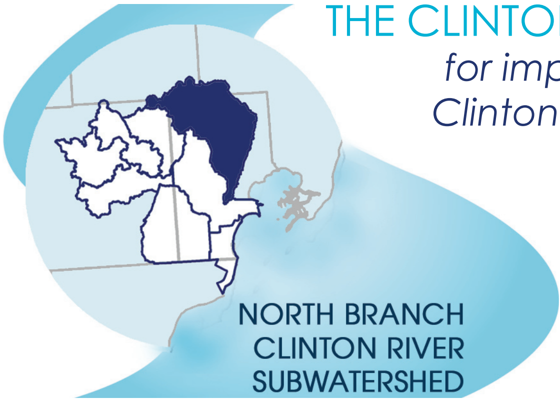
THE CLINTON RIVER WATERSHED MANAGEMENT PLAN

for improving water quality in the North Branch Clinton River, Lake St. Clair, and the Great Lakes



The North Branch Clinton River

TETRA TECH

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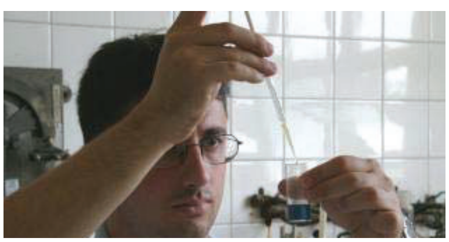
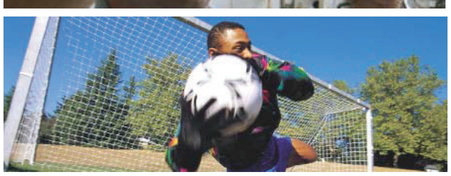
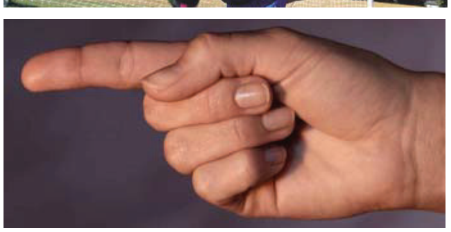

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Acknowledgements

Special thanks to all of the people who have contributed to this watershed management plan. Many were not named here because of space limits, but please know that you provided invaluable assistance. Most of all, a debt of gratitude is owed to the people from the general public who participated during the community outreach efforts. Your opinions shaped this watershed management plan.

Jeff Bednar, Anderson, Eckstein & Westrick, Inc.

Norman Stone, Chesterfield Township

Jeremy Geist, Clinton River Watershed Council

Michele Arquette-Palermo, Clinton River Watershed Council

Mary Bednar, Clinton Township

Sue Tepatti, Giffels-Webster Engineers, Inc.

Jason Neilson, Lapeer/St. Clair/Macomb Conservation District

Mitch Caskey, Lapeer County Health Department

Laura Pobanz, Macomb County Health Department

Jeff Trent, Macomb County Health Department

Gerard Santoro, Macomb County Planning and Economic Development

Lara Sucharski, Macomb County Public Works Office

Barb Saile, Macomb County Public Works Office

Robert Sweet, Michigan Department of Natural Resources and Environment

Bretton Joldersma, Michigan Department of Natural Resources and Environment

Chad Fizzell, Michigan Department of Natural Resources and Environment

Robert Zbiciak, Michigan Department of Natural Resources and Environment

Hannah Stevens, Michigan State University Extension Service

Donna Folland, Oakland County Parks

Jacy Garrison, Oakland County Water Resources Commission

Charles Bohm, Ray Township

Doug Stier, Ray Township

Kristen Jurs, St. Clair County Health Department

Megan Thomas, Six Rivers Regional Land Conservancy

Angela Reiss, Southeast Michigan Council of Governments

Brian McKissen, Spalding DeDecker Associates, Inc.

Dan Christian, Tetra Tech

Kelly Dubay, Tetra Tech

Kyle Paulson, Tetra Tech

Steve Pennington, Tetra Tech

Ben Thelen, U.S. Department of Agriculture-Natural Resources Conservation Service

Financial support for the development of this Watershed Management Plan was provided through a grant from the Michigan Department of Natural Resources and Environment (which at the time was referred to as the Michigan Department of Environmental Quality).

At Tetra Tech, Ken Kingsley was the executive project manager while Dan Christian and Steve Pennington assumed most day-to-day operations responsibilities and were the main voice for Tetra Tech at Subwatershed Advisory Group (SWAG), and other related, meetings. Kevin Kratt provided additional management level guidance with respect to the technical/modeling portions of the project.

Kyle Paulson was involved with the development of the plan. His duties included coordinating the technical content of the plan, providing GIS support, and drafting the documents. This work was closely coordinated with Steve and the other managers.

Natalie Trotter also provided GIS support, in addition to other data processing duties.

Scott Job ultimately conducted the bulk of the modeling efforts for the project with some assistance from Elizabeth Hansen and others.

Kellie Dubay was responsible for most of the public involvement tasks that were conducted throughout the development of the plan.

In addition to managerial duties, Steve Pennington also provided primary editing support and document preparation for the final version of the plan.

Numerous other team members (too many to mention) are appreciated for their specific contributions.

The authors of the various resources referenced in this plan are recognized for their contributions to the improving health of the Clinton River Watershed and science in general. Their names, and/or references to their work, appear in the plan as their work is presented.

All components of the plan were reviewed and commented on extensively by members of the SWAG.

Organization of the Plan

Watershed Management Plan Details

This plan defines an approach that is to be taken to protect ecological, hydrological, and cultural resources of the North Branch Subwatershed (NBW). It presents all of the data, analyses, public inputs, and conclusions used in developing the approach as well as components of the approach itself, including identifying: water quality threats and impairments, goals and objectives, actions to achieve the goals and objectives, and plan evaluation and revision mechanisms.

This watershed management plan (WMP) is a planning document only and it is fully expected that ongoing modifications will be necessary to reflect actual resources obtained and available for its implementation.

The plan is divided into 10 chapters that move through the watershed planning and implementation process. The Environmental Protection Agency's (EPA's) *Handbook for Developing Watershed Plans to Restore and Protect our Waters* (cover icon at left) has been utilized in developing this plan as it provides: a step-by-step guide through the watershed planning and implementation efforts, numerous tools to assist in the many analyses required, links to invaluable resources, guidance on where to focus efforts to get the greatest return on investment, milestones for assessing progress in conducting the analyses and developing the plan, and assistance in meeting the requirements of Clean Water Act (CWA) section 319 guidelines to develop effective watershed plans for threatened and impaired waters (with actions that are fundable through appropriate grants) . **Where the icon is used throughout this plan, the bold, parenthetical number at the end of the entry represents the section of the handbook from which the entry derives. In the chapter explanation below, the bold, parenthetical text at the end of the entry represents the step in the watershed planning and implementation process (see the appropriate sidebar) that the chapter embodies. Certain key issues and highlights related to a planning / implementation step may span multiple chapters**. **(EPA 1.2)**

As noted above, the handbook assists in meeting the CWA section 319 guidelines for effective watershed plans. The contents of the plan specifically included to meet these 9 requirements (denoted a-i) are called out with large, red letters such as the one at right.

a

In addition to the EPA's handbook discussed above, the plan was also developed using the Michigan Department of Natural Resources and the Environment (DNRE's) Developing a *Watershed Management Plan for Water Quality*. Following this handbook ensures that the plan will be compliant with non-point source administrative rules (part 88) for the Clean Michigan Initiative (CMI) watershed plan implementation funding. Where these requirements are addressed throughout the plan, the icon at the end of this entry appears with a description of the requirement being met.

In the interest of brevity, this plan makes significant use of other documents for content that has already been developed. Where this is the case, the plan clearly states where the information can be found. Additionally, the appendices contain additional related information and are referenced as appropriate.

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A Note about Photos

It should be noted that any photos or figures in the WMP are either: used with explicit permission, reprinted – where legal – with appropriate credit given, or in the public domain with respect to usage rights.

Steps in Watershed Planning and Implementation Process

Build Partnerships

Characterize the Watershed

Set Goals and Identify Solutions

Design Implementation Program

Implement Watershed Plan

Measure Progress and Make Adjustments

Source: (EPA, 2008).

Watershed Management Plan – Main Document

The WMP contains the information pertinent to the planning process organized in parts/chapters.

Introductory Materials

Detailed table of contents; lists of the figures, tables, and sidebars; acknowledgements; summary of the contents; foreword message.

Chapter 1. Introduction

This introductory chapter discusses background science important to understanding the plan, introduces the Clinton River Watershed and the North Branch Subwatershed, and describes the approach used to develop the plan (e.g. processes, partners, drivers) and its contents.

(Build Partnerships, Characterize the Watershed)

Chapter 2. Baseline Environmental Conditions

This chapter introduces the reader to the general environmental conditions in the subwatershed, including: climate; geology, topography, and soils; drainage; and ecosystem attributes and functions (flora, fauna, and habitat). This information defines the baseline conditions for assessments.

(Characterize the Watershed, Measure Progress and Make Adjustments)

Chapter 3. Environmental Stressor and Source Framework

This chapter introduces the reader to environmental stressors and their impacts on the natural environment, the sources of the stressors and the causes of these sources, and defines the basic conceptual model that defines the framework relationship between these elements.

(Characterize the Watershed, Measure Progress and Make Adjustments)

Document Organization

Each chapter is broken down into sections that utilize the following heading:

Section

Subsections utilize the following heading:

Subsection

These are broken down into topics:

Topics

And these are subsequently broken down into discussions:

<u>Discussion</u>

The colored boxes along the sides of the pages are referred to as sidebars.

Chapter 4. Public Input on Environmental Conditions

This chapter identifies the stakeholders involved in development of the plan, the efforts undertaken to engage them and the input they provided, and public education efforts in the past and those considered for the future.

(Build Partnerships, Characterize the Watershed, Measure Progress and Make Adjustments)

Chapter 5. Environmental Conditions Assessment

This chapter presents broad data and programmatic information that defines an assessment framework, describes existing data, defines the data gaps and the initiatives to fill the gaps, presents data with respect to assessment parameters in order to gauge subwatershed conditions, summarizes the conditions based on numerous criteria, discusses critical areas, presents a conceptual model for stressors and sources, and presents a 'scorecard'.

(Characterize the Watershed, Measure Progress and Make Adjustments)

Chapter 6. Goals and Objectives

This chapter defines the main purpose of the plan and lists the goals of the plan along with the objectives associated with each goal and the targets associated with each objective.

(Set Goals and Identify Solutions, Measure Progress and Make Adjustments)

Chapter 7. Priorities in Planning and Management

This chapter presents a prioritization of some plan elements including goals and objectives and critical areas and the categories of actions along with some initial priority actions.

(Set Goals and Identify Solutions, Design Implementation Program, Implement Watershed Plan, Measure Progress and Make Adjustments)

Chapter 8. Actions to Improve Environmental Conditions

This chapter defines the categories of actions to be taken to improve environmental conditions, presents the implementation options within these categories, and presents the final selected action plan along with specific details about each action to be taken.

(Build Partnerships, Set Goals and Identify Solutions, Design Implementation Program, Implement Watershed Plan, Measure Progress and Make Adjustments)

Chapter 9. Evaluation and Revision

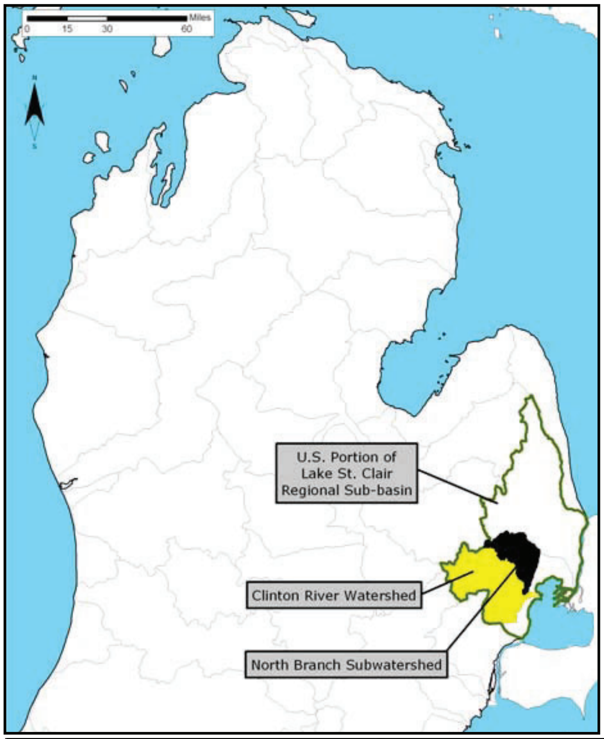
This chapter establishes the monitoring protocols to collect data, the protocols to assess conditions, and evaluation considerations to track progress, and the revision mechanisms to guide changes to the plan.

(Implement Watershed Plan, Measure Progress and Make Adjustments)

Chapter 10. References

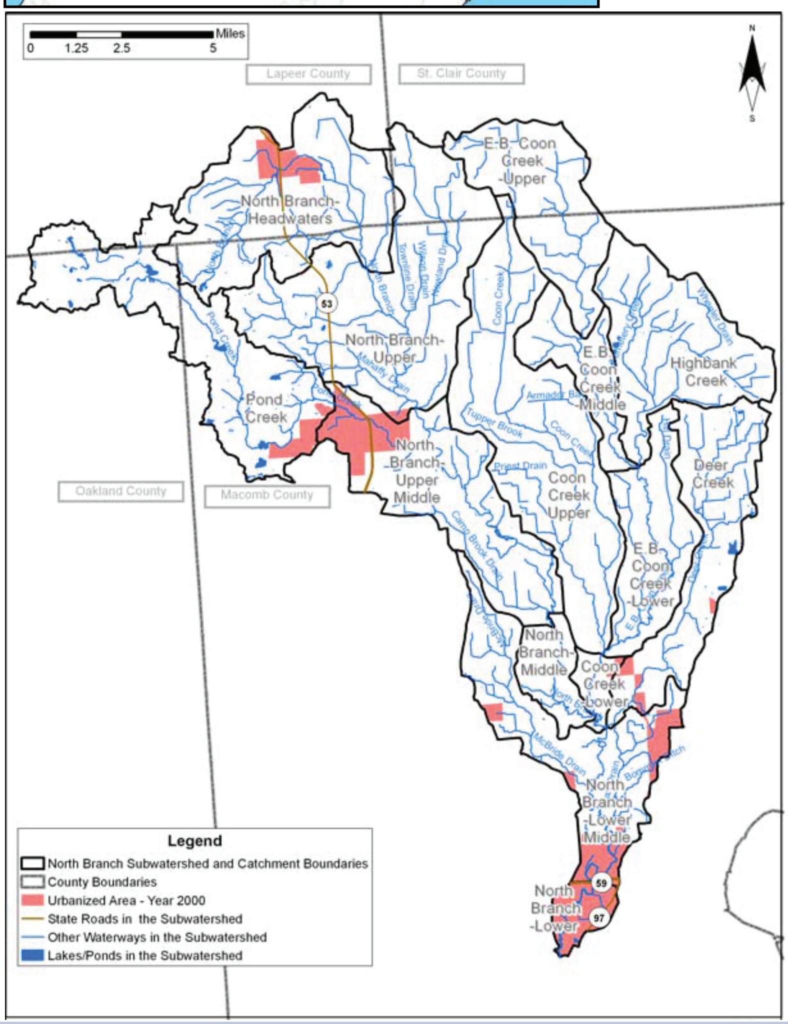
Appendices

Executive Summary



The Clinton River Watershed encompasses approximately 760 square miles in four Southeast Michigan Counties and is home to over 1.4 million people. The headwaters of the Clinton River are in Independence and Springfield Townships of Oakland County, where the river water begins its meandering 80 mile trek, passing through Macomb County, then finally discharging into Lake St. Clair.

The North Branch of the Clinton River is a 43-mile long major tributary to the Clinton River that extends from its northern headwaters in Bruce and Almont Townships (in Macomb and Lapeer Counties, respectively) south to its confluence with the Clinton River in Clinton Township – near Mt. Clemens. Its drainage area, a subwatershed to the Clinton River Watershed, is located mostly in north-central Macomb County (with portions in Oakland, Lapeer, and St. Clair Counties). The North Branch Subwatershed (NBCRW) has some 380 miles of open channel waterways, 10 large lakes (of over 10 acres), and nearly 300 small lakes and ponds.



This WMP was developed by the NBCRW Subwatershed Advisory Group (SWAG) to: 1) to present measurable and attainable methods for reducing NPS pollutants to meet water quality standards; 2) to restore and protect habitat (including wetlands, animal migration corridors, forested lands, and stream buffers); 3) to manage future planning and development in the watershed to sustain water quality levels; and 4) to prevent future watershed degradation.

The contents of this plan, including the goals and objectives and the actions to meet them, were developed cooperatively by SWAG members with consideration of the input from community leaders, residents, environmental and citizen groups, local businesses, schools, and universities. This WMP was also developed to be consistent with other planning efforts affecting the subwatershed, including: the Lake St. Clair Comprehensive Management Plan (U.S. Army Corps of Engineers), the Clinton River Watershed Remedial and Preventative Action Plan (Clinton River Public Advisory Council), and the Water Quality Management Plan for Southeast Michigan (Southeast Michigan Council of Governments).

In the 1830s, the subwatershed was primarily forest land and swamp/wetland. Since that time, permanent human settlement has transformed this land into developed types such as residential(29 sq. mi.), commercial and industrial (6 sq. mi) and agricultural (99 sq. mi.) uses About 50 square miles of miles of natural areas remain, most of which is not protected.

The health of waterbodies in the subwatershed can be gauged from water quality standards (WQS), defined by the DNRE, to: 1) protect health and public welfare, 2) enhance and maintain the quality of water, 3) protect the state's natural resources, and 4) meet the requirements of state and federal law. The WQS contain requirements for designated uses that the waters of the state must meet, including:

• Agricultural Water Supply;

• Public Water Supply;

• Other Aquatic Life/Wildlife;

• Industrial Water Supply;

• Navigation;

• Warmwater Fishery;

• Coldwater Fishery (specifically identified water bodies only);

• Total Body Contact (May 1st - October 31st); and

• Partial Body Contact.

Water quality monitoring has been and continues to be conducted by various organizations and agencies. While some historical data exist, the bulk of monitoring began in the 1970s, spurred by the passage of the Clean Water Act and other environmental initiatives. Analysis of this data tells a story of a severely impacted Clinton River that has improved over the past 30 years but still exhibits some problems. Impairments, as listed by the DNRE in 2010 include: a Fish Consumption Advisory (FCA) for PCBs, the presence of pathogens, and excessive mercury levels around Mt. Clemens. Additionally, all other waterbodies in the subwatershed are impaired due to elevated PCB levels.

The subwatershed, as part of the Clinton River Area of Concern, is affected by some beneficial use impairments that indicate other problems, including:

- Degradation of aesthetics;
- Beach closings and other "full body contact" restrictions;
- Degradation of benthos;
- Loss of fish/wildlife habitat;
- Restrictions on dredging activities (Not Applicable in the North Branch);
- Eutrophication/undesirable algae populations;
- Degradation of fish/wildlife populations; and
- Restrictions on fish/wildlife consumption.

Detailed analysis of water quality data has led to the identification of four major stressors that impact the subwatershed. These stressors are: sediment, phosphorus, pathogens, and flow variability. They have been treated to detailed analysis in the plan that includes discussion of: impacts, indicators, standards, load estimates and reduction goals, critical areas, monitoring, and improvement ideas. The framework for discussion of these stressors makes the implementation of actions to improve their conditions potentially eligible for grant funding.

In addition to addressing the problems causing the waterbody impairments and beneficial use impairments, this WMP also seeks to address issues of public stakeholders. Various meetings were held during the planning process to allow the stakeholders to express their issues and concerns as well as their goals and visions for the subwatershed. Consideration of the public input and the measurable water quality impairments led to the goals and objectives of the WMP, as well as the main principle:

"To improve and protect ecological, hydrological, and cultural resources of the North Branch Subwatershed."

Specifically, the goals of the WMP are:

1. To make progress towards achieving water (and sediment) quality standards for pollutants and parameters that affected the designated, desired, and beneficial uses in the subwatershed.
2. To stabilize the hydrology of the subwatershed including both high flow and low flow conditions
3. To protect and restore suitable, high-quality habitat to support aquatic life, wildlife, and fisheries
4. To protect and enhance existing natural features of the subwatershed
5. To maintain, protect, and enhance greenways through riparian buffers and green corridors

6. To preserve the rural character of the subwatershed for local citizens and visitors seeking a 'rural Michigan' experience
7. To preserve and enhance recreational opportunities for local residents and visitors
8. Cultivate an aware, informed, engaged, and involved public
9. Institutionalize an informed collaborative planning and implementation approach to achieve goals and objectives

Meeting the goals and objectives of the plan in an economically responsible way requires the implementation of numerous actions over many years. As presented in the plan, there are many actions that address the goals and objectives of the WMP and even more resources that provide assistance relative to these actions.

The planned actions have been grouped into the following s nine planning categories:

1. Watershed Planning, Institutionalization, and Implementation;
2. Public Education and Participation;
3. Ordinances, Zoning, and Development Standards;
4. Good Housekeeping and Pollution Prevention;
5. Stormwater Best Management Practices: Non-Construction Related Soil Erosion and Sediment Control;
6. Stormwater Best Management Practices: Other Pollutant Load Reducing Controls;
7. Natural Features and Resources Management;
8. Recreation Promotion and Enhancement; and
9. Environmental Monitoring and Other Data Collection.

The actions in these categories have specific details, including: the lead agency, the schedule, cost estimates, technical and financial assistance, the authority related to the action, any clarifying comments, permit requirement commitments (where appropriate), and applicability to the major stressors affecting the subwatershed.

As with any plan that is part of an adaptive management scheme, this WMP contains procedures for its evaluation and revision. Evaluation measures fall into six levels:

1. Compliance with Activity-Based Permit Requirements;
2. Changes in Knowledge/Awareness;
3. Behavioral Change / BMP Implementation;
4. Load Reductions;
5. Changes in Discharge Quality; and
6. Changes in Receiving Water Quality.

The evaluation measures in the six categories are also classified as: 1) a measure of activity completions (including milestones), 2) a measure of usage, or 3) a measure of change. The data to drive the evaluations will come from various existing and additional volunteer programs. The assessment of the various measures (including checking achievement of goals and objectives) will drive the modifications and revisions to the WMP.

The implementation of the WMP (actions, evaluation, and revision) will be through the SWAG and its individual members. The SWAG will continue its current voluntary structure but will consider alternate organizational structures and funding mechanisms and will initiate them as appropriate for the most effective implementation.

Watershed planning is meant to be an iterative process that provides for continuous input and revision of procedures, processes, and products. It is a tool in a comprehensive and systematic approach to balancing land uses and human activities to meet mutually agreed upon social, economic, and environmental goals and objectives in a watershed.

This WMP is a living document and is meant to be used, revised, and altered to fit the changing needs of the subwatershed as new information becomes available and new priorities arise.

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The North Branch Clinton River watershed management plan lays out the tools in which local government, residents and businesses can help protect and enhance the water quality in the watershed. Whether you farm, reside, work or visit the watershed, protecting the North Branch Clinton River should be of importance to you. As a farmer, you rely on the watershed health for your livelihood. By mitigating the flashy river flows that cause flooding, crops may be more abundant. As a resident, a healthy river and watershed improves property values and makes your community a more desirable place to live. If you work in the watershed, highly qualified employees can be recruited to an area boasting a river system that provides the backbone to a desirable and attractive community. Finally, as a visitor, by protecting the place you choose to recreate or entertain, you have the reassurance that the watershed will maintain its aesthetic beauty for future visits.

As you read through the watershed management plan, I hope you find that it is not placing blame on any one sector of society for the issues degrading water quality. Instead, the watershed management plan lays the framework in which all of us can work together to protect, restore and enhance the North Branch Clinton River. Only by working together will we achieve the outcomes desired for the watershed.

Lynne Seymour, P.E.

North Branch Clinton River Watershed Advisory Group Facilitator

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1. Introduction

Chapter Purpose

The purpose of this chapter is to: 1) introduce the reader to basic watershed science; 2) briefly discuss the Clinton River Watershed and the North Branch Clinton River Subwatershed's (NBCRW's) place within it; 3) present specific details about the NBCRW including: drainage areas, municipalities, and demographics; 4) define the framework for environmental protection and this plan's place within it; and 5) describe the mechanisms and programs utilized in developing this plan.

Watershed Science

A drainage area, commonly referred to as a watershed, is any area of land that drains to a common point (see the 'Drainage Areas' figure on the left-hand side of the page). That common point may be a lake, the outlet of a river, or any point within a river system. Throughout this document, a number of terms are used to describe the various classifications of drainage areas. The most commonly encountered system is the United States Geological Survey (USGS) / Natural Resources Conservation Service (NRCS) system. This system classifies drainage areas as follows (using the Hydrologic Unit Code [HUC] system):

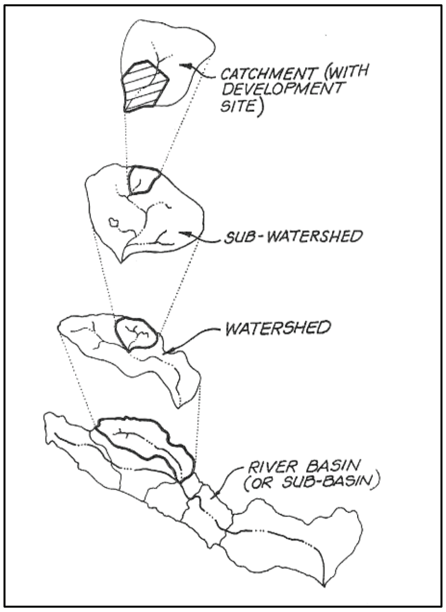
USGS/NRCS Hydrologic Units	Local Example	Local HUC
Regional (2-digit code)	Great Lakes	(04)
Subregional (4-digit code)	St. Clair System	(0409)
Accounting (6-digit code)	*- same area as above -*	(040900)
Cataloging (8-digit code)	Clinton River	(04090003)
Watershed (10-digit code)	North Branch	(0409000303)
Subwatershed (12-digit code)	Coon Creek	(040900030306)

The area commonly referred to as the 'Clinton River Watershed' is actually a 'Cataloging Unit'. However, for the purposes of this plan, the naming conventions have been modified to adhere to local customs and traditions. The adopted naming conventions to be used throughout this plan are:

USGS/NRCS	Local Naming Convention	Local Example
(2-digit code)	**Regional Basin**	Great Lakes Basin
(4-digit code)	**Regional Sub-basin**	Lake St. Clair Sub-basin
(6-digit code)	*-- not used as it covers the same area as above --*	
(8-digit code)	**Watershed**	Clinton River Watershed
(10-digit code)	n/a (see sidebar)	n/a (see sidebar)
n/a	**Subwatershed**	North Branch Subwatershed
(12-digit code)	**Catchment**	East Pond Creek Catchment
-- none	**Sub-catchment**	Subdivision

Regional Basins are the largest drainage areas typically utilized for management type activities (e.g. the Great Lakes and Mississippi River). The **Regional Sub-basins** comprising these drain to major receiving waters such as a large river, estuary or lake (e.g. Lake Michigan or the Missouri River). Within each **Regional Sub-basin** are a group of **Watersheds** that are a mosaic of many diverse land uses. **Watersheds** are composed of a group of **Subwatersheds**, which, in turn, are composed of a group of **Catchments**. Within **Catchments** are **Sub-catchments** defined as the area that drains an individual or group of parcels to the first intersection with a waterbody or storm sewer catch basin. **(EPA 4.4, 5.4.1)**

Drainage Areas



Source, graphic: (CWP, 1998).

HUCs and Local Naming Conventions

The 10-digit HUCs defined by the USGS / NRCS do not coincide with the subwatersheds defined by the Michigan Department of Natural Resources and Environment (MDNRE). For example, the Middle Branch of the Clinton River is part of the North Branch 10-digit HUC (0409000303) but is considered part of the Clinton River East Subwatershed for planning purposes.

Acronyms and Terms

A complete list of acronyms and terms and their respective definitions can be found in Appendix A.1.

The Clinton River Watershed

The Clinton River is a 79-mile long major river in southeast Michigan that drains a watershed of approximately 765 square miles located mostly in Oakland and Macomb Counties (with small portions of the watershed in Lapeer and St. Clair Counties; historic drainage areas in Wayne County no longer drain to the Clinton River). Figure 1-1 shows the location of the Clinton River Watershed in the State of Michigan. **(EPA 5.4.1)**

The Clinton River Watershed has nearly 1,100 miles of open channel waterways, more than 170 large lakes (encompassing over 10 acres), and hundreds of other small lakes and ponds. The watershed includes several high-quality trout streams and the main branch supports a thriving a rainbow trout fishery and one of the state's few urban fisheries. The watershed is also home to a variety of wetland and other ecosystem types from open marshes to hardwood forests.

Land use in the watershed is highly developed with over half of the land consisting of residential, industrial, commercial, and other urban types (e.g. transportation). Developed grassed areas account for nearly 15% of the land and agricultural land accounts for 20%. The remaining land is natural habitat (e.g. woodland, wetland, open water) but this land tends to be fragmented.

The people inhabiting the land and its associated uses have been, and continue to be, the primary factor in environmental and water quality degradation. 'Non-point sources' associated with the people and land (e.g. septic systems, impervious surfaces) contributes today's most problematic stressors.

Stormwater that flows over impervious surfaces and agricultural lands picks up many of the stressors from the non-point sources and delivers them to nearby waterbodies. Increasing stormwater flashiness (lower base flows with extreme peak levels during storms) due to impervious surfaces and agricultural tile drains cause increased stream bank erosion and degrade in-stream habitat. Recent focus has also been placed on the fact that urban expansion and other development has severe detrimental ecological effects through the loss of natural habitat (e.g. forests, wetlands).

In-depth characteristics of the Clinton River Watershed and the planning process for the watershed as-a-whole are presented in the *Clinton River Restoration Plan* (OCDC, 2008).

Subwatersheds of the Clinton River Watershed

The Clinton River Watershed is divided into six subwatersheds based on its major reaches and tributaries. These subwatersheds include: the Upper Clinton, the Clinton Main, the Paint Creek / Stony Creek, the Clinton River East, the Red Run, and the North Branch. The first five subwatersheds listed have distinct watershed management plans (WMPs) already available. This WMP focuses on the North Branch Subwatershed – an DNRE-approved, drainage-based planning area large enough to ensure that implementation will address all major issues but small enough to conduct detailed analyses and target key stakeholders. This will be reinforced by conducted analyses that are based on the catchments comprising the subwatershed. Figure 1-1 shows the location of the North Branch Subwatershed with respect to the State of Michigan and the Clinton River Watershed. **(EPA 2.2.3, 5.4.1)**

Clinton River Watershed Point Source History

In the past, industrial and municipal discharges were the primary sources of stressors (heavy metals, organic compounds – PCBs [polychlorinated biphenyls]) that impacted the natural environment. These stressors still reside in some sediment at levels of concern. Additionally, sewage discharges from combined/sanitary sewer overflows (CSOs and SSOs, respectively) and septic systems have contributed to pathogen and nutrient contamination in the waterways.

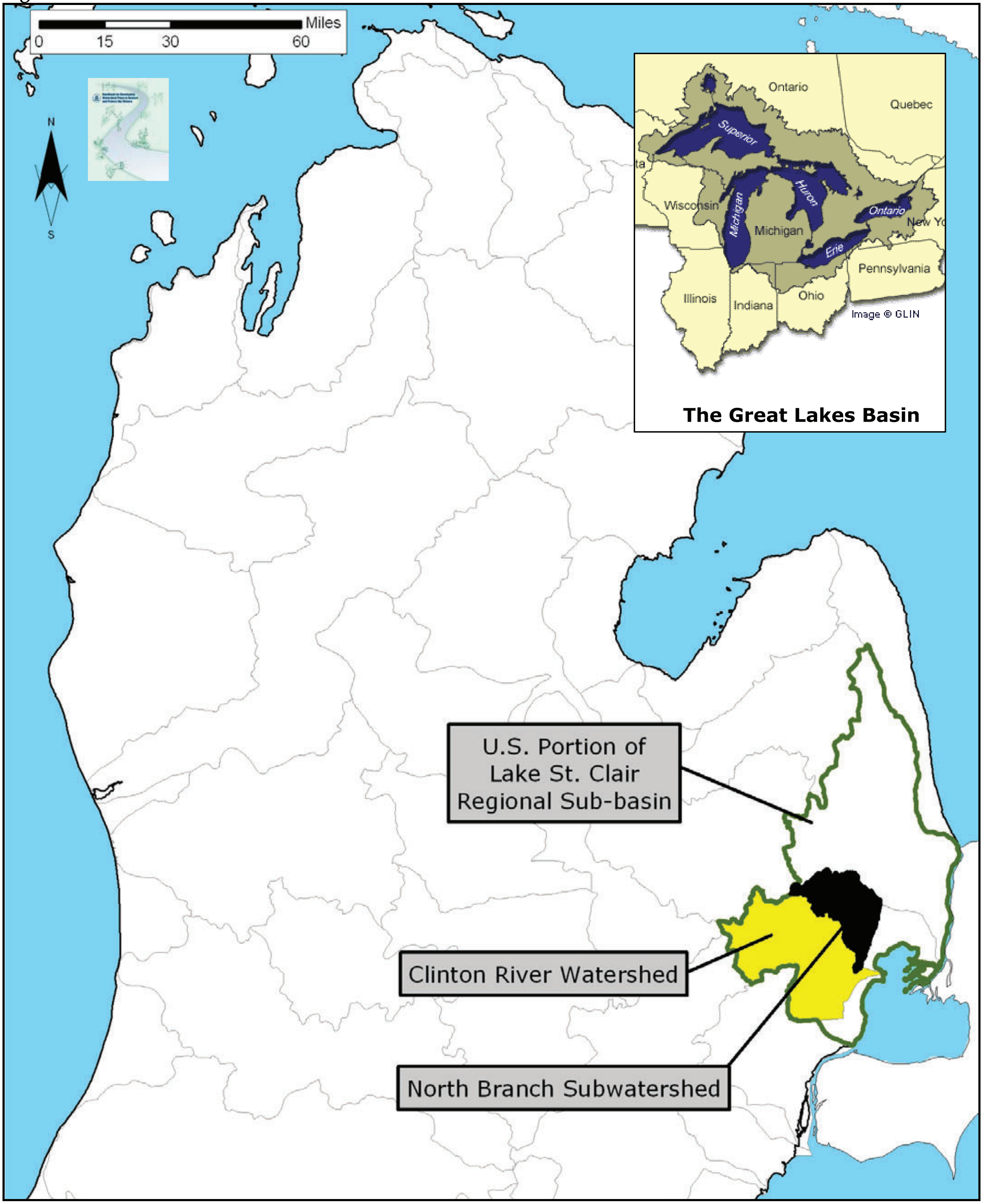
Today there are few of these 'point sources' in the watershed; industrial discharges have been limited to stormwater only or contact cooling water, municipalities have instituted industrial pretreatment programs to control discharges from waste water treatment plans (WWTPs), and contributions from CSOs and SSOs have been greatly reduced.

CMI Requirement

The geographic scope of the watershed

- Appropriate watershed boundaries.

Figure 1-1. Location of Clinton River Watershed and the North Branch Subwatershed.



(EPA 5.4.1) Source [main], data: (GN, 2005); (MIGDL, 2005); (MCPED, 2005). Source [inset], graphic; (GLIN, 2008).

The North Branch Subwatershed

The North Branch of the Clinton River, or simply the 'North Branch', is a 43-mile long major tributary to the Clinton River that extends from its northern headwaters in Bruce and Almont Townships (in Macomb and Lapeer Counties, respectively) south to its confluence with the Clinton River in Clinton Township – near Mt. Clemens. Its drainage area, a subwatershed to the Clinton River Watershed, is located mostly in north-central Macomb County (with portions in Oakland, Lapeer, and St. Clair Counties). **(EPA 5.4.1)**

The North Branch Subwatershed (NBCRW) has some 380 miles of open channel waterways, 10 large lakes (of over 10 acres), and nearly 300 small lakes and ponds. The North Branch itself is in the western half of the subwatershed (and the southern portion). Pond Creek, in the north, is the main tributary to the west. The Coon Creek system (which includes its East Branch and Highbank Creek) serves the northeast and central portions of the subwatershed. Deer Creek serves the southeast portion. The confluences of Coon Creek and Deer Creek with the North Branch are in Macomb Township approximately 7 and 5 linear miles (not river miles) north of the subwatershed outlet, respectively.

The NBCRW is rural in nature and consists primarily of agricultural land. There are highly developed urbanized areas in the south and less intense urban areas associated with the Villages of Romeo, Almont, and Armada. Portions of the subwatershed, especially those near existing urban areas, are experiencing rapid growth as farm land is developed for residential and commercial uses. Still, the rural setting of the NBCRW allows for ample recreational opportunities including non-motorized trails, parks (including Wolcott Mills, part of the Huron-Clinton Metroparks system), and fishing (as Pond Creek and most of the North Branch are designated as cold water fisheries by the DNRE).

Although there are some specific environmental issues in the subwatershed (e.g. *E. coli* issues in Deer Creek, Pond Creek, and the East Branch of the Coon Creek), the quality of waterbodies in the NBCRW is considered good and generally ranks as the best in the Clinton River Watershed (when compared to other subwatersheds as a whole) (CRWC, 2007).

Drainage Areas

The subwatershed covers approximately 200 square miles (sq. mi.) and consists of fourteen drainage areas that are based on the topographically-derived USGS / NRCS classification system (as shown in Figure 1-2) The drainage areas – referred to as 'catchments' in this plan – have been modified slightly to accommodate data analyses and modeling but maintain hydrologic integrity. Where appropriate, certain catchments may be lumped together or further divided to facilitate discussions.

The catchments range in size from 1.82 to 28.28 square miles.

Purpose of the Watershed Management Plan

Water quality in the North Branch Subwatershed has improved dramatically in the past 30 years (CRWC, 2008). However, runoff from urban and agricultural areas threatens to diminish water quality by increasing erosion and sedimentation; and poorly-planned development within the subwatershed has the potential to undo recent improvements in water quality.

Restoration and protection of the North Branch Subwatershed is a complex endeavor. This plan contains numerous goals, objectives, and actions toward those ends. As such, the overall purpose of this plan is:

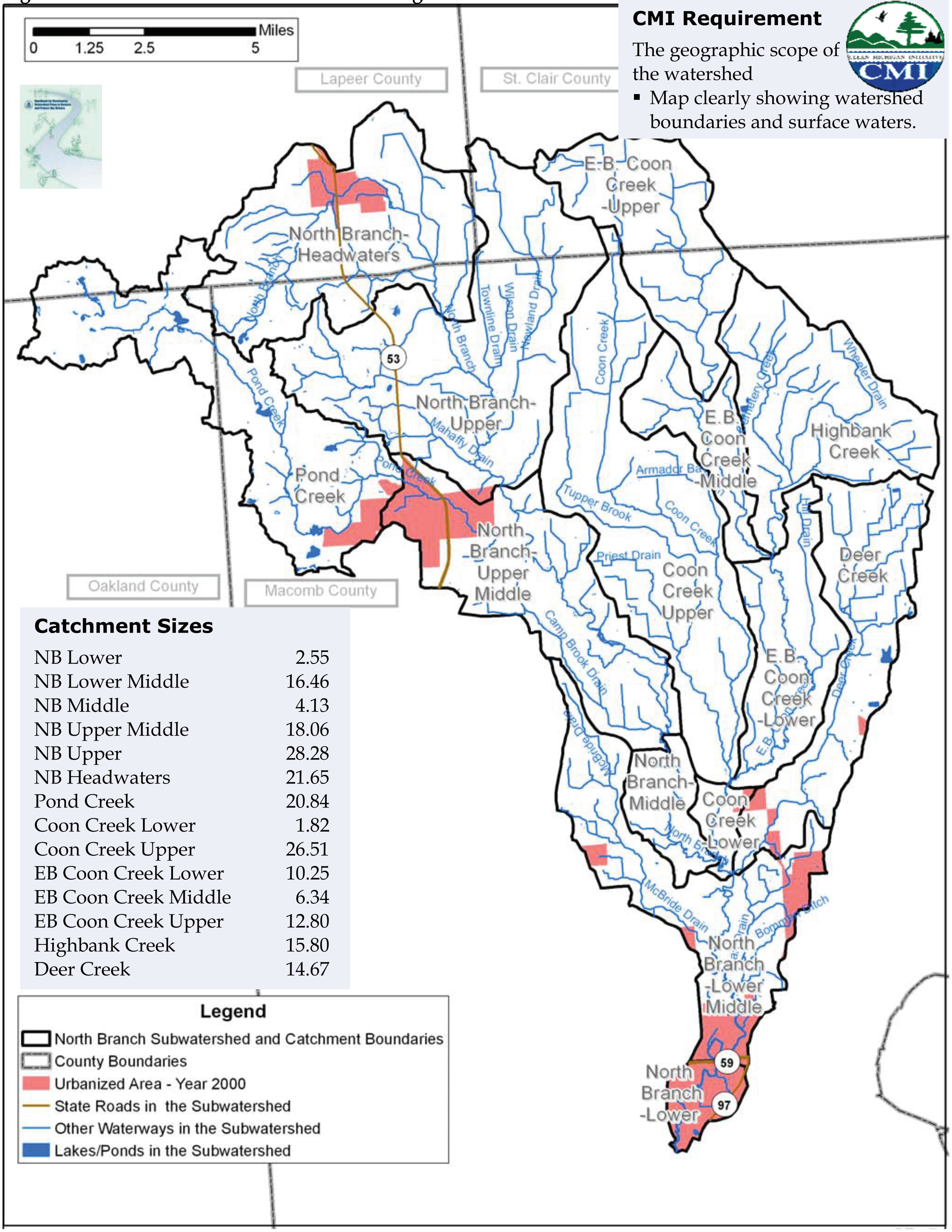
"To improve and protect the ecological, hydrological, and cultural resources of the North Branch Subwatershed."

Origin of the Name

The Clinton River was originally called Nottawasippee by French settlers and Native Americans or the Huron River of St. Clair by the English. It was renamed for New York Governor DeWitt Clinton (1817-1823; 1825-1828) who is often referred to as the 'Father of the Erie Canal'.

Source: (Wikipedia, 2008).
Source, graphic: (AHE, 2008).

Figure 1-2. North Branch Subwatershed drainage basins.



CMI Requirement

The geographic scope of the watershed

- Map clearly showing watershed boundaries and surface waters.

Catchment Sizes

NB Lower	2.55
NB Lower Middle	16.46
NB Middle	4.13
NB Upper Middle	18.06
NB Upper	28.28
NB Headwaters	21.65
Pond Creek	20.84
Coon Creek Lower	1.82
Coon Creek Upper	26.51
EB Coon Creek Lower	10.25
EB Coon Creek Middle	6.34
EB Coon Creek Upper	12.80
Highbank Creek	15.80
Deer Creek	14.67

(EPA 5.4.1)

Source, data: (MIGDL, 2005); (MIGDL, 2008). Catchment boundaries as modified by Tetra Tech.

The Watershed Management Plan Approach

A watershed approach is a flexible framework for managing water resource quality and quantity within a specified drainage area. This approach includes stakeholder involvement and management actions supported by sound science and appropriate technology. The watershed planning process works within this framework by using a series of cooperative, iterative steps to characterize existing conditions, identify and prioritize problems, define management objectives, develop protection or remediation strategies, and implement and adapt selected actions as necessary. The outcomes of this process are documented in a watershed management plan (WMP) – a strategy document that summarizes analyses, actions, participants, and resources related to and resulting from the process. The process is crucial because a successful plan requires the participation of a variety of people with diverse skills and knowledge.

Using a watershed approach is beneficial because it addresses the problems in a holistic manner and the stakeholders in the watershed are actively involved in selecting the management strategies that will be implemented to solve the problems. Additional benefits of the watershed approach include: access to grant funding; sharing of resources, expenses, products, information, and techniques; and expanded planning and implementation options. A watershed approach involves coordinated efforts with both public and private sectors focusing efforts to address the highest priority problems. **(EPA 2.1, 3.1)**

Supported Plans and Programs

A successful watershed plan is one that is integrated with existing planning and technical resources. In developing this WMP, there are a number of additional plans/programs that influenced the contents. Integrating these other efforts ensures a cohesive management strategy from the large scale to the small and fosters eventual progress towards implementing all of the plans. These resources include: (more programs are listed in later chapters)

- The St. Clair River and Lake St. Clair Comprehensive Management Plan (USACE, 2004);
- The Clinton River Restoration Plan a.k.a. Remedial and Preventative Action Plan (OCDC, 2008);
- Water Quality Management Plan for Southeast Michigan (SEMCOG, 1999) and its companion implementation guidance (SEMCOG, 2000);
- Blue Ribbon Commission on Lake St. Clair (MCBRC, 2000); and
- Other watershed management plans being implemented throughout the Clinton River Watershed.

This WMP was developed to comply with EPA's Clean Water Act (CWA) Section 319 National Nonpoint Source Monitoring Program grant requirements as described in the sidebar. Additionally, other planning requirements and guidance handbooks were utilized to ensure this WMP is as robust as possible. These include:

- The National Pollutant Discharge Elimination System (NPDES);
- Developing a Watershed Management Plan for Water Quality: An Introductory Guide; and
- Handbook for Developing Watershed Plans to Restore and Protect Our Waters.

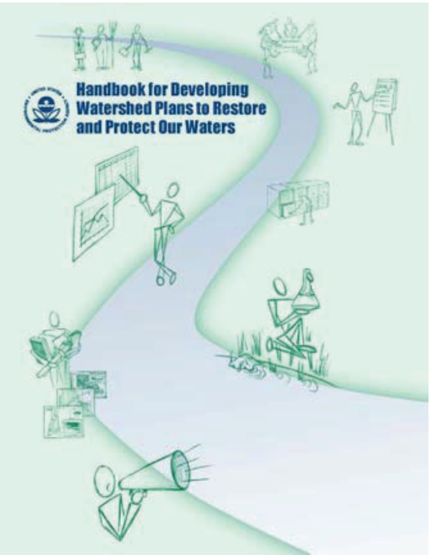
These plans and programs are discussed in Appendix A.2. **(EPA 2.2.4, 2.6)**

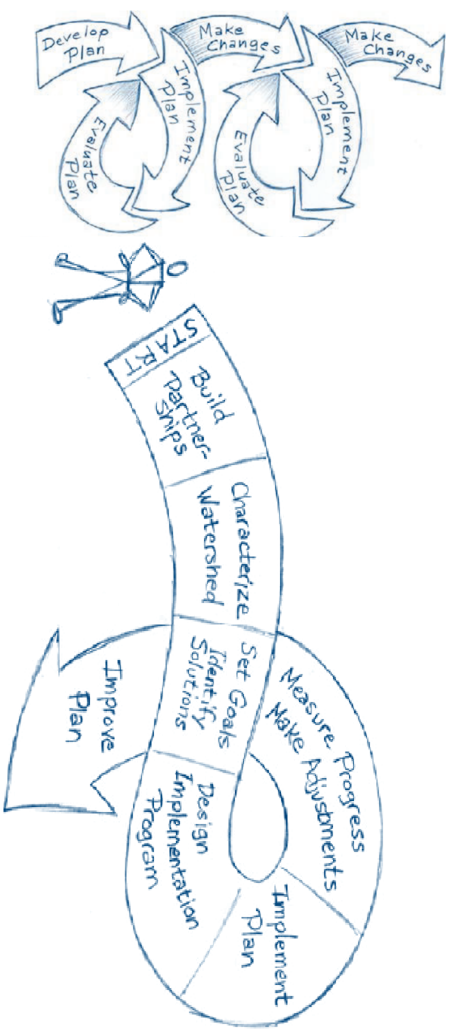
Requirements of the WMP

As described in EPA's Clean Water Act (CWA) Section 319 National Nonpoint Source Monitoring Program grant requirements, the WMP shall, at a minimum, contain the following:

a. Identification of the causes and sources of stressors that need to be controlled and other goals for the watershed;
b. Determination of the required reduction in stressor discharges to the natural environment to meet load reduction requirements and achieve other goals;
c. Management measures to be implemented to achieve stressor load reductions and other goals;
d. An implementation schedule for the management measures;
e. Interim milestones to track implementation of the measures;
f. Criteria to measure progress towards meeting stressor load reductions and achieving other goals;
g. A monitoring program to obtain the data with which to evaluate the progress-measuring criteria;
h. An educational component designed to help meet load reduction requirements and achieve other goals; and
i. Identification of technical and financial assistance required to implement the elements of the plan.

These elements are presented in terms of the planning process in Figure 1-3 and are highlighted by the number **319** and the appropriate lower case letter. **a-i** Figure 1-3 and are highlighted the by **319** and the appropriate lower case letter.





Source, graphics: (EPA, 2008)

Handbook for Developing Watershed Plans to Restore and Protect Our Waters

Although discussed in Appendix A.2, the importance of this document (EPA, 2008) to this plan warrants a discussion in the main text of the plan. This watershed management plan has been developed specifically using the handbook as its primary driver (while still relying on other important resources that the handbook itself advises should still be utilized in developing the plan).

The handbook logo appears throughout the WMP (same as the one at left, only smaller) to indicate that the text or concept discussed is derived from the handbook. An accompanying bold-font number in parentheses **(EPA #)** is placed at the end of the entry to indicate the location in the handbook from which the text or concept was taken.

The Watershed Planning Process

The watershed planning process is iterative and adaptive and is also holistic. The watershed planning process is also holistic. A quality WMP should address all of the impairments, stressors, sources, and causes; not only those of immediate concern, but also those that need to be addressed to ensure the long-term health of the watershed. A holistic WMP should also include a full range of other resource management activities (e.g. drinking water protection, forest management, agricultural resource management, greenspace management) or at a minimum reference the existence of these programs so that integration can occur. In order to generate a holistic WMP, a diverse stakeholder constituency must be involved in the planning process.

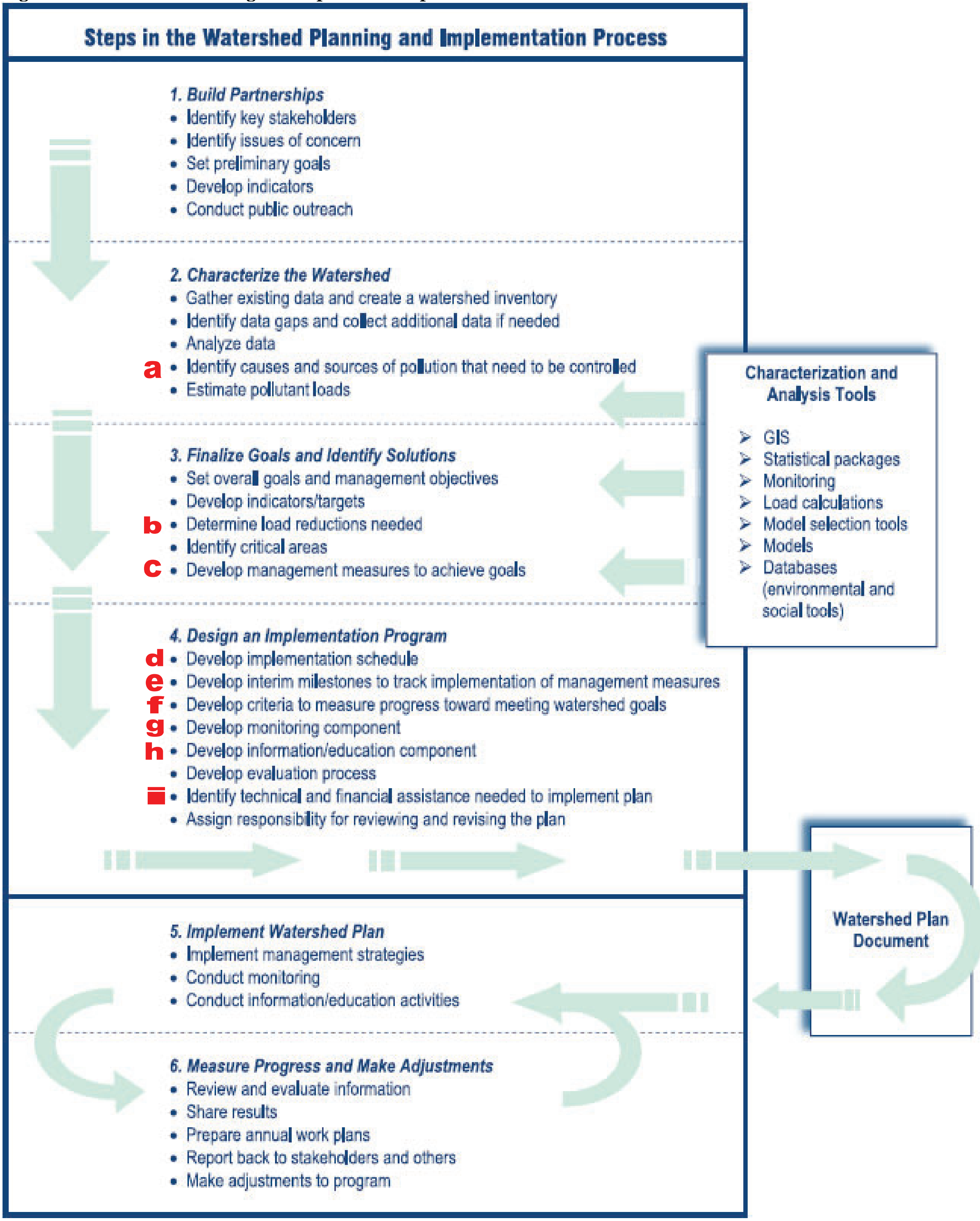
This last point is also important because the watershed planning process needs to be a collaborative, participatory process. Stakeholders need to be brought in at the beginning of the planning effort to ensure that implementation of the plan has the greatest chance at success (CWP, 1996). Public involvement is discussed in detail in Chapter 4.

The watershed planning process is organized into the following major steps:

1. Build partnerships;
2. Characterize the watershed to identify problems;
3. Set goals and identify solutions;
4. Design an implementation program;
5. Implement the watershed plan; and
6. Measure progress and make adjustments.

The steps are further refined in Figure 1-3 **(EPA 2.2.1, 2.2.2, 2.2.4, 2.3)**

Figure 1-3. Watershed management plan development.



Source, graphic: (EPA, 2008).

Development of the Watershed Management Plan

The North Branch Subwatershed (NBCRW) includes all or part of twelve Macomb County communities, part of three Lapeer County communities, part of two Oakland County communities, and part of one St. Clair County community. (See Table 1.1 for a list of the communities within the NBCRW.) Acting as the North Branch Subwatershed Advisory Group (SWAG), these communities and other representatives have been meeting regularly since November 2002 (with signatory approval coming from the communities in 2003 and 2004 – see Appendix A.4) to address environmental issues in the subwatershed. An MDNRE grant was applied for in October 2007 to seek funding for the development of a watershed management plan (WMP). This plan was developed in support of the awarded grant and represents the cumulative hard work of many people over many years.

Watershed Partners

The NBCRW SWAG spearheaded the efforts involved in developing this WMP. The SWAG was chaired by representatives from the Macomb County Public Works Office (MCPWO) as Macomb County represents the majority of the land area in the watershed and has the requisite staff and resources to provide a leadership position. During plan development, the group operated on an informal basis and included representatives from organizations that are able to affect change in the subwatershed and those who will be influenced by the changes, including:

- each community in the subwatershed (see Table 1-1 and Table 1-2**)**;
- the county drain commissioners;
- the county health departments;
- three county planning departments;
- the Road Commission of Macomb County (RCMC);
- the Macomb Conservation District (MCCD);
- the Macomb County Farm Bureau (MCFB);
- the Michigan State University Extension (MSUE);
- the Clinton River Watershed Council (CRWC);
- the Six Rivers Regional Land Conservancy (SRRLC);
- the Southeast Michigan Council of Governments (SEMCOG); and
- the MDNRE .

Additional stakeholders brought in during the public participation activities associated with this planning process include farmers and members of the general public. The Farm Bureau and MSUE are represented in the SWAG, but additional interfacing with individual farmers and additional researchers was required to obtain critical information about the subwatershed. **(EPA 3.4, 5.3.1)**

Refer to Appendix A.5 for a complete list of the SWAG members and their contact information.

Importance of Partnerships

The philosophy of partnership is embodied in the composition of any watershed organization and will play an integral role in implementing this and other plans in the subwatershed. To this end, the SWAG may utilize 'Partnership Agreements' to ensure that the WMP actions are actually implemented and are coordinated with other efforts. Critical partnerships for implementing this plan include: the farming community, the municipalities, the CRWC, and SEMCOG. Refer to the WMP for a more detailed discussion of how partnerships are important and additional specific information for some of these groups. **(EPA 3.1)**

Regulated Areas

The NPDES Phase II program, discussed later in this chapter, regulates all urbanized areas (as defined by the U.S. Census Bureau) operating a separate storm sewer system. This includes only a small portion of the subwatershed (see Figure 1-2), including all of certain small communities and small portions of larger and other smaller communities.

Table 1-1.Subwatershed communities.

	Total Community Size (sq. miles)	Percent of Community in Subwatershed (by Area)	Estimated Population in Sub-watershed (2000 Census)	Total Area in Sub-watershed (sq. miles)	Urbanized Area in Sub-watershed (sq. miles)	Non-Urbanized Area in Subwatershed (sq. miles)
Lapeer County	**662.53**	**2.6%**	**4,334**	**17.47**	**1.49**	**15.98**
Almont, Village of	1.36	87.5%	2,657	1.19	1.19	
Almont Township	35.56	40.0%	1,536	14.22	0.30	13.92
Dryden Township	35.08	5.9%	141	2.06		2.06
Macomb County	**483.81**	**33.7%**	**31,915**	**163.05**	**12.91**	**150.14**
Armada, Village of**	0.68	100.0%	1,566	0.68		0.68
Armada Township**	35.84	99.8%	3,663	35.78	0.03	35.75
Bruce Township	35.78	93.9%	6,005	33.58	2.47	31.11
Chesterfield Township	27.82	11.1%	977	3.09	1.03	2.06
Clinton Township*	28.10	7.8%	3,408	2.19	2.19	
Lenox Township	36.39	48.7%	2,013	17.74	0.07	17.67
Macomb Township	36.53	48.2%	4,736	17.62	2.39	15.22
Mt. Clemens, City of	4.20	9.0%	2,512	0.38	0.38	
Ray Township	36.68	86.8%	3,004	31.85		31.85
Richmond Township	37.53	42.1%	1,307	15.79		15.79
Romeo, Village of	2.01	77.6%	2,456	1.56	1.56	
Washington Township	36.14	7.7%	268	2.79	2.79	
Oakland County	**906.62**	**0.8%**	**756**	**6.83**		**6.83**
Addison Township	35.58	18.5%	705	6.58		6.58
Leonard, Village of	0.99	25.3%	51	0.25		0.25
St. Clair County	**735.30**	**1.7%**	**1,526**	**12.81**		**12.81**
Berlin Township	37.12	34.5%	1,526	12.81		12.81
Total	**--**	**--**	**38,531**	**200.16**	**14.40**	**185.76**

* - denotes a charter township; Source, data: (MIGDL, 2008); (TIGER, 2000).

** - new data lists Village of Armada at 0.73 square miles; the size has been kept at 0.68 to be consistent with the *Clinton River Restoration Plan*; the unaccounted for 0.05 square miles have been included in Armada Township's overall size

Table 1-2. Subwatershed communities and catchments.

Community (except for percentages, all numbers given as square miles)	Coon Creek – Upper	Coon Creek – Lower	Deer Creek	East Branch Coon Creek – Upper	East Branch Coon Creek – Middle	East Branch Coon Creek – Lower	Highbank Creek	North Branch – Headwaters	North Branch – Upper	North Branch – Upper Middle	North Branch – Middle	North Branch – Lower Middle	North Branch - Lower	Pond Creek	Total Area (square miles)	Percent of Subwatershed
Lapeer County								**15.14**	**0.12**					**2.21**	**17.47**	**8.7%**
Almont, Village of								1.19							1.19	0.6%
Almont Township								13.92	0.12					0.18	14.22	7.1%
Dryden Township								0.03						2.03	2.06	1.0%
Macomb County	**26.28**	**1.82**	**14.67**	**5.19**	**6.34**	**10.25**	**15.80**	**6.07**	**23.36**	**18.06**	**4.13**	**16.46**	**2.55**	**12.07**	**163.05**	**81.5%**
Armada, Village of				0.09	0.59										0.68	0.3%
Armada Township	13.59			5.10	5.02		1.48		9.10	1.49					35.78	17.9%
Bruce Township								6.07	14.15	1.94				11.42	33.58	16.8%
Chesterfield Township			1.52									1.57			3.09	1.5%
Clinton Township*												0.04	2.15		2.19	1.1%
Lenox Township			10.11		0.05	7.08	0.50								17.74	8.9%
Macomb Township		1.67	1.39			< 0.01					2.52	12.02	0.02		17.62	8.8%
Mt. Clemens, City of													0.38		0.38	0.2%
Ray Township	12.69	0.15	0.03		0.68	2.73	0.09			11.04	1.61	2.83			31.85	15.9%
Richmond Township			1.62	< 0.01	< 0.01	0.44	13.73								15.79	7.9%
Romeo, Village of									0.11	1.45					1.56	0.8%
Washington Township										2.14				0.65	2.79	1.4%
Oakland County								**0.27**						**6.56**	**8.83**	**3.4%**
Addison Township								0.27						6.31	6.58	3.3%
Leonard, Village of														0.25	0.25	0.1%
St. Clair County	**0.23**			**7.61**				**0.17**	**4.80**						**12.81**	**6.4%**
Berlin Township	0.23			7.61				0.17	4.80						12.81	6.4%
Total (square miles)	**26.51**	**1.82**	**14.67**	**12.80**	**6.34**	**10.25**	**15.80**	**21.65**	**28.28**	**18.06**	**4.13**	**16.46**	**2.55**	**20.84**	**200.16**	**100.0%**
Percent of Subwatershed	**13.2%**	**0.9%**	**7.4%**	**6.4%**	**3.2%**	**5.1%**	**7.9%**	**10.8%**	**14.1%**	**9.0%**	**2.1%**	**8.2%**	**1.3%**	**10.4%**	**100.0%**	**---**

* - denotes a charter township Source, data: (MIGDL, 2008). Catchment boundaries as modified by Tetra Tech.

Supporting the Planning and Implementation Process

In order to properly complete the planning and implementation process, the SWAG had to conduct a number of tasks. These are discussed below:

Meetings
This task consisted of bi-monthly SWAG meetings, SWAG subcommittee meetings as necessary, and monthly project management meetings between representatives from the MCPWO, the consulting firm Tetra Tech, and others as appropriate.

FTP Sites
An FTP site was set up during the planning process to facilitate public participation, coordinate project activities and meetings, provide updates as to project progress, disseminate information, and receive feedback.

Data Management
The Watershed Information Management System (WIMS) was used to access data identified during the development of the *Clinton River Restoration Plan*. Additional reports obtained during development of this plan were added to the WIMS.

Data collected during development of this plan were stored in appropriate databases and presented in separate technical documents.

Public Participation
See Chapter 4.

The Watershed Management Plan

Drivers and Purpose

The North Branch Clinton River Watershed Management Plan ultimately seeks to:

- Address all current and future causes of sources, sources of, and the stressors themselves in the subwatershed, to:
  - Address impaired waterbodies with total maximum daily loads (TMDLs),
  - Address other impaired waterbodies, and
  - Protect threatened and pristine waterbodies; and
- Better coordinate water resources activities and use resources more efficiently;
- Manage future planning and development decisions to:
  - Restore and protect natural habitat;
  - Protect the rural nature of the subwatershed; and
  - Ensure the continued presence of the agricultural community;
- Setup the urbanizing areas of the watershed to be ready to meet stormwater regulations should they be extended to cover additional areas of the subwatershed;
- Comply with CMI and 319 grant requirements to get funding to implement the actions in the plan; and
- Act as an example of utilizing the EPA's handbook in developing a watershed management plan. **(EPA 3.2)**

Incorporating the numerous and diverse requirements of the various supported programs and plan drivers, the resultant plan can be said to have this one main general purpose:

"**To improve and protect the ecological, hydrological, and cultural resources of the North Branch Subwatershed.**"

In addition to simply improving environmental conditions and eliminating documented water quality impairments, achievement of the goals and objectives of this plan (along with achievement of the goals and objectives of the regional *Clinton River Restoration Plan*) will also provide numerous ancillary benefits including:

- A potential increase in property values within the subwatershed;
- Increased desirability of the subwatershed for investment and development following elimination of impairments;
- Increased public use and enjoyment o the North Branch and its tributaries associated with increased recreational uses such as fishing and swimming;
- Increased public use and enjoyment of the North Branch and its tributaries associated with increased recreational uses such as wildlife viewing and the general ability to 'connect with nature' as aesthetics improve in the subwatershed;
- Reduction of pathogens within the North Branch and its tributaries and reduction of exposure related human health impacts;
- Specific criteria that can be used to evaluate the goals and objectives associated with the plan.

The implementation of the plan will require compliance with numerous regulatory issues. These are discussed in-depth in the following section.

Planning Considerations and Plan Contents

In order to be useful for the various purposes of the plan, the planning process had to address numerous considerations. These are addressed throughout the WMP and are discussed in detail in Appendix A.6. This appendix also details the streamlined narrative contained in the chapters of the plan, all of which combine to present the significant information of use to the general public. Where appropriate, the WMP utilizes appendices and references technical documents developed during the planning process or outside resources.

Legal and Regulatory Framework

There are numerous laws and regulations that are important to understand and often conform to during watershed management planning and implementation. While these are discussed in detail in Appendix A.7 (along with some historical background), the major laws and programs to consider include:

- The Federal Water Pollution Control Act Amendments of 1972 or the Clean Water Act (CWA) – a landmark environmental protection law that embodies the philosophy of water pollution control in the United States (e.g. requiring water quality-based controls and technology-based, or end-of-pipe, control strategies):
    - The National Pollutant Discharge Elimination System – the cornerstone of the CWA which requires permits and controls the discharge of pollutants from various sources;
    - The Total Maximum Daily Load (TMDL) Program – implemented by the MDNRE under federal authority, the TMDL program aims to detail stressors and sources related to waterbody impairments and to define the pathway for eliminating the impairments;
- The State Natural Resources and Environmental Protection Act (PA of 1994) – a codification of most environmental statutes at the state level; &
- The State Drain Code (Public Act 40 of 1956) – sets forth the procedures for the creation, maintenance, and financing county drains.
- The State Stormwater NPDES Phase I & II program (although the majority of the communities in the North Branch are not subject to this programs requirements).

2. Baseline Environmental Conditions

CMI Requirement

The geographic scope of the watershed

- Description of the subwatershed including soils, natural features, and hydrology information.

Hydrologic Cycle

The hydrologic cycle has three main parts: precipitation, evaporation, and transpiration.

Precipitation is water that falls from the rain clouds (as rain, snow, sleet, or hail). Upon reaching the ground, this water both percolates/infiltrates into the ground to become groundwater, and flows overland into waterbodies (e.g. rivers, lakes) collectively called surface water. In certain areas, the groundwater and surface water interface. Based on the hydraulic conditions, the groundwater may be seeping into streams and rivers to form the baseflow or the surface water may be recharging the groundwater aquifer.

From surface waterbodies, the water evaporates. From plants which have taken up water from the ground, the water transpires. These processes turn liquid water into a vapor which rises into the air where it eventually condenses into clouds. When conditions are right, the condensed water falls from its suspended state as precipitation and the cycle starts again.

Chapter Purpose

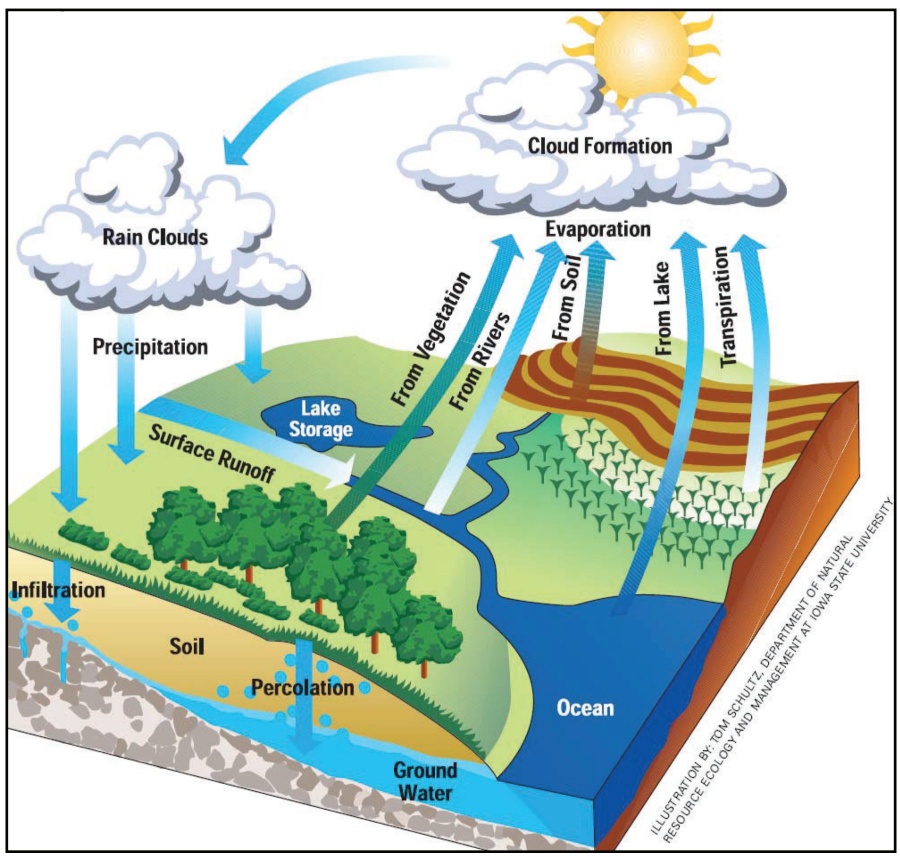
The purpose of this chapter is to introduce the reader to the general environmental conditions in the subwatershed. This information acts as a foundation for assessing how stressors impact the environment and for determining if current environmental stressors are causing impairments. Further description of the subwatershed is found in Chapter 5.

Introduction

The natural environment consists of all living (i.e. biota) and non-living features (i.e. land, water, air). The viability and sustainability of these features in the subwatershed are important from a planning perspective. This chapter of the WMP includes information about the physical, biological, chemical, and habitat characteristics of the subwatershed and includes commentary on the hydrologic conditions.

The hydrologic commentary begins with a brief introduction to the hydrologic cycle - how water moves on the land, in the soil and bedrock, and in the atmosphere. The discussion is presented in the sidebar. The processes in the hydrologic cycle are shown in Figure 2-1.

Figure 2-1. The hydrologic cycle.



Source, graphic: (Appel, 2003).

Climate

Climate is the meteorological conditions which prevail in a region. The climate of the subwatershed is temperate, showing variation between summer and winter conditions. The Great Lakes moderate the temperatures of the region, cooling the summers and warming the winters resulting in a milder climate compared to other locations of similar latitude. The lakes also act as a humidifier, increasing the moisture content of the air throughout the year (GLIN, 2005).

Climatic conditions strongly influence the biota and land use in a given region. The dynamics of water transport through river systems are determined by complex interactions between landscape elements and the climate (Wiley, 1997). Understanding how the local climate functions is vital to resource management activities within the subwatershed (Francis, 2006).

A Note on the Climatic Data for the Subwatershed

Temperature and rainfall data is an aggregate from ten southeast Michigan counties for 1931-2000. Snowfall data is an average of 30-year means for stations in Mt. Clemens and Detroit. Extremes are taken from the Mid-west Regional Climate Center website. Wind data is from a station in Detroit from 1930-1996.

Temperature

The temperature in southeast Michigan is seasonal, with a difference of 48.4°F between the highest and lowest average monthly temperature. Table 2-1 presents the low, mean, and high average monthly temperatures.

Table 2-1. Climatic data for the watershed / AOC.

