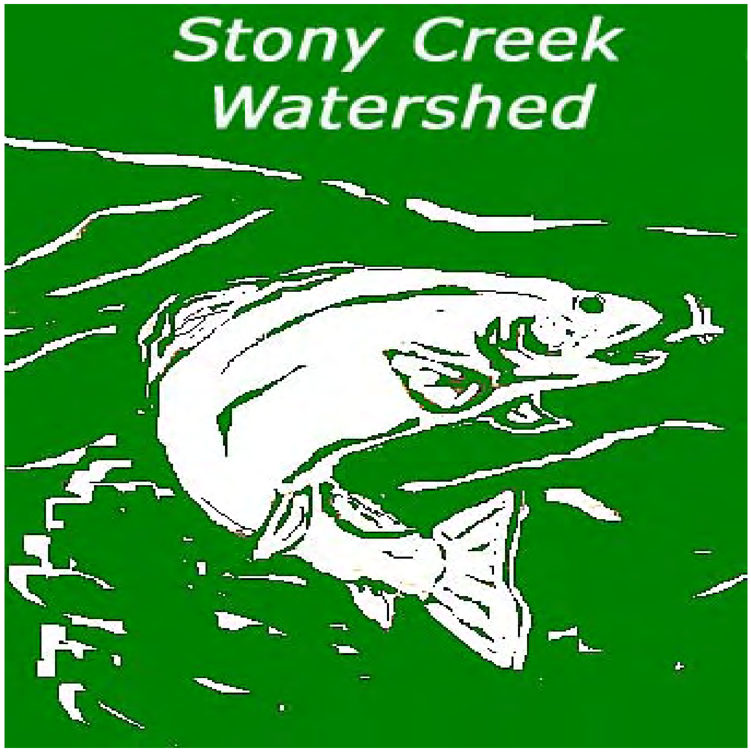

STONY CREEK WATERSHED MANAGEMENT PLAN

DEQ
Michigan's Nonpoint Source Program

June 2005

STONY CREEK
WATERSHED
MANAGEMENT PLAN

Prepared by

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June 2005

ACKOWLEDGEMENTS

This project could not have been completed without the support, encouragement and assistance of many people. We have identified the members of the two critical committees that guided and supported the planning process over the past two years in the Appendix. But several people made contributions above and beyond what was expected. They are acknowledged here.

Three members of the Steering Committee demonstrated tireless enthusiasm and unflagging support throughout the planning process:

> ***Kathy Giszczak, now Clerk of Augusta Township*—**Kathy attended almost every meeting and event sponsored by or convened during the planning process, including tours, Public Forums, the Macroinvertebrate Study and Steering Committee meetings. She pushed all of us to ask more questions, find more data, present information in a more user-friendly fashion, and bring more people into the circle of stakeholders.
>
> ***Cheryl Baltrip, Supervisor of Exeter Township*—**Cheryl and her staff graciously agreed to host Steering Committee meetings to minimize travel times for attending participants. This meant juggling other meetings in Township Hall and moving tables and chairs on a regular basis. But, most important, it meant providing coffee and soft drinks, cookies, chips, pretzels and other assorted goodies, necessary to improve the mood of meeting participants.
>
> ***Roger Bezek, watershed property-owner and farmer*—**Roger also was an active participant in planning activities as an alternative representative from Exeter Township, and he provided the group with an important perspective on the impact of agricultural uses on the watershed and of the potential impact of recommended strategies for mitigating watershed problems on those same agricultural uses. His was an important voice at the table.

Another person who contributed much time, energy and baked goods to the planning discussions is not named on either of the two committees mentioned above. ***Aretta Schils***, a resident living in the watershed in London Township, attended most of the Steering Committee meetings over the first twenty months of the project until health problems required her attention.

Many different professionals provided technical assistance and advice during the planning process, especially as the Steering Committee began to focus on recommendations for action. But, the work of ***Harry Sheehan*** from the Office of the Drain Commissioner, Washtenaw County, and ***Dennis Rice*** from the Washtenaw County Conservation District, warrant special mention. Harry participated in a number of Steering Committee meetings and shared his expertise from working with the Huron River Watershed Council. Both Harry and Dennis thoroughly examined and carefully commented on the draft table of action strategies over a three month period as final decisions were reached by the Steering Committee.

While the role of the two project staff from Eastern Michigan University is noted on the title page and in the list of Steering Committee members, two other groups of people need to be recognized, along with the contributions of a former EMU staff member.

Over the past two and half years, three different EMU students have supported the planning process, providing logistical support, attending meetings and taking minutes, and serving as the connecting link between ICARD and various project participants; they include ***Laura Shue (now Larson), Megan Lindsey and Jennifer Hartlep.*** We hope they learned as much as we did about watersheds, collaboration and grant relationships in the process.

In addition, Charles Monsma, Director of the Institute for Community and Regional Development, Jane Wright, Grant and Contract Administrator, and the rest of the ICARD staff took care of the mundane but nonetheless important financial and administrative details involved in implementing the 319 planning grant. This relieved the project directors of those duties and allowed more time to devote to the scientific/technical and political issues to be addressed in a watershed encompassing two counties and portions of three cities, a village and eight townships.

While she left the University before the project began, ***Dr. Anita Zot***, the Director of the Water Resources Consortium at EMU, was the instigator behind the project, assembled the initial working group of township and county officials and other stakeholders, and drafted the original 319 proposal. She left the area before seeing the fruits of her efforts, but her contributions should not go unnoticed.

Finally, several different staff from DEQ assisted project implementation over the past thirty months; they are listed among the members of the Technical Committee. But ***Janna Sebald***, the Stony Creek liaison from the Jackson Office, proved demanding yet patient and supportive. When she didn't have the answers to questions we asked because of her newness to the 319 task, she did not hesitate to identify other DEQ staff who could help. Her turnaround time in providing feedback on draft materials was always surprising, and she like several of the other committee members, had more than one run-in with bad weather during the winter months.

We appreciate the help of these and all the other people who were instrumental in creating the Stony Creek Watershed Management Plan.

Dr. Joe Ohren and Dr. Kevin Gustavson, June 2005

Stony Creek
Watershed Management Plan

Detailed Table of Contents

Volume II Appendices

STONY CREEK WATERSHED MANAGEMENT PLAN

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June 2005

Chapter 1: Introduction and Public Participation

1.1 Introduction

The Stony Creek Watershed lies within Washtenaw and Monroe Counties in Southeastern Michigan (Figure 2.1) and contains portions of Pittsfield, Ypsilanti, York, Augusta, Milan, London, Exeter, Ash, and Frenchtown Townships, and very small parts of the cities of Ann Arbor, Ypsilanti, Milan, and the Village of Maybee. Sandwiched between the larger Huron River Watershed and the River Raisin Watershed, the Stony Creek Watershed is a long, narrow watershed (about 32 miles long and 8 miles at its widest) that is oriented northwest-southeast and tapers as it drains toward Lake Erie in Frenchtown Township just north of Monroe, MI.

The upper portion of the watershed, in Washtenaw County, is developed, with significant residential, commercial and industrial land uses, and developing. More importantly, evidence suggests that the pace of development has quickened, especially in Augusta and Ypsilanti Townships, contributing to the pressures on and problems in the watershed. Land uses in the Monroe County portion of the watershed are largely agricultural, with pockets of residential development in the northern townships and more dense residential development in Frenchtown Townships, at the lower end of the watershed.

Several studies of water quality were conducted in the 1990s in various parts of the Stony Creek basin. A 1995 study by the Michigan Department of Environmental Quality concluded that the water quality and macroinvertebrate community in Amos Palmer Drain, one of the tributaries of the Stony Creek, were extremely impaired. A similar assessment two years later by the MDEQ concluded that water quality and the macroinvertebrate community in Amos Palmer Drain were extremely impaired.

Given development patterns in the watershed, particularly in the headwaters of Paint Creek and Stony Creek, which suggested continued threats to the quality of water in the several creeks and drains which make up the watershed, a group of local citizens came together in late 2001 to discuss the feasibility of preparing and submitting an application to MDEQ for funding to support preparation of a watershed management plan. Such a plan would provide a comprehensive and long-term effort to engage citizens and communities in a systematic effort to improve and protect water quality in the watershed.

With support from a number of local government officials in the watershed, a team of Eastern Michigan University (EMU) faculty was assembled, drawing on the resources of the Institute for Community and Regional Development (ICARD) and the Water Resources Consortium (WRC). In collaborative fashion the group met over several months and drafted a proposal for a 319 planning grant to support development of a watershed management plan for the Stony Creek watershed. The proposal was endorsed by nearly every local government unit with significant land area in the watershed, and an award was made to EMU as fiduciary agent for the planning process. Initial efforts to implement the proposed planning process began in early 2003.

1.2 Early Steps

Early project efforts were devoted to establishing a Steering Committee and creating other mechanisms for engaging and informing the public about the unfolding 319 planning process.

1.2.1 Establishing the Steering Committee

Initial efforts were devoted to selecting a representative body to guide the decision-making process. Given the fact that the watershed encompassed a number of local government jurisdictions in two counties, the decision was made to secure representation from as many of those local government jurisdictions as possible. These were viewed as the key implementation bodies and were viewed as critical to the success of the planning effort. Letters were sent out to each of the eight townships in the watershed as well as the village of Maybee, describing the process of assembling the 319 planning grant proposal and the tasks ahead in the watershed management planning process. An opportunity to present a brief discussion of the project at a regular board meeting was sought and each Board was invited to identify a representative to serve on a newly created Stony Creek Steering Committee.

Professor Ohren attended each meeting, outlined the process, answered questions and again reiterated the invitation to participate. Of the eight townships and one village, seven townships appointed a representative to the Steering Committee. Ash Township, with little land area in the watershed, was not responsive to the request; the village of Maybee assigned its engineer to keep abreast of progress of the watershed plan. In addition to the township representatives, each of the two Drain Commissioners was asked to appoint a representative to the Steering Committee. The membership of the Stony Creek Steering Committee is noted in the Appendix.

1.2.2 Role of the Steering Committee

The Stony Creek Steering Committee served as the key decision-making body throughout the planning process. Staff worked closely with the Committee, preparing supporting materials for monthly meetings and engaging the group in the critical decisions throughout the process. After the first one or two monthly meetings, held on the campus of EMU for convenience of staff, the remaining meetings were held in the Exeter Township Hall, located in the middle of the watershed. This minimized travel times for members, and generally five or six of the eight townships were represented at monthly meetings. Minutes were kept of all Steering Committee meetings and formed a record for purposes of preparing quarterly reports; they were also posted on a newly created website to insure wider dissemination. While there was some turnover among Steering Committee members over the course of the two-year planning process, the Committee provided leadership and continuity in decisions. Ultimately, as will be noted later, the draft watershed management plan was also presented to each of the Boards by EMU staff with an invitation to support the plan through a Resolution.

1.2.3 Stony Creek Stakeholders

In order to broaden participation in the planning process and to keep a wide array of community members informed about the unfolding watershed plan, a second group of individuals and organizational representatives were solicited to make up what came to be called the Stakeholders List. Included on the List was an assortment of other governmental agencies as well as representatives of groups with specific interest in the watershed.

In addition, any individual who expressed interest in the work of the Steering Committee or who participated in any of the Committee's meetings, volunteer activities or public events were added to the Stakeholder List. This insured that a wider group of interested residents and stakeholders would be kept apprised of the unfolding planning process.

Members on the list received email updates of the activities of the Steering Committee, were invited to attend all Committee functions, were sent minutes of Steering Committee meetings and copies of all supporting material, and specifically were invited to participate in several public participation efforts, described more specifically below. While the Stony Creek Stakeholders never formally convened as a group—hence the name Stakeholders List—the group served an important information-sharing role as the planning process progressed over two years.

1.2.4 Stony Creek Technical Committee

Still a third vehicle for sharing information and providing insight into the Stony Creek planning process is reflected in the creation of the Stony Creek Technical Committee.

Several of the municipal jurisdictions forwarded the names of individuals and groups that would be interested in providing professional or technical advice for the Steering Committee. In addition, staff sought out representatives of key watershed related agencies and organizations to secure nominations for an advisory group. These included individual citizens, community groups and national organizations such as the Sierra Club, as well as a variety of local, state and national agencies with relevant administrative responsibilities, such as the Soil Conservation Service. A contact list of such individuals and groups was maintained and they too were notified of committee meeting dates, agendas and meeting minutes. Ultimately, from among this smaller group of experts, a Technical Advisory Group was formally convened to provide continuing guidance to the Steering Committee (a list of Technical Committee members is included in the Appendix).

On several occasions over the past two years the Technical Advisory Committee convened to address specific issues and questions and provide advice and recommendations to the Steering Committee. Members were asked for feedback on the desired uses of the watershed, as defined by the Steering Committee, the pollutants and impairments identified, the most effective means for engaging the public in the discussion of these issues, and ultimately reaction to the list of best management practices that emerged to address the challenges facing the watershed. Feedback from the Technical Committee was provided to Steering Committee members at their regular meetings, often in the form of supporting material.

In addition to periodic meetings, and because of the busy schedules of members of the Technical Committee, regular interactive communication occurred between EMU staff and Committee members. This proved to be an effective and efficient means for securing insights and feedback on decisions of the Steering Committee in developing the watershed management plan.

1.3. Opportunities for Information-Sharing and Public Participation

1.3.1 Stony Creek Community Forums

After several months of working together on early watershed planning tasks, the Steering Committee directed staff to prepare for and implement two community forums to inform the public about the unfolding planning process and to solicit public input on goals for the watershed as well as perceived water quality problems. Assistance was sought from the Huron River Watershed Council in developing plans for the forums, with HRWC staff attending several monthly meetings of the Steering Committee to describe options and opportunities for public participation. To publicize the events information was disseminated through the Steering Committee, to the Stakeholder List and the Technical Committee, announcements were sent to each of the Township Clerks for posting on local websites and distribution at regular Board meetings, and the local media were contacted to share the meeting dates and times.

Forums were conducted in each of the two counties to maximize public participation, and a brief presentation of the 319 planning process and a summary of water quality testing data to date were shared. Both programs, conducted in early 2004, followed a similar format reflected in the agenda below. The Monroe County presentation at Frenchtown Township Hall was not well attended, while the Washtenaw County presentation, held at the Ypsilanti District Library, drew nearly fifty residents from across the upper portion of the watershed. In both instances, Steering Committee members were present to answer questions, hear the comments and concerns presented by residents, and to be recognized.

- The Stony Creek Watershed
  - What is a watershed?
  - What and where is the Stony Creek Watershed?
- The Watershed Management Planning Process
  - Past Activity in the Stony Creek Watershed
  - The 319 Planning Grant
  - The Stony Creek Steering Committee
  - The Watershed Management Planning Process
- Tell Us What You Think About the Stony Creek Watershed
  1. How has the Stony Creek watershed changed in the past two decades?
  2. What are your concerns about the watershed today?
  3. The Steering Committee has identified four uses as most important for the Stony Creek watershed—do you agree? Would you add others?
  4. In thinking about impairments and challenges to the watershed, the Steering Committee has begun to discuss the most critical pollutants and impairments. Which impairments do you consider the most important, given the desired uses?
  5. What do you perceive as the causes of these impairments?
- Next Steps

As suggested by the agenda, the opening segments of the forum were primarily descriptive, letting participants know about the unfolding process and decisions to date. The latter part of the agenda involved an interactive exercise; participants were asked first to identify what they

perceived as the most critical impairments in the watershed, and then asked to rank order those impairments. The exercise was designed to help the Steering Committee complete a similar task as part of the planning process, and the results of the public priority-setting process are included in the Appendix.

1.3.2 Volunteer Activities

Several additional opportunities for information sharing and participation were pursued over the past two years, as described below.

1.3.3 Website Outreach

One of the first steps taken at the start of the planning process was to create a Stony Creek Website on the EMU computer system; http://www.emich.edu/wrc/stonycreek/. Dr. Gustavson created and maintained the site throughout the two year planning process and on a regular basis uploaded all Steering Committee materials as well as the results of the water quality testing conducted on a regular basis. As the draft watershed management plan began to take shape, earlier versions of the text were also uploaded to provide an opportunity for those on the Stakeholder List, the Technical Committee as well as other interested residents to review the progress of the planning process.

Individuals were encouraged through the site to send email about their watershed concerns. In addition, sections were created on the webpage to provide links to related sites, to encourage further reading and to promote personal decisions that could improve water quality in the watershed. Given the size and land area in the watershed, use of the website was seen as one of the critical means of continually communicating with and updating residents and interested parties about the progress of the Steering Committee.

1.3.4 Watershed Tours

At several times throughout the planning process, small groups of individuals from the Steering Committee, the Technical Committee, and other interested individuals completed tours of the watershed to identify sensitive areas, discuss impairments and consider action strategies for remediation. Initial tours were intended to familiarize participants with the entire watershed, since those that lived in the headwaters were not necessarily familiar with the lower end of the water shed, and vice versa. The tours also were publicized as a means for drawing attention to the planning process and enlisting additional interested participants. Names of participants were routinely added to the Stakeholder List, and feedback through these outreach efforts were incorporated into the findings of the Steering Committee.

In the summer of 2004, an additional tour was scheduled to accommodate the interests of Congressman John Dingell, who expressed an interest in seeing first hand the problems faced in the watershed, particularly related to farming interests. Dr. Gustavson organized the Stony Creek portion of the larger tour arranged by the Congressman's staff and shared on behalf of the Steering Committee the ongoing planning process. The Congressman appeared to be very concerned about under-funding of soil conservation projects and the apparent link between urbanization and flooding in the watershed, concerns already incorporated by the steering Committee into the priority impairments.

Related to the tours and insuring coordination of activities in the watershed, Steering Committee members were also kept apprised of work being undertaken in the Stony Creek under the auspices of the Monroe Soil Conservation District, pursuant to a Consent Agreement in a case involving discharges from the London Aggregates facility. The work involved removal of several log jams in a stretch of creek below the aggregate site along with stream restoration work, funded by the company. In addition, fish stocking will also occur once testing confirms that the water quality will support fish.

1.3.5 Macroinvertebrate Study

During the spring of 2004 another opportunity for public participation was provided. Nearly two dozen volunteers joined EMU staff and HRWC volunteers for a macroinvertebrate study in the Stony Creek. Several different sites were selected across the watershed. Volunteers met and picked aquatic insects from the creek under the supervision of HRWC volunteer leaders and collectors. The product of that effort, spread over two weeks as a result of high rainfalls, was presented to the Steering Committee as part of its analysis of the conditions in the creek. The event also was used to educate the public about conditions in the watershed (the report of the study is contained in the Appendix and is discussed in more detail in Chapter 3).

1.3.7 Presentations to Township Boards and Residents

As the watershed management planning process came to an end, with the direction of the Steering Committee, EMU staff coordinated and conducted presentations to a number of governmental and community bodies, sharing the results of the water quality assessments and the products of the Steering Committee's deliberations. These included presentations to the Ypsilanti Township Water Resources Commission, the Pittsfield Township Natural Resources Commission, and the Township Boards of each of the eight Townships in the Watershed.

Meetings were scheduled in advance through the office of the Clerk, and a request was made to invite members of the local planning commission to attend the meeting at which the presentation was scheduled. A Resolution for consideration by the Township Board, drafted by EMU staff and approved by the Steering Committee, was presented at each of the Township Board meetings, with the understanding that the Board would take up the Resolution at a subsequent meeting. While not all the information in the plan was presented at such sessions, a summary of water quality findings was provided, the list of priority pollutants and challenges was presented, and the Table of Action Strategies was disseminated and discussed. Those seeking additional information about the plan were directed to the project website. Subsequent to these meetings, copies of several Board Resolutions were received.

1.4 Summary

The success of efforts to address the water quality concerns identified in the Stony Creek Watershed as a product of this planning process does not rest in the hands of township governments alone. As noted later, it will depend upon collaboration among governing bodies of the several units of government that make up the watershed, and the cooperation of a number of community groups and stakeholders with an interest in the environment. More importantly, it will depend upon changing the behavior of citizens and residents who live and work and shop in the watershed. This plan and its recommendations is designed to affect that change, through its findings and recommendations.

This opening chapter of the Stony Creek Watershed Management Plan is intended to identify the key participants in the decision-making process and to describe the outreach efforts undertaken during the two and half year project.

Chapter two describes the watershed in considerable detail, providing information on soil makeup, geography, geology and topography; land uses, development patterns and population density; and hydrology. The information is drawn from a variety of sources, with most recent data utilized wherever possible.

Chapter three summarizes the findings of water quality testing undertaken during the watershed planning process as well as data from other relevant sources. This includes the results of water quality monitoring over a number of months by EMU staff and volunteers as part of the project, a macroinvertebrate study conducted in cooperation with volunteer leaders from the nationally known Huron River Watershed Council, and a detailed road crossings assessment by EMU staff, as well as past studies undertaken by DEQ and others of various aspects of the watershed and creek system. To the extent possible, findings have been digitized and reported in maps and graphs to facilitate dissemination and understanding, and at the point where information was reviewed and endorsed by the Steering Committee, it was posted on the project website.

Chapter four discusses the process used by the Steering Committee to articulate a vision, identify designated uses, designate critical areas, establish priorities for pollutants and challenges, and ultimately identify suspected causes of the pollutants and challenges manifesting themselves in the watershed. Goals for the watershed are noted at the end of chapter four.

Chapter five describes the recommended action strategies designed to address the concerns identified in the prior pages. Those strategies are identified in a lengthy table in the chapter and discussed in detail in the narrative.

Chapter six describes the education and information strategies recommended for implementation of the watershed management plan, with a summary table identifying specific target audiences and estimates of costs. As noted above, the Steering Committee recognized that much of the success of efforts to ameliorate the problems in the Stony Creek Watershed will depend on changing the behavior of individual residents and visitors.

Chapter seven provides an implementation plan, spelling out steps in the coming months to insure that the recommendations contained in the plan will be carried out. The chapter also identifies a set of both qualitative and quantitative evaluation strategies designed to capture the impact of efforts to impact individual behavior, to improve conditions in the Stony Creek and its tributaries, and ultimately impact the quality of life in the watershed.

A set of appendices make up the balance of the plan; in it we identify the names of the key participants in the planning process, describe the findings of the macroinvertebrate study in detail and the prioritizing of pollutants undertaken by the Steering Committee and the public, and offer other relevant information.

Chapter 2: Characteristics of Stony Creek Watershed

2.1 Location and Size

The Stony Creek Watershed lies within Washtenaw and Monroe Counties in Southeastern Michigan (Figure 2.1) and contains portions of Pittsfield, Ypsilanti, York, Augusta, Milan, London, Exeter, Ash, and Frenchtown Townships, and very small parts of the cities of Ann Arbor, Ypsilanti, Milan, and the Village of Maybee (Figure 2.2). Sandwiched between the larger Huron River Watershed and the River Raisin Watershed, the Stony Creek Watershed is a long, narrow watershed (about 32 miles long and 8 miles at its widest) that is oriented northwest-southeast and tapers as it drains toward Lake Erie just north of Monroe, MI.

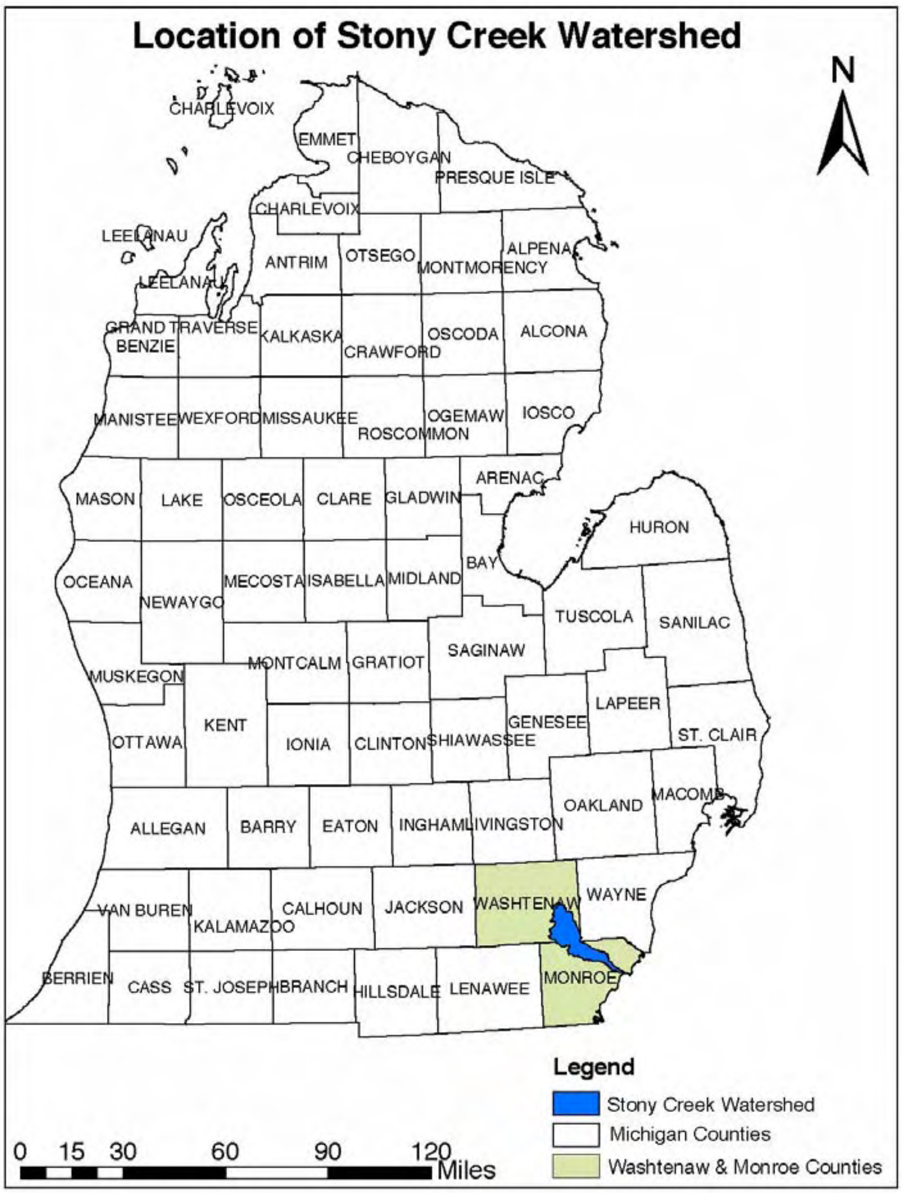

Figure 2.1: Location of Stony Creek Watershed in Washtenaw and Monroe Counties in Southeastern Michigan.

Figure 2.2: Map showing the boundaries of the Stony Creek Watershed, major roads, and the portions of local townships and cities within its borders. The boundary between York/Augusta and Milan/London Townships separates Washtenaw County to the north and Monroe County to the south (see Figure 2.1).

2.2 Geology and Topography

Bedrock Geology
The local bedrock that underlies the Stony Creek Watershed was deposited in a warm, shallow sea between 438 and 360 million years ago when most of North America was covered by oceans and had a tropical climate. The rocks that underlie the Stony Creek headwaters are younger shales and sandstones (rocks made out of clays and/or sand). The lower reaches of the watershed are underlain mostly by older limestone/dolostone (dissolvable) and sandstone (not easily dissolvable). Several quarries operate or have operated in the watershed in order to mine the limestone. The presence of this limestone and its chemical make-up also has an impact on surface and groundwater quality as discussed later in this document (Nicholas, et al., 1996).

Surficial Geology and Topograhy
Over the past million years, multiple glaciers have built up over the area and covered the bedrock with loose sediment as they melted away. The last glacier in the area piled sediment into a ridge along a line trending northeast-southwest passing through what is now Ypsilanti, building a moraine ridge a few miles wide and well over 100 miles long (Figure 2.3). This moraine ridge is made of sediments with a wide range of particle sizes (till), but with large amounts of fine particles (silt and clay) relative to till in many other parts of Michigan. Isolated pockets of sand and gravel deposited by glacial streams can be found associated with the till. This moraine ridge is in the extreme headwaters of the watershed and gives this part of the watershed the steepest slopes, up to 6 degrees (Figure 4). Water draining off the southeastern side of this ridge flows through the Stony Creek Watershed, whereas the northern side of this ridge drains the opposite direction into the larger Huron River and Raisin River Watersheds.

The rest of the watershed is dominated by glacial lake deposits. As the glaciers melted back, they occupied the low areas in Lake Huron and Lake Erie and blocked the current drainage of surface water through Lake Erie toward the Atlantic Ocean. As a result, the glaciers dammed a large lake that flooded the landscape to the edge of the moraine ridge in the upper part of the watershed. Fine clay and silt sized particles were deposited in the lake. Sand was deposited in places along the lake shorelines and in near shore environments as the lakes slowly got smaller toward their current sizes. This lower portion of the watershed tends to be much flatter than the upper watershed with maximum slopes usually no more than about 1 degree (Figure 2.4). Buried moraine ridges may be responsible for the slightly steeper slopes in this part of the watershed.

The surficial deposits are thickest in Washtenaw County and in London Township in Monroe County, where sediment thicknesses can exceed 150 feet. The lake deposits decrease to generally 20 feet or less in Exeter and Frenchtown Townships near the mouth of Stony Creek (Nicholas, et al, 1996). The thinner the surface deposits, the closer bedrock is to the surface. Therefore, quarries tend to be located in the lower half of the watershed. These surface sediments have a profound effect on the watershed hydrology, as discussed later.

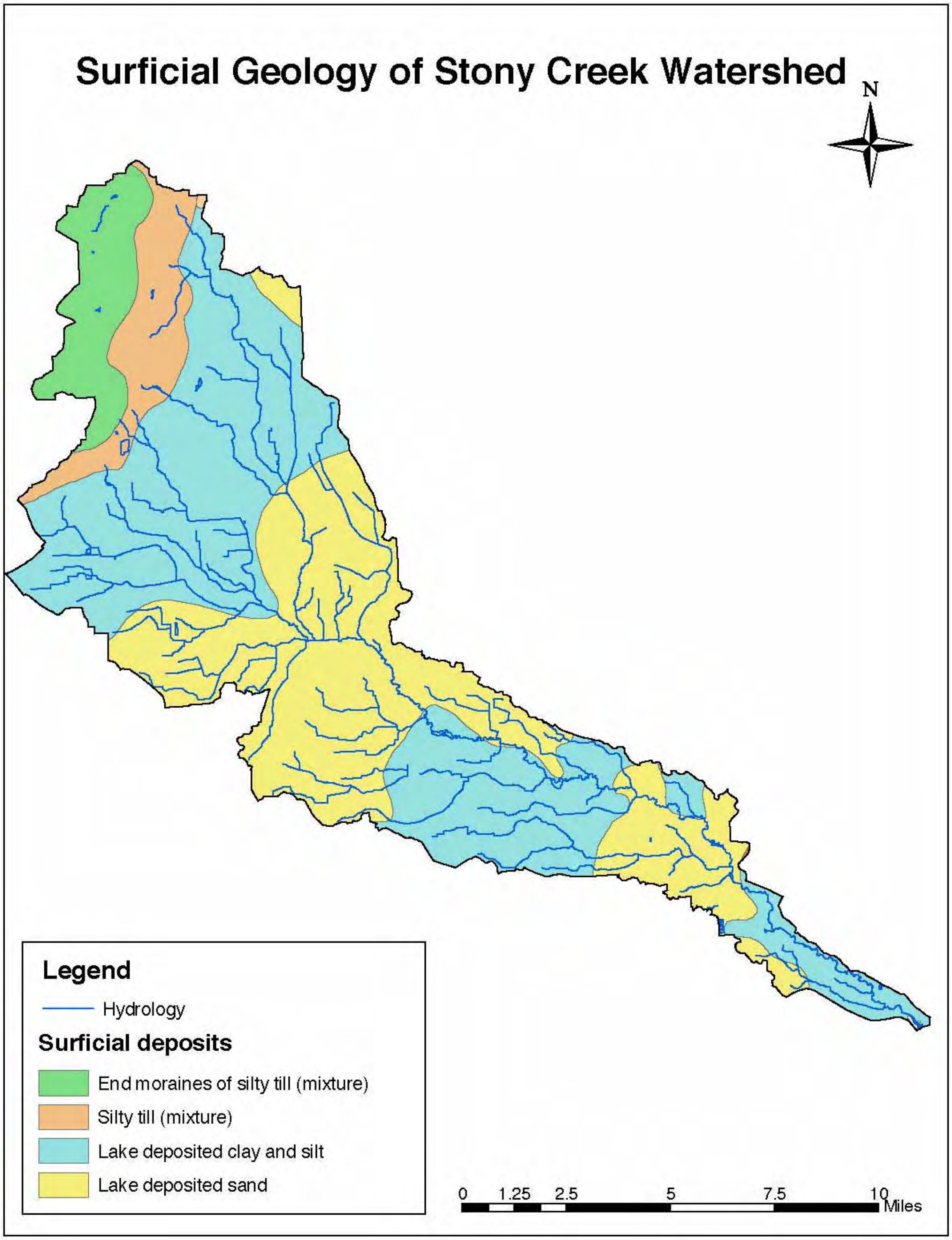

Figure 2.3: Map showing surficial geology (glacial deposits) in the Stony Creek Watershed. A relatively steep end moraine lies in the upper watershed made of a mixture of clay, silt, sand, and larger particles. Flatter sorted (not mixed) lake deposits of sand or silty/clay overlie the majority of the watershed.

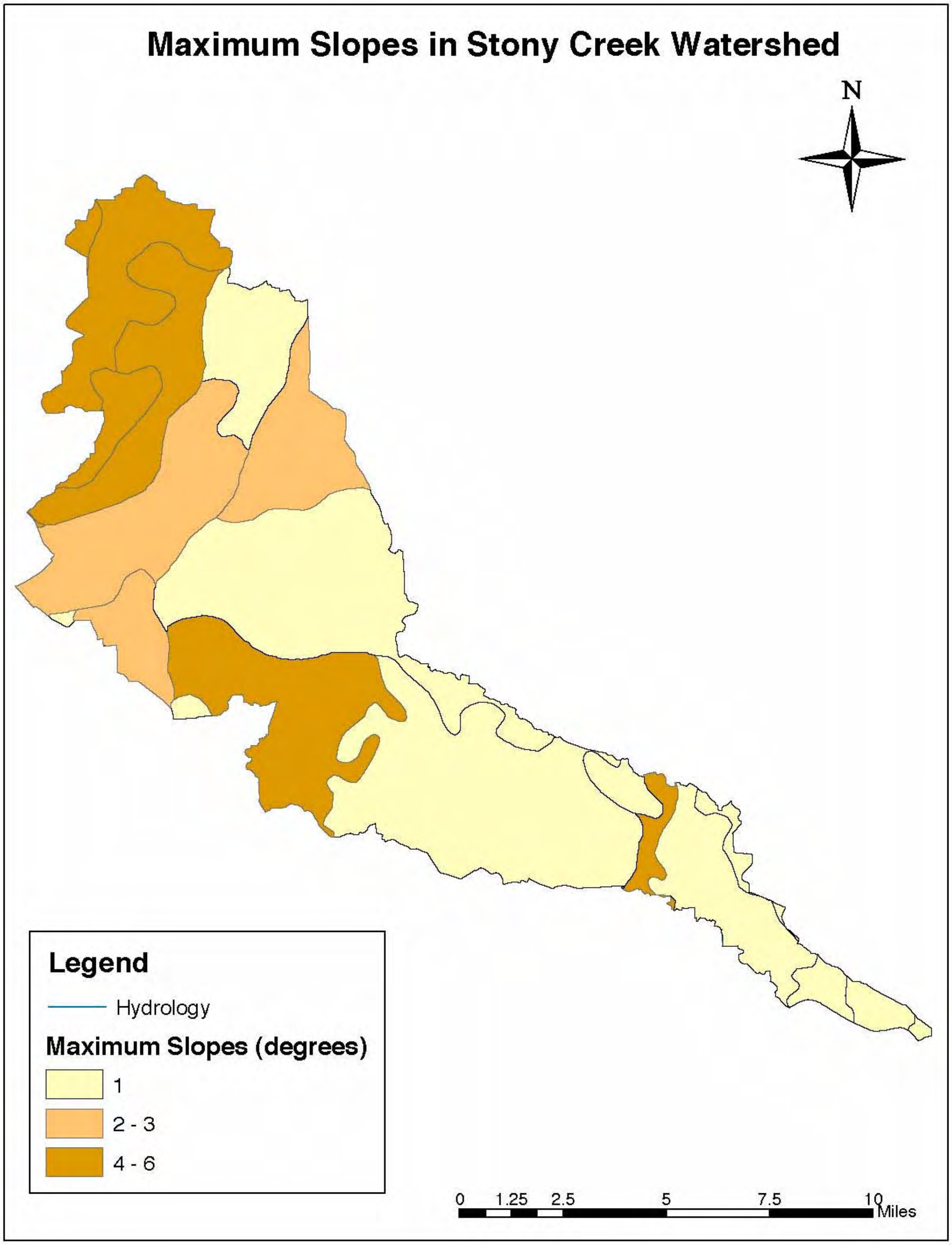

Figure 2.4: Map of the maximum slopes in areas of the Stony Creek Watershed. Notice how the areas with the maximum slopes in the upper watershed correspond to the glacial moraine (Figure 2.3). The other areas of high slope probably correspond to other moraine ridges buried by lake sediments at the surface.

