Dam)	Allegan	Private	1967	No	N. Branch Black River
Bangor Dam	Van Buren	Local Govt.	1975	No	S. Branch Black River
Breedsville Dam	Van Buren	Local Govt.	1837	No	S. Branch Black River
Denofrio's Pond Dam	Allegan	Private		No	Spicebush Creek
Scott Lk. Level Control Structure	Van Buren	Local Govt.	1967	No	Tributary to Black River
Harry Dam	Allegan	Private	1968	No	Tributary to Black River
Osterhout Lk. Level Control Structure	Allegan	Private	1975	No	Tributary to Black River
Lafler Dam	Van Buren	Private	1958		Tributary to Black River
Effner Dam	Van Buren	Private	1967		Tributary to Great Bear Lake
Ely Lk. Flooding Dam	Allegan	State	1985		Tributary to Utter Drain
Barden Dam	Allegan	Private	1963	No	Tributary to N. Branch Black River
Crooked Lk. Dam (Structure #4)	Allegan	State	1962	No	Utter Drain
Surprenant Dam	Allegan	Private	1964	No	Wolf Drain

Appendix D: List of Species

Name	Type
American Crow	Bird
American Goldfinch	Bird
American Kestrel	Bird
American Redstart	Bird
American Robin	Bird
American Tree Sparrow	Bird
Bald Eagle	Bird
Baltimore Oriole	Bird
Bank Swallow	Bird
Barn Swallow	Bird
Belted Kingfisher	Bird
Black and White Warbler	Bird
Black Tern	Bird
Blackburnian Warbler	Bird
Black-capped chickadee	Bird
Blackpoll Warbler	Bird
Black-throated Green Warbler	Bird
Blue Jay	Bird
Blue-gray gnatcatcher	Bird
Blue-winged Teal	Bird
Blue-winged Warbler	Bird
Bobolink	Bird
Bonaparte's Gull	Bird
Brown Thrasher	Bird
Brown-headed Cowbird	Bird
Bufflehead	Bird
Canada Goose	Bird
Cape May Warbler	Bird
Cedar Waxwing	Bird
Cerulean Warbler	Bird
Chimney Swift	Bird
Chipping Sparrow	Bird
Cliff Swallow	Bird
Common Grackle	Bird
Common Loon	Bird
Common Snipe	Bird
Common Yellowthroat	Bird
Cooper's Hawk	Bird
Cuckoo spp.	Bird
Downy Woodpecker	Bird
Eastern Bluebird	Bird
Eastern Kingbird	Bird
Eastern Meadowlark	Bird
Eastern Phoebe	Bird
Eastern Screech Owl	Bird

Eastern Towhee	Bird
Eastern Wood Pewee	Bird
European Starling	Bird
Falcon spp.	Bird
Field Sparrow	Bird
Grackles	Bird
Gray Catbird	Bird
Great Blue Heron	Bird
Great Crested Flycatcher	Bird
Great Egret	Bird
Great Horned Owl	Bird
Green Heron	Bird
Herring gull	Bird
House Finch	Bird
House Sparrow	Bird
House Wren	Bird
Indigo Bunting	Bird
Killdeer	Bird
Lesser Scaup	Bird
Lincoln's Sparrow	Bird
Louisiana Waterthrush	Bird
Magnolia Warbler	Bird
Mallard	Bird
Mourning Dove	Bird
Mute Swan	Bird
Nashville Warbler	Bird
Northern Bobwhite	Bird
Northern Cardinal	Bird
Northern Flicker	Bird
Northern Harrier	Bird
Northern Rough-winged Swallow	Bird
Northern Shoveler	Bird
Northern Waterthrush	Bird
Osprey	Bird
Ovenbird	Bird
Palm Warbler	Bird
Pied-billed Grebe	Bird
Pileated Woodpecker	Bird
Purple Martin	Bird
Red-bellied Woodpecker	Bird
Red-breasted Merganser	Bird
Red-eyed Vireo	Bird
Red-shouldered Hawk	Bird
Red-tailed Hawk	Bird
Red-winged Blackbird	Bird
Ring-billed Gull	Bird

Ring-necked duck	Bird
Ring-necked Pheasant	Bird
Rock Dove	Bird
Rose-breasted Grosbeak	Bird
Ruby-crowned Kinglet	Bird
Ruby-throated Hummingbird	Bird
Ruffed Grouse	Bird
Sandhill Crane	Bird
Sandpiper sp	Bird
Savannah Sparrow	Bird
Scarlet Tanager	Bird
Sedge Wren	Bird
Short-eared Owl	Bird
Solitary Sandpiper	Bird
Song Sparrow	Bird
Sora	Bird
Spotted Sandpiper	Bird
Swainson's Thrush	Bird
Tennessee Warbler	Bird
Tern sp	Bird
Tree Swallow	Bird
Tufted Titmouse	Bird
Turkey Vulture	Bird
Upland Sandpiper	Bird
Veery	Bird
Vesper Sparrow	Bird
Warbling Vireo	Bird
White-breasted nuthatch	Bird
White-throated Sparrow	Bird
Wild Turkey	Bird
Willow Flycatcher	Bird
Wood Duck	Bird
Wood Thrush	Bird
Woodcock	Bird
Yellow Warbler	Bird
Yellow-bellied Sapsucker	Bird
Yellow-billed cuckoo	Bird
Yellow-rumped Warbler	Bird
Yellow-throated Vireo	Bird
Appalachian Brown	Butterfly
Azure, Spring	Butterfly
Cabbage White	Butterfly
Common Buckeye	Butterfly
Eastern-tailed Blue	Butterfly
Eyed Brown	Butterfly
Fritillary, Aphrodite	Butterfly
Fritillary, Great Spangled	Butterfly
Fritillary, Silver-bordered	Butterfly

Fritillary, Varigated	Butterfly
Little Wood Satyr	Butterfly
Monarch	Butterfly
Mourning Cloak	Butterfly
Northern Broken Dash	Butterfly
Pearl Crecent	Butterfly
Red Admiral	Butterfly
Red-spotted Purple	Butterfly
Sulphur, Clouded	Butterfly
Sulphur, Orange	Butterfly
Swallowtail, Black	Butterfly
Swallowtail, Eastern Tiger	Butterfly
Swallowtail, Spicebush	Butterfly
Swallowtail, Zebra	Butterfly
Viceroy	Butterfly
Wood Nymph, Common	Butterfly
Clam	Clam
Damselfly, Ebony	Damselfly
Variable Dancer	Damselfly
Black Saddlebags	Dragonfly
Meadowhawk, Ruby	Dragonfly
Pennant, Calico	Dragonfly
Pennant, Halloween	Dragonfly
Pondhawk, Eastern	Dragonfly
Skimmer, 12-spotted	Dragonfly
Skimmer, Widow	Dragonfly
Whitetail, Common	Dragonfly
Alewife	Fish
American brook lamprey	Fish
Black bullhead	Fish
Black crappie	Fish
Blackchin shiner	Fish
Blacknose dace	Fish
Blacknose shiner	Fish
Blackside darter	Fish
Bluegill	Fish
Bluntnose minnow	Fish
Bowfin	Fish
Brassy minnow	Fish
Brook silverside	Fish
Brook stickleback	Fish
Brook trout	Fish
Brown bullhead	Fish
Brown Trout	Fish
Carp	Fish
Central mudminnow	Fish
Channel catfish	Fish
Chestnut lamprey	Fish

Chinook salmon	Fish
Common Carp	Fish
Common shiner	Fish
Creek chub	Fish
Emerald shiner	Fish
Freshwater Drum	Fish
Gizzard Shad	Fish
Golden Redhorse	Fish
Golden shiner	Fish
Grass pickerel	Fish
Greater redhorse	Fish
Green sunfish	Fish
Hornyhead chub	Fish
Iowa darter	Fish
Johnny darter	Fish
Jonny darter	Fish
Lake chubsucker	Fish
Largemouth bass	Fish
Logperch	Fish
Longnose dace	Fish
Longnose sucker	Fish
Long-nosed Gar	Fish
Mottled sculpin	Fish
Muskellunge	Fish
Northern brook lamprey	Fish
Northern hogsucker	Fish
Northern longear sunfish	Fish
Northern pike	Fish
Pirate perch	Fish
Pugnose shiner	Fish
Pumpkinseed	Fish
Rainbow darter	Fish
Rainbow Trout/ Steelhead	Fish
Rockbass	Fish
round goby	Fish
Sand shiner	Fish
Sea lamprey	Fish
Shorthead redhorse	Fish
Smallmouth bass	Fish
Spotfin shiner	Fish
Spottail shiner	Fish
Spotted gar	Fish
Spotted sucker	Fish
Stonecat	Fish
Striped shiner	Fish
Tadpole madtom	Fish
Tiger Muskellunge	Fish
Walleye	Fish

Warmouth	Fish
White sucker	Fish
Yellow bullhead	Fish
Yellow perch	Fish
Bullfrog	Frog
Eastern Gray Treefrog	Frog
Green Frog	Frog
Northern Leopard Frog	Frog
Northern Spring Peeper	Frog
Western Chorus Frog	Frog
Wood Frog	Frog
Water Striders	Insect
Eastern Chipmunk	Mammal
Eastern Cottontail	Mammal
Fox Squirrel	Mammal
Meadow Jumping Mouse	Mammal
Muskrat	Mammal
Opossum	Mammal
Raccoon	Mammal
White-tailed Deer	Mammal
Woodchuck	Mammal
Mapleleaf (*Quadrula quadrula*)	Mussel
Agalinis, Slender	Plant
Agrimony, Tall Hairy	Plant
Alder, Speckled	Plant
Alumroot	Plant
American Bellflower	Plant
Amur River Privet	Plant
Anemone, Wood	Plant
Angelica	Plant
Arrow Arum	Plant
Arrowglass, Slender	Plant
Arrowhead, Common (Wapato)	Plant
Ash, Black	Plant
Ash, Prickly	Plant
Ash, Red	Plant
Ash, White	Plant
Asparagus, Garden	Plant
Aspen sp	Plant
Aspen, Large-toothed	Plant
Aster, Flat-topped	Plant
Aster, Lake Ontario	Plant
Aster, Large-leaved	Plant
Aster, Panicled	Plant
Aster, Purple-stemmed	Plant
Aster, Side-flowering	Plant
Autumn Olive	Plant
Avens, White	Plant

Baneberry, Red	Plant
Baneberry, White	Plant
Bartonia	Plant
Basswood	Plant
Beaked willow	Plant
Beak-Rush	Plant
Bebb's Sedge	Plant
Bedstraw	Plant
Bedstraw, Fragrant	Plant
Bedstraw, Stiff Marsh	Plant
Beech, American	Plant
Beechdrops	Plant
Beggar-ticks, Leafy-bracted	Plant
Bellflower, Marsh	Plant
Bellwort, Perfoliate	Plant
Bergamot	Plant
Bindweed, Hedge	Plant
Birch, Yellow	Plant
Bittercress, Hairy	Plant
Bittercress, Pennsylvanian	Plant
Bittersweet, Oriental	Plant
Black Willow	Plant
Blackberry, Common	Plant
Black-eyed Susan	Plant
Bladderwort, Flat-leaved	Plant
Blazing Star, Marsh (Dense)	Plant
Blue Flag Iris	Plant
Blue Flag, Southern	Plant
Blueberry sp	Plant
Blueberry, Highbush	Plant
Blueberry, Highbush	Plant
Blueberry, Hillside	Plant
Blue-joint	Plant
Blunt Broom Sedge	Plant
Boneset, Common	Plant
Bottle Brush Sedge	Plant
Bottlebrush Grass	Plant
Brambles	Plant
Bright-green Spike-rush	Plant
British Soldiers	Plant
Brome sp	Plant
Broom-sedge	Plant
Brown-eyed susan	Plant
Buckthorn, Alder-leaved	Plant
Bugleweed, Northern	Plant
Bulrush, Dark-green	Plant
Bur-Marigold, Nodding	Plant
Buttercup, Small-flowered	Plant

Butternut	Plant
Button Bush	Plant
Canada Bluegrass	Plant
Canadian St. John's-wort	Plant
Capillary Beak-rush	Plant
Cardinal Flower	Plant
Cat's-ear	Plant
Cattail, Common	Plant
Centaury, Forking	Plant
Cherry, Black	Plant
Chickweed, Mouse-eared	Plant
Chokeberry, Black	Plant
Cicely, Sweet	Plant
Ciliate-leaved Paspalum	Plant
Cinquefoil, Common	Plant
Cinquefoil, Rough-fruited	Plant
Cinquefoil, Shrubby	Plant
Clearweed	Plant
Clover, Little Hop	Plant
Clover, Red	Plant
Club Moss, spp	Plant
Clubmoss, Stiff	Plant
Common Flat Brocade Moss	Plant
Coontail	Plant
Coral-root, Autumn	Plant
Coral-root, Spotted	Plant
Cottonwood, Eastern	Plant
Cress, Common Winter	Plant
Cress, Spring	Plant
Cress, Water	Plant
Crowfoot, Hooked	Plant
Cucumber Root, Indian	Plant
Currant sp.	Plant
Cushion Moss	Plant
Daisy, Ox-eye	Plant
Dandelion, Common	Plant
Day-Lily, Canada	Plant
Delicate Fern Moss	Plant
Dewberry sp	Plant
Dissected Grape Fern	Plant
Dock, Curly	Plant
Dodder, Common	Plant
Dogbane, Spreading	Plant
Dogwood, Alternate-leaved	Plant
Dogwood, Flowering	Plant
Dogwood, Gray	Plant
Dogwood, Gray	Plant
Dogwood, Pale	Plant