Month	Avg. Monthly Temperature (°F)			Avg. Monthly Precipitation* (inches)			Avg. Monthly Snowfall** (inches)			Prevailing Wind Direction	Average Wind Speed (mph)	Peak Gust Wind Speed*** (mph)
	Low	*Mean*	*High*	*Low*	*Mean*	*High*	*Mean*	*High*	*Day*			
January	12.8	23.7	35.5	0.12	1.83	4.44	11.3	34.2	14.7	WSW	12	66
February	13.4	25.2	36.7	0.09	1.71	5.14	8.9	28.5	12.0	SW	12	51
March	24.7	34.3	45.5	0.00	2.30	5.59	6.1	21.2	13.7	WNW	12	60
April	39.5	46.2	54.9	0.40	3.03	5.46	1.6	9.0	5.0	SW	12	64
May	50.0	57.8	67.1	0.33	3.12	7.66	trace	1.1	1.1	NE	10	58
June	61.8	67.6	73.3	0.22	3.38	8.15	0.0	0.0	0.0	SW	9	56
July	77.1	72.1	79.1	0.00	2.96	9.21	0.0	0.0	0.0	SW	9	59
August	65.3	70.2	77.2	0.37	3.15	10.43	0.0	0.0	0.0	SW	8	47
September	58.1	62.8	69.6	0.00	2.92	7.52	0.0	0.0	0.0	SW	9	54
October	45.7	51.6	62.7	0.00	2.42	8.54	0.2	0.8	2.7	SW	10	56
November	32.9	39.1	49.5	0.43	2.44	6.16	2.2	12.3	10.0	WSW	11	58
December	18.0	28.1	39.7	0.14	2.20	6.00	10.6	34.9	18.4	SW	11	59
Annual	---	---	---	**15.86**	**31.46**	**40.54**	**40.8**	**74.0**	---	---	---	---

* - Includes snowfall. ** - As a general rule, divide the snowfall amount by ten to convert to equivalent inches of rainfall. 'Day' indicates the maximum amount of snowfall ever recorded for one day in the month. *** - As recorded.

Source, data: (NOAA, 2002); (NCDC, 1998); (NCDC, 2002); (MRCC, 2005).

The record high temperature in the region is 105 °F on July 9th, 1936. The record low is -22 °F on February 9th, 1934 (MRCC, 2005).

In comparing the data from the last 30 years to the entire set (1931-2000), no major warming or cooling trends were identified.

Acronyms and Terms

A complete list of acronyms and terms and their respective definitions can be found in Appendix A.1.

Precipitation

The average annual precipitation in southeast Michigan is 31.46 inches, distributed seasonally, with a difference of approximately 1.7 inches between the lowest and highest average monthly precipitation. A portion of this precipitation occurs as snowfall in October through April (and sometimes May).

Table 2-1 presents the low, mean, and high average monthly precipitation. The record 1-day rainfall in the region is 5.13 inches on July 19th, 1976.

The average yearly precipitation for the period of 1971-2000 is 1.4 inches greater than the 1931-2000 average with most of the increase occurring in the late summer months.

The following percentages indicate the chance that the given 24-hour rainfall will be exceeded in a 1-year period: 50% = 2.26 in.(roughly a 2 yr, 24 hr storm); 20% = 2.75 in.; 10% = 3.13 in.; 4% = 3.60 in.; 2% = 3.98 in.; and 1% = 4.38 in (Huff, 1992). For example, there is a 50% chance that it will rain at least 2.26 inches in one 24-hour period during any given year.

Wind

The prevailing wind comes from the southwest. The average wind speed for the winter months (12 mph) is up to 4 mph faster than during the summer months and the highest wind gusts also occur during the winter.

Table 2-1 presents this information, including prevailing direction, speed, and peak gust speed. **(EPA 5.3.5, 5.4.5)**

Climate Change

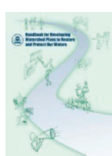
Long-term observations confirm that the United States climate is now changing at a rapid rate. Over the 20th century, the average annual U.S. temperature has risen by almost 1 °F and precipitation has increased by 5 to 10%, mostly due to increases in heavy downpours (NAST, 2000). These trends have been most apparent over the past few decades. Scientists generally believe that 21st century warming will be significantly higher than in the 20th century.

National Assessment Synthesis Team (NAST)

NAST is an advisory committee chartered under the Federal Advisory Committee Act. The committee is made up of experts drawn from government, universities, industry and non-governmental organizations

Scenarios examined by NAST (2000), assuming no major interventions to reduce world greenhouse gas emissions, indicate that temperatures in the U.S. will rise by about 5–9 °F (3–5 °C) on average in the next 100 years, which is more than the projected global increase. This rise may cause more extreme precipitation events and faster evaporation, leading to greater frequency of both very wet and very dry conditions.

Geology, Topography, and Soils

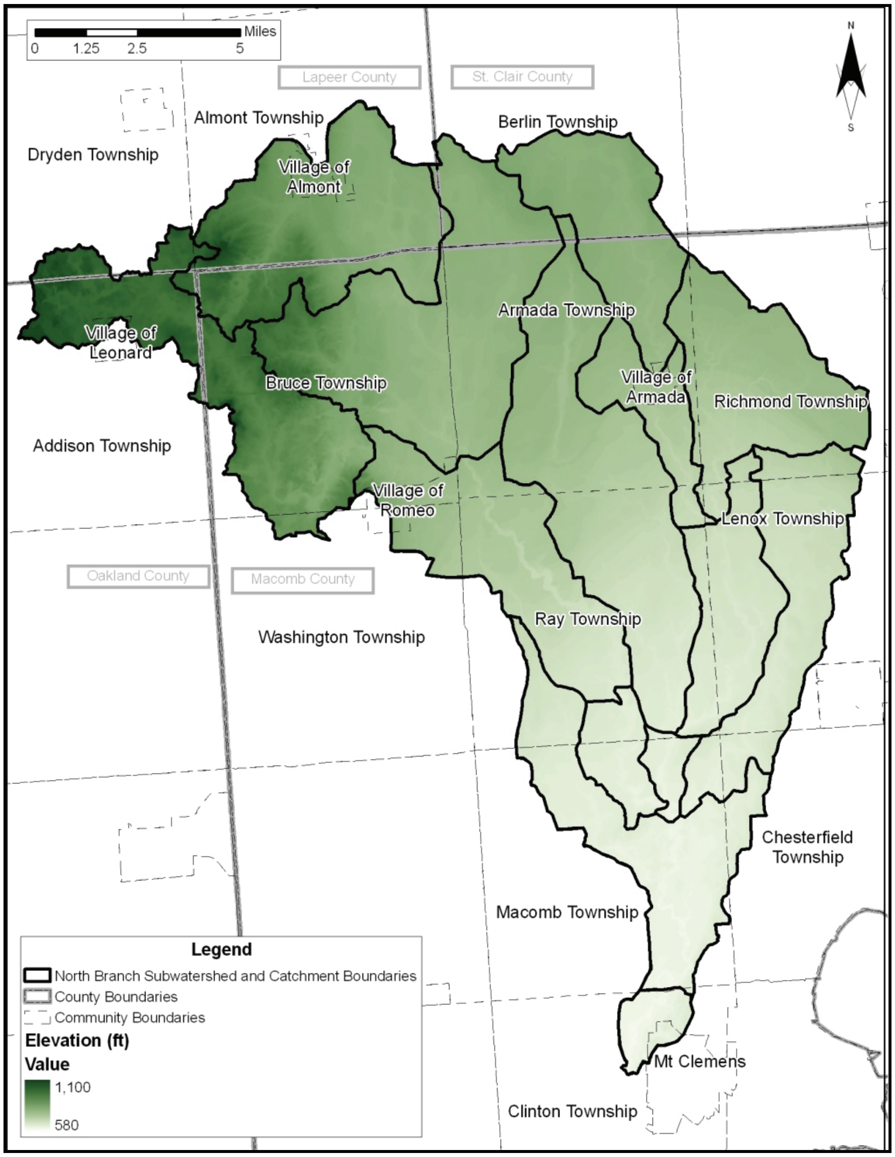


Historical climatic conditions have defined the current geology of the watershed. From a watershed planning viewpoint, the most important geological considerations are elevation (slope), soils, and hydrologic characteristics. In this plan, the discussion of geology includes the current topographical and soil characteristics of the watershed. A more detailed geologic history of the area and some supporting data can be found in the Clinton River RAP.

Topography

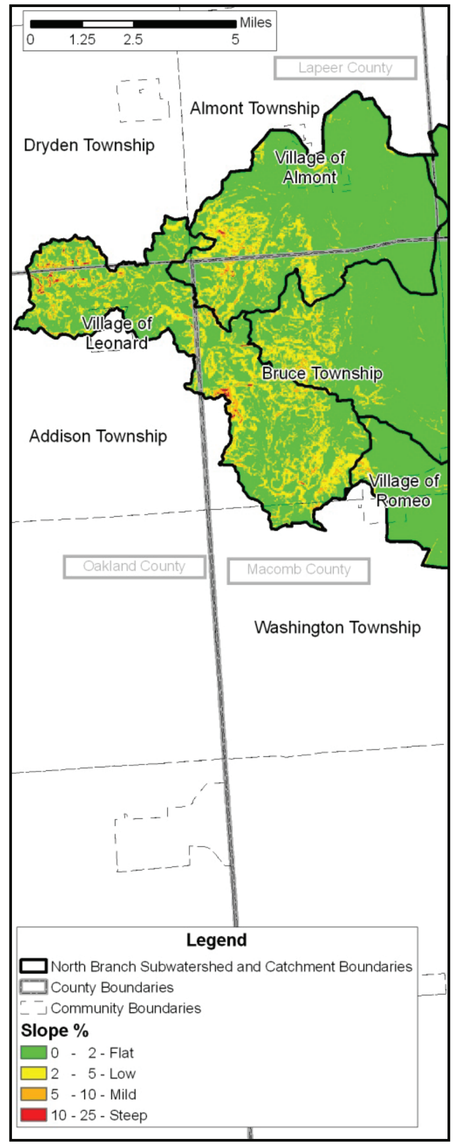
The subwatershed is a generally flat, rolling geologic lakeplain. The northwestern portion of the subwatershed extends into different geological regions (interlobate and moraines) which provide for more exotic formations resulting in larger and steeper hills. The elevations in the subwatershed range from 1,100 ft to 580 ft (based on a digital elevation model – DEM – developed by the United States Geological Survey – USGS). As shown in Figure 2-2, elevations are greater in the northwest portion of the subwatershed.

Figure 2-2. Elevations in the subwatershed.



Source. data: (MIGDL, 2008). Catchment boundaries as modified by Tetra Tech.

Slopes in the Western portion of the Subwatershed



See left for source.

North Branch Subwatershed Soil Associations

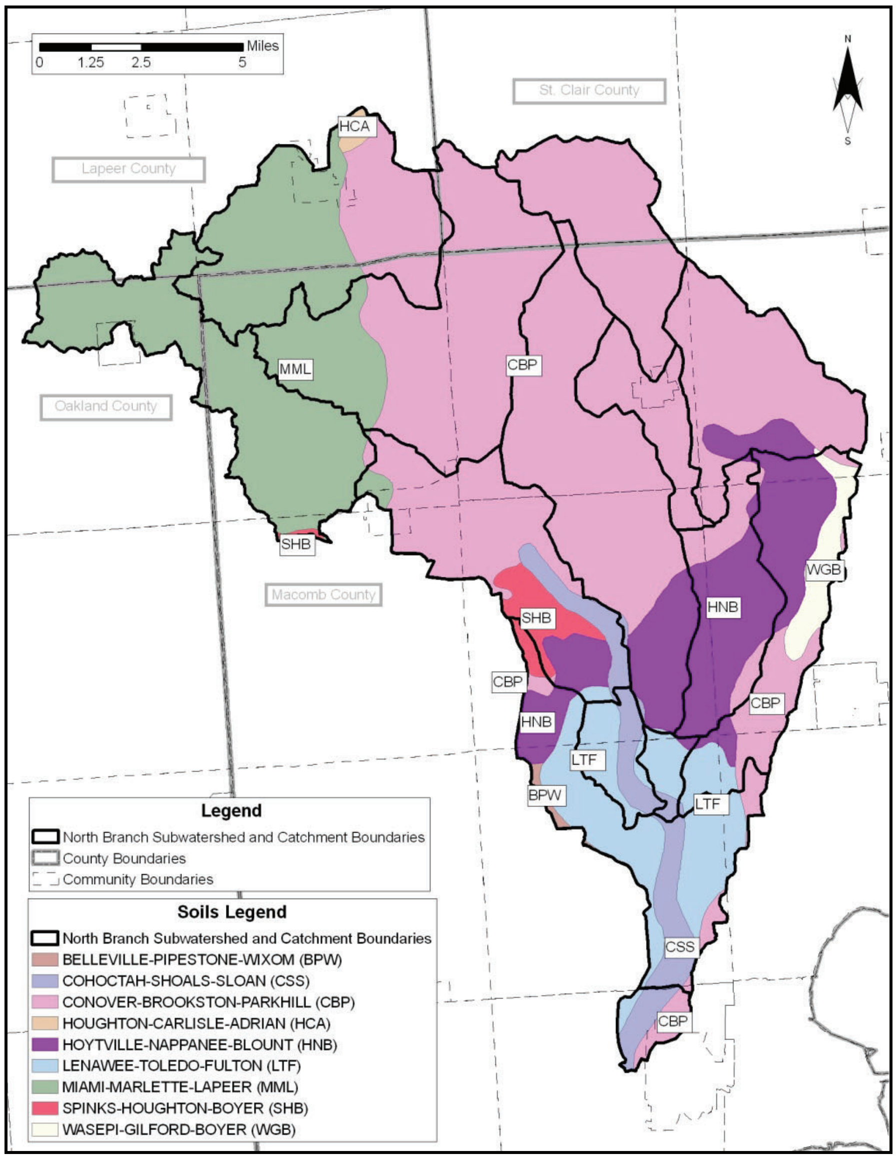
Belleville-Pipestone-Wixom (BPW) - Nearly level to gently sloping, somewhat poorly drained soils that are coarse textured or moderately coarse textured throughout; on outwash plains and lake plains.
Cohoctah-Shoals-Sloan (CSS) - Nearly level, poorly drained and somewhat poorly drained soils that are moderately coarse textured or medium textured throughout; on flood plains.
Conover-Brookston-Parkhill (CBP) - Nearly level to gently sloping, somewhat poorly drained and poorly drained soils that have a moderately fine textured and medium-textured subsoil; on uplands.
Houghton-Carlisle-Adrian (HCA) - Deep, depressional and nearly level, very poorly drained, organic soils on lake plains, outwash plains and till plains.
Hoytville-Nappanee-Blount (HNB) - Nearly level to gently sloping, poorly drained and somewhat poorly drained soils that have a dominantly fine textured subsoil; on uplands.
Lenawee-Toledo-Fulton (LTF) - Nearly level, poorly drained soils that have a moderately fine textured to moderately coarse textured subsoil; on lake plains.
Miami-Marlette-Lapeer (MML) - Gently sloping to rolling, well drained and moderately well drained soils that have a dominantly medium textured and moderately fine textured subsoil; on uplands.
Spinks-Houghton-Boyer (SHB) - Nearly level to hilly, well-drained soils that are coarse textured or moderately coarse textured throughout; on lake plains, beach ridges, and outwash plains.
Wasepi-Gilford-Boyer (WGB) - Nearly level to gently sloping, somewhat poorly drained soils that have a coarse-textured to moderately fine textured subsoil; on lake plains and glacial till plains.

Source: (USDA., 1971); (USDA., 1972); (USDA., 1982).

Soil Associations

Geologic process has resulted in almost 250 distinct soil types in the Clinton River Watershed (based on soil surveys for the four counties as interpreted through the Soil Survey Geographic – SSURGO – database developed by the NRCS). For planning purposes, it is useful to group the types into *soil associations* (landscapes having distinctive proportional patterns of soils consisting of major soil groups with some minor components). There are 17 of these soil associations in the watershed (based on the State Soil Geographic – STATSGO – database developed by the Natural Resources Conservation Service – NRCS). The 9 soil associations found in the subwatershed are shown in Figure 2-3 along with their spatial extent. These are discussed in the sidebar.

Figure 2-3. Soil associations in the subwatershed.



Source, data: (MIGDL, 2008). Catchment boundaries as modified by Tetra Tech.

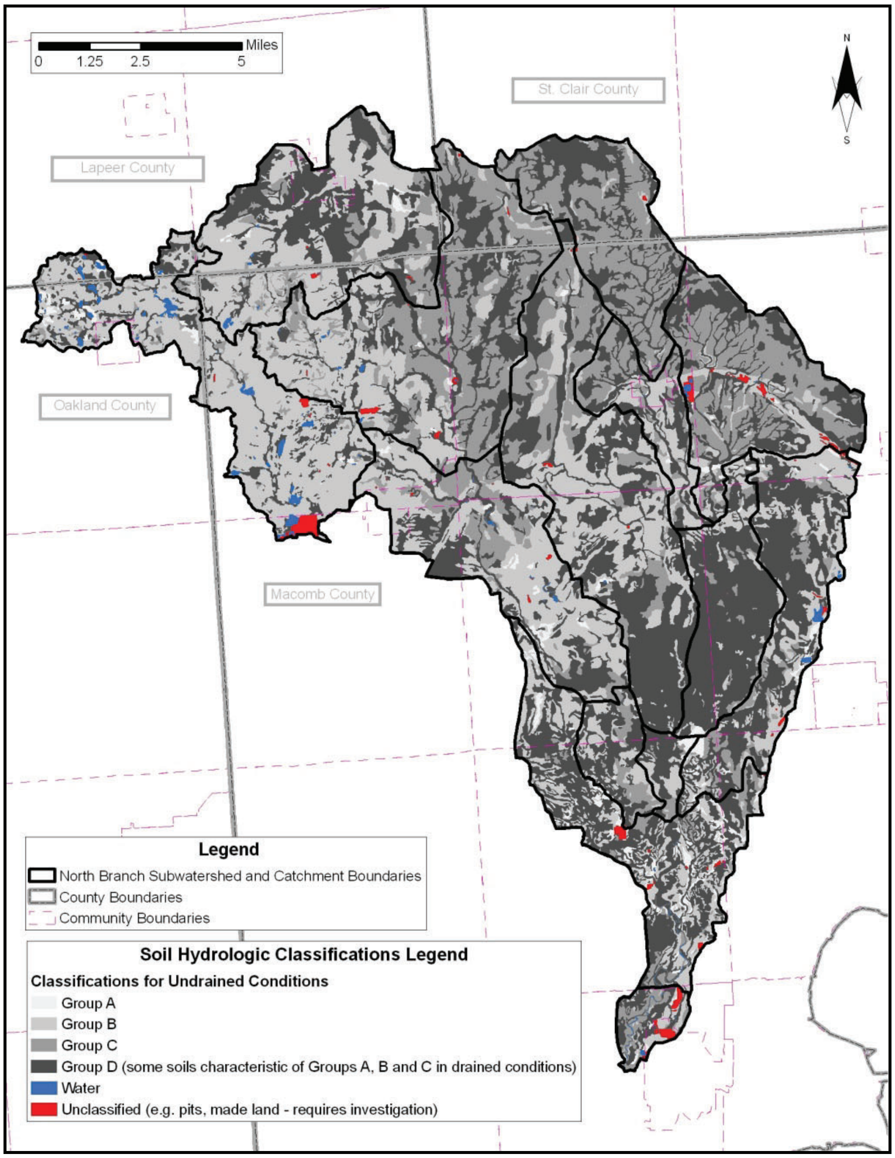
(cont'd)

Hydrologic Classifications of Soils

The subwatershed is largely flat geologic lakeplain comprised of fine clay and sand sediment layers that have generally low infiltration capacity. The more elevated, western region of the watershed is primarily coarse-textured tills that exhibit higher infiltration capacities.

A useful classification scheme to consider for soils involves their hydrologic characteristics. The usual classification scheme is one developed by the Natural Resources Conservation Service (NRCS) – see the sidebar. Figure 2-4 shows the hydrologic classification of the soils.

Figure 2-4. Hydrologic classifications of the soils in the subwatershed.



Source, data: (MIGDL, 2008); (MDEQ, 1999). Catchment boundaries as modified by Tetra Tech.

Figure 2-4 also shows areas of water, areas where the soil properties are influenced by urban development, and unclassified areas. The spatial coverage for the figure is from the NRCS Soil Survey Geographic database and the hydrologic classification (SSURGO) and are based on the *Stormwater Management Guidebook* (MDEQ, 1999). **(EPA 5.3.5, 5.4.3, 5.4.4)**

NRCS Hydrologic Soil Classifications

The NRCS system for classifying soils by hydrologic characteristics relies of four groupings:

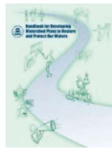
A - sand, loamy sand or sandy loam types of soils; low runoff potential and high infiltration rates even when thoroughly wetted; chiefly consist of deep, well to excessively drained sands or gravels and have a high rate of water transmission;

B - silt loam or loam; moderate infiltration rate when thoroughly wetted; consists chiefly or moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures;

C - sandy clay loam; have low infiltration rates when thoroughly wetted; consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine structure; and

D - clay loam, silty clay loam, sandy clay, silty clay or clay; has the highest runoff potential; very low infiltration rates when thoroughly wetted; consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface and shallow soils over nearly impervious material (NRCS, 1986).

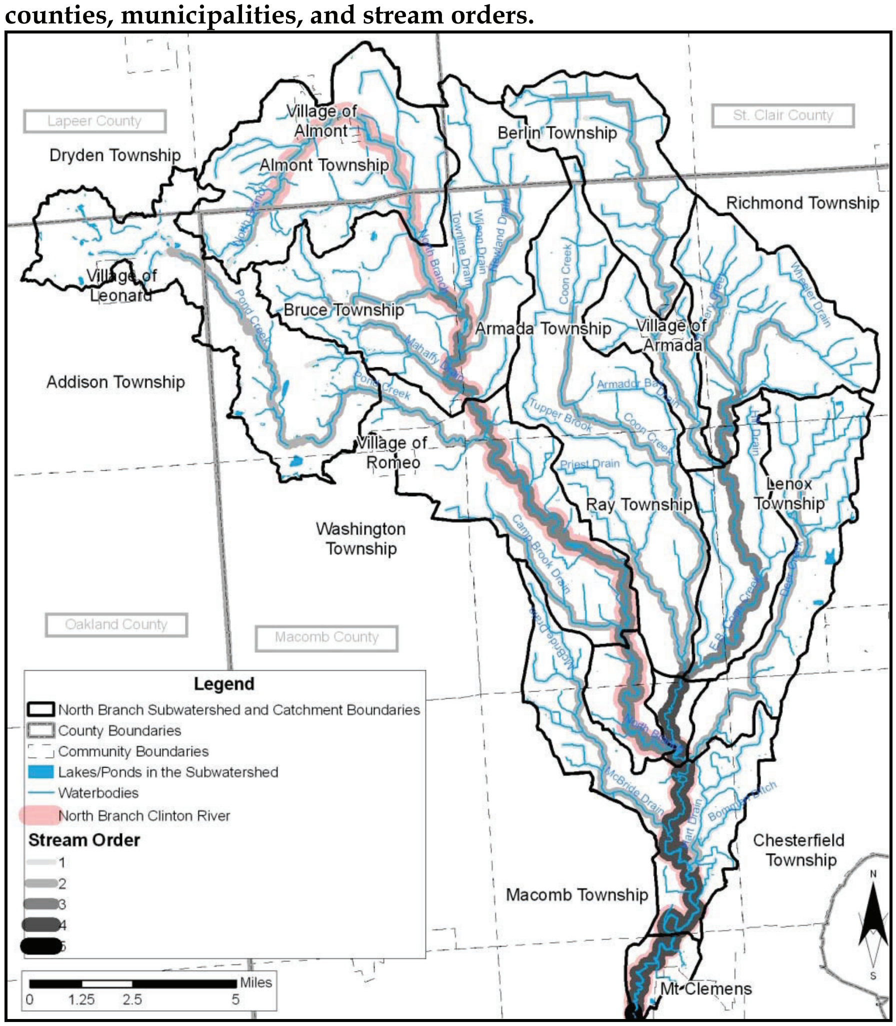
Drainage



Hydrological features in the watershed like rivers and streams (approximately 380 miles), lakes (approximately 667 acres with 10 being greater than 10 acres), and wetlands have developed over time as a result of climatic and geological conditions (terrain, bedrock, and soils). Local hydrologic 'systems' of interacting features also depend on such things as biological communities (predominantly vegetation), human developments on a global, regional, and local scale, and the interactions between surface water and groundwater.

The North Branch Subwatershed is an area of approximately 200 square miles and encompasses a great deal of Macomb County and smaller portions of Oakland, St. Clair, and Lapeer counties. The North Branch of the Clinton River drains this subwatershed, running nearly 43 miles from the headwaters in Almont and Bruce Townships to its confluence with the Clinton River in Mt. Clemens as shown in (Figure 2-5). Other waterways and additional information are also shown in the same figure.

Figure 2-5. Subwatershed and catchment boundaries, the North Branch, counties, municipalities, and stream orders.



Source, data: (MIGDL, 2008), (HSC, 2008). Catchment boundaries as modified by Tetra Tech.

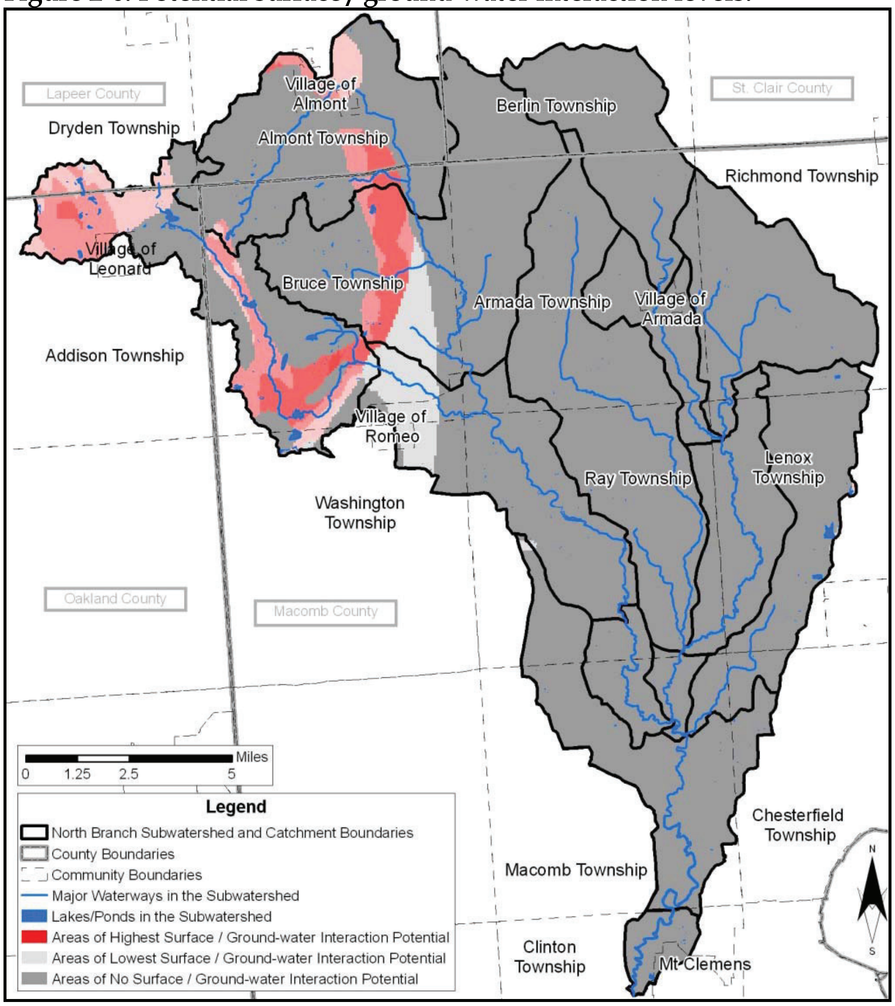
Drainage Path & Gradient
From its headwaters, the North Branch initially flows northeast through the Village of Almont where it then turns to flow south-by-southeast. The river flows in this general direction through northeastern Bruce Township, southwestern Armada Township, and the northern portion of Ray Township before it heads due south through the southern portion of Ray Township. The river meanders through Macomb Township and then flows southwest through northern Clinton Township before meeting the Clinton River. Over its journey, the North Branch drops a total of 323 ft for an average gradient (drop in elevation over distance) of 7.7 ft per mile (Francis, 2006). Gradients for NHD reaches are given on Page 2-9.

Catchment Number and Name		Maximum Stream Order
616	NB - Lower	6
615	NB - Lower Middle	5
608	Coon Creek Lower	4
613	NB Middle	3
612	NB Upper Middle	3
610	NB Upper	3
609	Headwaters	2
604	E.B. Coon Creek - Lower	3
603	Highbank Creek	3
602	E.B. Coon Creek - Middle	2
601	E.B. Coon Creek - Upper	2
607	Coon Creek – Upper	2
614	Deer Creek	2
611	East Pond Creek	2

The North Branch begins on glacial outwash sand and gravel in the northwest portion of the subwatershed then crosses end moraines of medium textured till before entering the lacustrine deposits of sand, clay, and silt. The glacial materials in the upper areas allow good groundwater transfer while the lacustrine deposits are resistant to groundwater flow.

Figure 2-6 shows the potential levels of surface / ground-water interaction throughout the subwatershed. The fine-grained glacial deposits throughout most of the subwatershed tend to restrict these interactions (gray) but there are certain areas where varying levels of interaction occurs (red denotes high, light gray denotes low).

Figure 2-6. Potential surface / ground-water interaction levels.



Source, data: (MIGDL, 2008); (Francis, 2006). Catchment boundaries as modified by Tetra Tech.

Runoff and Stream Flow

Runoff from the land controls the flow in the streams which drain the land. The flow characteristics are important to describing the condition of a stream network. As such, the United States Geological Survey (USGS) measures flow characteristics at numerous locations (or gages) throughout the country, including three in the subwatershed (and an additional nine where current data is not collected). The three current gages are on East Pond Creek, the East Branch of Coon Creek, and the North Branch itself. The locations of these three (and the other nine) gages are shown in Figure 2-7. The characteristics of flow at these locations are presented in Table 2-2.

(EPA cont'd)

Groundwater

Groundwater data for the state of Michigan is available at http://gwmp.rsgis.msu.edu/.

Surface / Ground-water Interactions

The data presented in the figure at left is based on a 'Darcy Groundwater Movement Model' developed by the Michigan Department of Natural Resources (MDNR) in 1999 for the Michigan Rivers Inventory. The primary concern for those developing the data was to identify locations where groundwater was likely to feed surface waters and thus create cold water fish habitat.

Stream Orders

Stream order is a relative measure of tributary size based on a hierarchy of tributaries. The most popular is the Strahler system (Strahler, 1952) that classifies streams from 1 (smallest) to 12 (Amazon River). The downstream reach of the Clinton River is a 6th order stream. Orders throughout the subwatershed are shown in Figure 2-5 and were calculated in the NHDplus dataset at the 1:100,000 scale (HSC, 2008). Those without orders are considered 0th order.

Average Annual Runoff

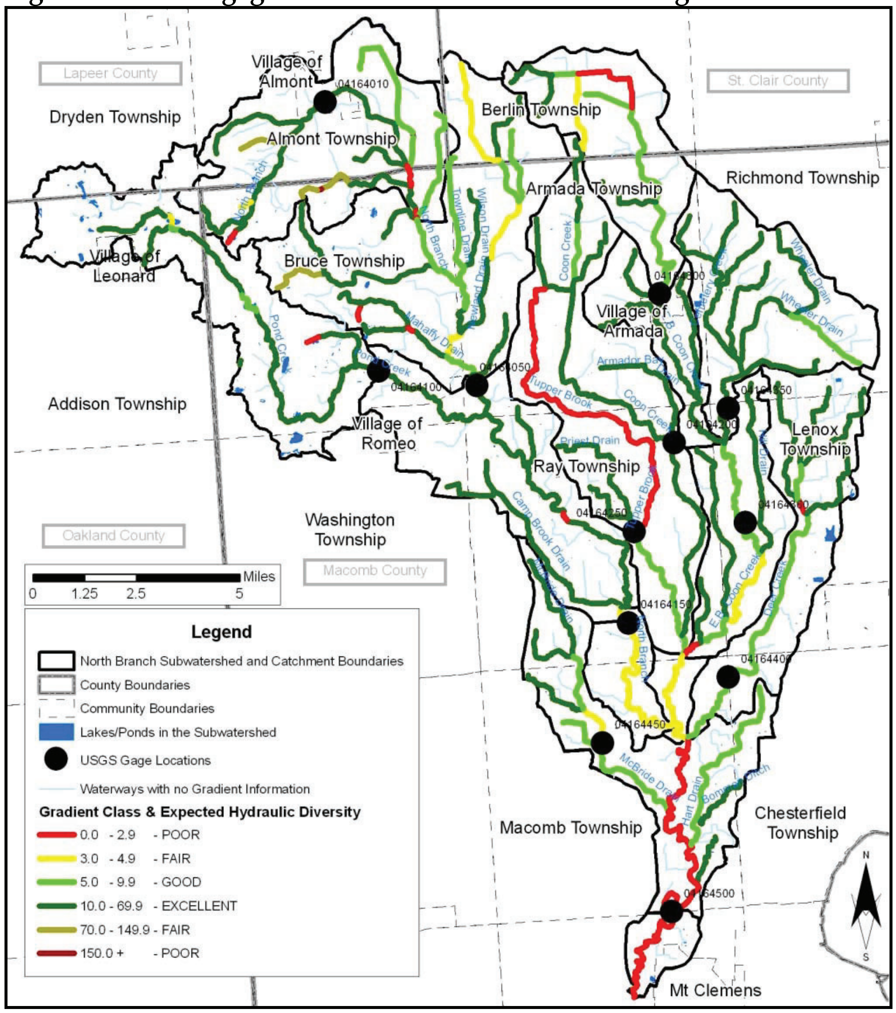
The average annual runoff in the watershed ranges from approximately 11 inches/year in the central and western/middle portion to 8 inches/year near the northeastern boundary and the subwatershed outlet (USGS, 1986).

Select Reach Gradients
The gradients for a select number of reaches in the subwatershed are given:

- North Branch – mouth to McBride Drain – 1.3 ft/mi
- McBride Drain – mouth to West Branch – 6.3 ft/mi
- North Branch – McBride Drain to Coon Creek – 2.1 ft/mi
- Coon Creek – mouth to Armada Center – 10.9 ft/mi
- E.B. Coon Creek – mouth to Highbank Creek – 2.1 ft/mi
- E.B Coon Creek – Highbank Creek to source – 10.8 ft/mi
- Deer Creek – mouth to Morton Drain – 6.7 ft/mi
- North Branch – Coon Creek to Camp Brook Drain – 4.2 ft/mi
- Camp Brook Drain – mouth to source – 17.8 ft/mi
- North Branch – Camp Brook Drain to Pond Creek – 12.1 ft/mi
- East Pond Creek – mouth to Secord Lake – 18.1 ft/mi
- North Branch – East Pond Creek to Newland Drain – 9.0 ft/mi
- Newland Drain – to 4 miles upstream from mouth – 7.7 ft/mi
- North Branch – Newland Drain to Boardman Road – 9.4 ft/mi

Source, data: (MDNR, 1988)

Figure 2-7. USGS gages in the subwatershed and reach gradients.



Source, data: (MIGDL, 2008), (HSC, 2008). Catchment boundaries as modified by Tetra Tech. USGS gage locations as generated by Tetra Tech from (USGS, 2007). See Page 2-19 for EHD scale.

Table 2-2. Characteristics of USGS gages of importance in the watershed (active gages in bold).

Waterbody	Number	Drainage Area (sq. mi.)	First Year of Data	Last Year of Data	Mean Ann. Flow Rate	Mean Flow Rate – Aug.[1]	Max. Avg. Daily Flow (cfs)	*Min. Avg. Daily Flow (cfs)*
North Branch	04164010	9.56	1962	1968	-	-	234	*0.2*
North Branch	04164050	49.7	1964	1969	-	-	1,650	*0.5*
East Pond Creek	**04164100**	**21.8**	**1958**	**Current**	**16**	**7**	**302**	***0.9***
North Branch	04164150	89.6	1967	1972	-	-	3,200	*1.7*
Coon Creek	04164200	10.0	1965	1970	-	-	320	*0.*
Tupper Brook	04164250	8.62	1959	1964	-	-	143	*0.*
E. Br. Coon Creek	**04164300**	**13.0**	**1958**	**Current**	**7**	**1**	**497**	***0.***
Highbank Creek	04164350	14.9	1965	1970	-	-	453	*0.*
East Br. Coon Creek	04164360	36.1	1967	1972	-	-	1500	*0.*
Deer Creek	04164400	12.7	1960	1965	-	-	487	*0.02*
McBride Drain	04164450	5.79	1959	1964	-	-	96	*0.*
North Branch	***04164500***	***199.***	***1947***	***Current***	***130***	***26***	***6,200***	***0.09***

1 – August is generally the month with the lowest flow
- – indicates that there is not sufficient data to make a meaningful calculation

Source, data:(USGS, 2007).

Annual Stream Flow

One reason that flow numbers are important is that the annual flow regime determines, in part, the ecological functions that will be supported and maintained.

The gage with the smallest drainage area in the subwatershed – 04164300 on the East Branch of the Coon Creek – had a mean annual discharge of 7 cubic feet per second (cfs). The average annual flow rate at the gage on the North Branch near the outlet of the subwatershed was 130 cfs. The same gages had mean flows for the month of August of 1 cfs and 26 cfs, respectively. Refer to Table 2-2 for data on the other gages. Annual discharge data for the three active gages is shown as Figure 2-8. These figures show the average flow rate for the year (at different scales) in addition to the range of average monthly flow rates (on a calendar year basis). The order of the gages in the three figures corresponds to increasing mean annual flow rates.

Seasonal Water Flow

The seasonal discharge of most rivers is variable (as shown in Figure 2-9). This is illustrated by comparing the average monthly stream flow (tick mark in the figures) with the range of monthly stream flow averages (vertical line in the figures) for the 3 current gages in the subwatershed.

The flow data shows the yearly variance in flow from January, increasing until its peak in March/April, decreasing to its lowest in August, then increasing again. Maximum discharge follows the spring thaw at all gages with minimum flows occurring in August during the driest part of summer.

Daily Water Flow

Mean daily discharge in the Clinton River vary considerably across the period of record. The largest daily maximum discharge at the North Branch gage was 6,400 cfs; the minimum was 0.09 cfs. This information can be seen for this and other gages, in Table 2-2.

Trends in daily water flow are used to assess whether significant hydrologic process changes are occurring. In the Clinton River Watershed, large portions of land have been developed in the past 30+ years; with this type of development generally leading to problematic hydrologic response (higher peak flows and velocities; lower base flows). This trend is likely to continue as land use changes in the subwatershed.

There are a number of possibilities that would contribute to an increase in discharge over time including a moderate increase in precipitation over the watershed and/or an increase in impervious surfaces. When rainwater absorbing field or forest land is replaced with impervious paved surfaces and rooftops, the result is an increase in runoff volume and peak rates which translate into the same increases in flow in nearby waterways. These impacts are discussed further in Chapter 3.

In some agricultural fields, rainwater is collected by sub-surface drain tiles and directed to a surface water body, bypassing natural evaporation, filtration, and absorption. This practice allows for better drainage on farm land and avoids the many problems associated with water saturated soil. Unfortunately, directing rainwater out of the soil via drainage tiles can also result in an increase in stream volume and flow following a rain event. **(EPA 5.3.5, 5.4.2)**

Water Budget

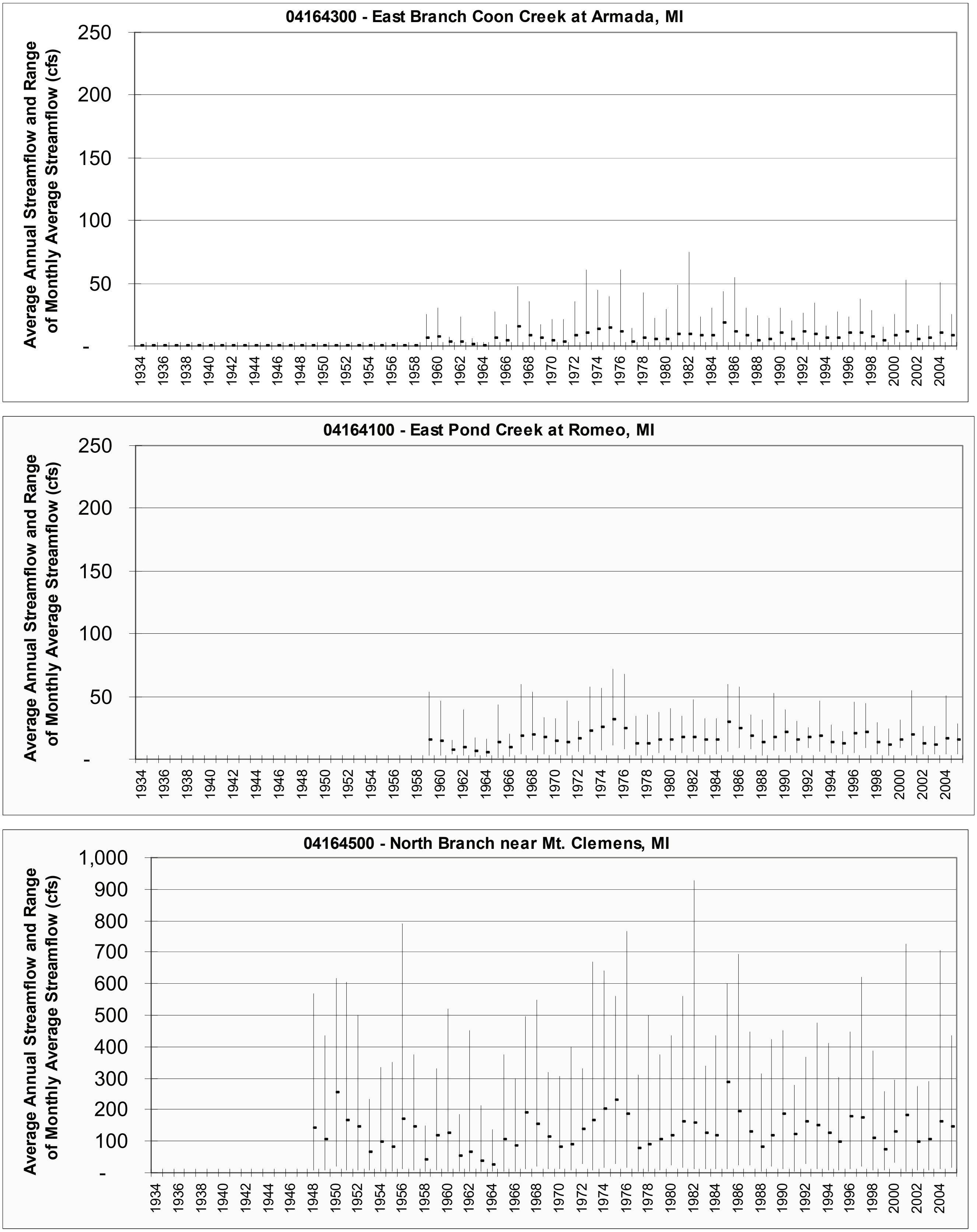
The changing water budget of the subwatershed over the year adds an uncertainty to the flow data with respect to conducting any analyses. Some notes on this phenomenon include:

- The Detroit Water and Sewerage Department (DWSD) Waste Water Treatment Plant (WWTP), which discharges to the Detroit River – outside of the watershed, serves the sanitary sewers in a portion of the subwatershed (see Chapter 5). This area has increased over the years, since the WWTP's 1940 opening, with the result of transporting a greater amount of flow (which may or may not have originated in the subwatershed) out of the subwatershed.
- Since 1974, DWSD has been utilizing a water intake from Lake Huron (in addition to the groundwater sources located within the watershed). As this is the case, a portion of the water supplied to households in the watershed is now from outside of the watershed (Francis, 2006).

Historical Flashiness

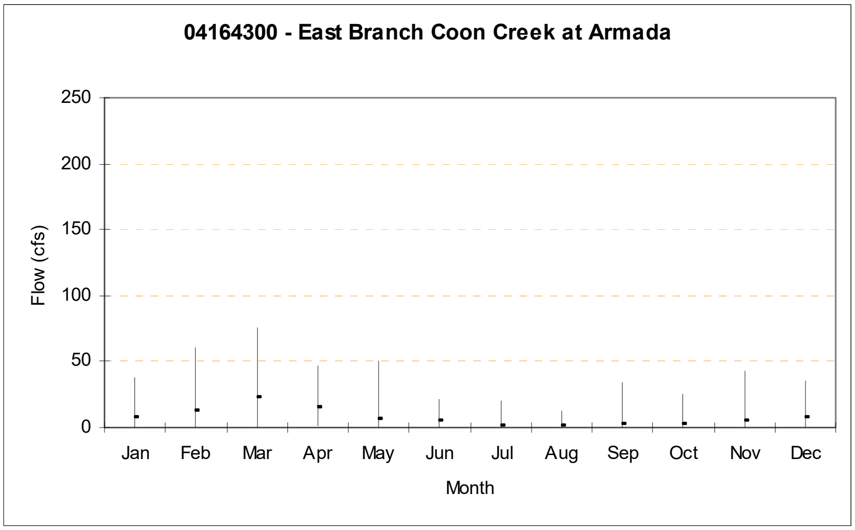
The Clinton River has been described as a naturally flashy system (fills quickly with water) because of its geography and soil types (MDNR, 1988).

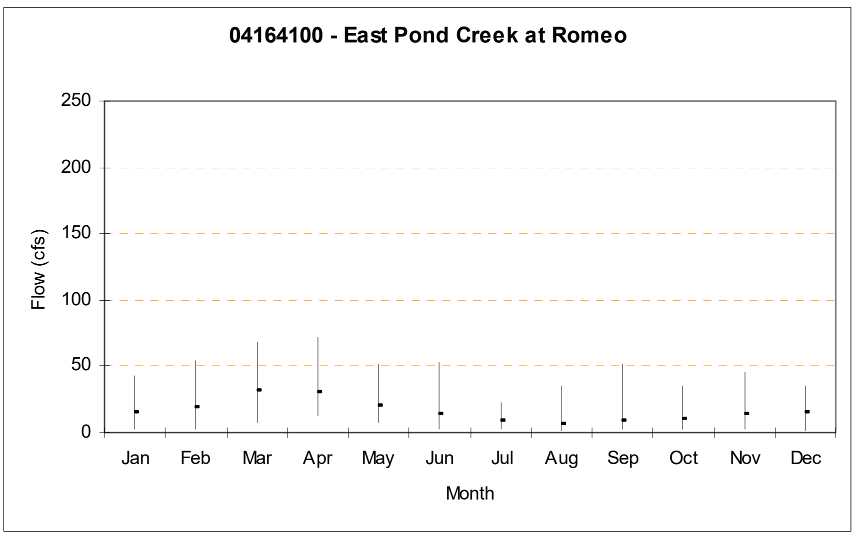
Figure 2-8. Average annual streamflow with range of monthly averages.

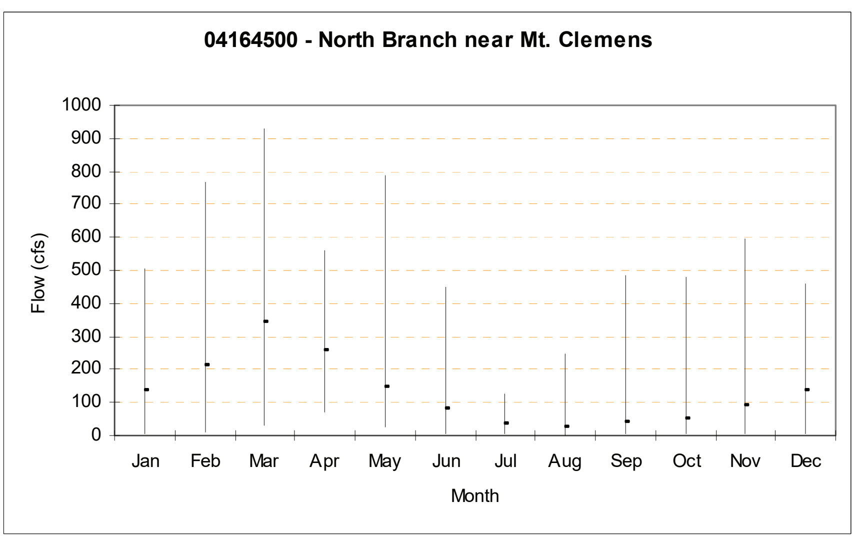


Source, data: (USGS, 2007)

Figure 2-9. Average monthly streamflow with range of monthly averages.







Source, data: (USGS, 2007)

The Riparian Corridor

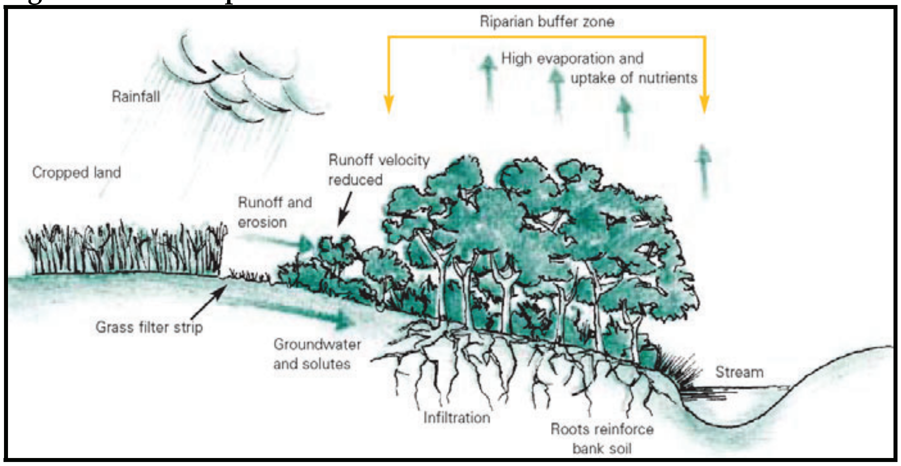
A healthy riparian zone and corridor provides numerous benefits:

- Leafy vegetation (trees, shrubs, grass, cropped land) protects the soil from the direct force of falling rain;
- The vegetation and organic matter on the forest floor act to slow runoff and erosion, thus reducing scour and allowing sediments to settle out;
- Tree limbs and organic materials falling into the water are important sources of habitat and nutrients;
- Organic materials on the forest floor act to filter pollutants from runoff flowing into waterbodies;
- The root systems of stream bank and shoreline vegetation act to encourage infiltration (thereby reducing runoff volume) and reinforce the bank by retaining the soil; and
- The vegetation and healthy, clean water provide habitat for benthic organisms, (organisms inhabiting the bottom of the aquatic environment), fish, and other wildlife.
- Provides edge or transitional habitat zones which are key areas for increasing wildlife biodiversity.

The Riparian Corridor

The riparian corridor encompasses the transition between water and land including the waterbody and its banks or shore, the surrounding lowlands (floodplain), and the fringe areas between the lowlands and uplands (see Figure 2-10).

Figure 2-10. The riparian corridor.



Source, graphic: (LWA, 2005).

Many wetlands can be found in the riparian corridor. These are discussed in detail later in the chapter.

Stream Banks, Shorelines, River Beds, and Lake Beds

Where stream banks define a river channel, a shoreline defines an impoundment such as a lake, reservoir, or pond. Natural, intact stream banks and shorelines are important because they reduce the potential for erosion and thus control migration of watercourses.

An examination of the importance of stream bank and shoreline health requires a discussion of detailed concepts outside the scope of this plan.

The result of the erosion and deposition occurring over a geologic period of time is the pattern of the stream. Although numerous types are possible, most natural channels in Michigan display a winding nature.

In this natural meandering state, streams develop extensive storage that reduces flooding. Additionally, the meandering nature of streams provides a longer flow path reducing the effective velocity and thus maintaining sediment erosion / deposition in a quasi-balance.

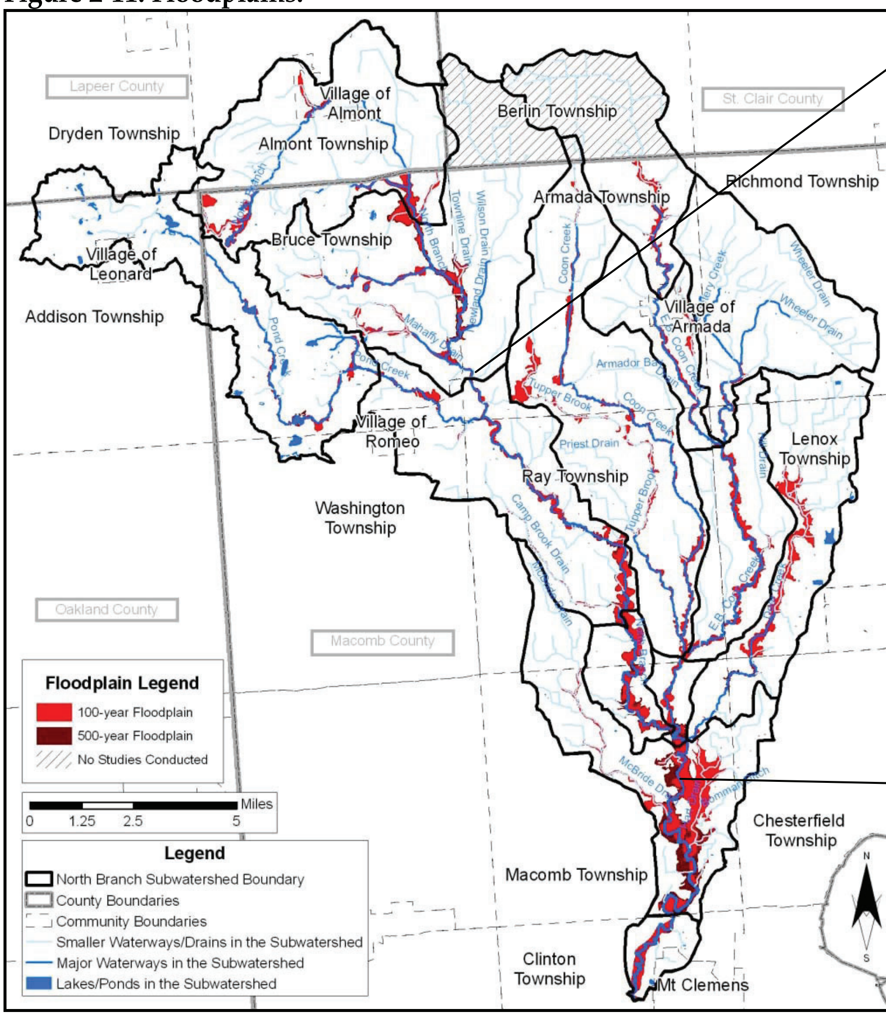
Statistically, a storm with the recurrence interval of 1.5 years is the dominant force in defining a stream channel (Leopold, 1994). This storm generally creates the 'bankfull discharge' in streams, where water stays within the defined streambanks (and does not enter the floodplain). While more extreme flows, such as the 50- or 100-year rate, transport more sediments in a single event, it is the high relative erosion potential of the bankfull discharge, coupled with its frequency, that make it the controlling flow with respect to channel formation processes.

Floodplains

All waterbodies have associated areas that will flood under various conditions; and man-made changes that affect the hydrology and hydraulics of a waterbody can exacerbate flooding problems.

As part of the National Flood Insurance Program, the Federal Emergency Management Agency (FEMA) has delineated 100-year and 500-year floodplains for many waterbodies throughout the watershed. These areas are presented in Figure 2-11. Floodplains delineations for the sub watershed have recently been updated but are not shown due to a lack of comprehensive spatial data.

Figure 2-11. Floodplains.



Source, data: (MIGDL, 2008), (FEMA, 2008) Catchment boundaries as modified by Tetra Tech..

The widest floodplains in the subwatershed occur along the North Branch, particularly in Macomb Township and southern Ray Township with some additional wide areas in Bruce Township. Other waterbodies with floodplains of note include the Hart Drain in Macomb Township, the upper reaches of Deer Creek, the East Branch of the Coon Creek through northern Armada Township and Lenox Township, and the Tupper Brook in Armada Township. Waterbodies with mapped floodplains that are not of note include: Coon Creek, Pond Creek, Apel Drain, Wilson Drain, Camp Brook Drain, and McBride Drain (among others). **(EPA 5.4.2)**

Southeast Michigan Flooding in May 2004: Before and After Photos

North Branch at 33 Mile Road

North Branch at 23 Mile Road

Photos courtesy of MCPWO.

Relationship of Modeling Catchments to 12-digit HUCs

The following lists the HUCs associated with the numbered subwatershed catchments (other waterbodies in parentheses).

601 - East Branch Coon Creek – Upper Upstream one-third of 040900030303.

602 - East Branch Coon Creek – Middle
Middle one-third of 040900030303.

604 - East Branch Coon Creek – Lower Lower one-third of 040900030303.

610 - North Branch – Upper
Equivalent to 040900030304 (Farley Drain).

609 - North Branch – Headwaters
Equivalent to 040900030301 (McKay Ditch).

611 – East Pond Creek
Upstream majority of 040900030105.

612 - North Branch – Upper Middle Downstream portion of 040900030305 and upstream majority of the western half of 040900030310 (Deer Creek, in the eastern half).

613 - North Branch – Middle
Downstream one-third of the western half of 040900030310

614 - Deer Creek
Eastern half of 040900030310

607 - Coon Creek – Upper
Upstream majority of 040900030306.

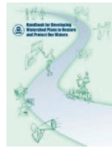
608 - Coon Creek – Lower
Downstream fraction of 040900030306.

615 - North Branch – Lower Middle Upstream majority of 040900030312.

616 - North Branch – Lower
Downstream portion of 040900030312.

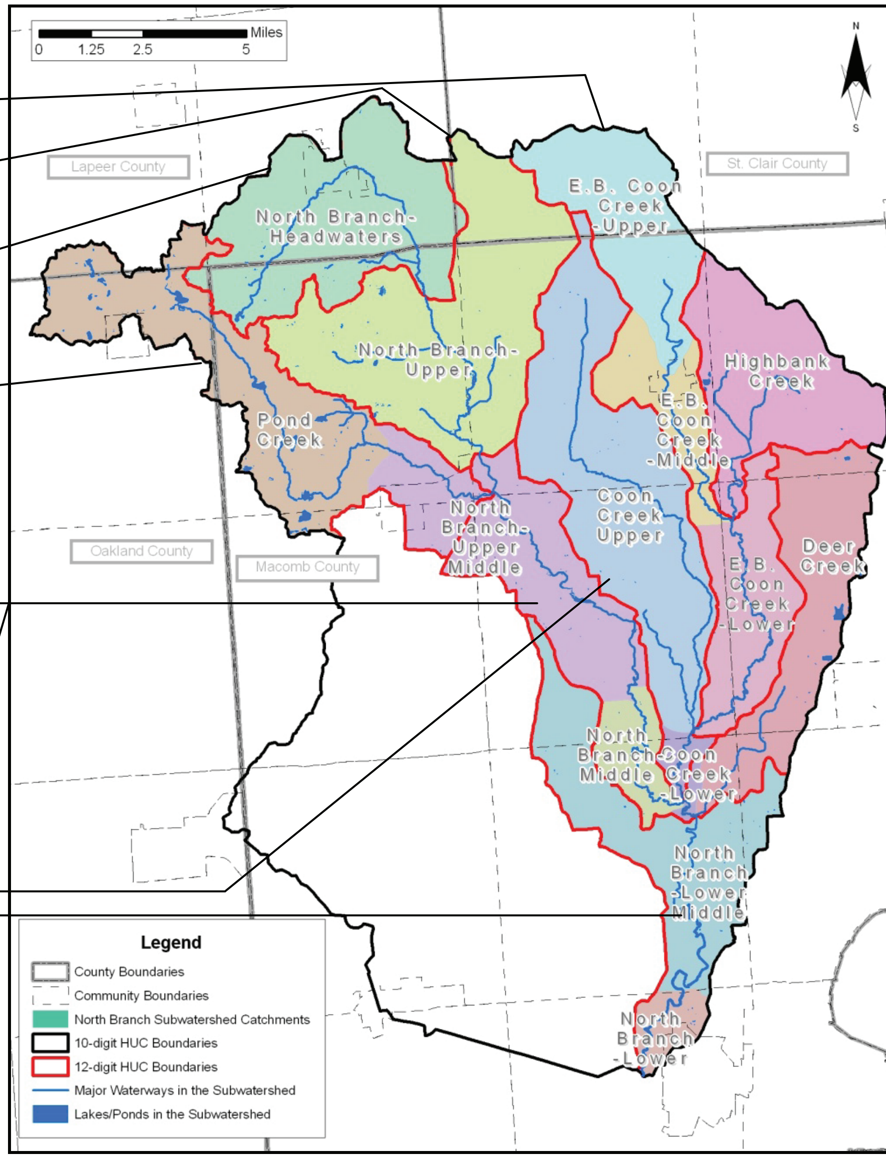
603 - Highbank Creek
Equivalent to 0409000030302.

Drainage Basins



A drainage basin can be defined as the land that drains to a common point. The North Branch Subwatershed includes all of the land that drains through the North Branch and discharges into the Clinton River. The subwatershed is further divided into catchments (smaller drainage basins) based on 12-digit Hydrologic Unit Code (HUC) boundaries with slight modifications based on the modeling performed in support of the Clinton River Restoration Plan. For a comparison of the catchments used in this plan, the 12-digit HUC boundaries, the subwatershed as a whole, and the 10-digit HUC subwatershed boundaries, refer to Figure 2-12.

Figure 2-12. Comparison of 10/12-digit HUC boundaries and modeling catchments.



Source, data: (MIGDL, 2008); (NRCS, 2008). Catchment boundaries as modified by Tetra Tech..

(EPA 5.4.1)

Ecosystem Attributes and Functions

The influences of nature dictate the distribution of plants and animals within an ecosystem. Over periods of time, these physical and biological factors determine the suitability of a habitat for a particular organism (APWG, 2006).

This section addresses these factors and distributions and presents some examples that may be encountered. A more detailed presentation of the ecosystem throughout the entire watershed can be found in the Clinton River RAP.

Ecosystem Details

Ecosystems are naturally integrated units of the landscape that can be identified and mapped. The classification of an ecosystem is based on significant differences in biotic and abiotic components within the system. The ecosystem concept provides a good framework for integrating resource management.

The document *Regional Landscape Ecosystems of Michigan, Minnesota, and Wisconsin* (Albert, 1995) defines the ecosystems of the sub watershed (and entire Clinton River Watershed) as part of the northern limit of the Eastern Deciduous Forest Biome (see the figure in the sidebar). Because of its link with forest communities located further south, it is considered part of the "Carolinian Life Zone" and many of the species found here are at the northern boundaries of their range.

The subwatershed (and entire watershed) lies within the Humid Hot-Summer Continental Division of the biome; in the Humid Temperature Domain of the division (Bailey, 1981); in the Southern Lower Michigan section of the domain; and in the Washtenaw subsection of the Southern Lower Michigan section. The Washtenaw subsection has three sub-subsections (a.k.a. region): the Jackson Interlobate, the Ann Arbor Moraines, and the Maumee Lake Plain. The dominant region in the subwatershed is the Maumee Lake Plain.

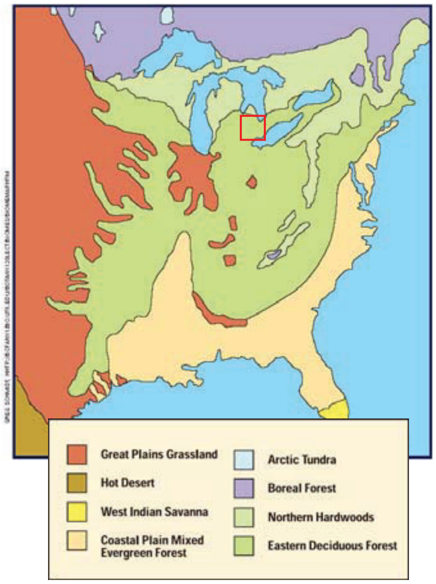
Pre-settlement vegetation of the clay lake plain areas supported upland forest and hardwood swamp. Well-drained forested areas were dominated by beech/sugar maple forest with some areas of mixed oak and hickory. Sandy areas generally had oak savanna on the uplands and wet prairie or marshes in the lowlands (Comer, 1993).

Beach ridges created by some proglacial lakes are also evident, one of which forms the eastern boundary of the watershed / subwatershed (Francis, 2006).

The pre-settlement vegetation, circa 1800, can be seen in Figure 2-13. This data is based on tree data on vegetation descriptions made by federal General Land Office surveyors between 1816 and 1818.

In the interlobate and moraine areas in the northwestern portion of the subwatershed the pre-settlement vegetation was highly variable due to the underlying differences in landform and topography. Oak barren and oak forest were present in similar amounts with a small amount of oak savanna also present. A small amount of hardwood swamp and conifer swamp was also present. **(EPA 5.4.8)**

Ecosystem Regions in the Eastern United States



Note: the location of the Clinton River planning area is shown with a red square:

Source, graphic: (Appel, 2003).

Present Day Conditions

There is a long history of land use by humans, beginning with Native Americans, who farmed areas of the lake plain. Additionally, the clay areas of the lake plain were among the first areas in the State farmed by European settlers. The intensive farming efforts only left small tracts of forest remaining, usually only 40 to 80 acres, and generally in the steeper areas.

Those oak savannas and barrens not converted into agriculture were allowed to grow into closed canopy oak forests due to fire suppression.

More recently, residential and commercial development has been converting farm land and the remaining forested lands. This development has resulted in rapid eutrophication of lakes and degradation of many wetlands, including altered hydrology (Albert, 1995).

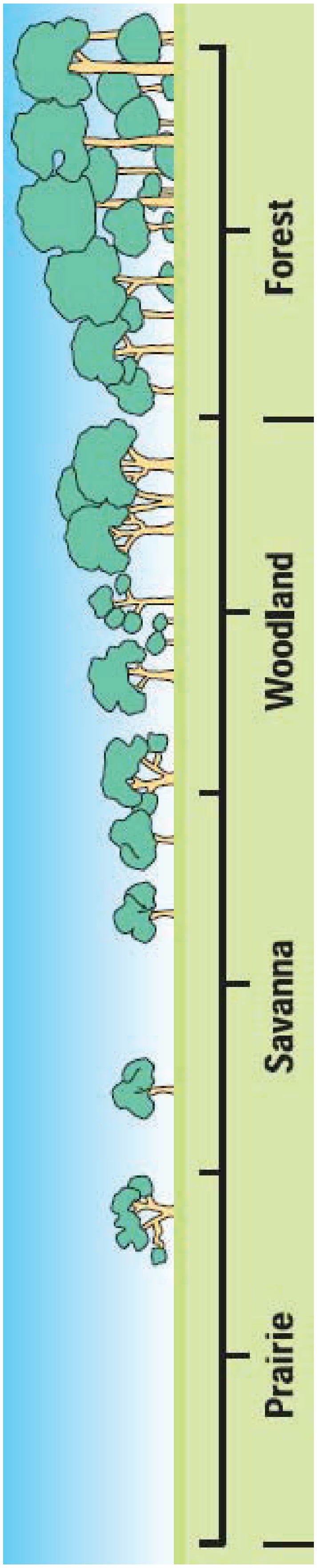
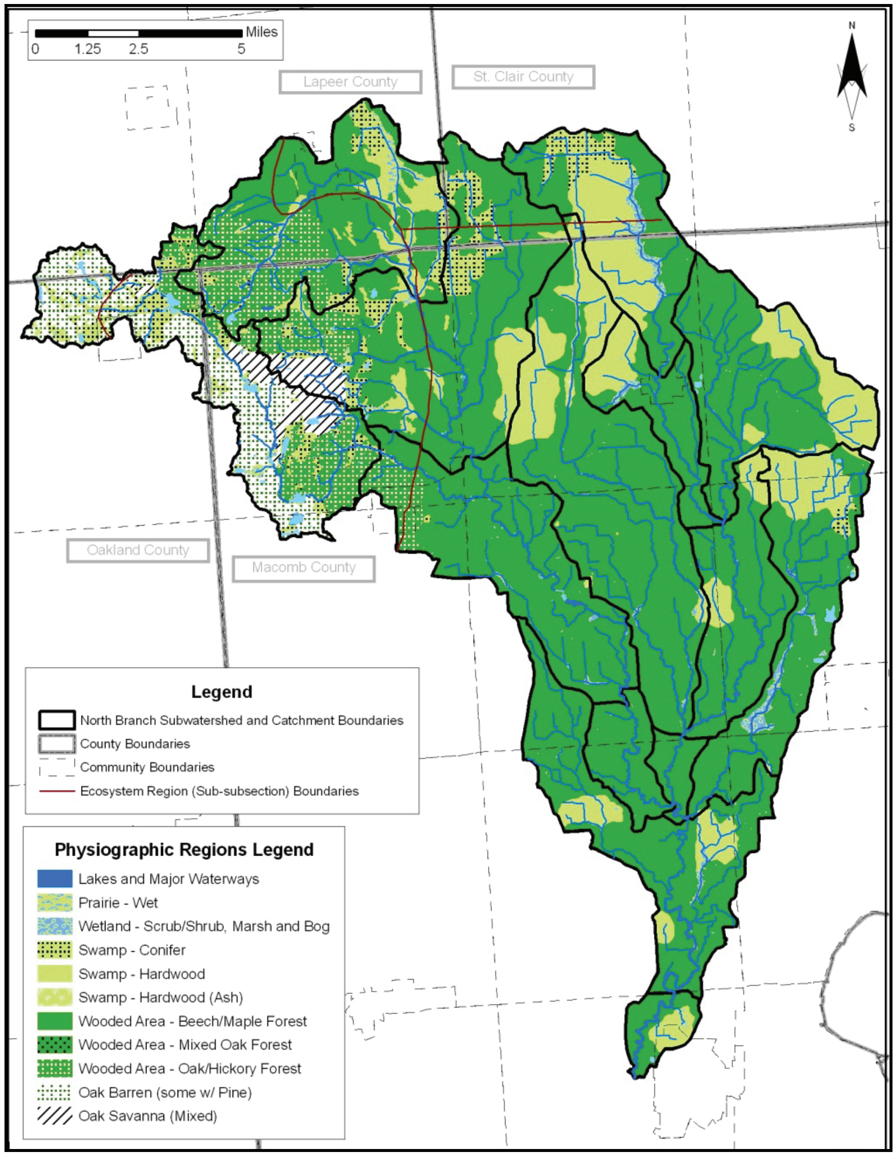
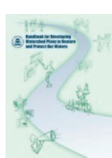


Figure 2-13. Pre-settlement vegetation in the subwatershed (circa 1800).



Source, data: (MIGDL, 2008). Catchment boundaries as modified by Tetra Tech..

Summary of Present Day Flora and Habitat in the Subwatershed



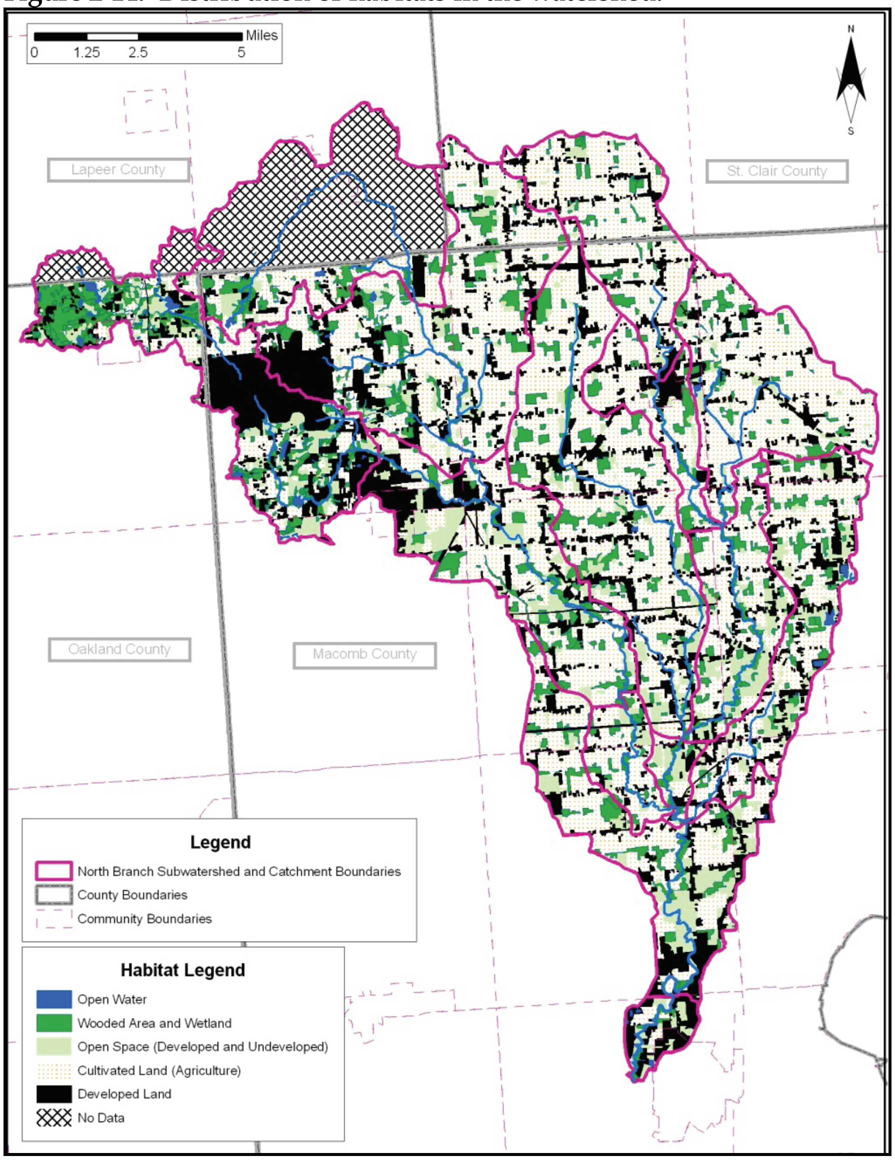
The natural characteristics of the Clinton River Watershed provide a place that supports an abundance of plant life. In turn, the plants support an abundance of animal life. Plants are primary producers, utilizing sunlight to produce energy and growth while providing energy for organisms that consume them. This relationship is referred to as a food web. An example of the food web is given in the sidebar figure on the following page. Additionally, organisms utilize plants in a physical sense, as shelter.