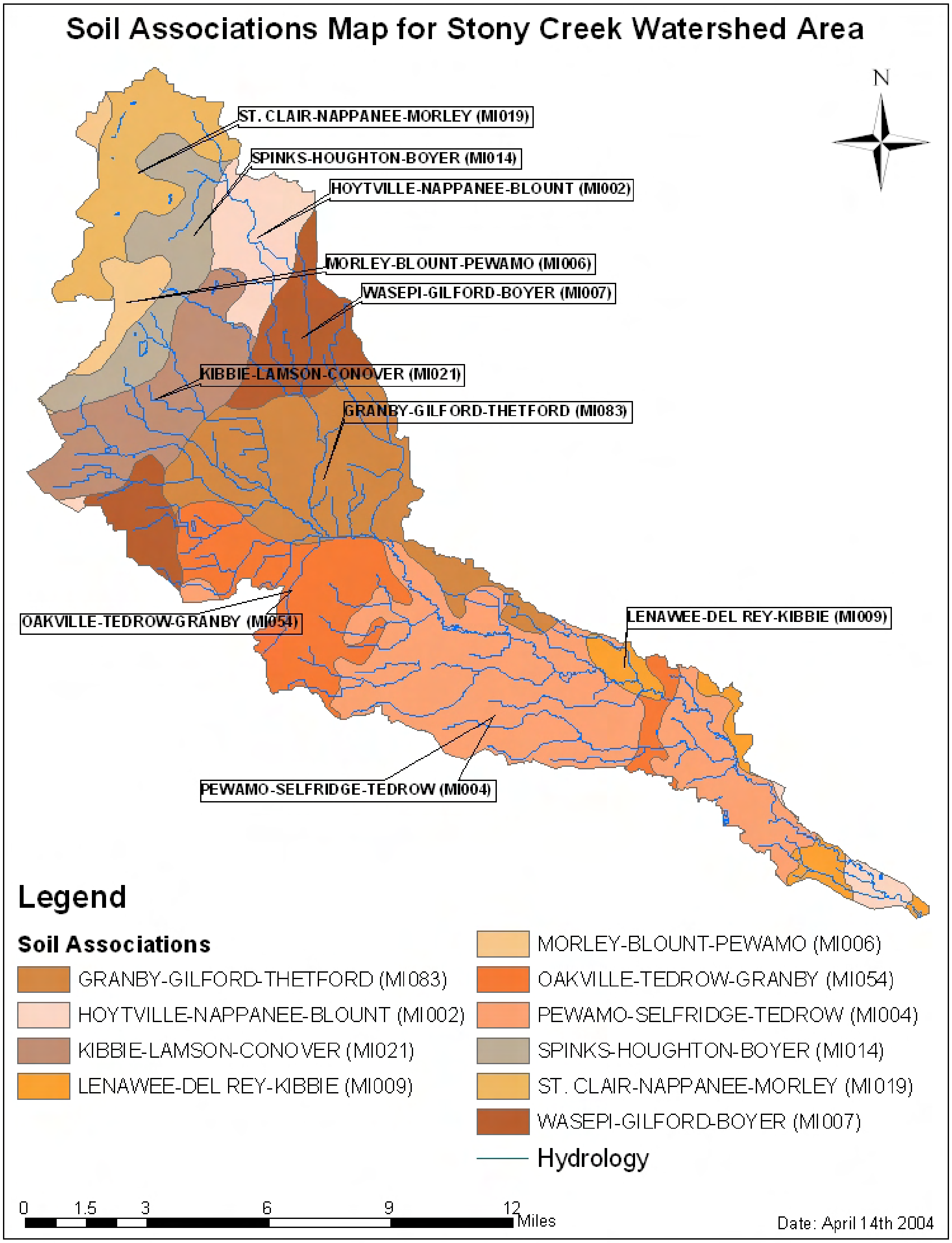

Figure 2.5A: Soil associations in the Stony Creek Watershed with their numeric codes. Descriptions of these soil associations are included in Figure 2.5B.

Soil Association Descriptions

Legend

Soil Associations

- GRANBY-GILFORD-THETFORD (MI083)
- HOYTVILLE-NAPPANEE-BLOUNT (MI002)
- KIBBIE-LAMSON-CONOVER (MI021)
- LENAWEE-DEL REY-KIBBIE (MI009)
- MORLEY-BLOUNT-PEWAMO (MI006)
- OAKVILLE-TEDROW-GRANBY (MI054)
- PEWAMO-SELFRIDGE-TEDROW (MI004)
- SPINKS-HOUGHTON-BOYER (MI014)
- ST. CLAIR-NAPPANEE-MORLEY (MI019)
- WASEPI-GILFORD-BOYER (MI007)

GRANBY-GILFORD-THETFORD (MI083)
Consists of poorly drained, rapidly permeable soils on lake plains, outwash plains, and in glacial drainageways. Formed in sandy loam material, slope is 0 to 2%. Gilford soils have more clay in subsoil. Tedrow soils are somewhat poorly drained.

HOYTVILLE-NAPPANEE-BLOUNT (MI002)
Consists of poorly drained soils on ground moraines & lake plains, formed in fine textured material, with low permeability and slope 0 to 2 %. Nappanee soils are somewhat poorly drained.

KIBBIE-LAMSON-CONOVER (MI021)
Somewhat poorly drained, moderately permeable soils on lake plains and deltas. Formed in loamy & sandy glaciofluvial deposits.

LENAWEE-DEL REY-KIBBIE (MI009)
Consists of poorly or very poorly drained, moderately permeable soil on lake plains, formed in loamy and clayey lacustrine. Del Rey soils are somewhat poorly drained, fine textured subsoil are on slopes similar to Kibbie soils.

MORLEY-BLOUNT-PEWAMO (MI006)
Nearly level to strongly sloping, poorly drained to well drained soils that have a moderately fine textured & fine textured subsoil and underlying material on moraines and till plains. Permeability is moderately slow.

OAKVILLE-TEDROW-GRANBY (MI054)
Consists of well drained, rapidly permeable soils on lake plains & glacial outwash plains, formed in sandy material. Tedrow soils are somewhat poorly drained & are in positions lower than Oakville soils. Grandby are poorly drained & are in low lying depression areas.

PEWAMO-SELFRIDGE-TEDROW (MI004)
Poorly drained, low permeability on ground moraines & lake plains, formed in loamy glacial till. Selridge soils have coarse texture, somewhat poorly drained & are on slight knolls. Tedrow soils are poorly drained.

SPINKS-HOUGHTON-BOYER (MI014)
Consists of very poorly drained, rapidly permeable soils on lake plains & glacial outwash plains, formed in deep sandy material.

ST. CLAIR-NAPPANEE-MORLEY (MI019)
Nearly level to very steep, poorly drained, moderately well drained and well drained soils that have a fine textured subsoil and fine textured underlying material on moraines, till plains and lake plains. Permeability is very slow.

WASEPI-GILFORD-BOYER (MI007)
Somewhat poorly drained soils on till plains, formed in sandy & loamy glacial till, moderately rapid permeability. Gilford are poorly drained soils on outwash plains.

Figure 2.5B: Legend for Soil Associations map (Figure 2.5A) showing descriptions of soil associations in the Stony Creek Watershed.

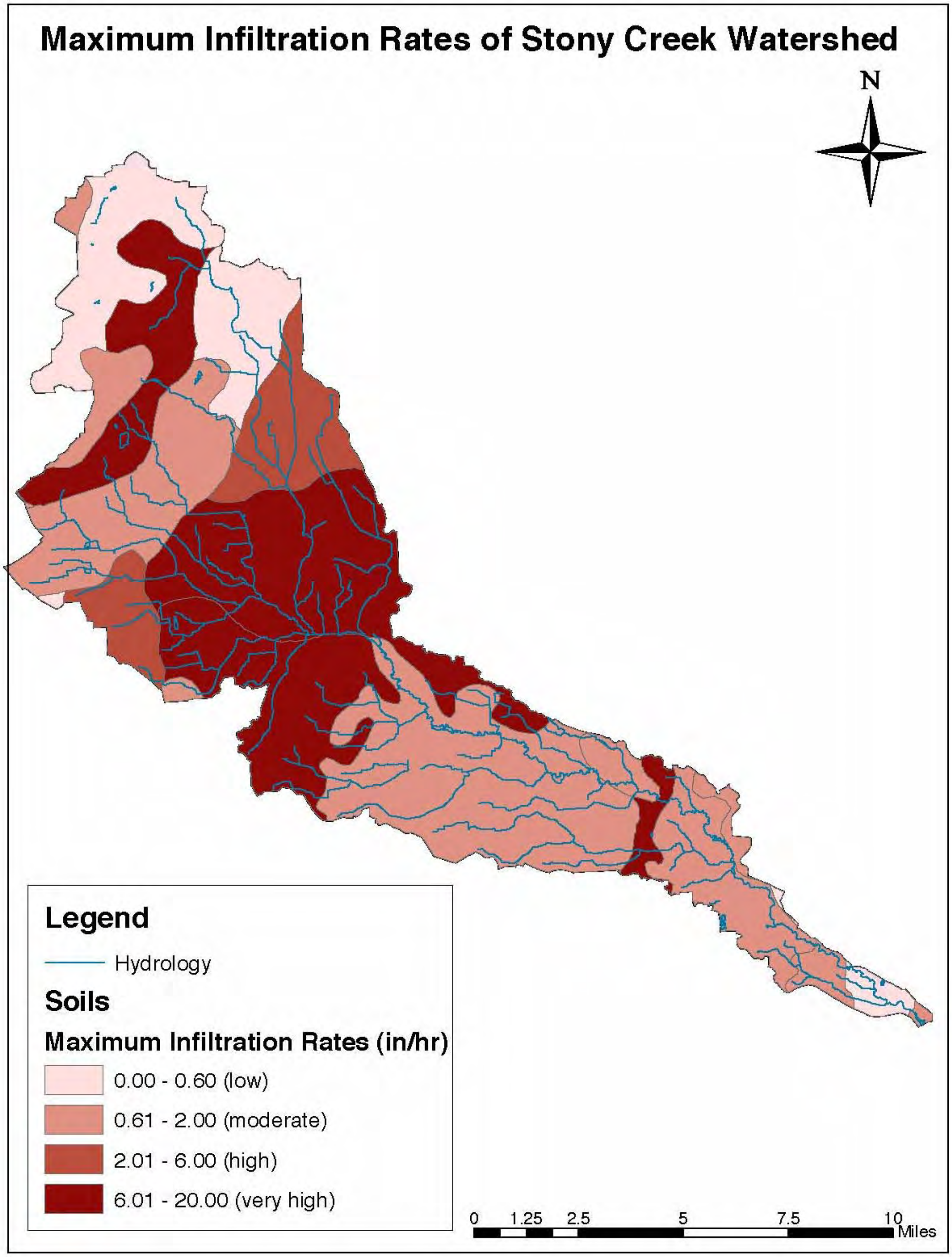

Figure 2.6: Map of the maximum infiltration rates for soil associations in the Stony Creek Watershed. Note that the best drained soils are generally in the central portion of the watershed and roughly coincide with the sandy areas on the surficial geology map (Figure 2.3).

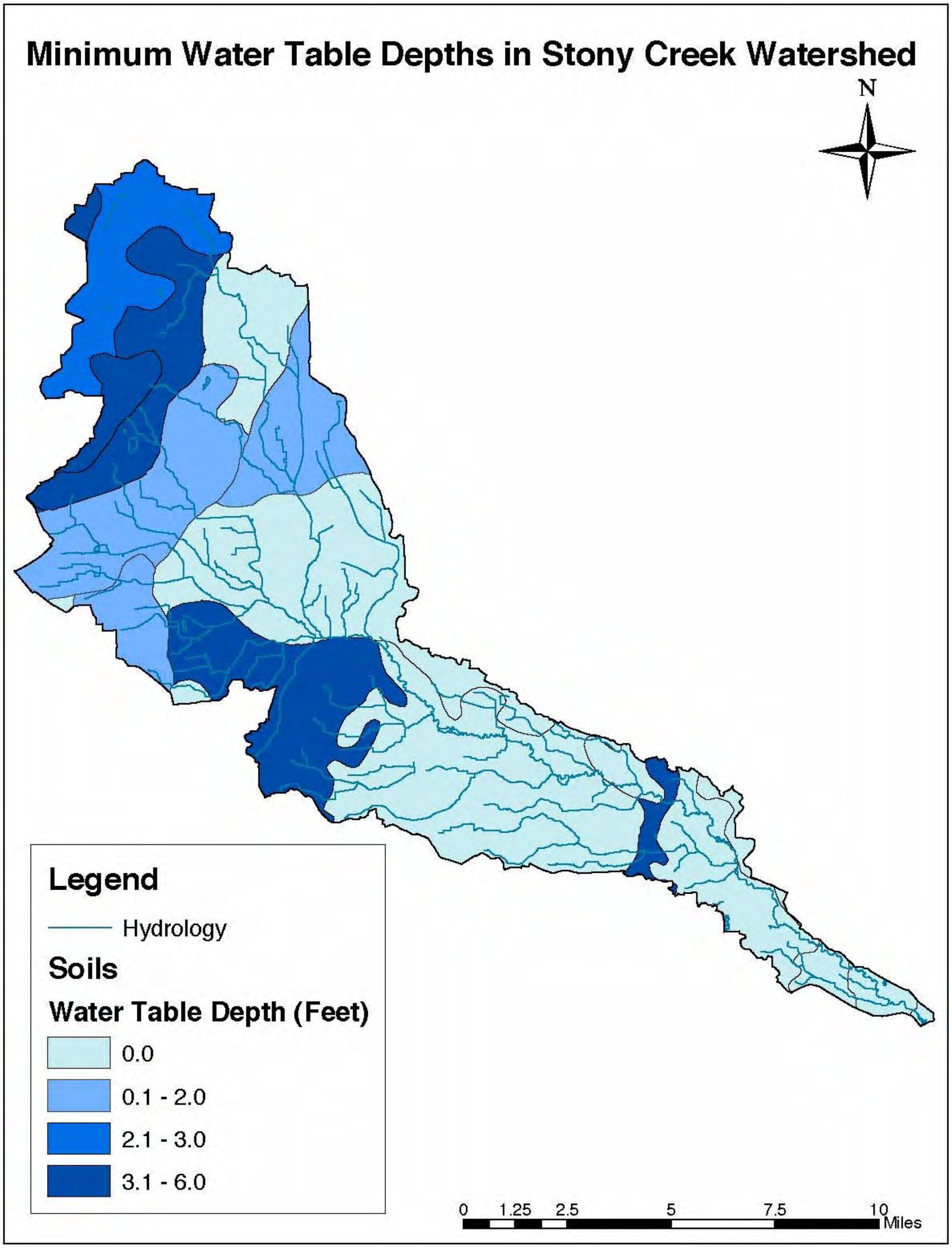

Figure 2.7: Depth to water table (generalized) shows relative drainage of the landscape. A large portion of the watershed has very high water table that indicates poorly drained soils.

2.3 Soils, Infiltration, and Groundwater

Ten soil associations have been mapped in the Stony Creek Watershed (Figure 2.5A) and are described in the detailed legend (Figure 2.5B). Soils are weathering horizons that form in glacial deposits and rocks that are exposed at the earth's surface. In the Stony Creek Watershed, the geologic material (sand, clay, etc) has a profound effect on the soil properties. The glacial tills dominated by fine particles in the upper watershed and the lake deposits that were dominated by fine particles in other parts of the watershed have developed into soils rich in fine particles. These soils generally have low to moderate maximum infiltrations rates below 2 inches per hour (Figure 2.6). The areas in the central watershed are rich in sand deposited in a lakeshore environment (Figure 2.3) and drain more readily with maximum infiltration rates 2 to 20 inches per hour (Figure 2.6). The infiltration rate of soils has a profound effect on the hydrology, as discussed later.

There are two main aquifers under the Stony Creek Watershed: the upper aquifer in the surficial deposits and a lower aquifer in the bedrock. The bedrock aquifer is closer to the surface in the area closest to Lake Erie, and is deeper in the upper watershed where there are thicker sequences of surficial sediments. Figure 2.7 shows a generalized depth to the water table map that is based solely on minimum expected depths based on soil association type. This map should not be used for specific projects where a more detailed distribution of groundwater should be determined. In general, over a large part of the watershed, the water table is essentially at the ground surface. However, the water table may be 6 feet or lower in other areas.

2.4 Land Use

Pre-settlement vegetation in the Stony Creek Watershed was dominated by wetland vegetation on the flat, poorly drained former lake plains (Figure 2.8) and generally forest in other areas. Conversion of the land to agriculture and development of the land for suburban and urban residential and shopping areas has drastically changed the vegetation in the watershed.

The most recent land use data for the Stony Creek Watershed is from 2001 and is based on the types of vegetation covering the landscape (Figure 2.9). As a result, the data actually represents earth cover rather than land use specifically. The major weakness of this system for determining land use is that trees that provide 25% canopy are considered forest, even if within a residential area. Therefore, the land use map actually visually minimizes the true scope of urbanization and suburbanization within the watershed. On the other hand, the satellite imagery used to generate these data can be used to identify types of trees present (including agricultural groves) and specific types of crops. So, the imagery is excellent at delineating land uses when the vegetation present is a clear indication of land use.

Agriculture

The land use map from 2001 (Figure 9) shows that the watershed is still dominated by agricultural uses (over 36%, excluding livestock). In addition, a substantial portion of the "Rangeland" category may be agricultural fields in fallow in 2001. The dominant crops in the watershed are corn and soybeans, in rotation. A third crop of significance, but much less common, is wheat. Agricultural areas tend to be on soils in flatter areas with high silt and clay

content (former wetlands in Figure 2.8). In addition, there are a few orchards in the upper half of the watershed. The main ways that agriculture affects surface water quality is through soil erosion and transport of fertilizers and pesticides with surface runoff. Many of the fields are tiled to increase drainage of the land and reduce surface runoff.

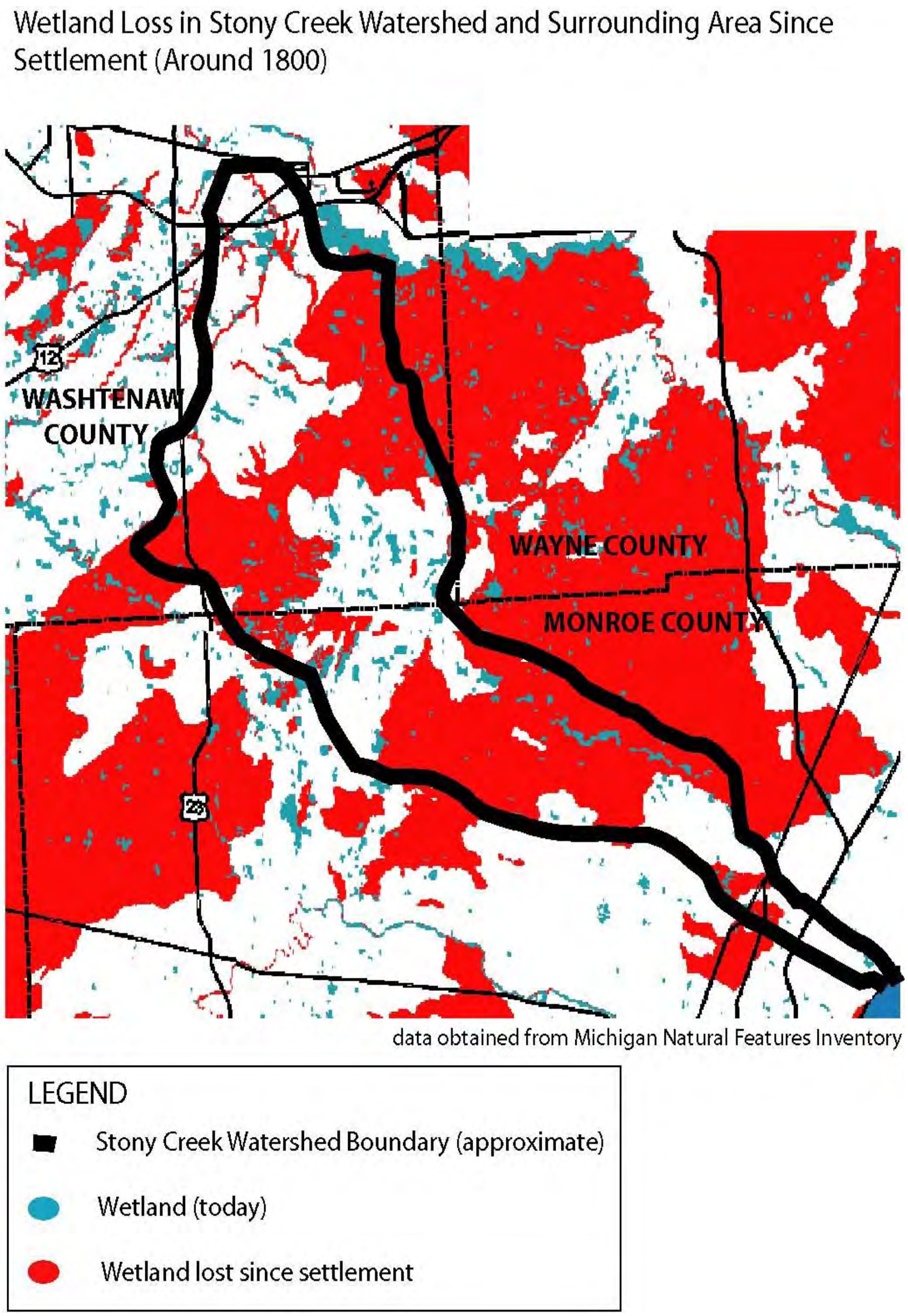

Figure 2.8: Map showing that about half of the Stony Creek Watershed was wetland before settlement. The remaining wetlands are only a tiny fraction of the original, natural condition of the watershed.

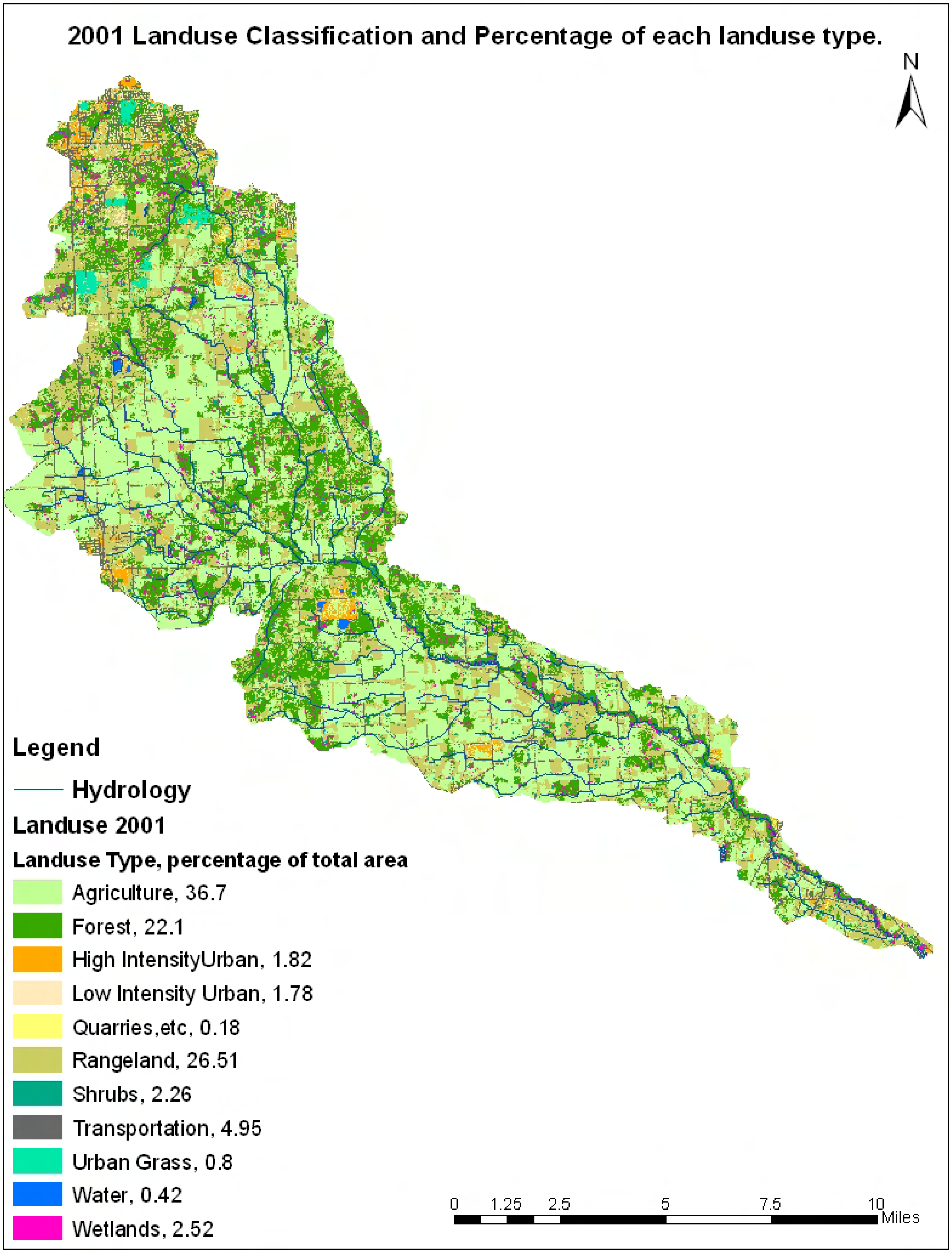

Figure 2.9: Map of the land uses in the Stony Creek Watershed in 2001 based on vegetative cover identified by satellite imagery. The image underestimates the amount of suburban land use where the tree canopy is at least 25% in residential areas.

Forest / Forested Residential / Shrubs

Over 24% of the watershed is classified forest or shrubs (Figure 9). There are fairly pristine stretches of forest, particularly along the major streams (Stony Creek and Paint Creek). The forest areas tend to correspond to coarser grained soils and generally hillier topography. A significant proportion of this category is actually forested residential areas or ones with significant tree cover, especially in the upper and central portions of the watershed. In general, forests provide good infiltration of stormwater, but forested residential areas are more likely to produce a fair amount of surface runoff, depending on how stormwater is managed in the area.

Rangeland / Grassland

Over 26% of the watershed is categorized as grassland. Some of this land is rangeland for raising animals (mostly cattle, horses, and sheep). A significant portion of this land, however, is probably agricultural fields that were fallow in 2001. Some of this land may also be farms that have been taken over by non-farming residents who have let prairie vegetation take over former agricultural fields. Prairie vegetation can absorb water well. Rangeland used for cattle can become more compacted by animals (leading to more runoff) and contain animal waste which could potentially contaminate surface water.

Urban / Transportation

About 9% of the watershed in 2001 was concentrated urban and impervious road surfaces. These areas are primarily concentrated in the upper watershed (the suburbs of Ann Arbor and Ypsilanti). To a lesser extent, there are concentrated urban areas around Milan, in the west central watershed and north of Monroe near the mouth of Stony Creek. As discussed previously, this category does not include residential areas with at least 25% canopy of trees. These areas collectively increase the amount of surface runoff in the watershed that can contain a variety of pollutants. This category, along with forested residential, is the most rapidly growing category in the watershed. Research has suggested that once a watershed attains roughly 8 to 10% imperviousness, streams start to exhibit severe erosion and severely increased flooding during rain events. As this land use expands, expect to find increasing problems with streams unless development takes place wisely.

Golf Courses and Urban Parks

Urban grass makes up close to 1% of the watershed. This grass is predominantly in the form of golf courses and a few parks. This category, however, would not pick up the numerous residential lawns that are included in the concentrated urban and forested residential categories. Use of fertilizers and pesticides on this type of vegetation can be a concern for watershed water quality.

Wetlands

Wetlands currently make up about 2.5% of the watershed area. Some wetlands are in the moraine areas in the upper watershed. Here, they are typically found in the low areas of this topography of undulating hills. Other wetlands are still concentrated along Stony Creek and, to a lesser extent, Paint Creek, Stony Creek's most significant tributary stream. The area had a much greater proportion of wetlands (about 50%) in pre-settlement times that were drained for agriculture and other uses. Wetland vegetation naturally cleans surface water. In addition, wetland areas provide natural buffers for water to be held by the landscape rather than sending

water quickly to streams when it rains. The loss of so much wetland in the watershed has significantly changed the hydrologic balance for Stony Creek.

Quarries
A few quarries exist in the central portion of the watershed totaling less than 1% of the watershed area, including one near Milan and one that is no longer operational in the center of the watershed. Since the quarries are pits, they would not affect surface water except that they draw down the water table (diverting baseflow to streams) and then discharge this groundwater into the surface water system, usually at higher volumes. As a result, pollutants normally found in groundwater can be detected in surface water. Although the percentage of land in this use is small, the impact on surface water quality can be very large.

Water
Less than a half percent of the watershed is in bodies of water. These features are mostly creeks and drains, discussed later. There are few open water bodies and none of significant size.

2.5 Community Profile

Census data from 2000 (Figure 2.10 on page 17) show the largest concentration or density of watershed residents living in the upper watershed (near Ann Arbor and Ypsilanti) and, to a lesser extent, farther south around Milan. Population has already increased dramatically since the census with the addition of hundreds of new homes in the upper watershed and will continue to increase. New developments are being constructed and others are in the planning stage.

Table 2.1 provides information on population for the two counties and the eight townships that make up most of the Stony Creek Watershed. The data on population and households are drawn from census figures and probably overstate population changes affecting the watershed since they reflect demographic changes for the entire jurisdiction, county or township, rather than just that portion of the jurisdiction in the watershed. Nonetheless, as is readily apparent, population has grown quite dramatically over the past two decades, especially in townships at the headwaters of the watershed in Washtenaw County.

Table 2.1 – Stony Creek Watershed Population and Population Change, 1980 - 2003

	1980	**1990**	**2000**	**2003**	**1990-2000 % Change**	**1980-2000 % Change**	**2000-03 % Change**
Monroe County	134,659	136,600	145,945	151,301	9.2%	83.8%	3.7%
Ash Twp.	7,688	4,710	5,048	5,793	7.2%	-34.3%	14.8%
Exeter Twp.	3,236	2,753	3,222	3,302	17.0%	0.4%	2.5%
Frenchtown Twp.	18,204	18,225	20,777	21,336	14.0%	14.1%	2.7%
London Twp.	3,266	2,915	3,024	3,182	3.7%	-7.4%	5.2%
Washtenaw County	264,748	282,937	322,770	340,406	14.0%	21.9%	5.5%
Augusta Twp.	4,643	4,415	4,813	5,971	9.0%	3.7%	24.1%
Pittsfield Twp.	12,997	17,650	30,167	32,855	70.1%	132.1%	8.9%
York Twp.	5,517	6,225	7,392	8,352	18.7%	34.0%	13.0%
Ypsilanti Twp.	44,511	45,307	49,182	52,138	8.6%	10.5%	6.0%

Table 2.2 provides similar information on households over the past two decades. Again, the data reflect continuing growth in the number of households throughout the watershed, with the exception of Ash Township (note that even in Ash Township the number of households has increased since 2000). Once again, the greatest increase in the number of households is evident in the townships at the headwaters of the Stony Creek Watershed.

Table 2.2 -- Stony Creek Watershed Households and Percent Change, 1980-2003

	1980 Households	1990 Households	2000 Households	2003 Households	1990-2000 %Change	1980-2000 %Change	2000-03 %Change
Monroe County	45361	46,508	53,772	57,000	15.6%	18.5%	6.0%
Ash Twp.	2556	1,588	1,803	2,138	13.5%	-29.5%	18.6%
Exeter Twp.	1021	861	1,092	1,146	26.8%	7.0%	4.9%
Frenchtown Twp.	6366	6,544	7,733	8,055	18.2%	21.5%	4.2%
London Twp.	939	919	1,009	1,085	19.8%	27.6%	6.8%
Washtenaw County	98172	104,528	125,232	133,807	17.5%	19.0%	29.2%
Augusta Twp.	1452	1,471	1,728	2,233	9.8%	7.5%	7.5%
Pittsfield Twp.	5797	7,013	11,817	12,924	68.5%	103.8%	9.4%
York Twp.	1218	1,416	1,901	2,193	34.3%	56.1%	15.4%
Ypsilanti Twp.	17259	17,637	20,194	21,668	14.5%	17.0%	7.3%

As evident in Table 2.3 below, the growth of households has outpaced the growth of population in almost all cases between 1990 and 2000. Since household size is decreasing, population has not been increasing as fast as households. But households drive the demands on land use. Thus, more households mean more demands for residential uses. And population and households drive commercial and other uses.

Table 2.3 – Comparison of Population and Household Change, 1990-2000

	1990-2000 Percent Change in Population	1990-2000 Percent Change in Households
Monroe County	9.2%	15.6%
Ash Township	7.2%	13.5%
Exeter Township	17.0%	26.8%
Frenchtown Township	14.0%	18.2%
London Township	3.7%	19.8%
Washtenaw County	14.0%	17.5%
Augusta Township	9.0%	9.8%
Pittsfield Township	70.1%	68.5%
York Township	18.7%	34.3%
Ypsilanti Township	8.6%	14.5%

Table 2.4 presents similar information on building permits over the past two decades, again reinforcing a general pattern of growth throughout the watershed. Notice that in some parts of the watershed, the pace of development has increased rapidly. For example, the number of building permits issued in London, Augusta, and Ypsilanti Townships in 2002 exceeded the annual average number of permits issued for the preceding four years. Indeed, the pace of construction has continued through 2003. For example, the number of permits issued in Augusta and Pittsfield Townships from January to October, 2003, exceeded the number for the entire year prior.