Dogwood, Red Osier	Plant
Dryad Saddle	Plant
Duckweed, Lesser	Plant
Dutchman's Breeches	Plant
Dwarf Raspberry	Plant
Eastern Red Cedar	Plant
Elder, Common	Plant
Elder, Red-berried	Plant
Elm sp	Plant
Elm, American	Plant
Elm, Siberian	Plant
Enchanter's Nightshade	Plant
Fern Evergreen Wood	Plant
Fern, Bracken	Plant
Fern, Cinnamon	Plant
Fern, Clinton's Wood	Plant
Fern, Grape	Plant
Fern, Lady	Plant
Fern, Marsh Shield	Plant
Fern, New York	Plant
Fern, Rattlesnake	Plant
Fern, Royal	Plant
Fern, Sensitive	Plant
Fern, Shield	Plant
Fern, Spinulose Wood	Plant
Figwort, Eastern	Plant
Flat-tufted Feather Moss	Plant
Flax, Wild	Plant
Fleabane, Annual	Plant
Fleabane, Daisy	Plant
Fly Agaric	Plant
Four Tooth Moss	Plant
Fox Sedge	Plant
Foxglove Beard-tongue	Plant
Fungus	Plant
Fungus	Plant
Fungus	Plant
Garlic mustard	Plant
Gerardia, Purple	Plant
Giant Reed Grass	Plant
Ginseng, Large	Plant
Golden Ragwort	Plant
Goldenrod, Canada	Plant
Goldenrod, Common Flat-topped	Plant
Goldenrod, Ohio	Plant
Goldenrod, Rough-leaved	Plant
Goldenrod, Rough-stemmed	Plant
Goldenrod, Tall	Plant

Goldthread	Plant
Gooseberry sp.	Plant
Gooseberry, Prickly	Plant
Graceful Sedge	Plant
Grape Fern, Leather	Plant
Grape, Fox	Plant
Grape, River-bank	Plant
Grape, Wild	Plant
Grass, Blue-eyed	Plant
Grass, Cut	Plant
Grass, Deer-tongue	Plant
Grass, Fowl Manna	Plant
Grass, Orchard	Plant
Grass, Reed Canary	Plant
Grass-pink	Plant
Green Dragon	Plant
Green Sedge	Plant
Green Silk Moss	Plant
Greenbrier sp	Plant
Greenbrier, Bristly	Plant
Green-headed coneflower	Plant
Ground Cedar	Plant
Ground-cherry, Clammy	Plant
Groundsel, Common	Plant
Gum, Sour	Plant
Hardstem Bulrush	Plant
Hawkweed, Orange	Plant
Hawthorn sp	Plant
Hemlock, Eastern	Plant
Hepatica, Round-lobed	Plant
Hickory sp	Plant
Hickory, Pignut	Plant
Highbush Cranberry	Plant
Hog Peanut	Plant
Honewort	Plant
Honeysuckle, Glaucous	Plant
Hornbeam, American (Blue-beech)	Plant
Hornbeam, Hop	Plant
Horse-nettle	Plant
Horsetail	Plant
Horsetail, Field	Plant
Horsetail, Meadow	Plant
Indian-hemp	Plant
Inland Sedge	Plant
Iris, Yellow	Plant
Ironweed, Missouri	Plant
Ivy, Poison	Plant

Appendix E: List of Fish Species

Name	Status
Alewife	introduced
American brook lamprey	common
Black bullhead	present
Black crappie	common
Blackchin shiner	common
Blacknose shiner	common
Blacknose dace	present
Blackside darter	present
Bluegill	common
Bowfin	common
Bluntnose minnow	present
Brassy minnow	present
Brook stickleback	present
Brook silverside	present
Brook trout	rare
Brown Trout	introduced
Brown bullhead	common
Central mudminnow	common
Channel catfish	present
Chestnut lamprey	present
Chinook salmon	introduced
Common Carp	introduced
Common shiner	common
Creek chub	present
Emerald shiner	present
Freshwater Drum	present
Gizzard Shad	present
Golden Redhorse	common
Golden shiner	present
Grass pickerel	present
Greater redhorse	present
Green sunfish	common
Hornyhead chub	common
Iowa darter	present
Johnny darter	common
Lake chubsucker	present
Largemouth bass	common
Logperch	common
Longnose dace	present
Longnose sucker	present
Mottled sculpin	present
Muskellunge	introduced
Northern brook lamprey	common
Northern hogsucker	present
Northern longear sunfish	present
Northern pike	common
Pirate perch	rare
Pugnose shiner	rare
Pumpkinseed	common
Rainbow Trout/ Steelhead	introduced
Rainbow darter	present
Rockbass	common
round goby	introduced
Sand shiner	unknown
Sea lamprey	introduced
Shorthead redhorse	common
Smallmouth bass	common
Spotfin shiner	present
Spottail shiner	present
Spotted gar	present
Spotted sucker	rare
Stonecat	unknown
Striped shiner	rare
Tadpole madtom	rare
Tiger Muskellunge	introduced
Walleye	common
Warmouth	common
White sucker	common
Yellow bullhead	common
Yellow perch	common

Appendix F: Threatened, Endangered, and Special Concern Species and Communities in the Black River Watershed

Scientific Name	Common Name	Federal Status	State Status	Type
Acris crepitans blanchardi	Blanchard's Cricket Frog		SC	Animal
Clemmys guttata	Spotted Turtle		T	Animal
Elaphe obsoleta obsoleta	Black Rat Snake		SC	Animal
Emys blandingii	Blanding's Turtle		SC	Animal
Erynnis persius persius	Persius Duskywing		T	Animal
Ictiobus niger	Black Buffalo		SC	Animal
Incisalia irus	Frosted Elfin		T	Animal
Lanius ludovicianus migrans	Migrant Loggerhead Shrike		E	Animal
Lycaeides melissa samuelis	Karner Blue	LE	T	Animal
Microtus pinetorum	Woodland Vole		SC	Animal
Notropis anogenus	Pugnose Shiner		SC	Animal
Notropis texanus	Weed Shiner		X	Animal
Sistrurus catenatus catenatus	Eastern Massasauga	C	SC	Animal
Terrapene carolina carolina	Eastern Box Turtle		SC	Animal
Coastal plain marsh	Infertile Pond/marsh, Great Lakes Type			Community
Great blue heron rookery	Great Blue Heron Rookery			Other
Adlumia fungosa	Climbing Fumitory		SC	Plant
Agrimonia rostellata	Beaked Agrimony		SC	Plant
Carex albolutescens	Greenish-white Sedge		T	Plant
Carex festucacea	Fescue Sedge		SC	Plant
Cyperus flavescens	Yellow Nut-grass		SC	Plant
Eleocharis melanocarpa	Black-fruited Spike-rush		SC	Plant
Eleocharis microcarpa	Small-fruited Spike-rush		E	Plant
Eleocharis tricostata	Three-ribbed Spike-rush		T	Plant
Fuirena squarrosa	Umbrella-grass		T	Plant
Hemicarpha micrantha	Dwarf-bulrush		SC	Plant
Hibiscus moscheutos	Swamp Rose-mallow		SC	Plant
Hydrastis canadensis	Goldenseal		T	Plant
Linum virginianum	Virginia Flax		T	Plant
Ludwigia alternifolia	Seedbox		SC	Plant
Lycopodium appressum	Northern Prostrate Clubmoss		SC	Plant
Panax quinquefolius	Ginseng		T	Plant
Platanthera ciliaris	Orange or Yellow Fringed Orchid		T	Plant
Polygala cruciata	Cross-leaved Milkwort		SC	Plant
Polygonum careyi	Carey's Smartweed		T	Plant
Populus heterophylla	Swamp or Black Cottonwood		E	Plant
Potamogeton bicupulatus	Waterthread Pondweed		T	Plant
Psilocarya scirpoides	Bald-rush		T	Plant
Pygarctia spraguei	Sprague's Pygarctia		SC	Plant
Rhexia virginica	Meadow-beauty		SC	Plant
Rhynchospora macrostachya	Tall Beak-rush		SC	Plant
Rotala ramosior	Tooth-cup		SC	Plant
Scirpus torreyi	Torrey's Bulrush		SC	Plant
Scleria reticularis	Netted Nut-rush		T	Plant
Sisyrinchium atlanticum	Atlantic Blue-eyed-grass		T	Plant

Strophostyles helvula	Trailing Wild Bean		SC	Plant

LE: Listed Endangered
C: Candidate for federal status under the Endangered Species Act of 1998
SC: Special concern
T: Threatened
E: Endangered
X: Probably Extirpated
Source: Michigan Natural Features Inventory, 2003

Appendix G: Black River Watershed land protection priority model & agricultural land protection model

Southwest Michigan Land Conservancy

Black River Watershed Project

Emily Wilke, Geoffrey Cripe
Land Protection Staff
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Overview/Scope of Work

In 2006, the Southwest Michigan Land Conservancy (SWMLC) was contracted by the Van Buren County Conservation District (VBCD) under the authority of the Michigan Department of Environmental Quality (MDEQ) to initiate educational outreach for landowners within the Black River Watershed in pursuit of private land conservation objectives. SWMLC assembled a land protection subcommittee and started developing criteria for a geographic information systems (GIS) model that would identify priority areas for land protection in the Black River Watershed (BRW). Properties that exhibited high conservation values, based on the existence of natural resources that sustain the functionality of the BRW, were then targeted for the educational outreach program. SWMLC held two educational workshops in 2008 and drew approximately 30 interested landowners. Many interested landowners that received our mailing but could not attend one of the workshops contacted SWMLC for more information about land conservation. SWMLC also presented at many other workshops throughout the BRW about land conservation. Using the model as a guide, SWMLC will continue outreach efforts and will pursue leads with the goal of protecting valuable lands within the watershed in perpetuity.

Background

The BRW encompasses 287 square miles (183,490 acres) across two counties and 13 townships. The Watershed contains 530 miles of rivers, streams, and drains, 43 large named lakes (the largest is Hutchins Lake), and over 500 small lakes and ponds. The high quality waters support 70 species of fish, 130 species of birds, and 471 species of plants as of recorded in 2004. More then half of the land in the watershed is agriculture planted in unique crops such as blueberries. The MDEQ recognized that this watershed is an important area for conservation and environmental education and awareness to protect these significant resources. SWMLC focused its conservation efforts on the identification of land parcels containing ecologically significant property that should be conserved to maintain the high water quality of the Black River. These properties contain high ground water recharge, riparian habitat, forested wetlands, emergent wetlands and a variety of habitats that provide valuable habitat and ensure the continuation of a viable watershed ecosystem.

Land Protection Subcommittee

A group of citizen volunteers, government officials, and regional experts was asked to assist SWMLC in formulating a list of criteria, based on property attributes, to use in the development of a GIS model. Over the course of the last three years, eight meetings were held with the Land Protection Subcommittee to coordinate the model, ground truth the model, develop and distribute outreach materials, and engage citizens in the pursuit of BRW objectives during educational workshops. The subcommittee played a major role in the identification of sites within the watershed in need of priority consideration and the development of detailed criteria that would enable the model to be a success. Participants on the subcommittee included:

Name & Years Participated	Affiliation	E-mail
Baerren, Al 2006-2008	Silver Lake Association	albert.baerren@nmcco.com
Boutin, Carl 2006-2008	Van Buren County Resident	cbouton@btc-bci.com
Clemons, Tina 2006-2007	Allegan County Conservation District	tina.clemons@mi.nacdnet.net
Debruyn, Jay 2006-2007	Realtor, Developer in South Haven	jay@shoresofsouthhaven.com
Fuller, Erin 2006-2008	Black River Watershed Coordinator	erin.fuller@mi.nacdnet.net
Haas, Greg 2006-2007	Casco Township Parks Committee	haas310@hotmail.com
Kirkwood, Julia 2006-2008	Department of Environmental Quality	kirkwooj@michigan.gov

Lerg, John 2006-2008	Michigan Department of Natural Resources	lergj@michigan.gov
Lockhart, Amy 2006-2008	Van Buren County Conservation District	amy.lockhart@mi.nacdnet.net
Mead, Eileen 2006-2008	Casco Township Parks Committee	dennyeileen@aol.com
Micklin, Phil 2006-2008	Southwest Michigan Land Conservancy	micklin@wmich.edu
Nielson, Larry 2006-2007	Bangor City Manager	bangormi@btc-bci.com
Parman, Joe 2006-2008	Van Buren County Drain Commissioner	parmanj@vbco.org
Sass, George 2006-2008	South Haven Resident	sassgsass@lodisnet.com
Soltysiak, Dawn 2006-2007	Artist, Fennville Resident	gangesdawn@ispwest.com
Matthews, Peter 2007-2008	Van Buren County Resident	canoenut@bciwildblue.com
Thomas, Art 2006-2007	Farmer, Van Buren County	blueone234@hotmail.com
Venner, Rob 2006-2007	DeGraaf Nature Center	r.venner@cityofholland.com
Wilke, Emily 2006-2008	Southwest Michigan Land Conservancy	ewilke@SWMLC.org