Development, including logging, clearing for farming, and urbanization, has resulted in the loss of most of the original natural habitat in the subwatershed.

(cont'd)

Despite this, the region is important as habitat for many rare species. Of the natural habitat remaining, the most abundant is the wooded area; although very little natural terrestrial habitat remains. In terms of water habitat, the subwatershed has river/stream habitat. A map of the distribution of current habitats can be seen in Figure 2-14. The habitat classifications are based on land use data for the year 2000 provided by the Southeast Michigan Council of Governments (SEMCOG).

Figure 2-14. Distribution of habitats in the watershed.



Source, data: (MIGDL, 2008), (SEMCOG, 2005). Catchment boundaries as modified by Tetra Tech..

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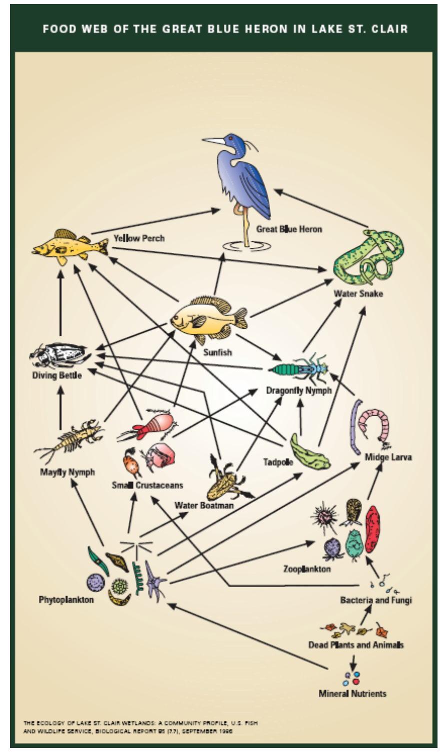


Primary Producers
phytoplankton, periphyton and aquatic macrophytes

Primary Consumers
zooplankton, mussels, snails, crayfish and aquatic insects

Secondary Consumers
minnows, gizzard shad, emerald shiner, frogs and turtles

Tertiary Consumers
muskellunge, white bass, walleye and northern pike

Quaternary Consumers
osprey, tern, bald eagle, great blue heron, raccoons and humans

Decomposers
invertebrates, bacteria and other microorganisms

Source, graphics: (Appel, 2003).

Hydraulic Diversity

The greater the number of different velocities and depths (a.k.a. 'hydraulic diversity'), the larger number of species or life stages that a river or stream reach can support. Hydraulic diversity is found to be directly related to a comparison of channel cross section versus the expected cross section based on flow characteristics. This is because channel morphology is determined by channel material, stream flow and velocity, and in-channel structures. Unstable flows will create flood channels that are over wide and shallow during average-flow periods. Unusually narrow channels are produced by bulkheads or channel dredging. Abnormal sediment loads (either too much or too little) will also modify channels by causing deposition or erosion. Bridges, culverts, bank erosion, channel modifications, and armored substrates will cause deviations from expected channel form.

As such, natural channels typically provide better habitat than degraded or manipulated channels. Hydraulic diversity is gauged on the Shannon-Wiener index (Francis, 2006): Poor = 0–1.5; Fair = 1.6–2.0; Good- 2.1–2.5; and Excellent >= 2.5.

Gradient Classes

- 0.0–2.9 ft/mi = LOW; mostly run habitat with low hydraulic diversity;
- 3.0–4.9 ft/mi = FAIR; some riffles with modest hydraulic diversity;
- 5.0–9.9 ft/mi = GOOD; riffle-pool sequence with good hydraulic diversity;
- 10.0–69.9 ft/mi = EXCELLENT; well established, regular riffle-pool sequences with excellent hydraulic diversity;
- 70.0–149.9 ft/mi = FAIR; chute and pool habitats with only fair hydraulic diversity; and
- >150 ft/mi = POOR; falls and rapids with poor hydraulic diversity

Wooded Areas

Historically, forests and woodlands dominated the subwatershed with a Beech/Maple climax forest predominating in the damp, rich soils of the lake plain, till plain, and moraine ridge geology. Transitional oak savannas and barrens were present in the northwestern portion of the subwatershed (in gravelly/sandy moraines and glacial outwash). Savanna and barren areas that were not destroyed by farming or development have generally progressed to woodland habitat due to fire suppression.

The wooded areas that remain today are disjointed and the habitats are fragmented. Some habitats are artificially maintained; meaning organic matter that enriches the forest floor is often removed. Additionally, fire suppression has resulted in the proliferation of fire-intolerant species. In some areas, abandoned farmland is returning to wooded cover.

Wetlands / Open Water

Wetlands are lands where saturation with water is the dominant factor determining soil types, plant communities, and animal communities (Cowardin, 1979).

Wetlands are often found in riparian and headwater areas and provide the essential ecosystem defined in the sidebar. They are important areas of transition between water and land that act as buffers, absorbing wave energy and reducing stream bank and shoreline erosion (Appel, 2003).

Wetlands are extremely diverse and productive biological systems that support the primary producers of the aquatic food chain.

Wetlands in the watershed are discussed in depth in Chapter 5, including the four main types of wetlands.

Rivers and streams are an open water habitat type that is comprised of several different micro habitats. These micro habitats include:

- Riffles – shallow areas where rocks break the surface and aerate the water;
- Runs – fast, deep areas where the water surface is turbulent;
- Pools – wide, deep areas with slow currents that occur between riffles and runs.
- Meanders –Winding areas that dissipate flow energy (i.e. velocity).

The availability of these habitats and the quality of the species in them is directly related to the hydraulic diversity of the reach.

The gradient of a stream also impacts the available habitat features, and as such, the hydraulic diversity. Standard gradient classes and their feature and diversity relationships found in the sidebar (Francis, 2006).

Temperature is also a critical factor affecting aquatic organisms in stream habitats. An important component of temperature regulation is groundwater inflow, which tends to be cool and thus lower temperatures.

(cont'd)

Throughout the subwatershed, urbanization, development in the floodplain, degradation and elimination of a natural riparian zone, stream channelization, filling of wetlands, and installation of drainage systems for agriculture and urban development have contributed to wetland / open water habitat degradation both through direct actions (e.g. filling) or the compounded impacts of many actions (i.e. flow instability).

Open Space

Open space in the subwatershed is generally developed land that is covered by turf grasses or other maintained cover such as parks and sporting fields. Other open space may include fallow cultivated land.

The rarest open space type is the natural prairie habitat (over 99% of original prairie lands in Michigan have been lost). Prairies contain an abundance of species dominated by prairie flowers / grasses and sedges with few or no trees. They are an important habitat for many, supporting more biodiversity than any other type of terrestrial ecosystem (Appel, 2003) Refer to the sidebar for additional discussion on prairies.

Cultivated Lands

Cultivated lands are abundant in the subwatershed and include lands that have been planted, tilled or harvested. Historically, agriculture was the primary cause of habitat fragmentation (isolated patches of habitat are created) and has caused the decline of about 40% of local endangered species. Fencerows, windbreaks, and shelter belts between agricultural fields, along with vegetative buffers along stream corridors, provide both food and cover for animals and birds, along with vital linkages between larger habitat patches (GLC, 2004).

Developed Lands

Developed lands range from urban centers to suburban residential neighborhoods. In developed lands, constructed materials make up at least 50 percent of the surface area. High intensity development generally has little habitat value, although numerous species have exhibited the ability to survive in these lands. Areas that do provide habitat can be particularly significant given the relative scarcity of alternatives. Natural areas in urban parks can serve as critical ecological corridors when they link to larger patches of habitat outside the urban core (GLC, 2004). Developed lands are primarily in the southern portion of the subwatershed.

It is interesting to note that tree canopy is essential to environmental and economic health in human society. Tree canopy reduces energy needs through its cooling effect, increases property values, improves air and water quality, reduces the cost of stormwater control, and contributes to a more beautiful, friendlier, and livable community. "The benefits represent hefty dollar amounts, many millions to big cities even after the costs of tree management, which average less than 1 percent of municipal budgets. Psychological benefits, too, are worth plenty. People simply feel better and kinder around trees. Trees bring birdsong. They provide privacy and a sense of protection. Hospital patients exposed to trees heal faster, feeling less pain." (Plotnik, 2000)

(EPA 5.4.6)

Additional Wetland Types

In addition to the 'traditional' wetland and open water habitats, there are several other types of wetland habitats. The first is the floodplain. These areas of periodic inundation often support other wetland types and even the drier areas have characteristic vegetation that may differ from more upland areas due to the influence of the waterbody (Cowardin, 1979). The second is the riparian zone; the transition from a waterbody to upland areas. The width of a riparian zone is variable, but invariably includes portions of the floodplain. This unique habitat includes diverse plant communities adapted to fluctuating water levels and provides an important migratory corridor for wildlife in an increasingly fragmented natural landscape. Approximately 70 percent of all terrestrial animal species use riparian zones at some point in their life cycle (GLC, 2004). Additional discussion on the riparian corridor and floodplains begins on Page 2-13.

Open Space - Prairies

Prairies were the first to yield to and be drained for farming practices in the early 1800s. Some of the prairies that were not drained have disappeared as fire suppression has allowed woody species to invade and begin the succession to wooded habitat (Appel, 2003). In fact, in Southeast Michigan, 122,245 acres of combined prairie and oak savanna existed prior to European settlement, but less than 800 total acres remain today (Appel, 2003). It is not known for certain if any ecologically significant prairie habitat exists in the subwatershed.

Headwaters

The smallest waterways, the 'headwaters', are the often the small intermittent and perennial flow paths (0^{th} and 1^{st} order) that drain the most upstream areas of a watershed. They are present, to varying degrees, throughout the subwatershed (more than 200 miles) – not just where the North Branch begins, but as the small flow paths that contribute to all of its tributaries. Flows through these unmapped channels feed the larger waterways.

Headwaters, although not often seen or recognized, provide many of the benefits that scientists call "ecosystem services", including (SC, 2003):

- Natural flood control through:
  - o dampening the effects of impervious cover; and
  - o providing storage and slow release, evaporation, and/or percolation of water;
- Maintaining water supplies by:
  - o Providing groundwater filtering and recharge; and
  - o Maintaining surface water flow levels;
- Trapping excess sediment;
- Cleansing/transforming nutrients;
- Recycling organic matter; and
- Maintaining biological diversity by:
  - o acting as habitat and spawning / mating grounds; and
  - o supporting populations that will later re-colonize impaired downstream waters as they improve.

Wetlands, which are discussed later in this chapter, are often found in headwater areas and provide many of the same ecosystem services.

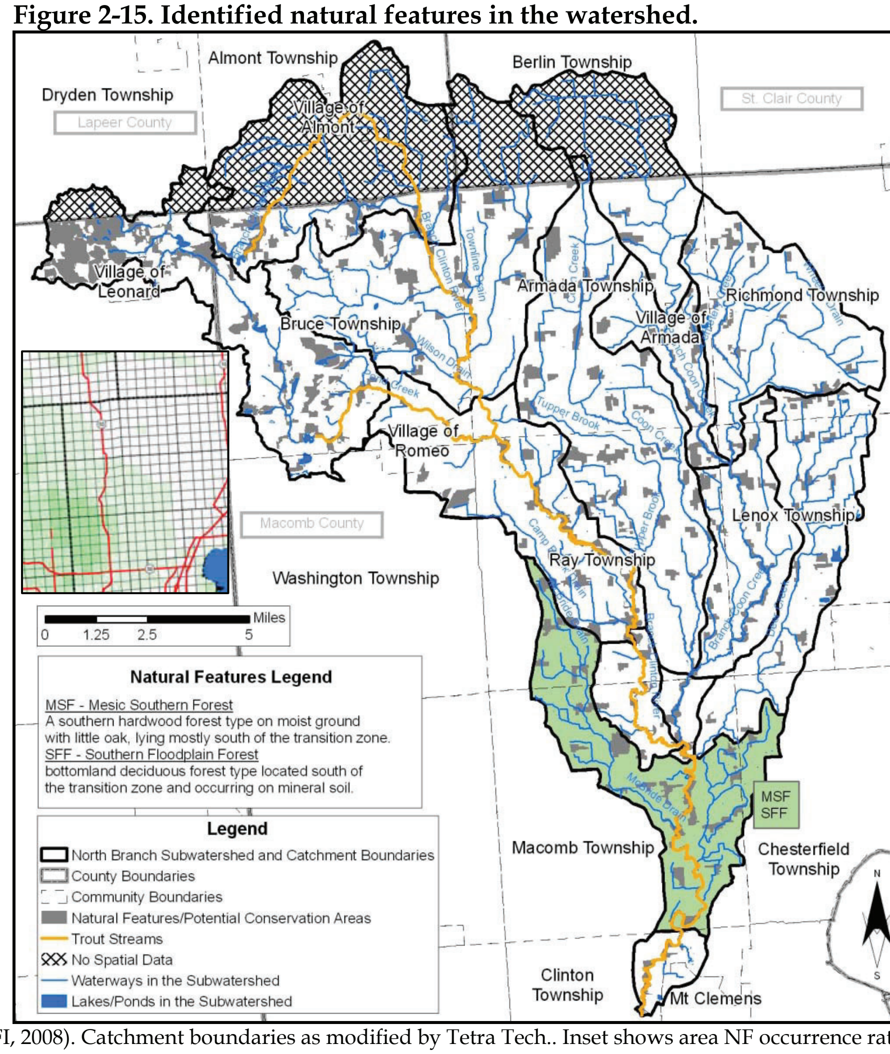
Natural Features Information

Natural features include elements of the natural environment that are recognized as valuable resources (i.e., communities, habitat, geological features, and waterbodies). This discussion focuses on those in which unique features exist.

Unique landscapes and environments provide an abundance of wildlife habitat and the protection of these areas has been directly linked to long-term water quality, especially in urban centers. The Michigan Natural Features Inventory (MNFI) has documented these valuable resources on a statewide basis and has assisted both Oakland (OC, 2004) and Macomb Counties (MCPED, 2004) in performing a detailed spatial identification of these features, known as potential conservation areas.

Figure 2-15 shows the distribution of these natural features / potential conservation areas including those subwatershed catchments identified by the MNFI as having various natural features (the most detailed scale of information available) according to the MNFI website. The MNFI overlay is only meant to indicate that the natural feature exists in the particular catchment; it is not meant to infer that all of the potential conservation areas are classified as such. The feature descriptions are taken from an MNFI document as referenced.

Figure 2-15. Identified natural features in the watershed.



Source, data: (MIGDL, 2008), (MNFI, 2006); (MNFI, 2008). Catchment boundaries as modified by Tetra Tech.. Inset shows area NF occurrence rate.

Fauna and Other Organisms of the Subwatershed

The vegetative habitats of the subwatershed support distinct animal populations. However, most animals rely on multiple habitat types to sustain their lifecycles (i.e., birds may nest in trees but feed on prey from the water). The general types of animals encountered in the subwatershed are discussed below.

Mammals

Mammals are warm-blooded animals that give birth to live young and include such organisms as bats, mice, squirrels, raccoons, and deer. Mammals are generally terrestrial but some such as beavers and muskrats are highly dependent on aquatic habitat. The watershed supports a diverse mammal population. A complete list of the mammals found in the Clinton River RAP.

Birds

Birds are warm-blooded animals that lay eggs and have wings for flight. Birds occupy an abundance of habitats including terrestrial and water-reliant and often migrate between winter and summer locations. The Lake St. Clair corridor, which includes a portion of the subwatershed, supports an abundance of globally significant waterfowl. The subwatershed is also an important migratory pathway for hawks. A complete list of breeding birds encountered in the Clinton River RAP. Scientific names can be found in the Clinton River Assessment (Francis, 2006).

Reptiles

Reptiles are cold-blooded animals that typically lay eggs and have scaly coverings. They typically utilize both terrestrial and aquatic habitats and are very sensitive to habitat fragmentation (thus their scarcity in urban/suburban settings). Snakes and turtles are two examples that may be encountered in the Clinton River Watershed. A complete list of reptiles encountered in the watershed in 1997 is presented in the Clinton River RAP.

Amphibians

Amphibians are cold-blooded, smooth skinned animals that undergo an aquatic larval stage. Like reptiles, they utilize both terrestrial and aquatic habitats and are sensitive to habitat fragmentation. Amphibians that may be encountered in the watershed include: frogs, skinks, newts, and salamanders. Many are rare and have experienced declines in their populations, making them in imminent danger of disappearing from the wild (USACE, 2004). A complete list of the amphibians encountered in the Clinton River Watershed in 1997 is presented in the Clinton River RAP.

Fish

Fish are aquatic, cold-blooded animals that breathe oxygen through gills.
A complete list of the fish historically encountered in the Clinton River Watershed is presented in the Clinton River RAP. A list of those encountered in 2001 and 2002, and the scientific names for all of these fish, is available in the Clinton River Assessment (Francis, 2006).

Macroinvertebrates

Macroinvertebrates are organisms without backbones that are large enough to see with the naked eye. One example, insects, perform important functions in ecosystems such as pollination and organic matter

Fish and Wildlife Service

The regional Fish and Wildlife Service (FWS) office was contacted to obtain data specific to the subwatershed. Although there is data available for other areas of the Clinton River Watershed, the FWS did not have any habitat conservation plans or other data available for the North Branch Subwatershed.

Zooplankton

Zooplanktons comprise the animal portion of the plankton community and are the most numerous animals in open waters. Zooplanktons prey on phytoplankton and subsequently provide a food source to other organisms. In this manner, nutrients are transmitted to higher organisms including macro-invertebrates, and planktivorous fish.

Fungi

Fungi, such as mushrooms, decompose organic matter, making nutrients from dead plants available for future plant growth (Appel, 2003).

Bacteria

These single-celled organisms exist in nearly all habitats in the world. They play important roles in the cycling of carbon, nitrogen, and sulfur in the environment. While many bacteria assist in the life cycles of humans, many have the potential to cause disease. These are of interest in terms of water quality (UCB, 2005).

decomposition. The larval stages of many are benthic (live at least part of their life cycle underwater within or upon the substrate).

An important example of a benthic organism is the mayfly; swarms of which can be seen around water during the summer. Mayfly nymphs feed on decaying plants and are an extremely important food for fish. The flying adult is eaten by birds. These insects are highly sensitive to environmental pollutants and thus good indicators of water quality. Populations of these organisms are often documented and analyzed during water quality assessments.

Another example of a benthic organism is the freshwater mussel. These mollusks have limited mobility and breathe and feed by filtering water through their gills. The reproduction of most mussels involves a parasitic larval stage that requires host fish. Due to their limited mobility and reproductive cycle, they are highly sensitive to disturbances in flow, poor water quality, and fish populations. Virtually all of the species that are listed as endangered, threatened, or of special concern in Michigan are confined to the waters of Southeast Michigan. Historically, Lake St. Clair and its tributaries have been home to large diverse populations of freshwater mussels (with over 30 species documented). **(EPA 5.4.7)**

Invasive Species

A native species is one that occurs in a particular ecosystem without direct or indirect human actions (APWG, 2008) . Organisms are considered non-native when they are encountered beyond their known historical natural ranges. Those non-native species that disrupt the ecology of natural ecosystems by displacing native plant and animal species are considered ‘invasive’. Invasive non-native organisms reduce the amount of light, water, nutrients and space available to native species, alter hydrological patterns, soil chemistry, moisture-holding capacity, and erodability, change fire regimes and are one of the greatest threats to the natural ecosystems of the U.S. (Randall, 1996). Some exotics are capable of hybridizing with native plant relatives, resulting in unnatural changes to a plant's genetic makeup while others have been found to harbor plant pathogens (McElrone, 1999). Some contain toxins that may be lethal to certain animals.

Many invasive species have been documented in or near the watershed. Examples from the Lake St. Clair Coastal Habitat Assessment (GLC, 2004) are presented in the Clinton River RAP. Invasive species of particular concern to the subwatershed are discussed in Chapter 5.

Rare Species

Most rare species are documented and protected through state and federal legislation and supporting programs. In Michigan, the documentation is officially handled by the MDNRE with field work coordinated by the MNFI.

At the federal level, the U.S. Fish and Wildlife Service is responsible for identifying and documenting rare species.

Rare animals and plants that are found in the ecosystem subsubregions that are represented in the subwatershed (Maumee Lakeplain, Ann Arbor Moraines, and Jackson Interlobate) and represent the set of rare organisms that can potentially be encountered in the subwatershed. The rare animals and plants actually documented in the subwatershed are presented in Chapter 5.

Conclusion

This chapter presented and discussed the natural environment in the subwatershed. The purpose of presenting this information was to set the baseline conditions against which future assessments will be conducted and is essential for understanding and implementing a successful WMP.

While some of the conditions in the subwatershed can be determined based on the information presented in this chapter, a deeper understanding of subwatershed conditions involves an examination of: 1) the stressors to the natural environment that cause its degradation (i.e. impairments); and documented levels of these stressors and impairments.

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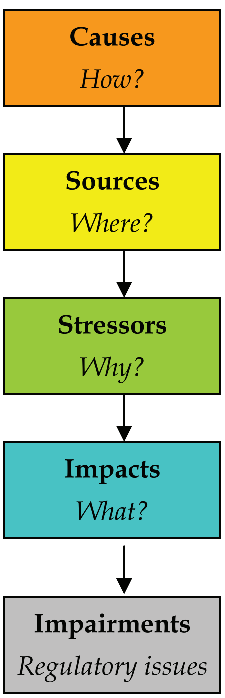
3. Environmental Stressor and Source Framework

The Need for this Chapter

Watershed management planning requires an understanding of the nature of the stressors that impact the natural environment and their sources.

Conceptual Model Framework for Causes, Sources, Stressors, Impacts, and Impairments



(EPA 4.3.1)

Acronyms and Terms

A complete list of acronyms and terms and their respective definitions can be found in Appendix A.1.

Chapter Purpose

The purpose of this chapter is to: 1) introduce the reader to the conceptual model framework that identifies the categories of data to be evaluated in the plan: causes, sources, stressors, impacts, and impairments; 2) identify the relationship between these elements; and 3) briefly discuss methods for assessing environmental conditions in general and collecting data specific to the elements of the conceptual framework.

Introduction

A conceptual model is a tool for understanding how to address impairments through watershed management planning and implementation. The basic conceptual model for causes, sources, stressors, impacts and impairments is shown in the sidebar figure.

For waterbodies where a Total Maximum Daily Load (TMDL) has been developed, it can be used to inform the conceptual model and other elements of the planning / implementation process. For impaired waterbodies without a TMDL in place, the conceptual model is useful in the planning process to define the issues for future TMDL development and in guiding actions to alleviate problems. Even non-impaired waters benefit from the conceptual model approach by identifying potential issues and focusing actions to avoid future problems.

In an example conceptual model, the lack of a natural buffer around a stream may be the **cause** of runoff from an agricultural field (the **source**) containing excessive amounts of sediment (a **stressor**) as it flows into a nearby stream and **impacts** habitat for fish and other aquatic life. If severe enough, the degraded habitat conditions may warrant being classified as an **impairment** by the appropriate regulatory agency. The definitions of these terms are expanded below.

Causes are the particular reasons that a given source contributes stressors to the natural environment. Causes help to define *how* a source introduces a pollutant or other stressor into the watershed and highlights the type of management strategy necessary to address the source.

Sources describe *where* stressors coming from. These sources are the activities, facilities, or conditions that generate the stressors that impact the natural environment. A source can be classified into one of two broad categories based on its origins:

- *Point sources* come from an easily identifiable location, such as a pipe from a waste water treatment plant (WWTP) or a ditch from a private property. Major point sources are typically regulated under permits obtained under the National Pollutant Discharge Elimination System (NPDES).
- *Non-point sources* (NPS) come from undistinguishable, hidden, or expansive areas that can collectively generate environmental stressors. Collectively, agricultural lands can be considered NPS as they may introduce sediment (from the land), pathogens (from domestic livestock), phosphorus (from manure and fertilizer), and pesticides into waterbodies. Transportation infrastructure is another example as runoff from roads can contribute dissolved solids (from road salt), oil and grease (from degraded automobile components).

The difference between non-point and point source pollutant definitions has to do with scale and certainty. A single WWTP is obviously a point source because it discharges from a discreet pipe. Also, the collection of all WWTPs in the watershed would be considered a collection of point sources because their specific discharge locations are known. Conversely, a single septic system that is known to be a source of pathogens is considered a non-point source, and a collection of septic systems in the watershed, with uncertain locations and discharge characteristics, are considered a non-point source.

Stressors are natural or man-induced things or conditions that are the reason *why* something impacts the natural environment. For example, excessive phosphorus in a waterbody may degrade habitat for desirable species by causing excessive plant or algae growth. In this example, phosphorus is a stressor even though it occurs naturally. The benefit in using the term 'stressor' instead of 'pollutant' is that it also encompasses conditions such as low flow in a stream or excessive flow variability, which are not typically defined as pollutants but can severely impact fish and other biological communities.

In some cases, the functional impact of a stressor is to create another stressor. For example, among the impacts of elevated water temperature (a stressor) is decreased dissolved oxygen (DO) in the waterbody. Decreased DO then negatively impacts fish and other biological communities in the waterbody. In this case, thermal pollution is considered a primary stressor and decreased DO is considered a secondary stressor (additional stressors are defined using the same nomenclature: e.g. tertiary, quaternary). Any level of stressor may also be considered an impact.

Impacts are the effects that a stressor has on the natural environment; or an impact defines *what* the problem is. The dividing line between stressor and impact is often hazy. The distinction between these elements is specific to the conceptual model being used. At times, it may be useful to leave the two elements linked.

Impairments are classifications of waterbodies that have impacts related to specific regulations, typically uses. For example, mercury (a stressor) bioaccumulates in fish (an impact) and is universally present in most fish in different amounts. However, when levels of mercury in the fish are significant enough, eating the fish becomes dangerous to humans. Under these conditions any related designated use (e.g. 'fish consumption' in Michigan) for the impacted reach of waterbody will be considered impaired by the appropriate regulatory agency. In some cases, an impact is assumed (although it may not be observable) when stressor levels reach a certain threshold in the environment. In this case, the conceptual model for the water resource in question may skip the impact classification and go directly from stressor to impairment.

The classifications of all of the elements discussed above are highly dependent on the specific situation being described by the conceptual model. **(EPA 2.4, 2.4.1, 2.4.2, 2.4.3)**

General Stressors

The Lake St. Clair Environmental Characterization defines a broad set of stressors that affect lands tributary to the lake. These stressors include:

- Land Development and Urban Expansion resulting in:
  - Stormwater;
  - Habitat Fragmentation and Destruction;
  - Fire Suppression;
  - Agriculture; and,
  - Soil Erosion and Sedimentation;
- Altered Hydrology resulting in:
  - Water Level Changes;
  - Draining of Wetlands;
  - Filling Wetlands and Dredging Waterbodies; and,
  - Diking and Breakwalls;
- Contaminants such as:
  - Nutrient Loading;
  - Toxic Contamination; and,
  - Sediment Contamination;
- Shoreline Modification, Shipping, and Boating associated with:
  - Vegetation Removal;
  - Shoreline Hardening; and,
  - Vessel Activity and Marina Development;
- Invasive Species including:
  - Aquatic and Wetland Invasives;
  - Terrestrial Invasives; and,
  - Potential Invasives; and
- Natural Disturbances such as:
  - Ice Storms; and,
  - Windthrow.

Obviously, not all of these stressors impact the subwatershed, nor are they necessarily at a scale appropriate for subwatershed planning. However, defining this framework allows one to see how this WMP fits into the bigger picture.

Source: (GLC, 2006)

Stressor and Source Framework

There are many different stressors that can impact the environment and any number of sources from which these stressors can originate. One can define a set of stressors and sources that encompass those most often encountered. These are presented and cross-referenced in Table 3-1.**(EPA 4.3.1)**

Stressors and Impacts

This section describes the most common stressors which can impact the natural environment and is a condensed version of the one found in the Clinton River Restoration Plan. To facilitate the analyses associated with the stressors (presented in Chapter 5), the stressors have been grouped according to 'type': chemical, physical, biological, and radiological. The individual tables of specific potential sources and their potential causes for each stressor of concern have been replaced with a master source/cause table at the beginning of the 'Causes' section. The sources associated with each stressor can still be cross-referenced through Table 3-1. **(EPA 7.2.6)**

Chemical Stressors

These are the chemicals and associated conditions that are components of, or negatively impact, a healthy natural environment. Some are necessary for life while others cause severe problems with biota or desired human activities.

Chemical stressors include compounds that contain nitrogen and phosphorus (nutrients), inorganic chemicals, organic chemicals, and metals. Fluctuations in oxygen level, dissolved solid levels, or pH in a water body are also considered chemical stressors. For a complete discussion of chemical stressors, refer to Appendix C.1.

Many toxic chemicals adhere to tiny particles that are taken up by plankton and benthos animals (bioaccumulation). These plankton and benthos are consumed by larger predators and the toxins concentrate upward within aquatic food chains (biomagnification); ultimately affecting birds, fish, and mammals. Impacts include lower hatching success and deformities in birds and amphibians as well as the loss of recreational fisheries and associated revenue, loss of food supply, impairment of drinking water supplies, and the potential for long term health impacts from ingesting contaminated organisms for humans (GLC, 2006).

Notes on Stressor and Source Framework

Not all of the stressors or sources listed in the table impact the subwatershed, nor are they necessarily at a scale appropriate for watershed planning. However, defining this framework allows one to see how this plan fits into an overall planning picture that includes the watershed-level Clinton River Restoration Plan, a comprehensive Lake St. Clair basin management plan, and myriad other programs and plans.

Physical Stressors

These are the physical characteristics of the natural environment that when altered may result in impacts to biota or desired human activities. Physical stressors include excess sediment and suspended solids, trash and natural debris, water temperature, and hydrologic/hydraulic characteristics (channel flows and water levels). Physical stressors are discussed in detail in Appendix C.1.

Biological Stressors

These are the living components of the natural environment that can cause problems for other living components, including humans. Some common biological stressors in the Clinton river watershed include invasive species and disease-causing microorganisms (pathogens). A complete discussion of biological stressors is found in Appendix C.1.

Table 3-1. General stressors and potential major sources.

Stressor Type	Stressors	Sources															
		Point Sources					Non-point Sources										
	For a given stressor, the table indicates the potential for the given source to be a primary contributor as per the legend: ● = likely; ◉ = somewhat likely; ○ = not likely but possible; and X = very unlikely. The table also works when interpreted from a source perspective. For a given source, the table indicates the likelihood of a stressor being associated with it.	A. Industrial Sites	B. Waste Management Sites	C. Contaminated Sites	D. Sewage Discharges	E. Other Businesses	F. Illicit Discharges/Spills%	G. Urban and Residential Land*	H. Transportation Infrastructure*	I. Agricultural / Cultivated Land*	J. On-site Disposal Systems %	K. Contaminated Sediments	L. Atmospheric Deposition (wind transport)	M. Soil Erosion	N. Other Human Activities%	O. Animal Sources (Non-agricultural)	P. Natural Occurrences & Disturbances
Chemical	I. Nutrients (N, P)	◉	◉	○	●	◉	◉	●	○	●	●	○	●	●	●	●	●
	II. Inorganic Compounds	◉	◉	●	●	◉	◉	◉	◉	◉	●	◉	○	○	◉	X	○
	III. Toxic Metals	◉	◉	●	◉	◉	◉	●	●	◉	○	●	◉	○	◉	X	○
	IV. Organic Compounds	◉	◉	●	◉	◉	◉	●	◉	●	○	●	○	○	◉	X	◉
	V. Oxygen Demand	○	●	◉	●	◉	◉	◉	◉	●	●	◉	○	○	○	◉	◉
	VI. pH	◉	◉	◉	◉	◉	◉	○	○	○	○	◉	○	X	○	X	○
	VII. Dissolved Solids	◉	●	◉	●	◉	◉	◉	◉	◉	◉	○	○	◉	○	X	◉
Physical	VIII. Suspended Solids / Sediment	○	◉	○	◉	◉	◉	●	●	●	●	X	◉	●	◉	X	◉
	IX. Debris	○	●	X	◉	◉	◉	●	◉	○	○	X	◉	X	◉	X	◉
	X. Temperature	●	○	○	●	◉	◉	●	◉	◉	◉	X	X	2	1	X	○
	XI. Hydrologic / Hydraulic Characteristics	○	○	X	○	○	○	●	●	●	○	X	X	◉	●	X	◉
	XII. Natural Feature / Habitat Degradation	○	○	○	◉	◉	◉	●	●	●	○	◉	○	●	◉	◉	X
Bio-logical	XIII. Invasive Species	○	X	X	X	○	X	X	X	◉	X	X	○	X	◉	◉	○
	XIV. Pathogens	○	●	○	●	◉	◉	◉	○	●	●	X	X	○	○	●	◉
Radio-logical	XV. Radiation	○	○	◉	X	○	○	○	○	X	X	○	○	X	◉	X	◉

* Includes associated land, infrastructure and activities (and stormwater runoff).

% There are limited circumstances where a source in this category could be considered a point source.

1 Other human activities such as channel widening (which leads to shallow waters) – Stressor XI – or removal of riparian shading – Stressor XII – can subsequently be the source of elevated temperature

2 Soil erosion is the source of suspended solids / sediment in water which can subsequently be the source of elevated temperature (due to increased absorption of heat by the more turbid water)

Radiological Stressors

This category includes only radiation, a form of energy that can impact natural biota or humans. Radiological stressors are discussed in detail in Appendix C.1.

Sources and Causes

As indicated in Table 3-1, the stressors can be introduced through a wide variety of sources. The sources are discussed briefly in this section. The source framework divides the sources into two main categories as discussed at the beginning of the chapter:

- Point sources – from an easily identifiable location, and
- Non-point sources – from an undistinguishable, hidden, or expansive area.

The sources can further be grouped in a number of ways. An additional way to group the stressors that is useful to the planning process in terms of land use-based versus mechanism-based. This classification scheme is discussed in the sidebar.

Additionally, the sources are invariably linked to their causes (and as indicated previously, the sources and causes are often difficult to distinguish or separate). Therefore, Appendix C.1 contains some discussion of causes within the discussion of the sources but also includes a separate section that discusses causes distinctly and links them back to the sources as appropriate. **(EPA 5.7, 7.3, 7.4)**

As with other elements of the stressor and source framework, there is uncertainty as to exactly what constitutes a point source or a non-point source. Some sources are easily classified. For example, the effluent from a WWTP is a point source. The stormwater runoff from the WWTP could also be classified as a point source (because it has a separate permit associated with it). These examples are relatively straightforward but this is not always the case. Generally speaking, whether a source is a point source or a non-point source is best done on a case-by-case basis, but the remainder of this section discusses various point and non-point sources as classified generically.

Note that although municipal separate storm sewer systems (MS4s) are regulated, require a discharge permit, and have distinct outfalls where pollutants are discharged, they are included under the discussion of urban and residential land as a non-point source because the actual sources of stressors in the urban environment are typically not precisely known and/or quantifiable.

For a complete discussion of the different categories of point sources and non-point sources, refer to Appendix C.1.

Secondary Source Classification Scheme

This classification scheme is not used extensively throughout the plan, but is useful in terms of understanding the sources.

Land Use Related
Industrial Discharges (Sites)
Waste Management Sites
Other Businesses
Urban / Residential Land
Transportation Infrastructure
Agricultural / Cultivated Land
Animal Sources

Mechanism Related
Industrial Discharges (Sites)
Waste Management Sites
Contaminated Sites*
Sewage Discharges
Other Businesses
Illicit Discharges / Spills
On-site Disposal Systems
Contaminated Sediments*
Atmospheric Deposition
Soil Erosion
Other Human Activities
Animal Sources
Natural Occurrences

* These sources deal with existing (legacy) environmental contamination.

Other Considerations

Additional groupings of sources may be required to facilitate prioritization, load calculations, management efforts, geographic location, or other assessment considerations. These groupings are utilized as appropriate in the data assessment chapter (Chapter 5) and the prioritization chapter (Chapter 7).

Assessing Environmental Conditions

Assessing environmental conditions is a required component of the Environmental Protection Agency's (EPA) nine minimum elements for watershed management plans to meet Section 319 grant funding requirements. Aside from funding program compliance, it is integral to successful watershed management and therefore to this plan. Current and future environmental conditions (with respect to stressors) must be known in order to assess whether or not the goals and objectives of this plan (as defined in Chapter 6) are being met.

This section presents parameters that are available to measure stressor conditions and programs available to collect or obtain data.

Assessment Standards

There are several methods available for assessing environmental conditions. An acceptable assessment practice involves comparing measured pollutant levels or other quantitative indicators against regulatory and other scientifically valid standards or values. This gives a glimpse into the relative health of a waterbody and this data, when compared over time, can be used to gauge trends in water quality. A number of quantifiable and qualitative standards and indicators are discussed in this section. These standards also: 1) provide a background against which to consider environmental conditions discussions presented later in the plan; 2) have been considered in the development of the goals and objectives for the plan, and; 3) have been considered in the development of the evaluation methods for the plan.

Water Quality Standards

Water quality standards (WQS) are the foundation of the water quality based pollution control program mandated by the Clean Water Act (CWA). The CWA requires that states, tribes, and territories adopt WQS to protect public health, support wildlife, and enhance the quality of life within their jurisdictions. WQS define the goals for a waterbody, serve as the basis for assessing waters, guide the establishment of designated uses, set criteria to protect those uses, help set discharge limits for National Pollutant Discharge Elimination System (NPDES) permits, establish provisions to protect waterbodies from pollutants, and are the basis for establishing Total Maximum Daily Loads (TMDLs) (EPA, 2005). Attainment of WQS helps to ensure that waters will remain useful to both humans and aquatic life. WQS also drive restoration activities as they help to determine which waterbodies must be addressed, what level of restoration is necessary, and which activities need to be modified to ensure WQS are met.

The Michigan Department of Natural Resources and Environment (MDNRE) has defined a number of WQS to establish minimum requirements which the waters of the state are to meet (Michigan, 2006). Michigan's WQS are intended to:

- Protect health and public welfare;
- Enhance and maintain the quality of water;
- Protect the state's natural resources; and
- Meet the requirements of state and federal law (including international agreements).

Key WQS, along with specifically regulated stressors (and the stressor category), are presented in Table 3-2. Only those directly related to stressors are shown. **(EPA 2.5, 2.5.1, 5.6, 5.6.1)**

Water Quality Standards and Their Relationship to the Stressor Framework

As indicated in the table on the following page, most of the stressors in the framework discussed in this chapter are associated, at least somewhat, with a WQS. Natural Feature / Habitat Degradation is not shown in the table but it is addressed, although indirectly, by most of the WQS. Hydrologic / Hydraulic Characteristics is not addressed by any of the WQS. Also, Invasive Species is not addressed by any of the WQS. However, all of the stressors have the potential to be addressed under the designated uses WQS given the broad uses defined and the non-specific manner in which they are assessed.

Table 3-2. Water quality standards.

Rule #	WQS	STRESSOR CATEGORY and Specific Stressors or Conditions
50	Physical Characteristics	SUSPENDED SOLIDS / SEDIMENT, DEBRIS; Turbidity, Color, Oil films, Floating Solids, Foams, Settleable solids, Suspended Solids, Deposits
51	Dissolved Solids	DISSOLVED SOLIDS; General Dissolved Solids, Chlorides
53	Hydrogen Ions (pH)	pH; Acids, Bases
55	Taste / Odor	Any such substances
57	Toxic Substances	INORGANIC COMPOUNDS, TOXIC METALS; ORGANIC COMPOUNDS; Arsenic, Cadmium, Chromium, Copper, Cyanide, Dieldrin, Endrin, Lindane, Mercury, Nickel, Parathion, Pentachlorophenol, Zinc, PCBs, others as listed or determined based on processes listed in rule
58	Radioactive Substances	RADIATION; Radioactivity
60	Plant Nutrients	NUTRIENTS; Phosphorus, others as determined by rule
62	Microorganisms	PATHOGENS; *E. coli*, Fecal Coliforms, others as determined by rule
64, 65	Dissolved Oxygen	OXYGEN DEMAND; Oxygen levels
69, 70, 72, 73, 75	Temperature	TEMPERATURE; Temperature
100	Designated Uses	ALL; -- refer to following discussion

Note: The WQS are subject to change at any time. Source, information: (Michigan, 2006), (MDEQ, 2000).

Water Quality Standards

The State of Michigan's water quality standards are developed and promulgated by the MDNRE's Water Bureau. The water quality standards are detailed in Part 4 of the Water Resources Protection Rules and are codified in the Michigan Compiled Laws (MCL) section 323.1041 through section 323.1117. The standards can be found directly from the Michigan Legislature's website

http://www.legislature.mi.gov/

or the MDNRE's website

http://www.michigan.gov/deq/

by following the 'DNRE Laws and Rules' link on the right hand side of the page.

The content appropriate to this plan has been included in Chapter 5.

The criteria associated with the standards range from quantitative and numeric (e.g. concentrations of stressors or surrogate indicators) to qualitative and narrative (e.g. unnatural quantities of a stressor). In some instances, the quantitative limits are variable based on certain conditions (e.g. water temperature) and must be determined based upon a specified calculation method. In some cases, the criteria may include sample weighting conditions (e.g. averaging samples over a period of days) and/or a recurrence interval (e.g. limiting the acceptable number of exceedances within a period of time, typically months or years). For stressors with impacts on humans and/or animals, criteria may also exist for both acute and chronic exposure. The state has minimal biocriteria in its standards such as with the palatability of fish (with respect to taste / odor producing substances) and the use of toxic substances concentrations in organisms in setting acute and chronic criteria. However, the MDNRE does use the results of macroinvertebrate and fish community studies when assessing the status of designated uses (discussed under the 'Designated Uses' topic) and the procedures for these studies generally rely on the presence of key indicator species, the structure of the aquatic community (abundance and diversity), and habitat conditions.

There are also numerous procedural WQS that define the applicability of standards and detail policies related to their interpretation. Perhaps the most important of these is the anti-degradation policy. This policy, required of each state, tribe, or territory, protects waters threatened by human activities that might cause degradation of water quality. Simply put, existing uses of waterbodies must be protected. For state waters of extremely high quality, resource managers must appropriately balance environmental, social, and economic interests, while ensuring that high quality waters are protected. This decision making process should be open and transparent and provide stakeholders the opportunity to become engaged and provide feedback on the management decisions for the water resource. For outstanding national resource waters, the extremely high water quality must always be protected. **(EPA 2.5.2)**

Designated Uses

Designated uses are descriptions of water quality expectation or goals. A designated use is a legally recognized and enforceable description of a use that the state wants its waterbodies (or a subset thereof) to support. Designated uses are an important subset of MDNRE's WQS and cover a broad range of concerns. The designated uses – in **bold** – include (in the order they are presented in the WQS):

- **Agriculture**– the ability to utilize water for agricultural purposes, including livestock watering, irrigation, and crop spraying;
- **Navigation** –the ability to utilize the water for navigation in watercraft of a size appropriate for the given waterbody;
- **Industrial Water Supply** – the ability to utilize water for commercial or industrial applications or for noncontact food processing;
- **Warmwater Fishery** – the ability to support a balanced, integrated, adaptive community of fish species which thrive in relatively warm water, including: bass, pike, walleye, panfish;
- **Other Indigenous Aquatic Life and Wildlife** – the ability for wildlife to utilize the water and not experience population-level impacts to mammalian and avian populations from lifetime exposure due to drinking the water or eating other organisms in the water;
- **Partial Body Contact Recreation** – the ability to utilize water for any activities normally involving direct contact of some part of the body with water, but not normally involving immersion of the head or ingesting water, including fishing, wading, hunting, and dry boating;
- **Fish Consumption** – the ability to support a fishery for human consumption;
- **Total Body Contact Recreation** (from May 1st – October 31st) – the ability to utilize water for any activities normally involving direct contact with water to the point of complete submergence, particularly immersion of the head, with considerable risk of ingesting water, including swimming;
- **Coldwater Fisheries** – the ability to support a balanced, integrated, adaptive community of fish species which thrive in relatively cold water, generally including any of the following: trout, salmon, whitefish, cisco;
- **Public Water Supply** – the ability to utilize water at public water supply intakes (and within a determined contiguous area) in a water treatment and distribution system. In addition, all Michigan waters of the Great Lakes and connecting waters shall meet the human cancer and human noncancer values for drinking water. The requirement shall not apply to pollutant loadings from a tributary in an area where it mixes with a public water supply designated waterbody, unless a water intake was located in this area on April 2, 1999; and
- Salmonid Migration – the ability for salmonids (i.e. salmon) to utilize migratory waterbodies without adverse impacts from water quality conditions (not listed as designated use by MDNRE in literature, but discussed in the WQS).

Those uses that are **underlined** apply to all waters of the state (unless otherwise suspended by the MDNRE). In all cases, the most restrictive water quality standards associated with the designated uses for a particular waterbody segment shall apply. (MDEQ, 2008)

Notes Associated with the Designated Uses

- **Total body contact** recreation immediately downstream of wastewater discharges, areas of significant urban runoff, combined sewer overflows, and areas influenced by certain agricultural practices is contrary to prudent public health and safety practices, even though water quality standards may be met.
- **Coldwater fisheries** include: all inland lakes identified in the publication entitled "Coldwater Lakes of Michigan" as published in 1976 by the Michigan Department of Natural Resources (MDNR); all Great Lakes and their connecting waters, except for the entire Keweenaw waterway, including Portage lake, Houghton county, and Lake St. Clair; all lakes listed in the publication entitled "Designated Trout Lakes and Regulations" issued September 10, 1998, by the director of the DNR; and all waters listed in the publication entitled "Designated Trout Streams for the State of Michigan" Director's Order No. DFI-101.97, by the director of the DNR.
- **Public water supplies** include all surface waters of the state that are identified in the publication "Public Water Supply Intakes in Michigan," dated December 9, 1999.
- Special **Limited Warmwater / Coldwater Fisheries** uses may be substituted in waterbodies where achievement of the primary DO standards is not likely to be met.

Notes Associated with the Designated Uses

- If uses are interrupted (e.g. flood, spills) the MDNRE will notify impacted entities and the entity causing interruption shall remedy the situation (if applicable).
- Effluent discharges to wetlands that result in water quality that is inconsistent with water quality standards may be permitted after a use attainability analysis shows that designated uses are not and cannot be attained and shows that attainable uses will be protected.

In evaluating the designated uses, the (MDEQ, 2008) uses the following assessment parameters (those in **bold** are also WQS parameters; those that are *italicized* are listed in (MDEQ, 2000) guidance but not necessarily considered in the assessment):

Agriculture	site specific information only, *hydrologic characteristics, nutrients*
Navigation	site specific information only, *sediment*
Industrial Supply	site specific information only, *suspended solids*
Warmwater Fishery	**dissolved oxygen (DO), temperature, nutrients** (nitrogen as unionized ammonia, NH_3), **dissolved solids, pH,** fish community, *sediment, hydrologic characteristics, pesticides*
Other Indigenous Aquatic Life and Wildlife	**toxic substances** *(organic compounds, toxic metals, pesticides)*, **nutrients**, **physical characteristics**, macroinvertebrate community, other organisms (bacteria, algae, macrophytes, fungi), *sediment, temperature*
Partial Body Contact Recreation	**pathogens** (***E. coli.***)
Fish Consumption	**toxic substances** (mercury, PCB, others), fish contaminants (mercury), fish consumption advisories (PCBs, DDT, Chlordane, Dioxin, others)
Total Body Contact Recreation	**pathogens** (***E. coli.***), *nutrients*;
Coldwater Fishery	**dissolved oxygen (DO)**, **temperature**, **nutrients** (nitrogen as unionized ammonia, NH_3), **dissolved solids**, **pH**, fish community, *sediment, hydrologic characteristics* (both inferred from the listing under 'warmwater fishery')
Public Water Supply	**toxic substances** (*pesticides*), **taste and odor**, *nutrients (nitrates)*.

Under the Clean Water Act, states, territories and authorized tribes have been required to submit: 1) a State Water Quality Report – as per section 305(b) – which describes whether waters are meeting WQS, the progress that has been made in maintaining and restoring water quality, and the extent of remaining problems; and 2) a List of Impaired Waters – as per section 303(d) – which lists waters not meeting WQS even after point sources of pollution have installed the minimum required level of pollution control technology and a prioritization of these waters with respect to scheduling development and implementation of TMDLs (along with status of uses, stressor, and sometimes source associated with the TMDL). As per EPA's request, entities are encouraged to submit an integrated report (IR). Michigan's IR also includes an assessment of status and trends of publicly owned lakes – as per section 314.

Designated use assessments are conducted on 12-digit HUC drainage areas. Based on specific conditions, 12-digit HUCs may be split into multiple assessment units and may consist of any set of waterbodies in the unit, most commonly all of the waterbodies, but in some situations limited to specific stream reach or simply the lakes. Within an assessment unit, designated uses are classified into one of five categories (sidebar) based on data collected and water quality standards.

In keeping with EPA's guidance, the MDNRE utilizes five attainment categories, based on the individual designated uses, to report on the status of all state waters (sidebar). **(EPA 5.6.2)**

Beneficial Uses

The Great Lakes Water Quality Agreement (GLWQA) defines Areas of Concern (AOCs) throughout the Great Lakes for areas consistently not meeting water quality standards. These areas are evaluated using fourteen beneficial uses impairments (GLIN, 2008):

- Aesthetics;
- Acceptable fish /wildlife taste;
- Open beaches;
- Healthy benthos conditions;
- No fish tumors / deformities;
- Healthy fish / wildlife habitat;
- Healthy phytoplankton / zooplankton populations;
- No dredging-restrictive contaminants in sediment;
- No eutrophication / controlled algae populations;
- No taste / odor problems or other drinking water restrictions;
- Healthy fish / wildlife populations;
- No contaminants in fish / wildlife;
- No costs incurred for agriculture and industrial water usage; and
- No bird / animal deformities or reproductive problems.

The Clinton River Watershed has been designated an AOC because it has eight beneficial use impairments (BUIs). The Clinton River Restoration Plan is a Remedial Action Plan (RAP) designed to address these impairments. Because it is part of the Clinton River Watershed / AOC, this North Branch Subwatershed plan must address the BUI framework in its approach. A useful way to approach this is to cross-reference the BUIs to the regulatory designated uses. This is done in Table 3-3. The BUIs and designated uses specifically associated with the AOC are shown in ***italics***.

Desired Uses

While the beneficial uses provide a broad set of environmental assessment parameters and the designated uses define the specific regulatory assessment parameters, the desired uses are meant to provide a specific set of focused assessment parameters based on the knowledge and perceptions of local stakeholders. In general, a desired use is a statement of how one would want to be able to use the resources in the planning area or the desired quality of the aesthetic conditions in the planning area. Desired uses are important because they are based on factors important to the local community and will help to encourage support for overall plan activities. Because desired uses are a function of stakeholder feedback, they are presented in Chapter 4 which summarizes the public involvement and community outreach actions taken in support of this plan (e.g. meetings, workshops). Prior to eliciting input from stakeholders, a list of potential desired uses was developed for them to respond to at a SWAG meeting. This list was developed from: research into local newspaper and internet stories related to conditions and activities in the subwatershed; referencing existing recreation, green infrastructure, and other plans affecting the subwatershed; contacting recreation, conservation, and other non-governmental entities; and examining desired uses from management plans for neighboring subwatersheds.

Designated Use Support Categories

The categories use to report on designated use attainment include:

- Category 1 – All designated uses are supported, no use is threatened.
- Category 2 – Available data/information indicate that some designated uses are supported.
- Category 3 – There are insufficient data/information to make a designated use support determination.
- Category 4 – Available data/information indicate that at least one designated use is not being supported or is threatened*, but a TMDL is not needed because:
  - 4a – TMDL has been completed.
  - 4b – Other pollution control requirements are reasonably expected to result in attainment of the designated use in the near future.
  - 4c – Impairment is not caused by a pollutant.
- Category 5 – Available data/information indicate that at least one designated use is not being supported or is threatened, and a TMDL is needed. (This category is essentially the 303(d) list)

Waterbodies can be classified in multiple categories.

* A designated use is considered threatened if water quality data currently indicate that the use is supported but that a declining trend in water quality is expected to cause the assessed waters to not attain associated water quality standards (i.e. not support the designated use).

Table 3-3. Relationship of BUIs to designated uses.

Beneficial Use Impairments (BUIs) (*italics* indicate those BUIs affecting the Clinton River AOC) Note: this information is based on the assessment provided by the Clinton River Public Advisory Council (CRPAC) and is in fact the exact table presented in the Clinton River Restoration Plan (CRPAC, 2008).	**Michigan Designated Uses**									
	Agriculture	**Navigation**	**Industrial water supply**	**Warmwater fishery**	**Other aquatic life / wildlife**	**Partial body contact recreation**	**Fish consumption**	**Total body contact recreation**	**Coldwater fishery**	**Public water supply**
1. Restrictions on fish & wildlife consumption.				X	X		X		X	
2. Tainting of fish & wildlife flavor.				X	X		X		X	
3. Degradation of fish & wildlife populations.				X	X				X	
4. Fish tumors or other deformities.										
5. Bird or animal deformities or reproductive problems.					X					
6. Degradation of benthos.					X					
7. Restrictions on dredging activities.		X								
8. Eutrophication or undesirable algae.										
9. Restrictions on drinking water consumption or taste/odor.										X
10. Beach closings and other 'full body contact' restrictions.						X		X		
11. Degradation of aesthetics.										
12. Degradation of phyto- and zooplankton populations.					X					
13. Added cost to agriculture and industry.	X		X							
14. Loss of fish & wildlife habitat.				X	X				X	

Example Desired Uses

Some example desired uses include:

- A recreational nature trail and ultimately trail network that is protected by easements;
- Healthy, protected riparian corridors;
- Identified, protected natural areas;
- Identified, protected habitat for endangered aquatic species;
- Abundant, protected agricultural land; and
- Abundant, protected open space.

Permit Program Standards

The MDNRE implements numerous permitting programs that control the quantity of pollutants discharged into the natural environment. Perhaps the most important permitting program with respect to water quality is the federal NPDES program which is implemented at the state level by the MDNRE. For each NPDES permit issued, specific pollutant discharge limits and other criteria are established for receiving water bodies. In evaluating permit compliance, the MDNRE will monitor for specific pollutant discharges and also consider sediment contaminant and biological samples. These assessments are performed two years prior to permit reissuance (in coordination with the regular 5-year basin monitoring cycle discussed later in this chapter) to ensure that this data is considered in these appropriate decisions.

Other permit programs may also have associated monitoring protocols to ensure permit compliance and appropriateness. In addition, the MDNRE may attach certain performance standards and monitoring requirements to various grants or loans that are issued.

Other Standards

There are numerous non-regulatory programs that identify certain standards as metrics for judging success (and indirectly assessing environmental conditions). For example, the Clinton River Coldwater Restoration project specifically aims to have a healthy trout population while the Clinton River Watershed Council's Cleanup and River Day activities aim to enhance streams by removing trash and debris (CRWC, 2005). In addition, various natural resources regulatory agencies such as the MDNRE and USFWS have abundance and diversity guidelines that are indicative of healthy fish and wildlife populations.

Assessment Parameters

With respect to the assessment standards previously discussed, there are generally two types of parameters that are of use in evaluating them. The first involves directly measuring a parameter of interest such as a stressor (e.g. to determine if WQS are being met). The second involves utilizing comprehensive indices or indirectly measuring information (e.g. to assess wildlife conditions).

Most of the direct assessment parameters for water quality are concentration based (as in mass per volume of water) or mass concentration based (as in mass per unit mass of sediment). In terms of many pollutants, it is useful to know loading rates (as in mass per unit time). These are typically found by multiplying a pollutant concentration by the flow rate of the water in which it was sampled. Other direct measurements may include such things as fish counts or miles of 100-foot riparian buffer. These direct assessments can stand by themselves or can be part of a more comprehensive assessment index that includes other direct and/or indirect measures.

The assessment parameters that will be encountered in existing data reports and those that should be considered for future monitoring efforts are presented in Chapter 5 along with the data that are being assessed.

Data Generating Programs for Parameter Assessment

There are numerous programs and protocols that have produced past data and can be leveraged or implemented to obtain data necessary to assess environmental conditions in support of this plan. Existing resources range from drinking water and surface water quality monitoring at the county level to databases of collected data maintained by federal agencies. If data appropriate for assessing a desired parameter is not currently being collected, there is always the possibility of establishing a program to collect such data.

A discussion of existing programs and some additional protocols can be found in Appendix G.2.

Conclusion

The relationship between the causes of sources, sources of stressors, stressors that impact the natural environment, and the impacts themselves is a complex one. This chapter has defined a framework in which to understand and assess these stressors, etc, with respect to the natural environment. Appendix C.1 expands greatly on the discussion presented in this chapter.

The content of this chapter is reflected in Chapter 5, except the general discussion of impairments, impacts, stressors, sources, and causes is replaced with specific data and analyses. The conditions discussed therein are framed by the assessment standards and parameters presented at the end of this chapter and the public input that is summarized in Chapter 4. Chapter 6 goes on to define the goals and objectives aimed at addressing the environmental issues that become apparent from the analyses.

Monitoring and Assessment Protocol Considerations

There are numerous considerations that should be incorporated into the monitoring/assessment protocols for this plan. These include:

- the spatial and temporal variability in environmental conditions;
- sampling during both dry weather and wet weather conditions;
- monitoring known and potential future pollutant sources both before and after remedial actions are implemented or facilities are constructed;
- monitoring water quality improvements associated with specific actions or BMPs that are constructed (and at a minimum providing calculations of projected reductions using standard and extrapolated/interpolated values); and,
- considering groundwater quantity and quality issues where appropriate.

4. Public Input on Environmental Condition

Chapter Purpose

The purpose of this chapter is to: 1) clearly define the stakeholders for this plan; 2) detail the public participation during the development of the plan; 3) summarize the public input used to develop the plan; and, 4) present the general elements of the continuing public education component of this plan with a brief discussion of those elements that are currently underway.

The public input information in this chapter was incorporated into the data analyses (Chapter 5) and was utilized to form the content and scope of the public education action proposed in the action plan (Chapter 8).

Acronyms and Terms

A complete list of acronyms and terms and their respective definitions can be found in Appendix A.1.

Public Involvement / Education Strategy Background

The overall strategy for dealing with the public and other stakeholders is referred to as the involvement / education (IE) strategy. IE is a tool that is used to efficiently obtain information from stakeholders and to improve behaviors with respect to protecting and restoring the environment (in addition to increasing understanding of the plan, its recommendations, and support for its implementation). The IE plan describes the tasks and requirements of the Subwatershed Advisory Group (SWAG), its **committees, and other stakeholder groups. Incorporating stakeholder** information is essential in developing a plan that is responsive to local conditions. Often, the solution to an environmental problem includes effecting voluntary behavioral changes (which requires that stakeholders understand how their actions impact the environment). Public involvement and education is essential to ensuring buy-in to the plan and increasing its chances for successful implementation.

There are many elements in a coordinated public IE program. These include: defining your audience; developing your message; selecting methods for gathering information and spreading your educational message; and summarizing and analyzing information to develop the watershed management plan and its educational component. These elements are discussed throughout the remaining sections of this chapter.

The general approach to developing an effective IE strategy includes MDNRE, 2000):

- Identifying key stakeholders (i.e. those who need to participate);
- Encouraging and involving a wide variety of agencies and interests;
    - Including, in the watershed management plan, an identification of all the stakeholder who need to participate and methods to get them to participate so that reluctant stakeholders can be pursued in the future;
    - Documenting, in the watershed management plan, how the various organizations and interests have been involved in the watershed planning effort;
- Developing a process for effective stakeholder involvement;
    - Including, in the watershed management plan, how the public will be involved in the implementation of the plan (and document these efforts in future plan updates);
- Develop methods to educate stakeholders and constituents; and
- Gather useful, measurable social feedback.

Stakeholder Categories

It is important to identify represent-atives from each stakeholder category and to ensure their input is included in developing the plan. The categories include:

- Those responsible for implementing the plan.
- Those affected by implementation of the plan.
- Those that can provide information on the issues and concerns in the subwatershed.
- Those that have knowledge of existing programs or plans.
- Those that can provide technical and financial assistance towards plan development and implementation.

(EPA 3.3.1)

Defining Stakeholders

Stakeholders are the people and organizations that have a stake in the outcome of the watershed management plan and, more broadly, those that have an interest in the environmental conditions of the subwatershed. They are the people that make and implement decisions, those that are impacted by the decisions, and those that have the ability to assist or impede implementation of the plan.

A successful watershed management plan is one that: 1) was developed primarily by local citizens and stakeholders with broad representation of interested parties (as it takes their support and fiscal backing to implement the plan); and, 2) makes provisions to educate stakeholders with respect to future actions to be implemented through the plan. As such, it is critical to build partnerships with key interested parties prior to developing the plan and to maintain the partnerships throughout the plan's implementation.

The primary groups of stakeholders that are essential in the subwatershed include: **county and municipal representatives**; **regional organization representatives**; federal and **state agencies**; business and industry groups; **agricultural representatives**; landowners; citizen groups and community service organizations; religious organizations; **universities, colleges, and schools**; **environmental and conservation groups**; and **conservation districts**. **(EPA 3.3.3)**

The primary group of stakeholders in the subwatershed is the subwatershed advisory group (SWAG). The SWAG members are documented in Appendix A.5. The major groups represented by the SWAG are presented in **bold** text in the above list.

Not all groups of stakeholders are represented on the SWAG so the input of these groups has been assessed through other means. For example, federal agencies such as the U.S. Fish and Wildlife Service, the United States Department of Agriculture Natural Resources Conservation Service (NRCS), and the Environmental Protection Agency (EPA) have been involved through data requests and consultations on specific subwatershed issues. Also, business and industry representatives, land owners, and other community based groups and organizations have and will continue to be targeted through specific surveys and/or other participation activities. Even the groups that are represented on the SWAG may have numerous representatives that are important during different phases of the planning process. A detailed listing of these involved and potential stakeholders is presented for reference:

- County and municipal representatives
  - Managerial staff
  - Public works departments
  - Parks and recreation staff
  - Engineering departments
  - Health departments
  - Planning departments
  - Road commissions
  - County drain commissioners
- Regional organization representatives
  - Southeast Michigan Council of Governments (SEMCOG)

Stakeholder Facilitation

There are a number of ways through which stakeholders can participate in the planning process.

Stakeholders act as decision-makers and advisors through the SWAG. Other stakeholders support the process by voicing concerns to their local representatives (who sit on the SWAG), participating in surveys, accessing websites and submitting information, reviewing and commenting on planning products, participating in educational and improvement activities.

Additionally, stakeholders periodically interface through-out the project through targeted meetings (to obtain information) or through specific requests for technical, financial or other support from organizations or individuals.

(EPA 3.3.3)

Roles and Responsibilities / Organizational Control

Stakeholders were involved in the watershed planning process – through the SWAG and related communications– long before development of the plan began. The Macomb County Public Works Office (MCPWO) formed the SWAG and involved stakeholders early through outreach efforts that brought additional stakeholders into the process, and increased the likelihood of the long-term success of the plan.

As with any effort requiring the cooperation of a diverse group of people or organizations, the roles and responsibilities of the stakeholders varied with their concerns or expertise. By allowing different stakeholders to approach the process at the level most comfortable for them, the plan incorporates the diverse needs of different stakeholder groups.

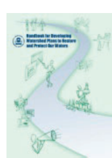
The level of involvement ranged from those simply wanting progress updates to those expressing their specific concerns. Future implementation of organizational, outreach, and participation activities involves utilizing stakeholders that are already performing particular actions and encouraging continued SWAG attendance by representatives from all stakeholder groups (e.g. CRWC, SEMCOG). Future implement-ation will rely heavily on the ability of the stakeholders to implement the actions presented in Chapter 8 and continue to participate in the SWAG and related subwatershed events.

(EPA 3.3.2, 3.3.5, 3.3.6)

- Federal agencies – numerous (see discussion above)
- State agencies
  - Michigan Department of Natural Resources and Environment (numerous divisions)
  - Michigan Department of Transportation
  - Michigan Department of Agriculture
- Business and industry representatives
  - Developers / home builders associations
  - Agribusiness
  - Recreation / tourism
  - Others
- Citizen groups
  - Religious organizations
  - Civic organizations
  - Homeowners/neighborhood associations
  - Landowners
  - Lake associations
  - Youth groups
- Universities, colleges, and schools
  - Michigan State University Extension
  - Macomb Community College, Local K-12 schools and districts
- Environmental and conservation groups
  - Clinton River Watershed Council
  - Six Rivers Regional Land Conservancy
  - Others

Stakeholder involvement is essential, although individual stakeholder contribution may change over time. Participation of stakeholders is a function of the skills and resources required versus those possessed by the stakeholders. Outside parties may need to be contacted and/or contracted if the stakeholders themselves cannot satisfactorily implement portions of the plan. The skills and resources that were required during plan development and that will be essential as the plan is implemented in the future are discussed in the following subsection **(EPA 3.4)**

Skills and Resources



The skills and resources of the stakeholders have been assessed informally as the plan was developed and specific skills and resources were required. Stakeholder skills that were essential in developing the plan include: graphic design, computer support, public relations, technical expertise, and facilitation. Stakeholder resources that were essential in developing the plan include: contacts with the media, access to volunteers, access to data, connections to local organizations, access to meeting facilities, access to equipment, and access to field locations.

The skills and access to resources utilized during development of the plan, and many others, will be essential to implementing the plan in the future. These skills and resources access are naturally associated with the actions to be taken during implementation of the plan and as such are identified in Chapter 8.

(EPA 3.3.4)

Stakeholder Participation and Input

Public involvement played a key role in the development of this watershed management plan (WMP). Throughout the development process, members of the general public and specific groups of stakeholders had the opportunity to actively participate and provide input and feedback through a wide array of activities and media. This input was used to develop much of the plan including the goals and objectives and management measures.

This section describes the public participation efforts that were undertaken in support of the project and any essential information that was obtained. The efforts are grouped into two categories for discussion: 1) those that occurred previously or are ongoing as the plan was developed, including:

- Remedial Action Plans
- TMDLs
- SWAG meetings

and 2) those that were conducted specifically in support of this plan, including:

- SWAG meetings with specific objectives
- Watershed surveys with stakeholder volunteers
- Social survey of key stakeholders
- Watershed community interviews
- Document review and comment

The two categories of stakeholder participation efforts are discussed in the two following subsections. **(EPA 4.2)**

Previous and On-going Stakeholder Participation Efforts

It is important to understand the public participation efforts that have gone on in the past in order to utilize and build from them and show progress in the future. This subsection touches on some of those previous efforts.

The First Remedial Action Plan (RAP)

In 1986, a public meeting was held to seek public comments to facilitate the development of the first *Clinton River Remedial Action Plan* (MDNR, 1988). It is interesting to note: 1) some of the concerns raised in 1986 still persist; and 2) some of the approaches suggested for pollution control can be utilized as a relative gauge of the progress that has been made.

The following categories summarize the comments:

- The need for watershed-based permitting and modeling;
- Sedimentation;
- Cooperative approach between governmental entities and other stakeholders;
- Stormwater runoff issues – quality and quantity;
- High and low flow issues in the Clinton River;
- Floodplain development;
- Polluted lands and other historic pollution sources;
- Sewer overflows;
- Wetland protection;
- Fish contaminants and health; and
- Other pollutants.

Relationship between Participation and Education

Although public education is a collection of activities that will be implemented in the future to change behaviors and improve environmental quality, it is important that educational activities be conducted at the very beginning of the watershed planning effort to make potential partners and stakeholders aware of the issues, recruit them to participate, and educate them on the watershed planning process.

Additional RAP-related Public Participation and Input

The 1993 Clinton River Public Advisory Council published a notebook of activities (CRPAC, 1993) that occurred in 1993 in support of the 1995 Remedial and Preventative Action Plan (RAP) (CRPAC, 1995). This document discusses stakeholder input on numerous issues, including: aquatic and terrestrial habitat, principles for planning, actions being taken, and the status of problems.

The 1998 RAP (CRPAC, 1998) included an evaluation of the CRPAC members' consideration of priorities, obstacles, and general feeling about river issues (among other things). The priority issue was stormwater management with untreated discharges, sediments, illicit connections, and septic systems ranking high. Obstacles included the lack numerous elements: education, funding, and resources. In general, the stakeholders felt that the river was in better shape than when the first RAP was developed.

The Clinton River Restoration Plan

In support of the *Clinton River Restoration Plan* (RAP) (CRPAC, 2008), a meeting was held on June 9th, 2007 to obtain input from stakeholders in the North Branch Subwatershed (since a subwatershed management plan had not yet been developed). From this meeting, the stressors and *impacts* of concern in the subwatershed include:

- Chemical Stressors
  - Nutrients – *Eutrophication or Undesirable Algae* (as 'fishing concerns')
  - Inorganic Compounds (as 'pesticides')
  - Heavy Metals (as 'pesticides')
  - Organic Compounds (as 'pesticides')
  - Oxygen Demand (as 'low dissolved oxygen')
  - Dissolved Solids (as 'salt')
- Physical Stressors
  - Suspended Solids / Sediment (as 'siltation/sedimentation')
  - Hydrologic / Hydraulic Characteristics (as 'flashiness/flooding)
  - Natural Feature / Habitat Degradation (as 'headwaters degradation' and 'destruction of sensitive natural areas') – *Reduced Rural / Agricultural Land*
- Biological Stressors
  - Pathogens (as 'bacteria' and 'E. coli')

Clinton River Restoration Plan

The June 9th, 2007 meeting (see main text) elicited the following **sources** and causes of concern in the subwatershed:

- Non-point Sources:
  - **Urban / Residential Land / Stormwater**
    - Floodplain Development
    - Waterbody Modifications
      - Enclosure of Open Streams
      - Modification / Obstruction of Open Streams
      - Loss of Wetlands
    - Residential Behaviors / Household Hazardous Waste
      - Excessive Fertilizer Use
  - **Transportation Infrastructure / Stormwater**
    - Floodplain Development
    - Waterbody Modifications
      - Enclosure of Open Streams
      - Modification / Obstruction of Open Streams
      - Loss of Wetlands
    - Residential Behaviors / Household Hazardous Waste
      - Excessive Fertilizer Use
  - **Agricultural Land / Stormwater**
    - Agricultural Practices
      - Excessive Fertilizer Use
  - **Soil Erosion**
    - **Streambanks**
    - **Crossings (including bridges, dirt roads, ditches)**
    - **Construction Sites**

TMDL Efforts

A stakeholder meeting was held on April 11, 2006, at the Lenox Township Hall in New Haven, Michigan. Stakeholders were determined by identifying municipalities (i.e., counties, townships, and cities) in the TMDL drainage areas. Copies of the draft TMDL were available upon request and posted on the MDNRE's Web site. Copies of the draft TMDL were also sent out with the stakeholder meeting invitations and available at the stakeholder meeting.

SWAG Meetings and Activities

The North Branch Subwatershed Advisory Group (NBSWAG), comprised of representatives from local governments and environmental stewardship organizations, has been meeting since 2003 to address environmental issues. This voluntary group was formed at the same time as those in the other Clinton River subwatersheds, but unlike the other groups, it does not have a focus on the Phase II stormwater regulations (although a number of the representatives participate in these other groups as their communities span multiple subwatersheds). The NBSWAG has been involved in numerous participation efforts including a 'Farmers Forum' to educate stakeholders and allow for feedback on the SWAG operations. The SWAG was also involved in getting stakeholders involved in subwatershed activities by engaging them in conducting road-stream crossing surveys.