Table 2.4 -- Stony Creek Watershed Building Permits

	Bldg. Permit 1992-1996*	**Bldg. Permit 1997-2001***	**Percent Change 92/96-97/01**	**Bldg. Permit 2002**	**Bldg. Permit 2003** (As of October**)**
Monroe County	681	755	10.9%	748	461
Ash Township	25	29	16.0%	23	11
Exeter Township	18	16	11.1%	11	7
Frenchtown Township	112	106	-5.4%	69	33
London Township	15	21	40.0%	27	12
Washtenaw County	1911	2531	32.4%	2396	2010
Augusta Township	29	38	31.0%	39	54
Pittsfield Township	539	467	-13.4%	296	301
York Township	63	89	41.3%	60	43
Ypsilanti Township	275	372	35.3%	537	417

* Number reported is the annual average for the years in question.

The data on population, households and permits reinforce one another and confirm the assessment that growth is occurring in the townships that comprise the Stony Creek Watershed. The increased building, and corresponding increase in population, will increase the pressure on the remaining natural areas, wetlands, and waterways. In addition, there is strong potential for an increasing impact on water quantity and quality in the streams as the imperviousness of the landscape increases with construction of new roads, roofs, parking lots, sidewalks, and associated urban lawns.

Population growth and development is not only a concern for the upper watershed. Drinking water lines are to be installed up Stony Creek Road into Exeter Township from Monroe. With a public water supply, this part of the watershed could become a new area of development in the near future.

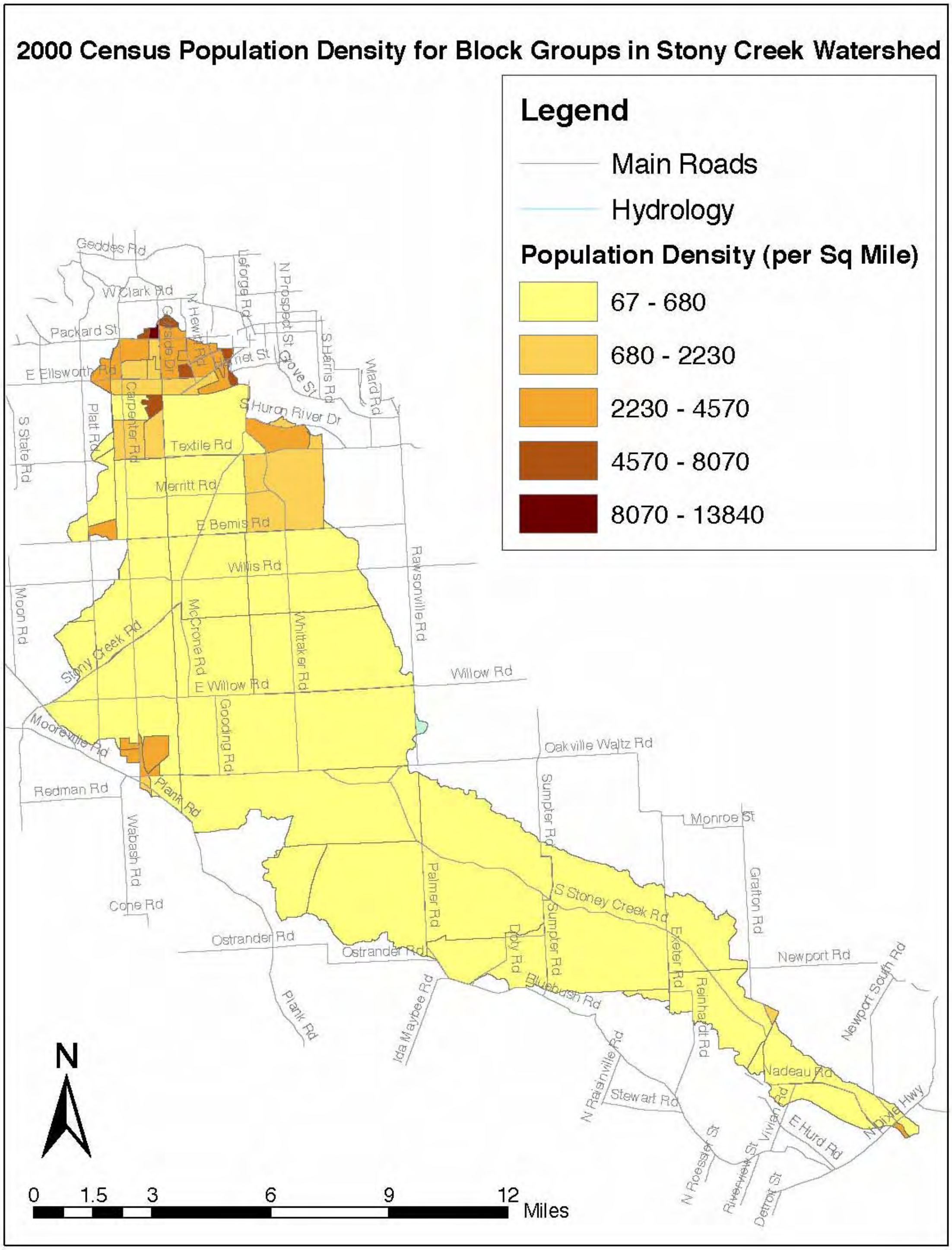

Figure 2.10: 2000 Census data show the largest concentration of watershed residents living in the upper watershed (near Ann Arbor and Ypsilanti) and farther south around Milan. Population has already increased dramatically this decade with the addition of hundreds of new homes and will continue to increase because new developments are on the way.

2.6 Rainfall and climate

Michigan's climate is strongly affected by the Great Lakes, which help ameliorate the typical extremes that most of the world's intercontinental areas experience. The greatest "lake effect" is in areas immediately adjacent to the lakes, with less influence farther inland. Stony Creek Watershed borders Lake Erie, but the watershed tapers to about 1 mile in the vicinity of this lake. As a result, the majority of the watershed experiences more of the inland extremes than otherwise might be expected from a watershed that directly feeds one of the Great Lakes. The greatest influence of the Great Lakes on the local climate is to contribute to cloud cover during late fall and early winter and therefore moderate daily low temperatures (Strommen, 1967, and Nurnberger, 1985).

There is one National Weather Service weather station in the Stony Creek Watershed, located in Willis on the border between Monroe and Washtenaw Counties – a central location in the watershed. Three other weather stations are located just outside the watershed in Ypsilanti and Ann Arbor (upper watershed) and Monroe (lower watershed). Summer temperatures seldom exceed 90°F with an average July high temperature of 83°F (slightly higher at Monroe). Winter low temperatures are regularly below freezing, but rarely fall below 0°F with an average January high temperatures of about 31°F (slightly higher in Monroe). The area does not often experience extended periods of extreme cold in the winter or similar periods of extreme heat and humidity in the summer (Strommen, 1967, and Nurnberger, 1985).

Average annual precipitation for the area is 30-32 inches per year (most at the Willis station). Precipitation generally falls regularly throughout the year with a relatively low risk of drought. More than half of the rainfall (about 18 inches) falls during the growing season (May-October). The driest month is February with less than 2 inches, while June is the wettest month with an average of about 3.5 inches at Willis. Summer precipitation generally comes in the form of thunderstorms or showers. Other months typically produce storms of lower intensity and longer duration (Strommen, 1967, and Nurnberger, 1985).

2.7 Hydrology

Water bodies

The major tributaries to Stony Creek include Paint Creek, Sugar Creek, and Buck Creek in Washtenaw County, and a series of drains mostly in Monroe County (Figure 2.11). Paint Creek originates in Pittsfield Township in the parking lot of Showcase Cinemas and flows through a heavily built up area of warehouses, strip malls and 5 lane roads. Paint Creek then passes through an area that has both older and newly developed and developing residential subdivisions. To the south, Paint Creek passes through farmland (which is quickly becoming subdivisions) until it reaches Stony Creek at the Washtenaw-Monroe County line. Sugar, Stony, and Buck Creeks all originate in York Township and pass through farmland, rangeland and newly developing land until they merge together within a couple miles of merging with Paint Creek. In Monroe County, a series of drains enter Stony Creek (including Amos Palmer Drain, Herkimer Drain, Ross Drain, and Robert Drain). These water bodies drain predominantly agricultural areas (mostly former wetlands).

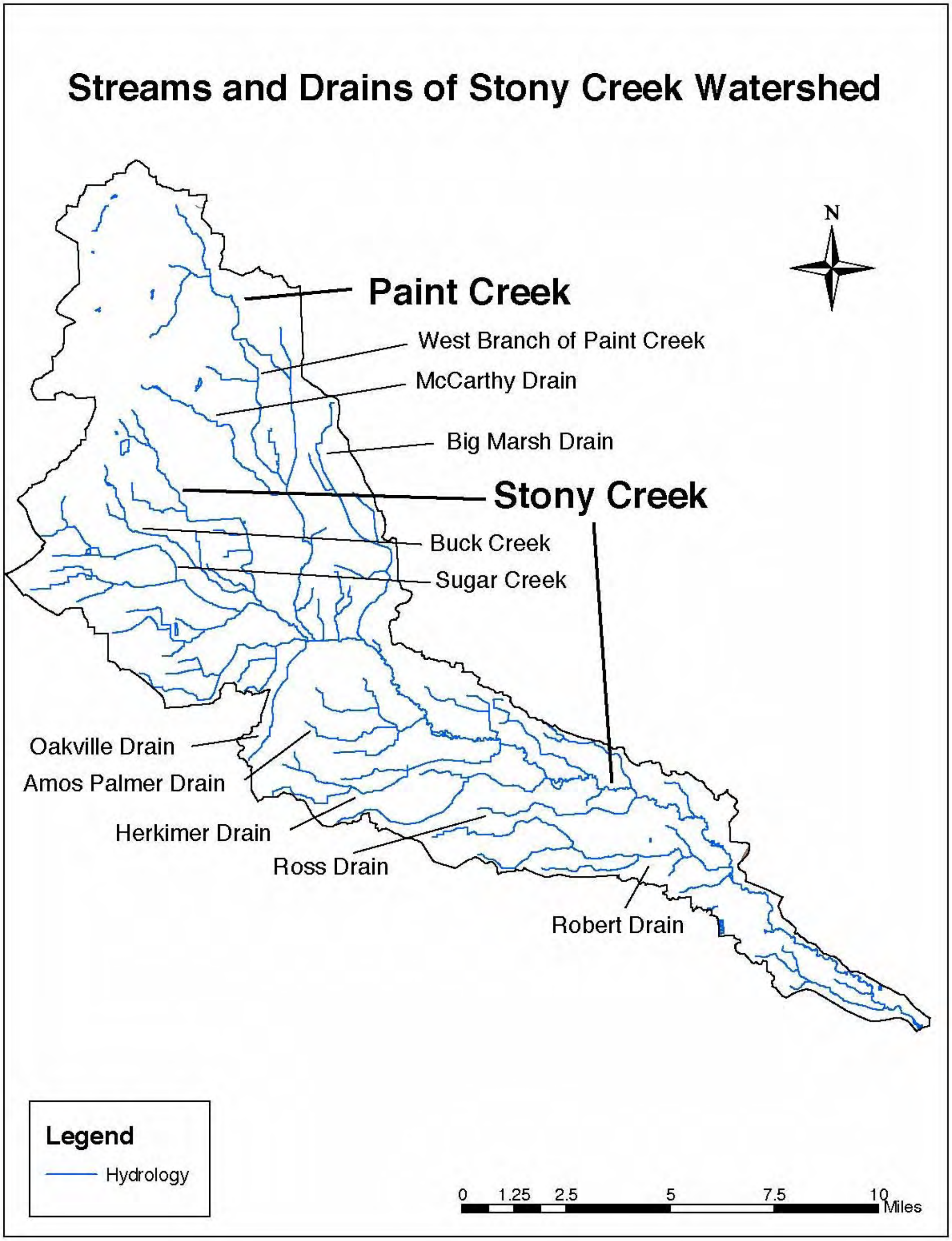

Figure 2.11: Map showing the location of Stony Creek and its major tributaries. The most notable and sizeable tributary to Stony Creek is Paint Creek, which drains the most heavily urbanized area in the watershed.

Discharge

The United States Geological Survey (USGS) has a monitoring station on Stony Creek where it crosses Tuttle Hill Road on the county line. This station is situated immediately downstream from the confluence of Paint Creek and Stony Creek. This station has been monitored regularly for discharge (volume of water per time) from 1970-1981, and then again for water year 2003 (from October 1, 2002 to September 30, 2003) as a part of a Monroe County groundwater study. During this period, discharge was measured continuously on Stony Creek using a pressure transducer and frequent measurements by USGS staff to ensure the proper relationship between pressure and discharge. For the full record (1970-81 and 2003), the annual mean discharge is 46.8 cfs (cubic feet per second), the highest discharge is 865 cfs (February 19, 1981), and the lowest discharge is 2.7 cfs (August 24, 1971). Figure 2.12 shows the streamflow over the 2003 water year. During this water year the mean discharge was 44.2 cfs, slightly lower than the mean annual discharge for the full period of record. The minimum discharge for water year 2003 was about 7 cfs (late July) and the maximum reached over 300 cfs (in mid-March). The discharge was generally greatest in the Spring (late March to June) and lowest during fall and winter (Figure 2.12).

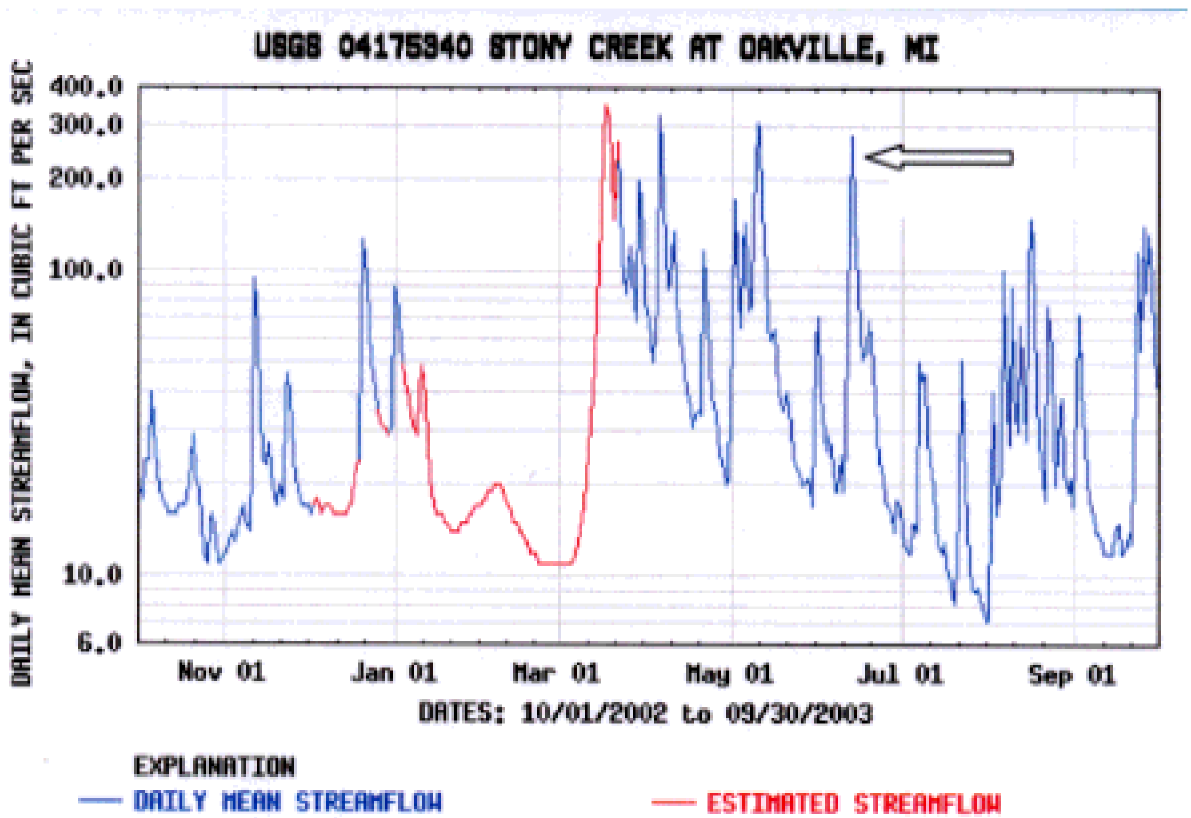

Figure 2.12: Graph showing discharge (volume per time of water) in Stony Creek over water year 2003 at Tuttle Hill Road on the county line. The curve for one rain event (indicated by an arrow above) is shown in Figure 2.13.

In general, the hydrograph of daily mean streamflow (Figure 2.12) shows a series of spikes in the graph that roughly correspond to rain events. Watersheds that experience a great amount of infiltration generally have a smoother graph (one with less rapid fluctuation). Figure 2.13 shows one of the "spikes" from the annual graph (Figure 2.12, spike indicated with an arrow) in greater detail with data recorded every 15 minutes over a period of 20 days. This graph of stream discharge from June 7-27, 2003, shows the response of Stony Creek to rainfall on June 11-13. A weather station near Milan reported rainfall amounts of 0.75 inches on June 11, 0.13 inches on June 12, and 0.80 inches on June 13. Given these data, it is safe to assume that the graph in figure 13 shows the response of approximately 1.68 inches of rainfall in the watershed, although summer storms are variable and may have dropped more or less rain over the watershed than at this one station.

Figure 2.13 shows that before the rain, groundwater was feeding the streams (baseflow) to produce about 20 cfs of discharge. After the rain started, the discharge increased to about 310 cfs within 24 hours – an increase of 15 times the pre-storm discharge. Note that this range of discharge values shows that within 24 hours the stream discharge was close to the lowest and highest values for the year. The stream returned to a discharge near the pre-storm discharge (baseflow) within about 5 days. This rapid response is shown by the high, sharp peak in the discharge curve (Figure 2.13).

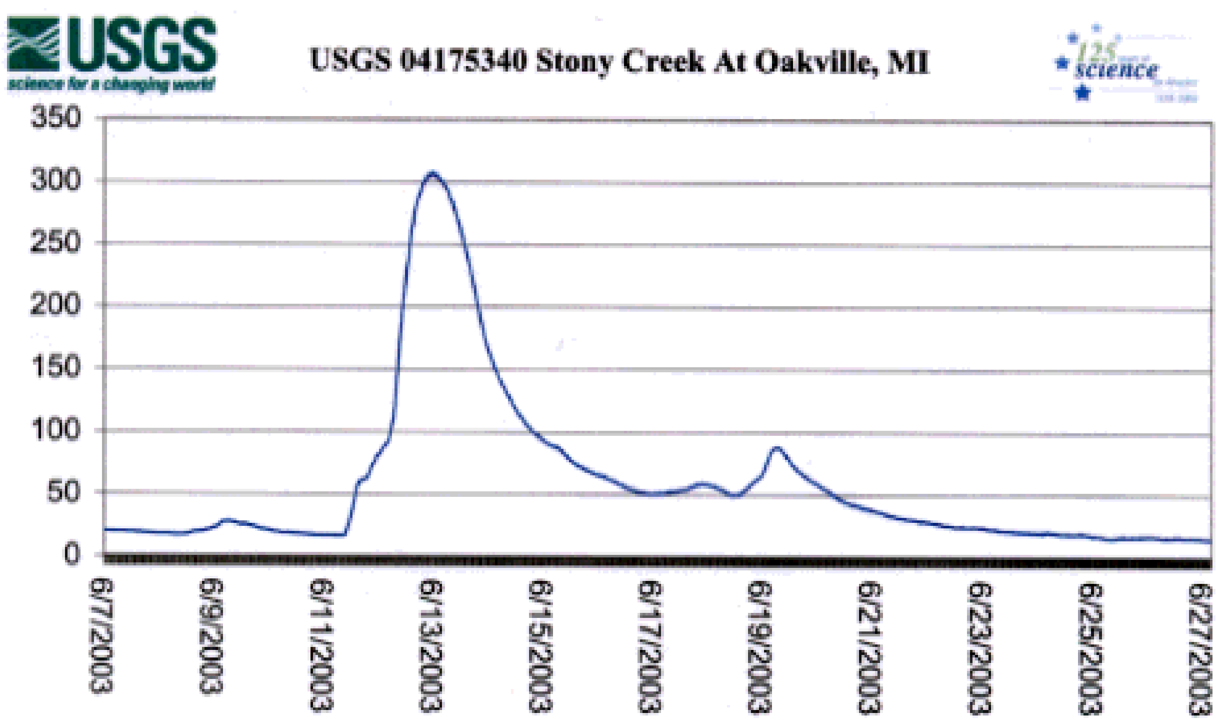

Figure 2.13: Graph showing discharge (cfs) vs. time (days) of the response of Stony Creek to rain over a few days starting June 11. Notice that the stream discharge increases rapidly and drops fairly rapidly again, typical of a watershed with low infiltration that produces a high amount of runoff.

Typically, this type of hydrograph response is produced in watersheds with low infiltration and therefore a high percentage of rain taking a fast path to streams over the land surface (runoff). The upper watershed has a fair amount of clay soils (Figure 2.5) that lead to low infiltration (Figure 2.6). In addition, the upper watershed is the most intensely urbanized part of the watershed (Figure 2.9), mostly around the creeks and drains that feed Paint Creek (Figure 2.11). The addition of rooftops, gutters, pavement, and compacted urban lawns drastically reduces the infiltration capacity of the landscape and produces much more runoff than other land uses. One additional factor is the loss of natural wetlands that help absorb surface runoff because of drain construction for development of agricultural fields. Drains increase the speed with which water is removed from the landscape and delivered to streams. Together, the clay soils, urbanized areas, and drained agricultural fields have led to a runoff problem in the upper watershed.

Flooding

The rapid response of the hydrograph to rainfall is an indication that flooding is a problem in Stony Creek. Robert Morawski, a watershed resident with agricultural property immediately upstream of the USGS monitoring station, claims that over 30 years ago Stony Creek did not overflow its banks some years, as is normal for streams in equilibrium. However, Mr. Morawski claims that Stony Creek has flooded an average of about 3 times a year since then. He sees this as an increasing problem over the years and does not think it is a coincidence that development has taken place upstream at the same time.

Mannik and Smith, Inc. published an engineer's report for the Intercounty Drainage Board in 1997 that addresses the flooding concerns in the Stony Creek Watershed (Buschmann, et al., 1997). In this report, they site that "residents claim that springtime flooding has been deeper and longer duration during the last few years than was previously experienced." The group analyzed rainfall data from the Ann Arbor area from 1970 to 1996 and showed that the average April rainfall was 27% greater for the 5 years preceding 1997 than for the 27 year period. The report noted that a number of agricultural fields in the central portion of the watershed encroached on the floodplains, making flooding more likely. Citing insufficient data to judge the impact of upstream development, the report indicated that logjams and blockages are "likely contributing factors to the flooding". They report that removal of those blockages would increase flow 25-40% for events up to the 2 year frequency rainfall. The report recommended removal of all blockages, plus dredging of some portions of the system. As a result, London Township proposed converting Stony Creek to an Intercounty Drain for the purpose of cleaning the creek. This discussion came to a halt in early 2003 when it was determined that members from at least one township from each county are needed to make such a proposal.

The Mannik and Smith, Inc. report indicated that the spacing between logjams increases downstream from 200-300 feet apart in Washtenaw County to 1300-3000 feet apart in the lower watershed. The decrease in the number of logjams downstream suggests that the cause of the logjams is upstream. Most likely, increased runoff from the urbanized headwaters has increased bank erosion and contributed to trees falling into the creek, resulting in logjams. The farther away from the urbanization, the lower impact of the increased runoff. This interpretation is consistent with other data collected during the course of the Stony Creek Watershed project, presented later.

Nonpoint Source Pollution
In addition to leading to flooding problems, runoff is responsible for picking up and delivering nonpoint source pollution to streams. If rain is allowed to infiltrate into the ground, vegetation and soil microbes help to clean the water as it slowly flows through the ground. Rapid flow on the surface of the landscape picks up pollutants such as sediments, fertilizers, pesticides, oil, grease, etc. and delivers it directly to the stream, quickly. This process is responsible for most of the pollution in the surface waters of the Stony Creek Watershed.

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Chapter 3: Water Quality Assessment

An attempt has been made to compile all readily available data on the Stony Creek Watershed that relate to water quality. The available data include water quality monitoring data from June 2003 through May 2004, a macroinvertebrate study conducted during the summer of 2004, and a road stream crossings inventory completed in July and August 2003, all included as part of the Stony Creek Watershed Project. In addition, studies conducted by other parties were studied and assessed including monitoring by the MDEQ for TMDL development, DEQ assessments of water quality in Stony Creek and Amos Palmer drain in response to effluent discharged by a local gravel pit. The overall view of the water quality of the Stony Creek Watershed is generally improving water quality in the downstream direction, indicating that the biggest problem areas in the watershed are from the urbanized and developing areas at the headwaters of the watershed.

3.1 Stony Creek Watershed Volunteer Macroinvertebrate Study 2004

Macroinvertebrates are visible insects and other organisms that lack an internal bone structure. The types and variety of macroinvertebrates that live in creeks, help determine the overall quality of the water in the Stony Creek Watershed. Some macroinvertebrates are sensitive to particular pollutants (such as some stoneflies, mayflies, and caddisflies), and other macroinvertebrates are pollution tolerant (such as the midge larva and the rat-tailed maggot larva). As a result, the presence of pollution sensitive macroinvertebrates or a wide array of macroinvertebrates in general indicates relatively good water quality, and the lack of the pollution sensistive macroinvertebrates or a narrow array of macroinvertebrate diversity indicates generally poor water quality.

In order to help determine the overall water quality in the Stony Creek Watershed, groups of volunteers collected macroinvertebrates from 6 locations along Paint and Stony Creeks between Ypsilanti and Monroe on Saturday, June 19, 2004. It rained especially heavily in the lower half of the watershed 2 days prior to the volunteer event, which made water levels unmanageably high, so sampling was confined to the upper watershed (sites 0, 1, 2, 3B, 4, 5, Table 3.1 and Figure 3.1). Subsequent sampling of 2 locations in the lower watershed were carried out soon thereafter, on July 1, 2004 (sites 7 and 9, Table 3.1 and Figure 3.1). The locations were selected to correspond to the sampling locations used in the water quality monitoring described above, with the exception of sites 0 and 3B. Site 0 was added for the June 19 event because it was unsafe for the volunteer groups to sample farther downstream than site 5 due to the conditions of the stream on the day the event was scheduled. Site 3B is less than a quarter mile downstream from sampling site 3, where permission to access the property for the study was denied. In this case, the closest downstream location was accessed as the best alternative to sampling at site 3.

The samples were collected based on the protocol of the Huron River Watershed Council's Adopt-A-Stream volunteer monitoring project. These samples were sent to the Huron River Watershed Council for identification to family by Jo Latimore, the resident macroinvertebrate specialist. Non-insects were identified to the categories used in the Michigan Department of Environmental Quality’s stream invertebrate survey protocol.

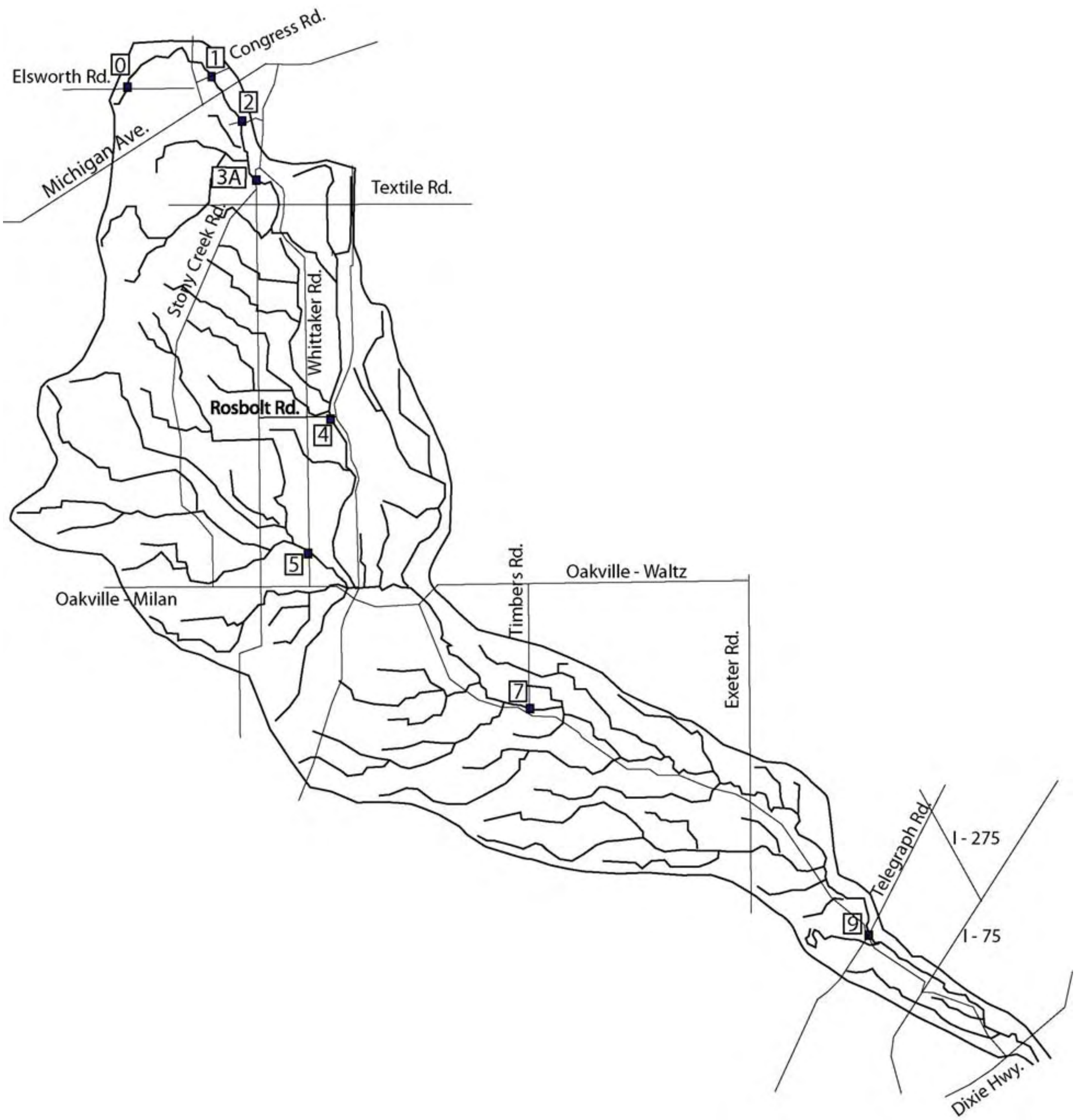

Figure 3.1: Summer 2004 volunteer macroinvertebrate study site locations, showing the distribution of sites within the Stony Creek Watershed.

Site	Stream	Location	Date Sampled
0	Paint Creek	Ellsworth Road	6/19/04
1	Paint Creek	Congress Road	6/19/04
2	Paint Creek	John C. Hart Parkway	6/19/04
3B	Paint Creek	Textile Road	6/19/04
4	Paint Creek	Rosbolt Road	6/19/04
5	Stony Creek	Whittaker and Liss Roads	6/19/04
7	Stony Creek	Timbers Road	7/1/04
9	Stony Creek	Telegraph Road	7/1/04

Table 3.1: Stream sites sampled for the volunteer macrionvertebrate study, summer 2004.

The invertebrate samples were analyzed in three ways: number of insect families, number of EPT families, and number of sensitive families. The number of insect families is an indication of the diversity of invertebrates found at the study sites, and a higher number indicates better stream quality. The EPT index refers to the number of families represented in each sample that belonged to the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). These orders have been documented to include families that are sensitive to stream degradation, and their presence and diversity are an indication of good stream quality. Finally, certain families of stream insects, both in and out of the EPT orders, have been identified as particularly sensitive to stream degradation (tolerance ratings of 0-2; Hilsenhoff, 1988). Their presence in the samples is an indicator of good stream health. A complete listing of the families present and their relative abundance is located in the complete report in the Appendix.

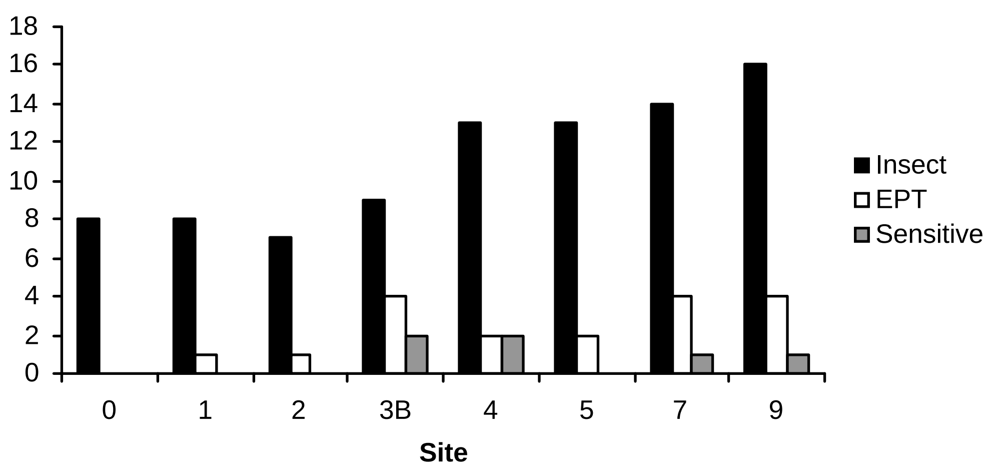

Figure 3.2: Benthic insect families found at each study stream site. Each category is a measure of stream quality. These results show generally improving water quality from the upstream (lower numbered sites) to downstream locations (higher numbered sites).

Insect data suggest that stream quality improves as you move from lower numbered upstream sites to higher numbered downstream sites (Figure 3.2 - Note that Figure 3.2 includes only the taxa included in the class "insect"; see Appendix A for the total taxa collected at each location including other classes of macroinvetebrates). The reliability of these data will improve with continual monitoring over a period of years to demonstrate trends in the condition of macroinvertebrates in the stream over time.

At most sites, water samples were taken before the collection of macroinvertebrates in order to take conductivity readings of the water samples. Conductivity is another measure of general water quality. It increases with the amount of dissolved ions, such as salts or metals. If the average conductivity measured at a site is 800 microSiemens (µS) or less, it is considered natural for stream water in this region. Conductivity over 800 µS may indicate the presence of toxic substances (of course, many toxins are not measured by conductivity). This measure is used as a red flag, signaling a need for further investigation of what is dissolved in the water. All but one of the sampled stream sites had conductivities of 805 or lower. However, site 2 measured 1058 µS on the day of sampling, and supported the lowest number of insect families, the lowest number of EPT families, and no sensitive species. These data suggest that site 2 is of relatively poor quality.

Site	Conductivity (µS)
0	Not sampled
1	Not sampled
2	1058
3B	805
4	717
5	727
7	781
9	742

Table 3.2: Stream water conductivity at the study sampling sites.

Together, the macroinvertebrate data and the conductivity readings suggest generally adequate water quality in the lower watershed, but problematically poor water quality in the upper watershed, where developed and developing areas are concentrated. These data help give rise to the determination, noted later, that the upper watershed poses the greatest threat to water quality in the watershed.