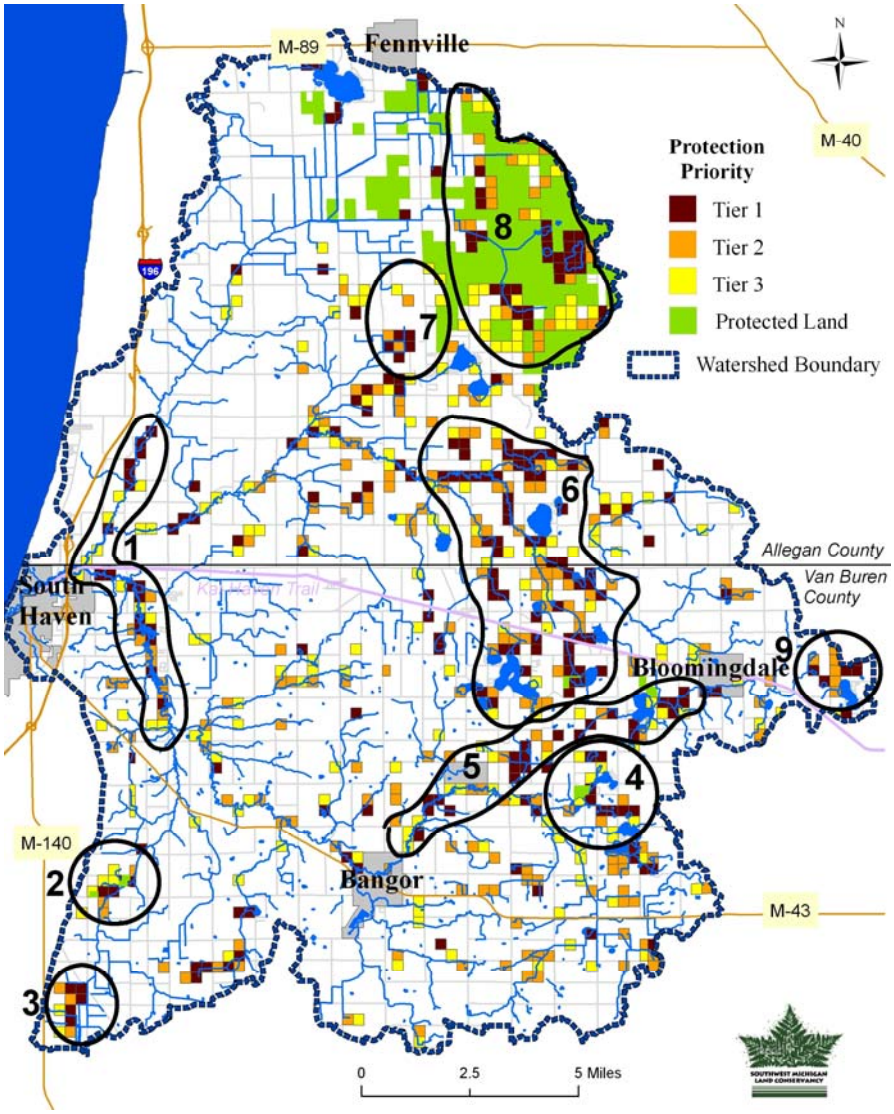
Natural Resources Based GIS Model

The model itself contains four "priority" tiers based on conservation value. In total, 233 quarter-quarter sections (Q-Q's) were identified as highest priority. The model was constructed by adding numerical ratings for a number of different conservation criteria to each Q-Q section in the BRW. Combining the values for each criterion allowed for the ranking of the Q-Q sections on the basis of conservation priority. The procedure for creating the model comprised the following steps:

- Creation of a quarter-quarter section base layer dataset.
- Creation and classification of a dataset for each conservation criterion decided by the Sub-Committee.
- Addition of data for each criterion as attributes to the base layer dataset.
- Classification (if necessary) of each criterion attribute in the model's database file (DBF) table.
- Weighting of each criterion class for each Q-Q section.
- Computation of the conservation value of each quarter-quarter section.
- Testing of outcomes against DOQ (aerial imagery), parcel data and other digital resources.
- Ground truthing the results by driving around the watershed.
- Classification and symbolization of the outcome for display in a map.

To date, the model has been accurate where highest-priority areas have been ground-truthed for verification. The attached map shows the final priority layer or "dataset" composed of priority Q-Q's and identifies the resulting nine SWMLC target areas which are circled. The following section summarizes the conservation attributes of each of the circled priority conservation areas as determined by the GIS model.

Priority Conservation Areas



1. **Forested River Corridor**. 1,480 acres of forested river corridor and adjacent forested wetlands. This relatively unfragmented forested river corridor is a buffer from the development along the lakeshore and sprawl from the city of South Haven. The forested river corridor is important breeding habitat for many bird species. Loss of this habitat type would have a major impact on the bird species that depend on river corridors for food and nesting. Riparian forests also play a critical role in water quality by preventing erosion and pollutants from entering the streams and providing shade for benthic macroinvertebrates, which are food for fish.

2. **Expanding Preserves**. 400 acres of high-priority natural land adjacent to 45 acres already conserved by SWMLC (Wintergreen Woods and Winterberry Woods preserves). This area is notable for its extensive wetlands of various types including forested, scrub-shrub, and emergent. Northern species, including eastern hemlock and magnolia warblers, are found in this area because the wetlands and back ridges stay very cool. Eastern hemlocks grow in the wetlands on the north facing side of the dunes and spotted salamanders cool off in the pools of water below the trees. This area has high groundwater recharge where currently high quality water is moving directly into the aquifer. Historically this area consisted of hemlock- white pine forest along the river and adjacent beech-sugar maple forest.

3. **Forested Wetlands**. 400 acres of forested wetlands near the Lake Michigan coast provides many benefits to wildlife. These forested wetlands contain the state-threatened swamp cottonwood and spotted turtle. This is a threatened ecosystem type along the highly developed coastline. The pre-European settlement land cover map shows that this area was historically a mixed conifer swamp with a section of black ash swamp.

4. **Upper and Lower Jeptha Lakes**. 720 acres of high-quality wetlands, marl flats, lakes with little development, and SWMLC's 50-acre Jeptha Lake Fen preserve. The Jeptha lakes are along a flight route for migratory birds and a haven for waterfowl. Other species of interest found in this area include the state-threatened Blanchard's cricket frog, Eastern Massasauga rattlesnake, state-threatened spotted turtle, and a beautiful display of marsh blazing star which thrives in the shallow grassy wet areas.

5. **River Corridor from Bangor to Gobles**. 1,800 acres along the lower river corridor. In the 1800s before European settlement more then 50% of the watershed was beech maple forest. This is a large area where some of the beech-maple forest still remains intact. A great blue heron rookery that at one time held over 200 nesting birds is located just south of Breedsville and is protected by the Michigan Nature Association. There is a large area of contiguous wetlands surrounding the rookery that is also home to species of concern such as the state-threatened spotted turtle and blandings turtle.

6. **Fisheries Protection**. 4,800 acres, encompassing many lakes with little development, including Lake 11, Lake 14, Little Bear Lake, Spring Brook Lake, and others that comprise the headwaters of the middle branch. There is also little development along the long stretches of shaded river corridor, which are a prime coldwater trout fishery. This area is also comprised of a large area of wetlands and an extensive amount of forested land including the forested area along the Kal-Haven Trail. This area also has high ground water recharge.

7. **Pullman Wetlands.** 360 acres of large contiguous wetlands near the town of Pullman. This is the largest area of intact privately owned wetlands in the watershed. Mostly emergent wetlands but also forested and scrub-shrub wetlands are very important duck breeding habitat. These wetlands are almost contiguous to the expansive protected land of the Allegan State Game Area providing even more wildlife habitat. These wetlands also serve as the headwaters of both the upper and middle branches of the Black River.

8. **Allegan State Game Area**. 2,920 acres, is a portion of the Allegan State Game Area (SGA) which is one of the two largest protected areas in Southwest Michigan. The in-holdings and unprotected land directly adjacent to the Allegan SGA are high priority for conservation for both the Michigan Department of Natural Resources and SWMLC. The Allegan SGA is comprised of forests, remnant oak-pine barrens, and wetlands including coastal plain marsh and bog. We would like to work to expand this already protected area. Headwaters of the upper branch of the Black River. Historically this area was majority white pine-white oak forest.

9. **Headwaters Area**. 440 acres, comprising the headwaters of the lower branch of the river, including Munn and Mill Lakes. Species of interest found in this area include the Blanchard's cricket frog, black rat snake, and Eastern Massasauga which are all indicative of the important wetlands, lakes, and surrounding undeveloped upland ridges. This area was historically the convergence of a white pine- mixed hardwood forest and a mixed conifer swamp.

Agricultural Model

OVERVIEW

University Outreach (UO) at the University of Michigan-Flint, on behalf of the Southwest Michigan Land Conservancy (SWMLC), developed an Agricultural Lands Inventory for the Black River Watershed in southwest Michigan. This inventory uses a multi-criteria scoring approach to identify agricultural lands throughout the Black River Watershed that are highest priority for perpetual conservation.

Currently, the nine counties of Southwest Michigan produce the highest cumulative agricultural receipts in the state (highest total market value of agricultural production). Farms within the Black River Watershed account for the vast majority of fruit/berry/nut production within Southwest Michigan, which ranks #1 in the state for fruit production. Van Buren County is ranked #1 in the nation for blueberry and cucumber production and second in the state for grape production. Allegan County also ranks among the top 5 counties in the state for fruit production and also provides significant agricultural acreage toward greenhouse and nursery operations. Southwest Michigan ranks highest in the state for acres of greenhouse and nursery operations.

Approximately 55% of land use in the Black River Watershed is agricultural in nature. Conversion pressures are an especially grave concern to the state of agriculture in the Black River Watershed, as Allegan and Van Buren Counties rank 2nd and 3rd respectively as the most agriculturally vulnerable counties between now and 2020 in the state (*MSU Land Transformation Analysis*.) Farmland loss and conversion threaten to erode the agricultural base in the watershed and ultimately devastate Michigan's #1 economic industry. Considering growth projections, lack of funding for purchase of development rights efforts, and inadequate zoning and subdivision regulations in the areas

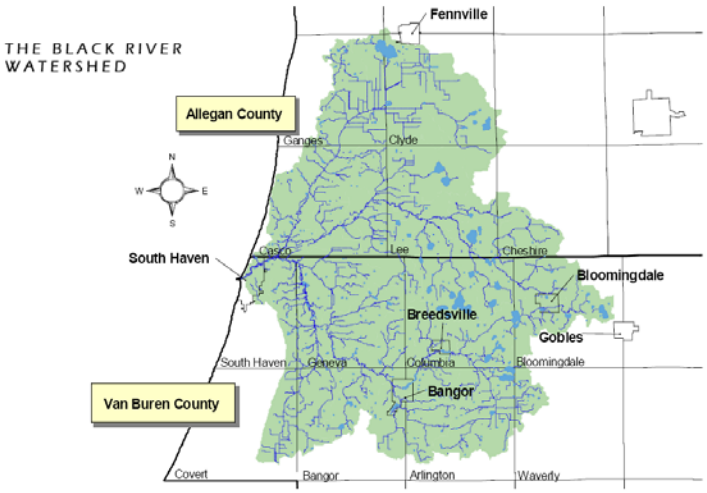
comprising the Black River Watershed, direct agricultural preservation through conservation easements and PA 116 enrollment is critical to this regions agricultural prosperity. The availability of significant federal and state income and property tax incentives will serve as a catalyst for voluntary land protection, and outreach and educational initiatives to promote these incentives will be prioritized and directed with this agricultural land inventory.

Southwest Michigan Land Conservancy staff has invested significant time over the past two years compiling information to assist with the creation of this analysis, and spent considerable time ground-truthing available crop data layers. The Conservancy found that existing crop data information from the National Agricultural Statistics Service's crop data layer was inaccurate with regard to the identification of certain specialty crops such as blueberries, though the accuracy of the layer in identifying common row crops was inconclusive. The Conservancy's initial efforts to mimic County level PDR program criteria and the scoring thereof through data layer creation, digitization and model criteria ranking proved difficult. Specifically, efforts to supplement spatial information with non-spatial criterion such as MAEAP and conservation reserve program enrollment were unsuccessful based on unavailable information or inaccurate data. Thus, the Conservancy and University Outreach have created new datasets based on a vast array of spatial and non-spatial information from state and local sources and developed an expanded analysis that both prioritizes existing farms for preservation and identifies land most suitable for agricultural use.

The objectives of this inventory are multiple and include 1) ensuring the long-term sustainability of the region's agricultural base and production stability by protecting established farms that meet these critical needs, 2) identifying potential areas for agricultural conservation practices that would increase water quality, 3) recognizing land that is best-suited to agricultural and classifying the most appropriate crop use accordingly based on various factors such as soil utility and texture, drainage, slope, irrigation needs, etc. and 4) determining where lands enrolled in temporary conservation programs exist, and how we can build off existing blocks of conserved farmland and balance farmland protection with growth needs.

This inventory utilizes a multi-criteria decision model for the Southwest Michigan Land Conservancy to support on-the-ground conservation activities such as the justification of acquisitions, proactive conservation, evaluation of opportunistic acquisitions, and the development of public relations.

The Agricultural Lands Inventory provides the Conservancy, as well as other conservation and agricultural organizations, with a mechanism to help direct and prioritize funds available for preservation efforts; to enhance collaboration on projects and planning across organizational boundaries; to allow for the prioritization of agricultural preservation activities; and to ensure the long-term sustainability of the Black River Watershed's agricultural resources.



METHODS

Data Development
Two data layers important to the analysis for prioritizing agricultural lands for protection that were not previously available are PA 116 lands and detailed agricultural land types. The Michigan Department of Agriculture administers the PA 116 program which restricts non-agricultural uses of a given parcel on a contract basis in return for income tax incentives and relief from certain local special assessments.

As part of this inventory, University Outreach has digitized all of the PA 116 lands within the Black River Watershed as currently identified by the Michigan Department of Agriculture as of Spring 2009. University Outreach has also developed a detailed agricultural inventory within the Black River Watershed. The detailed agricultural inventory was developed with existing crop data from SWMLC and aerial photos.

Criteria

The following criteria have been assessed and ranked at a parcel level for the Black River Watershed. These criteria can then be evaluated and prioritized for voluntary protection of farmland from development and conversion, and can also be used in the development of outreach and educational activities.