New Efforts in Support of This Plan

SWAG Meetings

SWAG meetings were held throughout the planning process and, at many of these, the stakeholders were asked to provide targeted input that was used to formulate various portions of this plan. Summarized below is the input from a meeting held in January of 2009 designed to elicit feedback related to the stakeholders visions for the subwatershed:

<u>What should stakeholders be able to do and see in the watershed?</u>

- Canoeing/kayaking
- Experiencing rural Michigan
- Interacting with wildlife (hunting, fishing)
- Rural activities = horseback/equestrian; golf courses; farm markets (u-pick)
- Concerns related to events such as soccer matches (traffic, noise)
- Biking and skiing trails
- More access to the water – not many points where people can see the river – camp rotary hardly used anymore
- Macomb County has no campground (only county in Michigan)
- Wetzel State Park should be designated for camping on Coon Creek – more of a small game area

<u>What should the watershed look like?</u>

- Green/open space in close proximity to development e.g. Bruce Township
- Preserve aesthetics
- Concerns about increases in traffic
- Concerns with ORVs/ATVs – impacts to Agriculture
- Restore Cascades (past used by families for picnicking)
- Flash flooding related property damage (26 mile south)
- Issues of residents now if floodplain due to new FEMA maps
- 26 Mile N. – metroparks – restoration efforts
- Hall Rd. to 26 Mile Rd. – not a large preservation effort
- Want to avoid loss of wetlands
- Development with good stormwater management – LID
- Promote smart growth principles by local governments
- Healthy ‘looking’ water
- Healthy fisheries (trout designated streams)

In light of the vision you have for the watershed, what should be the goals <u>of the North Branch Watershed Management Plan to achieve your vision?</u>

- Maintain visitor population for economic gain
- Address impairments / restore (pathogens, sediment, DO)
- Flashiness (unnatural blockages)
  - No clearly delineated responsibility for these
  - Message is often property owners
  - Using up funds from the lake and river fund – other funds
  - Technical issues related to clearing them up
- Try to link the economy to our goals for NBCR

Additional input from SWAG stakeholders on more specific goals and objectives, priorities, management measures, and evaluation efforts can be found in the separate Social Survey Report.

Local Knowledge

Visual assessments and existing local knowledge are essential to augment GIS data by providing observations to compare to less precise spatial data. These data are useful for identifying and connecting potential sources of impairment and watershed conditions and to guide and support data analyses. Where little monitoring data is available, assessments and observations are also useful for answering questions raised by data analyses, such as why changes in water quality manifest in areas where known sources are not prevalent. Local anecdotal knowledge may be less reliable than recently collected data but may be essential to identifying hidden sources. For example, the identification of past open dump locations may be necessary to determine why a certain reach of a stream is exhibiting elevated levels of certain pollutants. Stakeholders have provided such local knowledge throughout the process and it has been included throughout the plan where appropriate – even though it may not be obvious.

(EPA 7.2.7)

Subwatershed Surveys

Visual watershed assessments (e.g. stream walks, windshield surveys, and flyovers/photographic assessments) that utilize stakeholders as data collectors can provide them with a unique perspective about the watershed and what is going in it. It allows for them to make visual connections between sources, impacts, impairments, and possible management approaches. These surveys not only help the stakeholders develop a common vision of what needs to be done but also help determine if any additional data is needed, what the critical areas are, help identify sources and stressors, and what management measures should be taken. **(EPA 4.3.2)**

Two subwatershed survey types were implemented to generate data in support of this plan; the Unified Subwatershed and Site Reconnaissance protocol and the Unified Stream Assessment protocol. Both of these protocols were developed by the Center for Watershed Protection and have been implemented on other subwatersheds in the Clinton River Watershed. The results of each of these surveys have been documented extensively in separate reports and are available under separate cover. The important information from the reports has also been summarized in Chapter 5.

Social Surveys

In early spring of 2009, the SWAG conducted two social surveys. One survey was focused on agricultural producers and the other was sent to residential property owners. The format was a mail survey with the option of completing it on-line. Administered by the Macomb County Public Works Office, the two social surveys produced a statistically significant sample for the North Branch Clinton River Subwatershed. There were 144 responses from agricultural producers and 201 from residential property owners for a total of 345 respondents. The response rate was 35%. The survey assessed: public awareness, perception, and knowledge of the watershed and storm pollution issues; current activities impacting water resources; and willingness to take action to protect water resources. The following text presents some of the key findings revealed by these surveys. The detailed report summarizing all of the findings of the surveys can be found as Appendix D.1.

Respondent Knowledge

The surveys showed 74% of respondents understood the definition of a "watershed, yet only 48% of respondents knew the name of the watershed in which they reside. The survey also showed 78% of respondents knew that stormwater flows directly to lakes, streams, and groundwater.

Perceptions of Current Water Quality

Respondents felt that the current water quality was ***Good*** and best utilized for its scenic beauty and for picnicking and family activities. Conversely, respondents felt that the water quality was only ***Okay*** for Fish Habitat, Canoeing/Kayaking/Other Boating, and for Eating Fish Caught in Local Waters. Respondents felt that local water quality was ***Poor*** for swimming.

Additional Efforts in Support of the Plan

Document Review and Comment

The SWAG stakeholders were offered the opportunity to make significant comments on draft forms of the chapters of this plan. The general public was offered the opportunity to make comments on a final draft form of the entire plan. The Clinton River Watershed Council's website was utilized to host the documents being offered for comment to ensure the maximum exposure to interested stakeholders and general public during the commenting periods.

Websites

There are a number of websites available to allow stakeholders to seek out information in the Clinton River Watershed and North Branch Subwatershed and to provide comments and other information to the people that are responsible for improving environmental conditions. These websites include:

- CRWC
- Macomb County
- SEMCOG
- MDNRE

Social Survey Insight

The respondent knowledge assessment indicates a need for heightened awareness about which watershed residents live in. An easy way to accomplish this is through posting watershed signs at key road-stream crossings and other sites with educational potential, such as parks.

Impairments, Pollutant Sources, and Consequences of Poor Water Quality

Water quality testing and expert opinion have identified: *sediment, phosphorous, bacteria, low dissolved oxygen, flow alterations* and *habitat alterations* as key water impairments. Sources of these impairments are located throughout the watershed and have led to the MDNRE classifying several reaches as not attaining some of the state's eight designated uses for surface waters of the state. The survey results indicated a low awareness of the sources of water impairments, the impairments themselves and the consequences associated with the presence of these impairments.

Practices to Improve Water Quality

The residential survey inquired about respondents' awareness of, and willingness to adopt various best management practices (BMPs) designed to protect water quality. The agricultural survey inquired about forty-three best management practices. Results from this section are too complex to report here but in summary it can be said that respondents believe they are doing a good job of implementing BMPs. Respondents were overwhelmingly willing to adopt the majority of the surveyed agricultural and residential practices. BMPs requiring construction received the least support, perhaps due to the perceived expense to the property owner associated with them.

Making Management Decisions

This section solicited responses on what was perceived as constraints to adopting new management practices. Examples of constraints included cost, skill level required to implement, and available equipment. Fourteen of seventeen constraints pose barriers to roughly two-thirds of the agricultural respondents. Eleven of fourteen constraints pose barriers to roughly two-thirds of the residential respondents.

Septic Systems

Ninety-five percent of agricultural respondents had septic systems. Fifty-two percent (52%) of residential property owners had septic systems. The average age for respondents' septic systems was over 40 years old. The age of the septic systems presents a looming problem since the life expectancy of the average septic system is 25 years.

Information Sources and Policy

Of the agencies listed in the survey, the top three trusted sources for information by agricultural respondents were MSU Extension, Natural Resource Conservation Service (NRCS), and the Farm Bureau. The top three trusted sources by residential respondents were MSU Extension, the Clinton River Watershed Council, and the Michigan Department of Agriculture. Based on this information, any educational efforts may be most successful if led or distributed by these agencies. Agricultural respondents supported "partnering with other communities to work on environmental issues." Residential respondents supported "increasing parks and open space."

Social Survey: Your Water Resources

The most important activities to respondents were:

1. Enjoying scenic beauty/ enjoyment (72%)
2. Picnicking and family activities (40%)
3. Fish habitat for fishing (37%)
4. Eating fish caught in local waters (26%)
5. Swimming (22%)
6. Canoeing /kayaking /other boating (17%)

Social Survey Insight

If local residents' needs are being met by the currently perceived water quality conditions, then it will be difficult to motivate them to improve conditions. For marketing purposes it would be best to communicate proposed actions as necessary to preserve the current level of amenities for the future rather than improving conditions for activities that may not be supported.

Social Survey Insight

Regardless of people's willingness to adopt BMPs, if the constraints are perceived to be too great for property owners then the BMPs will not be adopted. Survey results indicated that a lack of under-standing surrounded many of the BMPs. Public education programs on the BMPs, terminology, and the required skill for implementation will help overcome the perceived barriers.

Constraints to Implementation

The following BMPs were correlated with not having enough information:

- Follow comprehensive nutrient plan
- Construct a sediment basin
- Use a filter strip
- Plant trees
- Construct a pond
- Plant vegetated riparian buffer
- Improve upland wildlife habitat
- Plug a well
- Properly dispose of household waste

Community Interview Participation

A total of eight interviews were received. Four (4) were Township Supervisors, Two (2) were Department of Public Works employees and there was two (2) engineers and one (1) clerk that participated.

Constraints to Implementation

There were several significant constraints (from the Management Decisions section) that were correlated with the "Willingness to Continue or try BMPs".

- "Out of Pocket Expenses" and "profitability' were cited as significant concerns and correlated with several BMPs indicating that they were potential barriers to implementation.
- The concern over "learning new skills or methods" was correlated with "planning vegetated riparian buffer", "planting forested riparian buffer" and "protecting streambanks with structures". This would suggest that if there is a desire to implement these BMPs then it should be preceded by a concentrated education effort in order to overcome this barrier.
- The following BMPs were correlated with being difficult to implement due to "Not having access to Equipment":
  - Plant vegetated riparian buffer
  - Plant forested riparian buffer
  - Improve upland wildlife habitat
  - Plug well

  This suggests that access to equipment may expedite the implementation of these BMPs.

Watershed Community Interviews

In the spring of 2010, SWAG members conducted one-on-one meetings with local administrators (supervisors, city engineers, clerks, etc.) to both inform and solicit input from them regarding the social survey results and draft Watershed Management Plan goals. There were six (6) discussion topics:

(1) Familiarity with the Subwatershed Advisory Group (SWAG)
(2) The Social Survey Results
(3) Discussion of the preliminary Goals developed by SWAG
(4) Specific concerns
(5) Community Willingness to update ordinances and master Plan to improve Water Quality.
(6) Interest in receiving SWAG information or participating in future meeting.

Participants were also given an opportunity to express any additional thoughts or concerns they might have regarding the subwatershed. A summary of the interviews, by discussion topic, is provided.

Familiarity with the Subwatershed Advisory Group

All of the participants were familiar with both the SWAG and that a Watershed Management Plan was being developed. Only one participant attended SWAG meetings regularly; another had attended one meeting.

The Social Survey Results

The participants generally confirmed that the survey results were reasonable. They chose to amplify the following points that the social survey raised:

(1) They expressed concern that the public does not understand the causes of the problems. This could mean that they either have a misperception and/or genuinely do not understand

the relationships between their actions and local water quality. Participants concurred that more education was needed.

(2) It was noted that the North branch did not have very many parks associated with the river and that access was limited. One participant thought that both fishing and canoeing had declined from the 1970s.

(3) There was genuine surprise concerning the reported age of septic systems in the watershed (The survey respondents self-reported an average age of 40 years). There was some skepticism surrounding the reported age. Regardless, there was agreement that people needed to be educated on how to better manage their septic systems.

(4) Participants were also surprised that the Macomb County Health Department (MCHD) did not rank higher as a trusted entity for information. This may be due to MCHD having to be the "bearer of bad news" or simply a distrust of government in general.

(5) The agricultural community wants to hear from their trusted sources the best course of action to improve water quality.

<u>Discussion of the Preliminary Goals Developed by the SWAG</u>

Participants supported the preliminary goals of the Watershed Management Plan. They especially liked that they reflected the rural character associated with the North Branch.

One participant noted that there is inherent conflict between farms needing to maximize their yield to remain profitable and programs like establishing buffers and preserving/creating wetlands. Government subsidies for programs targeted at getting producers to adopt these types of programs need to provide adequate compensation for them to work.

<u>Specific Concerns</u>

The following specific concerns were mentioned. Each concern was only mentioned once by an individual participant.

- Animal waste handling / horse manure.
- Agricultural runoff.
- Uncontrolled runoff from new development upstream of the Township. Participant believes this is causing more frequent flooding and increased sediment loads.
- The composting and sludge disposal operations on 32 Mile between Omo and Place Rd. may be adding to the DO and E.coli problems in the East Branch of the Coon Creek.
- The golf course at 31 Mile & Romeo Plank has been a problem in the past, but have been more receptive to better fertilizer applications lately.
- HCMA owns the majority of land adjacent to the North Branch. They should be brought into the watershed planning process.
- Agricultural sources could be a problem, and based on the survey, maybe MSU extension and/or NRCS could provide some support in educating our farmers.
- Lastly, we are concerned about the effects of future development. There is not the pressure that there has been in the past, so now might be a good time to set up for the future.

Designated Uses

The designated uses for waterbodies in the State of Michigan include (refer to Chapter 3 for more detail):

- Agriculture;
- Navigation;
- Industrial Water Supply;
- Warmwater Fishery;
- Other Aquatic Life / Wildlife;
- Partial Body Contact;
- Fish Consumption;
- Total Body Contact (May 1st – October 31st);
- Coldwater Fisheries (specifically identified waterbodies only); and
- Public Water Supply (specifically identified waterbodies only).

Willingness to Update Ordinances / Master Plans to Improve Water Quality
All of the community representatives interviewed thought that their communities were willing to update their ordinances and perhaps even their Master Plans to reflect the need for protecting local waterways

Interest in Receiving SWAG Information or Participating in Future Meetings
All of the participants were interested in receiving information from the SWAG.

Document Review and Comment

Various drafts of this watershed management plan were developed and presented to the various stakeholders for comments. These comments were incorporated into the subsequent drafts, culminating in the plan in its current state. **(EPA 12.11)**

Summary of Input

The input obtained from the stakeholders is one component of the information that will be utilized to develop the goals and objectives that are presented in Chapter 6 and the priorities presented in Chapter 7.

Table 4-1 compares the known problems as identified through expert opinion, modeling of the watershed and on the ground observations as recorded by the USA and USSR with the perceived problems articulated by various publics. The three sources of data used to represent the public's perceptions were from a 2007 SWAG meeting (pg. 4-5), the Social Survey (pg. 4-7), and Community Interviews (pg. 4-9). Compassion of the perceived problems and the actual problems will allow for identification of problems that the public is not aware of, misconceptions about problems, as well as publically known problems.

All three survey vehicles indicated the public's perception of the presence of pathogens in local waterways is a problem. This agrees with the results of the extensive monitoring programs that have indicated the persistent presence of bacteria in a large portion of the watershed. Unfortunately, the two other indicators receiving a "poor" rating, stream bank erosion and contributions from agricultural land, were not perceived by the broader public as being a problem although the latter was mentioned by local officials.

Sedimentation, hydraulic conditions, habitat conditions, and the effects of impervious cover were awarded a "average to fair" rating throughout the watershed and the public perceived these as problems. Public perceptions are consistent with the state of the watershed because certain areas of the watershed are more degraded than others and in fact do need have these problems addressed.

Lastly, the public indicated that they perceived nutrients and oxygen depletion as a problem. Monitoring and modeling results do not support these being urgent problems. Education on these problems should probably be strengthened.

Table 4-1: Summary of Stakeholder Perception of Watershed Health

Indicator^ (Impacts, *Stressors*, Sources, Other Parameter)	Watershed Health		Survey Vehicles		
	North Branch	USA & USSR Results	2007 Identified Priorities	Community Interviews	Social Survey
Sediment Contaminants / Dredging Restrictions	A				
Polluted Sites / Industry / Other Businesses	B	C			
Toxic Pollutants (Heavy Metals, Organic, Inorganic)	B				
Nutrients / Chlorophyll / Algae / Eutrophication (Trophic Status)	B	C	X		X
Oxygen Demanding Pollution / Dissolved Oxygen Levels	C		X		X
Dissolved Solid Levels	C		X		
Agricultural Land (extent of coverage and condition of land)	E			X3	
Stream Bank Erosion / Other Erosion	C	E			
Suspended Solid Levels / Sedimentation	C	D	X		X
Debris / Aesthetics	B	B5			
Temperature	B				
Effective Imperviousness (e.g. Urban, Residential)	C	D	X	X4	X
Hydraulic Conditions	C	D	X		X
Natural Features / Habitat Conditions	B	D6	X		X
Macroinvertebrates / Amphibians / Fish / Wildlife	B				
Consumption Advisories	C				
Invasive Species	B				
Pathogens / Beach Closings and Contact Restrictions	E		X	X	X
Sewer Overflows	B	B			
Septic Systems	C			X1	
Illicit Discharges / Connections	B	B			
Public Awareness and Participation	C	C			
Other					
Pesticides			X		
Lack of Parks				X	
Road- Stream Crossings		B			
Woody Debris		E			

A = excellent, B = good, C = average, D = fair, E = poor. * - the entire Clinton River Watershed average score does not include the score for the Lake St. Clair subwatershed, which is considered part of the AOC. ^ - the indicators presented are those that were utilized in the Clinton River Restoration Plan

1 Surprised at results from Social Survey
2 Horse manure
3 Runoff from Agricultural Land
4 Caused by both existing and future development
5 Not Woody Debris
6 Based on floodplain and streambank observation

Desired Uses

Desired uses for a watershed can be defined as the uses or appearance that stakeholders desire from their watershed (e.g. nature trails, riparian corridor protection, protecting agricultural land). The stakeholders' desired uses for the subwatershed have been elicited and summarized for the purposes of meeting Clean Michigan Initiative (CMI) grant funding requirements and assisting in development of the goals and objectives listed in Chapter 6. Note that the desired uses include, either explicitly or implicitly, the restoration and protection of designated uses (as defined in Chapter 3).

Desired Uses for the North Branch Subwatershed

Not all of the stakeholders' visions or goals for the subwatershed fit within the designated uses framework. As such, an expanded set of uses has been defined for the subwatershed which is based on factors that are important to the stakeholders. Desired uses are important because they help to encourage community support for overall plan activities by expanding the scope of the plan beyond that of water quality issues. This set of desired uses is presented in the following subsection.

The desired uses for the subwatershed have been determined based on the January 2009 SWAG meeting stakeholder input. In essence, the desired uses are addressed either through an existing designated use or a newly defined desired use. In some cases, a desired use that overlaps an existing designated use has been defined in order to stress its importance and/or in order to allow for a more in-depth examination of available information above and beyond the data that is associated with the designated use designation (as presented in Chapter 5).

The desired uses defined for the North Branch Subwatershed include:

- Support Restoration of Designated Uses that are Not Supported or are Threatened
- Support Improving Water Quality and Attaining Designated / Desired Uses in Downstream Areas (Lower Clinton River and Lake St. Clair)
- Support Local Terrestrial and Water-based Recreation through Enhanced Public Parks, Trails, and Access Points
- Support Local Recreational Fishing
- Support Maintaining and Restoring Healthy Aquatic Habitat to Protect Fisheries and Other Aquatic Life
- Support Local Recreational Hunting
- Support Maintaining and Improving Healthy Riparian Corridors and Streambanks to Protect and Enhance Water Quality, Aquatic and Terrestrial Habitats, and Fisheries / Hunting
- Support the Character of the Subwatershed by Preserving / Enhancing Identified Natural Features and Healthy Terrestrial Habitat to Maintain and Enhance Game Animal Populations and Threatened / Endangered Species
- Support the Character of the Subwatershed by Preserving / Enhancing Natural Drainage Systems by Minimizing Directly Connected Impervious Surfaces to Foster Healthy Terrestrial and Aquatic Habitat
- Support Healthy Aquatic and Terrestrial Habitat by Ensuring Wastes are Properly Disposed of through Appropriate Sewage Treatment and Effective Solid Waste Programs
- Support the Character of the Subwatershed by Preserving Prime and Unique Agricultural Lands
- Support the Character of the Subwatershed by Preserving Rural Residential Land and Culture and Preserving / Enhancing Other Aesthetic Conditions
- Support the Character of the Subwatershed by Preserving Historical and Cultural Resources

Public Education

Education efforts seek to encourage changes in behavior that will encourage the adoption of management measures, ensure sustainability of the plan, and ultimately help achieve the subwatershed goals. **(EPA 12.2)**

Public education is essential for providing a basic understanding of watershed concepts and the environmental conditions that are causing problems. Many water quality problems result from individual actions (with collective impacts) and the solutions are often voluntary practices.

A number of communities in the subwatershed have been involved with public education efforts that have been mandated as part of their stormwater permit (see Chapter 1 for additional information). Each of the permitted communities has prepared and submitted a public education plan (PEP) to the MDNRE that is designed to promote, publicize, and facilitate education to raise the public's awareness and motivate positive behavior. The Clinton River Watershed Council (CRWC) was responsible for developing some of these PEPs and has and will continue to provide assistance in the design and implementation of educational activities undertaken as part of each community's PEP.

In order to capitalize on existing efforts in the Clinton River Watershed and provide the most cost-effective program possible, the SWAG has modeled the public education activities for the North Branch Subwatershed after the common elements present in each of the communities PEPs. As such, the public education activities optimize existing programs and materials from regional organizations currently conducting public education such as the CRWC, the Southeast Michigan Council of Governments (SEMCOG), and the Michigan State University Cooperative Extension (MSUE) Program. The elements of the North Branch Subwatershed public education effort are as follows:

- A 'Personal Watershed Stewardship Program' with the following key messages:
  - Definition of a watershed;
  - Knowledge of what watershed an individual lives in and has an impact on;
  - Importance of protecting watersheds; and,
  - Ways that individuals can impact the watershed through their activities;
- An 'Ultimate Storm Water Discharge Location and Potential Impacts' program with the following key messages:
  - Storm drains discharge to waterbodies;
  - Stormwater discharged from separate storm sewer systems does not receive treatment prior to discharge;
  - The environmental impacts of stormwater pollutants in the watershed; and,
  - Knowledge of the separate stormwater drainage system in an individual's neighborhood and the waterbody to which the stormwater is discharged;
- A 'Reporting of Illicit Discharges' program with the following key messages:

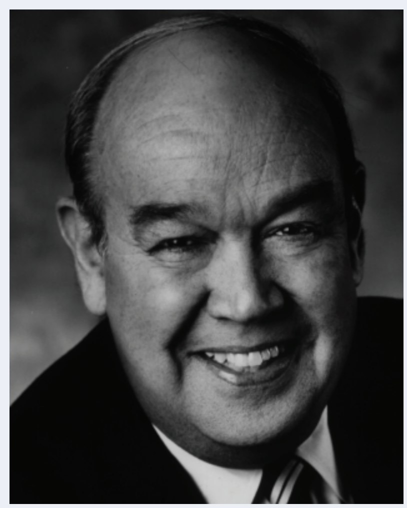
Target Audiences

There are specific groups of stakeholders that are target audiences for educational efforts. The target audiences identified in the North Branch Clinton River Subwatershed include:

- Agricultural Producers
- Residential Homeowners
- Industrial/Commercial Businesses
- Municipalities
- Youth

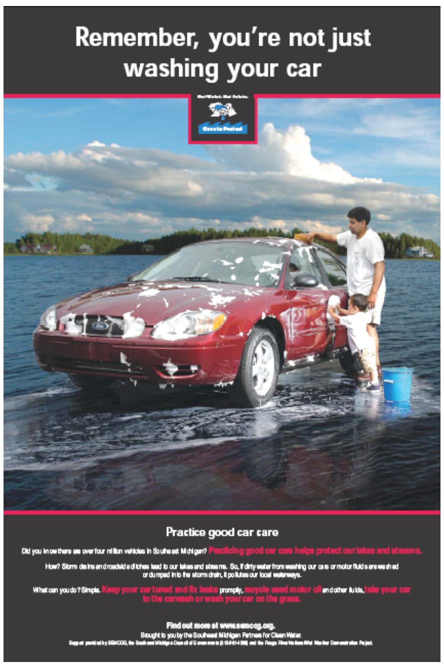
Quotable Quotation

"I started out thinking of America as highways and state lines. As I got to know it better, I began to think of it as rivers."



- Charles Kuralt

An Example of Public Education Materials Developed by SEMCOG



  - Definition of an illicit discharge and what to look for;
  - Promotion of the illicit discharge reporting system and how to report an illicit discharge;
  - Water quality impacts associated with illicit discharges and improper waste disposal;
  - Identification of failing on-site sewage disposal systems – physical symptoms to watch for; and,
  - Consequences/penalties associated with illicit discharges and improper waste disposal;
- A 'Personal Actions that Can Impact the Watershed' program with the following key message:
  - Best management practices for each of the following actions:
    - Car, pavement, and/or power washing (preferred cleaning materials and practices);
    - Pesticide use, fertilizer use, and their disposal;
    - Management of grass clippings, leaf litter, and animal wastes;
    - Residential de-icer use; and
    - Native vegetation on residential properties as an alternative to turf grass. The impacts of residential car, pavement, and power washing on water quality; and
  - Effects of residential wastes on our water bodies;
- A 'Waste Management Assistance' program with the following key messages:
  - Identification of household hazardous wastes and available alternatives; and
  - Disposal locations, requirements, and availability for household hazardous wastes and other chemicals, including motor vehicle fluids, travel trailer sanitary wastes, recreational boating sanitary wastes, and yard wastes; and
- A 'Management of Riparian Lands' program with the following key messages:
  - Importance of riparian corridors; and
  - Best management practices for riparian lands, including:
    - Protection through use of conservation easements;
    - Lawn maintenance for water quality (no-mow and no-chemical application areas);
    - Landscaping for water quality;
    - Shoreline stabilization techniques;
    - Proper septic system maintenance; and
    - Proper management of grass clippings, leaf litter, animal wastes, and other wastes.

The goals and objectives of the public education plan are not separately defined – they are the same as the goals and objectives for the plan as a whole (see Chapter 6). Public education is merely one of the many tools implemented to attain these goals and objectives. The specific actions associated with the public education effort are detailed in Chapter 8.

Effectiveness of Education Effort

The 2009 Social Survey that was conducted provides insight as to the effectiveness of the current public education effort as well as for planning for future education initiatives. The results of the survey have been summarized above and when compared to the MDNRE PEP requirements it can be seen that progress has been made. For example, the public generally knows the definition of a watershed. They also appear to be more cognizant that their actions affect the local water quality but they may not realize that this pertains to all residents not just those in immediate proximity to waterbodies. Another example of where education efforts have made inroads is with regard to impairments; the public is beginning to understand some of the impairments even if they do not associate the cost of introducing them to waterbodies. Changes in behavior have also been detected such applying low phosphorous fertilizer.

In general, the current educational effort appears to have elevated awareness of water quality issues in the consciousness of the general public but they still have limited knowledge on the subject. Consequently there has been only been a limited affect on behaviors to date.

Recommendations

The following recommendations are based on the results of the social surveys. The recommendations are as follows (numbering does not reflect priorities):

1. Institute an educational septic system program aimed at the inspection and maintenance of existing systems.
2. Incorporate more information with public education on impairments and the consequences associated with them; where to purchase eco-friendly products; as well as on techniques available to protect waterways (e.g. no-mow buffers).
3. Tailor marketing messages around enjoying the local scenic beauty, family activities and fishing. These are the most important activities to respondents.
4. Tailor all existing and new programs to the desired behavior of the target audience by cross referencing the constraints identified by respondents. For example, working with local suppliers to distribute information on how residence can better manage their property to help improve water quality.
5. Consider offering incentives to riparian property owners implementing BMPs and post construction controls on the site. Incentives could include fee reductions, technical support or even physical assistance.
6. Utilize MSU Extension, NRCS and the Farm Bureau for the distribution of water quality information intended for farm operations. For residential land owners, the transmission vehicles should be MSU Extension, The Clinton River Watershed Council and Michigan Department of Agriculture.
7. Promote existing subwatershed partnering efforts, especially those involving the Six Rivers Regional Land Conservancy. The two most supported policies were partnering with adjacent communities to undertake action and increasing parks / open space.
8. Increase work with agricultural producers through programs such as Farm-A-Syst and Crop-A-Syst to help them better understand

all the options available to implement BMPs. Producers identified lack of information as a constraint to implementing BMPs.

9. Use the Internet to distribute information. Efforts should be made to strengthen links from the subwatershed program information page and trusted information sources (e.g. Farm Bureau).

Current Public Education/Involvement Efforts

There are countless on-going efforts to educate and involve the public in the Clinton River Watershed and North Branch Subwatershed. These efforts include: the CRWC's Stream Leaders monitoring program, the CRWC's numerous regularly scheduled presentations and workshops (e.g. watershed background, native plants, lawn care, rain gardens and rain barrels, homeowner responsibility, clean boating, lakefront properties, farming practices, green roofs, business opportunities), the CRWC's Adopt-A-Stream program, the CRWC's river celebration days (Clinton Clean Up and River Day), the Clinton River Coldwater Conservation Project, the Lake St. Clair Clean Boating Campaign, signs throughout the watershed, educational programs for students, and numerous websites. There are also a host of resources that are dedicated to the Stormwater Phase II program that have materials and programs with messages that are also applicable to the non-regulated areas of the watershed such as the North Branch Subwatershed. A detailed list of existing public education programs is available in Appendix G.2.

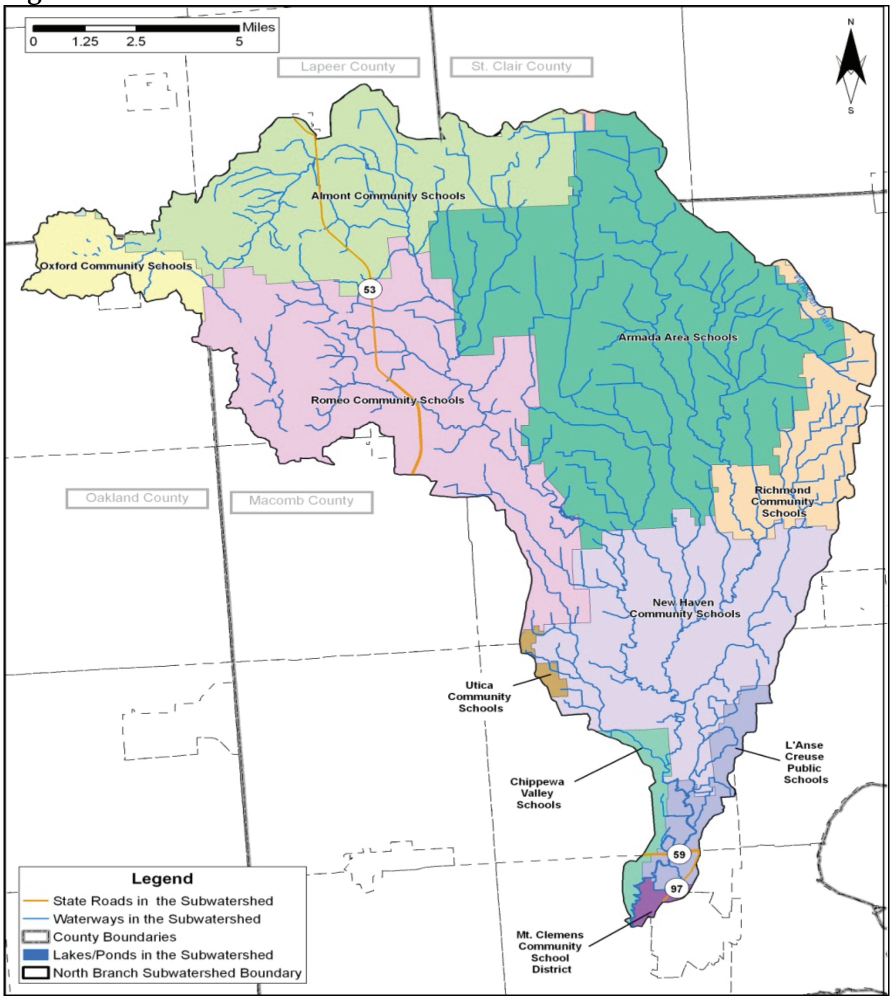
Future Public Education/Involvement

The public education and involvement efforts will continue to rely on existing programs to the extent possible. Based on the information presented in this chapter, additional messages for the target audiences may have to be selected or developed (if they do not currently exist) and appropriately packaged for the subwatershed (the rural nature of the subwatershed makes certain delivery mechanisms more appropriate than those that would be found in urban settings, e.g. mass mailings instead of billboards). The actual distribution of these messages and the evaluation of their effectiveness will also have to occur. The planned actions for doing all of these future education/involvement activities are defined in Chapter 8 with some of the evaluation-related information presented in Chapter 9.

School Districts

School districts are important partners in a watershed management plan. Often the school districts own numerous facilities that have extensive impervious and/or turf grass cover that contribute to problems associated with stormwater runoff (e.g. pollutants, flashiness). Additionally, the schools operated by the school districts are extremely important as the students in them are a key constituency of the public education and involvement efforts. The school districts that overlay the subwatershed are shown in Appendix A-2. The location of the schools themselves are also shown.

Figure 4-1. School districts in the North Branch Subwatershed.



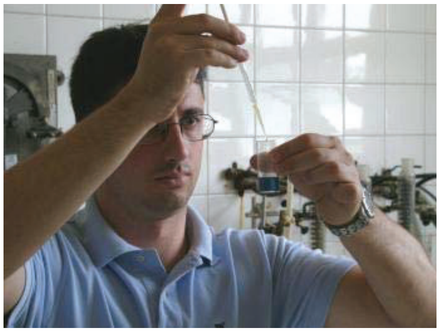
School Districts

The school districts in Macomb County that are participating in the SWAG (see Chapter 1) have been coordinating with the MCPWO to implement PEP activities.

Conclusion

Public involvement and participation was actively sought throughout the development process of the watershed management plan through various means. This input, along with data obtained and presented in Chapter 2 was used to focus the analysis of watershed problems for Chapter 5. The additional information and analytical results presented in Chapter 5 were then used to formulate the goals and objectives that are presented in Chapter 6.

5. Environmental Conditions Assessment



CMI Requirements in this Chapter

The following CMI requirements are addressed, at least partially, by the information that is presented throughout this chapter, including:.

- The designated uses that are not being met and those that are threatened; a list of desired uses;
- A list of known and suspected pollutants;
- Identification of critical areas;
- A list of all sources and causes for each pollutant in the critical area, which should be mostly verified;
- The number and location of sites corresponding with each source;
- A summary of the methods used to conduct the inventory;
- A prioritized list of designated uses, pollutants, sources, and causes and a description of the methods used to prioritize them

Acronyms and Terms

A complete list of acronyms and terms and their respective definitions can be found in Appendix A.1.

Chapter Purpose

Building on the information presented in Chapters 2, 3, and 4, the purpose of this chapter is to: 1) present the data and programmatic information for an analysis framework; 2) describe the data used for assessing the subwatershed conditions; 3) define the information gaps that data collection initiatives needed to fill the gaps; 4) present existing and newly collected data in order to gauge the conditions in the subwatershed on a catchment basis; 5) summarize the conditions in terms of: status of designated and desired uses and the causes, sources, stressors, impacts, and impairments; 6) discuss the critical areas of the subwatershed; and 7) a 'scorecard' for the subwatershed that summarizes the conditions for the elements in the conceptual model. **(EPA 5.1)**

The information in this chapter was utilized to determine the goals and objectives for the plan (Chapter 6), the priorities that should be addressed (Chapter 7), and to define the actions to be taken to achieve the goals and objectives (Chapter 8).

Limitations

The Environmental Protection Agency (EPA) recognizes the difficulty in obtaining relevant, accurate data with precision. Yet, it is critical to identify significant pollutant sources and specify the management measures that will most effectively address those sources so that broad estimates of the expected load reductions can be calculated. Without this analytic framework to provide focus and direction, it is much less likely that projects implemented under the plan can efficiently and effectively address the nonpoint sources of water quality impairments. However, even if reasonable steps are taken to obtain and analyze relevant data, the information available during the planning stage (within reasonable time and cost constraints) may be limited.

The analyses presented in this plan are as thorough as possible at this time. The data used in the analyses and the analytical techniques themselves will no doubt improve over time. Additionally, findings related to implementation of the plan will no doubt provide insights into numerous aspects of the plan. Given these considerations, major portions of the analyses in this plan (and subsequently the goals and objectives and actions) will need to be updated in the future as additional information becomes available. It is important to properly balance the need for detailed and accurate data supporting the plan with the need for a plan that can be implemented to address at least some of the environmental issues identified. The dynamic and adaptive manner in which the development and implementation of this plan is being conducted (as described in Chapter 1) is meant to ensure that this is possible; that implementation of the plan can proceed even though some of the information in the watershed plan is imperfect and might need to be modified over time as better information becomes available. **(EPA 2.2.1)**

Data

Existing Data

There is an abundance of information available documenting past and recent conditions in the subwatershed. The sources of this information include: primarily plans, studies, and datasets from regulatory agencies, are listed (along with a brief description of the information and findings, as appropriate) in Appendix E.1. Past studies and findings are not presented explicitly but have been considered and were appropriate referenced throughout the document. If additional information is needed it can be made available upon request. **(EPA 5.3, 5.3.1, 5.3.2, 5.3.3, 5.10, 6.1, 6.2)**

Gap Analysis and Data Collection

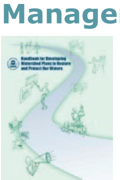
Although illuminating, this data is not sufficient in helping determine the current status of the stressors impacting the subwatershed, the impairments resulting from the impacts, the sources of the stressors, and the causes of the sources. Based on a gap analysis conducted on the known existing data and in consideration of the concerns and the public's desired uses (see Appendix E.1), a number of data collection programs have been utilized to ensure that the analyses in this plan reflect, to the greatest extent possible, the current conditions in the subwatershed. The data collection programs conducted in support of this plan include: **(EPA 5.2, 6.2, 6.3, 6.5, 7.2.7)**

- Unified Stream Assessment (USA) – (CWP, 2005a);
- Unified Subwatershed and Site Reconnaissance (USSR) – (CWP, 2005b); and
- A Social Survey (EPA, 2008).

The data is discussed as appropriate throughout the discussions presented in the following sections. Additionally, the MDNRE will be conducting monitoring in the Clinton River Watershed in 2009 and recommendations were made to conduct water quality and biological community monitoring on a number of waterbodies in the subwatershed, including: Deer Creek, Highbank Creek, McBride Drain, Camp Brook Drain, Mahaffy Drain, Tupper Brook, Newland Drain, Ray Lenox Drain, and Apel Drain.

All sources of data have been included in the References (Chapter 10).

Management: Organization, Storage, and Processing

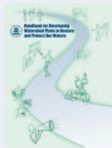


A challenging component of data analysis is the organization, storage, and manipulation of files. For the development of this plan, all appropriate raw data were initially placed into organizational folders under a common project folder. As the data was analyzed, new datasets were created in stored in alternate locations to ensure that only new data was modified. Maps generated for the plan and the data used to generate the maps were stored in the same location. Relative references to the data were made from the mapping software so that the files functioned regardless of where they were moved to in the future; so long as all of the data was intact. Details on these processes are presented in the Quality Assurance Program Protocol (QAPP). In addition, the metadata (where available) was downloaded and stored with each data set utilized **(EPA 6.4, 6.5)**.

Focused Data Gathering

The data-gathering and analysis phases of the watershed planning process are very important and often quite challenging. The Clinton River Watershed (CRW) is in the highly scrutinized Southeast Michigan region and there is a vast amount of information available. The data utilized in this plan (as presented through-out, but primarily discussed in Chapters 1, 2, 4, and 5) have been collected through a focused effort (in terms of data types and amount) designed to specifically facilitate development of the watershed management plan. The data collection effort relied heavily on the *Clinton River Restoration Plan* and additional early public input and important comprehensive reports that concern the CRW. **(5.2, 5.2.1, 5.2.2)**

Geographic Information System Considerations (GIS)



There are a number of considerations with respect to GIS that are worthwhile to note.

Data are sometimes in different **projections** (two dimensional representations of three dimensional space). Although differences can usually be rectified, errors may be introduced if projections are not the same.

The **scale** of the data included in a dataset will influence an analysis. For example, analysis of the high-resolution (large scale) National Hydrography Dataset (NHD) will yield a higher count of stream miles than one would find in the low resolution (small scale) NHD.

Many data are not collected on a regular basis. Important analytical data may be years old, and although useful in terms of analysis, it is important to know the **time frame** of the data.

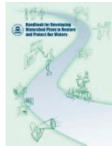
These elements have been considered as part of the normal analytical process supporting this plan, but where issues have arisen, additional discussion is provided. **(EPA 5.9.1)**

Nine Minimum Elements

319
a

The analyses in this chapter have been conducted to meet the first of the nine minimum elements (a) **Identification of causes and sources or groups of similar sources that need to be controlled to achieve load reductions, and any other goals indentified in the watershed management plan**

Data Analysis



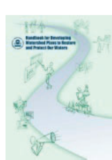
As with data collection, the analytical efforts were also focused to conserve resources. The resource of greatest value has been Geographic Information System (GIS) software. The GIS tool allows data to be analyzed spatially. All of the figures of the subwatershed in the plan have been developed, at least in part, utilizing GIS (specifically ESRI™ ArcGIS™). Many of the tables also rely on data extracted from GIS analyses (unless otherwise noted; also see sidebar).

Other analyses for data presented in this plan have utilized resources ranging from simple spreadsheets (Microsoft Excel™) to complex hydrologic/hydraulic models including Hydrologic Simulation Program – Fortran (HSPF). Although an important tool in terms of watershed management planning, remote sensing techniques have not been greatly exploited due to their cost-intensive nature. Certain analyses in this plan rely on digital data that has been derived from others' remotely sensed data (both aerial and satellite imagery), but only a very minor analyses has been conducted with respect to the most up to date aerial photography raw data for the subwatershed (which is from 2006). These analyses include the assessment of erosion areas, impacted buffers, and channel modifications to support the field data collection efforts (USA and USSR).

The major limitations of the analyses in this plan are generally the result of a lack of appropriate data. Although there are many programs generating data and organizations making data available, obtaining specific data (in a usable format) can be challenging. The major sources of data utilized in this plan include the State of Michigan and Macomb County. The sources of data and the programs that generated the data are presented where encountered in the plan. Other appendices and outside documents are referenced as appropriate. All the data utilized in the plan is also listed in the References (Chapter 10).

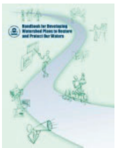
The remainder of this chapter presents analyses of all the environmental data that was obtained and collected in support of the plan. These analyses are presented within the source-stressor framework introduced in Chapter 3. The analyses are organized such that they first present the regulatory conditions that frame the assessments, then analyze information related to public input, followed by a an assessments of current parameters, and finally detail the documented conditions of specific stressors and sources throughout the subwatershed. The techniques used for analysis are those most appropriate for the situation and are described individually as encountered. **(EPA 5.9, 5.9.1, 5.9.2, 5.10, 6.1, 7.1, 7.1.1, 7.1.2)**

Assessment Framework Considerations



This section presents background information essential in understating the range of environmental conditions needed to assess the subwatershed. This information helps to generally characterize the subwatershed and identify the range of problems for further detailed analysis. The first step involves presenting the impairments. This is followed up with details of other regulatory compliance and programmatic classifications. **(EPA 7.2, 7.2.1)**

Designated Uses



As discussed at the end of Chapter 3, designated uses are an important subset of MDNRE's WQS. They define recognized important uses for waterbodies that are regulated by the state (see sidebar).

In its 2008 Integrated Report (IR) (MDEQ, 2008) the *MDNRE* identifies the status of designated uses for waterbodies in an assessment unit (typically a 12-digit HUC drainage area) throughout the state. The basis for the status determinations is generally environmental quality data collected in 2005 and 2006. Assessments of the data, with respect to the various WQS concentration limits or other thresholds, are then used to define the status of the uses (See Appendix E.3). For example, the status of fish consumption relies on the concentrations of mercury, PCBs and all other chemicals in fish and the water through a set of decision making criteria. The types of data used to assess the designated uses are presented in Chapter 3, but the assessment criteria and the decision making criteria are addressed in detail in the IR.

The designated use classifications presented in this subsection are those presented in the IR. Based on all of the data gathered and collected and analyzed in the plan (including additional water quality data, input from the stakeholders, and other sources such as newspapers), the final status of the designated uses is refined near the end of the chapter.

Integrated Report Categorized Waterbodies

The integrated report (IR) lists the designated use status for twenty assessment units throughout the subwatershed. Most of the assessment units apply to specific geographic areas but certain ones apply to overlapping geographic areas but different sets of waterbodies (e.g. waterways, a.k.a. streams/rivers, versus lakes/ponds). The status of the designated uses for the assessment units is presented in Table 5-2. This information is displayed graphically in Figure 5-1.

Only three of the reaches were evaluated for 'total body contact recreation' and 'partial body contact recreation' (the same ones that had a TMDL for pathogens developed in 2006: East Pond Creek, East Branch Coon Creek, and Deer Creek) and only East Pond Creek was found to be supporting either use, all others were classified as not supporting 'partial body contact recreation'. All reaches were supporting 'navigation', 'industrial water supply', and 'agriculture'. Only one reach was evaluated for 'warmwater fishery', East Branch Coon Creek, and deemed not supporting (a TMDL for dissolved oxygen was developed in 2006). All other reaches are classified as not assessed for warmwater fishery. None of the reaches where the 'cold water fishery' designation applies were assessed for that use; all others were classified as does not apply. Eleven reaches were found to be supporting 'other indigenous aquatic life and wildlife', eight were not assessed, and one (1) had insufficient information. All of the fourteen reaches were found to be not supporting the 'fish consumption' designated use due to PCBs and one (1), a stretch of the North Branch upstream of Wolcott Mills Park, was also not supporting the use due to mercury.

(EPA cont'd)

Designated Uses

The designated uses for waterbodies in the State of Michigan are (as presented in Chapter 3):

- Agriculture;
- Navigation;
- Industrial Water Supply;
- Warmwater Fishery;
- Other Aquatic Life / Wildlife;
- Partial Body Contact;
- Fish Consumption;
- Total Body Contact (May 1st – October 31st);
- Coldwater Fisheries (specifically identified waterbodies only); and
- Public Water Supply (specifically identified waterbodies only).

Designated Use Status Classifications

The following classifications are associated with the designated uses:

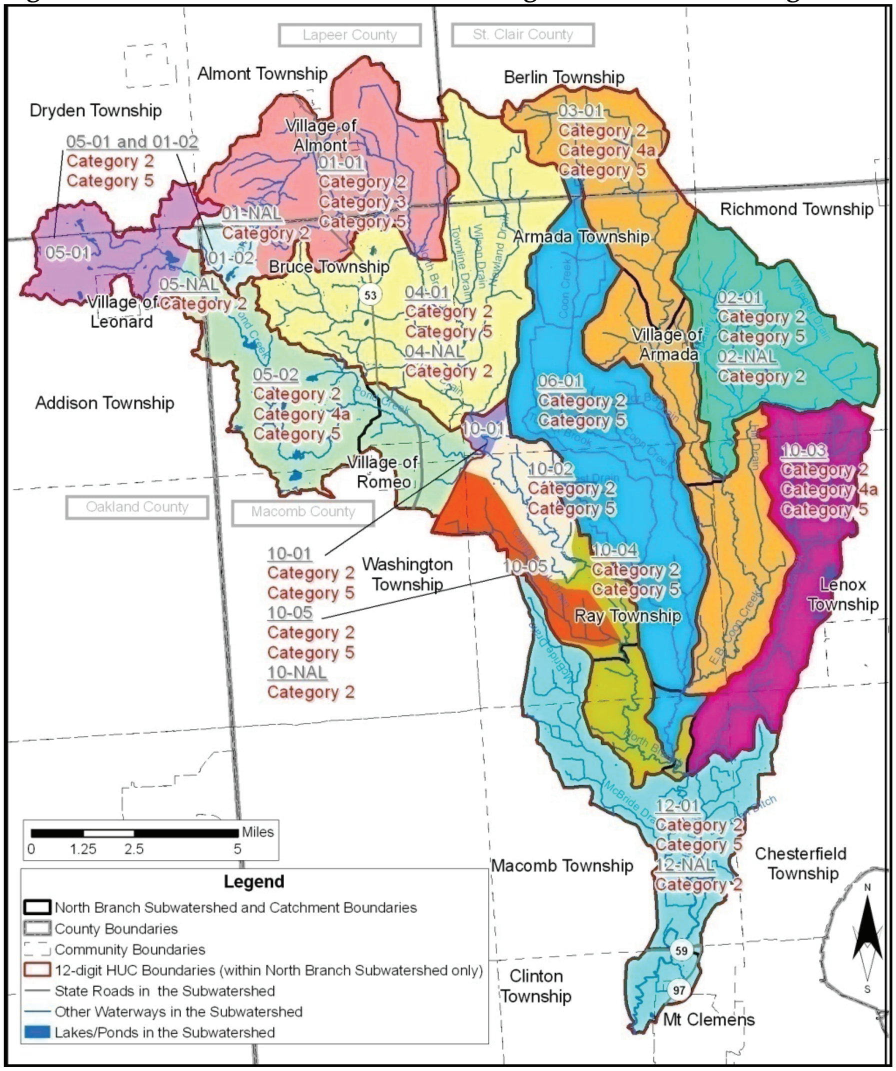
- Does Not Apply (-) - this means that the designated use is not applicable to the particular waterbody (in the 2008 report, this category is classified as 'Not Assessed' due to database limitations);
- Not Assessed (NA) – data not collected to evaluate the designated use status for the waterbody in question;
- Insufficient Information (II) – data is not available to accurately classify the status of the designated use for the waterbody in question;
- Supporting (S) – data indicate that the designated use is being supported by the waterbody in question; and
- Not Supporting (NS), i.e. impaired – data indicate that the designated use is not being supported by the waterbody in question. Source: (MDEQ, 2008).

Table 5-1. Designated use assessments.

Assessment Unit (HUC plus index number), Primary Waterbodies, and Notes (refer to Figure 2-12 for cross-reference of subwatershed catchments to HUCs); underlined text is short name - Figure 5-1 - = does not apply; NA^ = not assessed; II = insufficient information; S = supporting; NS = not supporting Where designated use is classified as Not Supporting (NS), the next line refers to the stressor and the final line indicates the TMDL year *=organic enrichment (sewage), biological; dissolved oxygen (DO), total suspended solids (TSS); Source: (MDEQ, 2008)	**Total Body Contact Recreation**	**Partial Body Contact Recreation**	**Navigation**	**Industrial Water Supply**	**Agriculture**	**Warmwater Fishery**	**Other Indigenous Aquatic Life and Wildlife**	**Cold Water Fishery**	**Fish Consumption**	**Public Water Supply**
040900030301-02 North Branch; McKay Drain; Unnamed Tributaries Note: refers to all waterways in downstream majority of the HUC	NA	NA	S	S	S	NA	S	NA	NS PCB 2010	-
040900030301-01 North Branch; Unnamed Tributary Note: refers to all waterways in an upstream portion of the HUC	NA	NA	S	S	S	NA	II	NA	NS PCB 2010	-
040900030301-NAL Un-assessed Lakes Note: refers to all lakes throughout entire HUC	NA	NA	S	S	S	NA	NA	-	NA	-
040900030302-01 Highbank Creek Note: refers to all waterways throughout the HUC	NA	NA	S	S	S	NA	S	-	NS PCB 2010	-
040900030302-NAL Un-assessed Lakes Note: refers to all lakes throughout entire HUC	NA	NA	S	S	S	NA	NA	-	NA	-
040900030303-01; East Branch Coon Creek; Hill Drain; Ray-Lenox Drain; Stark Drain; Woodbeck Drain; Unnamed Tributaries; Note: refers to all waterways throughout entire HUC; * see top	NS *E.coli.* 2006	NS *E.coli.* 2006	S	S	S	NS * 2006	S	-	NS PCB 2010	-
040900030304-01; North Branch; Farley Drain; Apel Drain; Mahaffy Drain; Newland Drain; Townline Drain; Unnamed Tributaries; Note: refers to all waterways throughout entire HUC	NA	NA	S	S	S	NA	S	-	NS PCB 2010	-
040900030304-NAL Un-assessed Lakes Note: refers to all lakes throughout entire HUC	NA	NA	S	S	S	NA	NA	-	NA	-
040900030305-01 East Pond Creek, Unnamed Tributaries Note: refers to all waterways upstream of Secord Lake	NA	NA	S	S	S	NA	S	-	NS PCB 2010	-
040900030305-02 East Pond Creek, Hidden Lake Outlet Note: refers to all waterways downstream of Secord Lake	NS *E.coli.* 2006	S	S	S	S	NA	S	NA	NS PCB 2010	-
040900030305-NAL Unassessed Lakes Note: refers to all waterways throughout entire HUC	NA	NA	S	S	S	NA	NA	-	NA	-
040900030306-01; Coon Creek, Armada and Ray Drain, Priest Drain, Tupper Brook, Unnamed Tributaries; Note: refers to all waterways throughout entire HUC	NA	NA	S	S	S	NA	S	-	NS PCB 2010	-
040900030310-01; North Branch; Note: refers to all waterways in the upstream portion (between upstream HUC boundary and 32 Mile Road) of the western half of HUC	NA	NA	S	S	S	NA	NA	NA	NS PCB 2010	-
040900030310-02 North Branch; Wyman Drain; Note: refers to all waterways between 32 Mile Road and Wolcott Mills Park dam in the western half of HUC; ** = PCBs, 2010 & Mercury, 2011	NA	NA	S	S	S	NA	NA	NA	NS ** **	-
040900030310-03 Deer Creek Note: refers to all waterways in the eastern half of HUC	NS *E.coli.* 2006	NS *E.coli.* 2006	S	S	S	NA	S	-	NS PCB 2010	-
040900030310-04; North Branch; Note: refers to all waterways in the downstream portion (between the Wolcott Mills Park dam and the outlet of the HUC) of the western half of HUC	NA	NA	S	S	S	NA	S	NA	NS PCB 2010	-
040900030310-05 Camp Brook Drain; Note: also includes all the waterways in the HUC tributary to the Camp Brook Drain	NA	NA	S	S	S	NA	S	-	NS PCB 2010	-
040900030310-NAL Un-assessed Lakes Note: refers to all lakes throughout entire HUC	NA	NA	S	S	S	NA	NA	-	NA	-
040900030312-01; North Branch; Conklin Drain; Hammon Drain; Hart Drain; McBride Drain; Thoel Drain; Unnamed Tributaries; Note: refers to all waterways throughout the entire HUC	NA	NA	S	S	S	NA	S	NA	NS PCB 2010	-
040900030312-NAL Un-assessed Lakes Note: refers to all lakes throughout entire HUC	NA	NA	S	S	S	NA	NA	-	NA	-

^ = public water supply was not reported for assessment units where there is not a public water supply intake and it is assumed that the appropriate classification should be 'does not apply' (-); in the 2008 IR, NA is used for both those that were 'not assessed' (NA) and those that 'do not apply' (-); in most cases it was assumed the meaning was 'not assessed' unless it was explicitly known that a use 'does not apply'

Figure 5-1. Assessment units and their designated use status categories based on the MDEQ's 2008 integrated report.



Source, data: (MIGDL, 2008); (MDEQ, 2008). Catchment boundaries as modified by Tetra Tech. Assessment units as interpreted by Tetra Tech.

TMDLs for this 'fish consumption' (based on stressors) are scheduled for 2010 and 2011, respectively. In 2006, the IR listed the entire watershed as impaired for PCBs. As described above, in 2008, this impairment has been distributed to each of the waterway's reaches (but not the lake assessments units). None of the assessment units have public water supply intakes (from surface waters) so they are all classified as "does not apply."

The 'threatened' classification (where a designated use is supported but data indicates that it may not be supported in the next integrated report); was not utilized throughout the 1,400 pages of Appendix B of the IR.

The TMDLs discussed mentioned in this section are addressed in detail in the following subsection. **(EPA 5.6.2)**

Categories

As presented in Chapter 3, the designated use based waterbody classifications are:

- Category 1 – All designated uses are supported, no use is threatened.
- Category 2 – Available data/information indicate that some designated uses are supported but still none are threatened.
- Category 3 – There is insufficient data/information to make a designated use support determination.
- Category 4 – Available data/information indicate that at least one designated use is impaired or is threatened, but a TMDL is not needed.
  - 4a – TMDL has been completed.
  - 4b – Other pollution control requirements are reasonably expected to result in attainmen of the designated use in the near future.
  - 4c – Impairment is not caused by a pollutant.
- Category 5 – Available data/information indicate that at least one designated use is impaired or is threatened, and a TMDL is needed.

Source: (MDEQ, 2008).

Not Assessed Uses

The not assessed (NA) category is used in many instances. In this report, this category is used for both does not apply (-) and not assessed (NA) uses. For cold water fisheries, the waterbodies in this category are known, so NA could be interpreted correctly. For others, it was always assumed that the use applies so as to not incorrectly discount a use that should be considered for further evaluation.

Existing Total Maximum Daily Loads

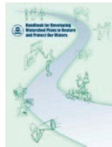


Figure 5-1 shows that there are four impairments in the subwatershed for which Total Maximum Daily Loads (TMDLs) have been developed. The details of the TMDLs (including waterbody, reach, listed problems, impairments, WQS, sourcesand stressors, and type) are presented in Table 5-2. The TMDL reports can be found at the MDNRE TMDL web site.

Table 5-2. TMDLs in the subwatershed.

Water-body	Reach	Year	Listed Problem: Stressor / Source	Use Impair-ments	Relevant WQS	Potential Sources and Additional Stressor Details	TMDL Type
East Branch Coon Creek	Highbank Creek confluence to upstream of Armada (12 miles)	2006	Pathogens* / CSOs * documented *E. coli* WQS exceedances	Total Body Contact Recreation	Rule 62: Micro-organisms (E. coli and Fecal Coliforms)	Agricultural land, illicit connections, septic systems, urban land (including two industrial stormwater permits), transportation infrastructure* (including MDOT and Macomb County stormwater permits), Armada WWTP Historic CSOs may have lingering impacts	Concentration-based (meet WQS)
East Branch Coon Creek	New Haven Road upstream to McPhall Road (14 miles)	2006	D.O. (WQS violations)	Warmwater Fishery & Other Indigenous Aquatic Life and Wildlife	Rule 64: Dissolved Oxygen	Agricultural land, illicit connections, septic systems, urban land (including two industrial stormwater permits), transportation infrastructure (including MDOT and Macomb County stormwater permits), Armada WWTP Primary stressor is oxygen demand (particularly sediment oxygen demand (SOD) from historic CSO deposits and on-going sedimentation); Secondary stressor is nutrients (causes plant growth and excessive respiration)	Load-based Total Suspended Solid (TSS) reduction – addresses both SOD and nutrients
Deer Creek	North Branch confluence upstream (7 miles)	2006	Pathogens* * documented E. coli WQS exceedances	Total Body Contact Recreation	Rule 62: Micro-organisms (E. coli and Fecal Coliforms)	Agricultural land, illicit connections, septic systems, urban and residential land (including three industrial stormwater permits), transportation infrastructure* (including MDOT, Macomb County, and two township stormwater permits), pet and/or wildlife areas	Concentration-based (meet WQS)
East Pond Creek	North Branch confluence upstream to East Mill Lake outlet (NW of Romeo)	2006	Pathogens* / Untreated Sewage Discharges * documented E. coli WQS exceedances	Total Body Contact Recreation	Rule 62: Micro-organisms (E. coli and Fecal Coliforms)	Agricultural land, septic systems, urban and residential land (including five industrial, Macomb County, and two township stormwater permits*), pet and/or wildlife areas, Romeo WWTP, Armada Industrial Park WWTF * MDOT permit and transportation infrastructure not listed but should be considered as per other TMDLs	Concentration-based (meet WQS)

Source, data: (MDEQ, 2006)

Beneficial Use Impairments

As a Great Lakes Area of Concern the entire Clinton River is subject to a second additional set of water quality criteria – Beneficial Use Impairments (BUI). Simply put a BUI is a water quality impairment (e.g. toxics) that prevents a waterbody from being used for specified "Best Uses" (e.g. eating fish).

Of the fourteen Beneficial Use Impairments (BUIs) associated with the Areas of Concern (AOC) program (see Chapter 3), the Clinton River Watershed / AOC is listed for eight of them (as listed in the sidebar).

The explanation, scope, and Great Lakes impact of these BUIs are given in **Table 5-3** – as adapted from *Restoration Criteria for the Clinton River Area of Concern* (CRWC, 2005) and *Final Restoration Criteria for the Clinton River Area of Concern* (CRWC, 2007).

Because the subwatershed represents only a portion of the AOC, only certain BUIs are applicable. These applicable portions are denoted with *italic* text (also shown for the BUI text in the sidebar). ~~Strikethrough~~ text indicates those portions that are not applicable. From the BUI and explanation text, a list of impacts/impairments, stressors, sources, and causes to consider (both likely, from the italic text, and potential) can be developed: (list continued on following page)

Beneficial Use Impairments for the Clinton River AOC

The Clinton River AOC is listed for eight BUIs, including:

- Restrictions on fish & wildlife consumption (#1);
- *Degradation of fish & wildlife populations (#3);*
- *Degradation of benthos (#6);*
- Restrictions on dredging activities (#7);
- Eutrophication or undesirable algae (#8);
- *Beach closings and other 'full body contact' restrictions (#10);*
- *Degradation of aesthetics (#11); and*
- *Loss of fish & wildlife habitat (#14).*

Table 5-3. Summary of Beneficial Use Impairments (BUIs) in the Clinton River AOC.

BUI	Explanation	Type (Habitat, Non-Habitat)	Scope (watershed; localized)	Impact to Great Lakes (Yes/No)
1	Fish consumption advisory ~~for the portion of the river below the Yates Dam~~ for PCB contamination specific to Carp, Rock Bass, and White Sucker; current sources of PCB are contaminated sediments and potentially non-point sources	Non-Habitat	Local	Yes
3	*Degraded native mussel populations attributable to in-stream sedimentation; zebra mussel presence may also threaten native mussel fauna; warm water fishery impaired by sedimentation, impoundment, changes in hydrology; cold water fishery in ~~Main Branch, Paint Creek, Stony Creek,~~ East Pond Creek threatened by sedimentation, low flows, habitat loss, elevated summer temperatures*	Habitat	Water-shed	Yes
6	*Benthic communities are impaired throughout the watershed because of sedimentation, and at specific locations due to contaminated sediments*	Habitat	Water-shed	No
7	Guidelines for open water disposal of sediments from the navigational channels are exceeded ~~in the lower Clinton River including the Clinton River East and Red Run subwatersheds~~ for PCBs, oil, grease, and metals; Confined disposal and special handling of sediments required for dredging and disposal operations	Non-Habitat	Local	No
8	Excessive algal growth occurs ~~in the lower Clinton River~~ and inland lakes primarily due to high nutrients from storm water runoff and low flows	Non-Habitat	Local	Yes
10	~~CSOs~~*, *urban and rural storm water runoff, failing septic systems, animal waste, and illegal connections to storm sewers all contribute to elevated fecal bacteria levels in many locations throughout the watershed;* *historically in subwatershed but no longer present	Non-Habitat	Water-shed	Yes
11	*Widespread erosion and in-stream sedimentation; localized algal blooms, habitat degradation, litter, log jams*	Non-Habitat	Water-shed	No
14	*Urban sprawl and inadequate land use planning; erosion, wetland loss, dams, hydrological changes, alteration of riparian habitat*	Habitat	Water-shed	Yes

Source, data: (CRWC, 2007).

- Impairments / Impacts
    - Restriction on fish and wildlife consumption – potential; PCB contamination specific to carp, rock bass, and white sucker – potential;
    - Degradation of fish and wildlife populations – likely; impaired warm water fishery – likely; impaired cold water fishery – likely
    - Degradation of benthos – likely; degraded mussel populations – likely; impaired benthic communities – likely;
    - Restrictions on dredging activities – potential
    - Eutrophication or undesirable algae – potential; localized algal blooms - likely
    - Beach closings and other 'full body contact' restrictions – likely
    - Degradation of aesthetics – likely
    - Loss of fish and wildlife habitat – likely
- Stressors
    - Nutrients – potential;
    - Heavy Metals – potential;
    - Organic Compounds (PCBs, oil, grease) – potential;
    - Suspended Solids / Sediment (in-stream sedimentation) – likely;
    - Debris (litter, log jams) – likely;
    - Temperature (elevated summer temperature) – likely;
    - Hydrologic / Hydraulic Characteristics (changes in hydrology, low flows) – likely;
    - Natural Feature / Habitat Degradation (habitat degradation / loss, wetland loss, alteration of riparian habitat) – likely;
    - Invasive Species (zebra mussels) – likely;
    - Pathogens (elevated fecal bacteria levels) – likely;
- Sources and *Causes*
    - Illicit Discharges / Spills (illicit connections) – likely;
    - Urban and Residential Land (urban and rural stormwater runoff) – likely;
    - Transportation Infrastructure (urban and rural stormwater runoff) – likely;
    - Agricultural Land (rural stormwater runoff) – likely;
    - On-site Disposal Systems (septic systems – *failing*) – likely;
    - Contaminated Sediments – likely;
    - Atmospheric Deposition (non-point sources) – potential;
    - Soil Erosion (widespread erosion) – likely;
    - Animal Sources (animal waste) – likely;
    - Other Human Activities (dams / impoundments) – likely;
    - Natural Occurrences and Disturbances (non-point sources) – potential; and
    - *Land Use Planning / Urban Sprawl* – associated with many sources – likely.

The six other BUIs (shown in the sidebar) are not applicable in the Clinton River Watershed / AOC, but are important to establishing a preventative component for this plan.

The data supporting the beneficial use classifications (as reported in Remedial Actions Plan – e.g. the Clinton River Restoration Plan – and other supporting documents) are presented and included in analyses later in the chapter (or in appendices).

Beneficial Uses that are Not Impaired in the Clinton River Watershed / AOC

The Clinton River AOC is considered to not be impaired for six BUIs, including:

- Tainting of fish and wildlife flavor (#2);
- Fish tumors or other deformities (#4);
- Bird or animal deformities or reproductive problems (#5);
- Restrictions on drinking water consumption or taste/odor problems (#9);
- Degradation of phyto- and zooplankton populations (#12); and
- Added costs to agriculture and industry (#13).

Potential Designated Use Impairments

Based on the BUIs in the Clinton River Watershed / AOC and the relationship between the BUIs and designated uses, the following designated uses are potentially threatened or impaired for some waterbodies in the subwatershed:

- Warmwater Fishery;
- Other Indigenous Aquatic Life and Wildlife;
- Fish Consumption;
- Coldwater Fishery;
- Navigation;
- Partial Body Contact Recreation;
- Total Body Contact Recreation;
- Agriculture; and
- Industrial Water Supply.

Other Programmatic Considerations

There are a number of other agencies and programs that classify environmental conditions. Many of these that are of use are discussed in this subsection (along with findings as they relate to the subwatershed).

Fish Consumption Advisories

Advisories to limit the consumption of organisms are published by MDNRE and the MI Department of Community Health (MDCH). These advisories are typically for fish but may also be issued for other aquatic life or wildlife. These advisories indicate the presence of undesirable contaminants in consumable organisms at potentially harmful levels (and thus indicate the presence of these contaminants in the natural environment)

According to the EPA's National Listing of Fish Advisories (EPA-NLFA, 2007), there are only fish consumption advisories for the State of Michigan (the *2008 Michigan Waterfowl Hunting Guide* notes a number of waterfowl consumption restrictions but none in the subwatershed). As listed in the *2008 Michigan Family Fish Consumption Guide* (MDCH, 2008), there are no fish consumption advisories (FCAs) specifically within the subwatershed but in 2009 an advisory due to PCB from the Yates Dam to the mouth was added. The statewide FCA for mercury which was first adopted in 1993 (EPA-NLFA, 2007) is applicable and is detailed in Table 5-4.

Table 5-4. Fish consumption advisories.

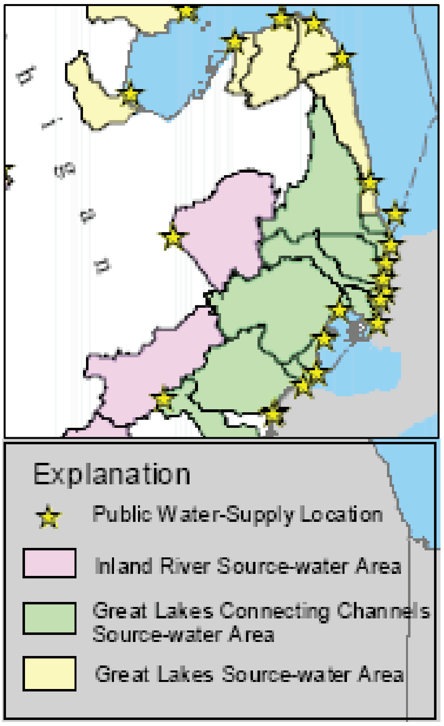
Waterbodies	Geographic Extent	Fish Species	Fish Size	Impacted Population	Restriction
Inland Lakes, Reservoirs, and Impoundments	Statewide	Rock bass, yellow perch, or crappie	Over 9 inch	All people	No more than one meal per week
Inland Lakes, Reservoirs, and Impoundments	Statewide	Large-mouth bass, smallmouth bass, walleye, northern pike, muskellunge	-	All people	No more than one meal per week
Inland Lakes, Reservoirs, and Impoundments	Statewide	Rock bass, yellow perch, or crappie	Over 9 inch	Women who are pregnant or may become pregnant in the future and children under fifteen (15) year old	No more than one meal per month
Inland Lakes, Reservoirs, and Impoundments	Statewide	Large-mouth bass, smallmouth bass, walleye, northern pike, muskellunge	-	Women who are pregnant or may become pregnant in the future and children under fifteen (15) year old	No more than one meal per month

Source: (MDCH, 2008).

The data supporting the fish consumption advisories is generated by the MDNRE's fish contaminant monitoring program. The program and data from the subwatershed are discussed later in the chapter.

The fact that the only FCAs is the subwatershed are statewide advisories has positive implications in that the sources of these impairments are not specific to the subwatershed but are at a much larger scale and generally not appropriate to be addressed as a main focus of the plan. **(EPA 5.8.1)**

Source Waters Areas in Southeast Michigan



Source: (MDEQ-USGS, 2003).

MDEQ Source Water Assessment

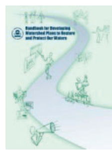
The source assessment addressed three categories of water supply: non-community groundwater, community groundwater, and surface water. The data in the report is only presented on a statewide basis. This data indicates that 69% of non-community supplies are at least moderately high in susceptibility to pollution but only 31% of community supplies are at least moderately high in susceptibility. Separate assessments were conducted for each surface water intake (see the following page).

Source: (MDEQ-SWA, 2004).

Contact Advisories / Beach Closings

To protect human health, contact advisories are issued and beaches are closed when measured levels of pathogens exceed regulatory or other guideline standards. As such, the occurrence of contact advisories and beach closings can be used as an indicator of excessive pathogen concentrations. However, neither the EPA's Beaches website (EPA-B, 2008) nor the counties (MCHD, 2008) indicate that there are monitored beaches within the subwatershed (although this does not preclude the existence of swimming areas, just monitored ones).

Source Water Assessments / Wellhead Protection Plans



The MDNRE has completed a Source Water Assessment Program (SWAP) – as required by the 1996 reauthorization of the federal Safe Drinking Water Act (SDWA) – to analyze existing and potential threats to the quality of public drinking water (MDEQ-SWA, 2008). The Clinton River Watershed (and by inclusion, the North Branch Subwatershed) falls into the source water area for public water supply intakes in the Great Lakes connecting channels (in this case, Lake St. Clair which has an intake for the City of Mt. Clemens water system near the mouth of the Clinton River and for the Detroit Water and Sewerage District – DWSD – which has an intake near the outlet of the lake). The source water assessment (SWA) indicates sources of contamination (i.e. stressors) and the susceptibility of these water supplies (and other well-based supplies in the region) to the stressors. This information is summarized in the sidebar.

In its *2007 Water Quality Report* (DWSD, 2008), the DWSD indicates that its water is highly susceptible to a number of contaminants, including:

- Microbial contaminants (i.e. pathogens) such as viruses and bacteria,
  - Sources: WWTPs, septic systems, agricultural operations (e.g. livestock), and wildlife;
- Inorganic compounds such as salts and metals,
  - Sources: naturally occurring, urban stormwater runoff, industrial discharges, treated and untreated sewage discharges, oil and gas production, mining, and farming;
- Organic compounds including synthetic and volatile compounds,
  - Sources: industrial processes, petroleum production, gas stations, urban stormwater runoff, and septic systems;
- Pesticides and herbicides (which can be inorganic, organic, and contain heavy metals),
  - Sources: agriculture, urban stormwater runoff, and residential uses; and
- Radioactive contaminants,
  - Sources: naturally occurring, oil and gas production, and mining.

Specific monitored pollutants (with environmental sources) noted in the DWSD's water quality report (DWSD, 2008) include (as reported by law and also in the drinking water quality report for the Mt. Clemens system):

- Nitrate (classified as a nutrient in this plan, but in the DWSD report is treated as an inorganic chemical due to its human health impacts) from fertilizer containing runoff, septic tank leaching, sewage discharges, and erosion of natural nitrate deposits;
- Fluoride (an inorganic chemical) primarily from amounts added during the treatment process, fertilizer containing runoff, aluminum factories, and erosion of natural fluoride deposits;
- Sodium (an inorganic chemical) from the erosion of natural deposits;
- Turbidity (as a measure of suspended solids) from soils in runoff;
- Coliform bacteria (pathogens), specifically *E. coli* or fecal coliforms that are naturally occurring and from various other sources;
- Lead and copper (heavy metals) leaching from wood preservatives and from the erosion of natural deposits; and
- Total organic carbon (an aggregate measure of organic compounds, i.e. chemicals, and biomass) that is naturally occurring and from various other sources.