3.2 1995 and 1997 MDEQ macroinvertebrate, fish, and water quality surveys

Studies were conducted in 1996 and 1997 to determine the impact of effluent discharged by Londontown Inc – London Sand gravel pit into the Amos Palmer Drain in London Township. Water discharges directly into Stony Creek from Amos Palmer Drain about a mile from the gravel pit.

1995 MDEQ Study

In 1995, the Michigan Department of Environmental Quality conducted a macroinvertebrate study of Amos Palmer Drain and Stony Creek upstream and downstream of the Amos Palmer Drain input. The upstream assessment was conducted where Rawsonville Road crosses Stony Creek and the downstream location was where James Road crosses the creek. In Amos Palmer Drain, the habitat was rated fair (one point from poor), but the macroinvertebrate community was rated "poor" with 12 taxa present. Upstream of Amos Palmer Drain on Stony Creek, the habitat was rated "acceptable" tending towards poor (attributed to abundance of sand and muck from upstream landuses), and the macroinvertebrate community was rated "acceptable" trending toward poor (moderate impairment) with 17 taxa present, principally because of lack of available habitat. Downstream of Amos Palmer Drain, the habitat rating was "acceptable", with a macrioinvertebrate community rated "acceptable" trending toward poor, 19 taxa present. Because the macroinvertebrate habitat was better in the downstream location, it made it difficult to determine the effect of the discharge from Amos Palmer Drain, despite similar diversity in the upstream and downstream locations.

Fish collection was attempted at a couple of locations, but was not able to be completed for various reasons. Water chemistry data from 2 sampling dates in 1995 showed total dissolved solids and conductivity levels were elevated way above upstream levels for at least 2.5 miles downstream. Hydrogen sulfide was also found downstream of the gravel pit at toxic levels. Ammonia, calcium, magnesium and hardness were also elevated above the upstream value for at least 2.5 miles downstream.

The 1995 study concluded that the water quality and macroinvertebrate community in Amos Palmer Drain were extremely impaired. It was further determined that additional study was necessary to assess the greater impact on Stony Creek.

1997 MDEQ Study

In 1997, the Michigan Department of Environmental Quality conducted another macroinvertebrate study of Amos Palmer Drain and Stony Creek upstream and downstream of the Amos Palmer Drain input. As previously, the upstream assessment was conducted where Rawsonville Road crosses Stony Creek, but the downstream location seems to have been switched to a location closer to Amos Palmer Drain, apparently where Timbers Road crosses the creek (inferred from a map that is not specific about the location). In Amos Palmer Drain, the habitat was rated fair, but the macroinvertebrate community was rated "poor" with 2 taxa present. Upstream of Amos Palmer Drain on Stony Creek, the habitat was rated "fair" tending towards poor (attributed to abundance of sand and muck from upstream landuses), and the macroinvertebrate community was rated "acceptable" trending toward poor (moderate impairment) with 13 taxa present. Downstream of Amos Palmer Drain, the habitat rating was "good", with a macroinvertebrate community rated "acceptable" trending toward poor, 16 taxa present. Because the macroinvertebrate community should have been better in the downstream location based on the much improved available habitat, this was taken as a sign of a problem with water quality.

Fish collection was completed about 2.5 miles downstream where Stony Creek crosses Exeter Road. The fish community was rated "acceptable" with slight impairment, but was dominated by taxa that are tolerant of degraded conditions.

Water chemistry data showed total dissolved solids in Stony Creek over the standard 500 mg/L average and 750 mg/L maximum all the way to Exeter Road. Hydrogen sulfide was determined to be well over the standard 0.088 ug/L average and 1.6 ug/L maximum. Also, conductivity, sulfate, and calcium were elevated in Amos Palmer Drain and the downstream Stony Creek locations relative to the upstream Stony Creek location by Rawsonville Road.

The 1997 study concluded that the water quality and macroinvertebrate community in Amos Palmer Drain were extremely impaired. In addition, based on the similar findings documented in the previous study, the DEQ determined that discharges from London Aggregates was having a significant effect on water quality in Amos Palmer Drain and downstream in Stony Creek.

Comparison of MDEQ studies to 2004 volunteer study

Settlement of a lawsuit brought the discharge from London Aggregates to a close prior to the initiation of the Stony Creek Watershed Project in 2003, so it is possible that the water quality and macroinvertebrate communities improved since the 1995 and 1997 studies by the DEQ.

Comparison of 2004 data with studies in 1995 and 1997 shows that the taxa diversity is still lower upstream compared to downstream sites. This can be attributed to upstream sources of sediment impairing the macroinvertebrate habitat to a greater degree near the upstream source. Furthermore, based on the comparison of number of taxa in the 2004 study relative to the number of taxa in the earlier studies, the diversity of taxa found in most sampled locations in Stony Creek watershed is perhaps "acceptable" at best, and potentially "poor" at sites 0 to 3B where the total number of taxa is 12 or lower.

The only site that overlaps well between the 2004 study and the earlier studies is the site at Timbers Road (site 7 in the 2004 study). At this site, 19 taxa (14 insect varieties) were found in 2004 compared to 13 taxa found at a site presumed to be Timbers Road (or very nearby) in 1997. The most significant addition in the 2004 study was the identification of a caddisfly (Brachycentridae), considered sensitive to pollution that was not present in 1997. Nineteen (19) taxa were found in 1995 at the site further downstream at James Road. If anything, comparison of these data show the potential that the macroinvertebrate community has improved moderately near Timbers Road (compared to the 1997 study), although comparison is difficult based on the uncertainty of the exact location for the downstream site in the 1997 DEQ study. Conductivity values have definitely improved, considering that conductivity readings taken during the 2004 Macroinvertebrate Study show levels below 800 µS (Table 3.2, Site 7), compared to the elevated levels in the 1995 and 1997 studies.

3.3 TMDL development

In 2002, the Michigan Department of Environmental Quality (MDEQ) listed portions of the Stony Creek Watershed on the Federal Water Pollution Control Act, Section 303(d) list for being "impaired" with respect to water quality. They are under order from the Environmenal Protection Agency (EPA) to develop "total maximum daily limits" (TMDLs) for those portions of the watershed. Once developed, there will be requirements to improve the water quality. As a result, funding may be more readily available for making improvements in the watershed related to these problems.

TMDLs are to be submitted soon for approval for 2 portions of the watershed that are listed on the 303(d) list. The North Branch of the Amos Palmer Drain and lower Stony Creek are listed for TMDL development for total dissolved solids (TDS), hydrogen sulfide (HS), and poor fish and macroinvertebrate communities. The TDS and HS were particular problems when a local gravel pit was discharging groundwater into the Amos Palmer Drain. Community members brought and won a lawsuit against the gravel pit and stopped the discharge of the groundwater. These items may be dropped from the list because the waters are no longer significantly impaired for TDS and HS. A portion of Paint Creek is listed for TMDL development for low dissolved oxygen (DO), fish kills, and pathogens. From discussions with MDEQ agents, recent monitoring for pathogens has shown little cause for concern, so that item may be dropped from TMDL development as well.

3.4 Water Quality Monitoring

Water quality monitoring was conducted monthly from June 2003 – May 2004 at 10 sites (Figures 3.3 through 3.10). Bulk grab samples were taken from the surface of the fastest flowing part of the stream and transported in Nalgene bottles on ice back to the laboratory at Eastern Michigan University for analysis of nitrate, phosphorous, and total suspended solids. In the field, turbidity was measured using a turbidometer, and temperature, pH, dissolved oxygen, and conductivity were measured using probes that were calibrated in the lab prior to each sampling day. In 2003, samples were collected every 2 weeks at predetermined times during dry or wet weather. In 2004, an attempt was made to sample before, during, and after anticipated storms to determine the change rainfall had on water quality.

Sediment

Sediment transported in the streams was measured as total suspended solids. One liter grab samples were taken back to the lab and filtered. The sediment remaining on the filter is weighed to get the weight concentration of sediment per liter of sample. The sediments captured by this method are typically finer particles that are suspended at the top of the stream in flowing water.

There are currently no required maximum limits for the allowable concentration of sediment in streams of Michigan, although there is a desire to develop standards. In the absence of state mandated standards, the technical committee adopted standards that are suggested in the scientific literature for sediment concentration in streams.

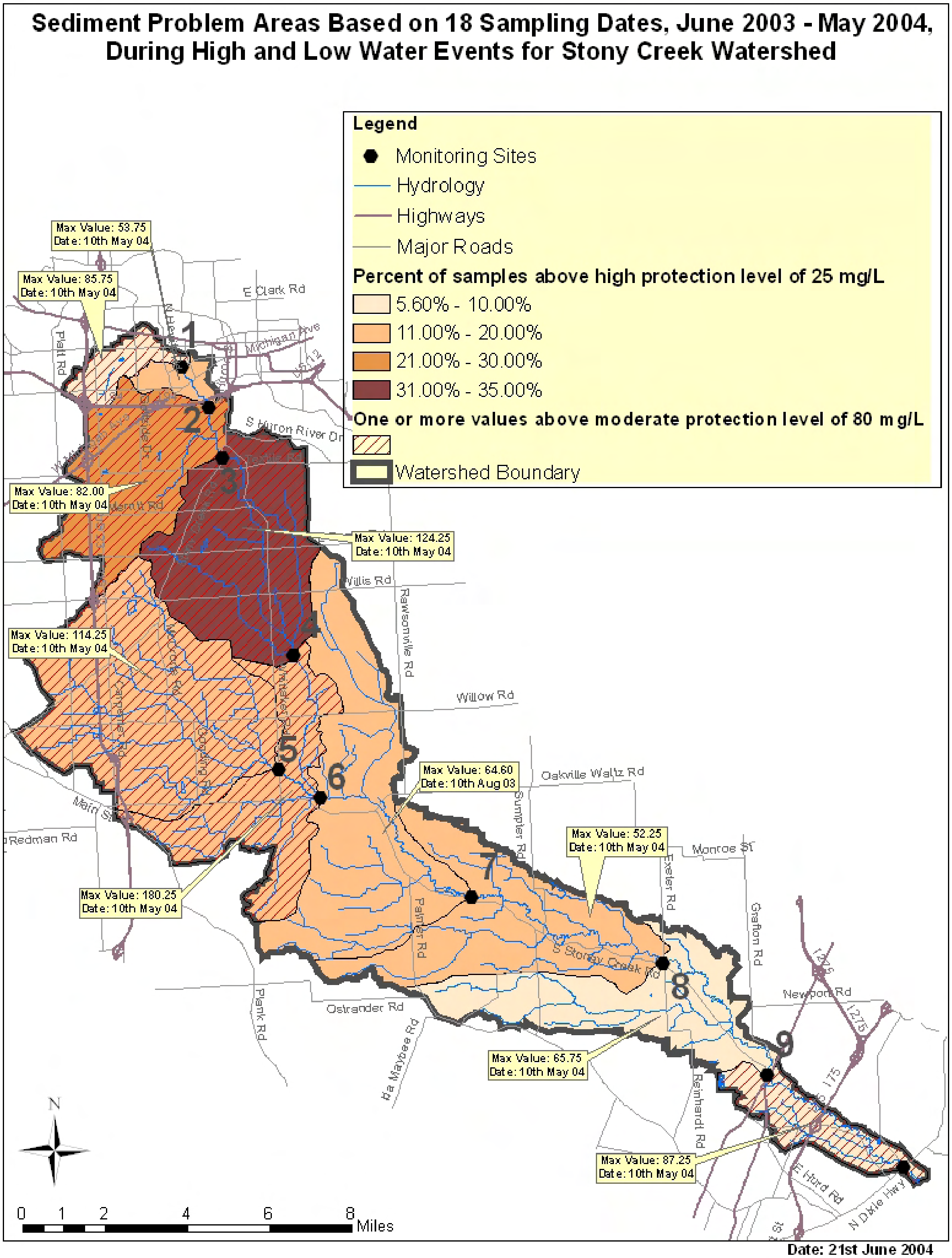

Figure 3.3: Map showing critical areas in the watershed for total suspended solids (sediment).

The recommendation of the National Academy of Sciences (National Academy of Sciences - National Academy of Engineering. 1973) is the following:

> Aquatic communities should be protected if the following maximum concentrations of suspended solids exist:
>
> · High level of protection 25 mg/l
> · Moderate protection 80 mg/l
> · Low level of protection 400 mg/l
> · Very low level of protection over 400 mg/l.

Therefore, the guidelines for maintaining a high water quality require low concentrations of suspended sediments. Higher concentrations than the 25 mg/l will result in lower water quality for macroinvertebrate communities.

Six of the ten sites had one or two sampling days with concentrations above the moderate protection level of 80 mg/l. However, 3 of these sites (sites 1, 3, 10, Figure 3.3) were within 8 mg/l of the limit on one day only (after exceedingly heavy rain on May 9-10, 2004). The other 3 sites (sites 4, 5, 6, Figure 3.3) had concentrations well over 100 mg/l and as high as 180 mg/l. At most sites, the increase in suspended sediment was 10 times or more greater than the suspended sediment load the previous day (Appendix). These sites are concentrated in the upper half of the watershed where the greatest amount of development is taking place. At site 6, the stream was out of its banks on May 10, 2004 and was passing over barren farm fields upstream of the bridge which may have increased the sediment concentration to a greater extent than the upstream locations where the stream was high, but still confined to the channel. Downstream locations on May 10, 2004 have wide floodplains with natural vegetation which would slow down the streamflow and would be less erosive during floods than barren farm fields. As a result, the sediment concentrations dropped off markedly in the lower half of the watershed even after drenching rains. The lower half of the watershed remained under the moderate protection level on all sampling days with the exception of the extreme downstream site in Frenchtown Township on one day of sampling after exceptional rainfall. No samples exceeded the threshold to very low protection (400 mg/l).

Each site was over the high protection concentration of 25 mg/l at least once. The worst locations for sediment concentration were the areas upstream of sites 3 and 4, where sediment concentrations were above 25 mg/l 21-35% of the sampling dates. These areas correspond to the greatest concurrent construction and land development. At site 4, there were only a few days when the stream was not cloudy with sediment on sampling days. Detention basins constructed for new developments may be somewhat effective at preventing all runoff from reaching the stream excessively fast, but they do not allow time for sediments to settle out in the pond before discharged to the streams, resulting in large amounts of suspended sediments to stay suspended in streams long after storms. The best sediment concentrations are in the extreme upper watershed with established neighborhoods and in the lower half of the watershed, where slopes are gentler and the stream is farther from the altered hydrology influence of urbanization and the sediment influx from eroding construction sites. In fact the only time sites 1, 9, and 10 were above the high protection concentration of 25 mg/l was on May 10, 2004 after drenching rains and high water, otherwise sediments concentrations at these sites were extremely low.

Nutrients

Nutrients are chemical elements that can stimulate growth of plants. Typical nutrients include nitrogen, phosphorus, and potassium. These nutrients are usually present naturally, but are often added to soils to aid in plant growth. Phosphorus is often considered to be the "limiting" nutrient because many plants find plenty of nitrogen and potassium in soils to thrive, but can only thrive if enough phosphorus is available. In this region of Michigan, however, phosphorus tends to be abundant naturally in soils, so nitrogen may be the limiting nutrient. Therefore, this study focused on these two potentially limiting nutrients to determine the potential nutrient problems in the watershed. Nutrients in water can lead to nuisance algae growth, potentially leading to fish kills, and can even be toxic for human consumption at high concentrations.

Phosphorus tends to attach itself to soil particles rather than becoming dissolved in water. Therefore, they tend to be carried to streams during rain events that erode sediment from the landscape. In contrast, nitrogen fertilizers tend to dissolve easily in water and are typically a major concern for groundwater contamination, although the abundance of tiled farm fields can allow nitrogen to enter the creek as the water is drained from fields toward the creeks and drains of the watershed.

For phosphorus and nitrogen monitoring, grab samples of creek water were taken from the point of fastest flow, stored in Nalgene bottles, and transported back to the Eastern Michigan University laboratory on ice. There samples remained in a refrigerator until analyzed in the lab for total phosphorus and the nitrate form of nitrogen.

There are not yet specific limits for phosphorus or nitrogen in Michigan streams. However, there are suggested limits above which problems with excessive plant growth may take place. These guideline values for phosphorus are 50 µg/l and for nitrogen 1 mg/l. Phosphorus is generally considered the greatest threat to surface water, whereas nitrogen is considered particularly threatening to groundwater quality.

<u>Phosphorus</u>

Phosphorus concentrations were above the suggested problem limit of 50 µg/l for 20 to 40 % of the sampling dates at all sites. The worst site represents area 4 (site 4, Figure 3.4) where the phosphorus concentrations were above 50 µg/l 40% of the time and the average value for all sampling dates was 62 µg/l, considerably higher than the next highest average phosphorus concentration. Phosphorus values at site 4 were generally low September through mid-March, but were otherwise high during the growing season. In fact, phosphorus values were low on March 24, 2004 after an extended dry period (6.61 µg/l), but jumped to a high level on the next two days after rain (61.4 µg/l, 91.2 µg/l respectively).

The second highest average phosphorus concentration (56.87 µg/l) was at site 1, where the phosphorus concentrations were over 50 µg/l 35% of the sample dates. Site 2, which was also over 50 µg/l 35% of the sampling dates, but had a lower average value (40.77 µg/l).

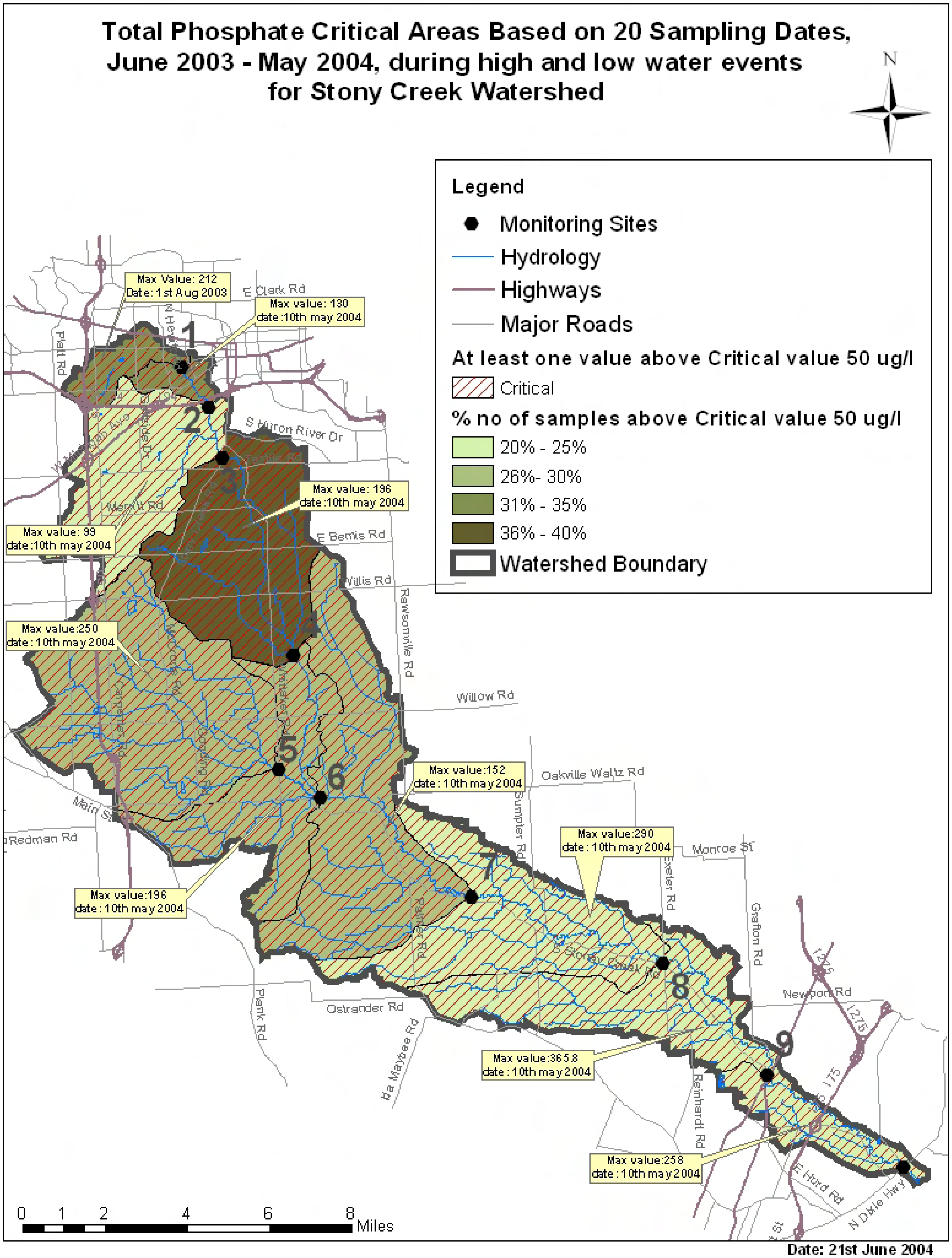

Figure 3.4: Map showing critical areas in the watershed for phosphorus concentration.

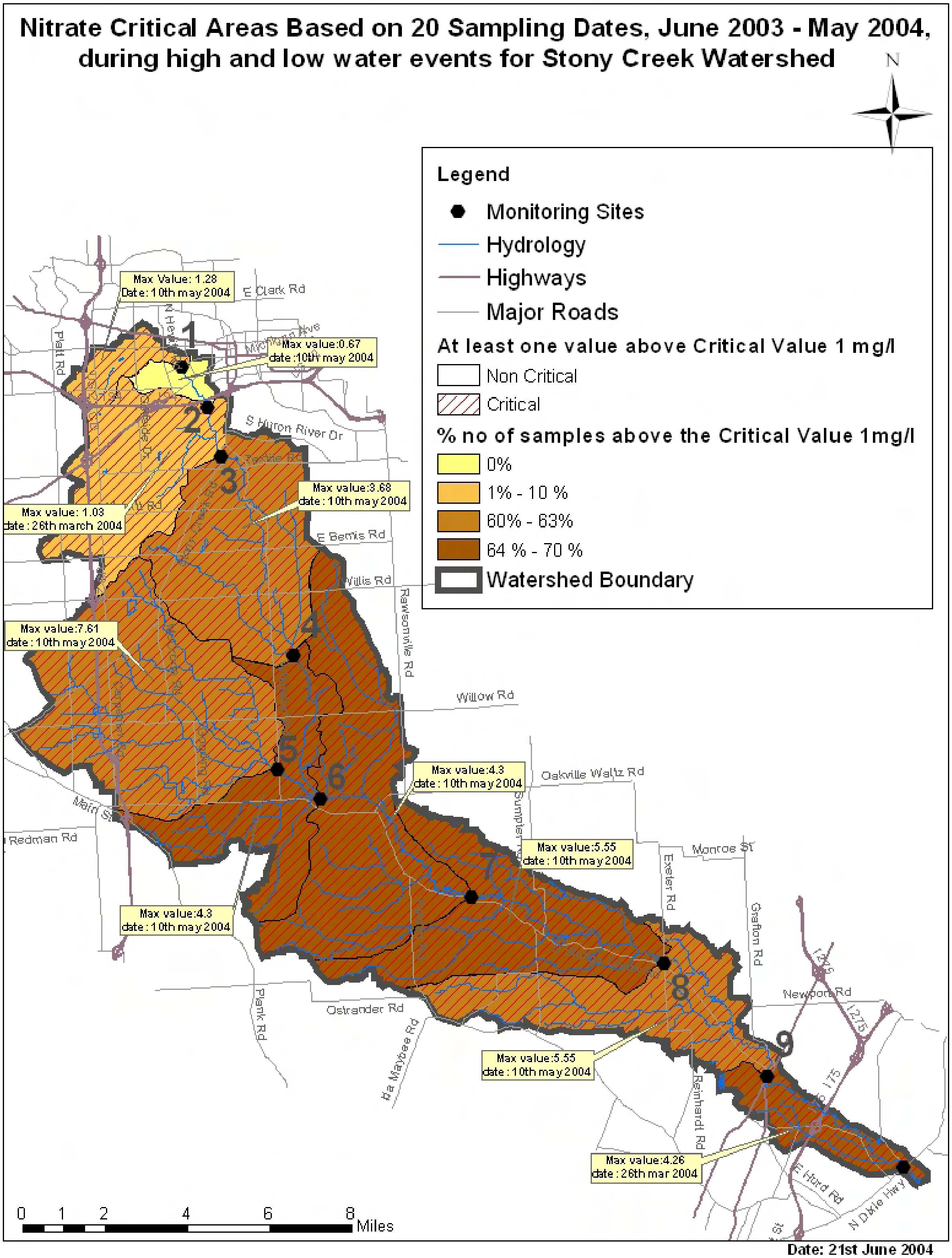

Figure 3.5: Map showing critical areas in the watershed for nitrate concentration.

The highest phosphorus concentration values were in the lower watershed, with values as high as 366 µg/l. These excessively high values all occurred on May 10, 2004, when the river was out of its banks in most of the lower watershed. Several farm fields were flooded causing especially high erosion of phosphorus-bearing sediments from the fields. Despite these high values on May 10, the average phosphorus concentrations range from 42-53 µg/l over the whole study period and were lower than 50 µg/l all but 20-30% of the sampling dates. Clearly there are problems with phosphorus entering the streams in the lower watershed agricultural areas, but the problems are generally less severe than at upstream monitoring areas 1 and 4.

The best site was represented by area 3, just upstream of area 4, where the average phosphorus concentration was about 25 µg/l, and the concentration rose above 50 µg/l on only 20% of the sampling dates. The land areas upstream of sites 1 and 2 are highly urbanized areas and the area upstream of site 4 is undergoing extensive suburban development (conversion from agricultural fields). The frequency and severity of phosphorus problems in these areas are generally worse than the predominantly agricultural areas in the lower watershed.

<u>Nitrate</u>

Nitrate concentrations were above the suggested problem limit of 1mg/l at least once at all sites except for site 2 (Figure 3.5). Site 3 barely exceeded the suggested limit only once (1.03 mg/l). Site 1, the third best site exceeded the suggested limit only twice with a maximum 1.28 mg/l).

Sites 4-10 had significantly higher nitrate concentrations that were over the suggested limit 60-70% of the sampling dates. The highest values for most sites came after the torrential rains early on May 10, 2004. The highest value (7.61 mg/l) came relatively close to the toxic value for human consumption. There were only a few days around September 2003 where the values were below 1 mg/l at most of these sites. Clearly the agricultural areas upstream of sites 4-10 have contributed high amounts of nitrate to the surface waters of the Stony Creek Watershed.

Dissolved Oxygen

Dissolved oxygen measures the amount of oxygen in water that is potentially available for aquatic life to use. The state of Michigan has standards for minimum dissolved oxygen levels in surface water. The standards are slightly more stringent for waters that feed the Great Lakes, because those standards have to be agreed upon by neighboring states and provinces. Since Stony Creek drains into Lake Erie, the standard of 7 mg/l holds for the entire watershed.

Dissolved oxygen was measured in the field with a probe that was calibrated in the lab before each sampling day. The dissolved oxygen levels were below the standard 7 mg/l at all but one site on July 4, 2003 (Figure 3.6). This was the only day that dissolved oxygen fell below the required level, however, a particularly hot day when water levels in the creek were excessively low following an extended period without rain. It is possible that the probe was poorly calibrated on that particular day, but the environmental conditions were such that low dissolved oxygen values could be anticipated. All in all, one day out of 16 with elevated levels suggests that dissolved oxygen levels may be a concern at times within the watershed, but probably is not normally a significant problem for sustaining a reasonable fish community.

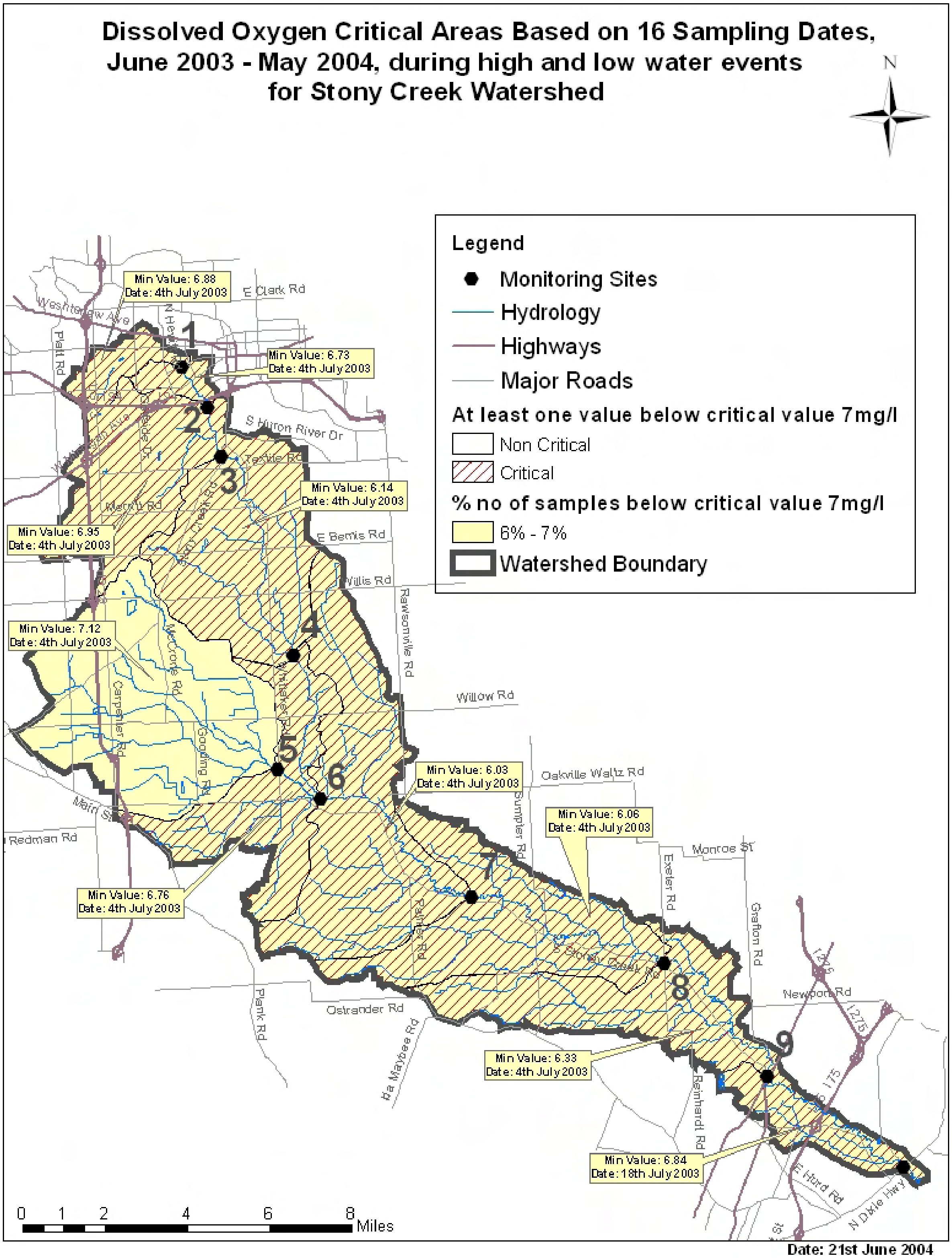

Figure 3.6: Map showing critical areas in the watershed for dissolved oxygen concentration.

The findings of this study suggest that the development of a TMDL for dissolved oxygen (as described above for Paint Creek) may be worth investigating, but may not be necessary.

Temperature

The main criteria for evaluating temperature in streams of Michigan is based on the necessary temperature requirements for fish to survive. Obviously, there are different temperature requirements for warmwater fish species to survive versus coldwater species. Paint Creek (Figure 2.11), a major tributary to Stony Creek, is a designated coldwater stream, so there are more stringent temperature standards for Paint Creek. In contrast, the rest of the watershed is only required to meet temperature standards for warmwater streams.

Temperature requirements vary by month for both types of streams. Basically the temperature requirements are lower for January than for July because the stream temperatures should be lower in the winter than the summer.

<u>Coldwater Fishery</u>
Allowable maximum temperatures for a coldwater fishery in Michigan are as follows (in degrees Fahrenheit): Jan 38, Feb 38, Mar 43, Apr 54, May 65, Jun 68, Jul 68, Aug 68, Sep 63, Oct 56, Nov 48, Dec 40. All sites on Paint Creek have temperatures above the monthly allowable temperature limits for a coldwater stream on 15-40% of the sampling dates, most often in the most urbanized areas upstream of sites 1 and 2 (Figure 3.7). The temperatures strayed from the limits as much as 5.4 degrees Celcius (close to 10°F). The highest divergence from allowable temperatures came in late March 2004, which was in the midst of an unusually warm and dry period for this part of Michigan.

<u>Warmwater Fishery</u>

Allowable maximum temperatures for a warmwater fishery in Michigan are as follows (in degrees Fahrenheit): Jan 41, Feb 40, Mar 50, Apr 63, May 76, Jun 84, Jul 85, Aug 85, Sep 79, Oct 68, Nov 55, Dec 43. Not only was the upper portion of the watershed too warm for a coldwater fishery, it was too warm for a warmwater fishery at sites 1-3 for 5-10% of the sampling dates (Figure 3.8). The highest divergence from the allowable temperatures again came in late March 2004 when the temperatures reached about 3°F over the allowable limit. Most of the watershed, however, had adequate temperatures to maintain a warmwater fishery.

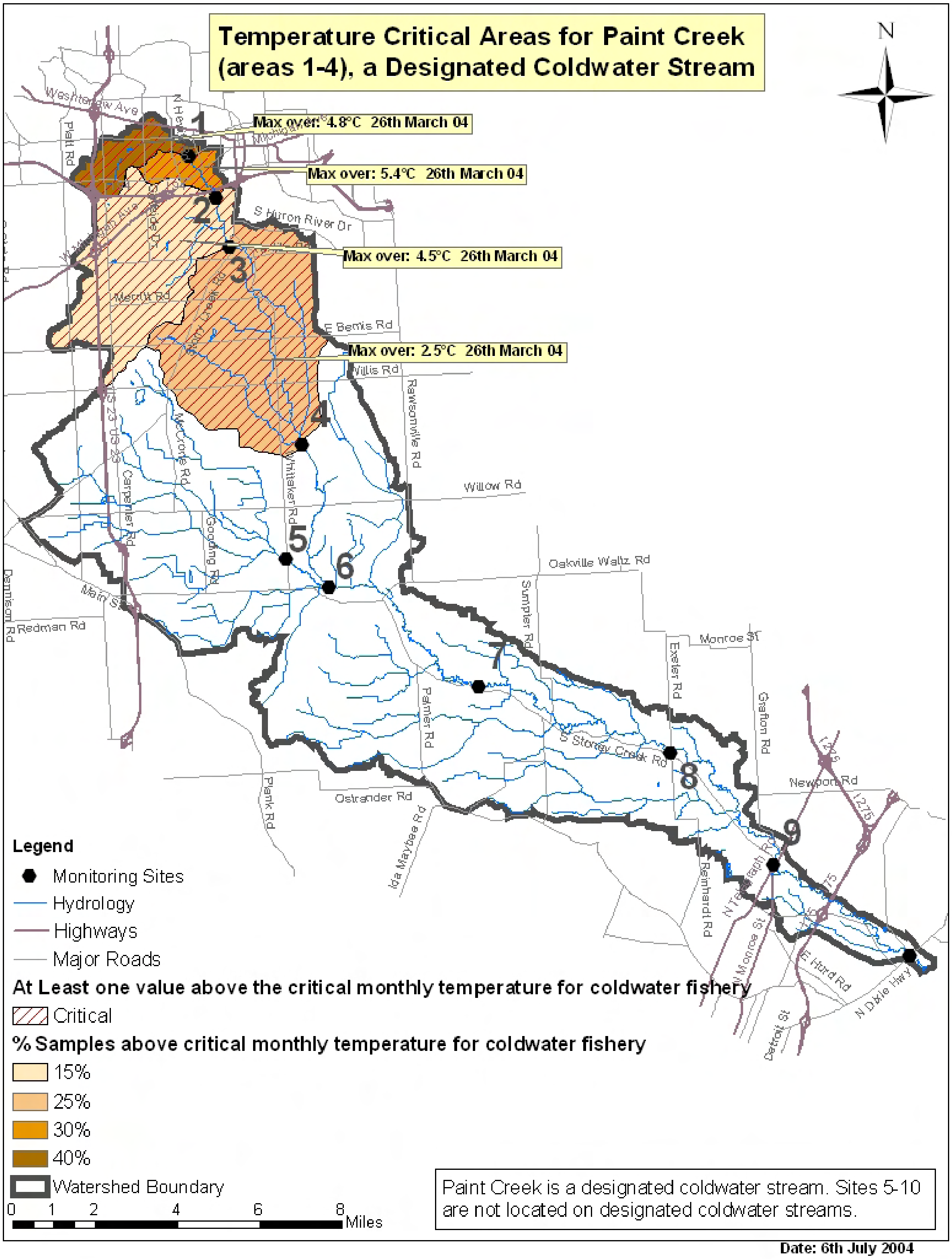

Figure 3.7: Map showing critical areas in the watershed for temperature for Paint Creek, a designated coldwater fishery.