1. Size
2. Greater than 50% AG
   a. Emphasis on specialty crops
3. Soil Productivity
   a. Prime Farmland
   b. Farmland of Local Importance
   c. Prime Farmland if Drained
4. Fruit Site Rating
   a. Soil Factors
      i. Texture
      ii. Drainage
   b. Physiographic Factors
      i. Slope
5. Fruit Site Presence/Absence (is flagged)
6. Ag Zoning (note: not all townships are zoned and not all zoning data is available- this criteria subject to availability)
7. Presence/Absence of Riparian Features
8. Length of River or Stream
9. Proximity to Existing Protected Land
10. Landscape Compatibility – Percentage of Agricultural land within 1 mile
11. Enrollment in PA 116

Results and Conclusions

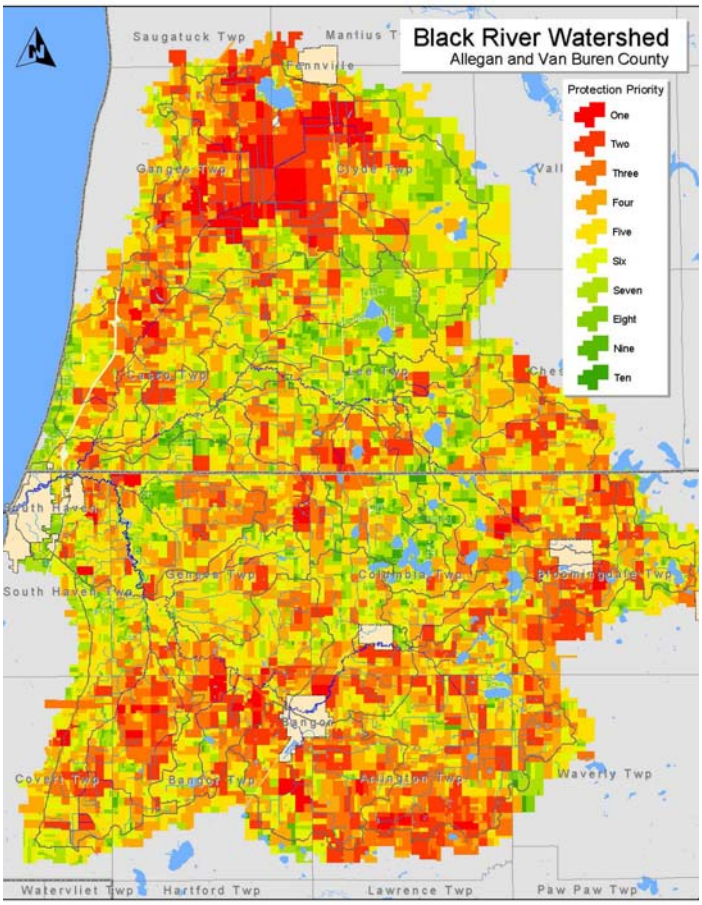
Just over 1,200 parcels have been promoted to the initial parcel subset for land protection. The major criteria used to highlight this initial data subset include parcel size (over 20 acres) and the specification that each parcel's dominant land use is agricultural (over 51%). All parcels in the watershed have been scored based on the criteria listed above regardless of size and use. This will enable SWMLC to consider the role of smaller agricultural properties, especially with regard to fruit production. It will also enable SWMLC and other entities to re-visit and

re-rank all parcels in the watershed as new information becomes available or as new factors become relevant. This data subset was further scored based on the spatial and non-spatial factors listed above.

The Black River Watershed is comprised of approximately 23,666 parcels of land, which are equal to approximately 183,490 acres. When scored using the criteria described above, the range of total score runs from 5 to 59 with a mean score of 25.

When ranked and broken into ten categories using natural breaks in the data, there are 1,233 parcels that fall into the top three categories with a sum total acreage of 59,146.99. The top three categories are as follows:

Priority One= 54 parcels with a score greater than 54
Priority Two= 450 parcels with a score greater than 43
Priority Three= 1233 parcels scoring greater than 39.

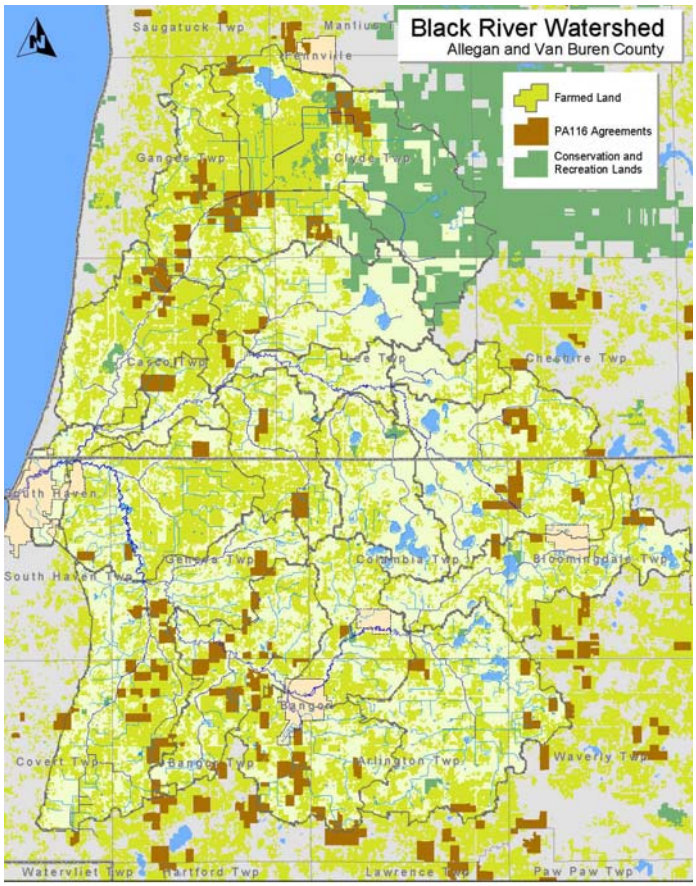


Parcels around the Allegan State Game Area scored very highly based on the large size of the parcels there, high PA 116 enrollment, and proximity to existing protected lands. Other common criteria that scored well here include the presence of factors that support very high potential for productive farmland (slopes, prime soils, soil texture, etc.), fruit site ratings, landscape compatibility and the presence and density of water resources. SWMLC will have the opportunity to protect compatible uses surrounding the Allegan State Game Area and negotiate best management practices through the conservation easement to protect water resources while expanding habitats conducive to wildlife and protecting the agricultural land base.

The lands comprising and surrounding the headwaters of the Black River Watershed also scored very highly based on soil types, drainage, and the presence and density of riparian features. These results underscore the utility of this model in recognizing the agricultural potential across the land base (Objective 3 above) and expand our conservation approach to avoid excluding non- agricultural property.

A third noticeable trend is that lands enrolled in PA 116 fared well overall across the watershed areas despite fairly even weights across the multiple criterion. This is a positive statistic in that some of the highest priority lands are at least temporarily protected.

PA 116 enrollment was derived from Michigan Department of Agricultural database queries and created from legal descriptions for the areas enrolled. Thus, these enrollment areas are not always parcel specific, as all or part of a particular parcel may be included or several parcels under the same ownership may be included under one enrollment. This results in a data layer that essentially ignores parcel boundaries. The advantages of this are many, but primarily, this will enable this layer to be updated annually as new parcel information becomes available without affecting the underlying PA 116 information. In addition, it is the intent of the County farmland protection programs to accept the perpetual maintenance of this layer for use into the future.



disruption of energy flow (wind, water, etc.) vital to the functionality of natural areas for wildlife.

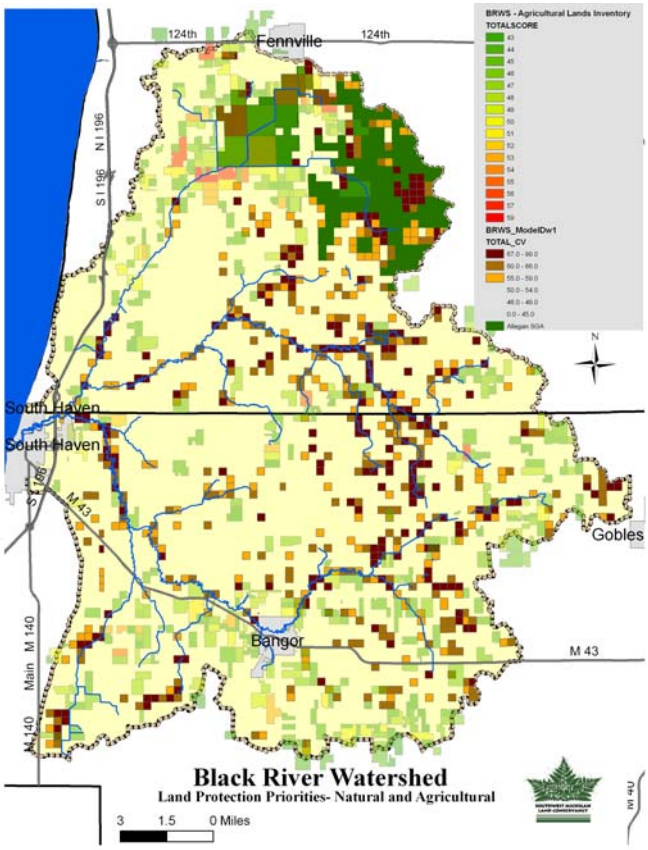
SWMLC plans to further study the relationships between the highest priority areas for protection and mechanisms for balancing multiple conservation goals across the landscape while protecting critical agricultural resources in the Watershed. The role that agricultural lands have in ensuring water quality and quantity protection is very significant, and through conservation measures we can help ensure that agricultural productivity is balanced with resource protection measures.

Outreach

A landowner workshop is planned for the landowners of high priority agricultural properties in the watershed sometime in the next six months. During the grant cycle, two landowner workshops were held -- in January 2008 and August 2008. SMWLC presented and participated in many other workshops and events focused on protecting the water quality of the Black River Watershed. The most recent event that we participated in as part of this grant included a walk, paddle, and roll event in August 2009 where more then

Several conclusions can be drawn from the PA 116 layer. First of all, the PA 116 program has good representation across the Black River Watershed. However, there is no evidence of a major core cluster or clusters of PA 116 land from which to center a permanent agricultural preservation effort. Thus, these farms may not be supporting each other. While micro-clusters of PA 116 enrolled lands are evident, they are not significant enough to create an urban growth boundary. Regardless, this layer has unique applicability to the model, as there is a direct correlation to these parcels and high developability factors based on their characteristics. PA 116 participation will be a major factor for directing education and outreach initiatives to protect existing farms, but enrollment alone has only a moderate positive correlation to how the parcel scored based on crop potential (scored by soils, drainage, and other physiographic criteria) across the board.

When we examine how the BRWS natural lands model interacts with the agricultural inventory it becomes apparent that though there is very minimal direct overlap (as would be expected), there are areas where ensuring compatible land uses adjacent to significant natural lands will achieve multiple goals including the protection of groundwater recharge through infiltration, habitat relationships that promote wildlife movement and low



30 people paddled down the Black River. Landowners with more then 20 acres in our high priority Q-Q sections were invited to the landowner workshops and the walk, paddle, and roll event. The Black River Watershed land conservation project is highlighted in our summer 2009 issue of *Landscapes*.

Landowner Contacts

Following is a list of landowners that we have had multiple communications with about land protection options for their property within the timeframe of this grant funded project.

	Landowner contact in the Black River Watershed 2006-2009		
	Name	**Phone #**	**Address**
1	Karl and Ruth Hewitt	269-253-4318	332 63rd St., S. Haven, MI 49090
2	Jack Spangler (daughter Jodie)	269-434-8619	35760 CR 687, Bangor, MI 49013
3	Don Sappanos Sr	269-906-0172	433 Blue Star, South Haven, MI 49090
4	Brent Sheridan	616-550-5231	
5	Dan Garvey	918-261-4355	
6	Carol Voytech	941-488-876	
7	Karen Hoad	843-406-0363	1101 Wayfarer Ln., Charleston, SC 29412
8	Nancy Kort		6 Brighton Ln., Oak Brook, IL 60523
9	Hilligan Family Farm		49th Street
10	Maynard Kaufman	269-656.1758	P.O. Box 361, Bangor, MI
11	Nelson Hodgman	269-434-6616	PO Box 215, Grand Junction, MI
12	HK Ellis		10940 CR 215, Grand Junction, MI
13	Dick Curtis	269-434-6662	
14	Jason Buero	269-838-2778	59119 16th Ave, Grand Junction, MI
15	Mike Wallace	296-227-3472	1113 68th Street, South Haven, MI 49090
16	Gloria Garner		211 Michigan Ave. #3, South Haven, MI 49090
17	Matt Sharl		212 W. Washington St Suite 1911, Chicago, IL 60606
18	Sam Ewbank	269-561-2505	On behalf of Bangor
19	Wendy Elsey	269-816-2837	54761 Lawerence Rd, Marcellus, MI 49067

In addition to these leads, SWMLC staff visited several additional sites of interest over the past few years. In total, 12 landowner contacts were made and discussions regarding conservation options were pursued and over four hundred of landowners were educated about BRW objectives, resource management, and conservation options.

Summary

In summary, SWMLC plans to continue to rely on the results of the natural resources based and agricultural models as we focus our conservation efforts within the Black River Watershed. The models have been a true success in targeting high priority properties as we and the many other project collaborators work to improve water quality within the BRW and ensure its sustainability in perpetuity. We will use the results of this planning/implementation process and the Paw Paw River Watershed planning/implementation process to work toward purchasing development rights of the high priority parcels with additional grant funding for these two watersheds through the MDEQ 319 program which spans over the next three years. We plan to keep the volunteers that have helped us with this planning process and the landowners that we have been in contact with abreast of the current conservation activities and opportunities available.