The DWSD notes that it is complying with all regulatory requirements and providing high quality water despite the many stressors in the water. It acknowledges that pharmaceuticals and personal care products (for both humans and animals) are a concern of many people and says that the U.S. Food and Drug Administration (FDA) has data showing levels in the environment are far below levels that cause human health impacts. The DWSD is participating in studies that are examining this issue in greater detail. The sources of these compounds are: human excretion, showered or washed off compounds, and discarding of expired medications.

There is only one community that has delineated a wellhead protection boundary that is in the subwatershed: the City of Richmond. This city is not in the subwatershed, but its wellhead protection zone encompasses a very small portion of the subwatershed. The Village of Romeo has an approved work plan from the State of Michigan to develop a wellhead protection plan (WPP) which will include a wellhead protection boundary. It is important to consider the existing and future wellhead protection plans and their boundaries in future watershed management activities to ensure that the actions outlined in there respective WPP address the stressors and sources of concern identified in this WMP

Even without data concerning the specific wells in the subwatershed, it is still known which areas have a high potential for surface water contamination of groundwater and which pollutants have the potential to impact these resources.

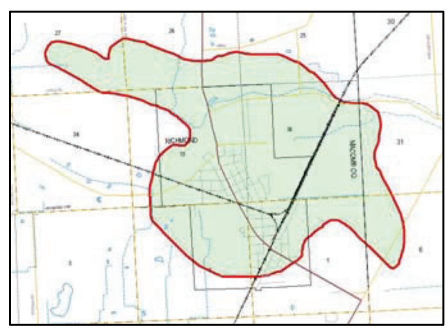
(EPA 5.6.3)

Consumer Confidence Reports

EPA's Consumer Confidence Report (CCR) rule establishes minimum requirements for the content of annual reports that community supplies must deliver to their customers. These reports must contain information on the quality of the water delivered by the supplies and characterize the risks (if any) from exposure to contaminants detected in the drinking water in an accurate and understandable manner. All community water supplies must develop a CCR, but smaller systems may simply reprint it in a local newspaper or provide a notice that the report is available on request.

Source: (EPA-OW, 2002).

Wellhead Protection Area for the City of Richmond



Source: (MDEQ-W, 2008).

More Information on Threatened and Endangered Species can be found in the *Clinton River Restoration Plan*.

Threatened and Endangered Species

The MDNR provides information on threatened and endangered species in Michigan. This work is coordinated by the Michigan Natural Features Inventory (MNFI). Table 5-5 identifies any plants or animals that are found in a subwatershed catchment and listed at the federal and/or state level.

Table 5-5. Rare animals and plants recently encountered in the watershed / AOC.

Common Name	Scientific Name	Federal Status	State Status	East Pond Creek (M)	North Branch – Lower (A)	North Branch – Lower Middle (B)	North Branch – Middle (C)	Coon Creek – Lower (C)	Deer Creek (C)	North Branch – Upper Middle (D)	North Branch – Upper (E)	North Branch – Headwaters (F, G)	E.B. Coon Creek – Lower (H)	E.B. Coon Creek – Middle (H)	Coon Creek –Upper (H, J, K)	Highbank Creek (I)	E.B. Coon Creek – Upper (L)
Animals																	
Brindled Modtom (NER*)	*Noturus miurus*		S	X		X	X			X							
Channel darter (NER*)	*Percina copelandi*		E							X							
Elktoe	*Alasmidonta marginata*		S		X	X				X							
Rainbow	*Villosa iris*		S	X	X	X	X	X	X	X	X						
Round Pigtoe	*Pleurobema coccineum*		S	X	X	X				X	X						
Slippershell Mussel	*Alasmidonta viridas*		S	X	X	X	X	X	X	X	X	X	X	X	X		
Snuffbox	*Epioblasma triquetra*		E		X	X											
Wavy-rayed lamp mussel	*Lampsilis fasciola*		T		X	X	X	X	X	X							
Plants																	
Davis's Sedge (NER*)	*Carex Davisii*		S			X											
Goldenseal	*Hydrastis Canadensis*		T	X													
Lake Cress	*Armoracia*		T		X												
Orange Fringed Orchid (NER*)	*Platanthera ciliaris*		T	X							X	X					
Oswego Tea	*Monarda didyma*		X			X	X	X	X	X			X	X	X		
Panicled Hawkweed	*Hieracium paniculatum*		S	X		X				X							
Richardson's Sedge	*Carex richardsonii*		S	X		X				X							
Rosinweed	*Silphium integriofolium*		T				X	X	X								
Round Hickorynut	*Obovaria subrotunda*		E		X	X											
Showy Orchis	*Galearis spectabilis*		T			X	X	X	X								
Shumard's Oak	*Quercus shumardii*		S							X							
Virginia Flax	*Linum virginianum*		T	X													

Note: the data is grouped based on old 14-digit HUCs so some catchments correspond to singular HUCs, some catchments have multiple HUCs that comprise them, and some catchments are a portion of a single HUC; where a HUC intersects more than one catchment, the data associated with that HUC was applied to each catchment; the letters following the catchment names indicate how the catchments and the HUCS intersect, where (using both the old the *14-digit number system* / and Michigan 12-digit numbering system and given that all HUCs begin with *04090003020* / 0409000312 and end with the following digits) A = *170* / 38, B = *120* / 33, C = *110* / 32, D = *050* / 26, E = *030* / 24, F = *010* / 22, G = *020* / 23, H = *100* / 31, I = *not given** / 28, J = *not given** / 30, K = *080* / 29, L = *not given**/ 27, and M = *040* / 25 (see Figure 2-12 for boundaries); * 'not given' means that the number was not available due to a website problem and an alternate source of the data was not identified
* NER = Northern Extent of Range

Source, data: (MNFI, 2008); (Francis, 2006).

At the state level the rare species classification scheme is as follows:

- Special Concern (S) – those species which are very uncommon in Michigan or have a unique habitat requirement and deserve careful monitoring;
- Threatened (T) – species likely to become classified as endangered within the foreseeable future;
- Endangered (E) – species that are near extinction throughout all or a significant portion of its range in Michigan; and
- Extirpated (X) – those species which once existed in Michigan but do not anymore (not encountered but believed to no longer exist, based on field surveys, in ranges in which they once did). Extirpated fish are shown on page 5-22.

The federal classification scheme is as follows (with just those that are appropriate listed):

- Being Considered (C) – those species which are currently being considered for classification as threatened or endangered;
- Threatened (T) – those species likely to become endangered within the foreseeable future throughout all or a significant portion of their range; and
- Endangered (E) – those species that are in danger of extinction throughout all or a significant portion of their range.

Wetlands

Wetland are a threatened and endangered land use category. Defined as land where saturation with water is the dominant factor determining soil types, plant communities, and animal communities (Cowardin, 1979), wetlands are under constant pressure due to human development.

Wetlands are often found in riparian and headwater areas and provide the essential ecosystem defined in the sidebar. They are important areas of transition between water and land that act as buffers, absorbing wave energy and reducing stream bank and shoreline erosion (Appel, 2003).

Wetlands are extremely diverse and productive biological systems that support the primary producers of the aquatic food chain.

The four main types of wetlands in the watershed are described in the sidebar. Figure 5-2 shows the location of existing wetlands in the subwatershed as well as the wetlands lost prior to 1978 and those lost between 1978 and 2001.

The recognition that as much as seventy-two percent (72%) of the wetlands in the North Branch have been lost (MDNRE 2010) has spurred efforts to identify areas where reestablishment of these precious ecosystems stands a better chance of flourishing. In an effort to identify potential wetland restoration sites the DNRE created a Potential Wetland Restoration map (Figure 5-3).

The MDNRE produced the map using the following information:

- The National Wetland Inventory conducted by the US Fish and Wildlife service through interpretation of aerial photos and topographic data.
- Hydric Soils and Hydric soils complexes as mapped by the US Department of Agriculture – NRCS
- Land Cover from the Michigan Resource Inventory System (MIRS).
- Basemap features from the MI – CGI
- Presettlement Wetlands created from MNFI – 1800 land cover layer
- Urban areas as mapped by MI DNR in 2001 IFMAP land cover layer

The potential wetland restoration areas include NRCS hydric soil areas, MNFI pre-settlement wetland areas, and the areas where these two layers overlap. Urban areas are eliminated from consideration. Building on this work the DNRE then created a Landscape Level Wetlands Functional Assessment Tool (LLWFA) in order to prioritize wetland sites for restoration and protection. This is presented and used later in the Plan (pg. 8-54.)

Wetlands (continued in sidebar)

There are four main types of wetlands in the watershed:

- Forested Swamps – Forested swamps occur where trees grow in moist soils. Many were once fen communities that transitioned due to colonizing by trees. They are often inundated with floodwater from nearby rivers and streams. The hardwood swamp variety is found primarily along the shores of lakes.
- Scrub/Shrub Swamps – Shrub swamps are similar to forested swamps except that shrubby vegetation predominates. These are poorly drained and have seasonally fluctuating water levels (including flooding) and are generally wetter than forested swamps.

Wetlands

- Emergent Wetlands – Include such various wet systems as
  - meadows – fire-dependent sedge and grass dominated communities in loam or muck soils with a high water table that is visible only during spring flooding,
  - marshes – soft-stemmed (e.g. cattail) dominated communities that almost always have standing or slow moving water of neutral pH and are affected by lake level fluctuations or surface / ground-water interactions,
  - fens – three part system (flats, sedge meadows, wooded area) typically next to lakes and rivers in glacial outwash or coarser-textured end moraines and derived from calcium rich seeps and springs that cause alkaline, oxygen poor conditions that lead to the accumulation of peat, and
  - bogs – transitions from fens, once dominant in the low-lands around many Oakland County lakes, derived from rainfall which pools in depressions and characterized by acidic, oxygen poor conditions which support sphagnum moss and lead to the accumulation of peat.
- Open Water and Bottomlands – These include deeper, perennial pools within wetlands and shallow portions of lakes and rivers. The warmth of the water supports numerous aquatic organisms. Typically home to submerged plants which provide unique habitat resources such as substrates for macro-invertebrates, cover and forage for waterfowl, and spawning and nursing for fish. In lake settings, this habitat can be subdivided into near-shore and open water areas. In certain settings (e.g. along the shoreline of Lake St. Clair), near-shore wetlands are important in deflecting the energies of ice scour that can cause shoreline erosion.

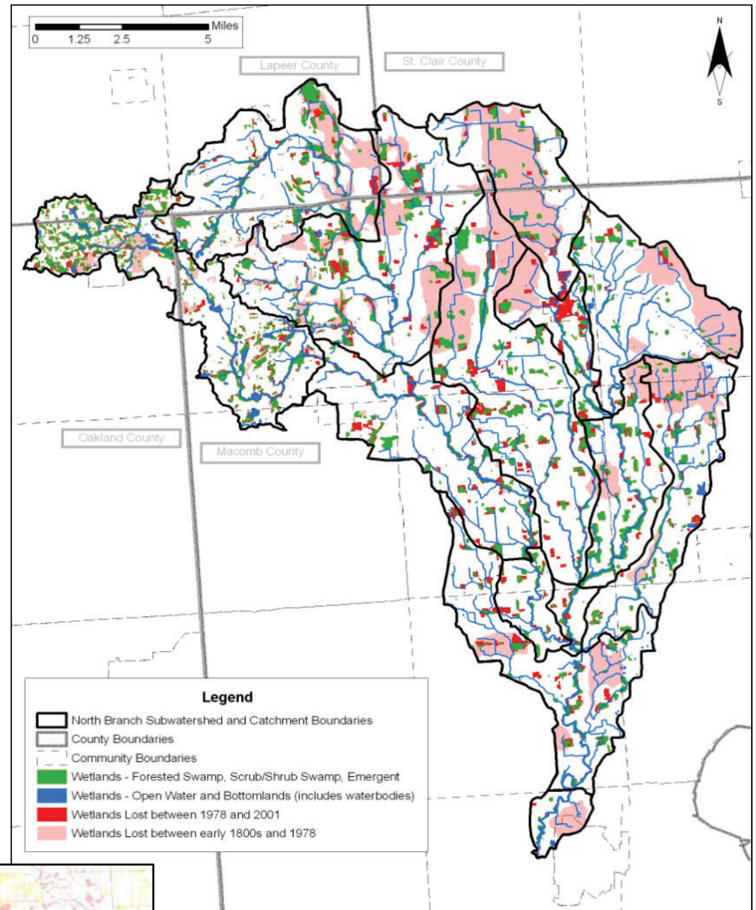


Figure 5-2. Wetlands in the subwatershed.

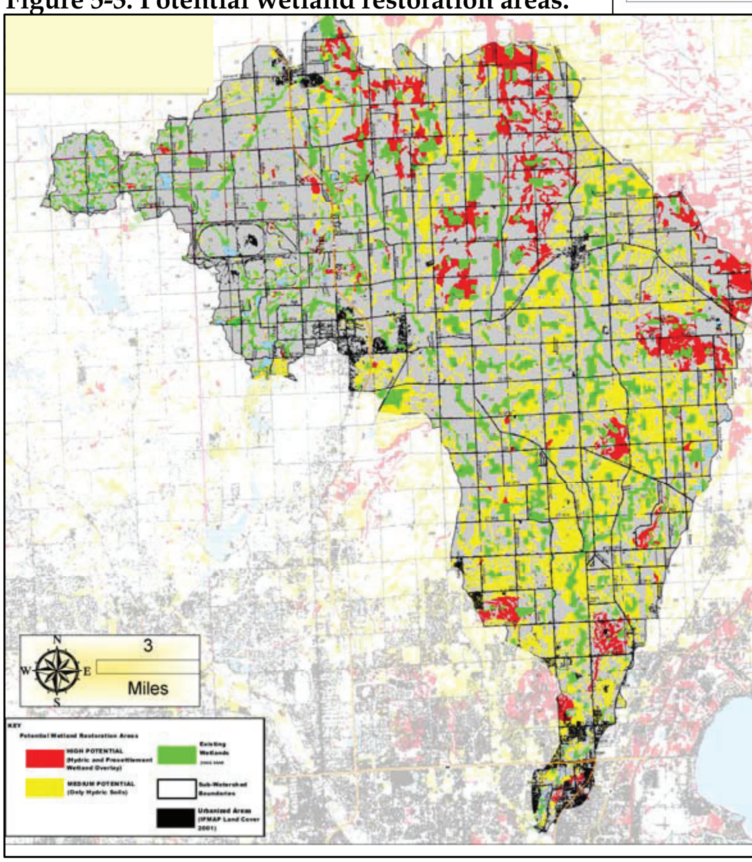


Figure 5-3. Potential wetland restoration areas.

Desired Uses

Desired uses are a reflection of how the public would like to use the subwatershed. They are determined through direct public input but also taking into consideration other sources of similar information (see Chapter 4). These may be based directly on goal- or use-based feedback (e.g. preserving unique habitat for wildlife) or may be construed from concern-based feedback (e.g. concern over loss of farmland or open space can be phrased in terms of a use: preserving farmland and open space).

The desired uses provided by the stakeholders do not all relate directly to water quality but are important to consider to help encourage community support for the plan and its implementation and also help define the scope of additional analyses (e.g. a use that relates to hunting ensures that appropriate access, animal health, and related regulations are examined). Many desired uses can be analyzed using available data and are included in this chapter for that reason. They are evaluated on a management area basis using similar categories to those used for designated uses: does not apply (-), insufficient information (II), supporting (S), and not supporting (NS) (see page 5-4 sidebar). **(EPA 5.2.2, 7.1.4)**

The desired uses to be evaluated for the subwatershed (and its various management areas) include:

- Support Designated Uses that are Not Supported or are Threatened
- Support Water Quality and Designated / Desired Use Attainment in Downstream Areas
- Support Local Terrestrial and Water-based Recreation through Enhanced Public Parks, Trails, and Access Points
- Support Local Recreational Fishing
- Support Healthy Aquatic Habitat to Maintain and Enhance Fisheries and Other Aquatic Life
- Support Local Recreational Hunting
- Support Healthy Riparian Corridors and Streambanks to Maintain and Enhance Water Quality, Aquatic and Terrestrial Habitats, and Fisheries / Hunting
- Support the Character of the Subwatershed by Preserving / Enhancing Identified Natural Features and Healthy Terrestrial Habitat to Maintain and Enhance Game Animal Populations and Threatened / Endangered Species
- Support the Character of the Subwatershed by Preserving / Enhancing Natural Drainage Systems by Minimizing Directly Connected Impervious Surfaces to Foster Healthy Terrestrial and Aquatic Habitat
- Support Healthy Aquatic and Terrestrial Habitat by Ensuring Wastes are Properly Disposed of through Appropriate Sewage Treatment and Effective Solid Waste Programs
- Support the Character of the Subwatershed by Preserving Prime and Unique Agricultural Lands
- Support the Character of the Subwatershed by Preserving Rural Residential Land and Culture and Preserving / Enhancing Other Aesthetic Conditions
- Support the Character of the Subwatershed by Preserving Historical and Cultural Resources

Considerations Implied in the Designated Uses

Certain consideration may not be explicit in a single designated use, but are a function of a number of them. These include:

- Financial considerations
- Controlling development
- Aesthetic conditions
- Public education / communication / participation
- Anti-pollution regulation

Support Designated Uses that are Not Supported or are Threatened

The inclusion of this desired use is mandatory as per CMI requirements. Since this is based on regulatory conditions, it only includes those designated uses that the assessed areas are 'not supporting' as defined by the *MDNRE* (see the 'designated uses' subsection earlier in the section).

Target Management Areas

Because the status of this desired use can be 'not supporting' if there is even one 'not supporting' designated use, the management area is defined as the subwatershed as a whole.

Current Status

There are twenty designated uses that are 'not supporting' for various waterbodies throughout the subwatershed. As such, the current status of this desired use for the subwatershed is: not supporting.

Support Water Quality and Designated / Desired Use Attainment in Downstream Areas (Lower Clinton River and Lake St. Clair)

The residents of the North Branch Clinton River Subwatershed (NBCRW) understand the concept of 'being a good neighbor' and as such wish to strive to ensure that the water quality problems in the NBCRW are localized and do not negatively impact downstream areas. The downstream areas to consider are: 1) the lower portion of the Clinton River from the confluence of the North Branch with the Clinton River in Clinton Township to Lake St. Clair; and 2) Lake St. Clair. The primary resources consulted for determining the problems in each of these areas are: 1) the *Clinton River East Subwatershed (CREW) Watershed Management Plan* (MCPWO, 2007); and, 2) the *Lake St. Clair and St. Clair River Comprehensive Management Pla*n (USACE, 2004). These documents list the stressors that are impacting uses in these areas:

Stressors	CREW	Lake St. Clair
Pathogens	X	X
Nutrients & Oxygen Demand	X	X
Heavy Metals & Organic Compounds	X	X
Suspended Solids / Sediment	X	X
Hydrologic / Hydraulic Characteristics	X	
Natural Feature / Habitat Degradation & Invasive Species	X	X

This desired use will be considered 'not supporting' if they are known to be significant sources of the above stressors in the *NBCRW*. This will likely be the case as long as there is a problem in one of these downstream areas and the *NBCRW* is a significant source of the stressors that are having the impacts.

Target Management Areas

Because the sources of the stressors are present to some extent throughout the subwatershed, the entire subwatershed is considered the target management area, but the catchments are prioritized based on the amount of stressor discharged per unit area.

Current Status

The current status of this desired use in the target management area (the entire subwatershed), as determined by the SWAG, is not supporting. The rationale for this is that there are impacts in the downstream areas associated with pathogens, nutrients, and suspended solids and there are significant sources of these stressors in the subwatershed as documented in a later section of this chapter.

Support Local Terrestrial and Water-based Recreation through Enhanced Nature Areas, Public Parks, Trails, and Access Points

Open space, nature areas, parks, golf courses, and trails allow citizens to interact with the natural environment (and foster a stewardship ethic) through terrestrial recreation opportunities (e.g. camping, picnicking, hiking, skiing, horseback riding, off road vehicle driving, snowmobiling, hunting) and access to aquatic recreational opportunities (e.g. swimming, boating, and fishing). To be enjoyable, these areas depend on an abundance of natural terrestrial land cover and habitat. Parks offering water-based activities also benefit from being situated in areas of good water quality and riparian health (for both aesthetic and health concerns).

There are fourteen public open space / nature areas / parks in the subwatershed ranging from the 1,880 acre Wolcott Mill Metropark (operated by the Huron-Clinton Metropark Authority – HCMA) in rural Ray Township to the 1 acre Memorial Park in the more developed Village of Armada. Wolcott Mill Metropark (see http://www.metroparks.com/parks/pk_wolcott_mill.php) offers an interactive farm learning center, historic grist mill, golf, camping, horseback riding, hayrides, picnicking, and hiking. The other major facility in the subwatershed is the 890 acre W. C. Wetzel State Park that is operated by the MDNR (see http://www.michigandnr.com/parksandtrails/Details.aspx?id=507&type=SPRK) and is located primarily in Lenox Township. The park offers cross country skiing, hiking, hunting, snowmobiling, and hunting. The remaining facilities are operated by local municipalities. Details on these and the previously discussed facilities are presented in Table 5-6. Facility locations are shown in Figure 5-4.

Nature Areas and Parks

Given the public ownership of many recreation areas, they are ideal places to pursue the conservation of natural areas and implement other restoration or water quality protection measures.

Having a strong set of local recreational activities also defines the area as a destination for sportsmen and, as such, serves as an economic boon.

Environmental Impacts

While generally viewed in a positive light, certain practices and activities associated with parks may be the sources of stressors to the environment. Proper management actions at parks seek to mitigate these environmental concerns.

Table 5-6. Public open space / nature areas / parks in the subwatershed.

Recreation Area	Acres	Municipality(ies)	Catchment(s)
1. Wolcott Mill Metropark	1,880	Ray Township	North Branch – Upper Middle
2. W. C. Wetzel State Park	890	Lenox Township; Ray Township	E.B. Coon Creek – Lower; Deer Creek
3. Closed Landfill Recreation Area	138	Macomb Township	North Branch – Lower Middle
4. Bruce Township Park	111	Bruce Township	North Branch - Upper
5. Macomb Corners Park	92	Macomb Township	North Branch - Lower Middle
6. Camp Rotary (at Wolcott Mill)	83	Ray Township	North Branch – Upper Middle
7. Macomb Town Center Park	82	Macomb Township	North Branch – Lower Middle
8. Macomb Township Property	54	Macomb Township	North Branch – Lower Middle
9. Crystal Diamonds Field	28	Bruce Township	North Branch - Upper
10. Macomb Township Property	26	Macomb Township	North Branch – Lower Middle
11. Armada Township Park	24	Armada Township	E.B. Coon Creek – Upper
12. Memorial Park	13	Mt. Clemens	North Branch – Lower
13. Orchard Hills Park	5	Bruce Township	North Branch – Upper Middle
14. Armada Memorial Park	1	Village of Armada	E.B. Coon Creek – Upper
Total	3,427	--	

Source, data: (MCPED, 2005).

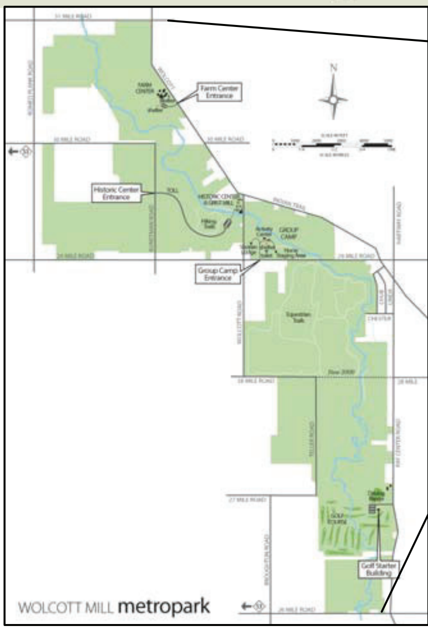
There is currently one trail, the Macomb Orchard Trial, which crosses the subwatershed from Romeo to Richmond Township, covering a total of 13.1 miles. Fourteen other trails are currently planned, primarily in the southern half of the subwatershed. The longest of these is the proposed 20.2 mile trail that primarily follows the North Branch from Clinton Township to Ray Township and then intersects the Macomb Orchard Trail in Armada Township. Details on the trails are presented in Table 5-7. Trail locations are shown in Figure 5-4. The trail miles presented reflect only the portions of the trails in the subwatershed.

Recreation Information

The map and tables presented herein contain park, trail, and green space data only for Macomb County. Data was not available for the other counties.

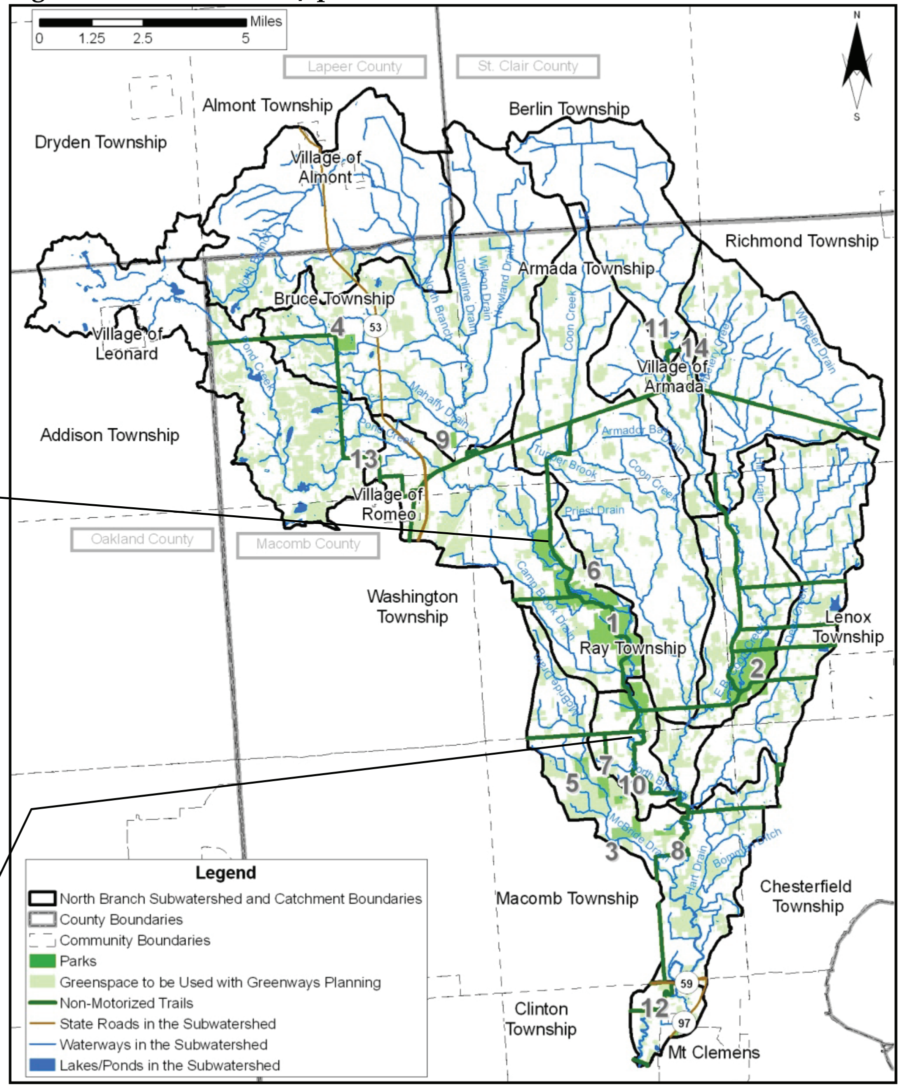
Wolcott Mill Metropark

HURON-CLINTON METROPARKS



Source, graphic: (HCMA, 2008).

Figure 5-4. Nature areas / parks and trails in the subwatershed.



Source, data: (MIGDL, 2008); (MCPED, 2005); (MCPED, 2008).
Catchment boundaries as modified per Tetra Tech.

Table 5-7. Trails in the subwatershed.

Trail	Miles	Municipality(ies)	Catchment(s)
A. Proposed North Branch Trail	20.2	Twps.: Clinton, Macomb, Ray, Armada	CC – U; NB – UM,– M, – LM, - L
B. Macomb Orchard Trail	13.1	Armada, Romeo; Twps: Richmond, Armada, Bruce	HC, EB CC – M, CC – U, NB – UM
C. Proposed Pedestrian Pathway	9.2	Romeo, Bruce Township	NB – UM, - U, PC
D. Proposed EB Coon Creek Trail	5.7	Lenox Township	EB CC – L, - M, HC
E. Proposed Multi-Use Pathway	2.8	Macomb Township	NB – LM, -M
F. Proposed Lenox Township Trail #1	2.6	Lenox Township	EB CC – L, DC
G. Proposed Macomb / Chesterfield Trail	2.5	Macomb Twp., Chesterfield Twp.	NB – LM
H. Proposed Lenox Township Trail #2	2.5	Lenox Township	EB CC – L, DC
I. Proposed Lenox Township Trail #3	2.4	Lenox Township	EB CC – L, DC
J. Proposed Lenox Township Trail #4	2.3	Lenox Township	EB CC – L, DC
K. Proposed Ray Township Trail #1	2.3	Ray Township	NB – M, CC – U , EB CC – L
L. Proposed Ray Township Trail #2	1.6	Ray Township	NB – UM
M. Proposed Armada Spur Trail	1.2	Armada	EB CC – M, - U
N. Proposed Macomb Township Trail #1	1.0	Macomb Township	NB - M
O. Proposed Armada Township Loop	0.4	Armada Township	NB – UM
P. Proposed Macomb Township Trail #2	0.3	Macomb Township	NB – L
Total	**70.1**	--	

Legend: CC = Coon Creek, NB = North Branch, HC = Highbank Creek, DC = Deer Creek, EB = East Branch, U = Upper, UM = Upper Middle, M = Middle, LM = Lower Middle, L = Lower. Source, data: (MCPED, 2005)

In addition, there are seven golf courses in the subwatershed (as indicated by red circles in the sidebar figure) listed from north to south with respect to the sidebar figure: Heather Hills Golf & Racquet Club, Inc.; Bruce Hills Golf Club; Pine Valley Golf Club; Wolcott Mill Metropark Golf Course; Hickory Hollow Golf Course; and Sycamore Hills Golf Club. Not shown is Burning Tree Golf and Country Club.

The aforementioned facilities, other types of land, and private land support the three classes of recreating covered by this desired use: terrestrial, aquatic – partial body contact, and aquatic – total body contact. Types of activities the fall into each of these categories (with additional sub-categories defined) include:

- Terrestrial (primarily done on land, only slight possibility of contacting waterbody)
  - non-motorized
    - stationary: camping, bird/wildlife viewing, hunting, gardening, etc
    - moving: walking, hiking, skiing, bicycling/ mountain-biking, snow-shoeing, horseback riding, hunting, etc
    - games: golf, disc-golf, baseball, tennis, football, etc
  - motorized
    - moving: snow-mobiling, off-road-vehiciling, etc
- Aquatic – partial body contact (primarily done in water without head being submerged)
  - non-motorized: wading, fishing (from shore or bridges), canoeing, kayaking, etc
  - motorized: boating, fishing (from boat), etc
- Aquatic – total body contact (primarily done in water with head likely submerged at least intermittently)
  - non-motorized: swimming, etc
  - motorized: water-skiing, jet-skiing, etc

The conditions that impact recreation activities are discussed throughout this chapter (e.g. land uses, pollutant sources, dams) but some of the considerations are discussed here, such as the type, number, and location of parks, trails, and surrounding green space.

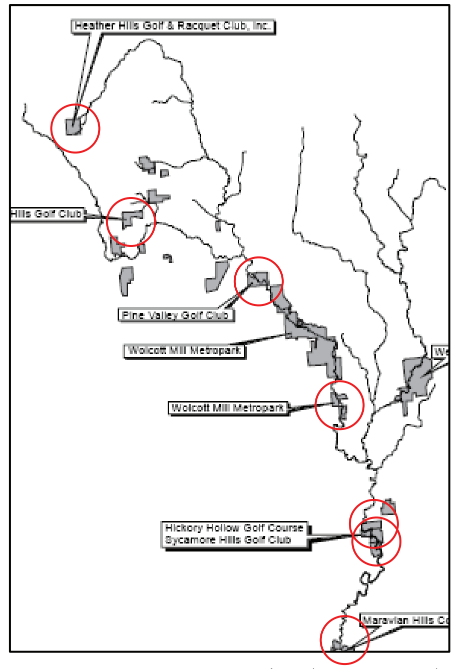
A number of communities in the subwatershed have special watercraft controls, including:

- Addison Township (Oakland County) prohibits the operation of motorboats on certain waters;
- Dryden Township (Lapeer County) limits operators of motorboats to observing a 'no-wake' speed for on a number of ponds and connecting channels.

The information presented above is taken from the MDNR's 'Inside DNR → Laws and Regulations → Local Controls' webpage located at http://www.michigan.gov/dnr/0,1607,7-153-10366_37141_37701---,00.html (MDNR, 2008d). The change in organizational structure as the MDNRE may result in the data being hosted in a different location.

With respect to information presented above and the information that follows, the recreational restrictions presented are simply the ones that were included in the respective references. There are likely additional local, county, and state-wide ordinances and regulations that are identified as yet unidentified sources.

Golf Courses in the Subwatershed



Source, graphic: (Francis, 2006).

Conditions Impacting Recreation

The following is a partial list of conditions that may impact the status of recreation activities.

<u>Terrestrial</u>

Lack of public land

Lack of compatible land uses

Lack of facilities

Degraded lands (e.g. contamination – i.e. brownfields, timber harvested, mined - stripped or sunken)

Imposed restrictions (e.g. many public lands don't allow over-night camping; horses and ORVs are not allowed on certain trails)

<u>Aquatic</u>

Obstacles (e.g. debris, sedimentation, dams)

Water contamination (e.g. bacterial pollution, toxic pollutants)

Imposed restrictions (e.g. wading and swimming is often not allowed downstream of dams; boat access and speed is often restricted due to habitat, noise pollution, erosive wake, and other concerns)

In the State of Michigan, it is illegal to operate Off-Road Vehicles (ORV) on public lands that are not specifically posted as being open. Snowmobiles are prohibited at any time in state game areas or state parks and recreation areas unless posted as being open. Where ORVs or snowmobiles are allowed on area open to public hunting, they are still prohibited from 7-11 A.M. and 2-5 P.M. during the late November deer season. (MDNR, 2008b).

Regulatory restrictions on activities should not be a rationale for considering an activity impaired as long as there are other reasonable opportunities for the activity in a given management area. Additionally, a particular activity should not be considered impaired where the activity is not considered feasible (e.g. not all waterways capable of supporting power boating).

Target Management Areas

The management areas utilized for assessing the status of terrestrial and water-based recreation in the subwatershed are the counties for Oakland, Lapeer, and St. Clair Counties and the individual townships in Macomb County. This approach is justified by the fact that recreation is not a hydrologically-based issue and that the counties/municipalities exert control only in their respective areas.

The management areas targeted for protection of existing resources include: Ray Township and Lenox Township.

The management areas targeted for expansion of existing resources, or the establishment of new resources, include: Bruce Township / Washington Township, Armada Township, Richmond Township, and the southern tier (Macomb, Chesterfield, and Clinton Townships, and Mt. Clemens).

The Oakland County, Lapeer County, and St. Clair County management areas should be assessed using appropriate data once it is available.

Current Status

The current status of this desired use in the target management areas, as determined by the SWAG, is given as:

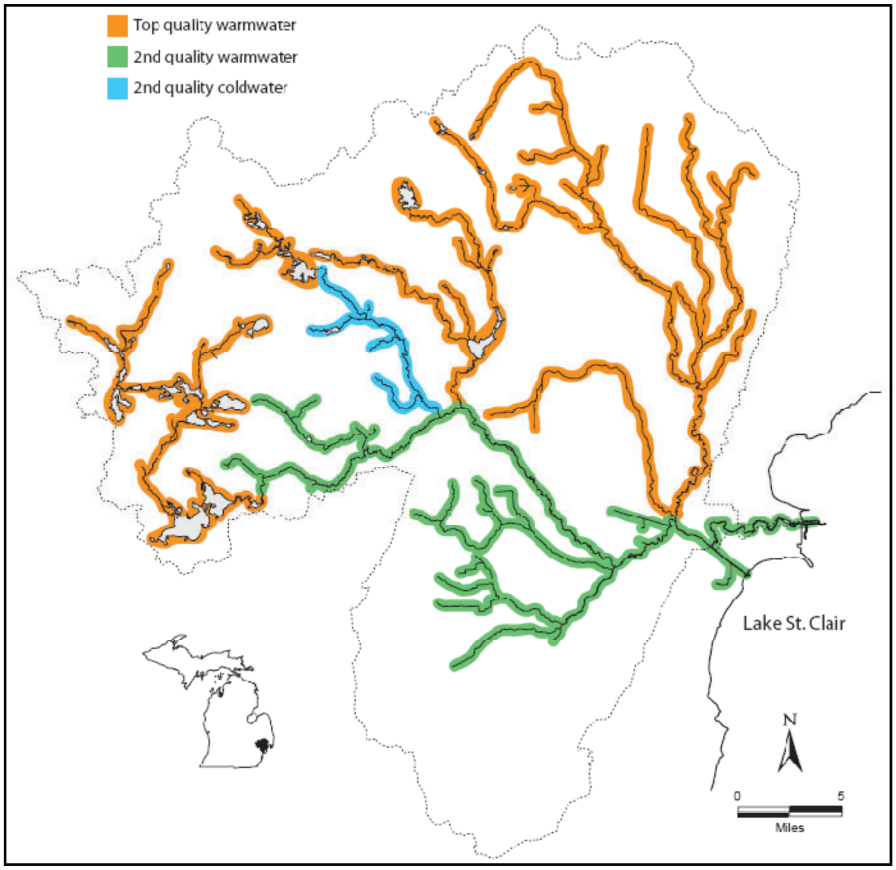
- Ray Township - Supporting
- Lenox Township – Supporting
- Bruce Township / Washington Township – Not Supporting
- Armada Township – Not Supporting
- Richmond Township – Not Supporting
- Southern Tier – Not Supporting
- Oakland County – Insufficient Information
- Lapeer County – Insufficient Information
- St. Clair County – Insufficient Information

Support Local Recreational Fishing

Sport fishing is a popular recreational activity in the subwatershed. The Clinton River and its tributaries (including the North Branch) support one of the healthiest urban fisheries in the state.

The North Branch and Pond Creek are designated as coldwater fisheries (i.e. trout streams) and all of the other tributaries are designated as warm water fisheries (having no fishery restrictions) and in the past have been classified as top quality warm water fisheries (Francis, 2006) along with the other less developed areas of the Clinton River Watershed (Upper Clinton Subwatershed, warm water portions of the Paint Creek Subwatershed, and the Stony Creek Subwatershed – see Figure 5-5).

Figure 5-5. Classification of fisheries quality for the Clinton River Watershed in 1967.



Source, graphic: (Francis, 2006).

The MDNR has supported recreational fishing through fish stocking programs that date back to the 1930s. Bluegill, smallmouth bass, largemouth bass, and rainbow trout were stocked in the 1930s and 1940s at the following locations: Bruce Township (Frantz Lake, Hidden Lake, Nolan Lake), Ray Township (Cascade Lake), and Washington Township (Cusik Lake). In the 1970s, the MDNR reported that there was no natural trout reproduction in the North Branch Subwatershed - NBCRW (MDNR, 1988), or throughout most of the Clinton River Watershed (CRW) for that matter, and again began stocking fish (with an emphasis on coldwater species) throughout the CRW with two sites in the NBCRW: East Pond Creek (brown trout, through the early 1990s) and Kidder Creek (brown trout, 1972). These fish stocking locations are shown in Figure 5-6.

Recreational Fishing Regulations

Fishing licenses are required in the State of Michigan for anglers 17 and older. The two basic types included 'restricted' (annual licenses for all species except trout and salmon) and 'all species' which come in a 24-hour and annual variety. Discounts generally apply for state residents, seniors, military personnel, and bulk purchases.

The following are the general regulations for fishing in the North Branch Subwatershed (by fish, minimum size, possession limit, and season):

- Largemouth and smallmouth bass* – 14" Saturday before Memorial Day to December 31st
- Walleye – 15" Last Saturday in April to March 15th
- Northern Pike – 24" season same as above
- Flathead catfish – 15" open all year (limit of 5 total for the species listed above)
- Channel catfish – 12" – limit of 10 – open all year
- Muskellunge – 42" – limit of 1 – First Saturday in June to December 15th
- Yellow perch – no size limit – limit of 50 – open all year
- Sunfishes** – no size limit – limit of 25 – open all year
- White bass* – no size limit – limit of 10 – open all year
- Lake whitefish or lake herring – no size limit – limit of 12 – open all year
- Lake Sturgeon
- All others – no size limit – no possession limit – open all year

* from the last Saturday in April to the Friday before Memorial Day, bass can be caught but must be immediately released
** black and white crappies, bluegill, green and hybrid sunfish, longear, pumpkinseed, redear, and warmouth

Source: (MDNR, 2008a).

Source available at: http://www.michigan.gov/documents/dnr/FishingGuide-with-compressed_229820_7.pdf

Recreational Fishing: Special Trout Stream Regulations

The following information is take from the 2008 *Inland Trout and Salmon Guide*. Only information pertaining to the North Branch Subwatershed is included.

All-species fishing licenses (24-hour or annual) are required for all anglers, age 17 or older to take and possess trout and salmon from any public waters.

The downstream portion East Pond Creek and the portion of the North Branch upstream of its confluence with East Pond Creek are classified as a Type 1 stream. The open/possession seasons are from the last Saturday in April to September 30th. All tackle is legal and the daily limit is five (with no more than 3 that are 15 inches or longer and no more than 1 Atlantic salmon. The following minimum size limits apply: brook trout – 8”; brown trout – 8”; rainbow trout – 10”; splake – 8”; lake trout – 24”; coho, Chinook, and pink salmon – 10”; and Atlantic salmon – 15”.

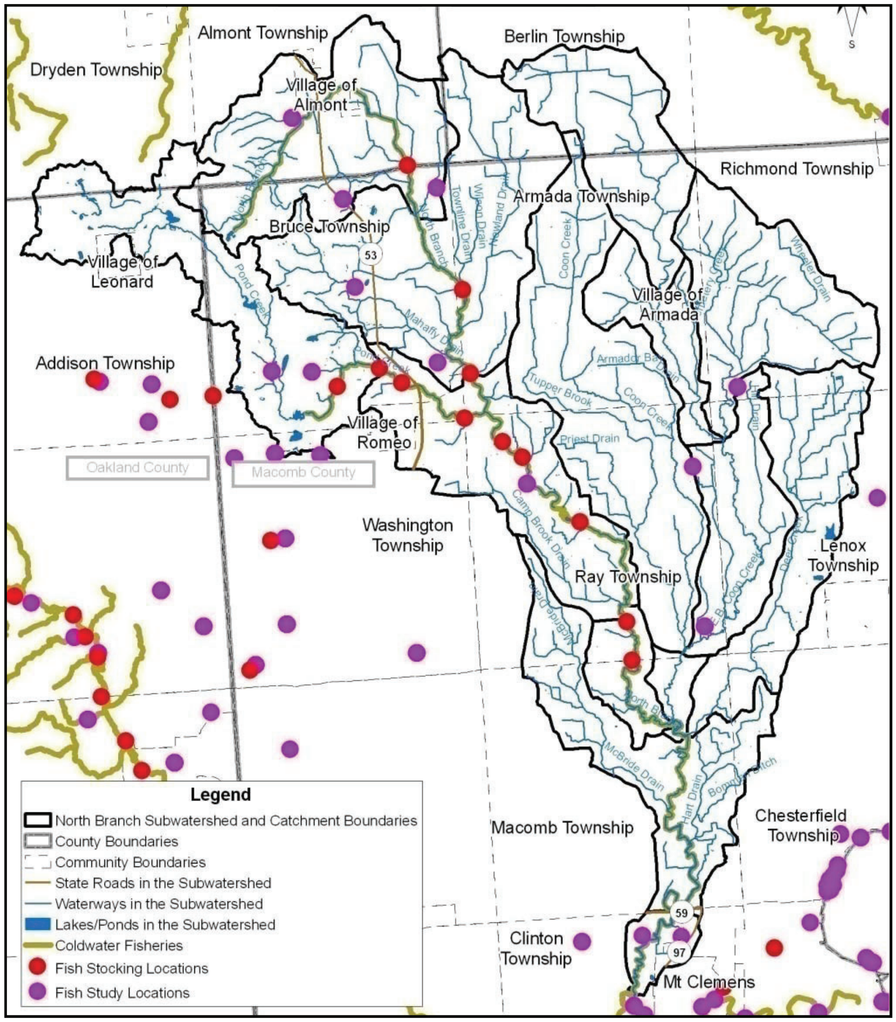
The North Branch from the East Pond Creek downstream to the confluence with the Clinton River (and including the Clinton River) is a Type 4 stream. The open season is all year and the possession season is all year except for brown trout, brook trout, and Atlantic salmon which are from the last Saturday in April to September 30th. All tackle is legal and the daily limit is the same is given for the Type 1 stream (above). The minimum size limits are the same except for brown trout and splake which are both 10”.

There are no trout (coldwater) lakes in the subwatershed.

Source: (MDNR, 2008c)

Source available at: http://www.michigan.gov/documents/dnr/Trout-salmon-guide-compressed_229886_7.pdf

Figure 5-6. Fish stocking locations and other fisheries related data.



Source, data: (MIGDL, 2008).

There are myriad restrictions and regulations that impact recreational fishing, including(MDNR, 2008a):

- net use limitations
- bow and spear use limitations, including special restrictions for rubber-propelled or spring-propelled spears
  - Oakland County in the subwatershed is closed to all spearing
- bow and light use limitations
- Lake sturgeon fishing limitations (use of hook and line only in the subwatershed; catch and release only)

As noted in the discussion under the previous use, these types of restrictions should not be a rationale for considering recreational fishing impaired as long as there are other reasonable allowances. The lack of a particular species where it is known to never have existed is not cause for a negative assessment, but the lack of certain species that are no longer present due to the influence of humans is a potential impairment to recreational fisheries, especially where the degradation extends to multiple recreational species.

Despite the need for stocking certain species of fish, the North Branch Subwatershed has abundant species. Of the 95 species found in the Clinton River Watershed, 69 of them are found in the North Branch Subwatershed. Of these 69, 42 were found in the subwatershed during the extensive fish sampling efforts in 2001 and 2002 (Francis, 2006). Refer to the sidebar for a list of fish species, and sport fish, in the Clinton River Watershed, the North Branch Subwatershed (and those found in 2001 and 2002), and some other Michigan sport fish. The Michigan Fish Atlas (at http://www.michigan.gov/dnr/0,1607,7-153-10364-30538--,00.html) documents where these and other fish have been found throughout the State of Michigan, including Lake St. Clair and the near shore waters of the Great Lakes.

The fishery in the North Branch Subwatershed is relatively healthy but does have a number of problems. A significant problem is the fish consumption advisories that are triggered by Michigan Department of Community Health (MDCH) standards, including: total chlordane (0.3 ppm); total DDT (5.0 ppm); dieldrin (0.3 ppm); dioxin toxic equivalents (10.0 ppt); hepatachlor and hepatachlor epoxide (0.3 ppm); mercury (0.5 ppm for restricted consumption, 1.5 ppm for no consumption); mirex (0.1 ppm); total PCB (2.0 ppm for general population, and 0.05 ppm, 0.1 ppm, 1.0 ppm, 1.9 ppm for women of childbearing age and children under 15 years of age for 1 meal per week, 1 meal per month, 6 meals per week, and no consumption, respectively); and toxaphene (5.0 ppm) (Francis, 2006).

The major adverse impacts (but not necessarily generating a fish consumption advisory) in the subwatershed are:

- impaired fish consumption designated uses due to PCBs and although this is a Clinton River Watershed-wide problem, and is not directly related to major local sources (but is rather the result of past widespread use of PCBs and their persistence in the environment), the problem must be addressed;
- a localized impaired fish consumption designated use due to mercury along the North Branch in the Upper Middle catchment;
- a catchment-wide impaired warm water fishery in the Coon Creek due to organic enrichment (from past combined sewer overflows - CSOs), elevated total suspended solids (TSS), and water quality standard (WQS) violations for dissolved oxygen (DO – due primarily to the impacts of the aforementioned stressors); and
- viral hemorrhagic septicemia (VHS), a mortal (non-native) pathogen that causes bleeding and bloating, among other symptoms, in 25 fish species, (including those denoted in red text in the sidebar – (WDNR, 2007)) many of them sport fish. While VHS has not been documented specifically in the subwatershed, it has been documented in Lake St. Clair, and as such, the Clinton River Watershed is being regulated as part of the 'VHS Positive Management Area' (VHSPMA) by the MDNRE. To combat the spread of VHS, the MDNRE has promulgated numerous regulations, many of them related to 'prohibited fish species' which includes those 25 denoted in red text in the sidebar, two additional species denoted in orange text, and three species not listed: burbot, pacific herring, and trout-perch. In general, the regulations address: 1) the transportation, sale, use, and release of

Fish Species in the North Branch Subwatershed

Species found in 2001/2002

Gizzard shad	Spotfin shiner
SPOTTAIL SHINER	Brassy minnow
Emerald shiner	Common shiner
Hornyhead chub	Blackside darter
ROSYFACE SHINER	White sucker
Fathead minnow	SPOTTED SUCKER
Tadpole madtom	Grass pickerel
Brook stickleback	***BROOK TROUT***
Golden redhorse	**Pumpkinseed**
Freshwater drum	**Yellow perch**
Largemouth bass	**Northern pike**
Bluntnose minnow	***BROWN TROUT***
Central stoneroller	Logperch
SMALLMOUTH BASS	Creek chub
Central mudminnow	Rock bass
NORTHERN HOG SUCKER	STONECAT
Western blacknose dace	**Bluegill**

Sunfish (Northern longear, Green)
DARTER (RAINBOW, IOWA, LEAST)
Darter (Greenside, Johnny, Fantail)

Species not found in 2001/2002

SILVER LAMPREY	Black bullhead
<u>BLACK REDHORSE</u>	<u>Striped shiner</u>
<u>Bigmouth shiner</u>	**White crappie**
CHANNEL DARTER	Brown bullhead
Brindled madtom	*Rainbow smelt*
Northern madtom	**Black crappie**
<u>BLACKNOSE SHINER</u>	*Common carp*
BLACKCHIN SHINER	<u>RIVER CHUB</u>
CHESTNUT LAMPREY	*SEA LAMPREY*
ORANGETHROAT DARTER	*Goldfish*

NORTHERN BROOK LAMPREY
<u>AMERICAN BROOK LAMPREY</u>
Shiner (Golden, Mimic, Redfin)
Redhorse (Shorthead SILVER)

Other Fish Species in the Clinton River Watershed

Warmouth	***Splake***
Round goby	**LAKE TROUT**
Yellow bullhead	*Alewife*
<u>Kokanee salmon</u>	Quillback
<u>LAKE STURGEON</u>	Longnose gar
<u>PUGNOSE SHINER</u>	Sand shiner
Channel catfish	***<u>MUSKELLUNGE</u>***
<u>LAKE WHITEFISH</u>	**LAKE HERRING**
RAINBOW TROUT	***COHO SALMON***
Brook silverside	***White perch***
Lake chubsucker	***Redear sunfish***
MOTTLED SCULPIN	**White bass**
Northern redbelly	Bowfin
CHINOOK SALMON	**Walleye**

<u>NINESPINE STICKLEBACK</u>
WESTERN BANDED KILLIFISH

Other Sport Fish Species

ATLANTIC SALMON	ROCK BASS
Flathead catfish	**Redear sunfin**
PINK SALMON	**Hybrid sunfish**

bold - sport fish; *italics* - those that have been introduced or have colonized; <u>underlined</u> – extirpated; dashed underline – possibly extirpated; ALL CAPS – intolerant to pollution. Source: (Francis, 2006).

prohibited fish species and baitfish.; and 2) roe (eggs) from the prohibited species. The regulations are strongest in the VHSPMA and, while they are designed for long-term protection of the fish and fisheries, the regulations do put additional burdens on recreational fishermen and thus do have short-term impacts on the conditions on the perceived conditions of the fisheries.

The conditions of the fisheries are obviously dependent on the types and abundance of fish in any given waterbody. The major factor that determines the types and abundance of fish in a waterbody is the condition of the habitat. The habitat is defined by many factors including water quality and physical attributes. A discussion of habitat is begun in Chapter 2, is continued in Chapter 3, and specific assessments of habitat in the subwatershed are presented in various locations in this chapter (as it is an important consideration in a number of assessment and analyses, including beneficial uses, desired uses, and stressors).

Target Management Areas

Because local recreational fishing relies primarily on access, the relatively small size of the subwatershed allows for it, as a whole, to be the appropriate target management area. In other words, if there is a problematic area, it is not a problem for someone who would like to fish to go to a nearby location in the subwatershed.

Current Status

The current status of this desired use in the target management area (the entire subwatershed), as determined by the SWAG, is supporting. The rationale for this is that there are coldwater designated reaches across the entire length of the watershed from north to south and fish stocking locations that span this entire reach. While problems do exist, the major ones are on a scale that cannot be addressed by the subwatershed alone, meaning that surrounding areas (outside of the subwatershed) have similar disadvantages in terms of supporting local recreational fishing.

Support Healthy Aquatic Habitat to Maintain and Enhance Fisheries and Other Aquatic Life

Healthy aquatic habitat consists of both the physical conditions of the stream bottom and banks and the chemical conditions of the water. Both are important to sustain fisheries and other aquatic life but this category deals with the physical aspect such as the chemical conditions of the water. This requires the assessment of every stressor class as they all have the potential to impact the quality of water. The assessments of the stressor conditions are presented later in the chapter.

In terms of physical habitat, the most extensive study was done in 1997 by the Clinton River Watershed Council (CRWC) (Synnestvedt, 1997). It documented conditions such as run/riffle substrate and depth, pool substrate and depth, deposition, embeddedness, in-stream cover, riparian width, bank vegetation, bank erosion, and bank cover and applied the GLEAS procedure to rate the condition of the habitat. The results of this study, presented on the basis of catchment, are as follows:

North Branch Headwaters - 6 sites rated – 5 good, 1 fair;
North Branch Upper – 3 sites rated – 1 excellent, 1 good, 1 fair;
North Branch Upper Middle – 4 sites rated – 2 excellent, 3 good, 1 fair;
North Branch Middle – 3 rated – 3 fair;
East Pond Creek – 3 rated – 3 good; Coon Creek – 1 rated – 1 fair; and

Special Consideration: Amphibians and Reptiles

Certain amphibians and reptiles may be taken under specific circumstances and for limited uses. Amphibian and reptiles:

- Cannot be harvested for commercial purposes;
- May not be shot with firearms or bow & arrow; and
- Taking any of the following require special authorization from the MDNRE director:
  - Turtles: Blanding's, spotted, wood, and eastern box;
  - Snakes: black rat, eastern fox, copperbelly water, Kirtland's, and massassauga rattle;
  - Frogs: boreal chorus, Blanchard's cricket;
  - Salamanders: smallmouth, marbled;
  - Any other species protected as 'endangered' by the State; or
  - Any reptile eggs.

Frogs and turtles require a fishing license to if taken and as such may not be bought, sold, or offered for sale. Turtles may not be taken using a set line. Frogs may be speared but not with the aid of an artificial light. Traps must have ownership information on them and no more than 3 traps can be used for taking turtles and have at least 1 inch mesh and set so that turtles can surface to breath.

A maximum of 10 frogs, toads, salamanders, or mudpuppies can be taken from the last Saturday in May through November 15th.

A maximum of 2 Snapping and 2 softshell turtles can be taken from July 15th through September 15th, with a maximum of 1 each per day. The snapping turtles must have at least a 13" carapace.

A maximum of 6 other turtles, snakes, or lizards may be taken in a calendar year with 3 taken in a given day. The limit includes 4 and 2 turtles, respectively, with a limit of 2 and 1, respectively, from the same species of turtle.

East Branch Coon Creek – 1 rated – 1 good.

There are a number of other studies performed in the past that had some habitat evaluation component. The details of the studies can be found in Appendix E.1, but the results are summarized here:

1979
North Branch Lower – habitat upstream of Grenier Drain fair, in the Grenier Drain poor, downstream of the Grenier Drain good;

1983
North Branch Headwaters – habitat upstream of the Almont WWTP good to fair, downstream of the WWTP poor improving to fair further downstream;

1988
East Pond Creek – habitat was not explicitly assessed but portions upstream of the current coldwater designated reach were noted to have the potential to support coldwater fisheries;

1994
North Branch Lower Middle – 1 site had poor habitat,
North Branch Upper Middle – 1 site had good habitat,
East Pond Creek – 1 site had fair habitat,
North Branch Upper – 1 site had good habitat,
North Branch Headwaters – 1 site had poor habitat.

2004/2005
North Branch Headwaters – habitat as good at 2 locations,
North Branch Upper – habitat was excellent on the North Branch and good on the Wilson Drain,
North Branch Upper Middle – habitat was good at 3 sites
East Pond Creek and excellent and good at the 2 sites,
East Pond Creek – 2 sites had excellent habitat, 1 site rated as good,
North Branch Lower Middle – 1 site had marginal habitat,
Highbank Creek – 1 site had good habitat,
East Branch Coon Creek Lower – 1 site with marginal habitat,
East Branch Cook Creek Middle and Upper 1 site each with good habitat,
Coon Creek Upper had 1 site with marginal habitat.

Additional data not presented here is summarized in Figure 5-13.

<u>Target Management Areas</u>

Because this use focuses on waterbodies, and waterbodies define the drainage areas, or catchments, of the subwatershed, the catchments, or groups thereof, are the target management areas for this designated use.

<u>Current Status</u>

Based on available habitat data, the conditions and trends of habitat, the SWAG has made the following determinations based on the main waterbody(s) in each catchment:

- North Branch Lower and Lower Middle – not supporting;
- North Branch Middle and Upper Middle – supporting;
- North Branch Upper and Headwaters – supporting but threatened
    - Kidder Creek, Wilson Drain – supporting;
    - Apel Drain – not supporting
- East Pond Creek - supporting but threatened;
- East Branch Coon Creek – supporting but threatened
- Highbank Creek - supporting
- Deer Creek – insufficient information

Hunting Regulations

Hunting licenses are required in the State of Michigan and are available for deer (for firearms and/or archery), fur-bearing animals, small game, and gamebirds. The available licenses also vary based on residency and age, in addition to a few other minor considerations.

The regulations regarding the taking of animals and the seasons for hunting apply to deer, bear, elk, wild turkey, furbearing animals, waterfowl, and small game. The takings license limits and seasons can get quite complicated (see waterfowl regulations and seasons, below, as an example) so please refer to the most reason hunting and waterfowl guides issued by the MDNRE.

Waterfowl Regulations
Total limit of 6 ducks (no more than 4 mallards; only one hen; 3 wood ducks; 2 redheads; 1 pintail; 1 black duck; 1 or 2 scaup); total limit of 5 mergansers (only 2 of which may be hooded); canvasbacks are not to be taken.

Waterfowl Hunting Seasons
Ducks and Mergansers – October 11 – December 7 and January 3-4 – 6 daily, 12 total
Scaup – October 11-24; November 14 – December 7 and January 3-4 – 1 daily, 2 total
October 25 – November 13 – 2 daily, 4 total
Coots and Moorhens – same as ducks – 15 daily, 30 total
Canada Geese – September 1 – 15 – 5 daily, 10 total; October 11 – November 13 – 2 daily, 4 total; November 27 – December 7 – 2 daily, 4 total; January 3 – February 1 – 5 daily, 10 total;
Snipe and Rails – September 15 – November 14 – 8 daily, 16 total
Snow, Blue, Ross, White-Fronted, and Brant Geese – Septebmer 22 – December 16 - 10 daily, 20 total; *1 daily, 2 total*

Source: MDNR, 2008.

Support Local Recreational Hunting

As one of the least developed areas in Southeast Michigan, the North Branch Subwatershed is a popular local hunting location.

A small game license entitles you to hunt rabbit, hare, squirrel (fox and gray), pheasant, ruffed grouse, woodcock (HIP endorsement required), quail, crow, coyote (applies to Michigan residents only) and waterfowl (with a federal waterfowl stamp and Michigan waterfowl hunting license, if age 16 or older) during the open season. Opossum, porcupine, weasel, red squirrel, skunk, ground squirrel, and woodchuck also may be taken year-round with a valid hunting license. No license is required for a resident, resident's spouse or resident's children to hunt small game on the enclosed farmlands where they live, except a federal waterfowl stamp and state waterfowl license are required to hunt waterfowl.

The subwatershed exists in the zone of the state, below M-55, where only shotguns, muzzle-loading rifles, and certain handguns may be used for hunting (due to the relatively high density of the population in the southern part of the state and the great distance that ordinance from high-powered rifles can travel). There are additional restrictions imposed by a number of municipalities (note this is for informational purposes only – hunters should consult that actual regulations before engaging in hunting activities).

Target Management Areas

Although there are some restrictions on hunting, there are plenty of locations in the subwatershed where hunting is allowed. And given that most people will travel a small, if not great distance, to hunt it is perfectly appropriate to assess this desired uses on a subwatershed wide basis.

Current Status

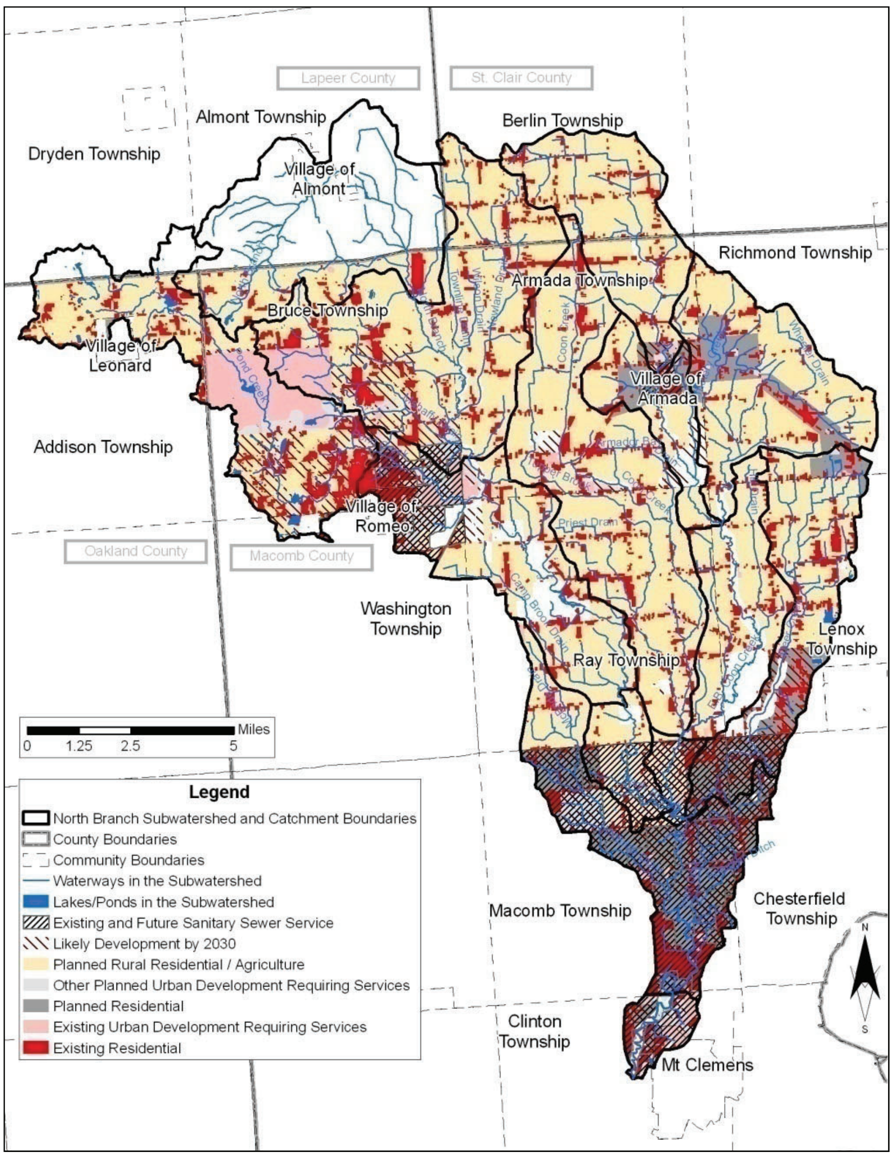
The restrictions on hunting are rather minor and at first glance it appears that the use should simply be considered 'supporting'. However, there is a general lack of public hunting lands in all areas of the subwatershed, making hunters dependent on the goodwill of private landowners. Additionally, the encroachment of developed land and more residences into the sparsely developed areas of the subwatershed may lead to even additional restrictions. In this case, it is more appropriate to consider the use 'supporting' for the entire subwatershed but also consider it 'threatened'.

Support Healthy Aquatic and Terrestrial Habitat by Ensuring Wastes are Properly Disposed of through Appropriate Sewage Treatment and Effective Solid Waste Programs

Proper disposal of sewage and solid waste is essential to support healthy aquatic and terrestrial habitat. Solid waste disposal issues relate to cost of collection services and availability of nearby transfer facilities and/or landfills (with affordable costs) to discourage illegal dumping in rural and other areas such as parks. There are no operating landfills or transfer facilities in the subwatershed and if dumping or other solid waste related issues are determined to be problematic, considerations will need to be made for studying this problem further and addressing the situation.

More important to the quality of habitat is the impact that improperly treated sewage disposal has on local waterbodies and aquatic habitat. Although the subwatershed covers a large area, only the most developed (or planned developed) areas have or are planned to have sanitary sewer service (see Figure 5-7 – note that no data exists in Lapeer County).

Figure 5-7. Data related to sewage treatment.



A Note on Data

Areas in the map that are not filled in are due to the lack of information in this area of the watershed on this particular topic.

Although sanitary sewer systems and WWTPs have occasional sewage discharge problems, the magnitude of the subwatershed development that is and will need to have sewage treated through on-site disposal systems (OSDS) is quite high (see planned sewer extent shown in Figure 5-7 and Figure 5-16). Coupled with the fact that the OSDS realm is loosely regulated and failure rates are high due to a lack of long-term maintenance, OSDS systems are and will continue to be a major source of pollutants that degrade aquatic habitat. Additionally, the relative lack of soils with appropriate infiltration rates (refer to discussion of soils in Chapter 2) often leads to the 'short-circuiting' of OSDS effluent directly into waterbodies, bypassing the finishing microbial decomposition that proper systems would receive from in situ micro-organisms.

Target Management Areas

Because the planning for sanitary sewage and treatment systems occurs on the municipal level, the appropriate management areas are the municipalities, or groupings thereof.

Current Status

The current status of this desired use in the target management areas (only for the sewage treatment portion of the use), as determined by the SWAG, is given as:

- Ray Township – not supporting
- Lenox Township – not supporting
- Bruce Township / Washington Township – not supporting
- Armada Township – not supporting
- Richmond Township – not supporting
- Southern Tier – supporting – this is the only area of the subwatershed that has extensive sanitary service to cover the planned areas of future development requiring utilities
- Oakland County – not supporting
- Lapeer County – insufficient information
- St. Clair County – not supporting.

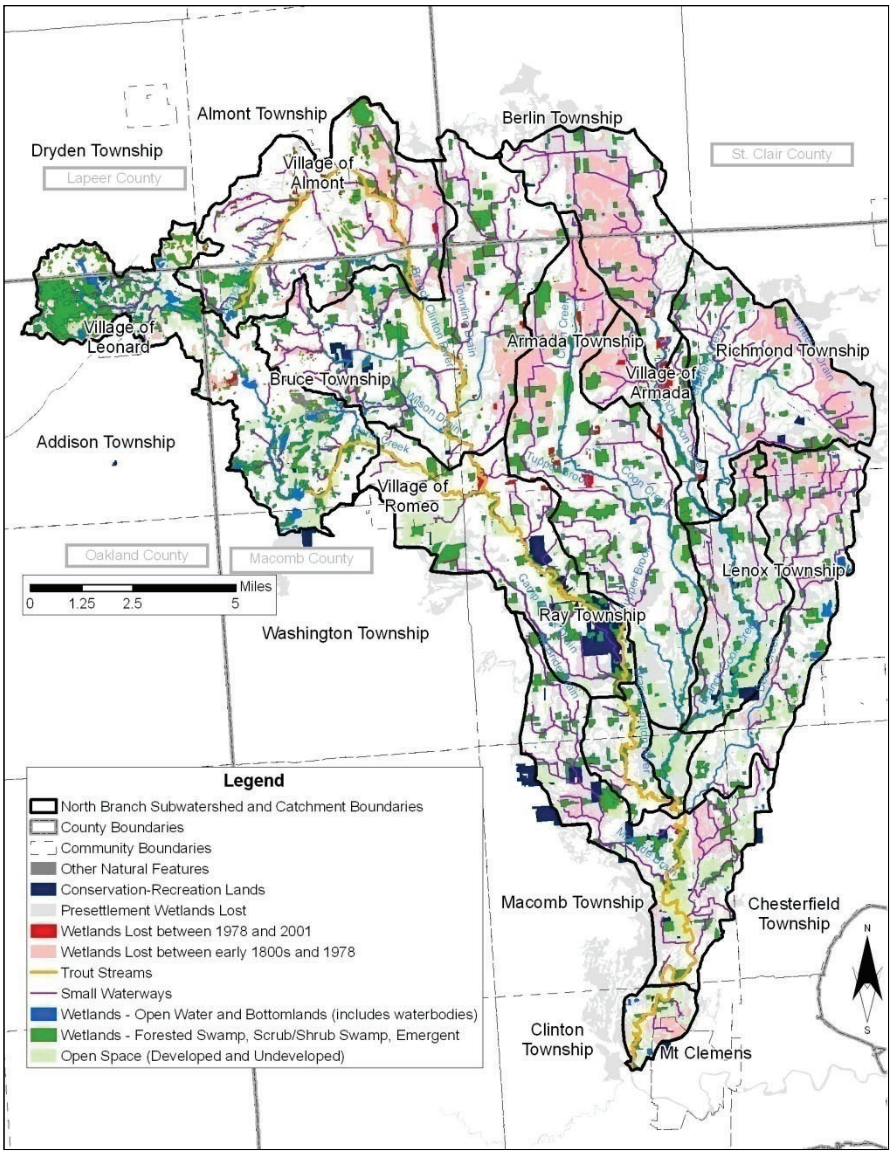
It should be noted that the mere absence of sanitary sewers to service developing or rural residential areas is not reason in and of itself to determine that there is a problematic situation. However, coupled with the lack of proper OSDS oversight, this condition is definitely one that leads to the improper discharge of waste to waterbodies over the long run.

The status of the desired use with respect to solid waste management should be evaluated once sufficient data concerning dumping problems has been determined and disposal access / price issues have been studied.

Support the Character of the Subwatershed by Preserving / Enhancing Identified Natural Features and Healthy Terrestrial Habitat to Maintain and Enhance Game Animal Populations and Threatened / Endangered Species

The natural state of the subwatershed needs to be preserved for both game and endangered organism populations by protecting and enhancing natural features and terrestrial habitat such as unique and sensitive waterbodies, groundwater discharge zones that feed cold-water streams, wetlands and woodlands, open space, and conservation / recreation areas. These elements are shown in Figure 5-8.

Figure 5-8. Natural features and habitat to be preserved and enhanced.



It is worthwhile to note that even the more developed portions of the subwatershed have opportunities to preserve and enhance the remaining natural features within the associated catchments.

Target Management Areas

Because many of the features that are to be protected and/or enhanced are hydrologic in nature, the appropriate management areas are the catchments of the subwatershed or groupings thereof.