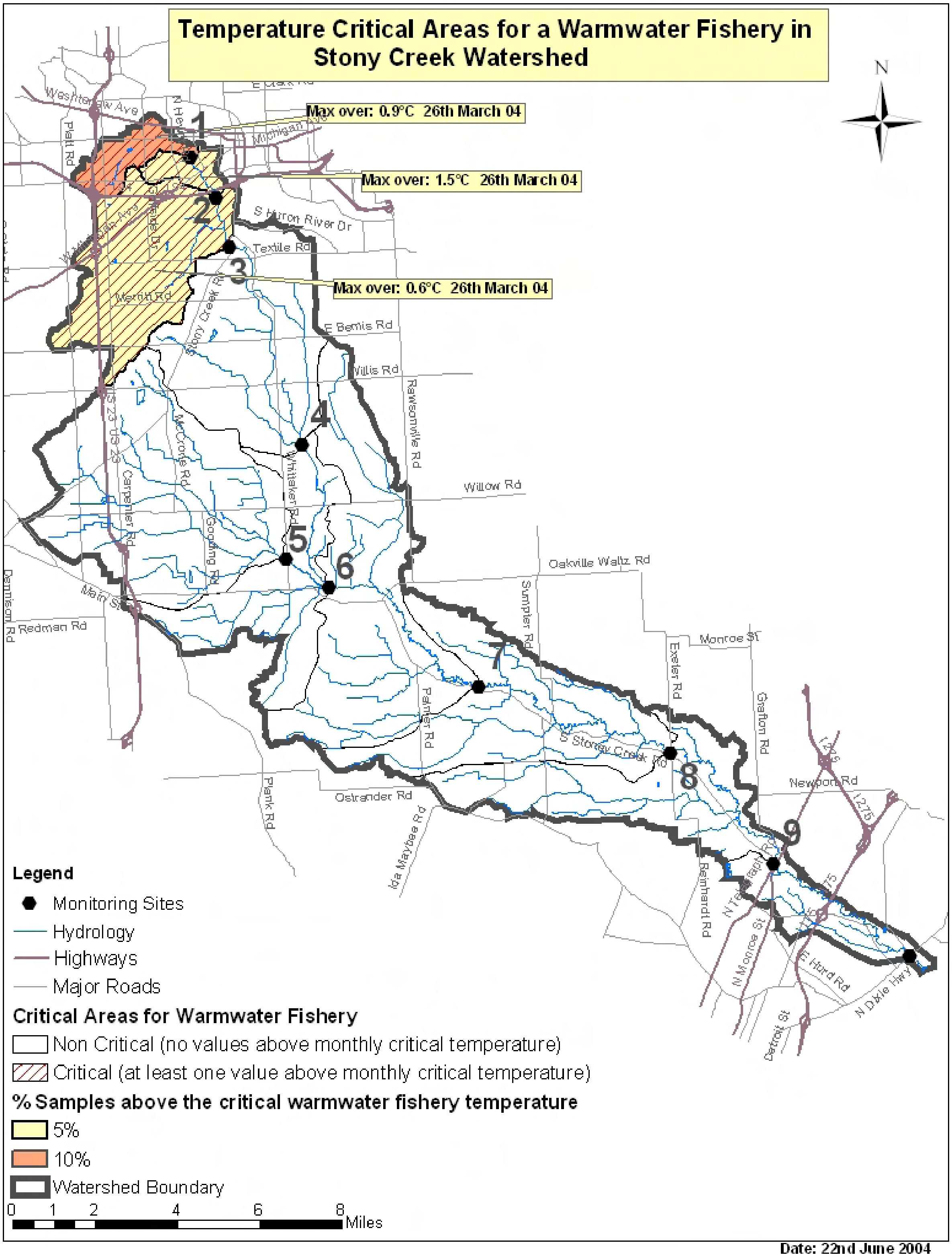

Figure 3.8: Map showing critical areas in the watershed for temperature for a warmwater fishery.

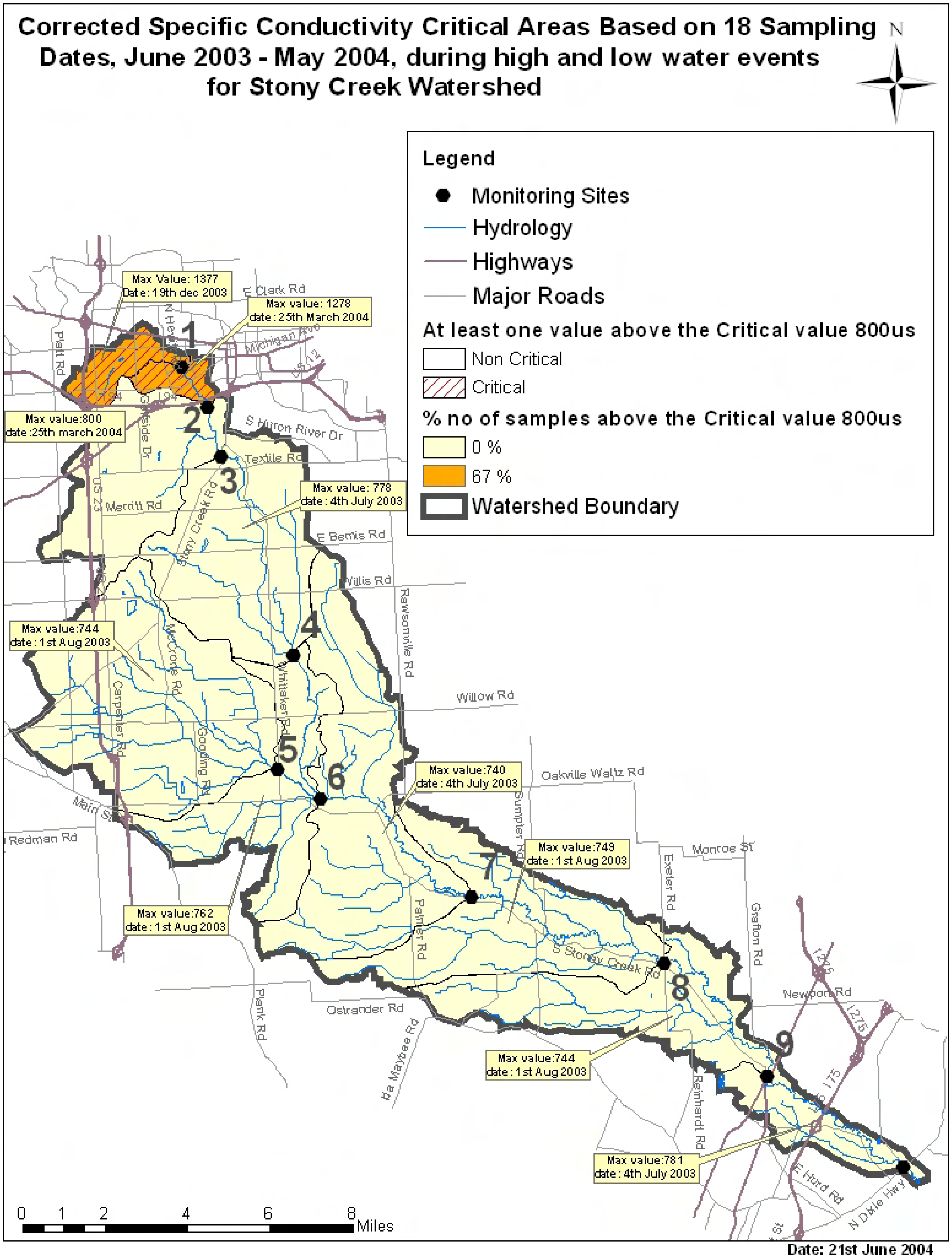

Figure 3.9: Map showing critical areas in the watershed for specific conductivity, a measure of the ease with which water transmits an electrical current that increases in polluted water.

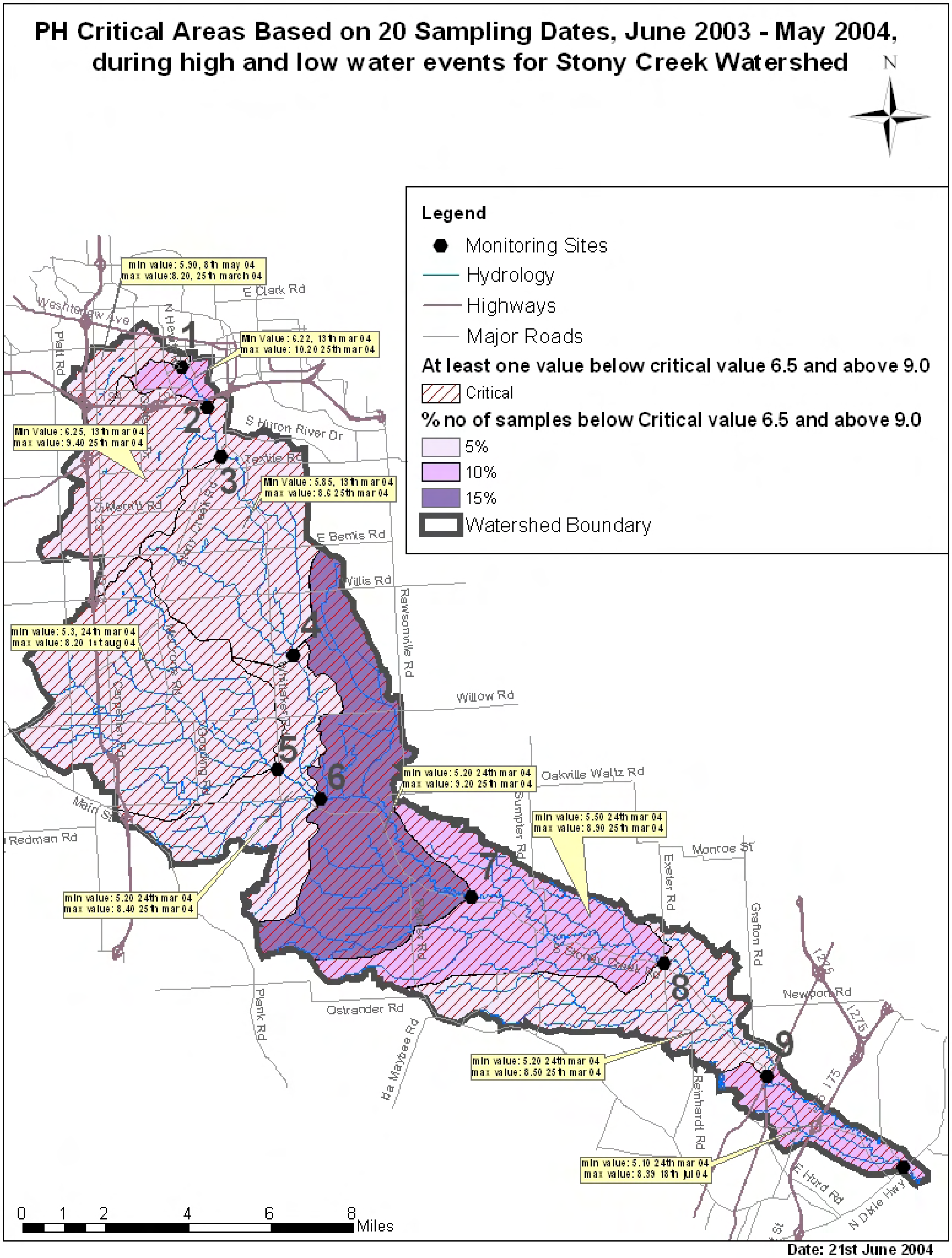

Figure 3.10: Map showing critical areas in the watershed for pH, the acidity (low pH) or alkalinity (high pH) of the water. Monitoring areas 2, 3, and 7 were the only sites to have values higher than the 9.0 allowable limit. All sites had one or two values lower than 6.5.

Conductivity

Conductivity measures the ability for water to transmit electricity, which is aided when contaminants such as oil, grease, metal, brine, salts are added to the water. As a result, higher conductivity values than normally found in a region can suggest that the water is polluted with some of these contaminants. The conductivity reading cannot tell which contaminants are present, but indicates generally polluted water. For the region around Stony Creek Watershed, conductivity values for healthy streams are generally below 800 microSiemens (µS).

Conductivity was measured in the field with a probe that was calibrated in the lab before each sampling day. Only sites 1 and 2 in the extreme upper reaches of Paint Creek, a major tributary to Stony Creek, have conductivity values above 800 µS (Figure 3.9). Not only were the values exceeded, but they were exceeded 67% of the time at values as high as 1377 µS. These data suggest that there is a considerable problem with generally polluted water in the extreme upper portion of Paint Creek. Site 3, downstream of these areas, reached 800 µS once, which was elevated relative to the approximately 750 µS that was the high value for the other 7 sites, but this one value does not represent a significant problem with these pollutants in this area.

pH

The measure of the acidity of water is pH and it can range in value from 0 to14. A pH of 7.0 is neutral water. Values of pH lower than 7.0 indicate increasingly acidic water as the value approaches 0, so very low numbers indicate strong acids. Values higher than 7.0 are increasingly basic with higher numbers indicating strong bases. Both acids and bases are caustic, corrosive substances that are not healthy for aquatic (or other) organisms. Michigan requires surface waters to have a pH between 6.5 and 9.0.

Acidity (lower pH) typically can result from acid rainwater entering the system, so acidity usually increases during rain events. Acidity can also increase due to respiration (breathing) of organisms in the water. Decomposition of organic material can similarly reduce pH. Acidity can be reduced (higher pH) by plant photosynthesis, which is most active during the day and during the growing season. Acidity can also be reduced by the addition of ammonia fertilizers and lime that are often added to agricultural fields and gardens.

In the field pH was measured with a probe that was calibrated in the lab before each sampling day. Monitoring areas 2, 3, and 7 were the only sites to have values higher than the 9.0 allowable limit, all occurring on March 25, 2004, after heavy rain. The highest value was 10.2 at site 2. The 9.4 value downstream at site 3 actually suggests pH improvement between the 2 sites. At site 7 the pH was 9.2 on that date. Other than the one date, the pH at these sites was well below the 9.0 allowable limit. Washing of fertilizers and lime into the streams in March may be responsible for the rise in pH after rain.

Each site had at least one day of pH below 6.5, usually occurring on March 24, 2004, before rain (Figure 3.10). At site 7, 8 and 10, the pH was also below 6.5 on March 13, 2004. The lowest recorded pH was 5.1 at site 10 on March 24, 2004.

3.5 Road Stream Crossings Inventory

In July and August 2003, a field survey was conducted by the Stony Creek Watershed Project staff. The survey involved a visual assessment of the creek and the adjacent land on either side of the creek in places where a road crosses the stream. Almost all "road stream crossings" in the watershed were surveyed (over 210) with a fairly uniform distribution over the entire watershed.

The survey was completed with a "Watershed Survey Data Sheet" using guidelines by MDEQ. Information gathered at each site include the type of streambed sediment (% various size particles) and the presence or abundance of aquatic plants, floating algae, filamentous algae, bacterial sheen/slime, turbidity, and oil. Other information recorded was width of riparian buffers, severity of bank erosion, % stream shading, important stream habitat, adjacent land uses, and sources of nonpoint source pollution and their severity. The data sheet is organized to allow a rapid qualitative assessment of each site that is easily comparable from site to site within the watershed. The most significant findings from the inventory are presented in maps and discussed below (see the Appendix for the full report)..

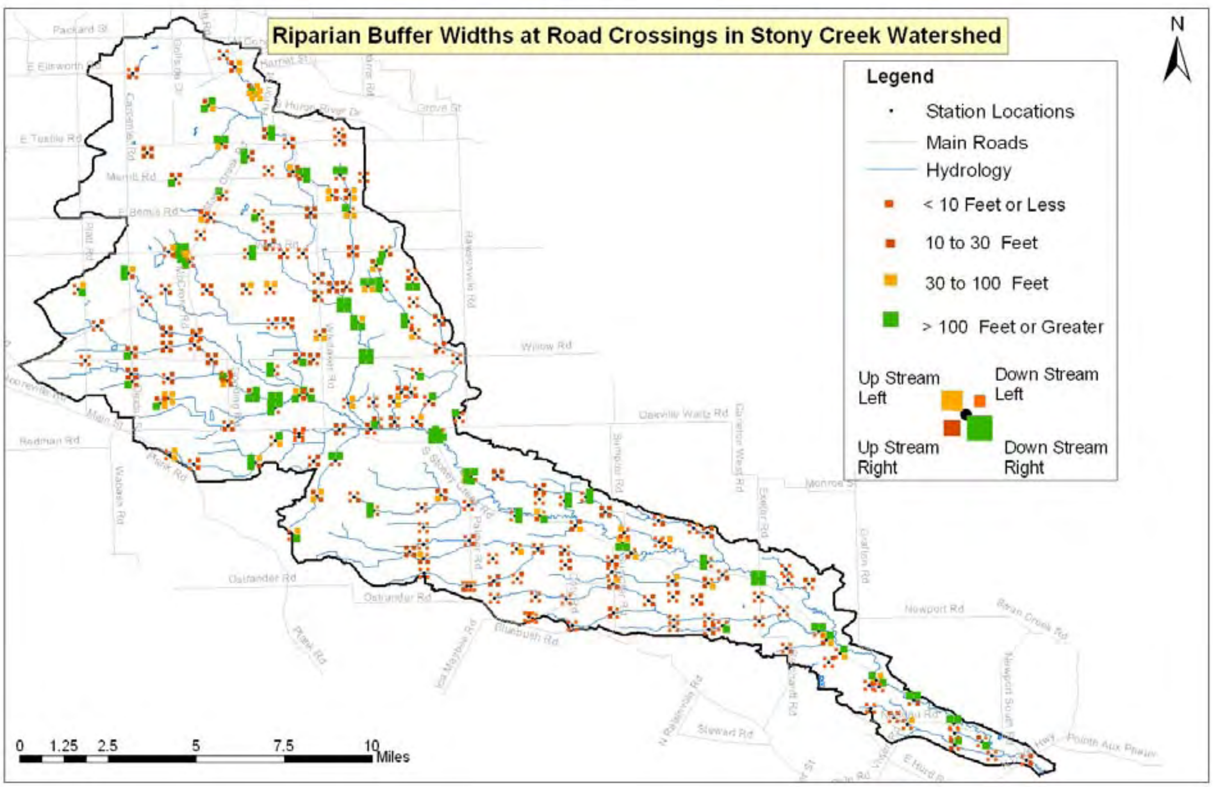

Figure 3.11: This map indicates a few locations with adequate riparian buffers greater than 30 feet (in green and yellow) and numerous locations with inadequate riparian buffers less than 30 feet (in orange and red).

<u>Riparian Buffer Widths</u>
Riparian buffers are areas along the edge of surface water bodies that are covered with grass, shrubs, or trees. This vegetated area acts as a barrier to runoff coming from adjacent areas. Vegetated buffers can trap sediments and pollutants that would otherwise find a direct route to streams and lakes. The best protection of the surface waters of Stony Creek from nonpoint source pollution would be attained with buffers at least 100 feet on each side of the stream and drains.

Buffers greater than 30 feet offer some protection, but buffers narrower than 30 feet subject surface waters to great risk of contamination from surface runoff. Figure 3.11 shows that a small fraction of the watershed has wide buffers between surface waters and adjacent land uses and most streams have buffers under 30 feet wide. Figure 3.12 shows the wide distribution of inadequate riparian buffers along agricultural fields within the watershed.

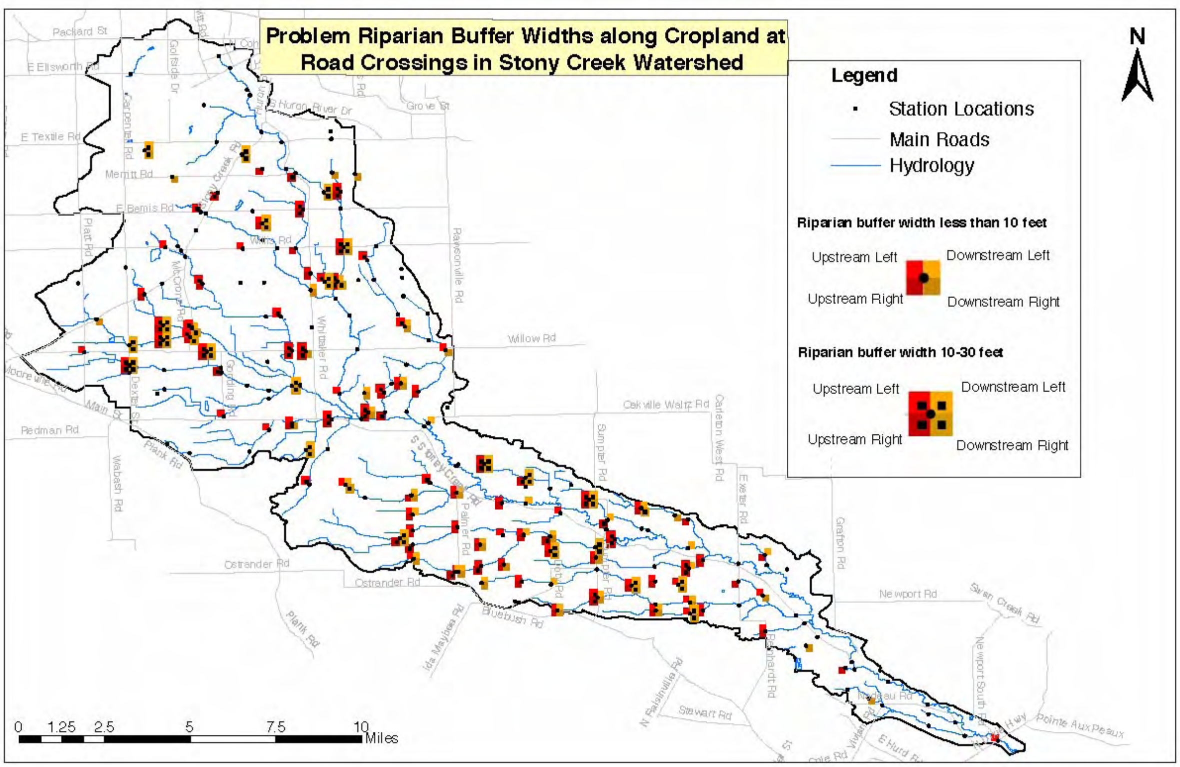

Figure 3.12: This map shows the location of problem riparian buffers adjacent to cropland in the Stony Creek Watershed. Particularly problematic are buffers less than 10 feet along streams and drains.

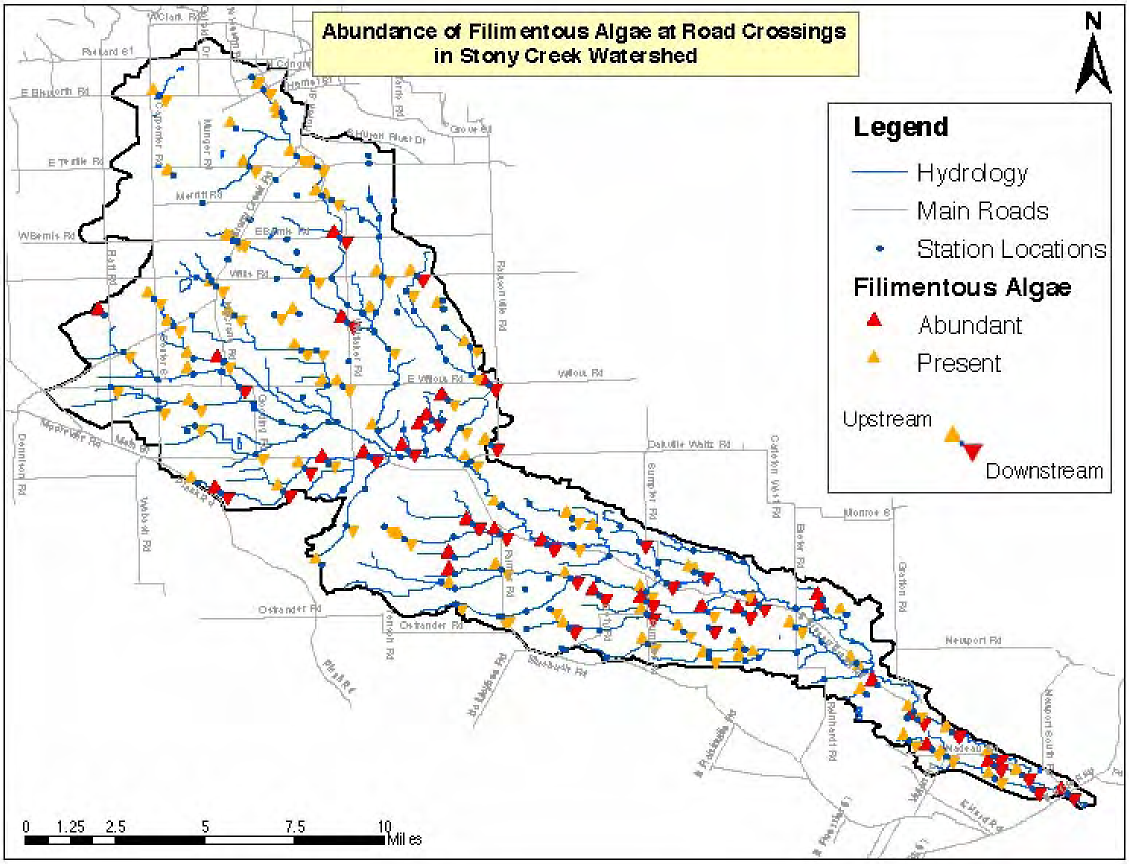

Figure 3.13: This map shows a number of road crossings in the Stony Creek Watershed with abundant filamentous algae, particularly in drains of the lower watershed.

<u>Abundance of Algae</u>

Typically algae growth is a problem in lakes, but can reach abundance in streams as well. Algae builds up in the watershed when excessive fertilizers or animal waste are added to surface waters or when there is inadequate flow to flush fertilizers out of streams and drains. Algae build-up can be an unattractive nuisance, but, more importantly, can lead to a drop in oxygen levels in the surface water that could eventually lead to the death of instream fauna. There are two types of algae that were identified as a part of the inventory survey. Filamentous algae attaches to the stream and floating algae hovers on the water surface. Figure 3.13 shows that filamentous algae is abundant in numerous parts of the watershed, particularly in the drains of the lower watershed. Figure 3.14 shows that floating algae is less common in the watershed, but is mostly concentrated in agricultural drains. One of the crossings where abundant algae was present is a site where cattle have access to the stream.

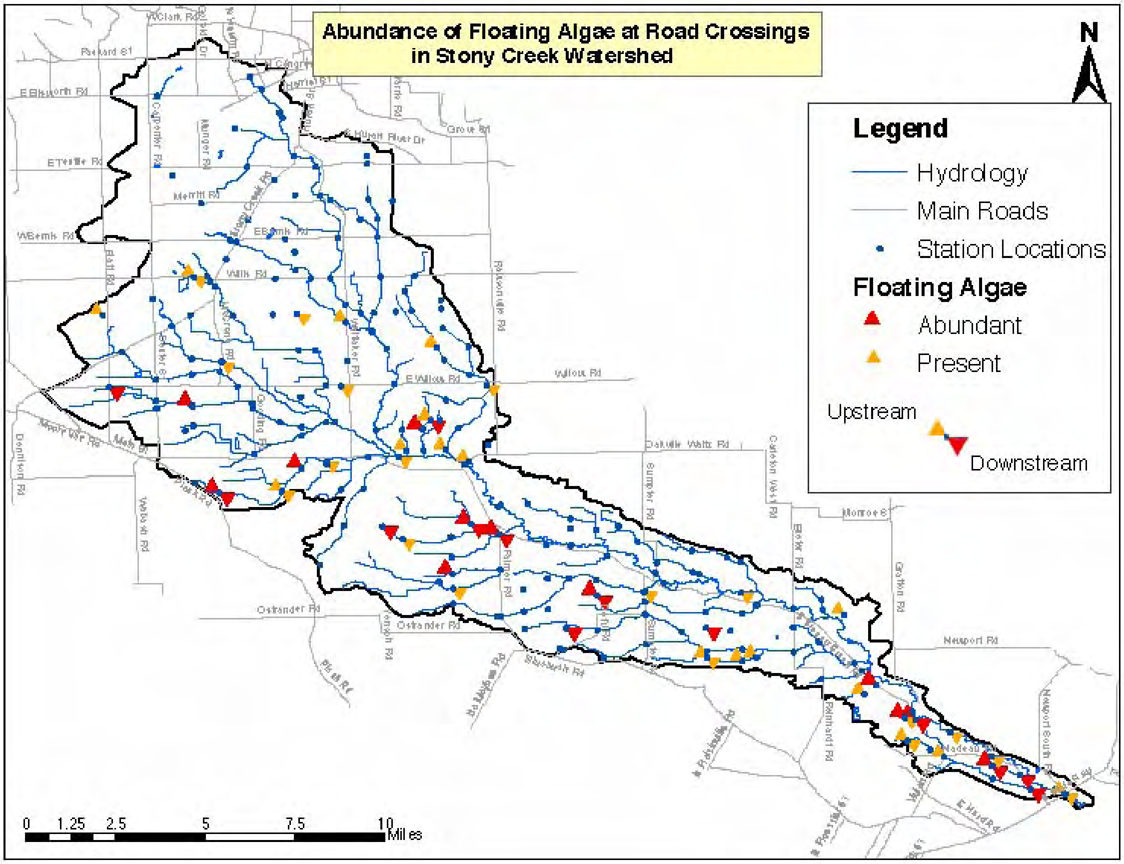

Figure 3.14: This map shows a few road crossings in the Stony Creek Watershed with abundant floating algae, particularly in agricultural drains of the lower watershed.

<u>Bank Erosion</u>

The sides of a stream channel are called banks; erosion is a normal process that takes place as a stream migrates from side to side or cuts into the streambed over time. Excessive erosion is typically caused by excessive flow fluctuation in streams or by the introduction of obstacles in the stream that diverts flow to the banks. Figure 3.15 shows areas of excessive bank erosion in the watershed. The areas of greatest concern are in the upper watershed where bank erosion is abundant. Locations where animals have access to streams have also been subjected to excessive erosion by animals trampling bank vegetation and damaging banks with their hoofs.

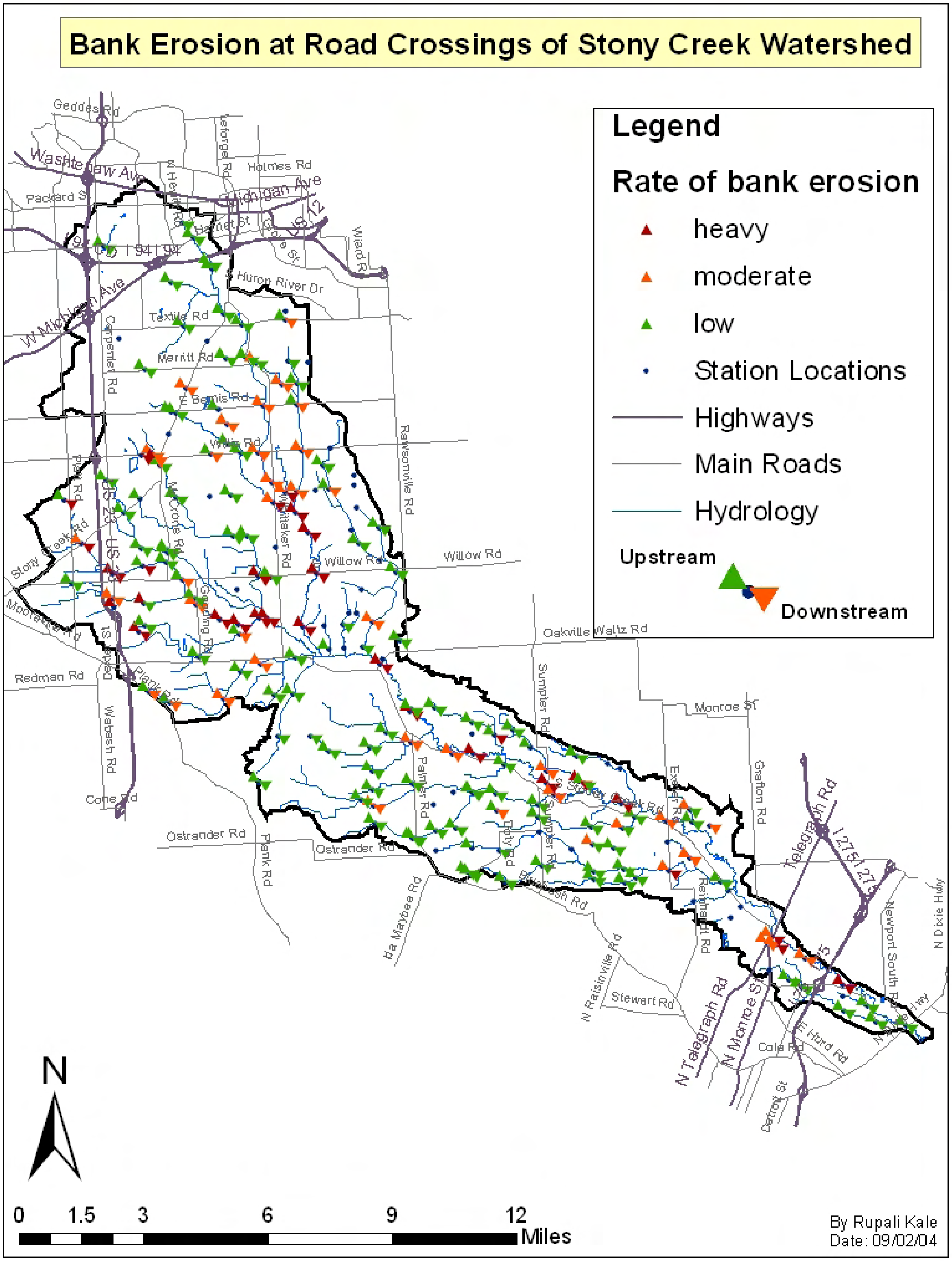

Figure 3.15: This map shows locations in the Stony Creek Watershed with abundant bank erosion, mostly concentrated in the upper watershed.