Appendix H: Officials in the Watershed

Name	Address	City	Zip	Phone	Position
Dean Kapenga	5634 136th Ave	Hamilton	49419	(269) 751-8586	Allegan County Commissioner - District 5
Tom Jessup	6717 108th Avenue	South Haven	49090	(269) 637-3374	Allegan County Commissioner - District 8
Fritz Spreitzer	1244 Turkey Ln Rd	Allegan	49010	(269) 673-4131	Allegan County Commissioner - District 9
Rebecca Rininger	113 Chestnut	Allegan	49010	(269) 673-0440	Allegan County Drain Commissioner
Bill Colgren	43129 CR 215	Lawrence	49064	(269) 674-8420	Arlington Twp (Van Buren) Supervisor
Regina Hoover	68129 34th Ave	Covert	49043	(269) 427-8965	Bangor Twp (Van Buren) Supervisor
Jim Lisowski	109 E Kalamazoo	Bloomingdale	49026	(269) 521-3800	Bloomingdale Twp (Van Buren) Supervisor
Allan Overhiser	7104 107th Ave	South Haven	49090	(269) 637-4441	Casco Twp (Allegan) Supervisor
Steve Revor	994 46th St	Allegan	49010	(269) 521-4522	Cheshire Twp (Allegan) Supervisor
Dorothy Appleyard	539 Phoenix St	South Haven	49090	(269) 637-0700	City of South Haven Mayor
Tommie Giles	2386 58th St	Fennville	49408	(269) 561-5214	Clyde Twp (Allegan) Supervisor
Dale Bradford	PO Box 323	Grand Junction	49056	(269) 434-6227	Columbia Twp (Van Buren) Supervisor
Wayne Rendell	45187 Blue Star Hwy	Coloma	49038	(269) 849-2074	Covert Twp (Van Buren) Supervisor
John Hebert	2107 68th St	Fennville	49408	(269) 543-4634	Ganges Twp (Allegan) Supervisor
Nancy Ann Whaley	63133 16th Ave	Bangor	49013	(269) 427-7607	Geneva Twp (Van Buren) Supervisor
Steve Miller	877 56th St	Pullman	49450	(269) 236-6485	Lee Twp (Allegan) Supervisor
Richard Sutherby	257 W. Monroe St.	Bangor	49013	(269) 427-5831	Mayor, City of Bangor
Dan Rastall	222 S Maple St	Fennville	49408	(269) 561-8321	Mayor, City of Fennville
Ross Stein	14149 73rd St	South Haven	49090	(269) 637-6746	South Haven Twp (Van Buren) Supervisor
The Honorable Tonya Schuitmaker	N1099 House Office Bldg., PO Box 30014	Lansing	48909	(517) 373-0839	State Representative - 80th District
The Honorable Bob Genetski	N1192 House Office Bldg., PO Box 30014	Lansing	48909	(517) 373-0836	State Representative - 88th Dist (Allegan)
The Honorable Ron Jelinek	PO Box 30036	Lansing	48909	(517) 373-6960	State Senator - 21st Dist (Van Buren)
The Honorable Patricia Birkholz	PO Box 30036	Lansing	48909	(517) 373-3447	State Senator - 24th Dist (Allegan, Barry, Eaton)
The Honorable Peter Hoekstra	31 E 8th St	Holland	49423	(616) 395-0030	US Congressman - 2nd District
The Honorable Fred Upton	157 S Kalamazoo Mall, Suite 180	Kalamazoo	49007	(269) 385-0039	US Congressman - 6th District
The Honorable Carl Levin	110 Michigan NW, #134	Grand Rapids	49503	(616) 456-2531	US Senator
The Honorable Debbie Stabenow	3230 Broadmoor St, Suite B	Grand Rapids	49512	(616) 975-0052	US Senator

Tom Erdmann	73280 8th Ave	South Haven	49090	(269) 637-8640	Van Buren County Commissioner - District 1
Susan Hammond	295 E. Main Street	Breedsville	49027	(269) 427-7281	Van Buren County Commissioner - District 2
Denise Massey	14961 32nd Street	Gobles	49055	(269) 628-5001	Van Buren County Commissioner - District 3
Richard Freestone	31002 60th Avenue	Bangor	49013	(269) 427-7674	Van Buren County Commissioner - District 4
James Toth	51640 35 ½ St	Paw Paw	49079	(269) 655-1814	Van Buren County Commissioner - District 5
Joe Parman	219 E Paw Paw St	Paw Paw	49079	(269) 657-8241	Van Buren County Drain Commissioner
Tom Rock	109 E Kalamazoo	Bloomingdale	49026	(269) 521-3222	Village of Bloomingdale President
T. Wayne Hammond	295 E Main St	Breedsville	49027	(269) 427-7281	Village of Breedsville President
Bernard Wilfong	42114 M-43	Paw Paw	49079	(269) 657-6847	Waverly Twp (Van Buren) Supervisor

Appendix I: Planning and Zoning Assistance in the Black River Watershed

The Van Buren Conservation District (VBCD) and the Southwest Michigan Planning Commission (SWMPC) with grant funds from the Michigan Department of Environmental Quality provided planning and zoning assistance to several municipalities in the watershed. The purpose of the assistance was to empower local officials to incorporate watershed protection measures into plans and policies. Further, the language developed during this project is provided as a model for other municipalities in the watershed. All master plan and zoning ordinance language can be viewed at www.swmpc.org/ordinances.asp.

The Van Buren Conservation District solicited proposals from municipalities within the Black River Watershed for planning and zoning assistance. The Black River Watershed Project Steering Committee ranked the proposals and awarded assistance to four communities (Arlington Township, Bangor City, Clyde Township and Columbia Township). The selection was based on amount of land in the watershed, the amount of land in a priority area, and the community's commitment to protecting water quality and natural resources. Each of the four communities signed a partnership agreement with the Van Buren Conservation District.

Process for Improving Master Plan and Zoning Documents in the Black River Watershed:

- Review master plan and zoning ordinance
- Meet with planning commission to identify issues of concern
- Develop priority list of issues
- Develop master plan language
- Adopt master plan language
- Develop zoning ordinance language

The assistance provided included a review of the master plan and zoning ordinance. A document review tool was developed by SWMPC to evaluate master plan and zoning ordinances. The tool can be found at http://www.swmpc.org/communityasmt.asp and can be utilized by other municipalities to review their master plans and zoning ordinances. The review was followed by meetings with the planning commission to identify issues of concern for the municipality. From the meetings, SWMPC developed a list of priority issues for the planning commission to consider addressing. Then SWMPC met with the planning commission to develop master plan and/or zoning ordinance language to address priority issues.

The following municipalities in the Black River Watershed received planning and zoning assistance from the Southwest Michigan Planning Commission:

Arlington Township
Bangor City
Bloomingdale Township
Bloomingdale Village
Clyde Township
Columbia Township
South Haven Township
South Haven City
Waverly Township
Van Buren County

In addition to the four selected municipalities, several other municipalities in the watershed received assistance in various ways. Waverly Township received assistance through the Paw Paw River Watershed Project. South Haven City asked SWMPC for assistance in developing parking requirements which would allow pervious pavement. Bloomingdale Township and Bloomingdale Village

were updating their Recreation Plan and incorporated water quality language. South Haven Township was updating their master plan and zoning ordinance and incorporated many water quality issues and concerns. Lastly, Van Buren County is currently working with the SWMPC to develop their first recreation plan. This plan will highlight watersheds, water quality issues and green infrastructure.

SWMPC developed recommended master plan language for Arlington, Clyde and Columbia Townships. The City of Bangor does not have a master plan. The following table summarizes the issues and topics that language was developed by municipality.

Master Plan Language Recommendations by Municipality

Issue	Arlington Township	Clyde Township	Columbia Township
Watersheds	X		X
Black River Watershed Plan	X		X
Lakes	X	X	X
Streams	X		X
Riparian Buffers	X	X	X
Wetlands	X		X
Floodplains	X		X
Stormwater Management – Low Impact Development	X	X	X
Impervious Surfaces	X	X	X
Native Vegetation	X	X	X
Woodlands	X		X
Wildlife Habitat	X		X
Wildlife Corridors	X		X
Agricultural Lands	X		X
Green Infrastructure	X	X	X
Erosion and Sediment Control	X		
Land Protection and Management	X		
Invasive Species		X	

The following zoning ordinance language recommendations were developed for each municipality.

Zoning Ordinance Language Recommendations by Municipality

Zoning Ordinance Language	Bangor City	Clyde Township	Columbia Township
Building setbacks from water bodies (streams, rivers, lakes, wetlands) with a native vegetative buffer	X	X	X
Improve parking standards to reduce impervious surfaces (shared parking, parking space size, minimum parking requirements)	X	X	X
Require open space in Planned Unit Developments	X		
Site plan review (identification of natural features and review standards for protection)	X	X	X
Encourage low impact development techniques	X	X	
Encourage use of native species in landscaping	X	X	X
Improve private road standards to reduce impervious surfaces			X
Require a buffer between agriculture and residential uses to protect agricultural landowners		X	

Appendix J: Summaries of Previous Water Quality Studies

Below are excerpts and summaries of previous studies that have been done in the watershed by organizations such as the Michigan Department of Environmental Quality and the Michigan Department of Natural Resources. These studies can help locate current problem areas in the watershed, but some information in them may be outdated (for example, areas in Bangor have undergone remediation for PCBs and heavy metals since these reports were completed). Updated reports will be added to this plan as they become available. Issues of concern are indicated in bold text. Locations of these waterbodies are shown in the figure at the end of this document.

Overall Watershed

- Walterhouse 2003

"…water quality throughout the Black River Watershed was adequate to support acceptable biological communities at locations with suitable riparian and in-stream habitat. Unfortunately, **historic channelization and dredging** of many of the streams, wetland drainage, sandy soils, and the current land management activities of riparian owners provides the aquatic biota of streams in the Black River Watershed with limited stable habitat" (p. 2).

North Branch Black River

- MDNR 1976

Bottom substrate of the North Branch was noted as being very **silty** and representative of slow flow. Suspended solid concentrations indicated a problem with **erosion** in this area. Fecal coliforms were generally low during this study. Water quality was **slightly nutrient enriched**. Macroinvertebrate sampling indicated good water quality with a high diversity of species.

- Cooper 1999

Habitat at one location (at 68th St. near 108th Ave.) was ranked as fair due to a **lack of hard bottom substrate and sand sediment**. Macroinvertebrate populations were rated as acceptable, though diversity was considerably lower than comparable locations on the Middle or South Branch.

- Walterhouse 2003

The North Branch has historically been dredged upstream of 111th Ave., creating a relatively **homogenous channel**, lacking meanders and diversity of depths and velocities. The stream channel at some locations was noted as **incised**, and the riparian zone was not functioning as a floodplain. Upstream stream segments have been **channelized** and have a **narrow riparian zone**. They have a low flow and are exposed to sunlight. Nutrients were within acceptable ranges. Macroinvertebrate communities were rated as acceptable at two sites on the North Branch. Of the two sites, the downstream site (103rd Ave.) had a habitat rating of "good", while the upstream site (113th Ave.) had a "marginal" habitat rating. Substrate was primarily sand.

<u>Black River Drain</u>

- Lakeshore Environmental 1996

Lakeshore Environmental, Inc. completed a study of the Black River Drain in the area of the Allegan State Game Area for the Allegan County Drain Commission. They examined a variety of water quality parameters, including fecal coliform, BOD, nitrate nitrogen, total phosphorus, and conductivity. Fecal coliform, nitrate nitrogen and phosphorus concentrations decreased in a spring sampling event (compared to a fall sampling event, a time at which waterfowl activity in the Allegan State Game Area is high). **Fecal coliform** levels were highest in areas downstream from the central portion of the game area, and these levels were elevated only in fall sampling events. Conductivity and BOD were also in the suspect or problem ranges for all sampling locations and dates.

- Cooper 1999

Cooper reviewed the Lakeshore Environmental (1996) study and nutrient export from the Allegan State Game Area:

> "While it is entirely possible that sediment and nutrient transport may be encouraged by feeding waterfowl, these water quality parameters are also known to degrade from agricultural practices in the watershed and channel dredging itself which promotes sedimentation from bank erosion.

> In addition, **channelization** increases erosive power of the stream itself during high water evens by the removal/elimination of meanders, bends, and channel debris that reduce bank erosion. Increases in nutrient concentrations in stream channels that have undergone dredging are common and even expected. The very process that lowers the channel bed to promote drainage **also removes critical substrate and flow diversity** that promotes/enables natural biological processes to utilize and thereby remove nutrients from the water column" (p. 4).

Thus, the origin of sediment and nutrients downstream of the Allegan State Game Area is not yet clearly defined.

Middle Branch Black River

- MDNR 1976

This study (with one station on this Branch) noted good gravel substrate and generally clear water. Salmon were observed in November 1975. Nutrients and suspended solid levels were low. **Sodium and chloride concentrations were elevated**, indicating a possible upstream source of wastes.

- Heaton 1997

Macroinvertebrate communities were rated as acceptable, tending toward excellent. The designated use of coldwater fishery was not being met. Habitat was rated as "fair" (moderately impaired), due to a **lack of cobble, boulder, and woody debris instream substrate** and excessive **sand and silt deposition from streambank erosion.** Water quality was within the normal range for streams in this ecoregion.

- Cooper 1999

Habitat was rated good for fish and macroinvertebrates due to the presence of woody debris and stable, undercut banks. High amounts of **sand deposition** were also noted. The macroinvertebrate community was rated as good, tending toward excellent.

- Walterhouse 2003

Macroinvertebrate communities were rated as acceptable, tending toward excellent, and habitat was rated "good." Sand was the predominant substrate, but habitat features such as woody debris, root wads, undercut banks, and deep pools were noted. The stream channel had not been channelized, and was surrounded by a wide wooded floodplain. Water quality was within the normal range for streams in this ecoregion.

<u>Barber Creek (Middle Branch)</u>

- Heaton 1997

The aquatic macroinvertebrate community and the physical habitat were both rated "excellent" (non-impaired). No salmonid species were collected during this study period, and thus, the designated use of coldwater fishery was not being met.

- Macroinvertebrate populations were rated as acceptable, though diversity was low. Populations were dominated by midge or black fly larvae, possible indicators of **nutrient enrichment**. Habitat was slightly impaired due to sediment **deposition, embeddedness, and channel structure lacking in diversity.**

<u>Scott Creek (Middle Branch)</u>

- Heaton 1997

Biological integrity of this creek was rated as acceptable based on aquatic macroinvertebrate communities. However, this acceptable rating tended towards poor downstream of an industrial point source discharge. Physical habitat was rated as "fair" (moderately impaired), due to **lack of available bottom substrate, extensive embeddedness, absence of pool and riffle habitat, and lack of vegetative stability of the streambanks**. Concentrations of **ammonia** were elevated at one site on this stream. Concentrations of **arsenic, chromium, copper, mercury, nickel, lead and zinc** in the sediment were relatively elevated at one station. **Acetone** was detected in the sediment at two sites. **Methyl ethyl ketone, toluene, ethylbenzene and xylene** were detected at one site (downstream of the above mentioned point source discharge).

- Cooper 1999

Riparian conditions were noted as excellent, contributing to good habitat scores. Macroinvertebrate communities were rated as acceptable, though limited by poor bottom substrate due to **deposition and embeddedness**. **High nutrient conditions** may exist as suggested by the high density of midge fly and black fly larvae.

- Walterhouse 2003

This stream has historically been channelized, but dredging had not occurred recently. The riparian zone is well vegetated. Macroinvertebrate community was rated as acceptable. Habitat was rated as marginal due to **absence of riffle habitat and deposition and movement of sand substrate**. Water quality was within the normal range for streams in this ecoregion

Spicebush Creek (Middle Branch)

- Heaton 1997

Biological integrity was rated acceptable based on the aquatic macroinvertebrate community. Physical habitat was rated as "fair" (moderately impaired), due to the **lack of bottom substrate cover, excessive embeddedness due to sand and silt, absence of pool and riffle habitat, and lack of vegetative stability of the streambank**. No salmonid species were collected in Spicebush Creek during this study, and thus the designated use for coldwater fishery was not met. Water quality was within the normal range for streams in this ecoregion.