Current Status

The current status of this desired use in the target management areas, as determined by the SWAG, is given as:

- North Branch Lower, Lower Middle, Middle and Coon Creek Lower – not supporting – areas need enhancement
- East Branch Coon Creek Lower and Deer Creek – supporting but threatened – elements exist but are becoming sparse due primarily to agricultural draining of wetlands
- East Branch Coon Creek Middle and Highbank Creek – supporting but threatened – elements exist but are becoming sparse due primarily to agricultural draining of wetlands
- East Branch Coon Creek Upper – supporting but threatened – elements exist but are becoming sparse due primarily to agricultural draining of wetlands
- Coon Creek Upper – supporting but threatened – elements exist but are becoming sparse due primarily to agricultural draining of wetlands
- North Branch Upper Middle – supporting - the presence of a large conservation area ensures that the remaining elements in this area will be linked to an extent only achieved in one other management area (East Pond Creek)
- North Branch Upper and Headwaters – supporting – there has been some loss of elements, but on the whole significant areas still exist
- East Pond Creek – supporting – there are extensive natural features and habitat available

Support Healthy Riparian Corridors and Streambanks to Maintain and Enhance Water Quality, Aquatic and Terrestrial Habitats, and Fisheries / Hunting

Healthy riparian corridors and streambanks are essential to ensuring the subwatershed and waterways are healthy. There are very many considerations to make including the width of buffers along major and minor waterbodies, development within the riparian corridor and adjacent floodplain, the type of vegetation and the amount of stream cover this vegetation affords the stream, how often does the county perform 'maintenance' which destroys the health of the natural ecosystem, and how often are these channels straightened to afford greater hydraulic capacity at the sacrifice the natural health of the corridors.

Information collected during the Unified Stream Assessment (USA) and an aerial photo analysis both indicated that the riparian corridors in many portions of the watershed were impacted. Of the sixty-two ratings for "Buffer and Floodplain Conditions" for the USA, thirty-one (31) were rated as *marginal* or *poor*, twenty-three (23) as *suboptimal*, and only thirteen (13) as *optimal.* Additionally, one-hundred and eighty (180) sites were identified through aerial photo analysis as needing remediation to the shore and near shoreline areas throughout the watershed.

Based on the above analyses, the entire subwatershed (despite the need for additional ground truthing of the one-hundred and eighty identified sites) should be considered threatened.

Support the Character of the Subwatershed by Preserving / Enhancing Natural Drainage Systems by Minimizing Directly Connected Impervious Surfaces to Preserve Healthy Terrestrial and Aquatic Habitat

Directly connected impervious area is a problem related to both fragmentation of terrestrial habitat and increased flows and degradation of aquatic habitat. However, based on the information presented later in this chapter, the amount of total impervious coverage for the subwatershed remains at a level of 6.5% and despite the presence of the three villages in the northern portion of the subwatershed, the only other significant portion of connection imperviousness exists in the lower tier of the subwatershed.

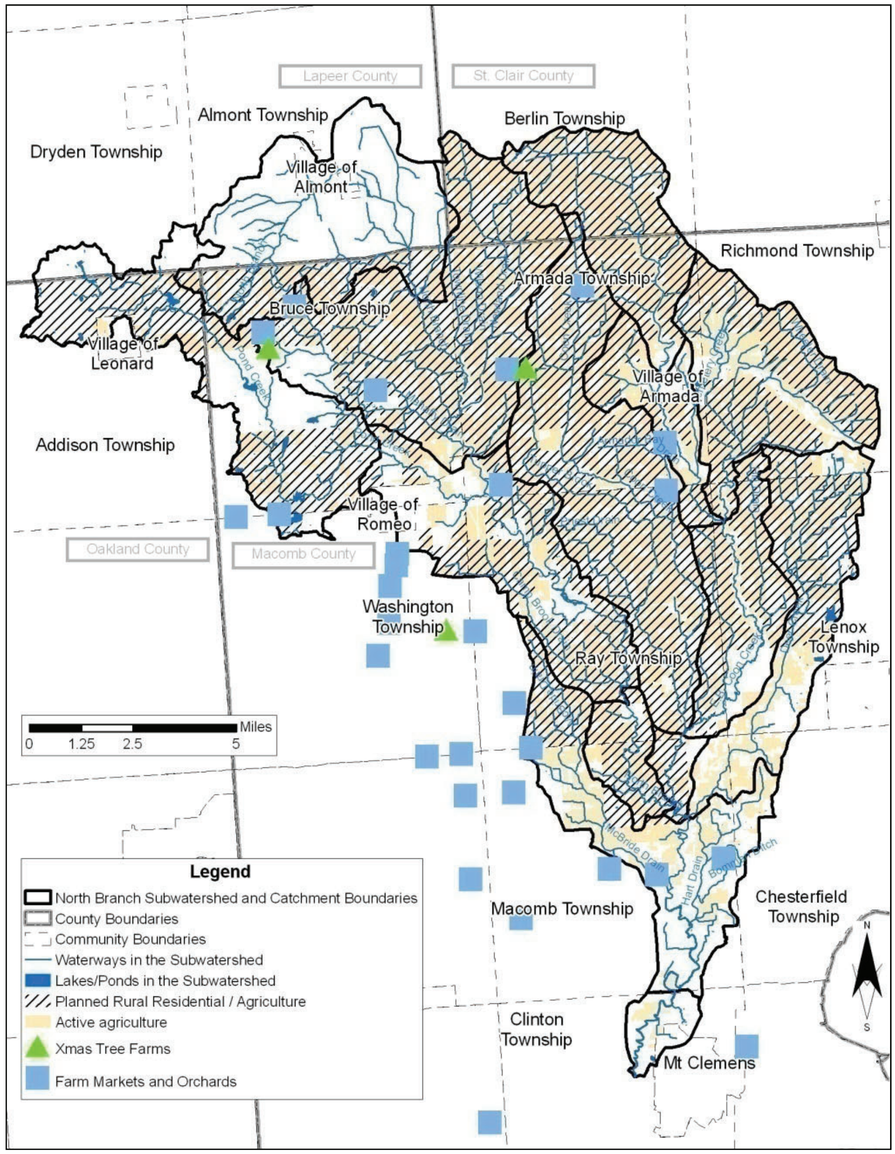
The other part of the equation when considering this desired use is the modification of natural drainage patterns to suit the needs of the local population. This occurs extensively in developed areas as streams are straightened and enclosed. However, straightening also occurs in agricultural areas to allow for easier management of waterbodies that are adjacent to farmland. Additionally, drain tiles that speed the rate at which water is drained from agricultural lands have been noted to be going in the subwatershed at an increasing rate (personal communications Farm Bureau October 2009). Until practices become such that these waterbodies are allowed to return to a natural state the entire subwatershed should be considered non-supporting, if for different reasons depending on if one is considering a developed area or an agricultural area.

Support the Character of the Subwatershed by Preserving Prime and Unique Agricultural Lands

The preservation of agricultural lands appears to be a priority in the rural areas of the subwatershed. Much of the planned future agricultural lands also appear to be in the areas where unique agricultural opportunities currently exist, except for the two in Macomb Township. However, there needs to be an effort made to address those areas of farmland that are truly 'prime' and worthy of strong protection efforts. Once these areas have been identified, strong protection measures that deal with the preservation of development rights need to be enacted. Until then, this lack of data means that the majority of the subwatershed should fall under the category of 'insufficient information', while the southern tier of the subwatershed should be considered to have this desired use as 'not applicable' based on the fact that these areas are designated for future urban development and are not generally considered as part of the rural aesthetic of the rest of the subwatershed.

A Note on Data
Areas in the map that are not filled in are due to the lack of information in this area of the watershed on this particular topic.

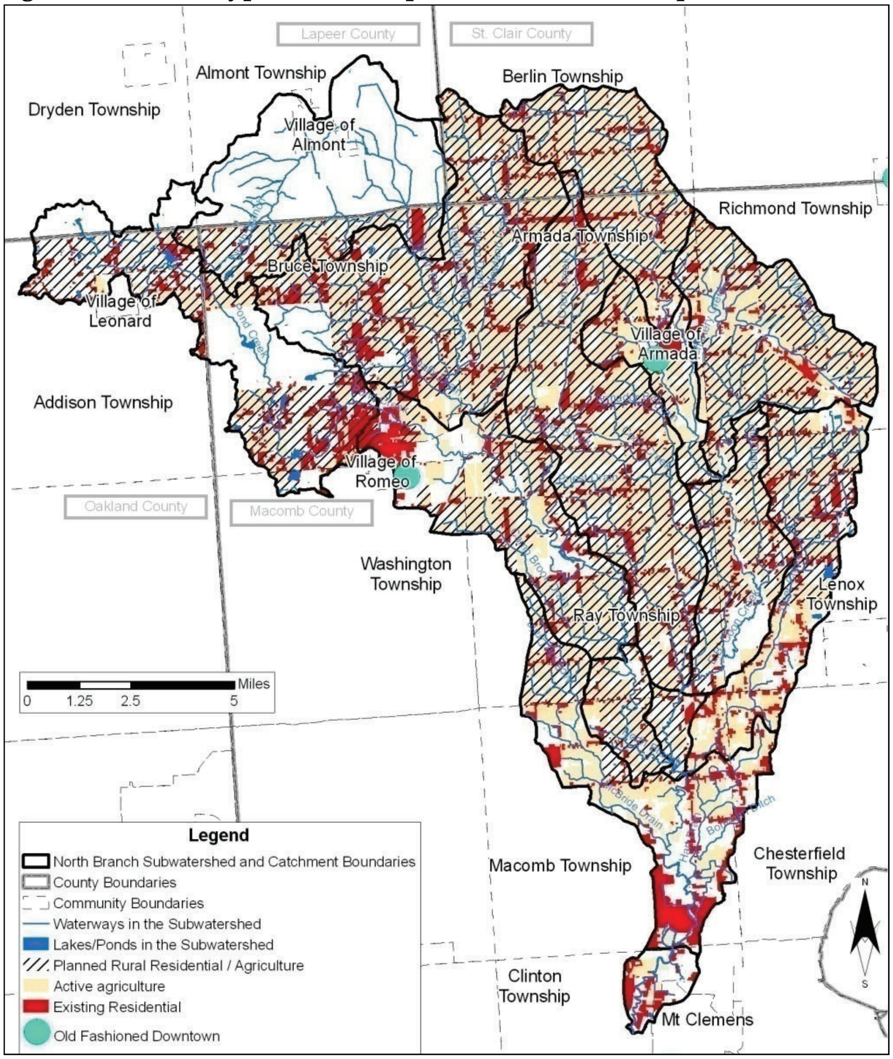
Figure 5-9. Agricultural lands, planned agricultural and rural residential lands, and unique agricultural locations.



Support the Character of the Subwatershed by Preserving Rural Residential Land and Culture and Preserving / Enhancing Other Aesthetic Conditions

The preservation of rural residential land and open space is essential to maintain the rural character of the subwatershed. Rural residential land is essentially synonymous with agricultural land, at least at the subwatershed scale, and the prospects for preservation can be determined by comparing the current agricultural land use versus residential land use in agricultural areas. Additionally, those areas that are planned to be developed based on the planning documents of the various communities need to be considered. This information is presented in Figure 5-6.

Figure 5-10. Rural type lands and planned future development.



A Note on Data

Areas in the map that are not filled in are due to the lack of information in this area of the watershed on this particular topic.

Target Management Areas

Because planning currently occurs on the municipal level, the appropriate management areas in this instance are the municipalities, or groupings thereof.

Current Status

The current status of this desired use in the target management areas, as determined by the SWAG, is given as:

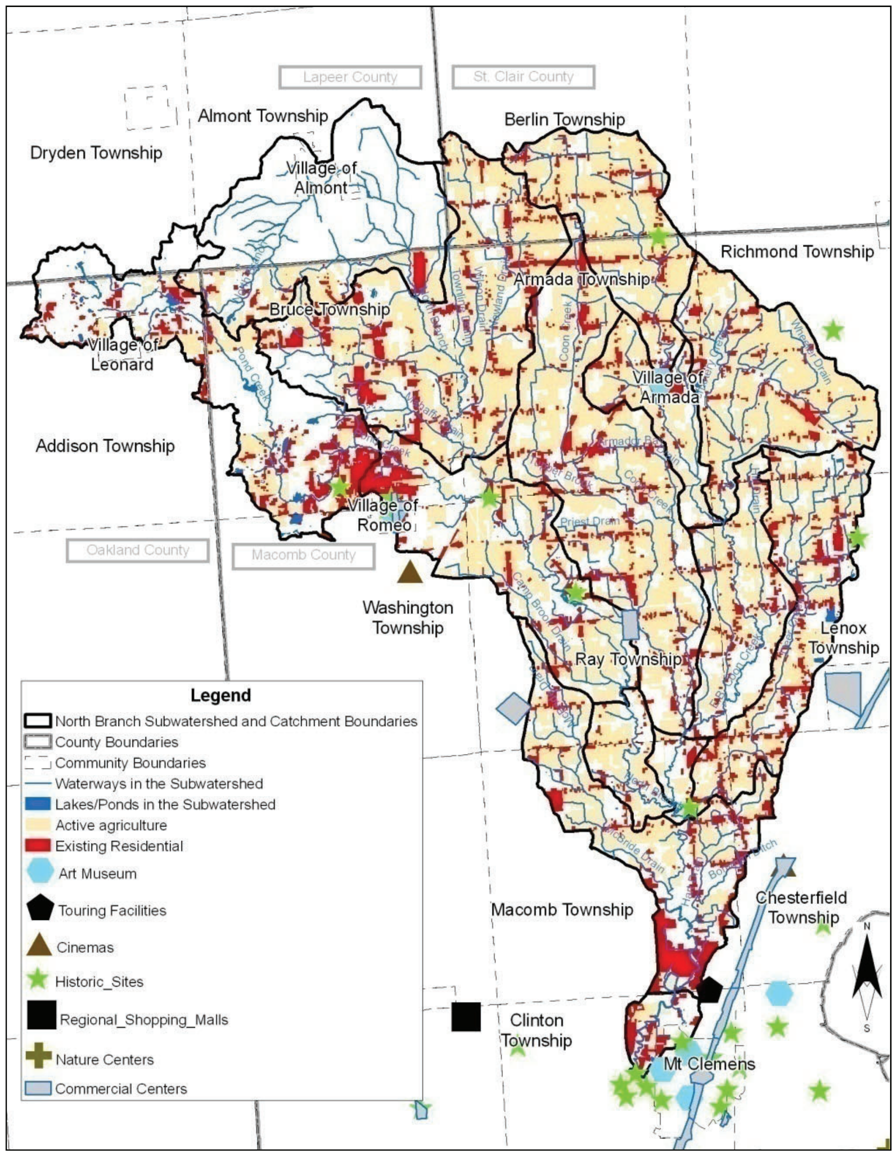
- Ray Township - Supporting
- Lenox Township – Supporting
- Bruce Township / Washington Township – Supporting but Threatened (half of the agricultural / rural residential land in these areas is planned for future development)
- Armada Township – Supporting
- Richmond Township – Supporting
- Southern Tier – Not Supporting (almost all of the existing agricultural / rural residential land in Macomb, Chesterfield, and Clinton Townships, and Mt. Clemens is planned for future development) – it can probably be considered based on this information that this desired use does not apply to these communities
- Oakland County – Supporting – the rural areas show no planned development
- Lapeer County – Insufficient Information
- St. Clair County – Supporting

A Note on Data
Areas in the map that are not filled in are due to the lack of information in this area of the watershed on this particular topic.

Support the Character of the Subwatershed by Preserving Historical and Cultural Resources

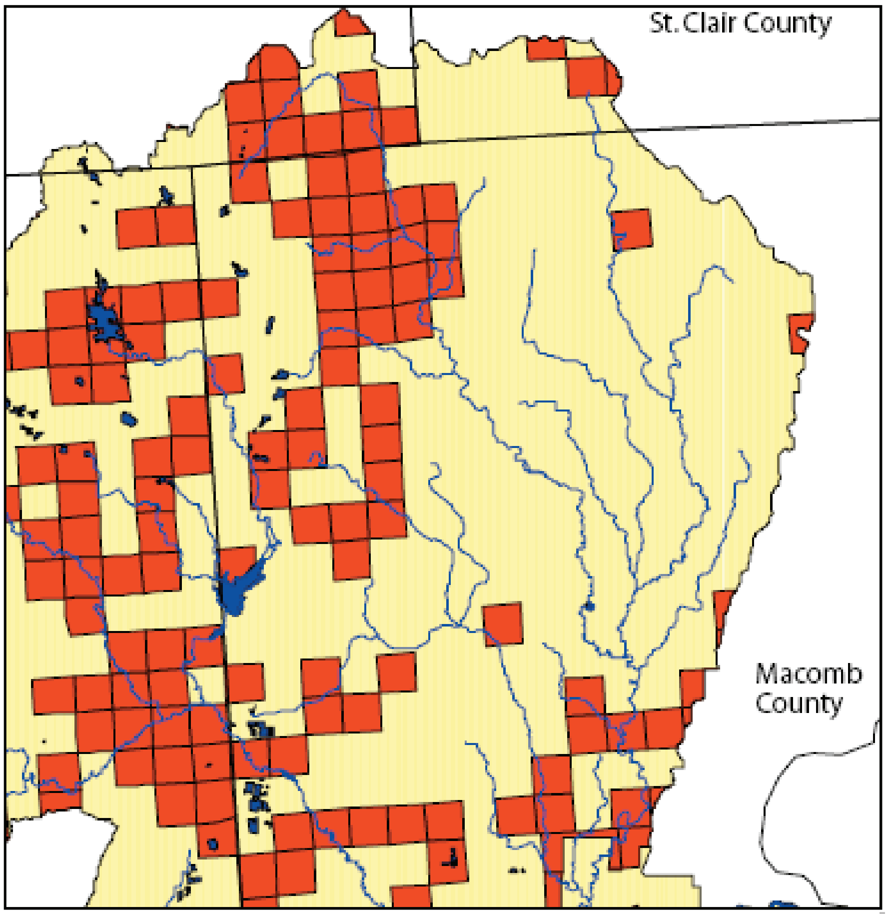
Historical and cultural resources in the subwatershed define an essential component of the character of the people. They define traditional and current values and may present unique opportunities for watershed management planning activities. The designated historical facilities include government buildings, religious buildings, residences, and libraries. The cultural resources include museums, shopping malls, touring facilities, cinemas, and commercial centers. Figure 5-11 displays the locations of these resources throughout the subwatershed. Summary data by management area is presented on the map.

Figure 5-11. Locations of cultural resources.



A special type of historical site is an archaeological site. An archaeological site typically has evidence of prehistoric or historic activities that can be investigated using the principles of archaeology (the study of past human civilizations). The archaeological sites documented in the *Clinton River Assessment* (Francis, 2006) are generally related to Native American populations (Figure 5-12), but other potential sites include those related to explorers of the 17th and 18th centuries and settlers of the 19th century.

Figure 5-12. Archaeological sites in the eastern portion of the Clinton River Watershed.



County	Township	Number of sites
Lapeer	T. 06 N, R. 12 E	25
St. Clair	T. 06 N, R. 13 E	1
Oakland	T. 05 N, R. 09 E	1
Oakland	T. 05 N, R. 10 E	15
Oakland	T. 05 N, R. 11 E	18
Macomb	T. 05 N, R. 12 E	62
Macomb	T. 05 N, R. 13 E	7
Oakland	T. 04 N, R. 08 E	2
Oakland	T. 04 N, R. 09 E	13
Oakland	T. 04 N, R. 10 E	33
Oakland	T. 04 N, R. 11 E	39
Macomb	T. 04 N, R. 12 E	22
Macomb	T. 04 N, R. 13 E	1
Oakland	T. 03 N, R. 09 E	15
Oakland	T. 03 N, R. 10 E	39
Oakland	T. 03 N, R. 11 E	46
Macomb	T. 03 N, R. 12 E	22
Macomb	T. 03 N, R. 13 E	26
Macomb	T. 03 N, R. 14 E	2
Oakland	T. 02 N, R. 10 E	1
Oakland	T. 02 N, R. 11 E	4
Macomb	T. 02 N, R. 12 E	40
Macomb	T. 02 N, R. 13 E	31
Macomb	T. 02 N, R. 14 E	12
Oakland	T. 01 N, R. 09 E	11
Oakland	T. 01 N, R. 11 E	10
Macomb	T. 01 N, R. 12 E	13
Oakland	Unknown	1

Source, graphic: Francis, 2006.

Because of the nature of historic and cultural resources, it is appropriate to assess this use and the relative abundance of these resources in the subwatershed and in the nearby region allows the use to be classified as 'supporting'.

Assessed Conditions: Stressors and Impacts

The most common type of assessments conducted to gauge environmental conditions are those that directly measure the stressors that are anticipated to impact the natural environment, and in extreme cases lead to impairments, in the future. The data is summarized in Figure 5-13.

Where data has been collected in support of this plan, it has also been included in the assessment. All of the newly collected data has been summarized in their respective reports that stand alone outside the WMP. Information about the individual stressors presented here can be found in Appendix C.1.

Some stressors have additional information that is useful to analyze. This information is presented in the figures following Figure 5-13.

Qualitative Rankings of Stressor Conditions

The following rankings are used to define the stressor conditions:

Excellent – well below standard

Good – below standard

Fair / Marginal – within 25% of standard

Poor – 25% to 100% above standard

Extremely Poor – greater than 100% above standard

Invasive Species

When non-native species are introduced into an environment in which they did not evolve, there often is no natural predator available to control their population. While there is little available data concerning the extent of any invasive species in the subwatershed, it is important to document regional invasive species such that these organisms can be identified if they are discovered.

Invasive Plant Species

There are a many invasive species which have been documented in or near the subwatershed. Examples from the Lake St. Clair Coastal Habitat Assessment (GLC, 2004) are presented in the following text.

Purple Loosestrife

Photo Source: UMN, 2005.

Eurasian Water-Milfoil

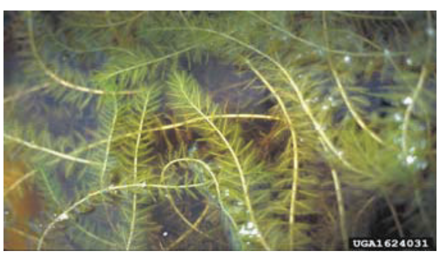


Photo Source: Echo, 2006.

Purple loosestrife

Purple loosestrife is a widespread and serious problem that continues to invade and thrive in wetlands in southeast Michigan. It has the ability to quickly displace native vegetation as a single plant can produce up to one million seeds.

Eurasian water-milfoil

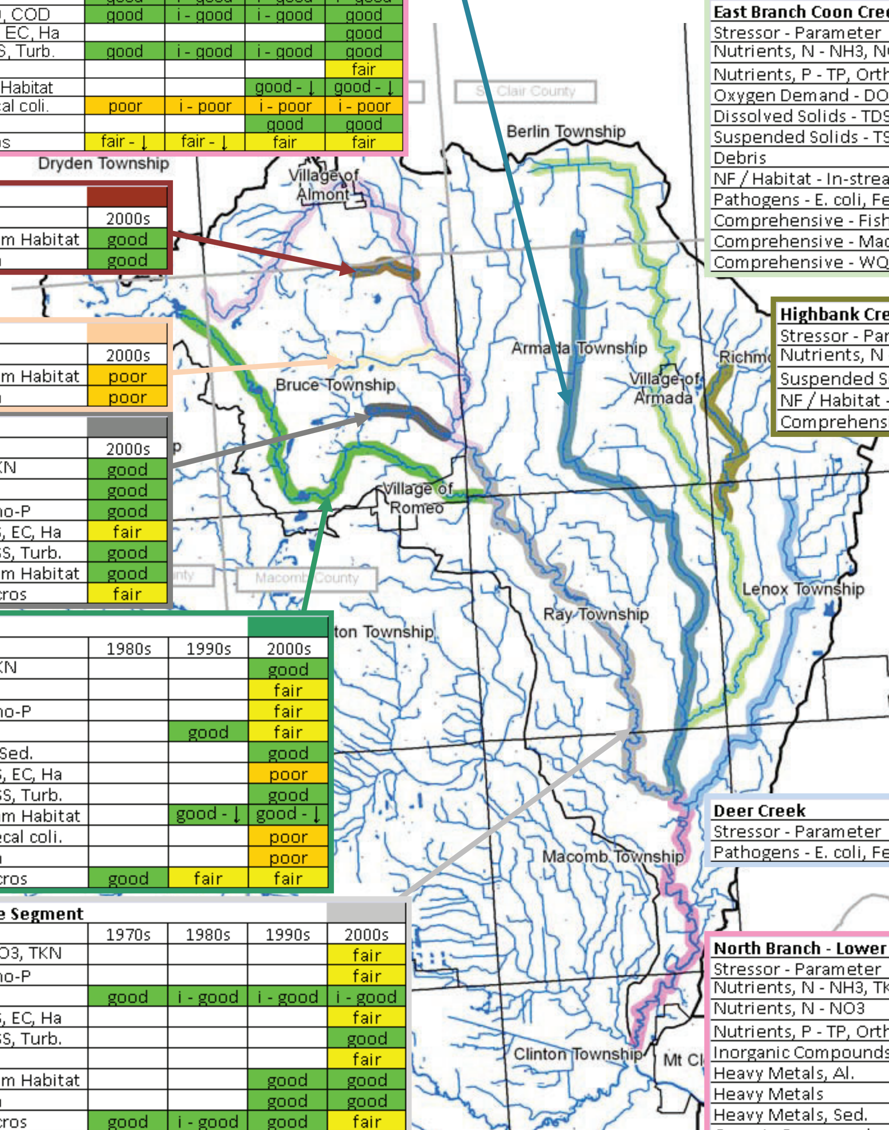
Eurasian water-milfoil is a rooted aquatic plant that can grow in a wide variety of habitats. Its long stems that branch near the surface of the water create a cover of floating foliage that blocks out native vegetation, affects macroinvertebrate communities, and impairs fish spawning. It is becoming common in Lake St. Clair with its frequency of occurrence at sampling sites doubling between 1978 and 1995 (LSCSCR, 1998).

Phragmites

Phragmites are fast-spreading weeds — some growing up to 15 feet high — that has invaded the Lake St. Clair shoreline and have spread up the Clinton River. With its distinctive feathery top, this invasive species of plant is "out of control," officials say, and is threatening the habitat of ducks, swans, turtles, frogs and native plants near the waterfront.

A list of other known and potential invasive plant species (both aquatic and terrestrial) includes: common buckthorn, common reed, honeysuckle, garlic mustard, privet, autumn olive, sweetclover, spotted knapweed, European frogbit, flowering rush, hydrilla, reed canary grass, cheatgrass, Japanese knotweed, leafy spurge, multiflora rose, smooth brome, and tree-of-heaven (GLC, 2004).

Figure 5-13. Stressor and comprehensive parameter conditions in the subwatershed.



North Branch - Upper Segment

Stressor - Parameter	1970s	1980s	1990s	2000s
Nutrients, N - NH3, NO3, TKN	good	i - good	fair	fair
Nutrients, P - TP, Ortho-P	good	i - good	good	fair
Heavy Metals				good
Heavy Metals, Sed.				fair
Organic Compounds - TOC				good
Organic Compounds, Sed.				good
Oxygen Demand - DO	good	i - good	i - good	i - good
Oxygen Demand - BOD, COD	good	i - good	i - good	good
Dissolved Solids - TDS, EC, Ha				good
Suspended Solids - TSS, Turb.	good	i - good	i - good	good
Debris				fair
NF / Habitat - In-stream Habitat			good - ↓	good - ↓
Pathogens - E. coli, Fecal coli.	poor	i - poor	i - poor	i - poor
Comprehensive - Fish			good	good
Comprehensive - Macros	fair - ↓	fair - ↓	fair	fair

Coon Creek

Stressor - Parameter	1990s	2000s
Nutrients, N - NH3, TKN, NO3		good
Nutrients, P - TP, Ortho-P		fair
Dissolved Solids - TDS, EC, Ha		fair
Suspended Solids - TSS, Turb.		good
NF / Habitat - In-stream Habitat	fair	fair
Comprehensive - Fish		fair
Comprehensive - Macros		fair

East Branch Coon Creek

Stressor - Parameter	1990s	2000s
Nutrients, N - NH3, NO3, TKN		good
Nutrients, P - TP, Ortho-P		poor
Oxygen Demand - DO	poor	poor
Dissolved Solids - TDS, EC, Ha		fair
Suspended Solids - TSS, Turb.		good
Debris		fair
NF / Habitat - In-stream Habitat	good	fair
Pathogens - E. coli, Fecal coli.		poor
Comprehensive - Fish	good	fair
Comprehensive - Macros		fair
Comprehensive - WQI		good

Kidder Creek

Stressor - Parameter	2000s
NF / Habitat - In-stream Habitat	good
Comprehensive - Fish	good

Apel Drain

Stressor - Parameter	2000s
NF / Habitat - In-stream Habitat	poor
Comprehensive - Fish	poor

Wilson Drain

Stressor - Parameter	2000s
Nutrients, N - NH3, TKN	good
Nutrients, N - NO3	good
Nutrients, P - TP, Ortho-P	good
Dissolved Solids - TDS, EC, Ha	fair
Suspended Solids - TSS, Turb.	good
NF / Habitat - In-stream Habitat	good
Comprehensive - Macros	fair

Highbank Creek

Stressor - Parameter	2000s
Nutrients, N - NH3, TKN	good
Suspended Solids - TSS, Turb.	good
NF / Habitat - In-stream Habitat	good
Comprehensive - Macros	fair

East Pond Creek

Stressor - Parameter	1980s	1990s	2000s
Nutrients, N - NH3, TKN			good
Nutrients, N - NO3			fair
Nutrients, P - TP, Ortho-P			fair
Heavy Metals, Sed.		good	fair
Organic Compounds, Sed.			good
Dissolved Solids - TDS, EC, Ha			poor
Suspended Solids - TSS, Turb.			good
NF / Habitat - In-stream Habitat		good - ↓	good - ↓
Pathogens - E. coli, Fecal coli.			poor
Comprehensive - Fish			poor
Comprehensive - Macros	good	fair	fair

Deer Creek

Stressor - Parameter	1990s	2000s
Pathogens - E. coli, Fecal coli.	poor	poor

North Branch - Middle Segment

Stressor - Parameter	1970s	1980s	1990s	2000s
Nutrients, N - NH3, NO3, TKN				fair
Nutrients, P - TP, Ortho-P				fair
Oxygen Demand - DO	good	i - good	i - good	i - good
Dissolved Solids - TDS, EC, Ha				fair
Suspended Solids - TSS, Turb.				good
Debris				fair
NF / Habitat - In-stream Habitat			good	good
Comprehensive - Fish			good	good
Comprehensive - Macros	good	i - good	good	fair
Comprehensive - WQI				good

North Branch - Lower Segment

Stressor - Parameter	1990s	2000s
Nutrients, N - NH3, TKN		fair
Nutrients, N - NO3		poor
Nutrients, P - TP, Ortho-P		fair
Inorganic Compounds - Sulfates		fair
Heavy Metals, Al.	fair	fair
Heavy Metals		good
Heavy Metals, Sed.		fair
Organic Compounds - O&G		fair
Organic Compounds, Sed.		good
Oxygen Demand - DO		fair
Oxygen Demand - BOD, COD		fair
pH		good
Dissolved Solids - TDS, EC, Ha	fair	fair
Suspended Solids - TSS, Turb.		fair
Debris		fair
Temperature		good
NF / Habitat - In-stream Habitat	fair - ↓	fair - ↓
Pathogens - E. coli, Fecal coli.		fair
Comprehensive - Fish	good	fair
Comprehensive - Macros	fair	fair

Invasive Animal Species

There are a many invasive species which have been documented in or near the subwatershed. Examples from the Lake St. Clair Coastal Habitat Assessment (GLC, 2004) are presented in the following text.

Zebra Mussel

Picture Source: Starfish, 2006.

Spiny water flea

The spiny water flea is a tiny crustacean with long, sharp, barbed tail spines. It is poised to invade Lake St. Clair and from there could colonize water in the Clinton River basin.

Zebra mussel

This invasive from the Caspian Sea region was first discovered in Lake St. Clair in 1988. They aggressively compete with indigenous species, which has resulted in the extirpation of the 18 native species from the open waters of Lake St. Clair. The zebra mussel also aggressively colonizes submerged infrastructure such as water intake screens at treatment plants, creating extensive problems for industry and municipalities.

A list of other known and potential invasive species includes: emerald ash borer, Asian long-horned beetle, rusty crawfish, sea lamprey, round and tubenose goby, ruffe, Asian carp, and northern snakehead.

Hydrologic / Hydraulic Characteristics

The following is a brief discussion of the hydrologic and hydraulic characteristics in terms of flashiness and its trend in the North Branch.

Using daily observed flow values at three USGS gages (East Pond Creek, East Branch Coon Creek, and North Branch Clinton River near Mt Clemens) the Richards-Baker (RB) index was calculated on an annual water-year basis (Figure 5-14). Annual RB index at East Pond Creek ranged from 0.1 to 0.25, reflective of soils containing a heterogeneous mix of outwash deposits and moraines left by retreating glaciers. Annual RB index at East Branch Coon Creek is significantly higher, ranging from 0.4 to 0.8, showing the influence of lacustrine soils with very low infiltration rates. Near the outlet of the subwatershed, the annual RB index ranges from 0.25 to 0.5, reflecting a mix of upstream conditions. The majority of the North Branch watershed is naturally flashy, and the effects of urbanization on RBI are likely buffered to some extent.

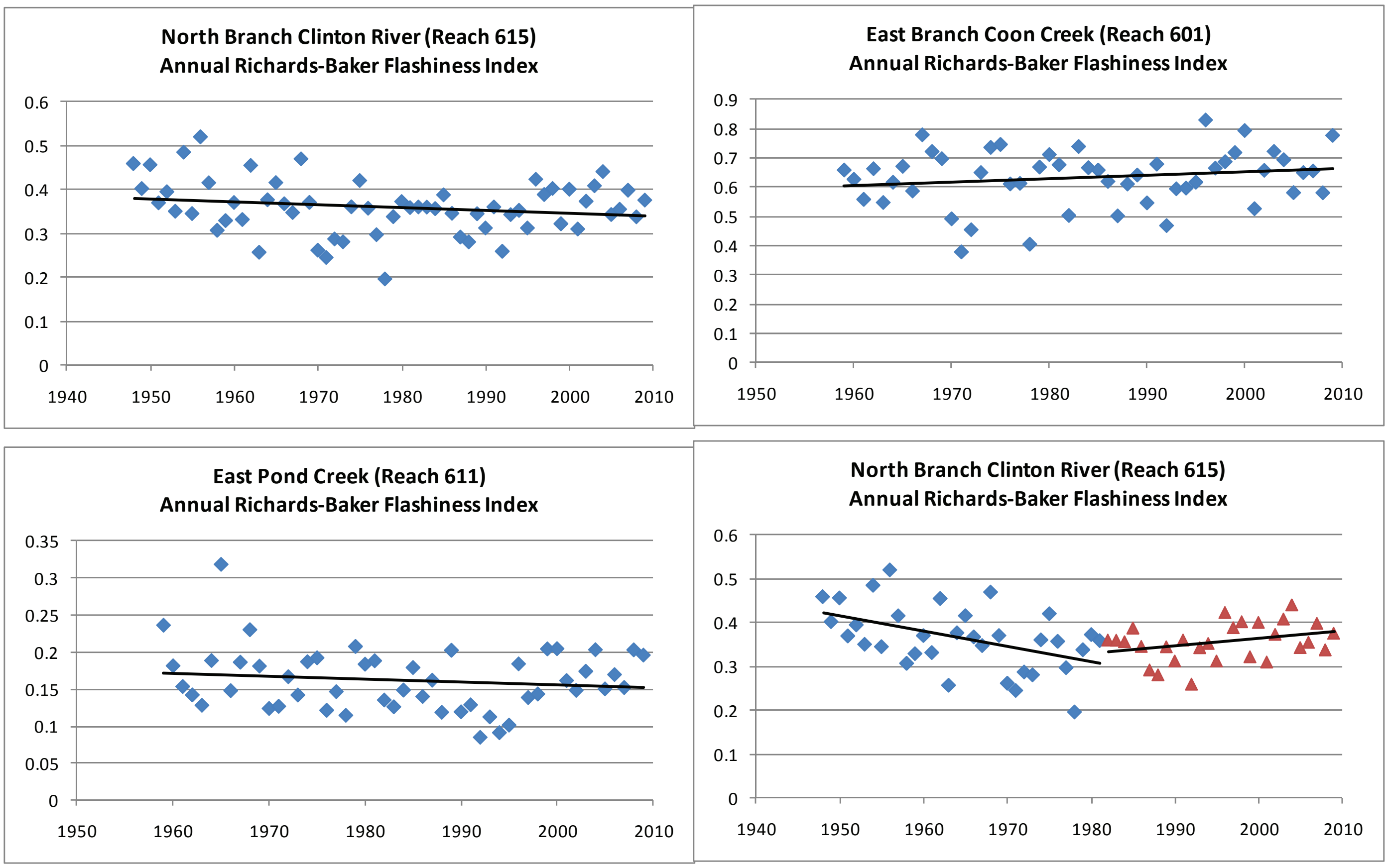
Regression analyses were performed to determine whether the predicted trends were statistically significant at a 95% confidence level (p= 0.05). None of the trends were significant at the 95% level (Table 5-8).

Table 5-8. Regression analysis of flashiness trends.

Stream Gage	n (data points)	Slope	P-value
East Pond Creek	50	-0.00041	0.303760
East Branch Coon Creek	50	0.00114	0.220004
North Branch Clinton River (all years)	62	-0.00062	0.156485
North Branch Clinton River (1948-1981)	34	-0.00345	0.005314
North Branch Clinton River (1981-2009)	28	0.00171	0.093124

However, a visual assessment of the trend for NBCR suggests a downward trend through the early 1980's, followed by an upwards trend. Regression analyses were performed separately for the two time periods. The earlier time period was found to have a decreasing flashiness trend at a significance level of $P < 0.01$; however, the upward trend for the later time period had a weak significance at $p = 0.09$. The cause of decrease in flashiness from 1948-1981 is not known, and may be related to any number of changes in land use and/or water management within the watershed. Assuming there is an increase in flashiness during the later time period, it is likely that recent development and accompanying increases in impervious cover is the primary driver.

Figure 5-14.Flashiness indices and trends for all full-year data at three gages in the subwatershed.



Assessed Conditions: Sources and Causes

The previous section presented assessments of the stressors. This section presents assessments of the sources of the stressors. Identifying and characterizing sources are critical to the successful development and implementation of a watershed management plan and the control of pollutant loads. Each source is discussed in at least one section even if available data is limited. Certain sections that discuss multiple sources have been formatted as such based on the most appropriate presentation.

(EPA 2.4.1, 5.1, 5.6, 5.7)

Point Sources

Pollutants discharged from any identifiable point, including pipes, ditches, channels, sewers, tunnels, and containers of various types are considered point sources. Some are facilities with permitted discharges, others are facilities that manage pollutants and may accidentally discharge them to the environment. Discharge permit limits and effluent monitoring data are the typical types of data that are available. **(EPA 5.7.1)**

A. Industrial Sites

In general, industries that discharge today contribute fewer pollutants to waterways than they have in the past (USACE, 2004). There are only a handful of industrial site discharges in the whole Clinton River Watershed (let alone the subwatershed), as most industries have instituted industrial pretreatment plans and discharge wastes to sanitary sewers (CRPAC, 2000). Existing NPDES industrial discharge locations for the subwatershed are indicated in Figure 5-15. This source can also be considered to include the industrial stormwater permitted facilities (although stormwater sources are generally considered of a non-point variety, the fact that a permit exists changes the consideration).

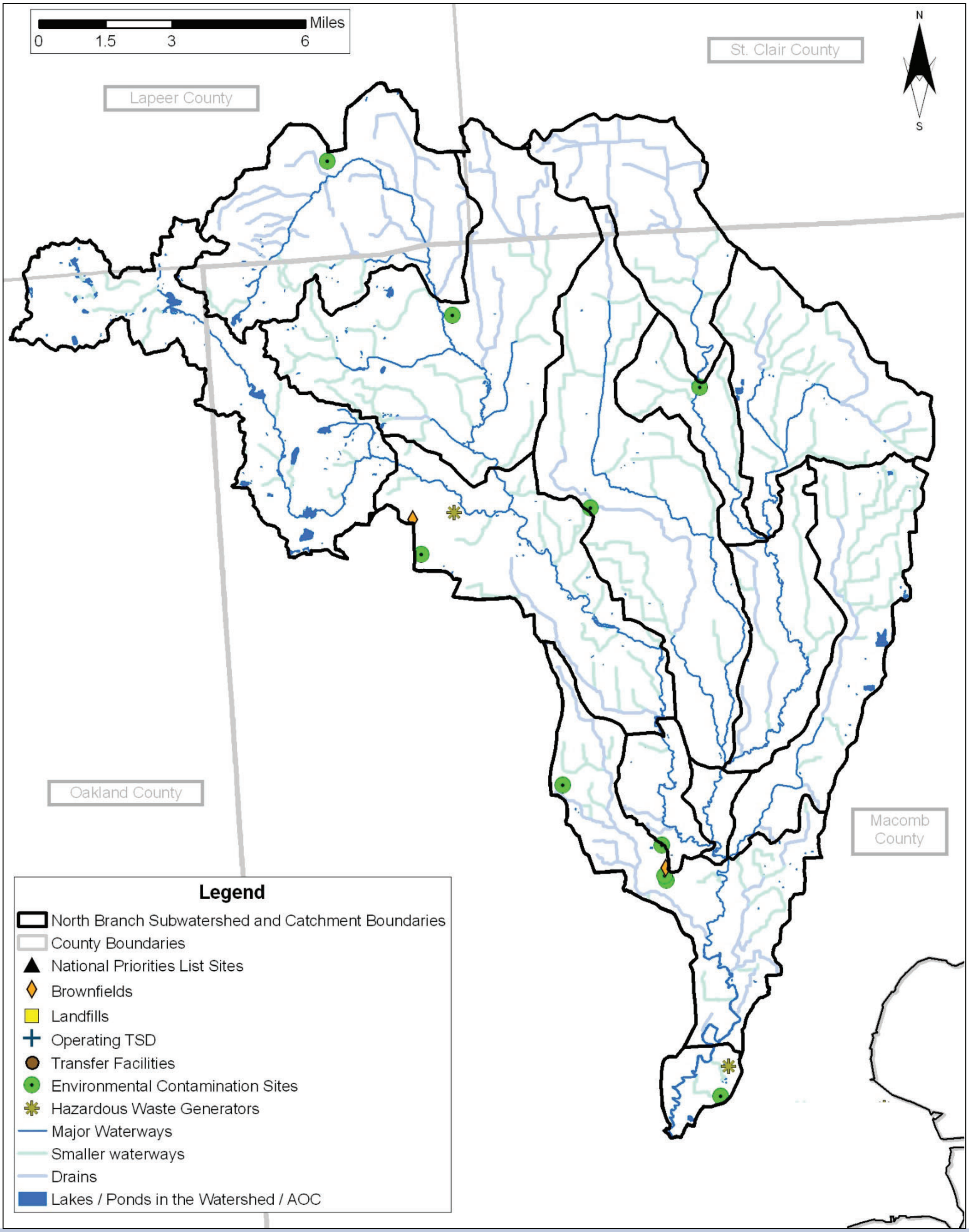
B. Waste Management Sites

A waste management site is a general term to describe an active facility that handles or disposes of various types of waste. Such facilities include hazardous waste generators, landfills, transfer facilities, and other general treatments, storage, and disposal (TSD) facilities and these are shown in Figure 5-15. The sparsely developed North Branch Subwatershed understandably has a smaller number of these facilities than most other areas of the Clinton River Watershed.

C. Contaminated Sites

Contaminated sites (which are generally inactive) can be the result of any number of causes, including historic dumping, improper industrial waste disposal and handling, abandoned landfills, and leaking storage facilities. Figure 5-13 shows known environmental contamination sites within the subwatershed (USACE, 2004). Brownfields and Part 201 sites of environmental contamination (as classified by the MDNRE) are shown in Figure 5-15. Another category of contaminated sites are leaking underground storage tanks (LUSTS). An abandoned mine such as an open pit used for gravel extraction, also has the potential to be contaminated.

Figure 5-15. Industrial, waste management, and contaminated sites in the subwatershed.



D. Sewage Discharges

Sewage discharges include both treated and untreated sources. WWTPs are designed to treat human sewage to prevent the spread of pathogens and reduce pollutant concentrations (e.g. suspended solids, nutrients, and biological oxygen demand [BOD]). Because municipal wastewater also includes treated industrial waste and household chemicals, sewage may also contain low levels of metals, inorganic and organic pollutants (USACE, 2004).

Municipal governments are required to obtain permits for discharging effluent from WWTPs. However, even when in compliance with regulations, these sources can be problematic due to seasonal variations in stream flow. These facilities may contribute a substantial load because they discharge a large volume of treated wastewater on a constant basis.

In the subwatershed, sewage is collected through a sanitary sewer system and routed to one of four WWTPs (Romeo, Armada, Almont and Detroit – which is outside of the subwatershed). The approximate areas served by these sewers (present and future) and the locations of the WWTPs are given in Figure 5-16.

The MDNRE requires that all sewage discharges to surface waters need to be reported. The reports are freely available on the internet and indicate that in the subwatershed, the following discharges have occurred:

- Almont WWTP sanitary sewer overflows to the North Branch Clinton River (1 in 2009, 3 in 2003, 3 in 2001, 2 in 2000) ranging from 1.04 million gallons to 40,000 gallons (with a number of events of unknown volume),
- Armada WWTP sanitary sewer overflows to Coon Creek (1 in 2010, 2 in 2009, 1 in 2008, 2 in 2004) ranging from 1.1 million gallons to 100 gallons;
- Macomb Township sanitary sewer overflow to the North Branch Clinton River (1 in 2003) of 540 gallons; and
- Romeo WWTP sanitary sewer overflow to East Pond Creek (1 in 2005) of 5.4 million gallons with one event in 2010 and one in 2009, each approximately 100 gallons (with receiving waterbody not given).

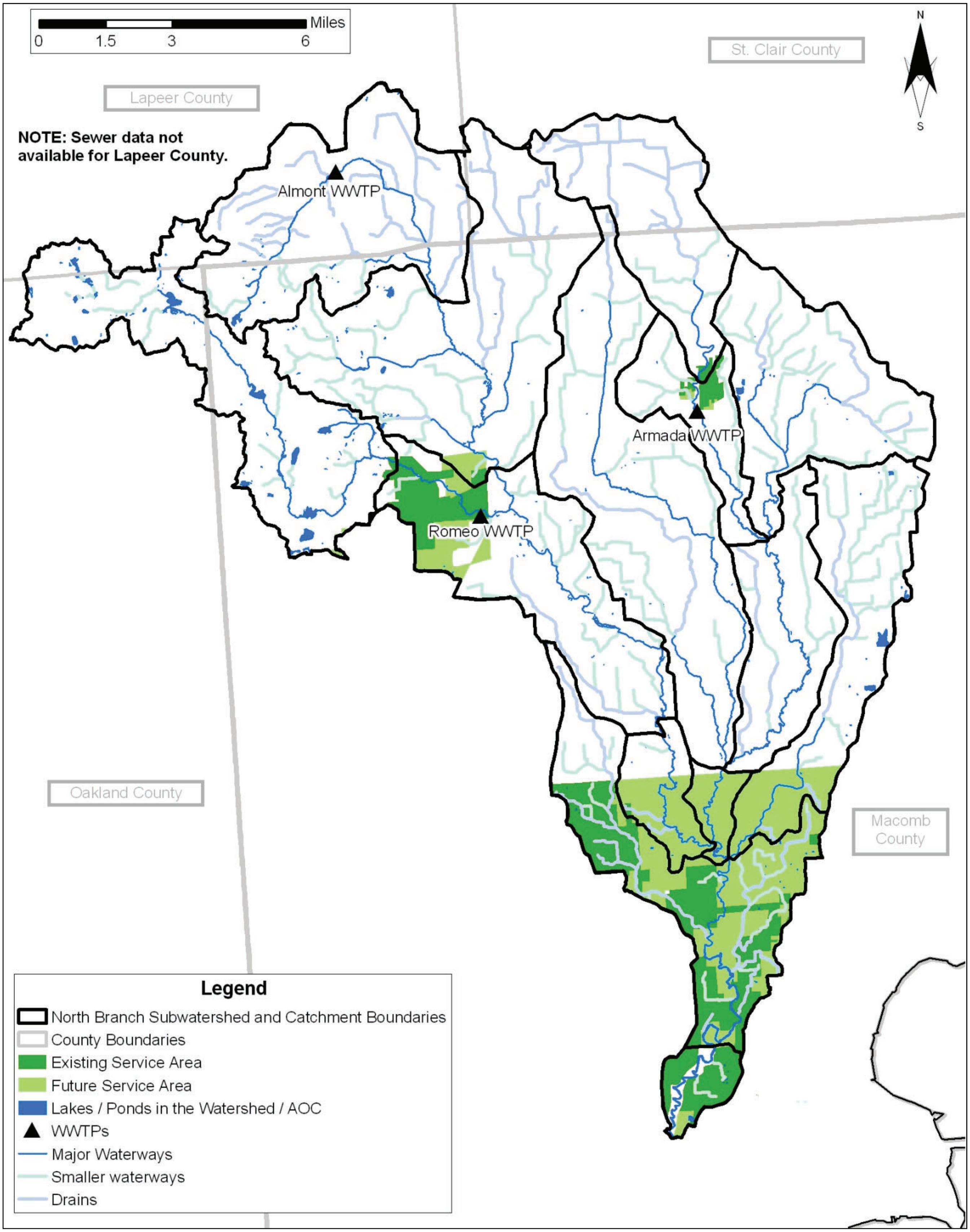
E. Other Businesses

Many other commercial businesses have the potential to introduce stressors in to the natural environment.

<u>Dry Cleaning</u>

Dry cleaning uses non-water-based solvents to remove dirt and stains from clothes. The most common chemical used today is tetrachloroethylene (TCE). It is stable, nonflammable, and has excellent cleaning power. However, TCE is toxic, and chronic exposure may cause liver and kidney damage. Alternative cleaning solvents also pose distinct concerns (MDNRE, last accessed July 27, 2010). Improperly stored and disposed chemicals and wastes have the potential to contaminate the natural environment, most commonly soil and groundwater.

Figure 5-16. Sewered areas and WWTPs.



Automotive Service Stations and Storage Tanks
Service stations are facilities which provide fuels and lubricants for motor vehicles. These and many other facilities store products in underground storage tanks. The chief causes of pollutant release from these sources are spills and storage tank leaks. Because of this risk, most (underground) storage tanks now have extensive measures in place to detect and prevent any such leaks. Other pollutants associated with auto-motive service stations include chemicals such as leaking antifreeze (caused by leaks or spills) and detergents from car washes (caused by uncontrolled drainage into the storm sewer system) – (EPA, 2007).

Non-Point Sources

Non-point sources are pollution that cannot be detected from a specific point or any specific land use. Prime examples include, street runoff, erosion from construction and agricultural runoff.

F. Illicit Discharges / Spills

An illicit discharge is the introduction of polluting materials (e.g., sewage or sediment) into a pipe that drains to surface water or the spilling, dumping, or mishandling of materials in a manner that allows those materials to drain to a watercourse.

Common illicit discharges include:

- Pipes intended for a sanitary sewer connected instead to a storm drain;
- Intentional dumping of wastes such as motor oil into storm drain catch basins; and
- Soapy water from outdoor cleaning activities (such as car washing) discharging to a storm drain.

Spills can involve industrial, municipal, commercial and agricultural sources. Although the number and size of spills or releases has reduced dramatically over the last several years due to measures implemented by industries, historical spills have had a large impact on water and sediment quality (USACE, 2004). Spills associated with distinct point sources should be considered under that particular source. All others can be included here.

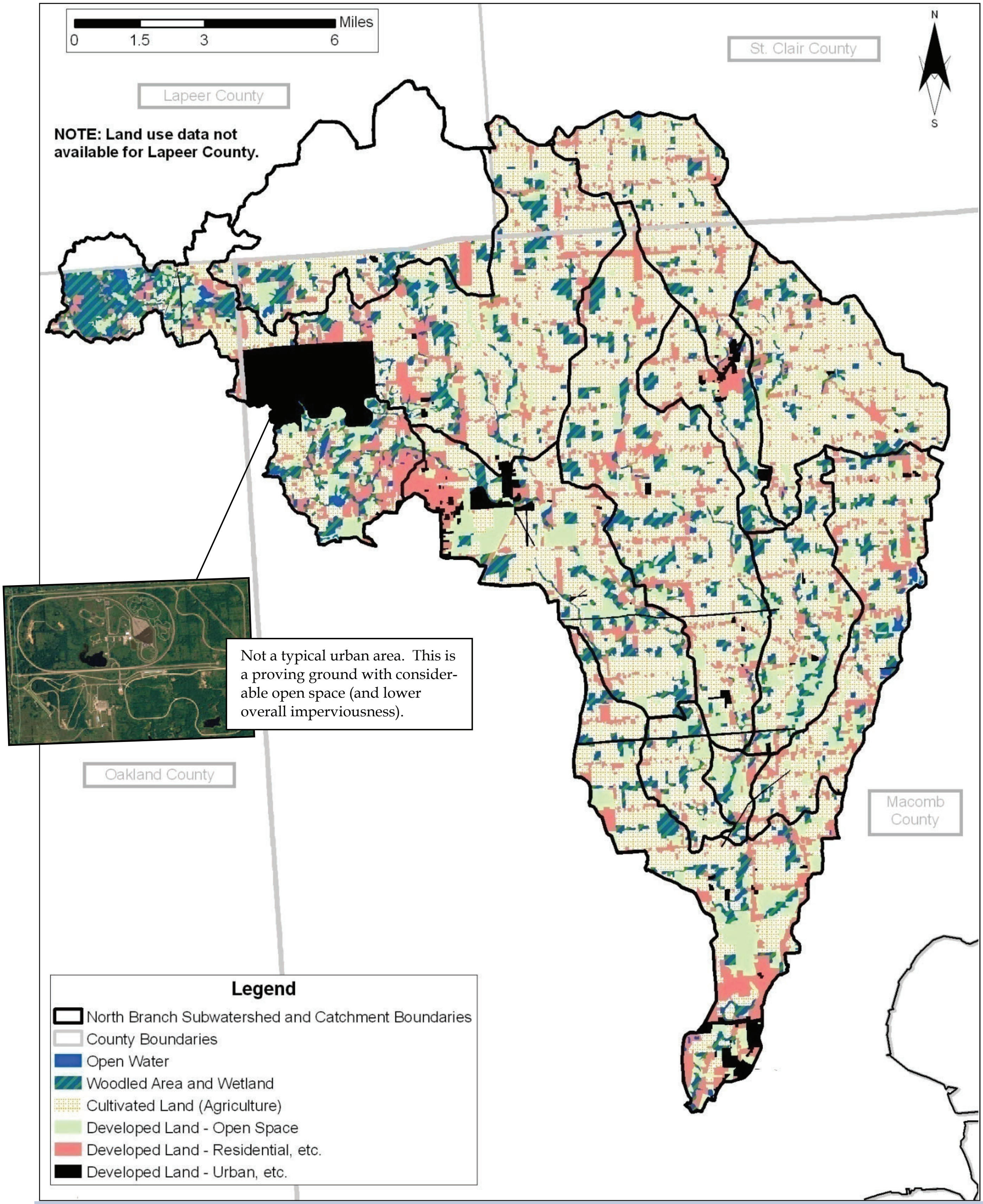
G. Urban and Residential Land

Land uses are an important factor influencing the physical conditions of the watershed, as well as an indicator of the types of sources active in the watershed. Together with land use characteristics, population can help you to understand the potential growth of the area and possible changes in land uses and sources **(EPA 5.5)**

Population and Demographics
As of 2000, the subwatershed was home to over 38,500 people (USCB, 2001). This population is the driver for the land uses that are present in the subwatershed (Table 5-8).

(EPA 5.5.2, 5.5.3, 5.7.2)

Figure 5-17. Land use in the Clinton River Watershed circa 2000.



SEMCOG Impervious Percentages

Each land use type allows varying amounts of storm water to pass through it. The percentages below reflect the amount of storm water that each land use will pass.

Open Water - 0.0

Woodland and Wetland – 0.0

Cultivated Land (Agriculture) – 2.0

Open Space (Recreation) – 10.9

Open Space (Grassland) – 2.0

Developed Land - Residential (Single-family) – 18.8

Developed Land - Residential (Multi-family) – 51.4

Developed Land – (Under Development/Other) – 18.8

Developed Land - Transportation / Utility – 52.9

Developed Land - Industrial – 75.9

Developed Land - Commercial and Office – 76.3

Developed Land – Institutional – 28.0

Source: Perry and Hamann, 1998.

Impervious Surfaces and Storm Sewers

While impervious surfaces cause numerous hydrologic problems, these are often exacerbated by the presence of enclosed storm sewers which introduce additional hydraulic problems (see Chapter 2).

Table 5-9. Land use in the subwatershed.

Land Use	Square Miles
No Data	***17.50**
Open Water	**0.82**
Wooded Area and Wetland	**24.69**
Cultivated Land (Agriculture)	**98.91**
Developed Land – Open Space	**21.32**
Recreation	3.85
Grassland	17.47
Developed Land – Residential, etc.	**28.74**
Single-Family	27.24
Multi-Family	0.19
Under Development / Other	1.31
Developed Land – Urban, etc.	**8.18**
Transportation / Utility	1.04
Industrial	5.97
Commercial and Office	0.62
Institutional	0.55
TOTAL	**200.16**

*Lapeer County GIS data is not available

Increased Imperviousness and Stormwater Runoff

Stormwater runoff is a natural event that occurs when the rate of rainfall exceeds the ability of the ground to absorb the rainfall and snow melt. In undeveloped areas, most rainwater, as well as springtime snowmelt, soaks into the ground, recharges aquifers, and slowly makes its way to nearby river systems. Unfortunately, increased development in some areas of the subwatershed has altered natural drainage patterns (USACE, 2004).

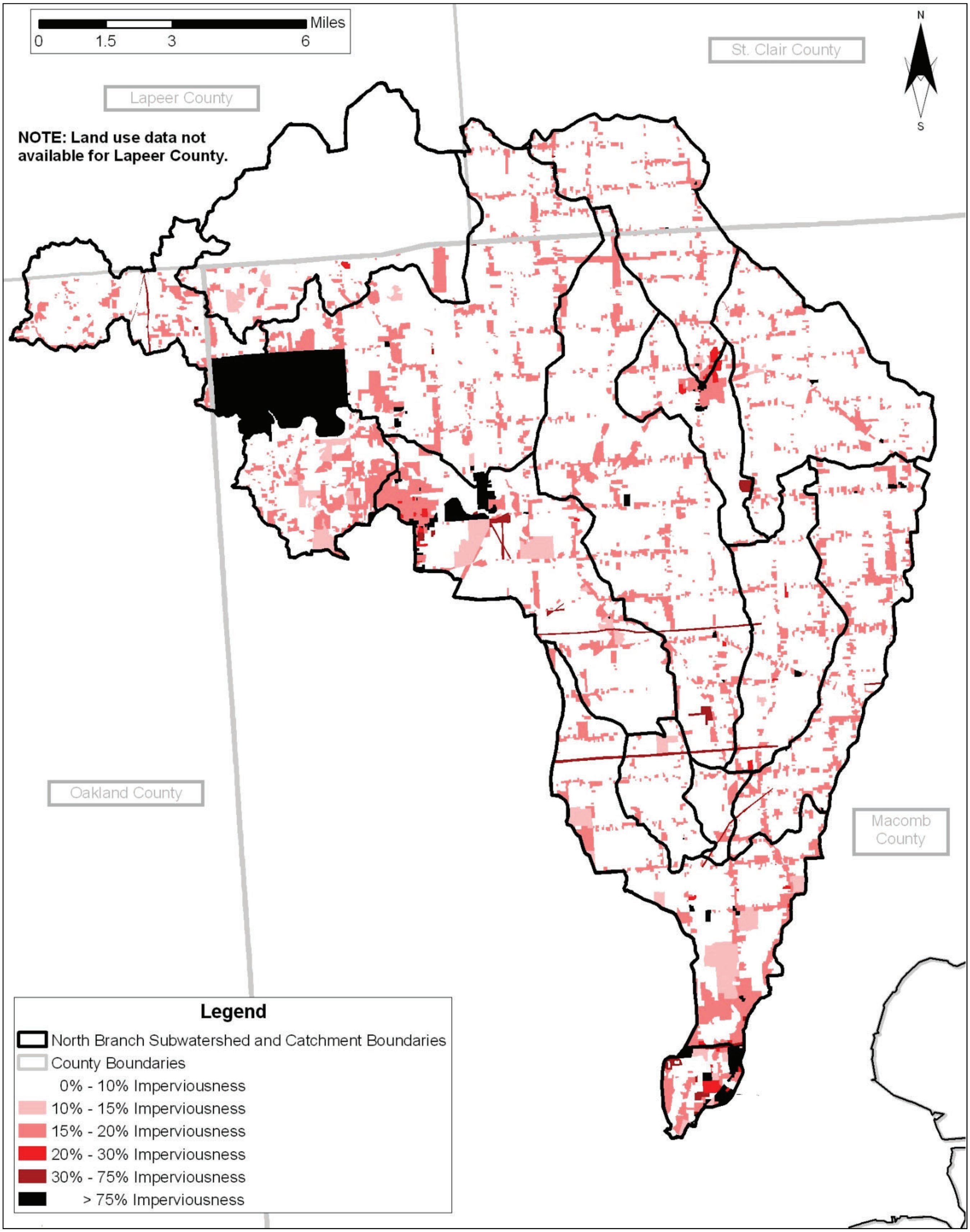
The conversion of natural landscapes into urban landscapes (e.g. rooftops, streets, parking facilities) results in surfaces impervious to the infiltration of stormwater. These surfaces increase the:

- Frequency of rainwater runoff reaching waterbodies;
- Total volume of runoff; and
- Peak flow rate of runoff.

It is not solely the ‘hard’ impervious surfaces (e.g. pavement) that contribute to the runoff problems. The heavy machinery used during development compacts soils and makes them less pervious, thus causing the post-construction pervious areas (e.g. yards) to generate more runoff than would be expected. Compounding this is the fact that storm sewers are often utilized in these areas to quickly route water, with no natural attenuation or pollutant filtering opportunities, directly to receiving waters.

The imperviousness based on land use is shown in Figure 5-18. The impervious percentages used to generate this are shown in the sidebar. Using this information, the subwatershed has an imperviousness of 7.6%.

Figure 5-18. Impervious cover in the Clinton River Watershed.



The importance of development and associated impervious surface as a stressor on the natural environment has been previously discussed. This analysis seeks to quantify the amount of impervious cover by land use type and reach. The ultimate goal of the analysis is to identify those reaches with the most impervious cover so that mitigation efforts can be focused on them and the targets set out in Chapter 7 achieved. In order to help quantify the imperviousness analysis, the reformulated impervious cover model will be used and is explained in Appendix E.4

An alternate analysis to the one based on SEMCOG's land uses (presented above) of imperviousness for the subwatershed is derived from the National Land Cover Data (NLCD) based on satellite imagery for the year 2000 (MRLC, 2001) and calculates the *effective* impervious area. Table 5-11 presents the percentage of each land use type as well as the percent effective impervious cover. Table 5-12 assigns each of the reaches a qualitative ICM rating which corresponds with the descriptions presented above.

Table 5-10. NLCD land use percentages for the catchments

Catchment Number	Catchment Name	Barren	Crop	Pasture (livestock)	Shrub	Forest	Wetland	Water	Developed	% Effective IC
601	East Branch Coon Creek – Upper	0.0	73.4	0.4	2.0	2.6	6.6	0.0	15.0	4.1
602	East Branch Coon Creek – Middle	0.0	60.8	0.4	3.3	11.0	6.8	0.0	17.5	10.3
603	Highbank Creek	0.0	74.4	1.0	2.1	8.4	2.6	0.2	11.1	1.9
604	East Branch Coon Creek – Lower	0.0	51.0	1.0	15.2	9.0	11.4	0.0	12.5	1.6
607	Coon Creek – Upper	0.0	60.5	0.7	6.6	7.0	9.9	0.1	15.2	1.6
608	Coon Creek – Lower	0.2	32.6	0.0	20.0	15.8	15.3	0.0	16.1	2.5
609	North Branch Clinton River - Headwaters	0.0	52.1	1.1	1.3	16.3	8.9	0.3	20.0	2.1
610	North Branch Clinton River – Upper	0.4	56.4	1.3	3.2	8.8	10.2	0.3	19.5	4.1
611	East Pond Creek	1.2	17.5	0.7	8.1	25.5	12.2	2.3	32.4	5.3
612	North Branch Clinton River – Upper Middle	0.1	45.1	1.3	8.5	8.8	8.8	0.0	27.4	12.4
613	North Branch Clinton River – Middle	0.0	58.4	0.5	8.4	7.6	12.5	0.0	12.6	1.6
614	Deer Creek	0.0	53.7	0.1	10.9	8.2	6.1	1.3	19.7	1.8
615	North Branch Clinton River – Lower Middle	0.2	44.7	0.4	6.5	10.1	8.3	0.0	29.8	8.8
616	North Branch Clinton River – Lower	0.1	14.4	0.0	10.6	4.3	9.6	1.6	59.4	39.9
Total		**0.2**	**51.9**	**0.8**	**6.1**	**10.8**	**8.9**	**0.5**	**20.9**	**6.5**

Using this method, the watershed as a whole is 6.5% impervious (as apposed to 7.5% using the SEMCOG method reported above) and falls within the 'sensitive' category based on the reformulated ICM. Four reaches exceed the 'sensitive' category; three (602, 612, and 615) are 'impacted' and one (616) is 'non-supporting'. Not surprisingly, the percent impervious cover associated with developed land sends the ICM classifications into 'impacted' or worse. These finding suggest that efforts to mitigate the effects of imperviousness should focus on reaches 602, 612, 615 and in particular 616 as well as on other more isolated urbanized areas in the other reaches. The four reaches rated greater than 'sensitive' should implement watershed protection activities that focus on reducing bacterial contamination and implementing pollutant load reducing BMPs.

Table 5-11. ICM class for each catchment in the subwatershed.

Catchment	% Effective IC	Average % IC in Developed Land	ICM Class
601	4.1%	27%	Sensitive
602	10.3%	59%	**Impacted**
603	1.9%	17%	Sensitive
604	1.6%	13%	Sensitive
607	1.6%	10%	Sensitive
608	2.5%	16%	Sensitive
609	2.1%	11%	Sensitive
610	4.1%	21%	Sensitive
611	5.3%	16%	Sensitive
612	12.4%	45%	**Impacted**
613	1.6%	12%	Sensitive
614	1.8%	9%	Sensitive
615	8.8%	30%	**Impacted**
616	39.9%	67%	Non-supporting

The general predictions of the ICM are as follows:

- Stream segments with less than 10 percent impervious cover (IC) in their contributing drainage area continue to function as ***Sensitive*** Streams, and are generally able to retain their hydrologic function and support good-to-excellent aquatic diversity.
- Stream segments that have 10-25 percent IC in their contributing drainage area behave as ***Impacted*** Streams and show clear signs of declining stream health. Most indications of stream health will fall in the fair range, although some segments may range from fair to good, as riparian cover improves. The decline in stream quality is greatest toward the higher end of the IC range.
- Stream segments with subwatershed IC that ranges from 25-60 percent are classified as ***non-supporting*** streams (i.e., no biological diversity). These stream segments become so degraded that any future stream restoration or riparian cover improvements are insufficient to fully recover stream function and diversity (i.e., the streams are so dominated by subwatershed IC that they cannot attain pre-development conditions).
- Stream segments whose subwatersheds exceed 60 percent IC are physically altered so that they merely function as a conduit for flood waters. These streams are classified as ***Urban Drainage*** and consistently have poor water quality, highly unstable channels, and very poor habitat and biodiversity scores. In many cases these urban stream segments are eliminated altogether by earthworks and/or storm drain enclosures. The figure in the side bar (and in Appendix e 4 shows in greater detail how stream corridor indicators respond to greater subwatershed impervious cover.

Some stormwater runoff related permitting information for the Clintor River Watershed is shown in Figure 5-19.

Notes on the ICM

The ICM is similar to other models that describe ecological response to stressors from urbanization in that the stream quality classifications are value judgments relative to some endpoint defined by society (e.g., water quality criteria).

It is important to understand that the ICM truly only classifies a stream at a given point (as it is based on the drainage area to that particular point). Performing an analysis to take develop data on a point-by-point basis is extremely time consuming for an area the size of this subwater-shed. Presenting the analysis based on the coverage in a given catchment is useful as it defines the condition of the majority of the stream points within the given catchment. It should be noted that there will exist reaches within a catchment that do not fall within the given classification (e.g. there will be reaches within a 'Sensitive' catchment that are classified as 'Impacted' – this would be the case if a location was picked for analysis that encompassed a higher percentage of the imperviousness within a given catchment.

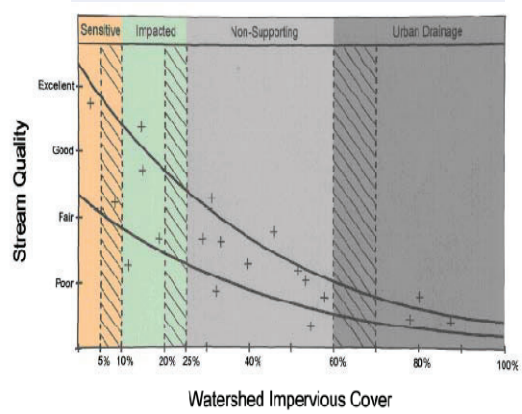
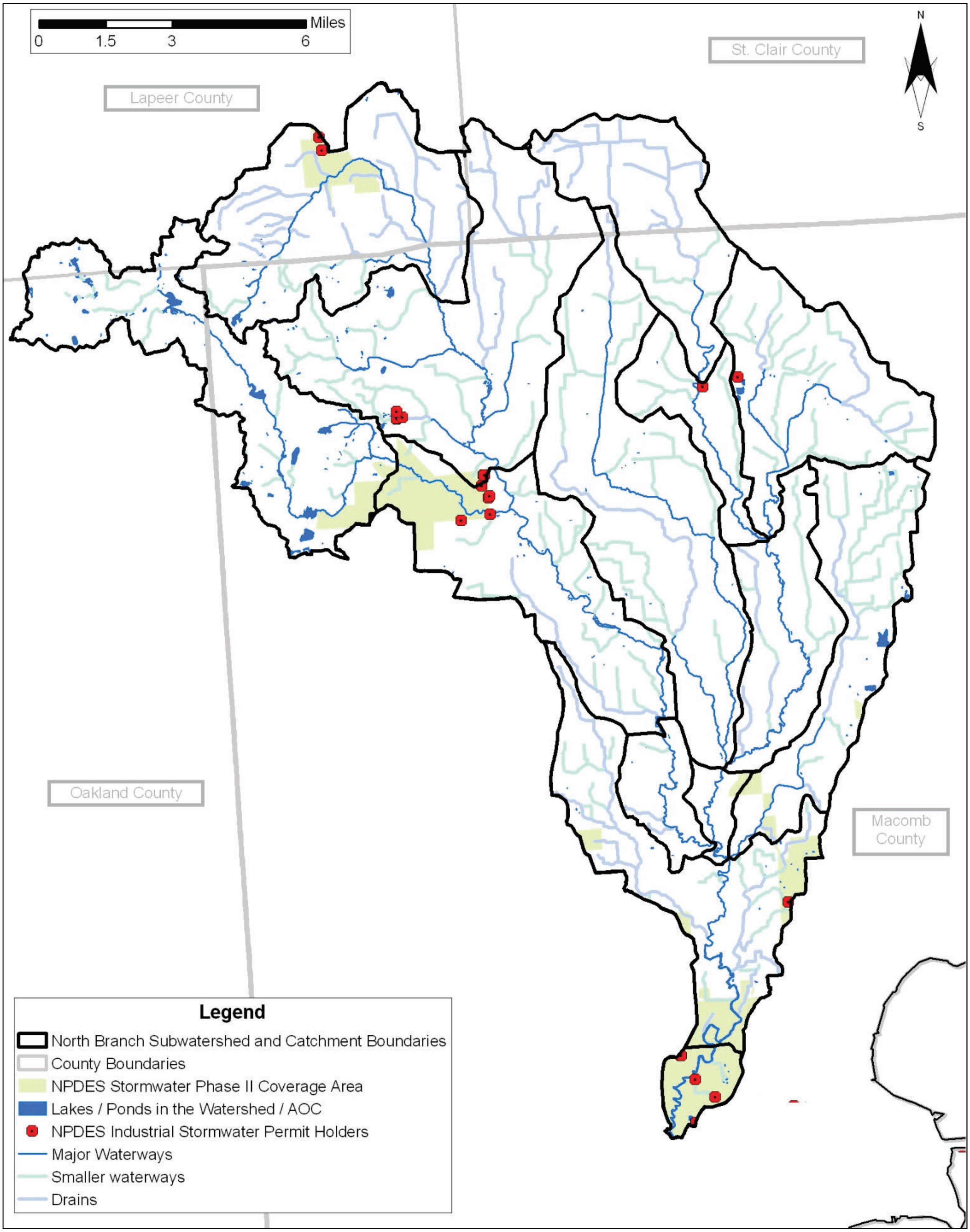


Figure 5-A.1. Reformulated Impervious Cover Model Reflecting Changes in Stream Quality in Response to Percent Impervious Cover in the Contributing Watershed.
(Source: Chesapeake Stormwater Network, 2008)

Figure 5-19. Stormwater NPDES permits and coverage areas.