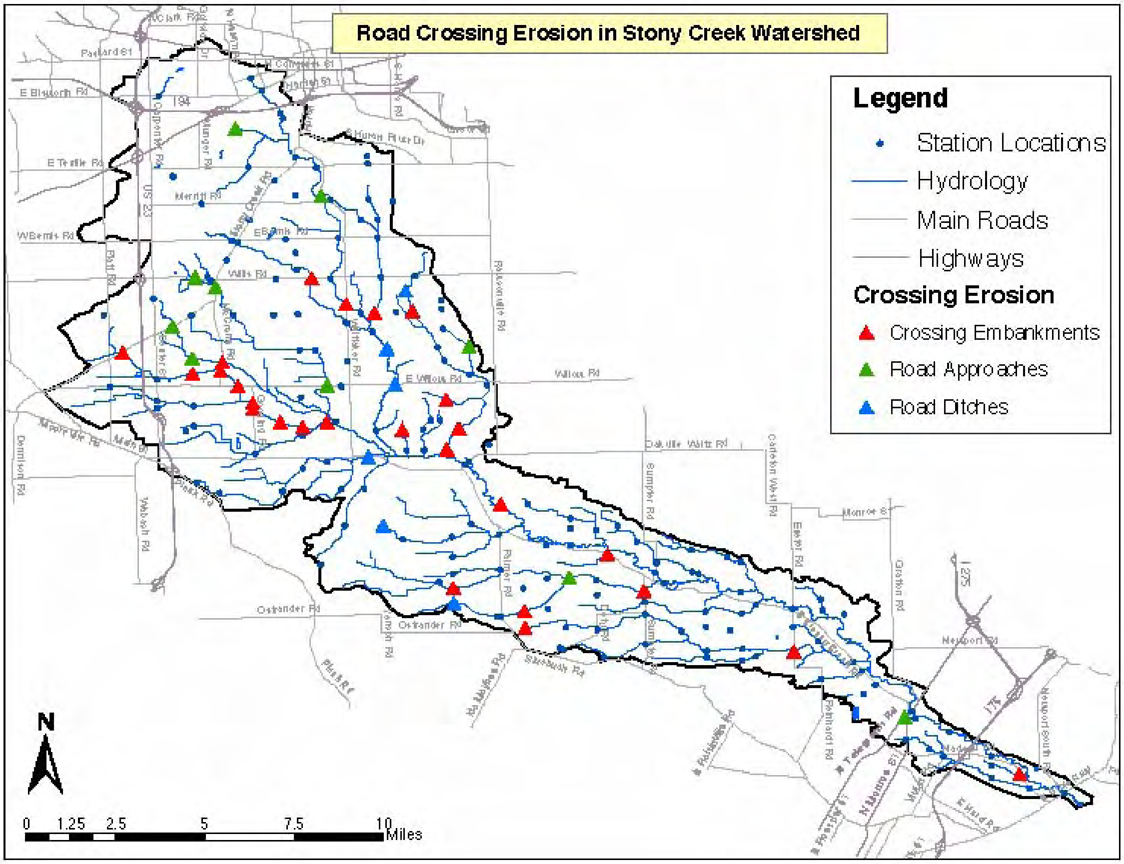

Figure 3.16: This map shows locations in the Stony Creek Watershed with abundant erosion of the road crossings, mostly concentrated in the mid-watershed.

Road Crossing Erosion

The locations where roads cross streams are often sources for sediment erosion. Problems related to the crossings themselves may be culverts or bridges that are inadequately sized to allow the flow volume to appropriately pass under the road. This problem could be because the crossing was designed inadequately or because altered hydrology is providing more flow than was normal at the time of construction. Aging crossings also wear out over time and may begin to provide inadequate protection of the embankment. In addition, gravel roads or roadside ditches near the crossings may be graded poorly and may begin to erode, providing additional sediment to streams at the crossing. Figure 3.16 shows a number of locations with erosion at road crossings in Stony Creek Watershed, mostly in the mid-watershed.

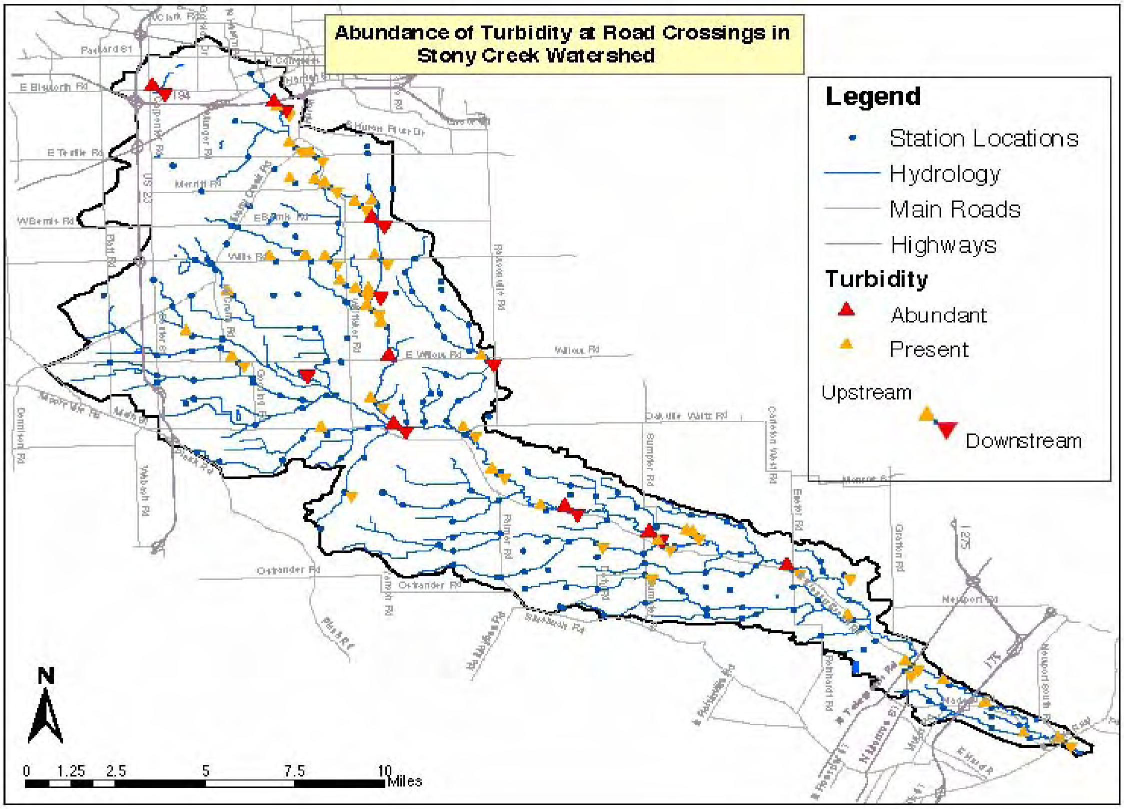

Figure 3.17: This map shows locations in the Watershed with abundant turbidity or suspended fine sediments in the water, mostly concentrated in Paint Creek and its tributaries.

Sediment

Sediment has multiple sources within the watershed. Sediment was documented in the watershed in two ways in this inventory survey: through turbidity and a visual estimate of grain size distribution on the stream bed. Turbidity is an indication of the clarity of surface waters. Low turbidity indicates clear water. High turbidity indicates water that has a number of suspended particles giving the water a muddy appearance. Excessive turbidity may prevent the bottom of the stream from being visible. Turbidity usually indicates that fine particle (silt and clay) are suspended in the water. Figure 3.17 shows locations where turbidity was present or abundant in the watershed. The most problematic portions of the watershed are branches of Paint Creek in the upper watershed. The map indicates turbidity farther downstream that was present because of high rainfall the day prior to surveying those locations.

Stream bed sediment was estimated visually at each site where the turbidity was low enough to see the bottom. This inventory measure can indicate the presence of sand as well as finer silts and clays commonly indicted with turbidity. Healthy streams are not covered in excessive sand, silt, and clay sized particles. Figure 4.18 shows that most of the streams and drains in the watershed are over 80% fine particles, most of these are more than 90% fines. The problem is fairly uniformly distributed across the watershed. Urban streams and agricultural drains alike are clogged with finer sediments and lack the gravels that apparently gave the watershed its name.

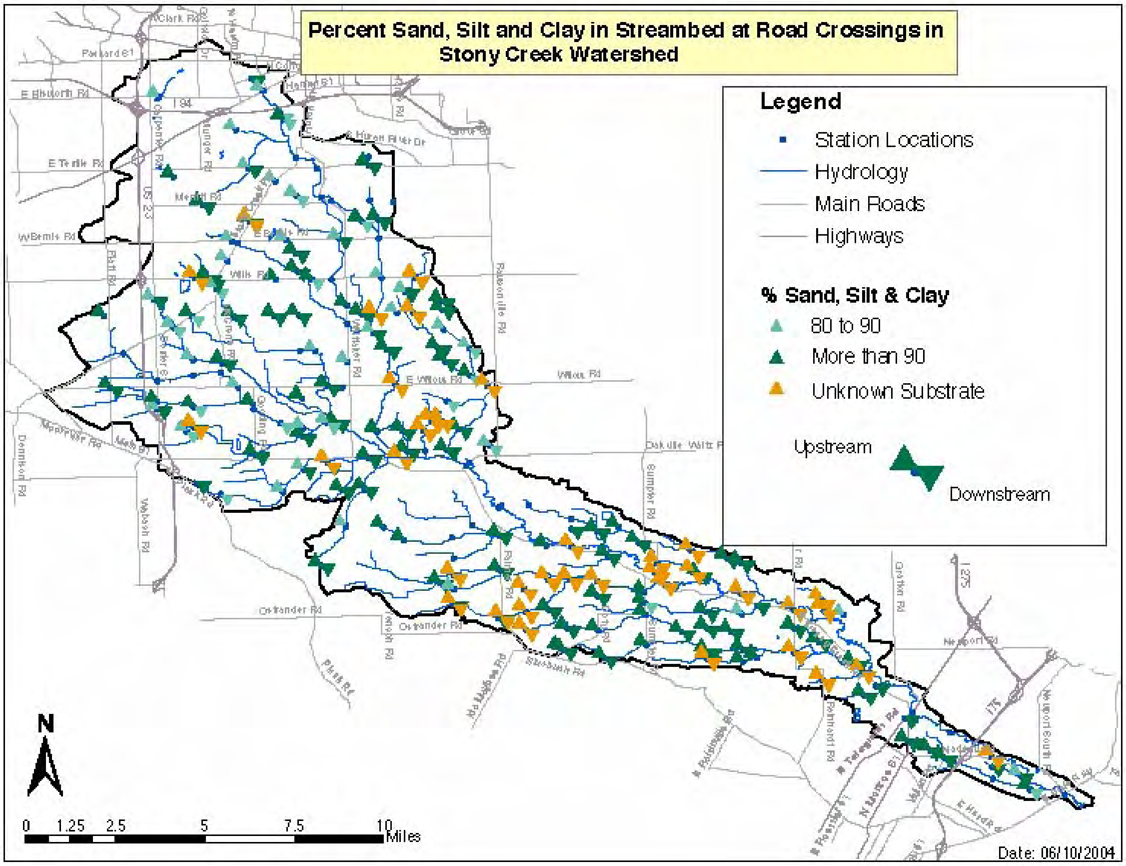

Figure 3.18: This map shows locations in the Stony Creek Watershed with abundant finer sediments and sand, distributed across the watershed.

Stream Canopy

Stream canopy is the measure of the degree of shading of the streams from overhanging vegetation, such as grasses, shrubs, and trees. Figure 3.19 shows that the stream canopy is remarkably extensive in most of the watershed. The upper watershed, where stream temperatures are most problematic (see section 3.4 above), has adequate canopy, so sources other than solar heating are likely responsible for the high temperature waters of Paint Creek. Lower in the watershed, the canopy is more frequently low to moderate, but stream monitoring (see section 3.5 above) indicates no apparent impact on stream temperature downstream of these locations.

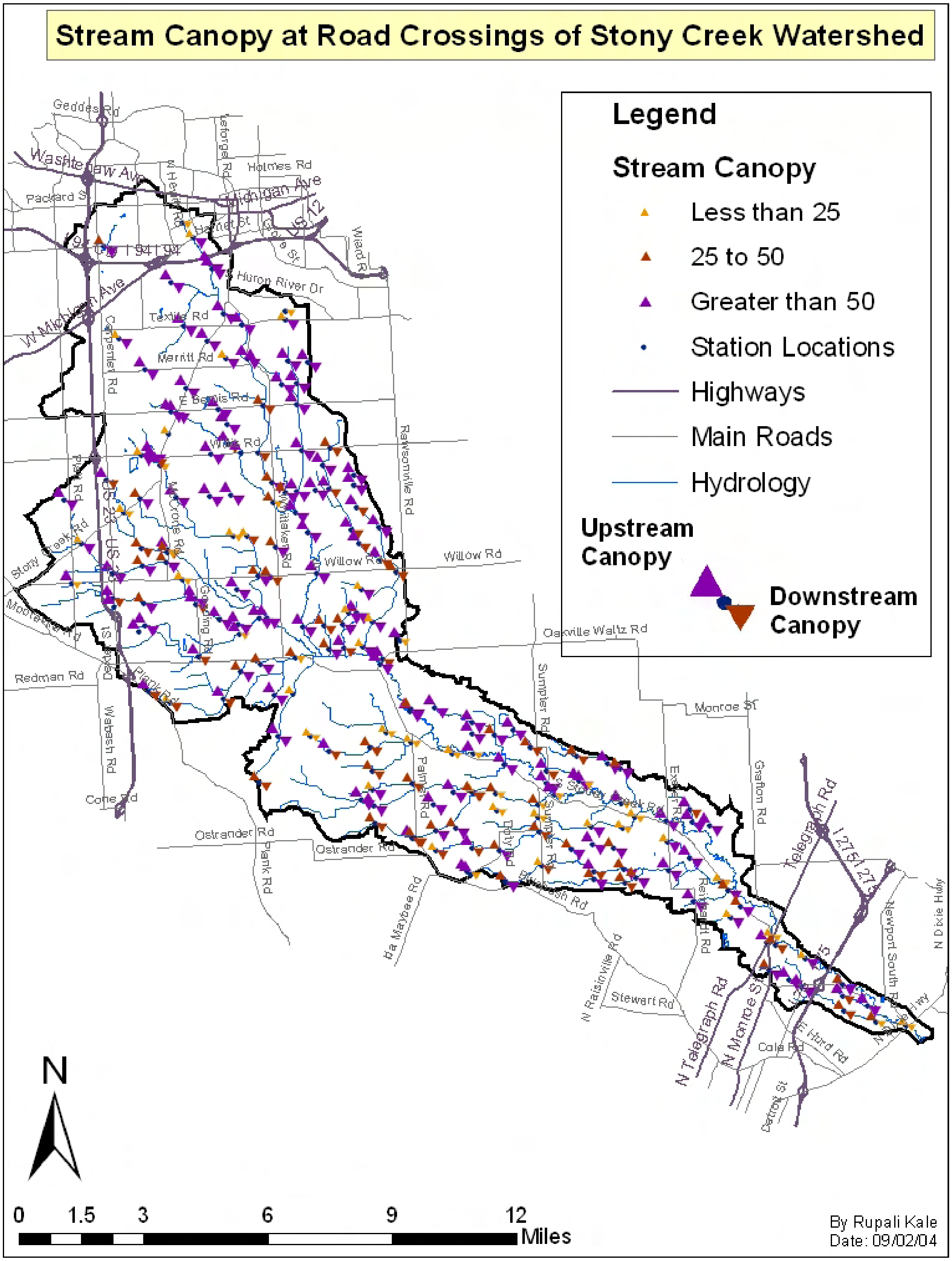

Figure 3.19: This map shows locations in the Stony Creek Watershed with abundant stream cover from overhanging vegetation. Areas of low to moderate stream canopy are concentrated in the lower watershed.

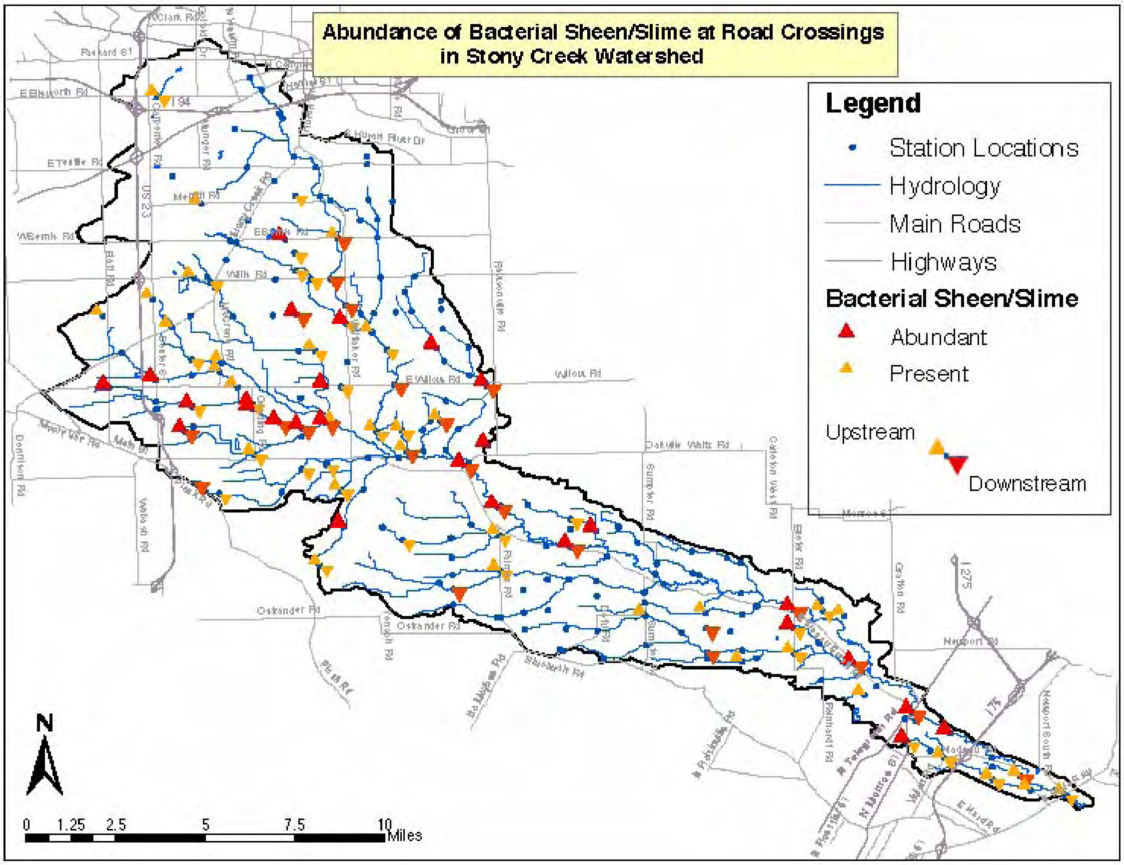

Figure 3.20: This map shows locations in the Stony Creek Watershed with abundant bacterial sheen and/or bacterial slime, mostly concentrated in the upper watershed along paint and Stony Creek.

<u>Bacterial Sheen and/or Slime</u>

Bacteria actively breakdown organic material that is present in streams. The rate of bacterial activity may also increase with the addition of phosphates in the water. When such activity is extensive a bacterial sheen may build up on the surface of a stream that looks like an oil film, but breaks up into clumps when poked. A reddish-orange bacterial slime may also build up on the streambed with abundant bacterial activity. Bacterial sheen or slime may build up in streams where extra inputs of organic material such as human or animal waste from malfunctioning septic systems or animal access to streams or from the added input of phosphates. Figure 3.20 shows a number of sites with bacterial slime or sheen, particularly abundant in the upper watershed.

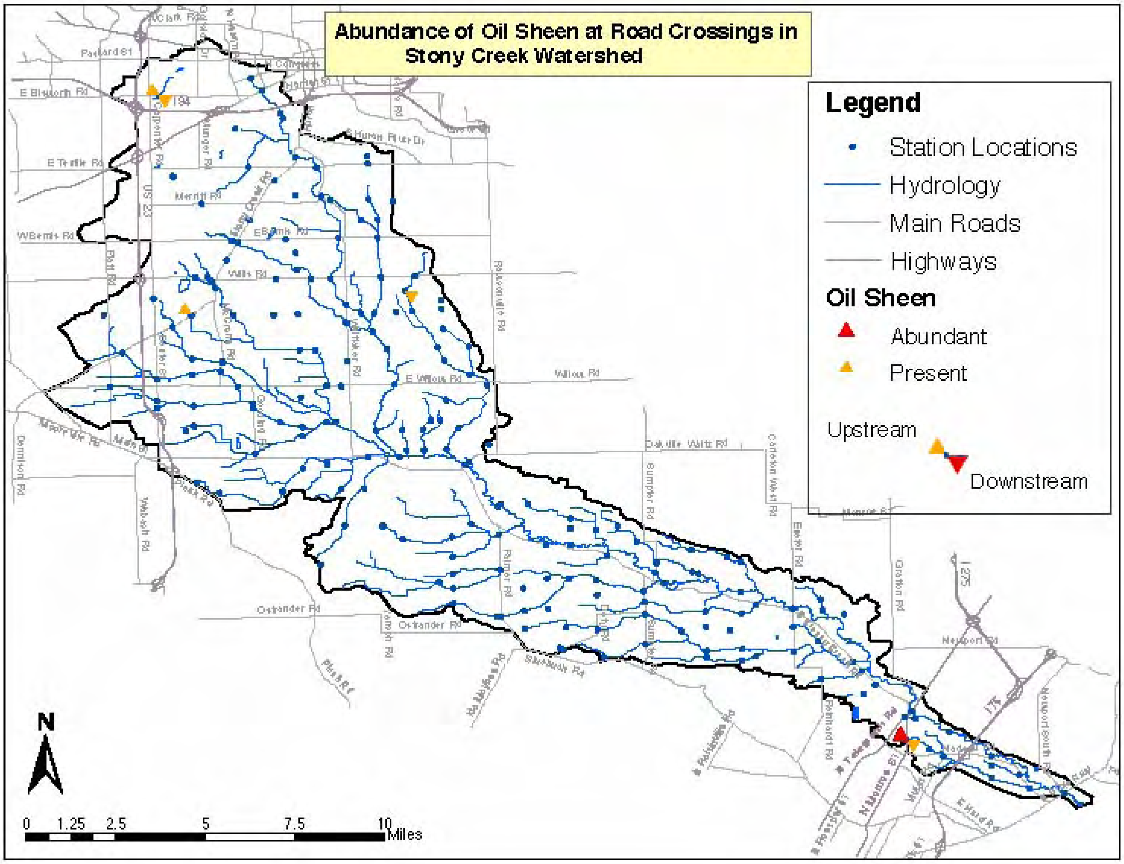

Figure 3.21: This map shows only a few locations in the Stony Creek Watershed with oil present in the surface waters.

<u>Oil Sheen</u>

Oil can wash into surface waters from parking lots and roads. Figure 3.21 shows only a few locations where oil sheen was identified at road crossings in the watershed. In the upper watershed, oil was identified in the water at perhaps the most developed crossing in the watershed, immediately downstream of an oil change facility. In the lower watershed, oil was found in the stream downstream of Telegraph Road.

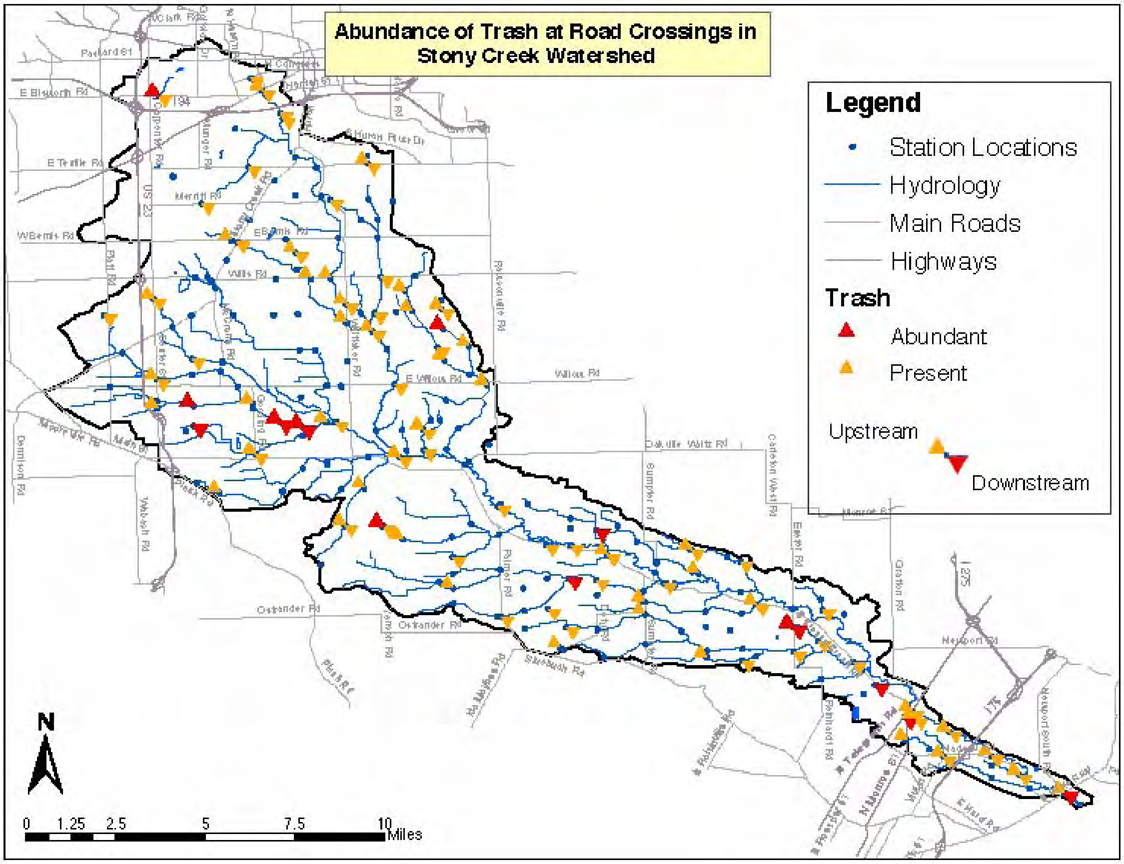

Figure 3.22: This map shows locations in the Stony Creek Watershed with abundant or present trash with distribution throughout the watershed.

<u>Trash</u>

Garbage thrown, blown, or washed into surface waters is aesthetically unappealing, but can sometimes add toxins to the water, depending on the type of trash. Figure 3.22 shows that excessive trash was found at a number of sites in the watershed and many others had trash present.

3.6 Summary

Generally, macroinvertebrate studies suggest that stream habitat and insect communities are poor in the extreme upper watershed, acceptable (trending toward poor) in the middle reaches, and more favorable in the lower watershed. Although the system is by no means pristine, some sensitive and pollution intolerant species are able to survive in the middle to lower reaches of the watershed. The general trend shows improving water quality conditions in the downstream direction.

Water quality monitoring and road stream crossings survey data suggest that sediment transport, phosphorus input, temperature, specific conductivity, and bank erosion are worst in the upper watershed where the land has been developed or is undergoing suburban development. There are, however, concerns about nutrients, sediment, and narrow riparian buffer widths in the lower watershed, but with an apparently less significant impact than the problems in the upper watershed.

References

MDEQ Staff Report, 1996. A biological survey of Stony Creek and Amos Palmer Drain, Monroe County, Michigan, September 13, 1995. Michigan Department of Environmental Quality, Surface Water Quality Division. MI/DEQ/SWQ-96/151.

MDEQ Staff Report, 1998. A biological survey of Stony Creek and its tributaries, Amos Palmer Drain and Ross Drain, Monroe County, Michigan, July 1997. Michigan Department of Environmental Quality, Surface Water Quality Division. MI/DEQ/SWQ-97/087.

National Academy of Sciences - National Academy of Engineering. 1973. Water Quality Criteria 1972. A Report of the Committee on Water Quality Criteria. Prepared for Environmental Protection Agency. Washington, DC

Chapter 4: Challenges and Project Goals

Identification of the most important challenges and goals of the watershed was left up to the community with the aid of project staff and the technical committee. This chapter outlines the process of establishing the priority of challenges and articulating goals for Stony Creek Watershed, and the role that the public, the steering committee, and the technical committee played in establishing those priorities.

4.1 Watershed Vision

Early in the planning process, the steering committee established a vision for the Stony Creek Watershed which this long-term planning effort will try to promote: "Creating and preserving a healthy watershed"

4.2 Designated Uses

All surface waters of the state of Michigan are designated for multiple uses and must be protected for each of those uses, including:

- <u>Agriculture</u> – water supply for farmland irrigation and livestock
- <u>Warmwater fishery</u> – maintains water quality for warmwater fish
- <u>Aquatic life and wildlife</u> – maintains water quality for other indigenous plants, animals, insects
- <u>Partial body contact for recreation</u> – sufficient quality for canoeing, boating, wading
- <u>Total body contact between May 1 and October 31</u> – sufficient quality for swimming
- <u>Public water supply</u> – maintains safe drinking water
- <u>Industrial water supply</u> – water available for industrial purposes
- <u>Navigation</u> – supports navigation in waterways

The Stony Creek Watershed steering committee, composed of representatives from each township with significant area within the watershed boundary, has been held responsible by the state of Michigan for developing a management plan to protect surface waters for the above designated uses. The surface waters of Stony Creek Watershed, however, are not used for industrial water supply. In addition, the Stony Creek system is deemed not suitable for navigation by the steering committee. As a result, the steering committee recognizes that the last two designated uses listed above are not reasonably applicable to the Stony Creek Watershed and therefore decided to focus attention on the other designated uses.

Within the watershed, public water supply is currently limited to groundwater use. Residents of Monroe, MI, however, intake water from Lake Erie near the mouth of Stony Creek, so the Stony Creek Watershed can potentially impact the quality of the public water supply at that location. All other designated uses are clearly relevant to the Stony Creek Watershed.

In addition, Paint Creek (a major tributary to Stony Creek in Washtenaw County) has been designated as a trout stream and will therefore be protected as a coldwater fishery and considered an additional designated use of the that portion of the watershed.

As a result, the list of most important designated uses that the steering committee decided to address are the following:

- Agriculture
- Warmwater fishery
- Aquatic life and wildlife
- Partial body contact for recreation
- Total body contact between May 1 and October 31
- Public water supply
- Coldwater fishery

The decision to focus on the above designated uses was communicated to the public at the April 2004 public meetings and have been posted on the project website since the decision was made by the steering committee.

4.3 Challenges / pollutants of concern in the watershed

Based on 1) concern raised by the public to steering committee members and 2) data from the macrioinvertebrate studies, water quality monitoring, and the road stream crossings inventory (presented in Chapter 3), the technical committee and steering committee established the following challenges and pollutants of concern in the watershed:

- Altered hydrology – land use induced changes in stream function causing multiple problems
- Sedimentation / Soil Erosion – high input of sediment pollution to streams
- Nutrients – high input of fertilizers, etc. from multiple sources
- Pesticides – known use of pesticides throughout the watershed
- Temperature – high temperature of stream waters threatening fish populations
- Dissolved Oxygen (DO) – low dissolved oxygen levels threatening fish populations
- Oil/grease/metal/brine/salts – common materials washed off parking lots and roadways
- Pathogens – common challenge when fecal material enters surface waters
- Hydrogen sulfide (HS)/total dissolved solids – challenge of recent concern to residents
- pH – acidity considered potentially problematic for fish if too high or too low

4.4 Sources and causes of challenges / pollutants in the watershed

The sources and causes of the identified challenges to the Stony Creek Watershed are described below. The general sources of pollutants vary by land use with developed and developing areas and agricultural areas providing a number of potential sources and causes of challenges to the watershed. These sources and causes are outlined in Table 4.1 and discussed in the narrative that follows.

4.4.1 Altered hydrology

Developed and developing areas result in altered hydrology first by removing wetlands and natural vegetation that allow water to be stored on the land surface or slowly infiltrated into the land rather than flow overland during rain events. Deep roots of native vegetation and low intensity use of land allow the soil to be loose and hold much more water than developed land.

In addition, pavement and other urban structures (buildings, etc.) are impervious surfaces that do not allow infiltration of water into the ground. Natural streams are often removed or relocated during development which alters the natural drainage of land. The replacement drainage feature is usually straightened and often with a smoother surface (such as an underground tunnel) that speeds the flow of water from the area. Inadequate stormwater management allows water to reach streams more quickly. All of these causes of altered hydrology in developed and developing areas lead to higher peak flows that occur more rapidly after the beginning of a rain event than before development. Groundwater tables and stream flows between rain events tend to be lower than normal because water is less able to infiltrate into the ground to recharge the groundwater that feeds streams between storms.

Agricultural fields result in altered hydrology first by removal of wetlands and natural vegetation that allow water to be stored on the land surface or slowly infiltrated into the land rather than flow overland during rain events. Deep roots of native vegetation and low intensity use of land allow the soil to be loose and hold more water than agricultural land that becomes compacted by heavy equipment. Natural streams are often moved, straightened, and disconnected from their floodplains with the construction of drains, which are designed to move water rapidly from the area. Tiling of fields may also increase flow in streams because it is designed to keep water from ponding on the land surface. On the other hand, tiling of fields may reduce overland flow during some storms by discharging water directly into drains or streams rather than allowing water to pool up too quickly on the land surface. All of these causes of altered hydrology in agricultural areas lead to higher peak flows that occur more rapidly after the beginning of a rain event than before alteration. Groundwater tables and stream flows between rain events tend to be lower than normal because water is less able to infiltrate into the ground to recharge the groundwater that feeds the streams between storms. Agricultural land generally has a smaller effect on altering hydrology than developed and developing areas.

Point sources from gravel pits are another source of altered hydrology. Large gravel pits and quarries pump groundwater in order to excavate deeper below the land surface. Discharge of pumped groundwater into streams results in abnormally high discharge in surface streams.

Altered hydrology in Stony Creek has produced accelerated erosion of banks, loss of bank vegetation, and downstream log jams that have, in turn, locally altered the hydrology in the creek. In some areas, these log jams have built up enough that they impede flow and result in localized flooding during rain events. Log jams also slow the arrival of water downstream.

4.4.2 Sedimentation / soil erosion

Developing and developed areas result in known sources of sedimentation/soil erosion mostly as a result of construction. Soil is loosened and uncovered during construction that allows stormwater to pick up and carry sediments along the land surface. There are required sedimentation and soil erosion controls for construction in Michigan, but the control methods are often inadequate and inspection and compliance with permits is often insufficient. Once an area is developed, inadequate stormwater management practices allow large concentrations of water to carry high volumes of sediment off roads and other impervious surfaces into sewers.