- Cooper 1999

This creek was noted as being a classic **dredged** channel with a wide, shallow streambed, steep banks, **sedimentation**, and **poor substrate**. The habitat was thus rated as fair. Macroinvertebrate populations were rated as acceptable, though there was a scarcity of species indicative of excellent water quality.

Spring Brook (Middle Branch)

- Walterhouse 2003

Some portions of Spring Brook appear to have been channelized in the past, but now appears to be a natural, wetland bordered, low-gradient stream with fine substrate. The macroinvertebrate community was rated acceptable and the habitat was rated as good. The stream substrate is predominantly sand, and riffle habitat was absent at the sample location.

South Branch Black River

- MDNR 1976

Nutrient levels in this study were low, as were total dissolved and suspended solid concentrations. The only parameters with elevated levels were **iron and fecal coliform** (indicating a possible sanitary or livestock waste source).

- Hull 1989

This study focused primarily on the South Branch of the Black River in the Bangor area, though one station was upstream, immediately below the Breedsville impoundment. Overall aquatic habitat quality was low as a result of **heavy deposition of sand and silt**. Despite the lack of quality habitat, aquatic macroinvertebrates were moderately to highly abundant. Lower species diversity and abundance was found below two **point-source discharges** in Bangor. Effluent from these discharges included heavy metals, PCBs, oil and grease, chlorides and dissolved salts. Substrate downstream of one discharge was described as "oily sludge beds overlain by several inches of silt" (p. 2).

- Gashman 1990

Sediment and fish samples were collected in this study of the South Branch in Bangor, in the area of a **point-source discharge**. PCBs were detected at high levels in fish samples. Elevated levels of PCBs and heavy metals were also found in sediment downstream of the discharge.

- Cooper 1999

Macroinvertebrate populations were rated acceptable at two sites (one upstream and one downstream of Bangor). Habitat was rated good at the upstream site and excellent at the downstream site. Signs of **nutrient enrichment** (such as dense growths of Cladaphora) were noted.

- Heaton 1997

The South Branch of the Black River in some locations was found to not meet its designated use as a coldwater fishery. Much previous sampling of this branch focused on the area of the Bangor Millpond, where elevated levels of PCBs and heavy metals were found. Biological integrity of the South Branch (based on fish collections) ranged from poor to excellent. Habitat was rated as "fair" (moderately impaired) for the majority of the south branch due to **a lack of cobbles, boulders, and large woody debris, as well as due to the excessive sand and silt deposition from stream bank erosion. Phosphorus and ammonia concentrations** were elevated at one location in this study.

- Walterhouse 2003

From the confluence of the Black River upstream to Bangor, the river is primarily a naturally meandering stream bordered by wooded floodplain with good sinuosity. The flow regime may be **flashy**. Sand is the predominant substrate and riffle habitat is infrequent. In this study, the most downstream site (at 70th St.) received a rank of excellent for the macroinvertebrate community (this was the only site rated as excellent in the study). Habitat was rated at good, with such elements as pools, woody debris, root wads, overhanging vegetation, and sand, muck, and detritus substrates. The flashiness of the flow regime was the only poor habitat element at this site.

The South Branch was also evaluated in Lion's Park in Bangor. The macroinvertebrate community was rated as acceptable and the habitat was ranked marginal. Riffle habitat was present (though consisted primarily of unnatural objects like brick and concrete), but the habitat was negatively impacted by the flashiness of the flow regime and **lack of a natural riparian zone** in Lion's Park.

This branch was also evaluated above the Breedsville impoundment (at 52nd St.). The macroinvertebrate community at this site rated as acceptable and the habitat was rated as marginal. Sand was the dominant substrate, and in-stream cover was sparse. **Movement and deposition of sand** at this site (just below the confluence of the Great Bear Lake Drain and the Black River Extension Drain) created a relatively uniform stream channel. Turbidity in the South Branch may be due to spawning and feeding behavior of carp in the Breedsville Impoundment (a large number of carp were documented here in June and July 2002).

- Wolf and Wuycheck 2004

Approximately 26,000 cubic yards of sediment were removed from the South Branch of the river in the area of the Bangor Mill Pond. The sediment was contaminated with PCBs and heavy metals. Restoration and remediation of the area concluded in June 2004 (L. Nielsen, personal communication, June 15, 2004).

<u>Black River Extension Drain (South Branch)</u>

- Cooper 1999

Macroinvertebrate sampling in this drain found very **poor diversity** and noted that the stream channel was **"void of all structure and channel diversity due to channelization"** (p. 2).

<u>Butternut Creek (South Branch)</u>

- Walterhouse 2003

This stream and all of its tributaries have been **channelized**, though dredging of some segments has not occurred for a number of years. The macroinvertebrate community was rated as acceptable, and the habitat was rated as good. Some meanders had reestablished, and the site had deep pools and woody debris. Sand was the predominant substrate. A wide riparian corridor was noted. Water quality results were within the normal range for streams in this ecoregion.

<u>Cedar Creek (South Branch)</u>

- Cooper 1999

Macroinvertebrate samples at two sites on this creek indicated fair to poor habitat and acceptable macroinvertebrate diversity (though relatively low density). **Hard substrate was lacking and excessive sedimentation and embeddedness were noted. Banks were also in poor condition.**

- Walterhouse 2003

This stream and all of its tributaries have been **channelized**, though dredging in some areas has not occurred recently. Streambanks were well vegetated. This stream is **incised** and sand is the dominant substrate. The **riparian zone if often very narrow**, and row crops were found to begin at the edge of the stream banks in many locations. Macroinvertebrates were scored as acceptable and habitat was rated marginal due to the **deposition and movement of sand substrates.**

Cedar Drain (South Branch)

- Cooper 1999

Two sites were sampled for macroinvertebrates (upstream and downstream of the Bangor wastewater sewage lagoons). The upstream site had a poor macroinvertebrate community rating and a **poor habitat** rating. The downstream site had acceptable populations with low density, and habitat was rated as fair.

Eastman Creek (South Branch)

- Cooper 1999

Macroinvertebrate populations were rated acceptable and habitat was rated good tending toward excellent. However, some of the species found were relatively pollution tolerant species.

- Walterhouse 2003

The macroinvertebrate population was rated as acceptable and the habitat was rated as good. Riffle habitat was absent, and sand was the predominant substrate. Portions of this stream have been **channelized** in the past. Streambanks were well-vegetated and were not eroding. The riparian zone was intact. Water quality results were within the normal range for streams in this ecoregion.

Great Bear Lake (South Branch)

- Fusilier 1998

Secchi disk trends show that both basins of Great Bear Lake are getting less clear. A significant **algal bloom** occurred in both the spring and summer of 1997. Surface **phosphorus concentrations** were high in both spring and summer. The north basin appeared to be more affected by nutrient inputs than the south basin.

- Walterhouse 2003b

Sampling results from this and previous studies indicate that phosphorus is the limiting nutrient in Great Bear Lake. Results of this study indicate that water quality may have improved.

- Fusilier 2003

There is no clear trend in phosphorus concentrations in the lake over the past 20 years. However, the phosphorus levels have at times been above 20 µg/L, a level at which excessive algae and aquatic plant growth may occur. The lake experienced a significant algal bloom in April 2000. Both the north and south basins of the lake have experienced a decline in clarity over the past 20 years. A Lake Quality Index (LQI) has been calculated for the lake over the past 20 years and shows no type of trend.

- Walterhouse 2004

The Michigan Department of Environmental Quality developed a Total Maximum Daily Load (TMDL) for phosphorus in Great Bear Lake. This report estimates that 90% of the total annual nonpoint source load comes from agricultural land uses in the Great Bear Lake watershed. The model used does not account for pollution from precipitation or several other sources. The TMDL establishes a spring overturn phosphorus goal of 0.030 mg/L, which will require a 29% reduction in annual phosphorus loading.

- Walterhouse 2007

Spring turnover phosphorus concentration in the north basin of the lake was 0.050 mg/L, and 0.025 in the south basin, for an acre weighted average concentration of 0.046 mg/L, above the TMDL goal. Sampling also indicated that a sediment trap installed upstream of Great Bear Lake does not reduce total suspended solids, nitrogen or phosphorus (though observations indicate that the trap is capturing storm event bed load). One sampling event occurred during a storm event, demonstrating that phosphorus loads increase dramatically during storm events.

Great Bear Lake Drain (South Branch)

- Cooper 1999

Macroinvertebrate diversity in this drain was low (though this may be due to the close proximity of the sampling site to Great Bear Lake). The habitat was considered fair (moderately impaired) due to **bottom deposition, embeddedness, and lack of streamside cover.**

Haven & Max Lake Drain (South Branch)

- Fusilier 1998

Sampling in the Haven & Max Drain indicated that **nutrients** were added to the drain between CR 388 (38th St.) and 41st St., upstream of Bloomingdale. Both nitrate **nitrogen and phosphorus** concentrations increased between these two road-stream crossings. Denitrification appeared to be occurring in the stream, and little or no nitrates were added below 41st St. The same appears to be the case for phosphorus.

- Cooper 1999

High concentrations of **phosphorus** (and ortho-phosphorus in particular) may indicate an impairment of the biological community and habitat (typically, ortho-phosphorus concentrations are low as a result of biological assimilation).

- DEQ 2000

Photographs and notes taken by DEQ personnel in the summer of 2000 noted **high, steep eroding banks** in a stretch of this drain between CR 388 (near 3850th St.) and the Remington & Powers Drain. **Turbid water, sediment, vegetation, and algae** were also noted in Fritz Drain, which enters Haven & Max Lake Drain in this segment. Downstream of this, (between 45th and 42nd Streets) **steep, eroding banks and heavy sediment deposition** were also noted, though at least one section with cobble substrate was also found. A rust colored matter (bacterial) was prevalent, especially in seep areas.

- Fusilier 2003

The highest phosphorus inputs to this drain come from the Munn Lake Drain.

- Walterhouse 2003b

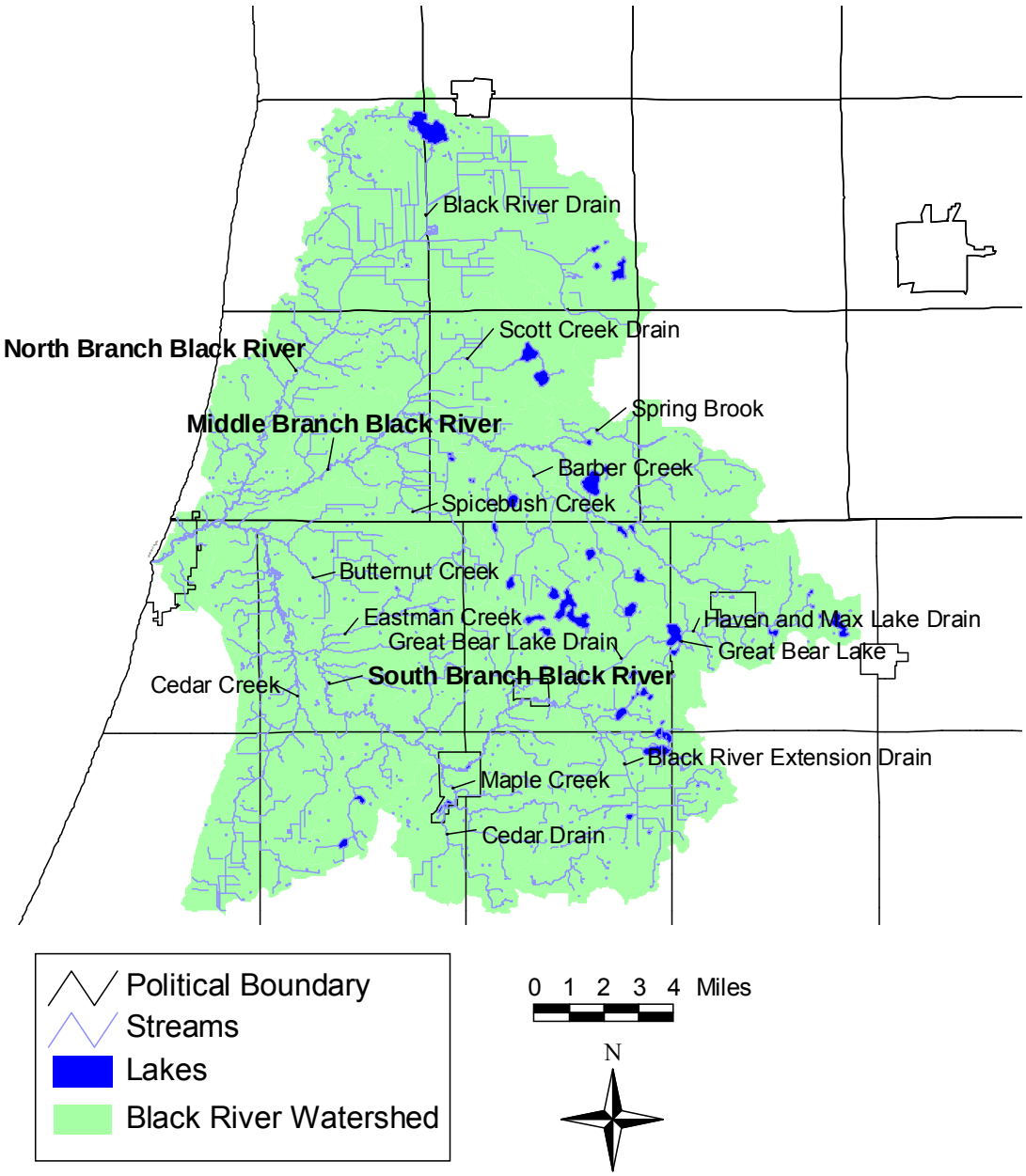
The highest concentrations of phosphorus upstream of Great Bear Lake were found in Munn Lake Drain (which flows into the Haven & Max Lake Drain near 3850th St.). This study concluded that phosphorus and nitrogen concentrations do not increase downstream of the Bloomingdale Wastewater Treatment Plant.