H. Transportation Infrastructure

Figure 5-20 shows the transportation infrastructure within the subwatershed. Transportation infrastructure has the potential to impact water resources through the effects of impervious surfaces compounded with automotive pollutant deposition (e.g. brake dust) and spills. Automobiles contribute a number of different types of pollutants to urban runoff. High levels of metals are found in tire wear, used motor oil and grease, diesel fuel and vehicle rust. Engine coolants and antifreeze containing glycols are toxic and contribute to high biochemical oxygen demand in receiving waters. Generally, fossil fuel combustion is the largest contributor of nitrogen to the waters in urbanized areas. Salts are used to keep facilities free of ice, but in large volumes can be toxic to fish and other wildlife. These pollutants accumulate on the impervious surfaces during dry weather conditions, only to form a highly concentrated first flush during storm events (Maumee, 2006). Even dirt roads and driveways are little more pervious than paved ones because the excessive, repetitive compaction drastically reduces the soil permeability. Additionally, these roads may be direct sources of sediment that reaches waterbodies, especially if severe erosion problems exist.

I. Agricultural / Cultivated Land and Livestock

Figure 5-17 and numerous other figures at the beginning of the chapter show the extent of agricultural land coverage in the subwatershed. Agriculture is a significant source of a large number of pollutants. Livestock sites, such as dairy, beef, swine, and poultry, plus intense cultivation of grain crops, such as corn and soybeans can be the source of numerous stressors including pathogens and nutrients from manure, excessive particulates from soil erosion, and organic compounds (e.g. fertilizers, pesticides, and herbicides) in runoff. Additionally there is some concern that agriculture may be a source of hormones and endocrine mimics that could impact fish, wildlife, and source water intakes. (USACE, 2004).

The following paragraph is directly from the pending Lower Clinton TMDL source assessment summary. In the North Branch Clinton River, livestock and manure spreading are a potential source of E. coli. The bovine bacteroidetes biomarker was detected on Coon Creek (NB2) and McBride Drain (NB7). Thirty-seven percent of the North Branch Clinton River land area is cultivated for row crops and another 17 percent are used for pasture or hay, and therefore, are potentially available for manure land application. While there are no permitted Concentrated Animal Feeding Operations (CAFOs) in the TMDL watershed, there is a CAFO upstream of the TMDL watershed near Romeo, Michigan. This CAFO (Ingleside – MIG010157) manifests (sells or gives away) its manure to other farmers. It is therefore not possible to know where, when, or if the manure from this operation is land applied within the TMDL watershed. According to the 2007 Census of Agriculture, there are 4,271 cattle, 1,356 horses, and 301 swine living in Macomb County (USDA, 2007).

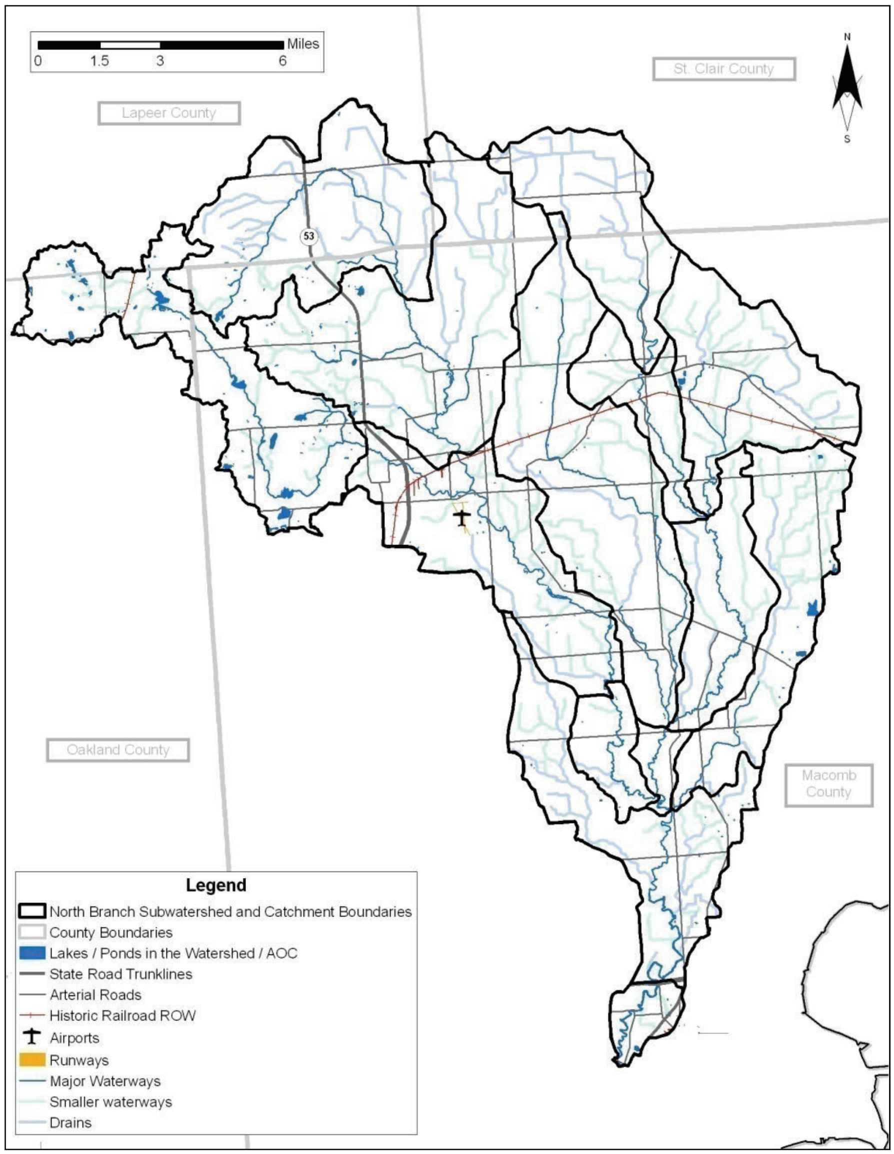
Crop cover makes soil up to four times less permeable than it would be with natural ground cover. Coupled with tile drains that keep the agricultural lands well drained, agricultural land (just as impervious land) imparts modified flow characteristics due to increased runoff to nearby waterbodies, although to a lesser extent. This increase flow also carries increased amounts of pollutants (JFNEW, 2007).

J. On-site Sewage Disposal Systems

Where sewer service is not available, facilities generally rely on on-site sewage disposal systems (OSDS) or septic systems to treat sewage. OSDSs are small underground systems consisting of a tank in which waste collection and treatment occurs and a drain field which disperse the effluent. OSDS systems typically serve one facility, but may serve more depending on size.

If properly located, constructed, used, and maintained, these systems can provide reliable service over many years. Unfortunately, the heavy clay soil present in much of the subwatershed represents a particular concern for the proper design and construction of septic systems, and many systems fail within a relatively short period of time.

Figure 5-20. Transportation infrastructure in the Clinton River Watershed.



K. Contaminated Sediments

Many of the sediments in our rivers and lakes have been contaminated by toxic pollutants such as organochlorines (carbon and chlorine compounds that resist breaking down) that and heavy metals. Some of these pollutants are directly discharged by industrial plants and municipal sewage treatment plants, others come from polluted runoff in urban and agricultural areas, some may be from waste management (e.g. landfill) or contaminated sites (e.g. leaking underground storage tanks), but most are the result of historical contamination. Although 'contaminated sediments' by themselves may be considered an impact of the contaminating stressors, they are treated in the plan as a source because it is the resuspension of these contaminants that poses the biggest environmental problem – not the formation of new contamination sites.

Contaminated sediments can threaten creatures in the benthic environment, exposing worms, crustaceans and insects to hazardous concentrations of toxic chemicals. Reduced benthic populations subsequently reduce the food available to larger animals such as fish. Some contaminants in the sediment are taken up by benthic organisms in a process called bioaccumulation. When larger animals feed on these contaminated organisms, the toxins are taken into their bodies, moving up the food chain in increasing concentrations. As a result, fish and shellfish, waterfowl, and mammals may accumulate hazardous concentrations of toxic chemicals (Scorecard, 2007).

Contaminated sediments do not always remain at the bottom of a water body. Anything that stirs up the water, such as dredging, can resuspend sediments. Resuspension may mean that all of the animals in the water, and not just the bottom-dwelling organisms, will be directly exposed to toxic contaminants (Scorecard, 2007).

L. Atmospheric Deposition

Atmospheric deposition – directly on structures or in precipitation – can potentially be the source for myriad stressors, including hydrogen ions (i.e. pH), inorganic compounds (e.g. sulfate), nutrients (e.g. nitrogen and phosphorus compounds), cations (i.e. dissolved solids), and heavy metals.

In the Great Lakes region, the stressor most associated with atmospheric deposition is mercury. Mercury enters the atmosphere through the release of geologically bound mercury by natural processes and human activities, such as waste incinerators, coal-fired power plants, and base metal smelting plants as well as others. In addition, the global reservoir of atmospheric mercury makes long-range transportation of mercury a concern. Sediments in the Clinton River Watershed, including the North Branch, contain some of the highest concentrations of mercury in the Great Lakes. Airborne deposition directly to the Clinton River represents a minor source because of the small surface area relative to its large flow. (USACE, 2004).

M. Soil Erosion

Soil erosion is a process through which wind, water, and other forces dislodge and displace soil particles. Impacts of soil erosion are diverse and are influenced by complex hydrological, physical, chemical, and biological factors. While soil erosion occurs naturally, it is accelerated by human activities.

The detailed processes of in-stream soil erosion are discussed in-depth in Chapter 3. This brief section deals with upland soil erosion.

While normal overland flows can potentially erode and transport small amounts of sediment, the problematic upland soil erosion types are:

- sheet and rill erosion - the removal of layers of soil from the land surface by the action of rainfall and runoff, and
- gully erosion - when concentrated flows of water scour along flow routes and cause sharp sided entrenched channels.

These erosive characteristics may manifest themselves due to agricultural practices (e.g. plowing), construction of roads and buildings, and the removal of trees. During these, or other similar processes, unprotected soils are vulnerable to erosion.

Soil erosion does not occur by water alone, but may also involve normal movement due to winds or extreme movements associated with storms.

Erosion is not just a source of sediment but may also increase the amount of pollutants in waterways, especially heavy metals, fertilizers, and pesticides, because these pollutants adhere to soil and are transported along with the detached soil (USACE, 2004).

Sedimentation, the process through which water transports dislodged soil particles and deposits them somewhere else (on land or in streams, rivers, lakes, or wetlands), is discussed in the previous section, under the 'Sediment' stressor (USACE, 2004).

N. Other Human Actions

There are numerous other human actions which can be considered sources of stressors. Dredging often destroys benthic habitat and, in concert with contaminated sediments, can act as a source by releasing contaminants into the water column. Dredging also causes temporarily elevated turbidity (i.e. sediment in the water column) and nutrient levels (GLC, 2004).

Another human activity that stresses the environment is the withdrawal of water from either surface or groundwater sources. These water withdrawals have the potential to impact hydraulic and hydrologic conditions.

O. Animal Sources (Non-Agricultural)

Animals can be significant sources of pathogens and nutrients as their wastes are often excreted directly into waterbodies or nearby, where they contaminate runoff that eventually enters waterbodies. Aside from livestock (which are included under the 'Agricultural Land' source), the three most recognized sources are domestic pets, wildlife and waterfowl, specifically geese.

Many parks that attract dog owners are near waterbodies. Dog droppings that are not disposed of properly can be problematic for the reasons stated above (i.e. contaminated runoff). The problem is not limited to nearby waterbodies, however, as droppings in urban areas have the potential to contaminate runoff into the storm sewers that eventually is discharged to waterbodies.

With geese, or other waterfowl, the problem is particularly acute when great numbers of the birds congregate in one area. This is common in urban areas that offer lakes and ponds as these settings provide the food, water, and protection the geese are looking for. The droppings can contaminate waterbodies either directly, when the birds are in the water, or through runoff, when rain washes the concentrated droppings off of nearby lawns and open spaces where the birds congregate.

P. Natural Occurrences and Disturbances

In general, natural causes of the sources (e.g. natural soil erosion) are included under those sources that are appropriate – only if they can potentially cause environmental impacts. Others, such as insect infestations and extreme storm events, are included here.

Natural occurrences and disturbances, as a source of stressors, range from extremely destructive events such as tornados to gentle, long-term fluctuations in lake levels. They are primarily due to natural phenomena with a minimal level of human influence. However, most natural disturbances are at least indirectly influenced by humans. For example, global warming (due in part to greenhouse gasses from human activity) has been attributed to changes in the frequency and intensity of storms, melting of glaciers, changes in heating and cooling patterns, and changes in rates of precipitation and evaporation (GLC, 2004).

Natural disturbances are an integral part of healthy ecosystem dynamics as certain plants require disturbances to proliferate. Disturbances, which often expand available habitat types, provide opportunities for exist species to persist, other species to exploit, and all species to continue along their natural evolutionary path (GLC, 2004).

In the past, fire (often caused by lightning) was extremely important source of habitat alterations that maintained certain natural communities (e.g. prairie) in the region. It kills or stunts woody plants, coverts dead plant material to nutrients, promotes seed contact with soil, warms the soil to promote seed germination, triggers certain seeds (e.g. resinous pine cones), and stimulates herbaceous plant growth. Today, fires are often suppressed due to the potential for extensive damage to human life and infrastructure (GLC, 2004).

Ice storms continue to be significant disturbances in hardwood forests. These storms prune small branches, break large branches, and snap entire trees to open gaps in the forest canopy and allow other species to proliferate. Damaged trees are often subsequently infected by decomposers and/or insects and eventually die standing or are windthrown (GLC, 2004).

The weather characteristics of the region also make windthrow an important disturbance in forests. Severe low-pressure storms frequently create gaps in forest canopy that are typically larger than those caused by ice storms. Windthrow events are the primary source of forest turnover and result in the mosaic of different age and species of trees encountered in forest stands (GLC, 2004).

In aquatic settings, flooding moves sediment and debris downstream, causing bank erosion and changing vegetation composition within the floodplain. Prolonged flooding can kill woody plants and trees, thus transforming their habitat characteristics and prevents tolerant woody plants from establishing in the understory. Flooding creates vernal pools which are important for amphibian reproduction and temporary pools for waterfowl and fish, which may use the areas for spawning (GLC, 2004).

Additionally, lake level fluctuations (and shifting ice cover) play an important role in maintaining the health of adjacent marsh lands by uprooting established plants at high levels and eventually allowing re-colonization of affected areas at low levels. These fluctuations tend to discourage the succession of these wetlands into upland habitat types, accelerate nutrient cycling, and increase habitat diversity (GLC, 2004).

Modeling the Clinton River Watershed

Using the water quality information collected over the years the watershed was modeled in order simulate proposed management practices to improve water quality. The fist step in this process is to create a model that simulates current conditions. An additional benefit of creating this baseline model is the synthesis of large quantities of diverse data and capturing their interactions. The baseline analysis was performed using a long–term hydrologic simulation watershed model called the Hydrologic Simulation Program – FORTRAN (HSPF). An HSPF model of the entire Clinton River watershed, including North Branch Clinton River was developed during 2007 – 2008 to support decision making and stakeholder processes. The HSPF model used meteorological data spanning 1994 – 2004. Further details about the model and its application are available in it modeling report (Tetra Tech, 2008).

For this project, the North Branch portion of the HSPF model was updated with meteorological data through 2008, and minor updates to model hydrology were made as well. In addition, model output was taken from all of the North Branch model subbasins instead of one location as was done for the Clinton River project.

The sediment and nutrient (TP, NO_3, and TKN) components were not revised since there were not sufficient water quality monitoring data for a recalibration of these parameters. In addition, there were limited monitoring data in the North Branch for sediment and nutrients during the original calibration – a handful of low flow measurements occurring during 2004 a few miles upstream of the mouth. Much of the model parameterization in the North Branch is tied to the larger Clinton River HSPF model where there were more monitoring data for a stronger calibration. As such, the North Branch HSPF model predictions are reasonable and well tied to the types of land uses present in the watershed, and the model provides a good indication of the degree of difference between subbasins, and will provide beneficial information about the impact of BMPs and other practices on reducing loads. However, it is not appropriate to use the model's results to gauge degree of impairment against statistical measures for sediment and nutrients, since the accuracy of the model is limited by the lack of monitoring data needed for calibration.

On the other hand, the E. coli component of the North Branch model was recalibrated for this project. A large amount of E. coli monitoring data are available in Macomb County, both spatially (11 of the 14 subbasins had monitoring data within them), and temporally (2000 – 2008). The monitoring data include both low flow and high flow conditions. The abundance of data allowed for a full recalibration of the model to the subbasin scale. As such, the North Branch HSPF model is an excellent tool for understanding sources of bacteria, and predicting the effects of practices to reduce bacteria.

Agricultural land uses dominate in much of the north part of the North Branch, with urbanization increasing towards the south.

The tables in Appendix E-2 show both subbasin area and cumulative area. The cumulative area is important because the subbasin water quality assessments are performed at the mouth of a subbasin's stream or river (*reach*). The water flowing into a reach includes the runoff from its own subbasin, and upstream contribution from other reaches. As one moves farther down in the basin, the upstream contribution tends to take over local impacts. However, the pollutant load in a reach is not equal to the sum of the loads from the upstream subbasins. Pollutant are deposited when water moves slowly, and resuspended in reaches during storms; nutrients are taken up or transformed; bacteria die off with time and exposure to sunlight. The impact at a single location is equal to the sum of the parts occurring upstream – and over a long period of time accounting for the range of hydrologic conditions that occur.

The modeling results provide the story of what is contributing to indicator bacteria (E coli) impairment in the North Branch watershed. Practitioners often focus on controlling storm event sources, which provide the high "spikes" that generally lead to statistical impairment according to the standards. Urban BMPs that treat stormwater and agricultural BMPs that reduce runoff from manure lots or manured land are thought of as appropriate treatment options. The North Branch certainly has urban sources, and to some extent, agricultural sources from the relatively small amount of livestock in the watershed. However, E coli levels are elevated *significantly* at low flow conditions in *all* of the North Branch subbasins. The typical low flow concentrations are high enough that perfect treatment of storm event sources would not address any of the impairments.

The model was calibrated for both low flow and high flow sources of bacteria. The model cannot distinguish between specific sources, but the subbasin land use does provide an indication of what is occurring. All of the subbasins have low flow sources – including the urbanized, sewered areas in the south. In the rural agricultural areas, the sources are likely from failing onsite septic treatment systems (OSTS). A failing OSTS from a water quality perspective may appear to be functioning perfectly to the operator. Given the low infiltration rates of most of the soils in North Branch and the use of ditches and tile drains, it is likely a large number of systems have short-circuited to drainage ditches or tile drains. In urban areas, it is more likely there is a combination of accidental and illicit connections to the storm drain network, as well as aged sanitary sewer infrastructure that leaches out contaminated water to storm sewers and to streams.

Annual E coli loads are reported here, but can be difficult to decipher due to the effect of upstream contributing area (as is the case with the remaining pollutants). The E coli annual loading rates provide a better indicator of degree of load (from all sources, including failing septic systems and low flow urban sources), but the decreasing trend as one moves downstream is strongly affected by die-off, which is fairly rapid for bacteria. The long term geometric means provide a better indicator of the trend in each reach. The E coli standards show that impairment is ubiquitous through the North Branch; even the daily max standard (300 #/100 mL May-Oct and 1,000 #/100mL Nov-Apr) are violated much of the time – though more so in the northern rural areas.

Sediment loading rates are highly correlated with predominantly agricultural catchments (as well as in the highly urbanized 616 catchment). In the agriculturally dominant catchments, sediment concentrations are more difficult to decipher; they are fairly uniform, influenced heavily by low flow conditions when sediment settles out. Plots of concentration versus flow show that high concentrations occur during and shortly after storm events. Stream channel erosion is known to be a serious issue in the North Branch watershed.

Phosphorus loading rates and average concentrations are highly correlated to agricultural land use. The percent > 0.1 mg/L is affected by both high flows (which is expected), and low flow untreated or poorly treated sewage sources (OSTS and urban sources discussed previously). During very low flows in North Branch reaches, the sewage sources begin to dominate as a source contribution. Reducing sewage sources will have a substantial impact on reducing this measure.

Nitrate/Nitrite loading rates and average concentrations are highly correlated to agricultural land use. The percent > 0.2 mg/L is affected by both high flows (which is expected), and low flow untreated or poorly treated sewage sources. During very low flows in North Branch reaches, the sewage sources begin to dominate as a source contribution. Reducing sewage sources will have a substantial impact on reducing this measure. This effect is not as pronounced in the lower mainstem reaches, as well as reaches 609 and 611 in the northwest part of the watershed, where the soils allow for more infiltration and interflow that tend to reduce the number of days with very low flows.

TKN loading rates and average concentrations are highly correlated to agricultural land use. The percent > 1.2 mg/L is affected by both high flows (which is expected), and to some extent low flow untreated or poorly treated sewage sources. However, the impact of low flow sources on the 1.2 criterion is fairly weak. The full baseline report is in Appendix E.2

Summary / Scorecard

The data presented in this chapter reinforce the concerns that were expressed for the North Branch Subwatershed. Nutrients, pathogens, sediment, and hydrologic / hydraulic modifications are becoming significant concerns in certain portions of the subwatershed. The conditions in the subwatershed are presented in Table 5-12, along with the conditions for the other subwatersheds in the Clinton River Watershed.

Timely and well-coordinated efforts are needed to stem the environmental degradation the subwatershed is beginning to experience. Focused efforts targeting the most damaging stressors will be required to stop continuing degradation. Early efforts should focus on protecting existing high quality areas and restoring those areas that are of most import ecologically.

Continued and enhanced coordination and cooperation among stakeholders is required to achieve such protection and improvements. Management practices must also be responsive to emerging issues so that these never reach severe levels. The need for quality, high-resolution information is paramount to deal with subwatershed problems effectively. The development of this data needs to happen concurrently with the initiation and implementation of solutions to deal with known existing and emerging problems so that environmental degradation is first ceased and then ultimately reversed.

Conceptual Model

The conceptual model shown in Figure 5-21 identifies the relationships between the sources, stressors, impacts, and impairments for the subwatershed.

Conclusion

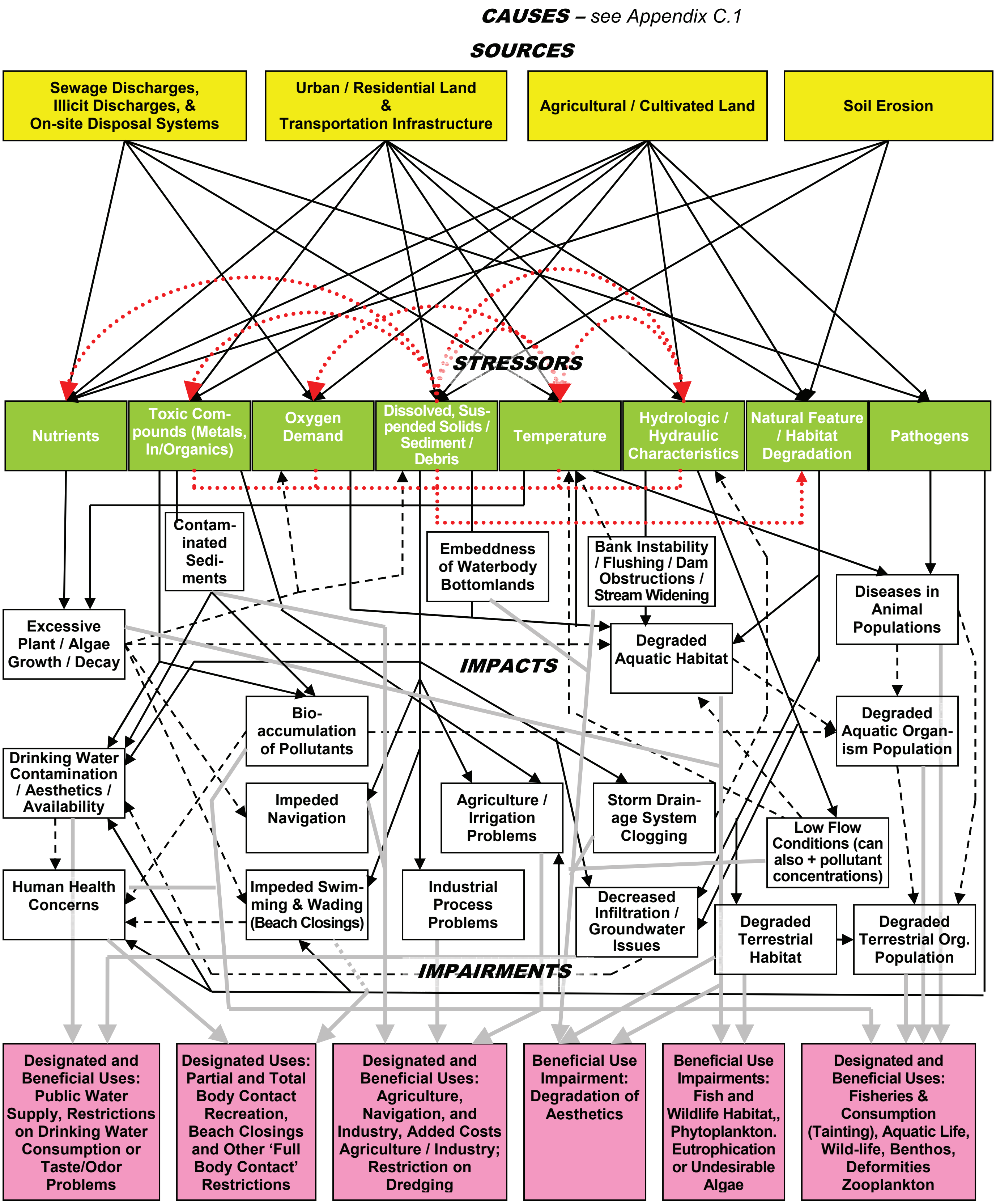
This chapter is built on the framework presented in Chapter 2 to define and analyze the environmental conditions in the subwatershed and to prioritize the stressors and other concerns from a watershed management perspective. The information in this chapter is utilized to define the goals and objectives presented in Chapter 6 and the actions defined in Chapter 8.

Table 5-12. Report card for the North Branch Subwatershed and priority catchments for each indicator.

Indicator^ (<u>Impacts</u>, ***Stressors***, **Sources**, Other Parameter)	**Clinton River Watershed Average**	**North Branch**	**Priority Catchments** (see Table 5-10 for cross-reference of catchment names and numbers and Chapter 1 for a map with catchment names)
Sediment Contaminants / <u>Dredging Restrictions</u>	B	A	616
Polluted Sites / Industry / Other Businesses	B-	B	602, 609, 611, 612, 615, 616
Toxic Pollutants (***Heavy Metals***, ***Organic***, ***Inorganic***)	B	B	615, 616
Nutrients / Chlorophyll / <u>Algae</u> / <u>Eutrophication</u> (Trophic Status)	B-	B	601, 602, 603, 604, 607, 608, 610, 611, 612, 614, 613, 615, 616
Oxygen Demanding Pollution / <u>Dissolved Oxygen Levels</u>	B	C	601, 602, 604, 609, 611, 612, 613, 616
Dissolved Solid Levels	C	C	601, 602, 604, 611, 612, 613, 615, 616
Agricultural Land (extent of coverage and condition of land)	D	E	601, 602, 603, 604, 607, 609, 610, 612, 614
Stream Bank Erosion / Other Erosion	C	C	604, 615
Suspended Solid Levels / <u>***Sedimentation***</u>	B-	C	609, 611,612, 613, 616
Debris / Aesthetics	C	B	601, 602, 604, 607, 608, 609, 610
Temperature	B	B	615, 616
Hydrologic Conditions / **Effective Imperviousness** (e.g. Urban, Residential)	C-	C	602, 603, 612, 615, 616
Hydraulic Conditions	C	C	611, 612
Natural Features / Habitat Conditions	C	B	615, 616 (Restore) 609, 610 (Protect)
Macroinvertebrates / Amphibians / Fish / Wildlife	C+	B	609, 610, 611, 615, 616
<u>Consumption Advisories</u>	C	C	All
Invasive Species	B	B	All
Pathogens / <u>Beach Closings and Contact Restrictions</u>	C	E	601, 602, 603, 604, 607, 608, 609, 611, 614, 615, 616
Sewer Overflows	B	B	602, 609, 611, 615
Septic Systems	B-	C	602, 603, 610, 611, 614
Illicit Discharges / Connections	B-	B	602, 609, 611, 612, 614, 615, 616
Public Awareness and Participation	C	C	All
WMP Participation and Institutionalization (e.g. funding)	C	C	All
WMP Implementation / Program Establishment	C	C	All

A = excellent, B = good, C = average, D = fair, E = poor. * - the entire Clinton River Watershed average score does not include the score for the Lake St. Clair subwatershed, which is considered part of the AOC. ^ - the indicators presented are those that were utilized in the Clinton River Restoration Plan

Figure 5-21. Conceptual model for sources, stressors, impacts, and impairments in the subwatershed.



6. Goals and Objectives

Beneficial Use Impairment Considerations

To ensure that this plan is consistent with the *Clinton River Restoration Action Plan* (CRRAP), the following were considered:

- Explicitly addressing restoration of the five beneficial use impairments (BUIs) applicable to this subwatershed:
  - o Degradation of fish & wildlife populations;
  - o Degradation of benthos;
  - o Beach closings and other 'full body contact' restrictions;
  - o Degradation of aesthetics; and
  - o Loss of fish & wildlife habitat.
- Implicitly addressing protection of the remaining BUIs (see Chapter 5).
- Incorporating appropriate 'delisting target' criteria for the BUIs such as: addressing flow variability and high/low extremes, and maintaining ecosystem health through genetic diversity of and healthy populations of flora and fauna.
- Considering other information from the CRRAP as appropriate.

Acronyms and Terms

A complete list of acronyms and terms and their respective definitions can be found in Appendix A.1.

Chapter Purpose

The purpose of this chapter is to: 1) present the broad, long-term goals of the plan; 2) show how the goals relate to planning elements such as causes, sources, stressors, impacts, and impairments; 3) present the measurable, short-term objectives associated with each goal; and 4) define the primary 'focused efforts' that will be undertaken to achieve each objective.

Introduction

As defined in Chapter 1, the main purpose of this plan is:

"**To improve and protect the ecological, hydrological, and cultural resources of the North Branch Subwatershed.**"

The long-term goals and short-term objectives defined in this chapter reflect this purpose. They also reflect:

- The natural environment of the subwatershed and the stressors that affect it (Chapter 2 and Chapter 3);
- Feedback and input from the stakeholders in the subwatershed (Chapter 4);
- Causes, sources, stressors, impacts, and impairments in the subwatershed and the analyses thereof (with respect to water quality standards and other metrics) (Chapter 5); and
- Support for various other plans that are applicable to the subwatershed: the *Clinton River Restoration Action Plan*, the *St. Clair River and Lake St. Clair Comprehensive Management Plan*; and the *Water Quality Management Plan for Southeast Michigan*.

The goals and objectives provide the framework for the environmental management strategies to be implemented, for the actions to be taken, and for the gauging success towards preserving, protecting, and improving the health of the subwatershed.

Subwatershed Goals

This section presents the goals for the subwatershed management plan (WMP) in an order such that stressor-focused goals appear first followed by those related to biological conditions, and finally those with no environmental components or of a programmatic nature. The goals, which aim to serve as many stakeholders as possible, define the scope of the planning effort. The goals are:

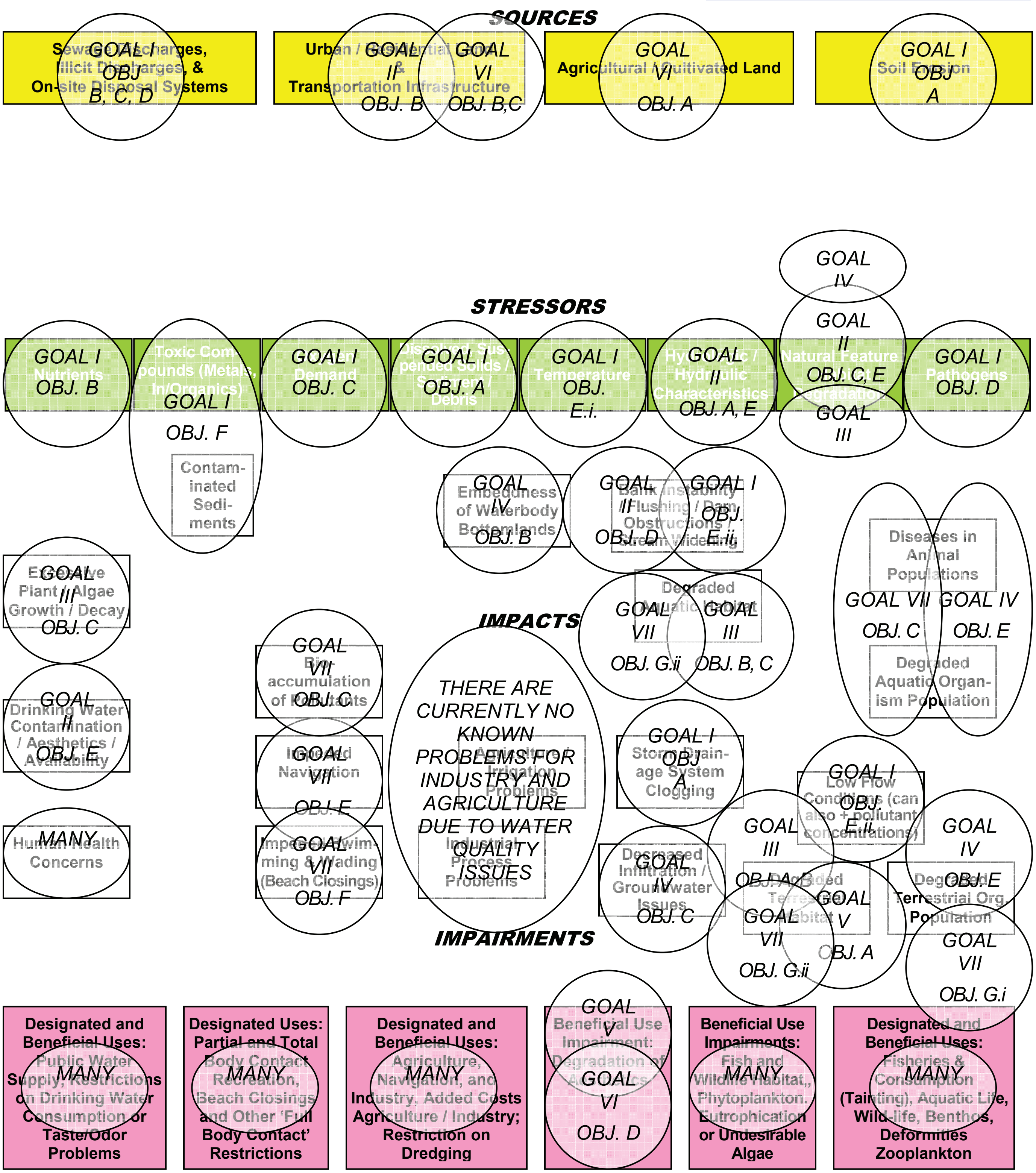
I. To make progress towards achieving water quality standards for pollutants and parameters that affected the designated, desired, and beneficial uses in the subwatershed.
II. To stabilize the hydrology of the subwatershed including both high flow and low flow conditions
III. To protect and restore suitable, high-quality habitat to support aquatic life, wildlife, and fisheries
IV. To protect and enhance existing natural features of the subwatershed
V. To maintain, protect, and enhance greenways through riparian buffers and green corridors
VI. To preserve the rural character of the subwatershed for local citizens and visitors seeking a 'rural Michigan' experience
VII. To preserve and enhance recreational opportunities in the subwatershed for local residents and visitors
VIII. Cultivate an aware, informed, engaged, and involved public
IX. Institutionalize an informed collaborative planning and implementation approach to achieve goals and objectives

(EPA 4.1, 4.3, 4.5, 5.2.2, 9.1)

Relationship of Goals to Conceptual Model

Each subwatershed goal relates to a number of causes, sources, stressors, impacts, and impairments associated with the subwatershed. Figure 6-1 shows these relationships graphically.

Figure 6-1. Relationship of Goals to Conceptual Model.



Detailed Conceptual Model

Detailed Conceptual Model

The detailed version of the conceptual model is presented at the end of Chapter 5.

Example Goal, Indicator, Objective, and Target

Goal
Support designated use for aquatic life.

Indicator
Phosphorus

Objective
Reduce phosphorus loads from agriculture

Target
Daily average of 25 µg/L (or 100 tons/year – for a reduction of 300 tons/year)

Priority Source
Cropland runoff (reduction of 100 to 25 tons /year, 50

Load Reduction Approaches

A range of approaches can be used to identify the load reductions needed for meeting the targets, including:

- Existing studies
- Qualitative linkages
- Mass balance approach
- Empirical techniques
- Statistical or mathematical relationships
- Reference watershed approach
- Receiving water models

The targets can be updated over time as more data becomes available. **(EPA 9.4)**

Additional Differentiation for Goals and Objectives

Goals and objectives may be appropriate for the entire subwatershed or only a portion thereof. The spatial applicability of each goal and objective is provided.

Relationship of Goals to Supported Plans

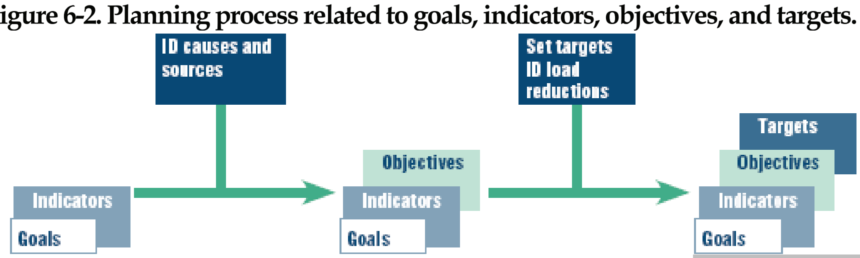
In developing this plan, it was essential to ensure that it fit within the constructs of other plans that are applicable to the subwatershed. To this end, the goals were developed such that they support a number of other plans, including: the *Clinton River Restoration Action Plan*, the *St. Clair River and Lake St. Clair Comprehensive Management Plan*; and the *Water Quality Management Plan for Southeast Michigan*.

Indicators, Objectives, and Targets for Each Goal

Each subwatershed goal has a number of indicators that were selected as appropriate elements to use to gauge progress towards achieving the goal. Generally, these indicators are stressors or more comprehensive parameters (as defined in Chapter 5). By coupling the indicators with the causes and sources of the stressors, a number of objectives can then be defined for each goal. Each objective has at least one target that defines the specific measurable threshold for determining whether or not it has been achieved. These elements together define a system for gauging the success of the plan: objectives are achieved as indicator targets are met and goals are achieved as the associated objectives are achieved.

The goals, objectives, and targets were developed and refined throughout the planning process, as indicated in Figure 6-2.

Figure 6-2. Planning process related to goals, indicators, objectives, and targets.



Source: EPA, 2008.

The primary indicators for each goal are the stressors that impact the impaired uses, concerns, or other problems associated with the goal. The most appropriate measure(s) for each stressor should be selected. For example, if the Hydrologic / Hydraulic Characteristics stressor is an indicator, 'flashiness' is often chosen as a measure. Additional measures for a particular indicator may also be appropriate (e.g. 'flow volume' for the Hydrologic / Hydraulic Characteristics stressor). Other parameters that assess impacts of stressors (e.g. macroinvertebrates) can also be considered indicators (Chapter 5 contains assessments of many potential measures). Finally, the list of indicators for each goal is rounded out with appropriate programmatic and social indicators. See Figure 6-3 for examples of indicators.

This chapter primarily deals with environmental indicators although some programmatic and social indicators may be presented. Most programmatic and social indicators are associated with the plan's actions and as such are presented in Chapter 8 and discussed further in Chapter 9 (which deals with plan evaluation).

Figure 6-3. Example indicators.

Environmental	Programmatic	Social
• Number (or percentage) of river/stream miles, lake acres, and estuarine and coastal square miles that fully meet all water quality standards • Number (or percentage) of river/stream miles, lake acres, and estuarine and coastal square miles that come into compliance with one or more designated uses • Number (or percentage) of river/stream miles, lake acres, and estuarine and coastal square miles that meet one or more numeric water quality standards • Demonstrated improvement in water quality parameters (e.g., DO, pH, TSS) • Demonstrated improvement in biological parameters (e.g., increase in numbers or diversity of macroinvertebrates) • Demonstrated improvement in physical parameters (e.g., increased riparian habitat) • Reduction in the number of fish consumption advisories, beach closures, or shellfish bed closures • Number of river/stream miles, lake acres, and estuarine and coastal square miles removed from the "threatened" list • Reduction in pollutant loadings from nonpoint sources • Reductions in frequencies of peak flows in developing areas • Increase in the number of acres of wetlands protected or restored • Reduction in the amount of trash collected in stormwater drains	• Number of management measures implemented in a watershed (e.g., number of stream miles fenced, number of riparian buffers created) • Number of approved or certified plans (e.g., sediment and erosion control plans, stormwater plans, nutrient management plans) • Number of ordinances developed • Number of hits on watershed Web site • Number of residents requesting to have their septic systems serviced • Number of illicit connections identified and corrected • Number of permits reissued • Elapsed time from permit violation reports to compliance • Number of public water systems with source water protection plans • Reduction in the amount of impervious surface area directly connected to buildings	• Rates of participation in education programs specifically directed to solving particular nonpoint source pollution problems • Increase in awareness, knowledge, and actions designed to change behavior patterns • Rates of participation in various nonpoint source activities, such as citizen monitoring and watershed restoration activities • Increase in participation at watershed stakeholder meetings • Increase in the number of residents signing watershed stewardship pledge • Number of homeowners requesting an inspection of their septic systems

As mentioned previously, the objectives have been written to explicitly address specific indicators and have been assigned associated target values. Each target is a specific value that represents a desired condition in support of its goal and is based on water quality criteria, data analyses, reference conditions, literature values, or expert examination of environmental conditions. The most problematic water quality problems have pollutant load reduction targets associated with them (as presented in Chapter 7) that go above and beyond the simple numeric or narrative criteria that are presented in this chapter.

The remainder of this section is broken down into a number of goal-based sub-sections each with a table defining the details of said goal. Other elements relating to each goal are addressed in the sidebars. The relationship of the goals and objectives to stressors/impacts and sources, is presented in Appendix C.1. **(EPA 4.6, 4.7, 9.2, 9.3)**

Water Quality Standards

All plans should include attainment of water quality standards (WQS) for surface waters as the WQS are the foundation of the EPA's water quality protection efforts.

(EPA 2.5)

Goal I – Related Elements

Water Quality Standards

Physical Characteristics (suspended solids / sediment)

Toxic Substances (organic, inorganic, heavy metals)

Plant Nutrients (phosphorus)

Microorganisms (pathogens)

Dissolved Oxygen

Temperature

Others – No degradation of standards currently being attained

Designated Uses

Total Body Contact Recreation (from pathogens)

Partial Body Contact Recreation (from pathogens)

Warmwater Fishery and Coldwater Fishery (from dissolved oxygen, suspended solids)

Fish Consumption (from toxic substances – organic and heavy metals)

Others – No degradation of uses currently being supported

Beneficial Uses

Degradation of Fish and Wildlife Populations (from sediment-ation, elevated summer temperatures)

Degradation of Benthos (from sedimentation, toxic contaminants in sediment)

Beach Closing and Other 'Full Body Contact' Restrictions (from pathogens)

Degradation of Aesthetics (from sedimentation, plant nutrients causing localized algal blooms, physical obstructions)

Loss of Fish and Wildlife Habitat (from erosion and sedimentation)

Total Maximum Daily Loads

E. coli (a pathogen)

Dissolved Oxygen

(continued on following page)

Goal I: To make progress towards achieving water quality standards for pollutants and parameters that affect the designated, desired, and beneficial uses in the subwatershed.

The aim of Goal I is to address known and potential water quality issues. These issues are defined by the indicators that have been selected for this goal: sediment, pathogens, nutrients, dissolved oxygen, temperature, and toxic substances.

The indicators for this goal have been selected based upon the information appearing in the previous chapters of this plan (as summarized in the sidebar): water quality standards, designated uses, desired uses, beneficial uses, and total maximum daily loads (TMDLs). The targets that are associated with the indicator have been pulled from the same sources as listed above or from additional literature as presented in Chapter 5.

The objectives and indicator targets for Goal I are listed in Table 6-1.

Table 6-1. Objectives, Sources, and Indicator targets for Goal I.

Objective	Prioritized Sources	Indicator Targets
A. Reduce sediment discharges to waterbodies *The 50, 65, and 75 mg/L limits for TSS are the basis for pollutant load reductions presented in Chapter 7.*	Agricultural / Cultivated Land Soil Erosion – Streambanks Urban / Residential Land Transportation Infrastructure	Total Suspended Solids – average TSS concentration (50, 65, or 75 mg/l for headwaters, wadeable streams, and downstream reaches of the North Branch, respectively) Macroinvertebrates – improved conditions at monitored sites over time Fish – improved population conditions at monitored sites over time
B. Reduce nutrient discharges to waterbodies *The 0.3 mg/L limit for nitrate and the 0.1 mg/L limit for TP are the bases for pollutant load reductions presented in Chapter 7.*	Agricultural / Cultivated Land On-Site Disposal Systems Illicit Discharges Sewage Discharges Urban / Residential Land Sediment Sources (as phosphorus often is attached to sediment)	Total Phosphorus – average total TP concentration (0.1 mg/l, 0.05 mg/l) Nitrate – average nitrate concentration (0.3 mg/l, 0.2 mg/l) Total Kjeldahl Nitrogen – average TKN concentration (1.2 mg/l) Algal Blooms – improved conditions at sites with previously documented problems
C. Reduce discharges of oxygen demanding substances to waterbodies	Agricultural / Cultivated Land On-Site Disposal Systems Illicit Discharges Sewage Discharges Temperature Sources (as increased temperatures lead to reduced DO levels)	Dissolved Oxygen – average DO concentration (5 mg/l, 7 mg/l, for warmwater and coldwater streams, respectively) Macroinvertebrates - improved conditions at monitored sites over time Fish - improved population conditions at monitored sites over time

Table 6-1. Objectives, Sources, and Indicator targets for Goal I. (continued)

Objective	Prioritized Sources	Indicator Targets
D. Reduce pathogen discharges to waterbodies *The 130 E. coli / 100 mL limit is the basis for pollutant load reductions presented in Chapter 7.*	On-Site Disposal Systems Illicit Discharges Agricultural / Cultivated Land Sewage Discharges Urban / Residential Land Animal Sources (non-agricultural)	E. coli – long term geometric mean (decrease current levels) E. coli – daily maximum concentration (300 E. coli / 100 ml) E. coli – 30 day geometric mean (130 E. coli / 100 ml, 1,000 E. coli / 100 ml)
E. i. Reduce discharges of elevated-temperature runoff to waterbodies ii. Address sources of in-stream temperature increases	Urban / Residential Land Transportation Infrastructure Sources of Hydraulic / Hydrologic Characteristics Stressor (as widened, shallow channels warm much faster) Sources of Natural Feature / Habitat Degradation Stressor (as loss of riparian shading allows increased exposure to direct sunlight and leads to temperature increases)	Temperature – maximum monthly temperature (20° C, 29° C for coldwater and warmwater streams, respectively) Macroinvertebrates - improved conditions at monitored sites over time Fish - improved population conditions at sites monitored sites over time
F. i. Reduce discharges of toxic compounds (includes inorganic, organic, and heavy / toxic metals stressors) to waterbodies ii. Address areas of existing sediment contamination – prevent re-suspension of contaminants, remove highly contaminated sediments	Urban / Residential Land Transportation Infrastructure Agricultural / Cultivated Land Contaminated Sediments Contaminated Sites Atmospheric Deposition Industrial Sites Waste Management Sites	Toxic Compounds – concentration limits (for maximum and chronic exposure; and drinking water versus non-drinking water) for human exposure* Toxic Compounds – concentration limits (for toxic and chronic exposure) for protecting aquatic life* Fish – levels of contaminants in fish tissue decreasing at monitored sites over time * the individual numerical targets for each contaminant are far too numerous to list here (refer to Chapter 5)

Note: not all possible sources are listed here, only those determined to be of the highest priority in the subwatershed based upon available data. A complete list of potential sources is available in Table 3-1. It may be necessary to address additional sources if the objective cannot be met by addressing only the prioritized sources listed above.

Goal I – Related Elements

(continued)

Desired Uses

Support Designated Uses that are Not Supported or are Threatened

Support Water Quality and Designated / Desired Use Attainment in Downstream Areas (Lower Clinton River and Lake St. Clair)

Support Healthy Riparian Corridors and Streambanks to Maintain and Enhance Water Quality, Aquatic and Terrestrial Habitats, and Fisheries / Hunting

Support the Character of the Subwatershed by Preserving / Enhancing Natural Drainage Systems by Minimizing Directly Connected Impervious Surfaces to Foster Healthy Terrestrial and Aquatic Habitat

Support Healthy Aquatic and Terrestrial Habitat by Ensuring Wastes are Properly Disposed of through Appropriate Sewage Treatment and Effective Solid Waste Programs

Goal II – Related Elements

Designated Uses

Agriculture

Navigation

Industrial Water Supply

Warmwater Fishery

Coldwater Fishery

Public Water Supply

Beneficial Uses

Degradation of Fish and Wildlife Populations*

Degradation of Benthos*

Degradation of Aesthetics

Loss of Fish and Wildlife Habitat*

Desired Uses

Support Restoration of Designated Uses that are Not Supported or are Threatened

Support Improving Water Quality and Attaining Designated / Desired Uses in Downstream Areas (Lower Clinton River and Lake St. Clair)

Support Maintaining and Improving Healthy Riparian Corridors and Streambanks to Protect and Enhance Water Quality, Aquatic and Terrestrial Habitats, and Fisheries / Hunting

Support the Character of the Subwatershed by Preserving / Enhancing Natural Drainage Systems by Minimizing Directly Connected Impervious Surfaces to Foster Healthy Terrestrial and Aquatic Habitat

* Note: although hydrology and flow conditions impact in-stream habitat conditions and organism populations, these have not been chosen as indicators because subsequent goals specifically address habitat and indirectly address organism populations.

Goal II: To stabilize the hydrology of the subwatershed including both high flow and low flow conditions

The aim of Goal II is to encourage the implementation of appropriate infrastructure (e.g. low impact development) and procedures (e.g. water reuse) to manage runoff in such a way that the subwatershed hydrology of is stabilized and mimics pre-settlement conditions where feasible. The indicators selected to assess these conditions relate primarily to the 'hydrologic / hydraulic characteristics' stressor and include: flashiness, impervious surfaces, wetlands, obstructions and water withdrawals.

The indicators for this goal have been selected based upon the information appearing in the previous chapters of this plan (as summarized in the sidebar): designated uses, desired uses, and beneficial uses. The targets that are associated with the indicator have been pulled from the same sources as listed above or from additional literature as presented in Chapter 5.

The objectives and indicator targets for Goal II are listed in Table 6-2.

Table 6-2. Objectives, Sources, and Indicator targets for Goal II.

Objective	Prioritized Sources	Indicator Targets
A. Prevent waterbodies in the subwatershed from exhibiting increased flashiness characteristics	Urban / Residential Land Transportation Infrastructure Agricultural / Cultivated Land Other Human Activities Sewage Discharges	R-B Index – show level or decreasing trends in the R-B index at monitored sites over time Peak Flow Rate – show improved high-flow exceedance curve conditions at monitored sites over time Minimum Flow Rate – show improved low-flow exceedance curve conditions at monitored sites over time Flow Path Length – ensure no manmade changes occur to rivers or streams that would shorten existing flow paths Development – All New Development and Redevelopment should comply with stormwater permit requirements
B. i. Limit / reduce impervious surface coverage ii. Limit / reduce impervious surface coverage and agricultural land in the 100-foot riparian buffers	Urban / Residential Land Transportation Infrastructure Agricultural / Cultivated Land	Impervious Surface Coverage in Catchments – less than 10% (or current levels if below 10%) Impervious Surface Coverage plus Agricultural/ Cultivated Land in 100-foot Riparian Buffers by Stream Reach – less than 2% (or current levels if below 2%)

Table 6-2. Objectives, Sources, and Indicator targets for Goal II. (continued)

Objective	Prioritized Sources	Indicator Targets
C. i. Increase wetlands coverage in catchments ii. Increase wetlands coverage in the 100-foot riparian buffers	Urban / Residential Land Transportation Infrastructure Agricultural / Cultivated Land Other Human Activities	Wetlands Surface Coverage in Catchments– increase coverage by 10% over current levels Wetlands Surface Coverage in 100-foot Riparian Buffers – increase to pre-settlement levels
D. Reduce the number of flow obstructions in the subwatershed	Urban / Residential Land Transportation Infrastructure Other Human Activities Natural Occurrences and Disturbances	Dams – reduce the number of man-made dams in the subwatershed Other Obstructions – reduce the number of other blockages (e.g. excessive debris) that cause detrimental flow conditions
E. Reduce water withdrawals	Agricultural / Cultivated Land Other Human Activities	Reduce Water Withdrawals at All Sites to Sustainable Levels Eliminate Water Withdrawals at Sites with Low Flow Problems Approve No New Water Withdrawals Where Low Flow Problems May Emerge

Note: not all possible sources are listed here, only those determined to be of the highest priority in the subwatershed based upon available data. A complete list of potential sources is available in Table 3-1. It may be necessary to address additional sources if the objective cannot be met by addressing only the prioritized sources listed above.

Goal III: To protect and restore suitable, high-quality habitat to support aquatic life, wildlife, and fisheries

The aim of Goal III is to encourage sustainable development and minimize modifications to existing terrestrial and aquatic habitat and restore degraded areas. The indicators selected for this goal primarily relate to the 'natural feature / habitat degradation' stressor, including: terrestrial habitat, riparian habitat, and aquatic habitat. Note that additional characteristics of waterbodies other than those noted here contribute to the suitability of the waters to act as habitat. This specifically refers to pollutant concentrations and hydrologic / hydraulic characteristics. These issues are not addressed here in detail as the two previous goals have done so. However, some discussion of these elements may be appropriate to provide a complete picture of the scope of the goal and how the various goals are inter-related

The indicators for this goal have been selected based upon the information appearing in the previous chapters of this plan (as summarized in the sidebar): water quality standards, designated uses, desired uses, beneficial uses, and total maximum daily loads (TMDLs). The targets that are associated with the indicator have been pulled from the same sources as listed above or from additional literature as presented in Chapter 5.

The objectives and indicator targets for Goal II are listed in Table 6-3.

Goal III – Related Elements

Water Quality Standards
(from related designated uses)

pH, Physical Characteristics (suspended solids / sediment)

Toxic Substances, Dissolved Solids

Plant Nutrients (phosphorus)

Dissolved Oxygen, Temperature

Designated Uses

Warmwater / Coldwater Fishery

Other Aquatic Life and Wildlife

Beneficial Uses

Degradation of Fish and Wildlife Populations

Degradation of Benthos

Loss of Fish and Wildlife Habitat

Total Maximum Daily Loads

Dissolved Oxygen

Desired Uses

Support Local Recreational Fishing

Support Maintaining and Restoring Healthy Aquatic Habitat to Protect Fisheries and Other Aquatic Life

Support Local Recreational Hunting

Support Maintaining and Improving Healthy Riparian Corridors and Streambanks to Protect and Enhance Water Quality, Aquatic and Terrestrial Habitats, and Fisheries / Hunting

Support the Character of the Subwatershed by Preserving / Enhancing Identified Natural Features and Healthy Terrestrial Habitat to Maintain and Enhance Game Animal Populations and Threatened / Endangered Species

Support the Character of the Subwatershed by Preserving / Enhancing Natural Drainage Systems by Minimizing Directly Connected Impervious Surfaces to Foster Healthy Terrestrial and Aquatic Habitat

Support Healthy Aquatic and Terrestrial Habitat by Ensuring Wastes are Properly Disposed of through Appropriate Sewage Treatment and Effective Solid Waste Programs

Table 6-3. Objectives, Sources, and Indicator targets for Goal III.

Objective	Prioritized Sources	Indicator Targets
A. i. Preserve existing terrestrial habitat and restore degraded terrestrial habitat ii. Reduce the fragmentation of terrestrial habitat iii. Improve quality of existing terrestrial habitat	Urban / Residential Land Transportation Infrastructure Agricultural / Cultivated Land Other Human Activities	Total Area of Terrestrial Habitat (including upland wetlands) – maintain current levels of terrestrial habitat and increase levels if restoration opportunities exist Diversity of Terrestrial Habitat Present (including upland wetlands) – ensure that all major terrestrial habitat types are represented by sustainable habitat clusters Average Size of Contiguous Terrestrial Habitat Clusters – increase the average size by 10% Average Distance Between Terrestrial Habitat Clusters – reduce the average distance between the edges of habitat clusters by 20% Percentage of Terrestrial Habitat Clusters Connected through Green Corridor – increase the percentage of habitat clusters that are connected by 25% Incidence of Invasive Species – eliminate the incidence of invasive species Incidence of Endangered and Threatened Species – increase the number of specimens of endangered and threatened species Documented Natural Features – increase the number of documented natural features if restoration opportunities exist Population Levels of Terrestrial Organisms – ensure populations of desirable and indicator terrestrial organisms are at sustainable levels
B. i. Preserve existing riparian habitat and restore degraded riparian habitat (with special focus on riparian wetlands and forested areas) ii. Improve the quality of existing riparian habitat	Urban / Residential Land Transportation Infrastructure Agricultural / Cultivated Land Other Human Activities	Amphibian Diversity – increase the number of amphibian species represented Amphibian Population Levels – increase amphibian populations by 25% Area of Wetlands in Riparian Corridor – maintain current levels of wetlands in the riparian corridor and increase to pre-settlement levels if restoration opportunities exist Area of Forest in Riparian Corridor – maintain current levels of forest land in the riparian corridor and increase to pre-settlement levels if restoration opportunities exist Documented Natural Features in Riparian Corridor – increase the number of natural features identified in the riparian corridor if restoration opportunities exist Incidence of Invasive Species - eliminate the incidence of invasive species
C. i. Preserve and enhance existing aquatic habitat ii. Improve areas of degraded aquatic habitat	Urban / Residential Land Transportation Infrastructure Agricultural / Cultivated Land Other Human Activities *Sources associated with other stressors*: Sediment Oxygen Demand Hydrologic / Hydraulic Characteristics Temperature	Natural Stream Miles / Straightened Stream Miles – maintain current ratio and increase ratio by restoring previously straightened reaches to a meandering state Number of Stream Miles Routinely 'Cleaned' for Maximum Hydraulic Capacity – reduce the number of stream miles 'cleaned' to only those deemed absolutely necessary to protect life and personal property Enclosed Reaches and Lengths – eliminate enclosed reaches of streams and drains to the maximum practical extent Areas of Streambank Erosion – reduce the total area of active streambank erosion Macroinvertebrate Community Conditions – ensure continuing high levels where currently attained and improve conditions where degradation is currently documented Fish Community Conditions – ensure continuing high levels where currently attained and improve conditions where degradation is currently documented Incidence of Invasive Species – eliminate the incidence of invasive species Incidence of Endangered and Threatened Species – increase the number of specimens of endangered and threatened species Incidence of Appropriate Woody Debris – increase the incidence of locations with habitat-providing woody debris

Note: not all possible sources are listed here, only those determined to be of the highest priority in the subwatershed based upon available data. A complete list of potential sources is available in Table 3-1. It may be necessary to address additional sources if the objective cannot be met by addressing only the prioritized sources listed above.

Goal IV: To protect and enhance existing natural features of the subwatershed

The aim of Goal IV is to encourage sustainable development and minimize modifications to the natural environment such that existing natural features are protected and enhanced. Note that the definition of natural features in this context does not include habitat, nor does it include the characteristics of the waterbodies (e.g pollutant concentrations, stream flow regimes), as these have been addressed by the previous goals. However, some discussion of these elements may be appropriate to provide a complete picture of the scope of the goal and how the various goals are inter-related

The indicators selected for this goal primarily relate to the 'natural feature / habitat degradation' stressor: geology, waterbodies, groundwater, wetlands, flora and fauna, other natural areas.

The indicators for this goal have been selected based upon the information appearing in the previous chapters of this plan (as summarized in the sidebar): water quality standards, designated uses, desired uses, beneficial uses, and total maximum daily loads (TMDLs). The targets that are associated with the indicator have been pulled from the same sources as listed above or from additional literature as presented in Chapter 5.

The objectives and indicator targets for Goal II are listed in Table 6-4.

Goal V: To maintain, protect, and enhance greenways through riparian buffers and green corridors

The aim of Goal V is to provide for a network of natural corridors along waterbodies and other corridors such as abandoned railroad lines. The greenways have many benefits including: improved rural and natural aesthetics, habitat protection and enhancement, water quality protection and restoration, and increased recreational opportunities. These benefits will extend to most of the other goals of the plan. The indicators presented here focus primarily on the greenways themselves and do not generally extend to the benefits provided to the other goals (as they have already been addressed) although they are referenced as appropriate. Some of the indicators selected for this goal relate to the 'natural feature / habitat degradation' stressor while others relate to development issues and are not directly related to impacts on the environment: riparian corridors and trails.

The indicators for this goal have been selected based upon the information appearing in the previous chapters of this plan: desired uses[1] and beneficial uses (Degradation of Aesthetics, Loss of Fish and Wildlife Habitat). The targets that are associated with the indicator have been pulled from the same sources as listed above or from additional literature as presented in Chapter 5.

The objectives and indicator targets for Goal II are listed in Table 6-5.

[1] Support Local Terrestrial and Water-based Recreation through Enhanced Public Parks, Trails, and Access Points; Support Maintaining and Improving Healthy Riparian Corridors and Streambanks to Protect and Enhance Water Quality, Aquatic and Terrestrial Habitats, and Fisheries / Hunting; Support the Character of the Subwatershed by Preserving Rural Residential Land and Culture and Preserving / Enhancing Other Aesthetic Conditions

Goal IV – Related Elements

Water Quality Standards (from related designated uses)

Physical Characteristics (suspended solids / sediment)

Toxic Substances

Dissolved Solids

Plant Nutrients (phosphorus)

Dissolved Oxygen

Temperature

pH

Designated Uses

Warmwater Fishery

Coldwater Fishery

Salmonid Migration (not specifically listed as a designated use but discussed as such in appropriate literature)

Beneficial Uses

Degradation of Fish and Wildlife Populations

Degradation of Benthos

Degradation of Aesthetics

Total Maximum Daily Loads

Dissolved Oxygen

Desired Uses

Support Maintaining and Restoring Healthy Aquatic Habitat to Protect Fisheries and Other Aquatic Life

Support the Character of the Subwatershed by Preserving / Enhancing Identified Natural Features and Healthy Terrestrial Habitat to Maintain and Enhance Game Animal Populations and Threatened / Endangered Species

Support the Character of the Subwatershed by Preserving / Enhancing Natural Drainage Systems by Minimizing Directly Connected Impervious Surfaces to Foster Healthy Terrestrial and Aquatic Habitat

Support the Character of the Subwatershed by Preserving Rural Residential Land and Culture and Preserving/Enhancing Other Aesthetic Conditions

Table 6-4. Objectives, Sources, and Indicator targets for Goal IV.

Objective	Prioritized Sources	Indicator Targets
A. Maintain natural geologic conditions in the subwatershed and restore those conditions that have been degraded	Urban / Residential Land Transportation Infrastructure Agricultural / Cultivated Land Soil Erosion Other Human Activities	Maintain Sensitive Slope Areas – ensure zero development occurs in sensitive slope areas Maintain Soil Hydrologic Capacity – the hydrologic capacity classifica-tion of soils should be maintained at current levels and restored to historical levels where feasible
B. Protect sensitive waterbodies in the subwatershed and restore those that have been degraded	Urban / Residential Land Transportation Infrastructure Agricultural / Cultivated Land Soil Erosion Other Human Activities	Maintain Headwater and Intermittent Streams – maintain current reaches of headwater / intermittent streams and restore those reaches that have been degraded if feasible
C. Protect groundwater resources in the subwatershed and restore those that have been degraded	Urban / Residential Land Transportation Infrastructure Agricultural / Cultivated Land Soil Erosion Other Human Activities	Maintain Surface-Ground-water Interface Zones – maintain natural state of interface zones and restore those areas that have been degraded Active Wells – ensure active water wells do not negatively impact groundwater conditions and restrict withdrawals to sustainable levels if problems are documented Abandoned Wells – identify all abandoned wells and ensure they are all properly sealed
D. Protect and restore wetlands and floodplain	Urban / Residential Land Transportation Infrastructure Agricultural / Cultivated Land Soil Erosion Other Human Activities	Wetland Coverage Area – current wetland area in catchments should be maintained and urbanized areas of catchments should have wetlands restored to 5% of the urbanized area Types of Wetlands – healthy examples of all existing types of wetlands should be maintained and all historically present types of wetlands in the subwatershed should be restored to at least 25% of the pre-settlement total area Wetlands in Floodplain – current levels of wetland coverage in the floodplain should be maintained and all degraded wetland areas in the floodplain should be restored Developed Lands in Floodplain – developed land types in the floodplain should not exceed current levels and 10% of currently developed lands in the floodplain should be returned to natural state
E. Support healthy native plant, wildlife, and aquatic life populations	Urban / Residential Land Transportation Infrastructure Agricultural / Cultivated Land Soil Erosion Other Human Activities	Population Extents- ensure populations of desirable and indicator organisms extend throughout all areas of appropriate habitat in the subwatershed Incidence of Rare, Endangered and Threatened Species – ensure that current rare, endangered, and threatened species found in the subwatershed continue to be present
F. Protect other existing natural features	Urban / Residential Land Transportation Infrastructure Agricultural / Cultivated Land Soil Erosion Other Human Activities	Maintain Documented Natural Features – ensure that existing non-biological natural features in the subwatershed are preserved and that incidences of historically present natural features are restored

Note: not all possible sources are listed here, only those determined to be of the highest priority in the subwatershed based upon available data. A complete list of potential sources is available in Table 3-1. It may be necessary to address additional sources if the objective cannot be met by addressing only the prioritized sources listed above.

Table 6-5. Objectives, Sources, and Indicator targets for Goal V.

Objective	Prioritized Sources	Indicator Targets
A.i. Improve riparian buffer conditions ii. increase the amount of riparian areas with intact green corridor	Urban / Residential Land Transportation Infra-structure Agricultural / Cultivated Land Soil Erosion Other Human Activities	Number of Stream Miles / Number of Stream Miles with 100-foot Natural or Restored Riparian Buffer – decrease this ratio from current levels by protecting existing 100-foot riparian corridors and restoring degraded corridors Condition of 100-foot Buffers – increase the percentage of 100-foot buffers that receive an optimal rating Reduce Incidence of Soil Erosion in Riparian Areas – stabilize areas of upland soil erosion occurring in the riparian corridor
B. Increase the number of trails and the green corridors associated with them	Urban / Residential Land Transportation Infra-structure Agricultural / Cultivated Land Other Human Activities	Number of Trails – create additional trails in the subwatershed Number of Trail Miles – double the number of total trail miles available for recreation Number of Trail Miles with Potential to Support Green Corridor – develop new trails in areas where significant green corridor can be provided Number of Trail Miles with Associated Green Corridor – ensure that all trails with green corridor potential have green corridors associated with them

Note: not all possible sources are listed here, only those determined to be of the highest priority in the subwatershed based upon available data. A complete list of potential sources is available in Table 3-1. It may be necessary to address additional sources if the objective cannot be met by addressing only the prioritized sources listed above.

Goal VI: To preserve the rural character of the subwatershed for local citizens and visitors seeking a 'rural Michigan' experience

The aim of Goal VI is to ensure that the subwatershed maintains its distinctive rural character that is an aesthetic value to the local citizenry and also acts to attract outsiders who enhance the local economy. This goal should not be construed to limit future development, but rather to ensure that it is done consistent with a rural setting and/or near areas that are already developed. Some of the indicators that have been selected for this goal are related to the 'natural feature / habitat degradation' stressor while others are not specifically related to a particular stressor (as they relate to development issues and not directly to impacts on the environment): land use, development, roads/traffic, and aesthetics. The rural character of the subwatershed is also dependent on elements of the natural environment that have been addressed through a number of previous goals. These elements include habitat conditions, water quality conditions, and its other natural features. As such, these elements are not significantly addressed here but some discussion of these elements may be appropriate and/or necessary to provide a complete picture of the scope of the goal and how the various goals are inter-related.

The indicators for this goal have been selected based upon the information appearing in the previous chapters of this plan (as summarized in the sidebar): water quality standards, designated uses, desired uses, and beneficial uses. The targets that are associated with the indicator have been pulled from the same sources as listed above or from additional literature as presented in Chapter 5.

The objectives and indicator targets for Goal II are listed in Table 6-6.

Goal VI – Related Elements

Water Quality Standards

Plant Nutrients (from the Agriculture designated use)

Designated Uses

Agriculture

Beneficial Uses

Degradation of Aesthetics

Loss of Fish and Wildlife Habitat

Desired Uses

Support the Character of the Subwatershed by Preserving / Enhancing Identified Natural Features and Healthy Terrestrial Habitat to Maintain and Enhance Game Animal Populations and Threatened / Endangered Species

Support the Character of the Subwatershed by Preserving / Enhancing Natural Drainage Systems by Minimizing Directly Connected Impervious Surfaces to Foster Heal-thy Terrestrial & Aquatic Habitat

Support Healthy Aquatic and Terrestrial Habitat by Ensuring Wastes are Properly Disposed of through Appropriate Sewage Treatment and Effective Solid Waste Programs

Support the Character of the Subwatershed by Preserving Prime and Unique Agricultural Lands

Support the Character of the Subwatershed by Preserving Rural Residential Land and Culture and Preserving / Enhancing Other Aesthetic Conditions

Support the Character of the Subwatershed by Preserving Historical & Cultural Resources

Table 6-6. Objectives, Sources, and Indicator targets for Goal VI.

Objective	Prioritized Sources	Indicator Targets
A. Preserve appropriate land uses to maintain rural character of subwatershed	Urban / Residential Land Transportation Infrastructure Agricultural / Cultivated Land Soil Erosion – Streambanks and Upland Areas Other Human Activities	Land Uses – ensure future land uses keep agricultural lands and other undeveloped land types at 75% of their current levels
B. Balance desirable new development and redevelopment with rural character	Urban / Residential Land Transportation Infrastructure Agricultural / Cultivated Land Other Human Activities	Acres Developed with Impact Minimizing Techniques / Acres Developed using Traditional Practices – increase this ratio by ensuring that new development utilizes conservation, smart growth, and other low impact development practices Acres Developed supporting Rural Aesthetic – ensure that all new development meets criteria designed to ensure a 'rural aesthetic' Development Characteristics – ensure new (and re-) developments over 1 acre in size meet stormwater permit requirements (even if not currently in urbanized area)
C. i. Minimize construction of new roads to those needed to support desired increases in the number of automobile trips ii. Ensure new roads are constructed using impact minimizing techniques	Urban / Residential Land Transportation Infrastructure Agricultural / Cultivated Land Other Human Activities	Traffic Counts – only major arterial roads should experience significantly increased traffic counts Road Density – road density in non-urban areas should remain with 20% of current levels Paved / Unpaved Road Miles – this ratio should only increase in areas that are targeted for future development Average Road Width – the average width of newly constructed and re-surfaced roads should be less than the current average for the given road type Curb and Gutter – curb and gutter road construction should only be utilized in urban areas and then only when absolutely necessary Sidewalk Characteristics – separate sidewalks should only be constructed when necessary for safety and then should be limited to one side of the street
D. Preserve general aesthetics of the natural environment	Urban / Residential Land Transportation Infrastructure Agricultural / Cultivated Land Soil Erosion – Streambanks and Upland Areas Other Human Activities	Reduce Incidences of Upland and Streambank Erosion – existing and potential areas of soil erosion should be repaired using engineering techniques to limit reoccurrence; natural techniques on streambanks should only be used in areas where hydrological changes are not exacerbating erosion problems; hydraulic causes of soil erosion (e.g. improperly designed culvert headwalls) should be corrected on a case-by-case basis Reduce Algal Blooms – conditions leading to algal blooms other than elevated nutrient levels (e.g. stagnant pooled water) should be corrected on a case-by-case basis Minimize Number of Waterbody Obstructions – all non-habitat providing obstructions in waterbodies should be removed; those essential for infrastructure (e.g. culverts for road crossings) should be replaced with non-obstructing (or otherwise waterbody modifying) elements (e.g. replace culverts with clear-span bridges)

Note: not all possible sources are listed here, only those determined to be of the highest priority in the subwatershed based upon available data. A complete list of potential sources is available in Table 3-1. It may be necessary to address additional sources if the objective cannot be met by addressing only the prioritized sources listed above.