Even detention structures that control the amount of water that enters streams from developed areas do little to control finer sediments from entering surface waters. In addition, inadequate riparian buffers during and after construction allow a close connection of the altered runoff producing landscape to the surface waters that may be a source of sediment to streams.

Agricultural fields result in known sources of sedimentation/soil erosion. Agricultural fields are without established vegetation for a portion of most of the year, which leaves the landscape prone to excessive soil erosion. Inadequate upland conservation practices result in unnecessary loss of topsoil that can work its way toward surface waters. Inadequate riparian buffers increase the likelihood that soil eroded off of fields will enter surface waters. In addition, wind can contribute to soil erosion, especially on the flatter landscape of the Stony Creek Watershed.

Eroding streambanks are known sources of sedimentation/soil erosion. Streambanks are eroding mainly because of high flow fluctuation caused by altered hydrology. With the faster arrival of water to the surface water system during rain events, greater flows are capable of greater bank erosion. This threat is expected to increase in the future with further development of the watershed. Some logjams in Stony Creek have been caused by bank erosion undercutting an unusually high number of trees. Logjams are large enough in many portions of Stony Creek to divert flow toward the banks, causing increased bank erosion. Insufficient vegetation on the banks, either by human or animal removal or by erosion induced by increased flow fluctuation, leaves the banks susceptible to erosion because vegetation stabilizes banks.

Eroding road stream crossings are known sources of sedimentation/soil erosion. Aging or inadequately designed road crossings can cause erosion of banks near the crossing, plunge pools downstream of the crossing, eroding road surfaces or roadside ditches leading up to the crossing or erosion of the fill over culverts, etc. Culverts that are inadequately sized can cause ponding upstream and erosive flows downstream of the culvert during rain events.

Livestock in streams is another source of sedimentation/soil erosion. Uncontrolled access of livestock can cause excessive erosion of streambanks and removal of vegetation on and near the banks of streams. These factors also accelerate soil erosion during rain events.

4.4.3 Nutrients

Agricultural fields are known sources of nutrients. Insufficient upland conservation practices and inadequate riparian buffers allow nutrients from fertilizer (often attached to soil particles) to wash off the landscape and into local streams. Sewage sludge applied to agricultural fields is a potential source for additional nutrients that could work their way to streams.

Homeowners in rural and urban locations are known sources of nutrients. Improper selection and application of fertilizers can result in the application of more nutrients than is necessary for healthy lawns and gardens. In addition, inadequate riparian buffers allow an easy pathway for those nutrients to reach streams during rain events. Some homeowners that have septic systems can contribute a suspected source of nutrients. Improperly maintained septic systems or use of poorly designed systems can release nutrients into the watershed that may work their way into streams.

Commercial lawns and golf courses are another known source of nutrients. Although generally managed more carefully than homes, regular application of fertilizers are common on these properties. Insufficient management practices and inadequate riparian buffers are suspected causes of nutrients entering streams.

Livestock in streams is another known source of nutrients in streams. Uncontrolled access allows livestock to deposit digestive waste directly into streams.

Storm sewers are suspected sources of nutrients to streams. Illicit connections of sanitary sewers to storm sewer systems may connect sewage to streams. Pet and animal waste may wash directly into streams through stormwater sewers with direct connections to streams.

4.4.4 Pesticides

Agricultural fields are known sources of pesticides. Insufficient upland conservation practices and inadequate riparian buffers allow pesticides (often attached to soil particles) to wash off the landscape and into local streams.

Homeowners in rural and urban locations are another known source of pesticides. Improper application and use of pesticides and inadequate riparian buffers allow easy pathways for pesticides to reach streams during rain events.

Commercial lawns and golf courses are another known source for pesticides. Although generally managed more carefully than homes, regular application of pesticides is common on these properties. Insufficient management practices and inadequate riparian buffers are suspected causes of pesticides entering streams.

4.4.5 Temperature

Runoff from hot, impervious areas is a suspected source of high water temperature. Solar heating is a suspected cause of high temperatures in Paint Creek. Loss of riparian canopy is the suspected cause of excessive solar heating, especially in tributary streams that feed Paint Creek.

4.4.6 Low dissolved oxygen (DO)

High temperature water can hold less oxygen than colder water. As a result, high temperature water leads to lower dissolved oxygen that can be critically low for the survival of fish. High nutrient concentrations can also lead to lower dissolved oxygen levels as increased plant growth (particularly algae) leads to a short-lived abundance of oxygen consuming organisms in the water. High concentrations of organic material from poorly operating septic systems, stormwater, feedlots, agricultural runoff, or urban construction leads to high rates of decomposition, an oxygen depleting process.

4.4.7 Oil/grease/metal/brine/salts

Impervious surfaces, especially those related to vehicle use such as roads, parking lots, and driveways, are known sources for a variety of pollutants such as oil, grease, metals, brine, and salts. Homeowners (urban and rural) contribute to this set of pollutants through improper oil disposal and vehicle maintenance and unsparing use of salt for snow removal.

4.4.8 Pathogens

Homeowners (urban and rural) are known sources of pathogens through improperly maintained or poorly designed septic systems that leak human waste into the watershed. Livestock waste is a known source of pathogens. Insufficient upland controls allow livestock direct access to streams or allow direct pathways from holding areas to streams. Pet waste is a known source of pathogens that can have direct access to streams through stormwater sewers. Waterfowl waste is a direct source of pathogens to streams. Agricultural fields that apply sewage sludge for fertilization are known sources of pathogens, although there are few fields within the watershed that are permitted to accept sludge. Human waste from sanitary sewers are a potential source of pathogens through illicit connections to storm sewers.

4.4.9 Hydrogen sulfide/total dissolved solids

The known source of hydrogen sulfide and dissolved solids in the Stony Creek Watershed is groundwater. The main cause for high amounts of these pollutants is groundwater pumping with direct discharge into streams that is associated with gravel pit and quarry operations.

4.4.10 pH

One suspected cause of low pH in the Stony Creek Watershed is acid rain. Coal burning power plants are largely responsible for producing acid rain, which can increase acidity of surface waters following storms. Another source of low pH is respiration (breathing) of organisms in the water. Decomposition of organic material can similarly reduce pH.
Acidity can be reduced (higher pH) by the addition of ammonia fertilizers and lime that are often added to agricultural fields and gardens. Acidity can also be reduced by plant photosynthesis, which is most active during the day and during the growing season.

4.5 Prioritization of challenges / pollutants

Prioritization of challenges / pollutants are shown below and in the major headings of Table 4.1. The public established this prioritization during two public forums in April 2004. The community members who attended the forums were educated about the planning process, the list of designated uses, the list of challenges / pollutants of concern in the watershed, and information related to each challenge / pollutant and how they relate to the designated uses of concern. The public was then asked to rank the challenges / pollutants according to their concern, based on the information provided.

The data was entered into a spreadsheet and averaged to create an overall priority list of challenges / pollutants in the Stony Creek Watershed. Following the forums, the steering committee approved the list of critical challenges.

1. Sedimentation / soil erosion
2. Altered hydrology
3. Nutrients
4. Low DO
5. Pesticides
6. Oil/grease/metal/brine/salt
7. Temperature
8. Hydrogen sulfide / total dissolved solids
9. Pathogens
10. pH

There were two public forums, one held in Monroe County and one held in Washtenaw County. The priority lists of each county were remarkably similar (see spreadsheet, Appendix), so averaging the concerns of all attendees seemed an appropriate gauge of the public concern. In fact, the top five priorities were the same in each county in almost the same order.

4.6 Prioritization of sources and causes of challenges / pollutants

Prioritization of the sources and causes of the challenges / pollutants was a collaborative effort between the public, project staff, technical committee and the steering committee members. First, the public was asked to discuss sources and causes of concern at the public forums. These comments, along with data collected from the monitoring and watershed inventory, were used by project staff to draft an initial priority table (similar to Table 4.1) of sources and causes of challenges and pollutants in the watershed. This table was distributed to the technical committee over the internet for additions, subtractions, and alterations. Over a period of several months, the table was changed repeatedly based on feedback from technical committee members and discussions at steering committee meetings. Ultimately, the table of prioritized sources and causes of each challenge / pollutant was approved by the Steering Committee.

4.7 Critical Areas

It was clear from the beginning of the project that the two main land uses that could pose the greatest potential problems for water quality were the residential/commercial developments that had or were taking place in the upper watershed, and the agricultural use which dominates most of the rest of the watershed. It was also evident that clay soils would produce the potentially greatest amount of polluted runoff directed toward surface waters of the watershed. Finally, the areas bordering surface waters posed the greatest threat to surface water contamination. As a result, the most critical areas of the watershed were initially considered to be 1) the developed and developing areas, and 2) agricultural areas, particularly where either land use was on clay soils and/or where land uses were not well buffered from surface waters.

Table 4.1: Known/Suspected Sources and Causes of Challenges in the Stony Creek Watershed

1. SEDIMENTATION / SOIL EROSION

Sources	Causes
Developing and developed areas	- Inadequate sediment / erosion control methods - Inadequate riparian buffers - Inadequate inspection / compliance with permits - Inadequate stormwater management
Agricultural fields	- Inadequate upland conservation practices - Inadequate riparian buffers - Flooding of fields - Wind erosion
Eroding streambanks	- High flow fluctuation - Some log jams divert flow to banks - Insufficient vegetation on banks
Eroding road stream crossings	- Erosive road / overpass surface - Old failing structures - Inadequately sized culverts for current flows
Livestock in streams	- Uncontrolled access

2. ALTERED HYDROLOGY

Sources	Causes
Developing and developed areas	- Imperviousness of landscape - Loss of wetlands and natural vegetation - Inadequate stormwater management - Natural streams removed/relocated with development
Agricultural fields	- Loss of wetlands and natural vegetation - Streams moved, straightened, and disconnected from floodplain) with construction of drains - Tiling increases flow in streams, but may reduce overland flow by reducing ponding of water on surface
Point sources (gravel pits)	- Discharge of pumped groundwater into streams
Log jams (locally)	- Bank erosion induced tree fall (from increased flow)

3. NUTRIENTS

Sources	Causes
Agricultural fields	- Insufficient upland conservation practices - Inadequate riparian buffers - Flooding of fields - Sewage sludge applied to agricultural fields
Homeowners, urban and rural	- Improper selection and application of fertilizers - Inadequate riparian buffers - Improperly maintained, poorly designed septic systems
Commercial lawns and golf courses	- Inadequate riparian buffers - Insufficient management practices
Livestock in streams	- Uncontrolled access
Storm sewers	- Stormwater sewers transport plant material and animal waste directly into streams - Illicit connections of sanitary sewer to storm sewer?
Waterfowl waste	- Direct access to streams

Table 4.1 (cont.): Known/Suspected Sources/Causes of Challenges in Stony Creek Watershed

4. LOW DO – Strongly correlated with stream temperature

Sources	Causes
Higher water temperature (see temperature sources and causes)	- High temperature water holds less oxygen

5. PESTICIDES

Sources	Causes
Agricultural fields	- Insufficient upland conservation practices - Inadequate riparian buffers
Homeowners, urban and rural	- Improper application and use - Inadequate riparian buffers
Commercial lawns and golf courses	- Inadequate riparian buffers - Insufficient management practices

6. OIL, GREASE, METAL, BRINE, SALT

Sources	Causes
Roads, parking lots, driveways	- Inadequate stormwater management practices - Road ditches drain directly to streams - Storm sewers and drainage paths connected directly to streams
Homeowners, urban and rural	- Improper oil disposal and vehicle maintenance - Salt overuse for snow removal

7. TEMPERATURE

Sources	Causes
Runoff from impervious areas	- Inadequate stormwater management
Solar heating	- Loss of riparian canopy (mostly tributaries)

8. HYDROGEN SULFIDE / TOTAL DISSOLVED SOLIDS

Sources	Causes
Groundwater	- Groundwater pumping and discharge from quarries

9. PATHOGENS

Sources	Causes
Homeowners, urban and rural	- Improperly maintained, poorly designed septic systems
Livestock waste	- Insufficient upland controls
Pet waste	- Stormwater sewers create direct path to streams
Waterfowl waste	- Direct access to streams
Agricultural fields	- Sewage sludge applied to agricultural fields
Human waste from sanitary sewers	- Illicit connections of sanitary sewer to storm sewer?

10. pH

Sources	Causes
Acid Rain lowers pH	- Coal burning power plants
Agricultural fields	- Addition of lime raises pH - Ammonia fertilizers may raise pH

As scientific data from monitoring and the watershed inventory emerged, and as public comments emerged from the public forums and in discussions between and among steering and technical committee members, the overall picture of critical areas that emerged is not much different than the initial areas of greatest concern. The most significant problem areas are the developed and developing areas in the upper watershed. The second most significant problem areas are the agricultural areas. This general order of priorities was acknowledged and supported by both the steering and technical committees.

4.7.1 Developed and Developing Areas

Developed and developing areas in the upper watershed were determined to be the most critical areas in the watershed because they are the areas with:

- the lowest general water quality according to the macroinvertebrate study, which showed increasing water quality away from the developed and developing areas
- the highest conversion to impervious areas that could alter the watershed hydrology
- the lowest infiltration rates in extreme upper watershed
- the most extensive erosion of banks (in Paint Creek and upper Stony Creek)
- the highest percentage of days with high sediment concentration during water quality monitoring
- the greatest turbidity during the watershed survey
- the highest percentage of days with high phosphorus concentrations during water quality monitoring
- the only indication of temperatures too high for a warmwater fishery, especially detrimental considering that Paint Creek is designated as a coldwater fishery
- the only indication of high conductivity that suggests generally polluted water

To make matters worse, these critical areas are in the upper part of the watershed, which means that the problems in this area impact the rest of the watershed. In addition, formerly agricultural areas are quickly being converted to developed areas in the upper watershed, which means that this most critical land use (and its nonpoint source pollution) is expanding and threatening larger portions of the watershed. Focusing on agricultural issues in the areas undergoing pressure from development would be a losing battle if the land converts to residential/commercial in the near future.

Conversely, development in the lower watershed seems to have a much lower impact on water quality because the bank erosion, gravel in streams, conductivity and other water quality indicators are not of particular concern in this area. In addition, the watershed narrows considerably in this area and there are few downstream areas within the watershed that are greatly affected by the development in the area. There are certainly sources and causes of nonpoint source pollution in Frenchtown Township, but the extent and impact of those sources are of much lower concern than in the upper watershed.

4.7.2 Agricultural Areas

Agricultural areas distributed throughout the watershed were determined to be the second most critical areas in the watershed because they are the areas with:

- many streams and drains with low buffer widths
- high alteration of hydrology with tiling, drain construction/maintenance, and loss of natural vegetation
- low gravel percentages in streams and drains
- high percentage of days with high phosphorus concentrations during the water quality monitoring
- an extremely high percentage of days with high nitrate concentrations during the water quality monitoring
- the greatest abundance of filamentous and floating algae
- areas with livestock contributing sediment erosion, nutrients, and pathogens to streams

The agricultural areas of greatest concern are in monitoring areas 5-8 (see figures 3.3 – 3.10), in particular the areas in Exeter, London, and the lower half of Augusta and York Townships, where the sediment and phosphorus concentrations are highest, and the buffer widths are typically low. These areas also are currently experiencing less pressure for development compared to agricultural areas that remain in the upper watershed.

<u>Summary</u>
As a result, the developed and developing areas of the upper watershed are considered to be the most critical areas in the watershed. The developed and developing areas in the lower watershed are of less concern. The second most critical area is agricultural fields, particularly agricultural areas in the Exeter, London, and the lower half of Augusta and York Townships.

4.8 Impaired / Threatened Uses and Project Goals

The Stony Creek Watershed has three designated uses that are impaired: 1) warmwater fishery, 2) coldwater fishery, and 3) aquatic life/wildlife. The threatened designated uses include: 1) agriculture, 2) partial body contact recreation, 3) total body contact recreation, and 4) public water supply. The pollutants or challenges that threaten and impair these uses include altered hydrology, sedimentation/soil erosion, nutrients, pesticides, high temperature/ low dissolved oxygen, oil/grease/metal/brine/salts, pathogens, and hydrogen sulfide/dissolved solids. Seven specific project goals emerged from this assessment and were approved by the steering committee. They are described below.

4.8.1 Restore the warmwater fishery

The first project goal is to restore a warmwater fishery by reducing hydrologic impacts, sedimentation and erosion, and reducing loads of nutrients, pesticides, and oil/grease/metal/brine/salt. The designated use of warmwater fishery is impaired by altered hydrology and sedimentation/soil erosion and is threatened by nutrients, pesticides, temperature/low dissolved oxygen, oil/grease/metal/brine/salts, and pH. Hydrogen sulfide/total dissolved solids from gravel pit discharges has impaired the warmwater fishery and pending future discharges threaten the warmwater fishery.

Altered hydrology impairs warmwater fishery by producing increased and more extensive flooding that scours the stream system and destroys fish habitat, in particular the loss of pools.

In addition, water levels are typically lower than normal between storms, resulting in lower flow volumes which sustain fish population.

Eroded sediments inundate the surface waters of the watershed with large amounts of fine to sandy sediment that may abrade fish fins and gills and cover stream gravels that are important for laying fish eggs. Sediments also fill in deep pools that are important fish habitat. Decomposition of organic sediments uses oxygen, so it can lower dissolved oxygen in streams creating a potential hazard for fish.

Nutrients have the potential to degrade the warmwater fishery by leading to a drop in dissolved oxygen that is necessary for a healthy fish population.

Pesticides threaten warmwater fishery by being potentially toxic for fish. In addition, pesticides can build up in the fatty tissues of fish and be transferred to humans and other animals that eat fish from these streams.

High temperatures stress even warmwater fish and can lower dissolved oxygen levels in the creek to potentially fatal levels.

The presence of oil/grease/metal/brine/salts can have adverse health consequences for fish if present in high enough concentrations for long enough durations. Some metals build up in the fatty tissues of fish and can trigger health consequences for the fish and those who eat them.

Hydrogen sulfide/total dissolved solids from groundwater can cause impairment of the warmwater fishery because they can be toxic for fish. There has been documented impairment of the fishery in Stony Creek due to this practice from the now closed London Aggregates gravel pit discharges into the surface water system.

Levels pH threaten the warmwater fishery if they remain outside the range that is suitable for many fish species.

4.8.2 Restore aquatic life/wildlife diversity

The second project goal is to restore aquatic life/wildlife by reducing hydrologic impacts, sedimentation and erosion, and reducing loads of nutrients, pesticides, and oil/grease/metal/brine/salt. The designated use of aquatic life/wildlife is impaired by altered hydrology and sedimentation/soil erosion and is threatened by nutrients, pesticides, oil/grease/metal/brine/salts, and hydrogen sulfide/total dissolved solids.

Altered hydrology impairs the aquatic life/wildlife by producing increased flows that scour the stream system, destroying aquatic habitat.

Eroded sediments inundate the surface waters of the watershed with large amounts of fine to sandy sediment that cover a variety of aquatic habitat, lowering the diversity of aquatic life.

Nutrients have the potential to degrade the aquatic life/wildlife by possibly leading to a drop in dissolved oxygen that is necessary for diverse aquatic life.

Pesticides threaten aquatic life/wildlife by being potentially toxic for aquatic life.

The presence of oil/grease/metal/brine/salt can have adverse consequences for aquatic life/wildlife if present in high enough concentrations for long enough durations.

Hydrogen sulfide/total dissolved solids can cause impairment of aquatic life/wildlife because they can be toxic for aquatic life/wildlife.

4.8.3 Restore the coldwater fishery in Paint Creek

The third project goal is to restore a coldwater fishery by reducing temperatures in Paint Creek in addition to the above improvements for a warmwater fishery. Paint Creek is a designated coldwater trout stream. The designated use of coldwater fishery is impaired by temperature/low dissolved oxygen, altered hydrology, and sedimentation/soil erosion and is threatened by nutrients, pesticides, oil/grease/metal/brine/salts, hydrogen sulfide/total dissolved solids, and pH.

All of the known impacts of the above challenges are described under "warmwater fishery" except for cold temperature streams. Coldwater fish cannot tolerate sustained warm water temperatures or potentially lower dissolved oxygen levels that higher temperature waters yield. Due to changes in land use, Paint Creek no longer maintains temperatures for warmwater fish, much less coldwater species.

The Department of Natural Resources used to stock Paint Creek with trout, but has refrained from such actions for several decades due to the degraded quality of Paint Creek. The steering committee recognized the desire to restore the creek to its former quality as a coldwater fishing stream, but also recognizes that this is a long term goal. Restoring a warmwater fishery is a more attainable first step toward reestablishing a coldwater fishery, so the committee decided to make this designated use a lower priority than the others.

4.8.4 Protect agriculture

The fourth project goal is to protect agriculture by reducing hydrologic impacts and soil erosion. The designated use of agriculture is threatened by altered hydrology and sediment erosion in parts of the watershed.

Altered hydrology impairs agriculture by producing increased and more extensive flooding of fields. In addition, lower groundwater levels means less available water during dry periods that is more expensive to pump from deeper sources underground.

Sediment erosion from agricultural fields threatens the designated use of agriculture. Inadequate upland conservation practices allow valuable topsoil to be depleted or washed away during rain events and can result in reduced yields from fields over time.

4.8.5 Protect for partial body contact recreation

The fifth project goal is to protect partial body contact for recreation by reducing loads of nutrients, pathogens, pesticides, and oil/grease/metal/brine/salt. The designated use of partial body contact for recreation is threatened by nutrients, pesticides, pathogens, oil/grease/metal/brine/salts, and hydrogen sulfide/total dissolved solids.

Known sources of nutrients include agricultural fields, homeowners (urban and rural), commercial lawns and golf courses, livestock access to streams, storm sewers, and waterfowl waste. Known sources of pesticides include agricultural fields, homeowners (urban and rural), and commercial lawns and golf courses. Known sources of pathogens include homeowners (urban and rural), livestock, pet waste, waterfowl waste, agricultural fields and a suspected source for pathogens is human waste from sanitary sewers. Known sources of oil/grease/metal/brine/salts include impervious surfaces and homeowners. The known source of hydrogen sulfide/total dissolved solids is groundwater.

Nutrients threaten partial body contact for recreation by possibly building up algae in surface waters that can interfere with wading and fishing.

Pesticides threaten partial body contact for recreation by being potentially toxic for humans.

Pathogens threaten partial body contact for recreation by increasing the risk for human and animal illness through open sores or other areas on the body.

The presence of oil/grease/metal/brine/salts can have adverse consequences for partial body contact because the water can become unpleasant and the presence of these may indicate the presence of additional pollutants from the urban landscape.

Hydrogen sulfide/total dissolved solids can cause impairment of partial body contact for recreation because hydrogen sulfide, in particular, is toxic at high enough concentrations.

4.8.6 Protect for total body contact recreation

The sixth project goal is to protect total body contact for recreation by reducing loads of nutrients, pathogens, pesticides, and oil/grease/metal/brine/salt. The designated use of total body contact for recreation is threatened by nutrients, pesticides, pathogens, oil/grease/metal/brine/salts, and hydrogen sulfide/total dissolved solids.

Nutrients threaten total body contact for recreation by possibly building up algae in surface waters that can interfere with swimming.

Pesticides threaten total body contact for recreation by being potentially toxic for humans. Some pesticides build up in human tissues and can lead to cancer.

Pathogens threaten total body contact for recreation by increasing the risk for human and animal illness through open sores or other areas on the body.

The presence of oil/grease/metal/brine/salts can have adverse consequences for total body contact because the water can become unpleasant and the presence of these may indicate the presence of additional pollutants from the urban landscape.

Hydrogen sulfide/total dissolved solids can cause impairment of total body contact for recreation because hydrogen sulfide, in particular, is toxic at high enough concentrations.

4.8.7 Protect public water supply

The seventh project goal is to protect public water supply by reducing hydrologic impacts and by reducing loads of nutrients, pathogens, pesticides, and oil/grease/metal/brine/salt. The designated use of public water supply is threatened by altered hydrology, pesticides, nutrients, pathogens, oil/grease/metal/brine/salts, and hydrogen sulfide/total dissolved solids. The public uses groundwater as a water source in parts of the watershed.

Altered hydrology impairs public water supply by reducing groundwater levels. This means that there is less available water during dry periods that is more expensive to pump from deeper sources underground.

Nutrients threaten public water supply by being toxic or lead to "blue baby syndrome" at high concentrations in drinking water.

Pesticides threaten public water supply by being potentially toxic for humans. Some pesticides build up in human tissues and can lead to cancer.

Pathogens threaten public water supply by increasing the risk for human and animal illness through drinking contaminated water.

The presence of oil/grease/metal/brine/salts can have adverse consequences for public water supply because they can cause health consequences at high concentrations. Some metals are toxic or build up in fatty tissues to produce long-term health problems. In addition, the presence of these pollutants may indicate the presence of additional pollutants from the urban landscape.

Hydrogen sulfide/total dissolved solids can cause impairment of public water supply because hydrogen sulfide, in particular, is toxic even at low concentrations.

Chapter 5: Recommended Management Strategies

Strategies or management practices that help to decrease surface water pollution are called Best Management Practices, or BMPs. These BMPs can be structural, vegetative, or managerial. Structural BMPs are constructed structures that can help improve water quality by limiting soil erosion or better controlling stormwater. Vegetative BMPs use vegetation to control stormwater or filter pollutants. Managerial BMPs are ways of managing the land through policies or operational procedures that improve water quality. Together, these best management practices can help improve water quality compared to many of the practices that are in place today. Table 5.1 outlines all of the strategies described in more depth in the following pages. Education and information strategies and evaluation strategies are discussed in more detail in the following chapters.

The recommended strategies listed in Table 5.1 are based primarily on monitoring areas (from the water quality monitoring described in chapter 3). Figure 5.1 shows landuses within each monitoring area with pie charts to show the percentage of each landuse in each area. Strategies that are primarily for developed and developing areas are targeted primarily for areas that have a high percentage of urban landuse or that have undergone a fair amount of construction since 2000 (when the data for the map were collected). Along similar lines, strategies for agricultural areas are targeted for monitoring areas with a large percentage of agricultural area in the watershed.

5.1 General Strategies

Develop Stony Creek Watershed Council

Establish a Stony Creek Watershed Council under the Michigan Local Rivers Management Act 253 of 1964. Establishment of the Watershed Council will encourage continued cooperation among local Stony Creek Watershed jurisdictions in discussing issues related to Stony Creek and its water quality. The council can also coordinate, receive grants, or help other groups carry out many of the recommendations laid out below. It is highly recommended that a full time employee be hired to coordinate all activities recommended in this plan. This individual can be responsible for ensuring the plan is sustainably implemented and revised according to need.

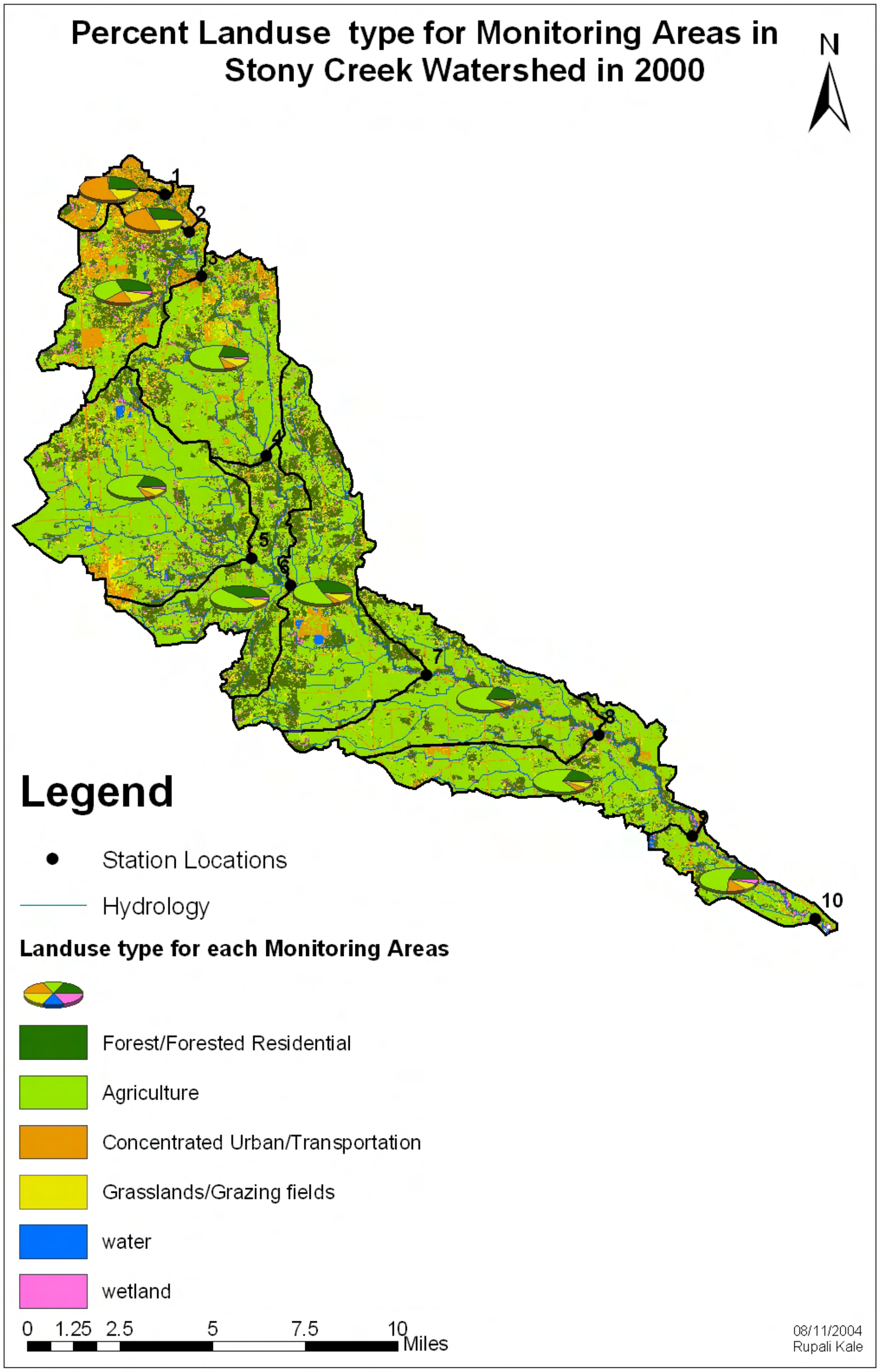

Figure 5.1: This map shows the percentage of landuses present in each monitoring area in 2000. Note the upper watershed has the highest percentage of concentrated urban landuse and the rest of the watershed is mostly agricultural, with the exception of monitoring area 4, which has undergone a transformation from agricultural to residential since the data were collected for this map.

5.2 Developed and Developing Areas

The primary focus of the watershed management plan is on developed and developing areas because the greatest concentration of surface water quality problems originates from these areas.

Hydrologic Study of the entire watershed

A hydrologic study of lower Stony Creek (almost entirely in Monroe County) was conducted in 1996 to address issues related to flooding. However, the upper portion of the creek system was not included during the study. With the developed and developing areas that are prevalent in the upper watershed, these areas are likely the ones most responsible for causing the downstream problems. In order to adequately address the problems of altered hydrology that lead to flooding, a comprehensive study of the hydrology of the entire watershed should be conducted to help refine the interaction of precipitation, infiltration, surface runoff, stream discharge, and storage. The study would refine information about water velocity, discharge, flood elevations, channel erosion, storm drains, bridges, and culverts. This study can also help refine the location and severity of particularly problematic source areas that result in high flows and bank erosion. In addition, a new hydrologic study of the lower watershed can help determine the effect of the log jam removal that took place during the summer of 2004 as a result of a local lawsuit. The new study could help determine whether significant log jams that are causing bank erosion and problematic local flooding should be removed.

Implement Consistent Stormwater Management Standards

Development and redevelopment proposals are subject to a range of storm water management regulations depending on the location, size and use of the property. Road Commissions, municipalities and Drain Commissioners may have overlapping jurisdiction, but separate storm water standards. Many of these standards are designed to protect downstream flooding. Typical flood control requires that the 10-year storm be detained on site and released slowly after a rainfall. Less common are requirements that detain the more common smaller storms that affect water quality.

In addition to flood control, first flush and bank full treatment should be implemented to protect downstream water quality. First flush is the initial water that washes off the landscape during a storm, which typically is the most polluted because it picks up all contaminants that are sitting around at the surface. It is recommended that the first flush be directed into the ground where many of the contaminants can be partially cleaned by soil bacteria before the water reaches streams. Bank full treatment refers to holding enough water on site to prevent high water flows that do not result in flooding, but that are highly erosive of the stream banks. These erosive flows are more frequent after development unless stormwater management addresses the bankfull floods as well as the 10 year flood. It is recommended that local communities apply the Washtenaw County standards to all new developments. The goal is to keep as much water as possible onsite during rain events across the entire watershed to prevent problems associated with altered hydrology.

Low Impact Development (LID) Roundtable Discussion

There are numerous local ordinances that control the way development takes place, however, many of those ordinances require specifications that were originally designed for drainage or other goals that do not adequately address the quality and quantity of water that enters streams during rain events. For example, the allowable width of roads is usually designated in county or city ordinances. Wide roads increase the amount of water that runs quickly to streams. Roads that have low traffic volumes could be much smaller and make a smaller impact on local streams.

A roundtable discussion of LID strategies among local planning commissioners and elected officials in all the watershed townships could help in educating township boards about LID strategies and could help watershed jurisdictions work toward a common set of strategies to limit the impact of new developments on the watershed streams.

Enhance Site Plan Review

Local communities can revise site plan review standards to include the 100-year floodplain, location of water bodies, location of slopes over 12 percent, site soil types, location of landmark trees, groundwater recharge areas, vegetation types within 25 feet of water bodies, woodlands and other vegetation on site, and site topography, if applicable.

Local Open Space (Natural Areas) Easement

Counties or townships may accept or purchase easements from private landowners for open space and resource conservation purposes, essentially the purchase of development rights. Land owners may also donate easements to land conservancies. Upon transferal of an easement to the local government or land conservancy, restrictions are placed on the use of the property as open space (natural area) or resource conservation. Uses are enforced and restricted so that the land can provide benefits to the landowner and the watershed, primarily in the form of continuing to aid in infiltration of water that can help sustain groundwater levels, and reduce pollution of surface water.

Natural Features Ordinance

Local communities can adopt ordinances that explain the importance of protecting key natural features and how they will be protected by law. Local protective ordinances can be better adapted to local conditions and more protective than state and federal protections. This process can provide a framework for land development while protecting key features. Among the features that may be considered for protection may be floodplains, woodlands, farmland, and open space (natural areas). Large parts of Stony Creek and Paint Creek have natural features that are rare in Southeastern Michigan -- a wide wooded floodplain that is intact. This natural feature is a treasure that should be protected by local ordinances. Not only is the floodplain a beautiful area, it helps prevent flooding of areas further downstream, helps improve water quality, and provides a wonderful habitat for wildlife. County planning offices or the Huron River Watershed Council can provide sample ordinance language to help protect the floodplain and other natural features in the watershed.