Maple Creek (South Branch)

- Heaton 1997

Biological integrity was rated as acceptable tending towards excellent. The habitat was rated as good (slightly impaired). Ammonia and phosphorus concentrations were elevated, both upstream and downstream of the Bangor wastewater sewage lagoons. Upstream sources of nutrients may be agricultural runoff. Most of the above-mentioned studies have been entered into a Geographic Information System (GIS) housed at the Van Buren Conservation District.

Waterbodies in the Black River Watershed



Map created by Erin Fuller, Van Buren Conservation District, March 2005
Data Source: Michigan Center for Geographic Information

Appendix K: Black River Watershed Bank Erosion Study

Monitoring Stream Bank Erosion with Bank Pins in the Black River Watershed (Allegan and Van Buren Counties)

Final Report
3/12/05

Black River Watershed Project
(Tracking code 2002-0067)

Project Partners:
Van Buren Conservation District
Michigan Department of Environmental Quality

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-Erin Fuller

Introduction

Black River Watershed Project staff and volunteers monitored stream bank erosion at various locations in the Black River Watershed in Allegan and Van Buren Counties. Erosion and sedimentation have been determined to be critical issues in the watershed, but data on the rate of bank erosion in the watershed is lacking. In addition to helping locate sites where erosion is most critical and providing information with which to estimate of sediment loading in the watershed, this study helps provide a baseline against which to evaluate best management practice (BMP) effectiveness in the future.

Bank erosion pins were placed at eight sites throughout the watershed. The methods followed the standard operating procedure cited in Appendix A. Embeddedness was also analyzed using the procedure described in the Michigan Department of Environmental Quality's Great Lakes and Environmental Assessment Section Procedure #51 (May 2002). Volunteers were engaged to perform measurements of the bank pins and embeddedness at several of the sites. The Black River Watershed Coordinator monitored bank pins at the remaining sites and acted as project manager.

Methods

The methodology for this study was derived from the standard operating procedure "Monitoring Stream Bank Erosion with Erosion Pins," (Appendix A) devised by Joe Rathbun of the Michigan Department of Environmental Quality (MDEQ). This procedure has been used by MDEQ in similar studies in the Rouge River watershed in southeast Michigan (J. Rathbun, personal communication).

Sites for placement of bank erosion pins were chosen by selecting road-stream crossing sites with visible signs of erosion. Sites with obvious human-induced erosion were eliminated. Sites were distributed on both tributary streams and on the three main branches of the river. Some sites were on natural reaches and some were on previously channelized reaches. All sites had natural vegetation adjacent to the streambank. Fifteen sites were initially chosen that met these criteria. Landowners were contacted by phone or mail and permission was granted to access eight of the fifteen sites. These eight sites are shown in

Figure .

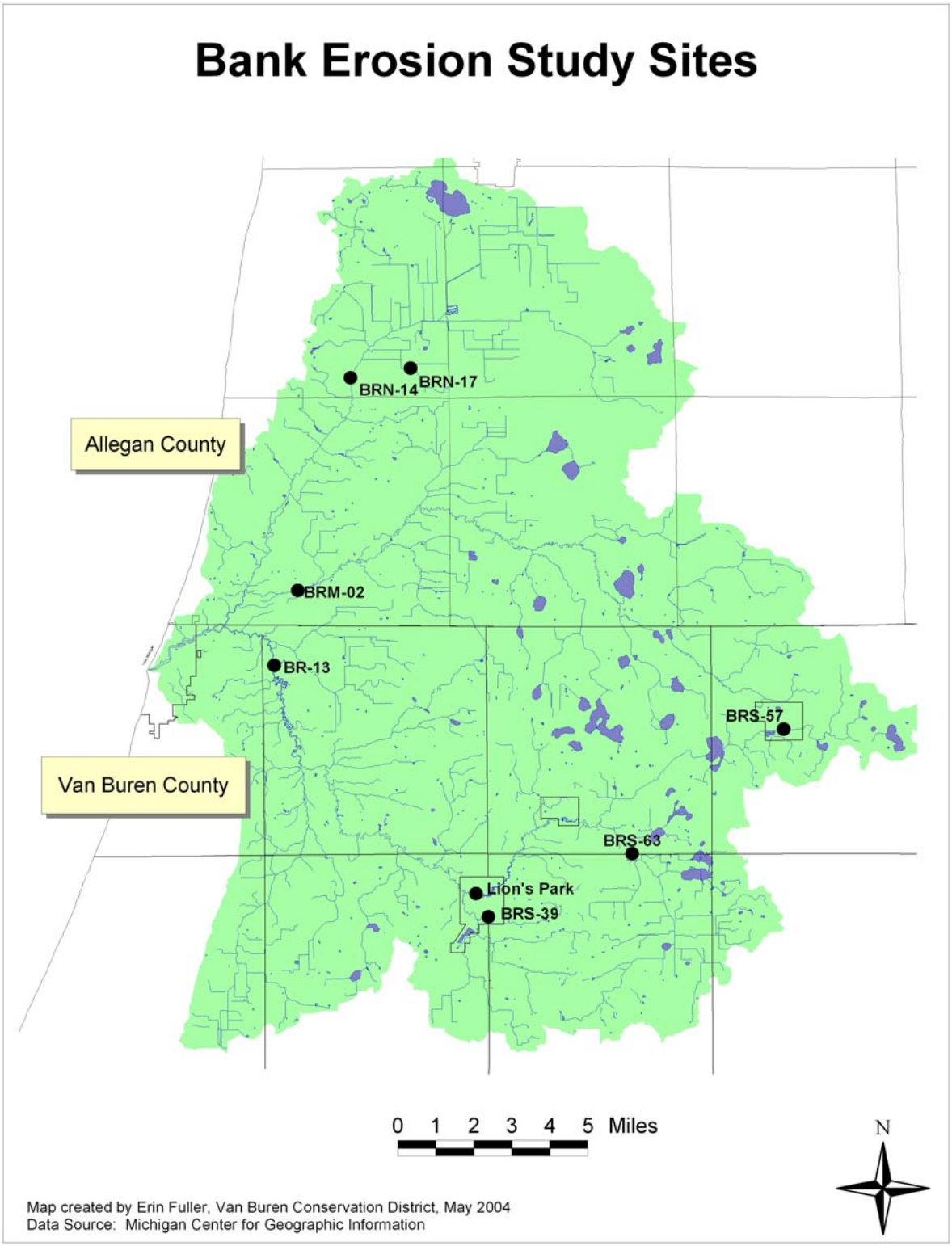
Pins were installed on June 9, 2004. The pins were 1/8 inch-diameter wooden dowels spray-painted fluorescent orange. Where conditions permitted, pins were installed in two locations at each site (denoted as the "upstream" location and the "downstream" location), and on both the left and right banks. This was not always feasible due to bank height, substrate, and vegetative cover. Several pins (the number depended on bank height) were installed at each of these locations, typically in a vertical arrangement on the bank. Photographs were taken of the sites, and each site was marked with orange flagging tape. At the time of installation of the erosion pins, bricks were placed in the channel for the purpose of estimating embeddedness at those sites lacking natural cobble substrate.

Volunteers were all trained individually on the proper methodology for measuring bank pins and embeddedness. Measurements of bank pins were taken from June 9, 2004 to November 18, 2004. Sites were visited shortly after major storms (a major storm was defined as any event in which rainfall of 0.25" or more occurred in any 24-hour period). The project manager contacted and alerted volunteers to take measurements. Precipitation information was obtained from the Michigan Automated Weather Network website at <http://www.agweather.geo.msu.edu/mawn/> from sites in the watershed (Grand Junction in Van Buren County and Fennville in Allegan County).

Measurements were taken in the following manner: a washer was placed over the dowel and pushed toward the bank until it touched the bank. The distance from the washer to the end of the bank pin was measured with a ruler, in millimeters. Measurements were recorded on the "Black River Watershed Bank Pin and Embeddedness Inspection Form" (Appendix B). The washer was used to improve accuracy of the measurement.

Embeddedness was estimated by grasping and removing a brick or existing cobbles and estimating the percentage that they were buried in the sediment. This estimate was scored on the "Black River Watershed Bank Pin and Embeddedness Inspection Form" (Appendix B).

Figure 1: Bank Erosion Study Sites

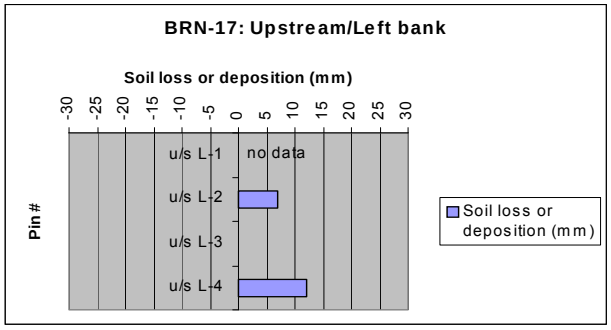


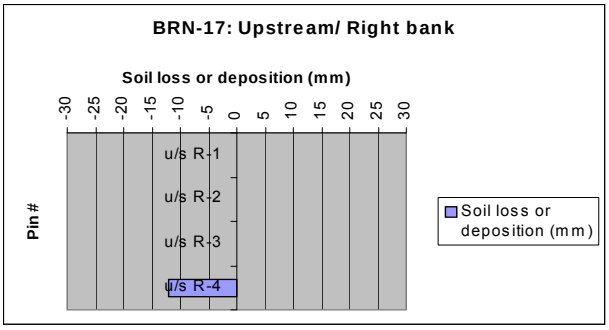
Results

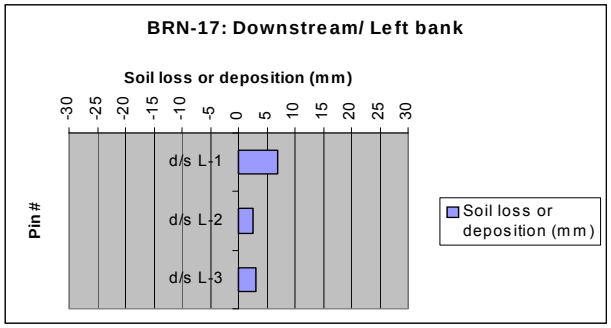
Measurement precision for this type of study has previously been established as approximately ± 1 or 2 mm (see Appendix A). Thus, any changes in measurements that were less than 2 mm were recorded as "no change." The site with the most soil loss over the course of the study was BR-13, with a loss of 29 mm of soil recorded from the lowermost pin (L-6). The site with the most soil deposition over the course of the study was BRN-14, with 9.5 mm of soil deposited over the course of the study at the downstream/left bank location (pin # L-2). Other locations at the same site, however, also had soil loss. The full results of the study are below.

Site number: BRN-17

This site is located on the Black River Drain, a narrow, previously channelized tributary of the North Branch of the Black River. The surrounding land use is agriculture and forest. Pins were placed in three locations at this site.
Average embeddedness: 9.75 (Marginal)



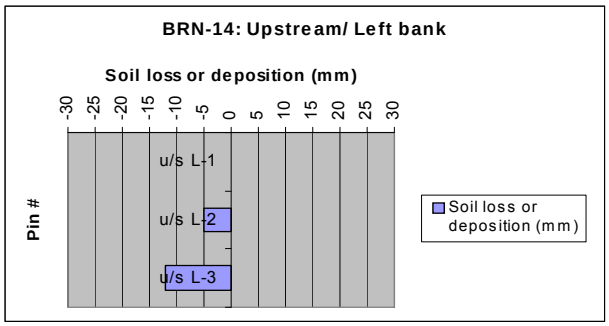


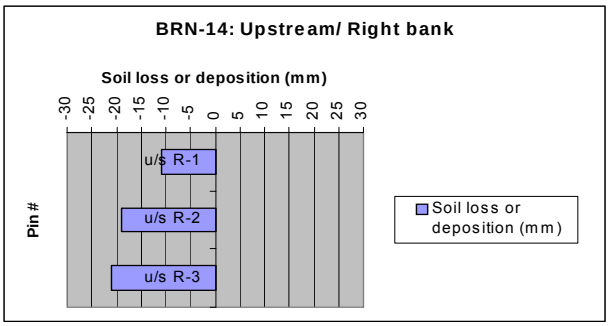


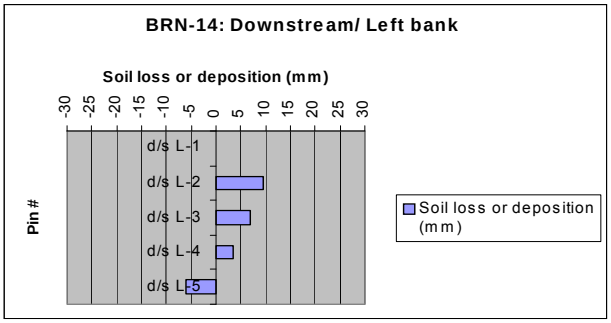
Site number: BRN-14

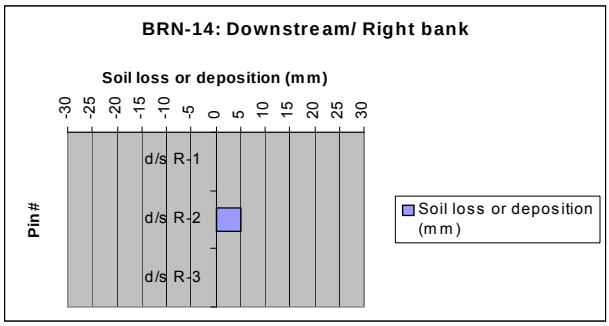
This site is located in a shallow section of the main stem of the North Branch of the Black River (this section is also technically considered part of the Black River Drain). The surrounding land use is forest. Pins were placed in four locations at this site.