Wetlands Ordinance

Destruction of wetlands causes a change in the natural hydrology that degrades water quality and the character of nearby streams. During storms, wetlands take in stormwater, thereby preventing the water from taking a rapid route to streams that results in high peak flows. In addition, wetlands capture sediments and pollutants and provide clean water to groundwater storage and are also home to a variety of wildlife. Wetlands are a natural treasure for outdoor enthusiasts. Today, only a tiny fraction remains of the original natural wetlands that made up at least half of the Stony Creek Watershed. Federal and state laws protect some wetlands (in counties with 100,000 or more people, wetlands 5 acres or larger, and wetlands within 500 feet of a water body). Smaller wetlands require local wetland ordinances for protection. Together, many small wetlands can help provide a cleaner, healthier watershed. Model wetlands ordinances can be obtained from the MDEQ Michigan Coastal Zone Program or the Huron River Watershed Council. All townships should adopt a more protective wetlands ordinance.

Construct and Maintain Stormwater Retention/Detention

Design, construct, and maintain stormwater retention/detention structures that meet or exceed county drain rules. These structures can limit the flow in the creek system during storm events either by temporarily storing runoff for gradual release (detention) or encouraging infiltration (retention - preferred). Wet detention ponds (below) provide for both control of water volumes as well as water quality by partially cleaning water before it is released to the local stream.

Construct/Maintain Wet Detention Ponds

Wet detention ponds are stormwater control structures that maintain a pool of water with emergent aquatic plants planted around the border. This type of system controls water volumes as well as water quality by partially cleaning water before it is released to local streams. Particles settle in the basin while dissolved material is removed from the water by biologic uptake. The structure is designed to retain water from each storm and treat it until the next storm displaces that water. Overflow channels are established for extraordinarily high water volumes. A vegetated buffer should be installed around the structure to decrease goose habitat and to increase the aesthetic appeal of the structure. Proper maintenance is required for 5-10 years after construction to ensure the proper establishment of wetland vegetation in the pond.

Bioretention Systems

Bioretention systems are lowered vegetative parking lot islands or shallow landscaped depressions that clean stormwater runoff before sending it on to the stormwater conveyance system. Runoff is directed toward the bioretention systems where it filters through the vegetation, mulch, and soils. The system is designed with an emergency overflow directed to a stormwater conveyance system for inputs higher than the designed capacity.

Infiltration Systems

Infiltration systems include infiltration trenches, infiltration basins, and permeable pavements. An infiltration trench can be constructed in residential areas where curb and gutter would otherwise be considered. The trench has no outlet and is filled with rock overlying permeable soil. Incoming water infiltrates in the trench, but must be pre-treated by passing through a swale or detention basin prior to entering the infiltration trench.

An infiltration basin captures most surface water from small storms for infiltration into the ground rather than discharged to a stream. The result is improved water quality and quantity in local streams. Use of permeable pavement allows water to infiltrate in developed areas that would otherwise produce 100% runoff (impermeable pavements).

Grassed/Vegetated Swales

Grassed/vegetated swales are vegetated channels that run along residential roads or highways that receive stormwater runoff. They are similar to traditional drainage ditches, but they have gentler downchannel slopes and flatter side slopes. They are basically designed to slow down the conveyance relative to traditional drainage ditches to enable water to be filtered as it passes through the vegetation and infiltrates into the substrate soils.

Disconnect Directly Connected Impervious Areas

Residential areas are often designed principally to move water off-site as quickly as possible. Lawns are graded toward the street and gutter downspouts and footing drains/sump pumps have been routed directly to the stormwater conveyance system. Planning developments that direct downspouts and sump pump toward green spaces or rain barrels can reduce peak flows in local streams by preventing rapid connection of water discharges to the stream system. Planning departments can encourage this practice by including it in their Zoning Ordinance.

Municipal and Residential Rain Gardens

Rain gardens are attractive landscaping that use native wildflowers, shrubs, and grasses in a depression in a lawn or along impervious surfaces such as driveways, sidewalks and beyond roof downspouts. Rain gardens pool the first flush (the most contaminated) stormwater and clean the water by forcing it to filter through roots and soil. Using plants native to the area means that plants, once established, require little effort to maintain. A municipal rain garden is proposed for the Ypsilanti Township Public Library using volunteers from the community to help establish the garden. This rain garden can serve as an example of the concept for the community. Hopefully, community involvement in the project will encourage community members to establish their own residential rain gardens at home.

Green Roofs

Green roofs are durable, easily maintained roof systems that support plant growth. With carefully selected plants, a green roof will last much longer than a traditional roof, provide energy efficiency savings, as well as significantly reduce the runoff normally prevalent with traditional roof systems. A green roof has recently been constructed on the Ford Motor Company's Rouge Plant in Dearborn, Michigan and the Malletts Creek Branch of the Ann Arbor District Library.

Alternative Road Specifications (for low-traffic roads in new developments)

Roads within new housing developments are often designed to uniform specifications whether the road experiences heavy or light traffic volumes. By permitting narrower widths than county road standards for low-traffic roads in new developments, the imperviousness of the landscape can be reduced while producing the side benefit of safer residential roads for walking and playing children.

Soil Erosion and Sedimentation Control Enforcement: Mudbuster Program

Michigan has long had regulations in place to minimize the negative impact of soil erosion during construction of 5 acre or larger lots. These Soil Erosion and Sedimentation Control (SESC) measures include sediment trapping devices (silt fences, filter fabric on drain inlets, and catch-basins) and erosion control efforts (soil stabilization). These efforts are planned for construction sites, but are often enforced inadequately. One way to ensure the enforcement of SESC regulation is to hire an adequate staff for enforcement efforts. A more cost-effective means of improving SESC enforcement would be reviving the Mudbuster Program. This program, supported by the Washtenaw County Drain Commissioner's office, would train volunteers to inspect construction sites daily (on the way to work, for example) and to report suspected violations to the Mudbuster Program Coordinator (possibly even documenting with digital photos). This coordinator can then pass on relevant information to enforcement officers for action.

Sand and Organic Filter

A sand and organic filter can be constructed beyond the outlet of settling basins. Larger particles settle out in the settling basins, but finer sediments take a long time to settle out. Therefore, a second chamber filled with sand, a sand/peat mixture, or other filtering medium can help remove finer particles and/or dissolved pollutants (depending on the filtering medium) before discharge to streams.

Street Sweeping

High-powered street sweeping of roads and parking lots removes sediments and other pollutants which might otherwise make their way to nearby streams during storm events. Street sweeping is particularly recommended during (or prior to) spring snowmelt in cold climate areas.

Golf Course Nutrient Management

In order to maintain their turf, golf courses tend to use fertilizers and herbicides that often wash into local streams. The Michigan State University-Extension offers a golf course nutrient management program that certifies golf courses that use environmentally sensitive buying and landscaping practices such as alternative turf management, reestablishment of wetland and watercourse buffers and retrofitting of water hazards to stormwater detention basins. All current and future golf courses should become certified members of the program.

Native Vegetation Restoration Program

Native vegetation within the Stony Creek Watershed has mostly been converted to agricultural and urban vegetation to which people apply cultivation chemicals. Native plants require less water and maintenance because they are adapted to the local climate, improve infiltration, stabilize soils, and provide habitat for native insects and wildlife. A native landscaping ordinance can reduce the barriers to planting native vegetation in residential and commercial areas. As a part of the Mill Creek Watershed Plan, a Native Vegetation Restoration Program was proposed that would enable trained staff to provide technical services to the community related to native landscaping. This program could also be involved in restoring portions of the Stony Creek Watershed with native vegetation.

Illicit Connection Correction

There are often unintentional or purposeful connections of sanitary sewers or other sources directly to stormwater sewers (that drain directly to streams). Phase II Stormwater management communities are required to disconnect these illicit connections to ensure that only stormwater enters stormwater sewers.

5.3 Agricultural Areas

The secondary focus of the watershed management plan is on agricultural areas because the second greatest concentration of surface water quality problems originates from these areas. Most of the recommendations listed below are recommended to be refined after the Inventory of Agricultural Conservation Practices is completed and specific areas can be targeted for implementation efforts. Most of the estimates of level of effort for Agricultural strategies come from percentages of agricultural acres determined from the inventory of Mill Creek Watershed completed recently in a nearby location with characteristics similar to the Stony Creek Watershed.

Inventory Agricultural Conservation Practices

A comprehensive inventory of agricultural conservation practices should be conducted across the agricultural areas of Stony Creek Watershed to determine what practices are being used and where they are being used, and to identify areas where conservation practices are not currently being used, particularly where those practices could provide clear benefits to farmers and to the quality of surface water. This inventory should be completed by trained professionals from county soil conservation districts. Following the inventory plans for agricultural conservation implementation efforts can be more specifically defined by concentrating on the areas of greatest need and greatest potential impact.

Riparian Buffer

Riparian buffers are vegetated areas alongside streams or other water bodies that provide a physical separation of the water body and bordering land uses. Buffers slow runoff velocities and remove pollutants such as sediment, nutrients and pathogens. USDA programs help pay for these practices for eligible landowners. Refer to Figure 3.12 for the location of problem buffer widths identified in the watershed survey. Priority should be given to buffers less than 10 feet wide, then where buffers are less than 30 feet wide.

Grassed Waterways

A grassed waterway is a broad, shallow channel constructed or maintained on farmland to move surface water without causing surface soil erosion. Often, grassed waterways are constructed in previously existing low areas in a field. Maintaining a vegetated cover helps protect soil erosion and the development of rills and gullies. USDA programs help pay for these practices for eligible landowners.

Grade Stabilization Structures

A grade stabilization structure is used to drop the elevation of a channel (like a grassed waterway) to a lower level without inducing erosion of the channel and gully formation. Often,

the structure consists of a cross-channel embankment or dam with an outlet pipe at the base to drain the upslope channel to a lower elevation. USDA programs help pay for these practices for eligible landowners.

Conservation Cover

Conservation cover involves establishing and maintaining permanent vegetative cover to protect soil and water resources and is useful for land that is retiring from agricultural production.

Conservation Crop Rotation with Cover Crop and Mulch/No-till

Conservation tillage methods such as mulch or no-till, are effective methods for reducing soil erosion on agricultural fields because the soil is not broken up and exposed on the surface. Cover crops are vegetation grown solely to protect the ground from being exposed before harvest crops grow on the land. Unfortunately, these tillage methods can lead to problems such as soil compaction, perennial weeds, plant disease, and slow early season growth. Crop rotation, planting a recurring sequence of crops in the same field, can increase yields dramatically over planting a single crop year after year. Research has shown that the benefits of crop rotation can overcome the difficulties associated with conservation tillage. As a result, these three practices, together, make an effective approach to maximizing yields while minimizing damage to the environment.

Nutrient Management

This BMP involves managing the amount, source, form, placement and timing of the application of nutrients and soil amendments on agricultural lands. The goal is to maximize the nutrient benefits to crops while minimizing excess nutrients that cause environmental damage. Efficiency is the key and ultimately increased profits are common. Through voluntary measures called Generally Accepted Agricultural Management Practices, or GAAMPs, agricultural landowners can obtain guidelines for nutrient and pesticide application and storage, manure management, groundwater protection, and many other agricultural BMPs. County Conservation Districts have outreach programs for landowners to learn about such recommended practices. This program should be used as much as possible to control potential pollutants from impacting local streams.

Waste Storage Facility

Waste storage facilities are embankments, pits or other structure used to temporarily store liquid or solid waste until it is spread on the land. The temporary storage helps keep it safely stored so that is does not wash off the landscape into local streams. USDA programs help pay for these practices for eligible landowners.

Livestock Use Exclusion

Water quality can be degraded when livestock have direct access to streams. Animals cause erosion by continued trampling of stream banks and by removing riparian vegetation. These sediments wash into streams and cause sedimentation problems. Livestock with stream access also add nutrients and pathogens to the water through their waste. Livestock continue to have access to the Stony Creek system in a few places. Fence installation and maintenance should take place to keep livestock at least 25 feet from local streams and drains. USDA programs help pay for these practices for eligible landowners.

There is one recommended location for implementation of this practice based on the watershed survey: upstream of the first crossing north of Arkona Road on Sanford Road (near Milan). Cows have regular access to the stream and have caused tremendous erosion as well as added nutrients and pathogens to the stream via animal waste entering the stream directly.

Vegetative Filter Strips

A vegetative filter strip is an area, generally at the lower end of a field, of grass or other permanent vegetation that is intended to trap sediments and other pollutants by slowing the velocity of sheet flow and by providing some infiltration into the ground. Filter strips can also be used to prevent wind erosion with 1) a Cross Wind Trap Strip – Field, a wind resistant vegetative cover established in one or more strips across the prevailing wind erosion direction or 2) a Cross Wind Trap Strip – Filter, a wind resistant vegetative cover established adjacent to waterways across the prevailing wind erosion direction. USDA programs help pay for these practices for eligible landowners.

The level of effort needed for vegetated filter strips was calculated as follows:

1. Stream length (est. 158 miles = 834240 ft) % Ag acres (56%)
2. #1 X 2 (for both sides of stream)
3. #2 X (% of stream length still needing treatment)*
4. #3 X 30 (avg. width of strips in feet)
5. #4 divided by 43,560 (to convert feet to acres)

Total = about 13 acres

> * = For Mill Creek, this figure was 1.3% of the Agriculture acres, estimated by examining aerial photos and calculating the amount of untreated stream length in several representative areas, then extrapolating this calculation across the entire Agricultural area. Since the Stony Creek Watershed has a greater percentage of stream length still needing treatment, the number used in this calculation was 2%.

Purchase/Acquisition of Development Rights

A Purchase of Development Rights ordinance is a government initiative that limits development by obtaining the development rights of property. This initiative helps protect natural areas or agricultural land and guides development toward other areas more suitable for development. It is important to identify areas that should be protected, then purchase the development rights or properties outright. Purchase of Development Rights could also help establish or maintain greenways for wildlife or recreation. Land owners may also donate or sell development rights to a Land Conservancy or Land Trust.

5.4 Stream Channels and Roadways

Road/Bridge Surface Stabilization

Many roads in the watershed are not paved. These unpaved roads often become eroded and road materials find their way into local streams. By altering grading practices, selecting new road/bridge surfaces, or retrofitting bridges, erosion at road surfaces at the sites identified in the road stream crossing survey can be improved to prevent sediments from entering streams. See Appendix "road approaches" for recommended locations for implementation.

Soil Stabilization at Road Crossing Embankments

In a number of places in the watershed the road crossing embankments are eroding and dumping sediment directly into the stream. The erosion is created either by water running off road surfaces during storms or by high stream flows cutting into or around an embankment. The locations identified in the road stream crossing survey should be stabilized. In some cases, altered hydrology may be responsible for the problem, thus completion of a hydrologic study prior to stabilization of these structures would be beneficial. See Appendix "crossing embankments" for recommended locations for implementation.

Culvert Replacements

During the course of the road stream crossing inventory, several problems were noted that resulted from undersized culverts, including the ponding of water upstream by the culvert and downstream erosion associated with increased flow velocities created by increased upstream pressure on the system. In order to correct this problem, a hydrologic study must be completed to determine the impact of upstream development on these downstream crossings. Only then can a properly sized culvert be designed that will allow the proper flow of water under roads. See Appendix "perched culvert" for recommended locations for implementation.

Bank Restabilization

Places in the watershed, particularly downstream of urban areas, are experiencing destabilizing stream bank erosion. In places, the banks should be stabilized to prevent further erosion. In order to adequately address the problem, however, the hydrology should be studied first. Stream bank stabilization works either by reducing the force of the flow or increasing the strength of banks. If high peak flows are the problem, then the hydrology should be stabilized before attempting to stabilize the banks. Stream banks can also be stabilized by engineering methods such as installing riprap, deflectors and gabions. Bioengineering uses vegetation to stabilize stream banks. Vegetating stream banks can increase their strength because roots hold the material together, plants provide a barrier to the force of the water, and plants can remove water from banks. Vegetation can also provide other benefits, such as shading the stream and providing habitats for aquatic and terrestrial wildlife. Biotechnical methods involve the paired use of biological and high-tech materials for reinforcement. Stabilization methods using vegetation help to improve habitats and aesthetics. Refer to Figure 3.15 for the priority sites for bank restabilization. The most important sites are north of Oakville-Waltz Road on Paint Creek and Stony Creek.

In some places in the watershed logjams can be so large that they contribute to the erosion of the banks and add sediment load to the stream conveyance system. In cases where logjams are contributing considerable harm to the banks, it could be recommended to remove them after completion of a hydrologic study of the entire watershed.

Implement Alternative Drain Practices and Rehabilitation

Many of the problems in the watershed are caused by channelization of streams for the purpose of rapid drainage of the land. Drainage is the job of the Drain Commissioners; however, there are opportunities to return some drains to a more natural condition. In places where agricultural areas are being converted to urban uses, especially in Ypsilanti and Augusta Townships, opportunities exist to implement alternative drain practices and rehabilitation. To restore hydrologic function to the creek in areas converting to urban uses, drainage tiles can be broken in developing areas in conjunction with rehabilitation of drains. In addition, alternative drain practices can be implemented in agricultural areas. One way to improve drainage with a smaller impact on peak flows is to construct larger drains with a built in floodplain. In this way, water can leave fields rapidly, but spend more time in drains before contributing to downstream flows.

Ash Tree Removal and Restoration in floodplains

The emerald ash borer is killing ash trees that grow in the forested floodplain of the Stony Creek Watershed. Concern has been raised that the trees will die and fall into the creek, destabilizing banks and causing large logjams. Stabilization of banks and flow of water is threatened by this sudden die-off of infected trees. In order to prevent these problems, removal of some dying or dead trees that threaten to fall into the creek is advisable. Removal of trees should be followed by tree replacement with appropriate native vegetation through a program such as the Michigan Department of Natural Resources Emerald Ash Borer grant program, funded by the USDA Forest Service. This program provides up to $20,000 per community to replace trees lost to the infestation. Michigan Department of Agriculture programs provide free wood disposal of Ash trees requiring disposal.

5.5 Educational Outreach

I&E: Yard care, native landscaping, Septic System Maintenance, Vehicle Maintenance and oil disposal

"I & E" stands for Information and Education. By educating the public about the ways in which current behaviors might affect the watershed and informing them about some alternatives, a change in behavior is likely to result. Many watershed residents use pesticides and fertilizers without knowing how much to use, or realizing that there are other ways to achieve the same result without using chemicals. Septic System failures can be devastating to water quality (and to a homeowner's financial situation). Educating the public about proper and prudent septic system maintenance can help avoid problems. A variety of toxic fluids are contained within vehicles. The impact of those fluids on the watershed can be minimized when citizens are informed about ways to lessen those impacts. The education and information plan is further detailed in Chapter 6.

5.6 Monitoring and Stewardship

An evaluation process will provide measures of the effectiveness of strategy implementation (outlined above) at achieving watershed goals. Evaluation methods can document successes in implementation efforts or can show where improved strategies are necessary to make a positive impact on water quality. The main recommended programs include water quality, macroinvertebrate, and hydrologic monitoring. Volunteers from the watershed should be utilized where possible to promote education and stewardship while producing cost-effective usable data to help evaluate/reevaluate the plan strategies. The monitoring and stewardship plan is further detailed in Chapter 7.

Chapter 6: Public Information and Education

The public plays a vital role in watershed management plans because the public is often inadvertently the cause of some pollution of surface water. As a result, the support and cooperation of the public is necessary to make a positive impact on water quality in the watershed. This section of the watershed management plan outlines the public education strategy to reach target audiences and to track the impact of education efforts. The goal of the public education plan is to 1) increase awareness of water quality issues in the watershed, 2) deliver key messages to target audiences about ways to reduce the pollution of the watershed, 3) increase public actions that contribute to increased water quality for the watershed, and 4) ultimately reduce pollution in the watershed.

6.1 Target Audience and Message Priorities

In the Stony Creek Watershed, the priority areas of concern are residential areas, particularly the urban and urbanizing areas in the upper watershed. As outlined earlier in this watershed management plan, these areas reflect the greatest concentration of the major pollutants of concern in the watershed and the greatest concern about altered hydrology that impacts the rest of the watershed. As these developed areas expand in the watershed in the near future these issues of concern will increase, underscoring the importance of educational efforts. As a result, the primary target audience for education is homeowners in the developed and developing areas of the upper watershed.

The main issues and concerns that need to be communicated to these homeowners include:

1. General awareness of water quality issues and challenges in the watershed;
2. Beneficial lawn and garden practices such as mowing habits, fertilizer and pesticide use, yard waste disposal, landscaping with native plants and water conservation;
3. Housekeeping practices and disposal of toxic wastes; and
4. Surface water retention by retaining water with rain barrels and washing cars on lawns.

Rural residents can benefit from this same information. Septic maintenance, however, is of greater concern for rural residents, especially those living along the creek system. Education about septic system maintenance is best performed during sale of properties using septic systems and is performed at very low cost. Although septic systems are not as great a concern for the watershed as urban lawn and housekeeping practices, education efforts are generally cost-effective.

The second priority areas of concern are agricultural areas. Many farmers have adopted conservation techniques that limit the impact of farming practices on surface waters. However, many local farmers could be better informed of the benefits of conservation practices and opportunities such as:

1. Advantages of and opportunities for buffer and filter strips;
2. Impact of tillage methods;
3. Importance of agricultural soil erosion and sedimentation control practices;

4. Impacts of fertilizer/pesticide use and alternative options;
5. Impacts of livestock waste and alternative options; and
6. Opportunities for farmland conservation partnerships.

6.2 Marketing Plan

The marketing plan for the Stony Creek Watershed can be broken into four types of market outreach: publicity, direct mail, paid print advertising, and retail promotions (see Table 6.1). It is important to note that these marketing vehicles are designed to run concurrent, thus "flooding" the market with messages in short bursts (called "flights") throughout the year. For example, marketing efforts related to lawn care practices are concentrated in the early spring, when purchasing decisions are being made for the coming season.

Publicity through local radio, cable TV, newspapers, and newsletters, as noted in Table 6.1, promotes the watershed management plan to the public and generates general awareness of the watershed and ways to protect the watershed. This is a no-cost way to reach a large number of watershed residents while increasing awareness of the Stony Creek Watershed to the broader community. The DVD suggested for cable TV is on managing turf in the home landscape, developed by Kevin Frank, a turf grass specialist in the MSU Crop and Soil Science Department.

Direct mail puts information about water quality in the hands of each individual who can make an impact on water quality in the watershed. The Huron River Watershed Council (HRWC) has developed color coded "tip cards" with effective messages about water quality on a variety of topics including lawn and garden care, automotive care, home toxics disposal, and protection of storm drains. These tip cards can be distributed to Stony Creek Watershed residents at a minimal charge since there are no design or development costs; only printing and mailing costs are noted in the estimate. The HRWC also produces a calendar for their residents with tips for improving water quality by making changes in home management practices. This calendar can be adapted for the Stony Creek Watershed and distributed to residents at minimal cost. A riparian brochure could be developed to inform residents who own property on the creek system of special considerations for land bordering surface waters.

Septic system education is best done through handouts. Often people buy homes with septic systems without the knowledge to properly maintain the systems. When property with a septic system changes hands, a handout provided by a realtor can help the new resident take proper care of this important protector of water quality. Distributing information in this fashion means that the information can go right into the hands of those who may need it most before problems arise. As noted in Table 6.1, the cost is minimal for distributing material during a home transaction.

Handouts can also be provided to farmers and other visitors at County Fairs to educate them about the benefits of and opportunities for conservation practices on farms and rural homesteads. Having a booth or distributing flyers at a county fair can be a cost-effective way to reach this audience.

Paid print advertising in local newspapers can reinforce information that is sent directly to homeowners. The advertising is intended to encourage watershed awareness and highlight information from the tip cards to increase the likelihood that residents absorb information and remember to make desired changes in home and garden habits.

Promotion of soil testing through print advertisement and flyers can increase participation in the MSU-Extension soil testing program. Many residents do not realize that their lawns and gardens may already have abundant amounts of some nutrients and lacks other nutrients. Soil tests can help residents find the appropriate blend of fertilizer that is needed for their lawn, yielding a cost-effective application that reduces the potential pollution of surface water in the watershed (Table 6.1). Partnering with the Soil Conservation Service or the Extension Service may provide a cost effective means of making this information available.

Promotional and trade partnerships must be cultivated, leveraging existing funds to obtain increased exposure. For example, a retailer may assist with advertising costs and/or a customer satisfaction survey.

Evaluative mechanisms are specified in Table 6.1. These include tracking coupon redemptions, evaluation forms, tracking phone calls, and monitoring the number of soil tests conducted in the watershed. Partnerships will also be critical to expanding evaluative capacity. For example, asking a toxics drop-off facility to survey participants shortly after a related media campaign can help determine where people get information regarding toxics, plus allows for monitoring changes in the number of drop-offs.

This proposal suggests an ambitious multi-faceted marketing plan for the Stony Creek Watershed. Should the level of funding required to implement such a plan not be available, revisions should be made to reduce both the scope and cost of the plan. Concentrating resources over a short period of time (i.e. 4 weeks) may help preserve the market impact despite reduced placements.

6.3 Other Educational Opportunities

A number of other opportunities for education and information sharing have been included in the recommended strategies described in Chapter 5. For example, the proposed construction of a municipal rain garden by the Ypsilanti District Library and multiple private rain gardens within the watershed offer hands-on opportunities for the public to learn about water quality and to learn how to make a positive impact on the watershed through construction of rain gardens. Similarly, a roundtable discussion among planning commissioners, elected officials and interested residents regarding Low Impact Development models is an opportunity for a Stony Creek Watershed facilitator to engage and educate the community about development issues that impact water quality.

Evaluation techniques outlined in Chapter 7 also offer opportunities to engage the public in stewardship of the watershed. In addition, they provide opportunities to educate the public about ways individuals can help minimize their contribution to water pollution.

Chapter 7: Implementation and Evaluation

Chapter 5 and 6 of the watershed management plan identifies a number of specific steps to be taken to address the pollution problems in the Stony Creek and its tributaries and the challenges posed to the watershed itself. The following section identifies a suggested timeline for action and a later section describes the concomitant evaluation efforts that will need to be undertaken to assess the impact of steps taken.

7.1 Implementation Efforts

The recommendations for action of the Stony Creek Steering Committee described in Chapter 5 and 6 represent an ambitious agenda for addressing and ameliorating the problems identified over the course of two plus years of assessment and planning. Collectively they represent a long-term agenda for action, though presented in terms of a five year action plan. As noted below, it will also require creation of a monitoring program and periodic evaluation to assess progress toward the goals spelled out by the Steering Committee.

In considering the extensive action agenda, however, it is clear that there are both short term and long term steps toward improving water quality in the Stony Creek system and the quality of life in the Stony Creek Watershed. The following section identifies those deemed immediate first steps.

7.1.1 Short Term Actions

Several immediate steps should be taken to begin the process of implementing the Stony Creek watershed management plan. Each will require initiative on the part of one or more of the communities or groups in the watershed to secure funding and support local efforts.

Stony Creek Watershed Council: The first step in implementation involves organizing and developing a formal watershed council. The foundation for such a step has been established in the form of the Stony Creek Steering Committee that has functioned over the past two years. The watershed council would build on the foundation, with additional membership to represent other key stakeholders in the two county region, including environmental groups, agricultural and farm interests and development and real estate interests, among others. Once this broader membership is established, next steps include drafting a set of by-laws and filing the legal paperwork to secure 501c3 status. The nationally recognized Huron River Watershed Council has indicated a willingness to assist in this development process, and a number of volunteers and residents in the Stony Creek watershed have worked with the HRWC in the past.

The intent is to establish a broad based continuing entity that can serve as:

- Catalyst—initiating or prompting action by others to secure support for the recommended strategies included in the management plan;
- Facilitator—bringing together interested groups, governmental bodies and residents to bring visibility to the challenges facing the Stony Creek watershed and the need for collective action;

- Coordinator—insuring that efforts across the watershed are coherent and cost-effective, avoiding duplication and building on the success of one another;
- Advocate—securing appropriate action on a whole range of measures designed to minimize the impacts of development on the watershed and the quality of the water in the creek system.

Just as important, a continuing entity like a watershed council can serve the important roles of monitor and evaluator noted explicitly in the narrative in Chapter 7.

Hydrologic Study of the Watershed: As noted in Chapter 5, many decisions about necessary strategies for improving conditions in the watershed require better information on flow conditions in the creek system; e.g., erosion, flooding, log jams, and so on. Thus, a second immediate action step is to secure funding for and complete a comprehensive study of the hydrology of the entire creek system. Parts of the creek system have been studied in the past, but a comprehensive study is warranted to guide decisions on implementation. Such a study could take several months but is integral to subsequent decisions by the newly formed Stony Creek Watershed Council.

Other Analyses: Two other important areas of analysis identified in the watershed management plan warrant immediate attention. One involves an inventory and assessment of local development standards and ordinances covering wetlands, open space, natural features and drainage. Given the diversity among the many units of government in the watershed, there are different development standards, and in some instances, no local ordinances or regulations governing wetlands or natural features. The analysis should identify "best practices" in the watershed and build consensus around a common and consistent set of regulations by municipal units across the watershed. There is considerable diversity among the eight townships in the watershed, for example, ranging from densely settled urban residential areas to primarily rural and agricultural areas. But, developing a common set of local ordinances will protect the watershed, the interests of current and future residents, and the needs of developers who are looking for consistent and equitable treatment from local governments.

A second area of analysis designed to guide decisions on action relates to agricultural areas in the watershed. The Steering Committee identified a number of specific strategies related to agricultural practices that can prevent pollution from entering the creek system What is required first, however, as noted in Chapter 5, is a detailed inventory of agricultural practices and areas designed to allow targeting of effort by the new Stony Creek Watershed Council.

Information and Education: A third broad set of short run actions involve the recommended information and education strategies. As noted in Chapter 6, many of these involve minimal effort and limited costs, since most of the materials have already been developed and will require simple adaptation for use in the Stony Creek watershed. Yet implementing a small number of such efforts offers several benefits. It will alert residents in the watershed to the emerging collaborative effort under the auspices of the Stony Creek Watershed Council, provide visibility and contact information for the new council, and establish a baseline for an expanding information and education efforts over time.

7.1.2 Long Term Actions

As the above discussion suggests, immediate efforts are devoted to creating a capacity for continuing action and supporting further study designed to facilitate targeting of attention and action across the watershed. Longer term efforts are devoted to BMP's in both developing and agricultural areas designed to reduce run-off and minimize pollution. These include development of retention/detention, infiltration and bioretention systems at selected locations in the watershed and in conjunction with development as well implementation of advanced agricultural practices in targeted areas.

Similarly, given limited resources in the two local Road Commissions and the long lead time required to integrate proposed road stream crossing improvements into capital improvement plans, soil stabilization, culvert replacement and bank restoration strategies are viewed as long term efforts.

Finally, monitoring and evaluation efforts will of necessity be ongoing, a key role of the new Stony creek Watershed Council, as the next section suggests.

7.2 Evaluation

An evaluation process will provide measures of the effectiveness of strategy implementation (outlined above) at achieving watershed goals. Evaluation methods can document successes in implementation efforts or can show where improved strategies are necessary to make a positive impact on water quality. In addition, if practices can be shown to be successful, support can be more easily garnered for sustaining or expanding the successful efforts within the watershed. Finally, involving the public in appropriate elements of the evaluation process can also constitute an effective public information and education strategy.

7.2.1 Qualitative Evaluation Methods

Qualitative methods of evaluation can be used to determine whether water quality goals are being met or whether progress is being made toward those goals. These methods can also be used to determine whether the watershed plan needs to be revised if little progress is being made. Qualitative measures of success can show that the programs put in place may, over time, have a positive effect on stream conditions, even if quantitative measures (discussed in the next section) show little improvement over a short time frame.

Table 7.1 shows a list of qualitative evaluation methods that can be used to assess programs that are put in place as part of the implementation of this watershed management plan. These methods can be used to measure the success of implementing structural or vegetative BMPs, educational efforts by mail or in person. The road stream crossings survey is designed to enable comparisons between surveys performed by multiple trained individuals and had been performed by volunteer groups in the past. Performance of this qualitative data collection method by volunteers can be a learning opportunity for the community as well as provide a method of qualitative evaluation of the watershed plan implementation.

7.2.2 Quantitative Evaluation Methods

Quantitative measures of evaluation can determine the long-term progress and effectiveness of the cumulative efforts of implementation of the watershed management plan. A monitoring effort of this scope will need support at the county or state level and a regional perspective. Monitoring water quality across the watershed can show progress or lack thereof of watershed initiatives toward attainment of the ultimate goal of watershed management—improved water quality. Recommended quantitative assessment methods include water quality monitoring, a volunteer-based ongoing macroinvertebrate study, and hydrologic monitoring. Details about each of the recommended programs should be defined as a part of the application process as funding is sought for implementation.

Table 7.1: Qualitative Evaluation Methods

Evaluation Method	Program/Project	Measured	Implementation
Public Surveys	Education efforts by mail	Concerns, knowledge, behaviors	Before and after surveys by mail. Trends can be shown by repetition of surveys over time.
Written Evaluations	Education programs, volunteer programs	Awareness, knowledge	Evaluations completed on-site at the end of an event that asks what was learned, ways to improve the program
Photographic Evaluation	BMP installations	Before and after conditions.	Take photographs of before and after conditions to show visual improvements.
Participation Tracking	Public education and volunteer events	Number of people participating. Geographic distribution of participants.	Have sign-in and evaluation sheets, count those in attendance at events or pass through gardening stores as a result of educational efforts.
Stream Surveys	Road stream crossings survey performed by trained volunteers from the public.	Turbidity, bank erosion, algae growth, potential sources of pollution.	Teach volunteers to use MDEQ standardized form, organize an event to perform the inventory, analyze results.

<u>Monitor Water Quality</u>

In order to determine whether implemented strategies are having a positive effect, water quality should be monitored 5–6 years after implementation of recommended watershed strategies. A follow-up study, conducted at the stations used in the Stony Creek Watershed Project water quality study, can provide comparison of water quality before and after BMP implementation. In addition, baseline data should be collected in additional locations before implementation of new BMPs. Monitoring should include dry and wet weather events and seasonal variation. Total suspended solids, phosphorus, nitrogen, conductivity, temperature and dissolved oxygen should be considered. Ideally, pesticides should be monitored as well as they are a suspected pollutant of high concern within the watershed, but there is no data to determine the degree of the problem. Volunteers from the watershed should be utilized where possible to promote education and stewardship while producing cost-effective usable data to help evaluate/reevaluate strategies.

Monitor Macroinvertebrate Diversity / Develop Evaluation Model like HRWC Program

Macroinvertebrate studies are relatively easy ways to track trends in water quality over time. It is strongly recommended that an ongoing macro-invertebrate study be developed and carried out twice a year (in the spring and fall). This study should be completed with the help of volunteers from the community in order to help educate the public about the water quality concerns in the watershed while producing quality data for evaluation of the watershed improvement strategies. The number of locations included in the study should increase around areas that are specifically targeted for BMP implementation. In order to complete such a study, a model needs to be created to evaluate the significance of the data collected, such as the one used by the Huron River Watershed Council's Adopt-A-Stream Program. Once completed, the model can be used indefinitely to evaluate the quality of streams in the Stony Creek Watershed. The data can be used to show the effectiveness, or lack thereof, of implemented BMPs.

Hydrologic monitoring

Considering that altered hydrology is the second overall greatest concern in the watershed, and the greatest concern in the lower watershed, hydrologic monitoring should take place in the watershed. In addition to the hydrologic study that is recommended as a part of this plan, an ongoing hydrologic study should monitor the watershed for trends of increasing flood frequency, stream widening/downcutting, and low dry weather flows. Volunteers from the watershed should be utilized where possible to promote education and stewardship while producing cost-effective usable data to help evaluate/reevaluate the plan strategies.