Average embeddedness: 0.7 (Poor)





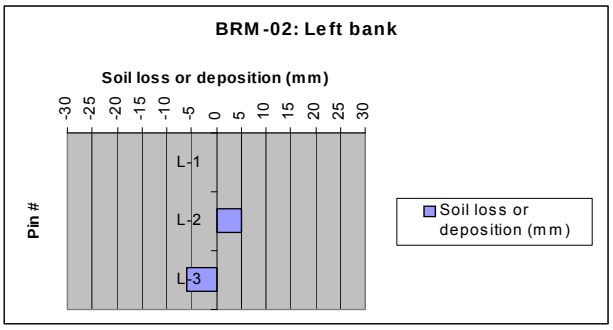


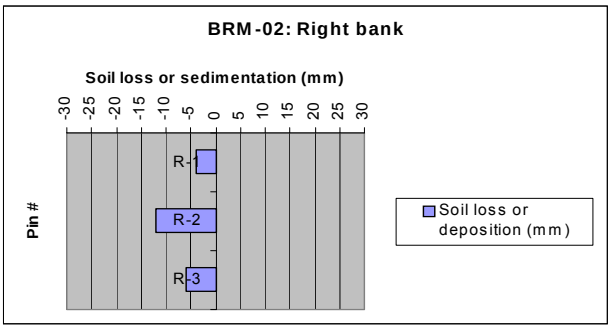


Site number: BRM-02

This site is located in a shallow section of the main stem of the Middle Branch of the Black River. The surrounding land use is forest. Pins were located on both the left bank and right bank. Due to the short height of the streambanks at this site, pins were placed on a horizontal axis approximately 5 feet apart. Pin #1 was the farthest pin upstream and pin #3 was the farthest downstream.

Average embeddedness: no data

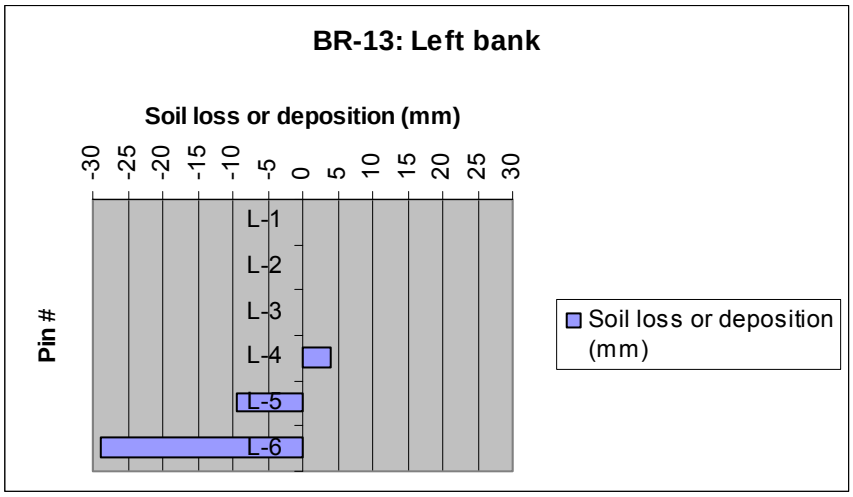




Site number: BR-13

This site is located in a section of the South Branch of the Black River. The surrounding land use is forest. Pins were placed in one location at this site.

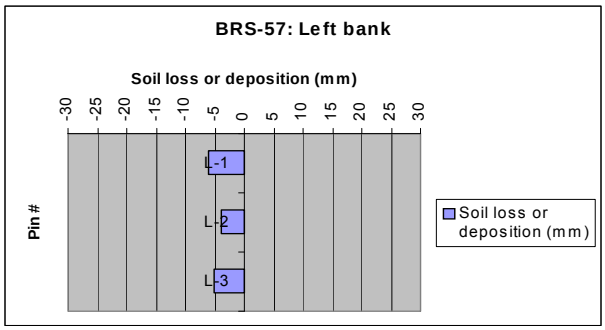
Average embeddedness: 1 (poor)

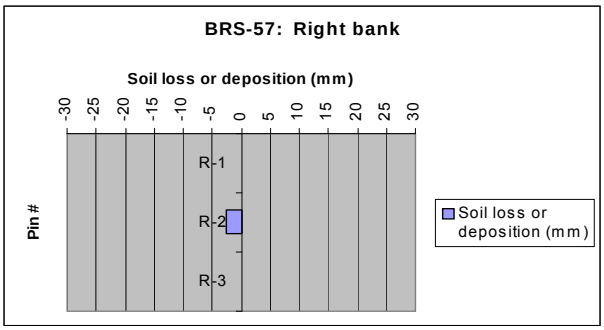


Site number: BRS-57

This site is located on the Haven & Max Lake Drain, a small tributary of the South Branch of the Black River. This drain has been channelized in the past, but is recovering. The site is just downstream of a park in the Village of Bloomingdale. The surrounding land use is forest and parkland. Pins were placed at two locations at this site.

Average embeddedness: 16.4 (excellent)

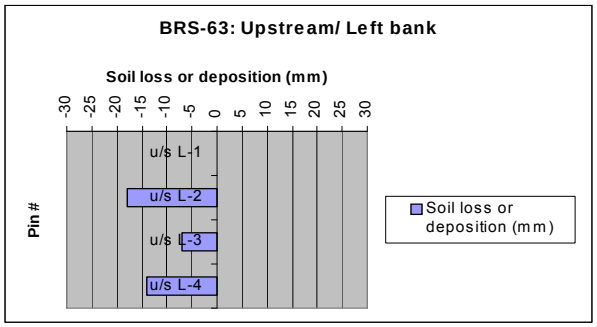


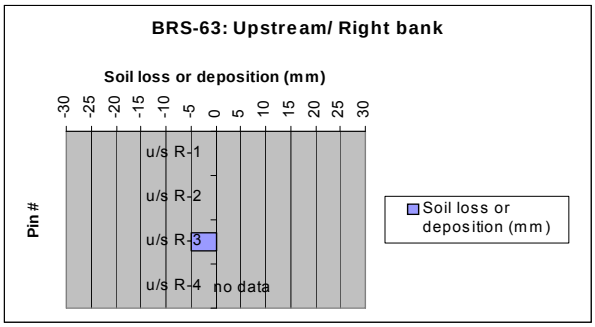


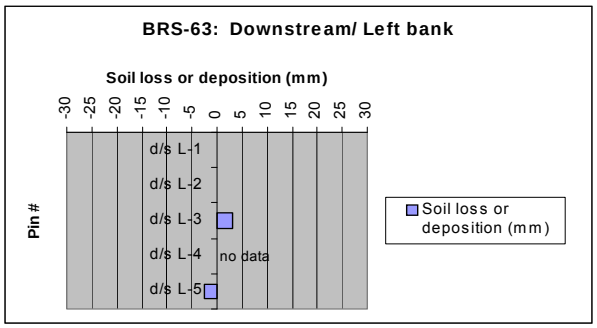
Site number: BRS-63

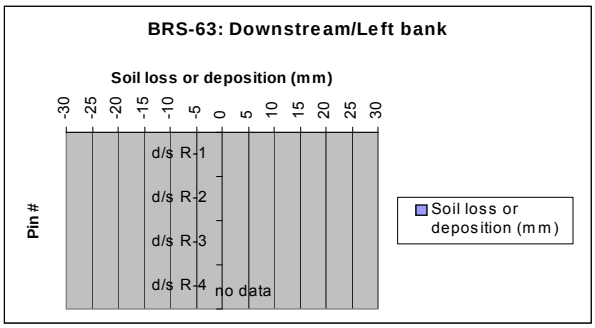
This site is located on the Black River Extension Drain, a tributary of the South Branch of the Black River. The surrounding land use is forest (a road also parallels this site). Pins were placed in four locations at this site.

Average embeddedness: 12 (good)





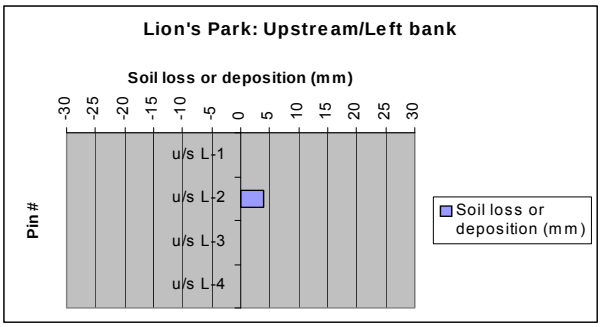


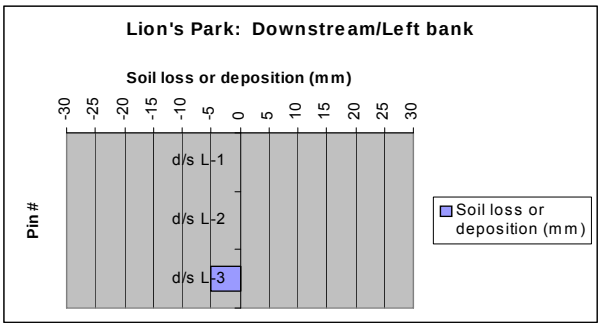


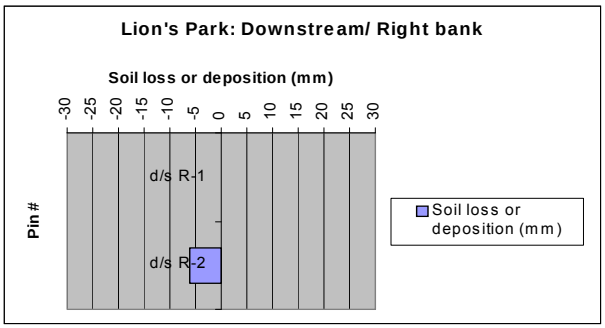
Site number: Lion's Park

This site is located on the South Branch of the Black River, in Lion's Park in the City of Bangor. The surrounding land use is forest and park land. Several foot paths run along the river. Significant disturbance occurred at this site (to both the vegetation and the erosion pins) during the fall fishing season. Pins were placed in three locations at this site.

Average embeddedness: 4 (poor)



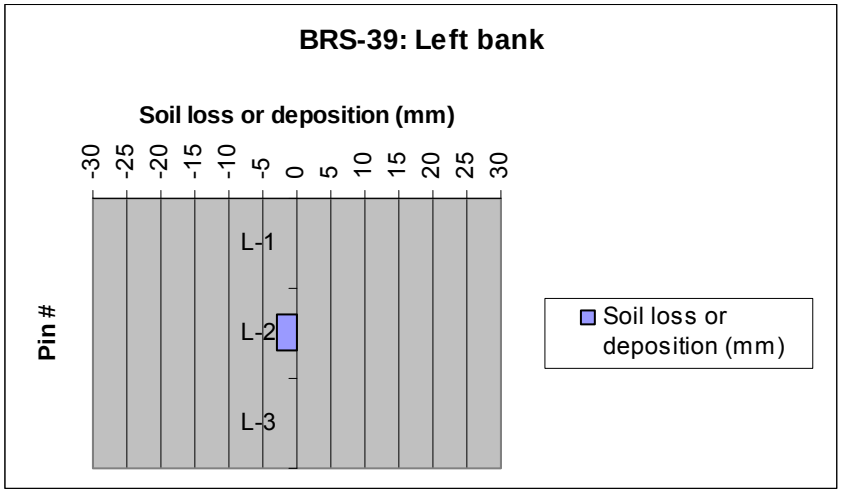




Site number: BRS-39

This site is located on the Boyer Drain, a small tributary of the South Branch that runs through the City of Bangor. The surrounding land use is forest and residential. Due to the short height of the streambanks at this site, pins were placed on a horizontal axis approximately 5 feet apart. Pin #1 was the farthest pin upstream and pin #3 was the farthest downstream.

Average embeddedness: 16.8 (excellent)



Discussion

At some sites, the river channel appears to be quite actively changing, while other sites appeared relatively stable. Sites in which high levels of bank erosion were expected (Lion's Park and BRS-57, for example) did not always exhibit this. Other sites that appeared relatively stable had higher rates of erosion than expected (such as BRM-02). The precise location of the pins at each site certainly influenced the measurements. For example, at BRN-14, a relatively straight-channeled reach, measurements of the upstream set of pins demonstrated soil loss on the left bank, while measurements on the downstream set of pins on the left bank demonstrated soil deposition (with the exception of the lowest pin, L-5, which lost 6 mm of soil over the course of the study). This is due to many factors, including the vegetation surrounding the pins, water currents, and streambank soil composition.

Embeddedness was also highly variable, ranging from a low score of 0.7 (poor: gravel, cobble and boulder particles [or bricks] are more than 75% surrounded by fine sediment) at BRN-14 to a high of 16.8 (excellent: gravel, cobble and boulder particles [or bricks] are 0-25% surrounded by fine sediment) at BRS-39.

Many pins broke over the course of this study, which certainly limited data collection. Several bank pins were sited in areas frequented by wildlife such as deer and raccoons (BRN-14 and BRN-17 especially). These locations suffered from high amounts of pin breakage, likely as a result of wildlife interference. Deer and raccoon tracks were found in close proximity to the pins and human interference at these sites was considered unlikely due to their remote locations. Some pins likely broke in high water events when debris was washed against them. Other pins likely broke due to human interference (especially the two sites that were in parks, BRS-57 and Lion's Park). Future studies should utilize pins of a larger diameter (3/8 inch or 1/4 inch).

Related to pin breakage, another issue that hampered this study was the difficulty of determining a pin's number if pins above or below it had been broken. For example, site BR-13 had 6 pins in a vertical arrangement. On 7/9/04, the volunteer in charge of the site reported a pin missing. Due to fluctuations in water level, it was impossible to determine if the pin was L-5 or L-6. In future studies, pins should be labeled with their number (or possibly color-coded). Additionally, the distance from the top of the bank to each pin could be measured.

In the future, more sites should be monitored if at all possible. The small sample size makes it impossible to draw conclusions for the watershed (or even a specific branch or tributary of the river). However, one of the most difficult

aspects of this study was receiving landowner permission for accessing the river. Many landowners simply never responded to phone calls or letters. Access to sites can be physically difficult as well, given the steep banks in many areas, as well as the prevalence of poison ivy and stinging nettles. Safety is certainly concern for staff and volunteers monitoring these sites (most sites were monitored by one person rather than a team). Deeper sections of river may not be safely monitored by one person.

Overall, this was a useful pilot study. It brought out some aspects that should be improved upon in future studies. This is a simple, relatively inexpensive study that can be undertaken by volunteers. Before-and-after bank pin studies should be useful in monitoring effectiveness of streambank remediation efforts in the future.