Goal VII: To preserve and enhance recreational opportunities in the subwatershed for local residents and visitors

The aim of Goal VII is ensure that the subwatershed continues to be a pleasant place to live and a travel destination by providing appropriate recreational opportunities such as canoeing/kayaking, fishing (for sport and consumption), swimming, hunting, picnicking, bird- and animal watching, camping, and hiking. Some of the indicators that have been selected for this goal are related to the 'natural feature / habitat degradation' stressor while others are not specifically related to a particular stressor (as they relate to development issues and not directly to impacts on the environment): public land, campsites, fisheries, trails, boating, swimming, wildlife, cultural/historical resources, and tourism. The condition of recreational facilities and opportunities is also dependent on elements of the natural environment that have been addressed through a number of previous goals. These elements include habitat conditions, water quality conditions, the rural aesthetic of the subwatershed, and its other natural features. As such, these elements are not significantly addressed here but some discussion of these elements may be appropriate and/or necessary to provide a complete picture of the scope of the goal and how the various goals are inter-related.

The indicators for this goal have been selected based upon the information appearing in the previous chapters of this plan (as summarized in the sidebar): water quality standards, designated uses, desired uses, beneficial uses, and total maximum daily loads (TMDLs). The targets that are associated with the indicator have been pulled from the same sources as listed above or from additional literature as presented in Chapter 5.

The objectives and indicator targets for Goal II are listed in Table 6-7.

Goal VIII: Cultivate an aware, informed, engaged, and involved public

The aim of Goal II is to encourage the development of a knowledgeable public that understands the issues facing the subwatershed and actively participates in the management actions that have been defined to improve environmental, aesthetic, and other conditions. The indicators selected to assess achievement of this goal are not specifically related to a particular stressor (as they relate to educational issues and not directly to impacts on the environment): knowledge levels, participation levels

The indicators for this goal have been selected based primarily upon information presented in Chapter 4 concerning public education and other sources that discuss the characteristics of successful public education programs. Because public education and involvement has the potential to impact all designated uses, desired uses, beneficial uses, TMDLs, and water quality conditions it is redundant to list them all again in a sidebar as was done for the previous goals. The targets that are associated with the indicators have been pulled from the same sources as listed above or from additional literature.

The objectives and indicator targets for Goal VIII are listed in Table 6-8.

Goal VII – Related Elements

Water Quality Standards (from related designated uses)

Physical Characteristics (suspended solids / sediment) – from Navigation

Dissolved Solids – from Warmwater and Coldwater Fisheries

Plant Nutrients (phosphorus) – from Partial and Total Body Contact Recreation

Microorganisms (pathogens) – from Partial and Total Body Contact Recreation

Dissolved Oxygen – from Warmwater and Coldwater Fisheries

Temperature – from Warmwater and Coldwater Fisheries

pH – from Warmwater and Coldwater Fisheries

Toxic Substances – from Fish Consumption

Designated Uses

Navigation

Total Body Contact Recreation

Partial Body Contact Recreation

Warmwater Fishery

Coldwater Fishery

Fish Consumption

Beneficial Uses

Degradation of Fish and Wildlife Populations

Degradation of Benthos

Beach Closing and Other 'Full Body Contact' Restrictions

Degradation of Aesthetics

Loss of Fish and Wildlife Habitat

Total Maximum Daily Loads

E. coli (a pathogen)

Dissolved Oxygen

(continued on following page)

Goal VII – Related Elements (continued)

Desired Uses

Support Restoration of Designated Uses that are Not Supported or are Threatened

Support Improving Water Quality and Attaining Designated / Desired Uses in Downstream Areas (Lower Clinton River and Lake St. Clair)

Support Local Terrestrial and Water-based Recreation through Enhanced Public Parks, Trails, and Access Points

Support Local Recreational Fishing

Support Maintaining and Restoring Healthy Aquatic Habitat to Protect Fisheries and Other Aquatic Life

Support Local Recreational Hunting

Support Maintaining and Improving Healthy Riparian Corridors and Streambanks to Protect and Enhance Water Quality, Aquatic and Terrestrial Habitats, and Fisheries/Hunting

Support the Character of the Subwatershed by Preserving / Enhancing Identified Natural Features and Healthy Terrestrial Habitat to Maintain and Enhance Game Animal Populations and Threatened / Endangered Species

Support the Character of the Subwatershed by Preserving / Enhancing Natural Drainage Systems by Minimizing Directly Connected Impervious Surfaces to Foster Heal-thy Terrestrial & Aquatic Habitat

Support Healthy Aquatic and Terrestrial Habitat by Ensuring Wastes are Properly Disposed of through Appropriate Sewage Treatment and Effective Solid Waste Programs

Support the Character of the Subwatershed by Preserving Rural Residential Land and Culture and Preserving / Enhancing Other Aesthetic Conditions

Support the Character of the Subwatershed by Preserving Historical & Cultural Resources

Table 6-7. Objectives, Sources, and Indicator targets for Goal VII.

Objective	Prioritized Sources	Indicator Targets
A. Increase public lands to be used for general recreation purposes	Urban / Residential Land Transportation Infrastructure Agriculture / Cultivated Land Other Businesses	Public Lands in the Subwatershed – publicly owned lands should be increased by 10% Riparian Public Lands – publicly owned riparian lands should be increased to the maximum practical level Number of Parks / Natural Areas / Recreation Areas – the number of parks, natural areas, and recreation areas should be increased by 10%
B. Increase the number of campsites in the subwatershed	Urban / Residential Land Transportation Infrastructure Agriculture / Cultivated Land Other Businesses	Number of Public Campsites – the number of public campsites should be increased above current levels Number of Private Campsites – the number of public campsites should be increased above current levels
C. Ensure the fisheries in the subwatershed are healthy for both sport anglers and fish consumption	Urban / Residential Land Transportation Infrastructure Agriculture / Cultivated Land Other Businesses *Sources associated with other stressors*: Hydrologic / Hydraulic Characteristics All other physical and chemical stressors	Fish Community Characteristics – documented fish community characteristics should consistently show improvement Fish Tissue Contaminants – there should be no documented increases in fish tissue contaminant levels
D. Increase the number of trails available for recreation	Urban / Residential Land Transportation Infrastructure Agriculture / Cultivated Land Other Businesses	Number of Trails- the number of trails should increase by 20% over current levels
E. Ensure that waterbodies in the subwatershed that can support boating do not have impediments to doing so	Urban / Residential Land Transportation Infrastructure Agriculture / Cultivated Land Other Businesses Natural Occurrences and Disturbances	Number of Public Access Points per Reach – increase the number of public access points per reach by 50% Number of Obstructions – eliminate all obstructions that are a barrier to boating recreation and provide portage facilities for those that cannot be eliminated

Table 6-7. Objectives, Sources, and Indicator targets for Goal VII. (continued)

Objective	Prioritized Sources	Indicator Targets
F. Ensure wading and swimming is safe for waterbodies throughout the subwatershed	Urban / Residential Land Transportation Infrastructure Agriculture / Cultivated Land Other Businesses Sewage Discharges Illicit Discharges On-Site Disposal Systems	Number of Contact Advisories – eliminate the incidence of contact advisories due to pathogens Number of Beach Closings – eliminate the incidence of beach closings due to pathogens
G. i. Ensure native wildlife populations are healthy and can support hunting, as appropriate ii. Ensure endangered and threatened species can find habitat in the subwatershed	Urban / Residential Land Transportation Infrastructure Agriculture / Cultivated Land Other Human Activities	Native Wildlife Population Samples and Trends – ensure native wildlife populations do not exhibit disease and that levels are steady or increasing at a healthy rate Game Wildlife – ensure game wildlife are present in sustainable levels and that populations are otherwise healthy Takings – ensure that takings of game wildlife is done at levels that do not negatively impact population dynamics Endangered and Threatened Species Habitat – ensure that sufficient habitat exists to support the sustaining of threatened and endangered species
H. Maintain and restore valuable cultural and historical resources	Urban / Residential Land Transportation Infrastructure Agriculture / Cultivated Land Other Human Activities	Number / Type of Cultural Resources – ensure that current level of cultural resources are maintained and that all current types of desirable cultural resources continue to be present Number of Historical Sites – preserve existing historical sites and protect other historical sites that have yet to be officially identified as such
I. Increase low impact tourism in the subwatershed	Urban / Residential Land Transportation Infrastructure Other Human Activities	Dollars – Number of tourism dollars flowing to local communities

Note: not all possible sources are listed here, only those determined to be of the highest priority in the subwatershed based upon available data. A complete list of potential sources is available in Table 3-1. It may be necessary to address additional sources if the objective cannot be met by addressing only the prioritized sources listed above.

Table 6-8. Objectives, Sources, and Indicator targets for Goal VIII.

Objective	Prioritized Sources	Indicator Targets
A. Increase the knowledge levels among key subwatershed constituents: i. General Public ii. School-age Youth iii. Business iv. Agricultural Community v. Municipal Employees vi. Municipal Officials	The priority sources associated with each objective should be addressed by the specific public education message tailored for that particular objective.	Knowledge - Increasing knowledge and understanding should be demonstrated in all of the following areas addressed by the public education plan: • Watershed Stewardship • Stormwater • Illicit Discharges • Impacts of Personal Actions • Waste Management • Riparian Lands Basic understanding of the following concepts should also be demonstrated: • Habitat • Native / Invasive Species • Threatened / Endangered Species • Watercraft Operations • Environmental Ordinances and Codes • Regulatory and Assistance Organizations • Pollution Prevention – for business, agriculture, and municipal operations • Generally Accepted Agricultural Management Practices – for agriculture
B. Increase the participation levels among key subwatershed constituents: i. General Public ii. School-age Youth iii. Business iv. Agricultural Community v. Municipal Employees vi. Municipal Officials	Public participation collectively addresses all possible sources although particular participation activities may focus on particular sources.	Participation - Increasing participation should be demonstrated by all of the key constituents in the appropriate organizations and activities listed below: • SWAG participation • Participation at SWAG hosted stakeholder workshops • Attendance at SWAG hosted community forums • Interaction with the Clinton River Watershed Council (e.g. through the internet – questions, donations) • Attendance at topical information and training sessions • CRWC Stream Leaders volunteer monitoring program • CRWC Coldwater Conservation Project • CRWC Adopt-a-Stream program • CRWC River Day and Clinton Clean Up events • Sponsored and in-house municipal training sessions • Southeast Michigan Sustainable Business Forum • Michigan Department of Agriculture Environmental Assurance Program • Organic farming certification • Macomb County teachers programs • Farm-A-Syst, Home-A-Syst programs • Natural Resources Conservation Service programs

Goal IX: Institutionalize an informed collaborative planning and implementation approach to achieve goals and objectives

The aim of Goal IX is to encourage the institutionalization of the plan to ensure that progress is made towards achieving the goals and objectives. The indicators selected to assess achievement of this goal are not specifically related to a particular stressor (as they relate to institutionalization issues and not directly to impacts on the environment): SWAG membership, institutional mechanism, funding source, implementation schedule, efficiency, effectiveness.

The indicators for this goal have been selected based primarily upon information presented in Chapter 7 and the characteristics of institutionalization. Because institutionalization has the potential to impact all designated uses, desired uses, beneficial uses, TMDLs, and water quality conditions it is redundant to list them all again in a sidebar as was done for the first seven goals. The targets that are associated with the indicators have been pulled from the same sources as listed above or from additional literature.

The objectives and indicator targets for Goal IX are listed in Table 6-9.

Conclusion

This chapter defines goals and objectives that the SWAG would like to achieve as part of this plan which is aimed at improving environmental conditions in the North Branch Clinton River Subwatershed. The information presented in the previous chapters has informed these choices through an adaptive management process (described in Chapter 1). If this process is continued throughout future planning efforts (e.g. iterative planning based on new data, completed actions, achievements, and other information) the goals and objectives may change.

Chapter 7 builds on the information presented in this chapter and identifies the priority goals and objectives, identifies the critical areas, presents the necessary pollutant load reductions, describes the management context and the categories of actions to be taken, and identifies the specific priority actions to be taken.

Chapter 8 then defines a more complete picture of the actions that will be taken to achieve the goals and objectives. It presents all of the actions along with a significant amount of detail about each, such as the implementation schedule, cost, assistance needed, and responsible party, among other information.

Finally, Chapter 9 expands on the actions and protocols, first identified in Chapter 8 and utilizing the indicator targets from this chapter, which will be utilized to monitor progress towards achieving the desired goals and objectives as well as for making future revisions to the plan.

Table 6-9. Objectives, Sources, and Indicator targets for Goal IX.

Objective	Prioritized Sources	Indicator Targets
A. Expand SWAG membership beyond current levels	Institutional-ization will impact how effectively the plan can address all of the priority sources associated with each of the other goals / objectives.	Number of Representatives – increase the number of representatives that regularly attend SWAG meetings Cross-section of Representatives – increase the organizational types that are represented by the regularly attending SWAG members; at a minimum, the following organizations should be represented: • All municipalities • SEMCOG • Michigan Department of Natural Resources and Environment • Michigan Department of Agriculture • Business / industry • Agriculture • University faculty • Clinton River Watershed Council • Six Rivers Regional Land Conservancy Desirably, representatives from the following groups should also regularly attend meetings: • Environmental Protection Agency • Home builders associations • Recreation / tourism representative • Youth groups • Religious / civic organizations • Neighborhood associations • K-12 school districts
B. Adopt an institutional mechanism that clearly defines that structure and legal responsibilities of the SWAG	<same as above>	Institutional Mechanism – the SWAG should be institutionalized under a stronger legal structure unless it is determined that objectives C, D, E, and F, below, are being satisfactorily met under the current organizational structure
C. Define clear funding source(s) that allow the SWAG to operate as a distinct entity and have sufficient influence in the subwatershed	<same as above>	Funding Source – the SWAG should have clear, reliable funding source(s) that allow it to successfully implement the plan; this objective should not be considered met if objectives D and E are not first met
D. The implementation schedule defined in this plan should be followed	<same as above>	Implementation Schedule – the SWAG should have enough autonomy and authority to ensure that the implementation schedule defined in the plan is met 90% of the time; if this is not the case, then it should be considered that objectives B and C (above) are not achieved – although some leeway may be allowed in the case of unforeseen circumstances
E. The SWAG should implement the plan in the most efficient manner possible	<same as above>	Efficiency – the chair of the SWAG should, on an annual basis, conduct a survey of SWAG members to determine if they believe that the plan is being implemented in the most efficient manner possible; if not, then it should be considered that objectives B and C (above) are not achieved
F. The plan should be effective in achieving its goals and objectives	<same as above>	Effectiveness - the plan should be consistently achieving its goals and objectives according to the milestones defined in Chapter 9; if this is not the case, then the SWAG should undertake the task of refining the plan to be more effective and/or more realistic

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7. Priorities in Planning and Management

Prioritization of Goals and Objectives: Results

The results of the goal/objective prioritization process are listed below. The highest priority goals are listed at the top. Under each goal, the objectives (represented by a letter and its number underneath it) are listed such that those with the highest priority are on the left. The relative priority of the objectives across goals is given by the number 1 through 34, with relative spacing shown for effect.

GOAL IV: Natural Features

B D EC FA
2 4 9,10 24, 25

GOAL III: Habitat

B A C
3 5 22

GOAL VI: Rural Character

C B AD
18 26 30,31

GOAL VII: Recreation

G C D FBH AIE
8 15 23 27-29,32-34

GOAL II: Hydrology

BC E A D
6,7 14,16 21

GOAL I: Water Quality

DF AECB
11,12,17-20

GOAL V: Greenways

A B
1 13

1← Absolute Objective Ran k →34

Chapter Purpose

The purpose of this chapter is to: 1) prioritize the goals and objectives; 2) identify critical areas for the sources of stressors; 3) present the planning/management context of the plan as a common element that links the contents of the plan; 4) define pollutant load reduction targets; 5) identify the categories of actions and priority actions that will be employed to meet pollutant load reduction targets and otherwise achieve the goals and objectives of the plan.

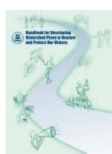
Introduction

This chapter because it links the current state of the subwatershed (Chapters 2, 3, and 5), the desired state of the subwatershed (Chapters 4 and 6), and the presents a significant amount of important information. Although the topics are diverse and the content is somewhat general in nature, the information is essential steps that will be taken to bring about the necessary changes (Chapters 8 and 9).

Prioritization of Goals and Objectives

Prioritization of the goals and objectives is done utilizing a fairly straightforward methodology. Specifically, the entire list of objectives was cross-referenced with all goals to determine which objectives have the greatest impact (since they often overlap). The prioritization / cross-referencing of the objectives can be seen in Appendix G.4. The ranking results are presented in the sidebar.

Identify and Prioritize Critical Areas



The subwatershed conditions discussed in the previous chapters of this plan are in large part a result of local/county/regional plans, programs, projects, and ordinances. As such, an analysis was performed to identify and critique the status of these various documents with regard to their effectiveness in managing water quality and quantity (excluding those documents that were not publicly available). Tetra Tech performed an analysis of master plans and ordinances of communities in the Clinton River Watershed for both the 2008 Remedial Action Plan and three 2007 subwatershed plans. The results from this inquiry in-part rely on the previous findings. The next three subsections document this effort. The final sub-section extends this information and utilizes source-related data from Chapter 5 to develop a list of critical areas.

Identification of Existing Management Efforts

A full audit of each community's land use planning documents was not conducted. Based on the 2007 and 2008 audits conducted by Tetra Tech (see above) together with the current economic climate it was felt that little would be gained. Both SEMCOG's *Opportunities for Water Resource Protection in Local Plans, Ordinances, and Programs* (2002) and CWP's Eight Tools of Watershed Protection (2002) were used to guide the inquiry.

There were several reasons leading to the decision not to conduct a full audit (see Appendix G.1). Still, many reasonable inferences could be made about the current state of affairs in the subwatershed based primarily on the two previous audits. The following characterizes the general state of the legal framework for protecting water resources in the watershed:

- Fewer than one in five communities have a Community Master Plan or have one that addresses the impacts of stormwater;
- Ordinances, including zoning ordinances are based on a template created in the 1970s and have been only updated on an as-needed-basis. Some deficiencies may include:
  1. No overlay zoning protection for riparian areas and greenways;
  2. Stormwater references deal simply with connections to the storm sewer system;
  3. Most communities do not have a tree ordinance;
  4. Lack of reference to cluster or open space development in master plans or ordinances;
  5. Lack of reference to floodplains, stream corridors, wetlands, or natural areas/greenways preservation;
- Most preservation and improvement efforts occur at the site plan review level and there is not strong support for them at the ordinance or master plan level;
- There is general lack of ability by communities to strictly and uniformly enforce standards due to not having formally adopted them. Current methods are not defensible in court and protection measures must be codified to provide true watershed protection.
- Communities in the watershed will likely defer regulating soil erosion and sediment control to the county-level agencies.
- If the 2008 NPDES Phase II permit is used as a standard, it is doubtful that many communities would meet its requirements for: water quality and quantity (rate and volume) for development and redevelopment; municipal maintenance, illicit discharge elimination (IDEP); public participation and education

There will be variation from the above characterization from community to community but in general this represents an accurate depiction of the state of watershed management measures at the local municipal level in the watershed.

There are two new planning mechanisms since the last two audits that have the potential to make a significat differnce in the protection of water resources. The first is a farm preservation agreement for parts of the upper reaches of the North Branch. Specifically, Armada, Richmond, Bruce and Ray townships in the watershed and Lennox outside the watershed passed an Intergovernmental Urban Cooperation agreement (Act of 8 of 1967) that enables them to enter into a contract with each other providing for the transfer of functions or responsibilities between themselves. In 2003, under this authority, the group known as the Macomb Agricultural PDR Committee (MAPDRC) concluded the first interlocal agreement associated with land use for the purpose of preserving farmland through purchase of development rights. In 2006 - 2007 the MAPDRC executed the first purchase of development rights on a local farm. The major obstacle to undertaking PDR is finding funds to purchase the properties.

The MAPDRC promotes four ownership options for conservation and restoration easements. They are:

1. Retention of private ownership through a conservation easement without public assess;
2. Retention of private ownership through a conservation

Audit Details

The following eight categories were considered when reviewing practices in the North Branch (CWP, 2002; SEMCOG, 2002):

- Watershed Planning - The application of regulatory measures and/or planning techniques that are designed to maintain or limit future impervious cover, redirect development, and protect sensitive areas;
- Land Conservation - Programs or efforts to conserve undeveloped, sensitive areas or areas of particular historical or cultural value;
- Aquatic Buffers - The protection, restoration, creation, or reforestation of stream, wetland, and urban lake buffers.
- Better Site Design - Local ordinances and codes to incorporate techniques to reduce impervious cover and/or redirect runoff onto pervious surfaces in the design of new development and redevelopment projects.
- Erosion and Sediment Control - The use of erosion control, sediment control, and dewatering practices at all new development and redevelopment sites;
- Stormwater Management - The incorporation of structural practices into new development, redevelopment, or the existing landscape to help mitigate the impacts of storm-water runoff on receiving waters;
- Non-Stormwater Discharges - Locating, quantifying, and controlling non-stormwater pollutant sources in the watershed. May also include operation and maintenance practices that prevent / reduce pollutants from entering the natural/ municipal drainage system; and
- Watershed Stewardship Programs - Stormwater and watershed education or outreach programs targeted towards fostering human behavior that prevents or

easement with public access;

3. Surrender of land to a public entity for conservation; and
4. Surrender of land to a private entity or foundation for conservation.

The second mechanism is the County's 2008 Stormwater Management Design Standards. The County has a watershed-based NPDES General Permit and is working with local communities, school districts and other stakeholders to implement several watershed management plans. As a result, the new requirements were developed to meet many sets of goals and objectives. This integrated stormwater management approach includes design criteria for water quality, channel protection (from erosion due to increased runoff), flood protection, and long-term maintenance to ensure the long-term effectiveness of stormwater management facilities. As these standards are applied across the county, over time it they have the potential to both preserve and mitigate development impacts.

Identification of New Management Opportunities

The identification of new management opportunities is derived from the previous discussion on planning documents as well as additional actions thought essential to protect and restore the water resources in the North Branch. It is recommended to:

1. Update or create master plans that specifically refer to the need to preserve open space, sensitive natural areas (e.g. riparian zones and wetlands), and water resources..
2. Update or create master plans that recognize stormwater, the pollutants it contains and the need to manage it.
3. Update and/or expand ordinances to include water quality and quantity requirements consistent with the Phase II permit.
4. Generally, communities need to adopt ordinances that are coordinated with other municipalities in the county and are applicable throughout their jurisdictions.
5. Update and/or expand ordinances to require that riparian zones, wetlands and sensitive natural areas not be developed.
6. Undertake an IDEP program within the areas of your community not covered by the Drain Commissioner.
7. Prohibit (through ordinances) the introduction of pollutants to storm drains and local waterways. Enable local capability to monitor, investigate, remedy and levy fines for illicit discharges.
8. Adopt a procedure for the receipt and consideration of complaints or other information submitted by the public regarding illicit discharges and construction activities discharging wastes to municipal systems and waterways.
9. Adopt standard operation procedures for municipal operations that protect waterways. Key areas of concern are landscape maintenance, street and parking lot sweeping, catch basin cleaning, bridge maintenance, fleet and storage yard maintenance, and hazardous materials handling.
10. Institute a septic system maintenance ordinance requiring property owners to demonstrate systems are performing optimally.

11. Formally recognize that *E.coli.* Total Maximum Daily Loads (TMDL) exist in the watershed and assist with monitoring of pollutant levels and activities designed to mitigate them.
12. Adopt a procedure for the receipt and consideration of complaints or other information submitted by the public regarding illicit discharges and construction activities discharging wastes to the MS4.

Identify Critical Areas Where New Management Efforts Are Needed

The identification of critical areas involved refining the source-related data presented in Chapter 5.

Critical areas are defined by the relationship between sources and stressors. These areas are subsequently linked (in Chapter 8) to actions designed to address particular sources and their associated critical areas. Low priority source areas are not shown on the maps for clarity. Figures 7-1 and 7-2 present the source-based critical areas.

Urban and residential land uses individually are somewhat sparse throughout the subwatershed and have therefore grouped into one category. The clusters of these areas are of higher priority than the isolated areas. The areas defined as 'urban areas' by the census are shown to help define where the most intense urban development is. The Village of Armada is also an area of interest. Note that the area in western-central Bruce Township is a large automotive proving grounds facility that actually has quite a bit of green space and should not be considered a priority urban area. Developed areas that are older should be given higher priority as they are more likely to have developed infrastructure problems over time and are likely to have implemented fewer stormwater pollutant control practices than more recent developments. Consideration should also be given to land that will be developed on by 2030 as determined by SEMCOG's review of planning documents from the local municipalities.

Land classified as used for transportation and utilities is actually quite small, but can have a significant impact due to the miles of roads. In addition to direct impacts of roads, they also act as the focal point for the expansion of development into undeveloped areas. Of particular concern are where roads cross open waterbodies. In the North Branch, this is a large number. Not only do these locations serve to introduce road-related pollutants into waterbodies, but the structures required to allow the water to flow often cause in-stream hydraulic, sedimentation, and debris accumulation problems. Problems directly associated with roads themselves can be defined based on whether the road has curb and gutter with storm sewers or uses roadside ditches to route stormwater flow. An attempt has been made to distinguish these by assuming rural and collector roads that are likely using ditches while larger roads use curb and gutter. This information needs to be verified before any actions are taken or planned. Additional characteristics used to determine the critical nature of a road as a stressor source are the 'time since its last resurfacing'and 'frequency of maintenance' such as street sweeping. This information is not readily available, but should be obtained prior to implementing actions that deal with addressing road-based pollutants. Other transportation facilities such as railroads and airfields are too sparse in the subwatershed to be considered critical areas.

Prioritization of Sources

Since the critical areas are directly related to the sources of stressors, the prioritization of the sources of stressors is effectively also a prioritization of the critical areas associated with them. The prioritization of sources presented below is based on the prioritization of the goals/objectives (and considering the priority sources identified for each) in addition to the assessments presented in Chapter 5:

HIGH PRIORITY

- Urban and Residential Land
- Transportation Infrastructure
- Agricultural/Cultivated Land
- Soil Erosion
- On-site Disposal Systems
- *Sewage Discharges*
- Illicit Discharges/Spills
- Other Human Activities

LOW PRIORITY

- *Waste Management Sites*
- *Industrial Sites*
- *Contaminated Sites*
- Contaminated Sediments
- *Other Businesses*
- Animal Sources (non-agricultural)
- Atmospheric Deposition
- Natural Occurrences and Disturbances

Italicized sources are point sources; others are non-point sources.

Acronyms and Terms

A complete list of acronyms and terms and their respective definitions can be found in Appendix A.1.

Existing and future sanitary sewer service does not extend far into the subwatershed, encompassing only the areas in south Ray Township / Lenox Township, around the Village of Romeo, around the Village of Armada, and around the Village of Almont (not shown due to a lack of spatial data). All sanitary sewer areas have the potential for overflows under the extreme conditions, but there are very few documented in the subwatershed. These areas should still be studied to determine if there are any unknown overflows. Although data is not available, it is likely there are illicit connections and discharges in these areas. Detection and elimination of connections and discharges are logical management actions. The extent of storm sewers in the subwatershed should be documented prior to implementing such actions.

Discharges from the three WWTPS (Almont, Armada, and Romeo) will likely remain constant in terms of flow as there is little expansion of their service areas proposed. Additional technologies and stricter standards are capable of reducing the residual amounts of stressors that are discharged from these facilities.

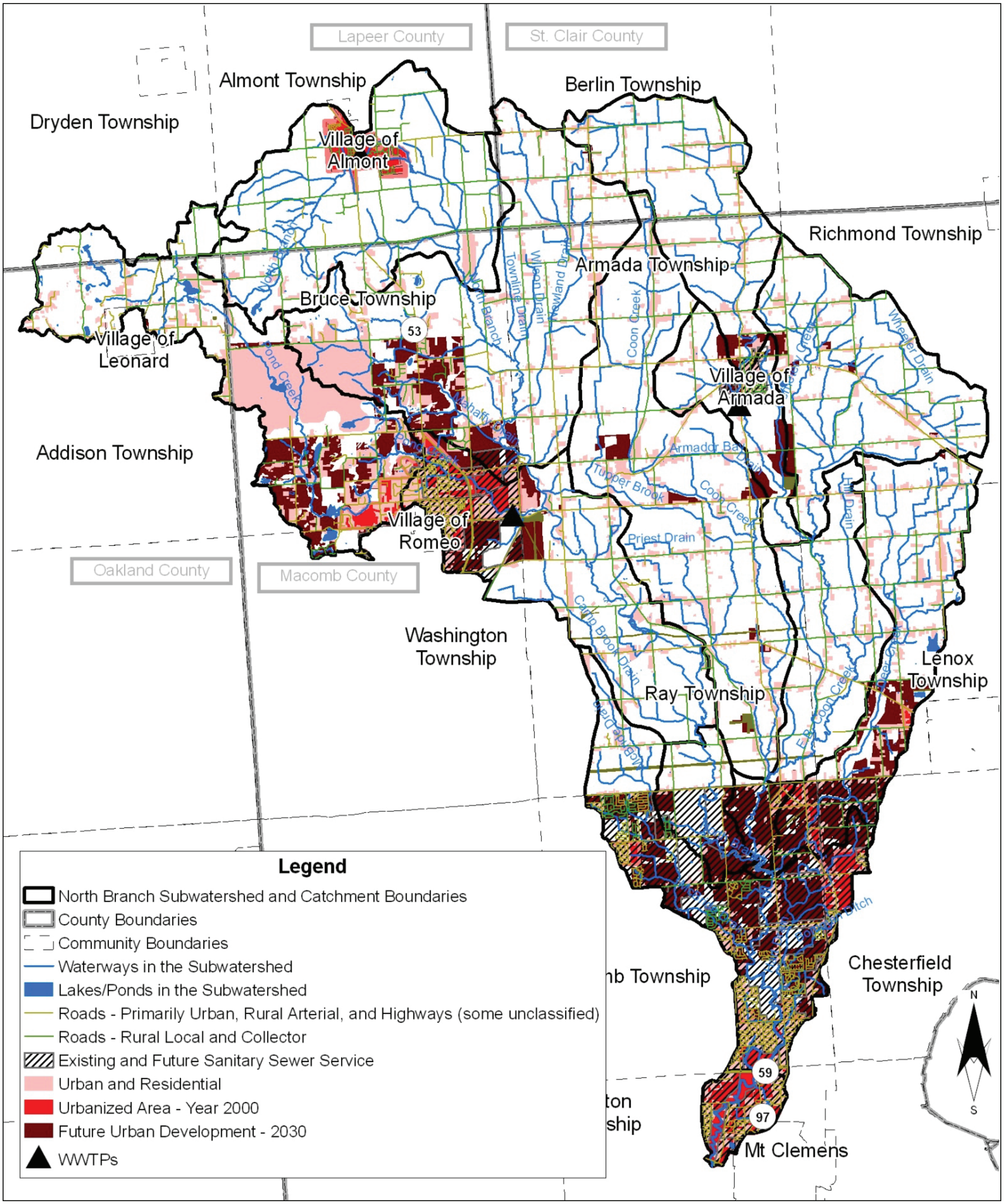
The urban and residential areas outside of the sanitary sewer areas are critical areas due to the presence of on-site disposal systems (OSDS). Some small communal treatment facilities may exist, but the majority of these houses, farms and businesses are served by individual septic systems. Refer to Figure 7-2 for the remaining critical areas.

Agricultural land can be seen as both a source of stressors and a commodity to be preserved. This dichotomy requires that agricultural land be broken into categories for prioritization. For addressing stressors from agricultural land, land within the 100-ft riparian buffer on either side of a waterbody are given top priority. For preserving farmland, land within the future urban development area should be prioritized for future developed. The farmlands that are on the interface of this area will be the most crucial to protect as it will be under the greatest pressure to be developed in the future. As such, these are the farmlands that should be targeted for priority preservation.

There are a significant number of non-natural open spaces; primarily athletic fields, cemeteries, and other outdoor turf grass type fields that may serve as habitat for species such as geese that are problematic in terms of pathogen discharges to waterbodies. Open space adjacent to waterbodies should be inventoried to determine which ones need additional management measures to mitigate impacts.

Waterbody obstructions can be problematic for a number of reasons. There are four dams in the East Pond Creek catchment that should be evaluated to determine weather they are good candidates for removal. In addition, other natural and unnatural obstructions should be documented throughout the subwatershed in order to determine the extent of the problem and which ones need to be dealt with (begin with the information presented in the USA survey conducted in support of this plan).

Figure 7-1. Some 'source' critical areas in the subwatershed.



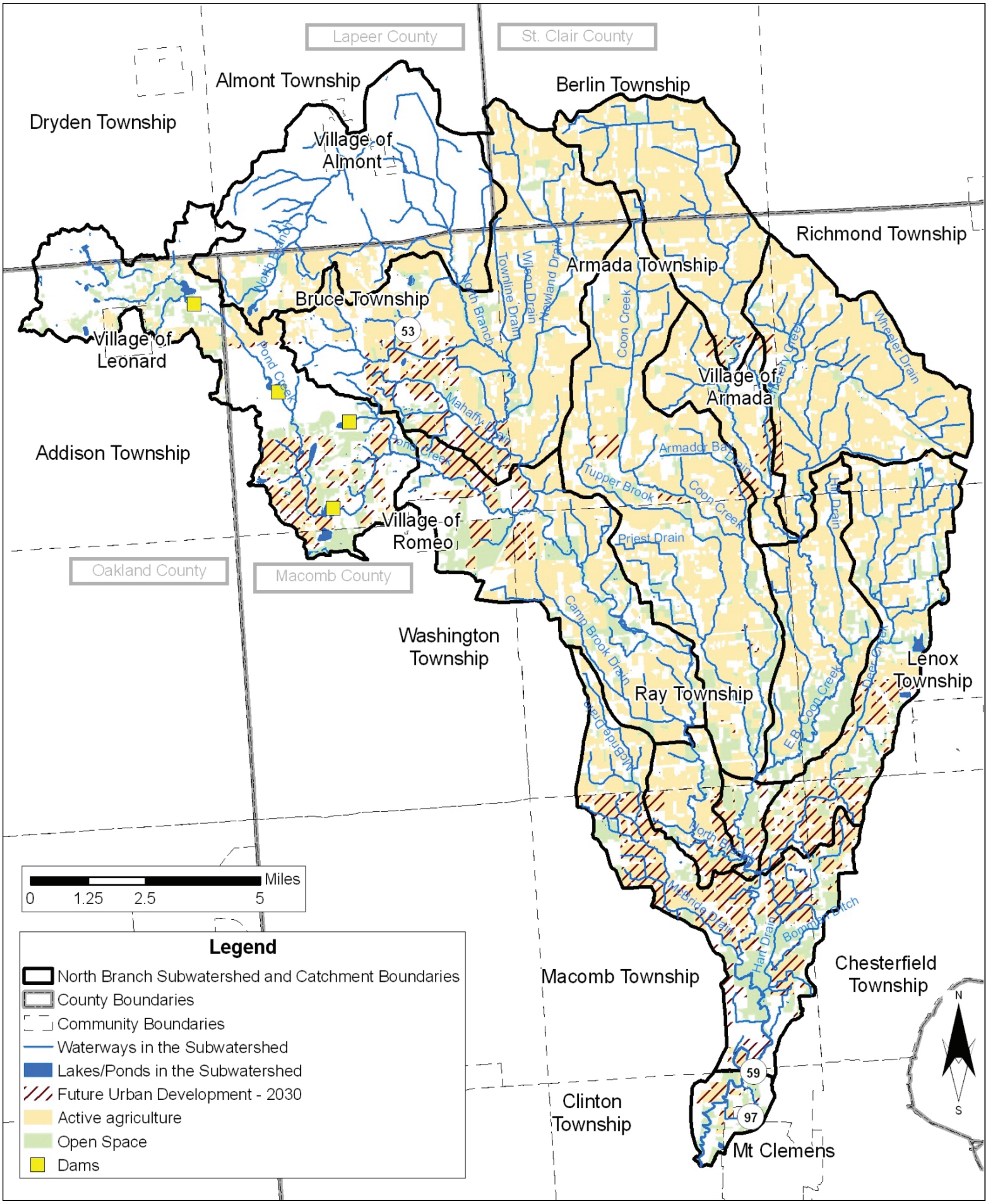


Figure 7-2. Some 'source' and 'protection' critical areas in the subwatershed.

Reducing soil erosion is critical to reducing the levels of sediment being discharged to waterbodies. Soil erosion sites fall into three major categories; 1) construction sites, 2) streambanks and 3) upland. Construction sites are transient in nature. As a critical area, they need to be addressed on a case-by-case basis as permits are obtained to engage in construction. Effort to prevent construction without the proper permits and to encourage best management practices are installed needs to be ongoing. It is estimated from the USA that about forty percent (40%) of the North Branch would benefit from streambank stabilization in order to reduce soil erosion. An aerial photo survey was conducted over the entire watershed and an initial attempt to identify streambank stabilization sites was made (see Appendix H). On a similar note, the USSR estimated that less than ten percent (10%) of the urban areas in the watershed are bare soil. An initial list of these sites is also included in Appendix H. One limitation to the USSR is that it does not consider agricultural land and much of the North Branch is in tiled fields. Tiled fields are thought to be a major contributor of sediment.

Other stressor sources that can be located throughout the watershed include, landfills, other waste management facilities and industrial stormwater permit holders (presented in Chapter 5). There also exists a number of other stressors sources that cannot be easily spatially pinpointed. Areas of contaminated sediments exist at a few spots in the subwatershed, but the specific areas have only been documented in a few specialized studies. These studies need to be referenced to pinpoint the documented sites of sediment contamination. There are also numerous other businesses that can be considered sources of stressors and they are usually done so on a case-by-case basis. In general, landscaping businesses, especially those in riparian areas, have a high potential to contribute some stressors to the storm sewer system or directly to waterbodies. Other types of pollution may come from businesses that routinely handle chemicals, such as dry cleaners. The locations of such businesses would have to be found using the public telephone directory and/or internet and then their locations mapped.

Because the plan has diverse goals and objectives, it deals with a number of stressors and strives to support numerous desired uses. As such there is a second group of critical areas that are of the 'protection' variety. These critical areas are based on factors such as land use, soil type and other geologic conditions and require preservation and and/or actions to enhance them.

The most obvious critical area are the waterbodies that the plan is protecting from pollutants and other stressors. Of particular concern are those with special function or susceptibility, such as smaller headwater streams that are more affected by pollution and provide buffering capacity against changes in flow regimes. Coldwater streams are unique in that they support highly desirable species that are desired by anglers and are a important to the recreational tourist economy.

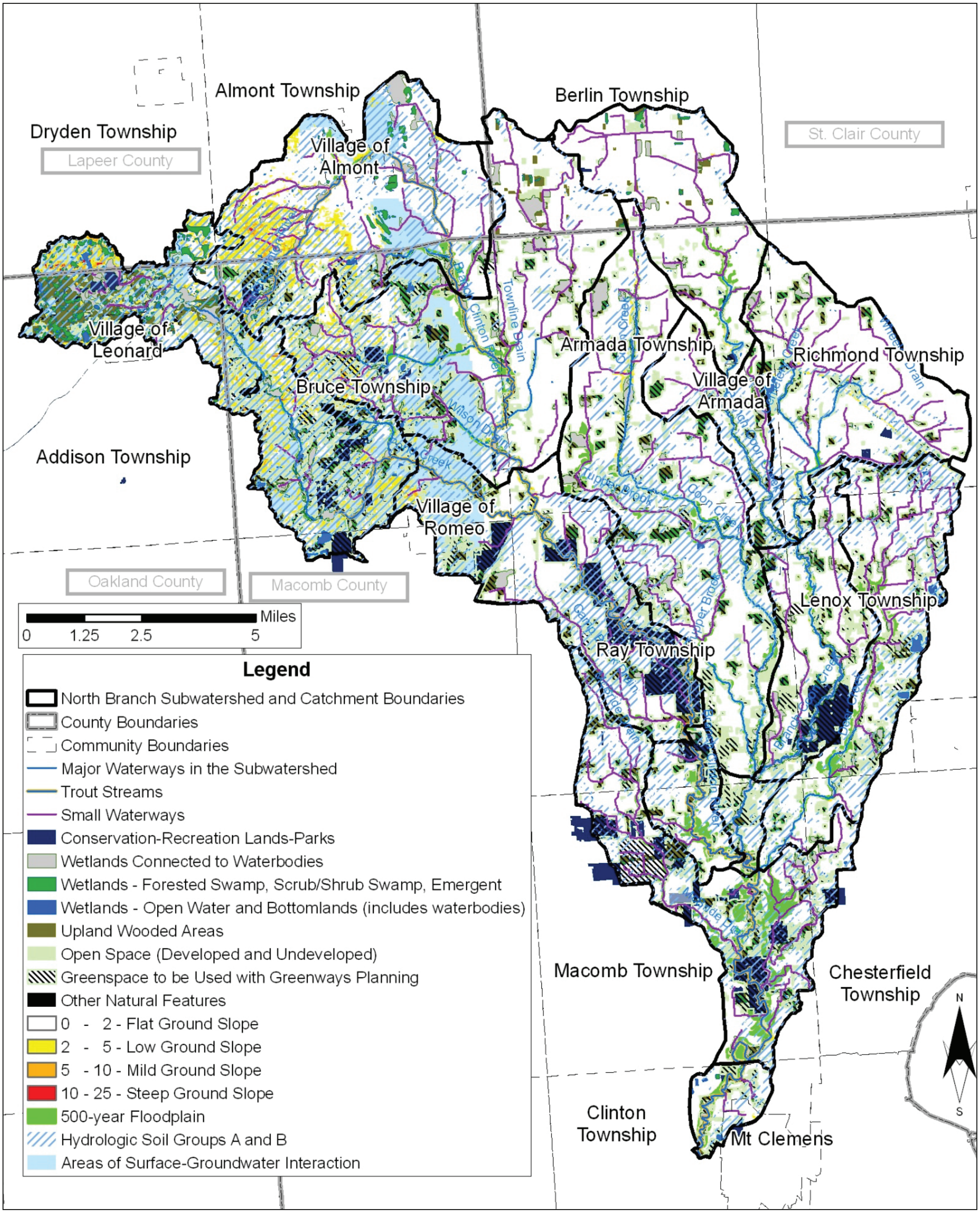
One type of transition zone between waterbodies and land are known as wetlands and these unique features provide similar hydrologic/hydraulic services as headwater streams (such as flood mitigation) and act as habitat for vulnerable species such as amphibians which are indicators of overall environmental health.

CMI Requirements in this Chapter

The following CMI requirements are addressed, at least partially, by the information that is presented throughout this chapter, including:.

- Identification of critical areas;
- A list of all sources and causes for each pollutant in the critical area, which should be mostly verified;
- A prioritized list of designated uses, pollutants, sources, and causes and a description of the methods used to prioritize them

Figure 7-3. Some 'protection' critical areas in the subwatershed.



Some wetlands are directly connected to waterbodies and the ecological services that these features perform separately are enhanced when they are connected. Isolated wetlands are still extremely important as they provide needed sources of water, especially in a modern landscape that is divided by developed and agricultural lands, to migrating organisms from the smallest newt to the seasonally sojourning waterfowl.

Aquatic and riparian habitats are not the only valuable types. Terrestrial habitat such as wooded areas and prairies are important to many species and are generally quite sparse and fragmented. In fact no viable prairie land remains because of the interruption of natural burn cycles, but some natural open space areas do remain as the last vestiges of what was once prairie land. On the other hand, scattered wooded areas do still exist in a somewhat natural state and although fragmentation of habitat is high, there are some contiguous green corridors comprised of riparian buffers, wooded areas, wetlands, and grasslands such as parks. It is one of the goals of the plan to improve existing green corridors and the preservation and restoration of such features is essential.

The floodplain associated with a waterbody is another expression of the transition between aquatic and terrestrial habitats. Although there are wetlands that exist in the floodplain, the regularly dry floodplain often has specialized organisms that can withstand elongated periods of inundation a couple of times per year. Floodplains are often important from a purely societal perspective as provide area for flood waters to disperse laterally and reduce flow rates and velocities that can be damaging to urban infrastructure.

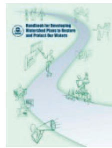
Many engineered solutions to deceasing flows involve infiltration of rainfall into the ground – the so called conductivity of the soil. Given that the subwatershed is comprised of soils with relatively low conductivity, those areas with higher conductivity soils should be protected for the implementation of best management practices and development in these areas should take care to avoid compacting such soils which results in so reducing their infiltration rates. Although these types of soils are scattered throughout the subwatershed, they are concentrated in the East Pond Creek and North Branch Headwaters catchments. It is not surprising that in these areas we also find the more coarse soils that actually allow for interactions between groundwater and surface water and provide for the cool source water of the North Branch and lower East Pond Creek – which are designated as cold water fishing streams. These headwater areas are also the highest areas and have some steep slopes associated with them. Protection should be sought for these critical headwaters in order maintain the natural drainage characteristics and to prevent erosion of the less cohesive gravelly soils that provide for the relatively high

Although it is not shown on the figure, the SWAG desires to preserve certain agricultural and residential rural areas to maintain the existing character of the subwatershed. **(EPA 10.3.1-10.3.4)**

Priority Actions Related to Watershed Planning, Institutionalization, and Implementation

- Continue to convene and expand participation in the SWAG. Implement the public participation and education actions set forth in this plan.
- Formally recognize that *E.coli.* Total Maximum Daily Loads (TMDL) exist in the watershed and implement appropriate actions into the plan.
- Adopt a procedure to provide notice when pollutants are discharged from construction activity in violation of Section 9116 of Part 91 of the Michigan Act, Michigan's Permit by Rule at R 323.2190(2)(a).
- The two most supported policy directions were partnering with adjacent communities to undertake action and increasing parks and open space. Therefore, the existing subwatershed council should self promote more of the work it has been doing. Also the, subwatershed group should consider working closer with the Six Rivers Regional Land Conservancy in an effort to demonstrate to the public that open space is being increased.
- HCMA owns the majority of land adjacent to the North Branch. They should be brought into the watershed planning process.
- Continue to enforce the SESC requirements for new construction.

Management Context, Action Categories, and Priority Actions



Given the known current environmental conditions (as presented in Chapter 5) and the wide range issues addressed by the goals and objectives (Chapter 6), it is apparent that implementation of this plan will require the actions of many different entities and their various programs. This section briefly introduces the various management entities, programs, and potential actions as they relate to nine primary action categories (based in part on the Center for Watershed Protection's *Tools of Watershed Protection*, 2002), including:

1. Watershed Planning, Institutionalization, and Implementation;
2. Public Education and Participation;
3. Ordinances, Zoning, and Development Standards;
4. Good Housekeeping and Pollution Prevention;
5. Stormwater Best Management Practices: Soil Erosion and Sediment Control;
6. Stormwater Best Management Practices: Other Practices;
7. Natural Features and Resources Management;
8. Recreation Promotion and Enhancement; and
9. Environmental Monitoring and Other Data Collection.

Although the discussion of most of the categories is rather brief, a detailed discussion of all of the action categories is provided as Appendix G.2.

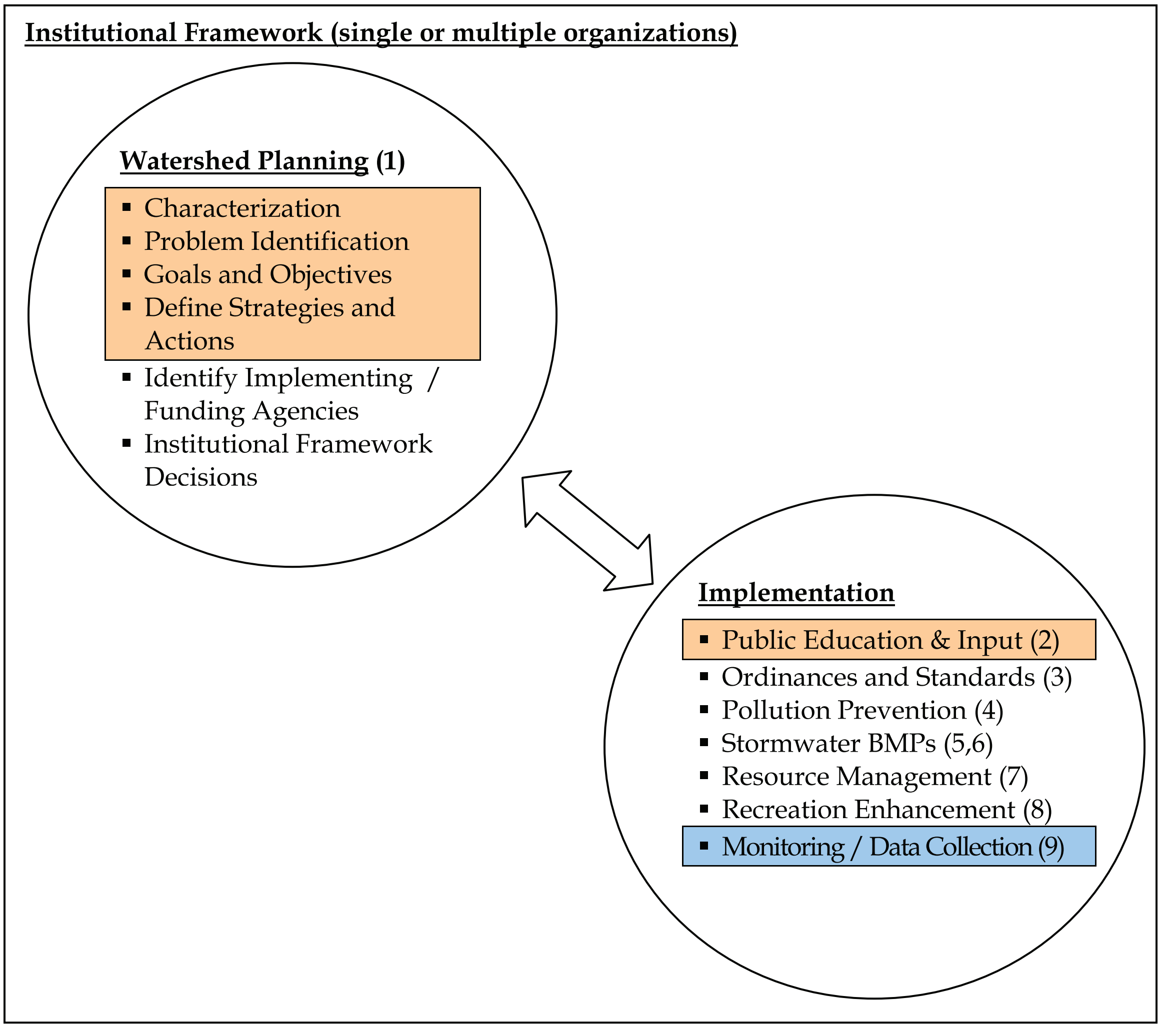
The following subsections provide a brief discussion for each of the action categories listed above.

Action Category 1: Watershed Planning, Institutionalization, and Implementation

This category of actions is a comprehensive embodiment of a watershed approach to water quality management – addressing problems in a holistic manner and considering the input of local stakeholders. The actions in this category are meant to foster a long-term, cooperative watershed planning, decision-making, and implementation approach that involves all levels of government and local stakeholders through a series of clearly defined, iterative steps (as discussed in Chapter 1). A graphical representation of this approach is presented as Figure 7-4. The numbers in parentheses in the figure denote the action category. Additional discussion of the figure can be found in the following text.

The institutional framework, whether it be a single organization or a collection of them, and whether it operates under strictly defined relationships or a loose confederation, is the backbone for the planning and implementation activities that are related to the plan.

Figure 7-4. The elements of watershed planning and their relationship.



The planning phase and implementation phases are generally sequential with the planning activities setting the framework for implementation and the final implemented actions feeding results back into the planning process (monitoring and data collection – indicated by - inform the effectiveness assessment). However, the relationship is more complex than that. Many of the planning activities such as characterization, problem identification, goals and objectives development, and defining the actions require a significant amount of public input (also indicated in the figure by).

Details concerning the three elements are discussed in the following text.

Watershed Planning

Watershed planning can be broken down into three distinct phases:

- Initial Phase – consists of characterizing the watershed, identifying problems, developing goals and objectives, and defining strategies and actions from implementation and the details thereof;
- Concurrent Phase – consists of planning decisions that need to be refined during implementation of the plan, including: identification of responsible and funding agencies and making decisions concerning the institutional framework; and,

- Assessment Phase – consists of actions taken to evaluate the effectiveness of the plan, typically after a significant amount of implementation has occurred.

Institutionalization

Institutionalization involves defining a mechanism to implement the plan once it is complete (if done earlier, it then involves defining a group to develop the plan, such as the SWAG in this case). Making this decision involves researching the alternatives and then clearly defining the inner workings of such a group and its procedures. The remaining text under this heading is devoted to briefly discussing structural considerations, legal relationship options, and available funding mechanisms.

<u>Structure</u>

This plan has been developed under the direction of a voluntary group structure known as the Subwatershed Advisory Group(SWAG). The SWAG is chaired by the Macomb County Public Works Office (MCPWO) and deals with matters directly or assigns specific tasks to ad-hoc committees that are developed on an as-needed basis. Regardless of the structure of such a group, it has to be flexible and be able to implement actions of its own accord, ensure that members are implementing the actions that fall within their realm of responsibility, and coordinate the involvement of many stakeholders when an action requires a subwatershed-wide approach. Ultimately, whatever institutional mechanism is employed will have to be structured such that it can meet its responsibilities under the plan.

<u>Legal Relationship Options for Institutionalization</u>

Considering various legal relationships is a critical component of institutionalization. At least seven approaches, that can be used independently or in combination, are available to groups in Michigan to lead and assign funding responsibilities for plan implementation. These options include the following:

1) Drain Code – Public Act 40 (1956);
2) County Department and Board of Public Works – Public Act 185 (1957);
3) Inter-Municipal Committee Act – Public Act 200 (1957);
4) Municipal Sewerage and Water Systems - Public Act 233 (1955);
5) County Public Improvement Act – Public Act 342 (1939);
6) Watershed Alliance Act – Public Act 517 (2004); and
7) Voluntary Cooperation.

<u>Funding</u>

When looking to cooperatively implement the plan, it is important to consider how costs will be divided and paid. There are numerous formulas that can be used to divide costs amongst the members and different allocations can be used for different tasks and initiatives. Variables to consider in these formulas include: land area, population, parcels, impervious area, land use, diversity of development, opportunity for new development, and community resources.

Independent of fund allocation is the issue of raising the funds to pay for the activity. There are four general methods for raising funds: special assessments, taxes, fees and federal and state loads and grants.

Implementation

Stakeholders are faced with implementing a wide range of actions associated with this plan. The actions that can be taken by stakeholders are grouped into two different categories:

- planning / program implementation activities – on-going and not requiring a large outlay of financial resources but needing a stable source of funding; and,
- capital projects – short-term construction projects that often require borrowing and a long-term commitment of funding to service the debt.

There are a variety of alternatives for funding these activities that need to be evaluated in choosing a course of action for any particular activity. Table 7-1 lists a number of actions communities may implement and the institutional mechanisms available for funding them. This table was prepared to use as a tool to compare and contrast the desirability of the different mechanisms with respect to any particular activity.

Table 7-1. Examples of Action Types and Potential Funding Mechanisms.

Action	Drain Code[3]	County Department and Board of Public Works Act	Inter-Municipal Committee Act	Municipal Sewer and Water Authorities	County Public Improvement Act	Watershed Alliance	Stormwater Utilities	Sewer Rates	Special Assessment Districts	Natural Resources and Environmental Protection Act	Revised Municipal Finance Act	State Revolving Fund	Other Grant Programs
Planning and Implementation Activities[4]	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**					**X**
Planning, Institutionalization, and Implementation	X	X	X	X	X	X	X	X					X
Ordinances, Zoning, and Development Standards	X	X		X	X	X	X	X					X
Public Education and Participation	X	X	X	X	X	X	X	X					X
Good Housekeeping and Pollution Prevention[1]	X	X	X	X	X	X	X	X					X
Stormwater Best Management Practices: SESC	X	X		X	X	X	X	X					X
Stormwater Best Management Practices: Other	X	X		X	X	X	X	X				X	X
Natural Features and Resource Management	X	X		X	X	X	X		X	X			X
Recreational Promotion and Enhancement		X			X	X	X			X			X
Environmental Monitoring and Data Collection	X	X		X	X	X	X	X					X
Capital Improvement Projects[2]	**X**	**X**		**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**

Notes

1 - Includes Illicit Discharge Elimination Plans and Catch Basin Cleaning/Street Sweeping (although the latter is not fundable through the Inter-Municipal Committee Act).

2 - Includes Stormwater Control Facilities, Sanitary Sewer Overflow Control, Combined Sewer Overflow Control, Sewer Rehabilitation, and Sewer Extension.

3 - While the Drain Code is primarily used for generating funding for capital projects, other activities can be funded if included in a petition and inter-municipal agreements.

4 - Most of these activities will include both a planning and an implementation component, e.g.: an illicit discharge elimination program will require developing a plan, which may include new ordinances, periodic assessment of program effectiveness, etc, as well as implementation activities, such as surveying commercial/industrial facilities to identify cross-connections or inspecting residential septic systems on a periodic basis.

More on Guiding Principles

Globally, organizations such as the World Wildlife Fund, Sierra Club, or the United Nations have guidelines with respect to environmental protection and restoration. Nationally, the various federal government departments and agencies with an environmental interest (e.g. Environmental Protection Agency (EPA), Fish and Wildlife Service, United States Geological Survey (USGS) have similar guidelines.

For example, the National Oceanic and Atmospheric Administration's (NOAA) vision is: "An informed society that uses a comprehensive understanding of the role of the oceans, coasts and atmosphere in the global ecosystem to make the best social and economic decisions" Thus, even at a national level, similar principles are applicable.

A regional entity of interest is the Water Resources Management Decision Support System for the Great Lakes (WRMDSS). This large scale binational collaborative effort will yield, in unprecedented detail, a status assessment of Great Lakes water resources, an inventory of the sources and use of Great Lakes water, and enhanced understanding of the ecological consequences of such use.

Both Macomb and St. Clair counties have established citizen-led water quality boards. These boards provide input for local stakeholders to have their issues and principles heard and considered with respect to planning and implementation.

<u>Guiding Principles</u>

Regardless of the mechanisms used to implement the actions of this plan, the actions need to be guided by rational scientific principles. There are many programs and entities that can guide the implementation ranging from those with broad, global principles to those with a narrow, local focus. With respect to the plan, the implementation principles at the regional, state-wide, or local levels are much more appropriate for achieving success.

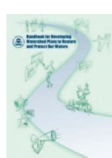
The various state agencies in Michigan with an environmental interest will be essential to the successful implementation of this plan. More localized cooperation and guidance will be provided through the common forum and planning entity of SEMCOG. Cooperation across county borders occurs through inter-county watershed advisory groups and inter-county drainage boards.

Most of these organizations will be important for 'soft' (e.g. principled) implementation guidance. 'Hard' guidance, which includes specific action guidance and site-specific calculations, may be provided through some regulatory agencies (as appropriate) and the numerous plans and studies completed throughout the Clinton River Watershed.

Clinton River Basin Watershed Initiative

The goal of the CRBWI was to support coordinated decision-making and action that will improve, restore, and protect the Clinton River Watershed by giving watershed stakeholders access to the information they need to identify and implement solutions. There were three main products developed as a part of the project, including:

- Watershed Information Management System (WIMS) - an on-line database that centralizes and integrates all watershed data and information for easy access;
- Clinton River Watershed Model (CRWM) – a model that allows planners to evaluate the potential water quality benefits of a range of implementation measures, including facility improvements and urban, suburban, and rural stormwater best management practices; and
- Site Evaluation Tool (SET) – a spreadsheet based tool that is available to assist stakeholders in selecting best management practices for pollution reduction and to assist in achieving the pollutant load reductions.



The WIMS was utilized to define the data available for analyses of current conditions in the subwatershed. The SET will be utilized during the implementation phase as specific sites are studied to determine the specifics of BMPs to be employed. For the development of the plan, the CRWM (or 'model') was the most useful element of the CRBWI. The results of the modeling project are defined in a final report and presented in the *Clinton River Restoration Plan* (the Remedial Action Plan for the Clinton River Area of Concern) but the major results with respect to the North Branch Subwatershed are reported in a sidebar on the following page. Pollutant load calculations and required reductions for the entire subwatershed were also defined. However, in support of this plan, the inputs to the model have been updated and the analyses refined such that updated pollutant load calculations and reduction targets are now defined for all of the catchments in the subwatershed. The inclusion of this data in the plan is essential for it to meet the EPA Section 319 grant funding element 'b': a determination of the load reductions needed.

The loading and reduction calculations are provided for five stressors: suspended solids (as total suspended solids), nutrients (phosphorus as total phosphorus and nitrogen as nitrate), pathogens (as *E. coli*), and hydraulic / hydrologic characteristics (as flashiness). For each specific stressor, allowable loads were based on standards, current loads were estimated using the model, and target load reductions were calculated as the difference between the allowable and current loads.

Table 7-2 presents a summary of this information (for the full analysis by flow levels refer to Appendix E.2; the modeling Scenarios can also be found in Appendix G.3).

Immediately after the pollutant load reduction tables there are two tables that present the percentage distribution of the stressors broken down by contributing source. In other word, the tables attempt to allocate the percent of total loads based on origin. The numbers in the tables are estimates based on careful consideration of all of the data analyzed for the plan, including: natural environment characteristics (Chapter 2), stressor and source characteristics (Chapter 3), details of environmental quality conditions (Chapter 5) and information generated by the model on load rates, target loads, and required reductions.

(EPA 8.1, 8.2, 8.5, 9.4, 9.5, 9.6 – includes tables on the following pages)

Priority Actions Related to Watershed Planning, Institutionalization, and Implementation

- Continue to convene and expand participation in the SWAG.
- Implement the public participation and education actions set forth in this plan.
- Implement appropriate actions to address TMDLs into the plan.
- Adopt a procedure to provide notice when pollutants are discharged from construction activity in violation of Section 9116 of Part 91 of the Michigan Act, Michigan's Permit by Rule at R 323.2190(2)(a).
- The two most supported policy directions in the Social Survey were partnering with adjacent communities to undertake actions and increasing parks and open space. Based on these findings, the SWAG should self promote more of the work it has been doing. Also the, subwatershed group should consider working closer with the Six Rivers Regional Land Conservancy in an effort to demonstrate to the public that open space is being increased.
- Invite HCMA, owner of significant land adjacent to the North Branch Clinton River, to join the watershed planning process.
- Continue to enforce the SESC requirements for new construction.

Notes for the following tables:

- Only catchment numbers are presented in
- Table 7-2.
- To correlate catchment numbers with names see Table 7-4.
- Sediment can be broken down into total suspended solids (TSS), total dissolved solids (TDS) and bed load (BL). The modeled parameter was TSS. Therefore, targets for total sediment will be easier to attain than simply if they were TSS.

319 b

Clinton River Basin Watershed Initiative Modeling Results for the North Branch

The following statements are the major findings of the CRBWI model as applies to the North Branch Subwatershed:

- Flashiness is correlated with urban areas due to the high percentage of impervious surfaces and in agricultural areas because of the underlying clay/silt soils and agricultural tiles;
- Sediment loading rates are high most likely due to the agricultural activity, re-suspension due to high flows and, in small pockets of the subwatershed, the high percentage of impervious surface;
- Most waterbodies exhibit a seasonal pattern for E.coli levels, with the summer months producing higher levels;
- E. coli levels had long-term geometric means that exceed full-body contact standards but meet the lower partial body contact standards;
- Elevated total phosphorus loading rates are present throughout the subwatershed most likely due to the liberal application of fertilizers, the presence of waste water treatment facilities, and isolated urbanized areas.

Table 7-2. Allowable loads, current loads, and target load reductions for hydraulic/hydrologic characteristics.

Load Catchment→	601	602	603	604	607	608	609	610	611	612	613	614	615	616
Sediment Total Allowable Load (tons/year)	288	451	399	1,446	806	2,453	1,516	2,418	1,367	4,952	5,019	365	8,532	9,954
Sediment Total Modeled Current Load (tons/year)	559	871	615	2,656	1,608	4,755	2,628	3,424	1,767	6,779	3,892	398	14,063	15,821
Sediment Total Modeled Current Load (tons/acre/year)	0.07	0.21	0.06	0.40	0.09	4.09	0.63	0.19	0.15	0.59	2.51	0.07	1.34	0.72
Sediment Net Targeted Load Reduction (tons/year)	271	411	216	1,210	802	2,302	1,113	1,005	400	1,827	1,874	333	5,532	5,867
Sediment Total Targeted Load Reduction (tons/year)	**271**	**411**	**267**	**1,210**	**802**	**2,302**	**1,113**	**1,192**	**537**	**2,246**	**2,308**	**333**	**6,053**	**6,500**
TP Total Allowable Load (tons/year)	0.43	0.71	0.52	1.58	0.88	2.56	2.15	3.26	1.99	6.50	6.55	0.52	10.79	11.15
TP Total Modeled Current Load (tons/year)	0.48	0.69	0.40	1.46	0.78	2.14	3.33	1.43	0.53	2.53	2.48	0.55	4.99	4.51
TP Total Modeled Current Load (tons/acre/year)	0.0001	0.0002	0.0000	0.0002	0.0000	0.0018	0.0008	0.0001	0.0000	0.0002	0.0009	0.0001	0.0005	0.0028
TP Net Targeted Load Reduction (tons/year)	0.06	0.00	0.00	0.00	0.00	0.00	1.18	0.00	0.00	0.00	0.00	0.09	0.00	0.00
TP Total Targeted Load Reduction (tons/year)	**0.19**	**0.23**	**0.15**	**0.49**	**0.28**	**0.74**	**1.94**	**0.01**	**0.00**	**0.00**	**0.00**	**0.23**	**0.14**	**0.00**
NO3 Total Allowable Load (tons/year)	1.28	2.12	1.56	4.75	2.65	7.69	6.45	9.77	5.98	19.49	19.98	1.55	32.38	33.49
NO3 Total Modeled Current Load (tons/year)	3.36	4.87	2.79	11.14	5.96	18.86	8.26	3.32	1.42	9.39	10.85	3.48	33.95	38.79
NO3 Total Modeled Current Load (tons/acre/year)	0.0004	0.0012	0.0003	0.0017	0.0004	0.0145	0.0020	0.0002	0.0001	0.0008	0.0041	0.0004	0.0035	0.0238
NO3 Net Targeted Load Reduction (tons/year)	2.08	2.74	1.23	6.39	3.32	9.17	1.81	0.00	0.00	0.00	0.00	1.92	4.53	5.30
NO3 Total Targeted Load Reduction (tons/year)	**2.39**	**3.29**	**1.70**	**7.84**	**4.11**	**11.71**	**3.04**	**0.00**	**0.00**	**2.53**	**3.73**	**2.37**	**21.73**	**23.46**
E.coli. Allowable Exceedances (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
E.coli Modeled Current Exceedances (% of time) -30 day geometric mean	99%	99%	76%	92%	74%	84%	100%	99%	98%	96%	99%	94%	99%	100%
E.coli Modeled Current Exceedances (%) -summer daily maximum	81%	82%	38%	65%	44%	58%	71%	33%	41%	29%	31%	56%	47%	52%
E.coli Modeled Current Exceedances (%) -winter daily maximum	16%	15%	14%	10%	12%	8%	6%	11%	2%	7%	6%	10%	7%	8%
E.coli. Targeted Exceedance Reductions (%) -30 day geometric mean	**99%**	**99%**	**76%**	**92%**	**74%**	**84%**	**100%**	**99%**	**98%**	**96%**	**99%**	**94%**	**99%**	**100%**
E.coli. Targeted Exceedance Reductions (%) -summer daily maximum	**81%**	**82%**	**38%**	**65%**	**44%**	**58%**	**71%**	**33%**	**41%**	**29%**	**31%**	**56%**	**47%**	**52%**
E.coli. Targeted Exceedance Reductions (%) -winter daily maximum	**16%**	**15%**	**14%**	**10%**	**12%**	**8%**	**6%**	**11%**	**2%**	**7%**	**6%**	**10%**	**7%**	**8%**

Recall from Chapter 5 that due to only having three stream gauges that measure flow that it was not possible to assess flow for each of the fourteen reaches. For the three stream gauges that were assessed there was no discernable statistical trend in flow between 1980 and current conditions for two of the upstream gauges. Therefore, targets were only set for the entire subwatershed (which was statistically significant) and are presented below.

Table 7-3. Targets reductions for hydraulic / hydrologic characteristics.

Trend Analysis / Regression Data	North Branch[3] (USGS gage = 04164500)	Comment
Desired Level: 1980 R- B Index (from trend analysis)	0.330	From 1980 to 2009 regression.
Desired Level: 1980 Imperviousness – based in GIRAS[1] data with SEMCOG impervious % (Chapter 5)	4.7%	Geographic Information Retrieval and Analysis System data from the USGS / EPA.
2009 R-B Index (from trend analysis)	0.374	From 1980 to 2009 regression.
2009 Imperviousness – from the NLCD	6.5%	National Land Cover Data from the EPA. The two imperviousness estimates rely on different methods and therefore direct comparison between them may not be applicable in all situations. However, the data is provided and compared to allow for the setting of general targets and not for precise data analysis.
Target Imperviousness Mitigation (2009 -1980 Imperviousness)	1.8%	
Expected Resultant R-B Index Reduction (2009 R-B Index – 1980 R-B Index)	0.044	
Although the targets set are for the entire watershed, mitigation efforts should be directed to those reaches and land uses previously identified in the Impervious Cover Analysis (Chapter 5). Recall that the impervious cover analysis findings indicated that efforts to mitigate the effects of imperviousness should focus on reaches 602, 612, 615 and in particular 616 as well as on other more isolated urbanized areas in the other reaches. The four reaches rated greater than 'sensitive' should implement watershed protection activities that focus on reducing bacterial contamination and implementing pollutant load reducing BMPs.		

Table 7.4 summarizes the impairments associated with each catchment as well as the dominate land use(s). The dominant land uses reflected below are only the most significant uses within each catchment and are listed in the order of importance. Based on the pollutant load (Table 7-2&7-3) and the summary table below the catchments are prioritized for preservation or restoration in agricultural areas and urban-residential areas.

Table 7-4. Summary of impairments.

Catch-ment ID	Name	Catchment Area (ac)	Estimated Impacted Miles	Impairments	Dominant Land Use*
601	East Branch Coon Creek	8,190	3.8	TP, NO3, E.coli.,	Ag, SFR, W&W,G&S
602	East Branch Coon Creek	4,059	5.4	TP, NO3, E.coli., IC	Ag
603	Highbank Creek	10,109	8.2	TP, NO3, E.coli., IC	Ag, SFR
604	East Branch Coon Creek	6,561	4.9	Sediment, TP, NO3, E.coli., D.O.	Ag
607	Coon Creek	16,966	14.0	TP, NO3, E.coli.	Ag, SFR, W&W,G&S
608	Coon Creek	1,162	1.6	Sediment, TP, NO3, E.coli.	Ag, G&S, W&W
609	North Branch Clinton River	13,858	3.6	Sediment, E.coli.	Ag, W&W
610	North Branch Clinton River	18,099	12.0	Sediment, NO3	Ag, SFR, W&W
611	East Pond Creek	13,337	5.2	Sediment, NO3, E.coli.	W&W, SRF, IND, Ag
612	North Branch Clinton River	11,559	4.7	Sediment, NO3, IC	Ag, SFR, W&W
613	North Branch Clinton River	2,644	0.5	Sediment, NO3	Ag, W&W
614	Deer Creek	9,375	6.5	TP, NO3, E.coli.	Ag, SRF, G&S
615	North Branch Clinton River	10,533	8.2	Sediment, NO3, E.Coli., IC	SRF, Ag, W&W, G&S
616	North Branch Clinton River	1,630	0.2	Sediment, NO3, E.coli., IC	SFR, Ag, G&S, IND
	Total North Branch	**128,082**	**78.8**		

* Ag = Agricultural; SRF = Single Family Residential; W&W = Woodland and Wetlands; G&S = Grass and Shrub; IND = Industrial; IC = Impervious Cover

Catchments Prioritized

Tables 7-2, 7-4, and 8-2 to 8-6 were used to prioritize catchments in the watershed. Headwaters are given a higher priority for preservation due their ability to influence the entire system. For prioritizing restoration in *agricultural areas* the percentage of time that parameters exceeded a given water quality threshold was considered. This information is derived from the modeling effort and can be found in Tables 8-2 through 8-6. For example, catchment 601's sediment load exceeded the 90-percentile TSS load forty-percent or more of the time and was given an increased priority. Similarly, 601's E.coli. levels exceeded the 30-day geometric mean forty-percent (or more) of the time and NO^3 exceeded .2 mg/l forty-percent of the time. Catchments where three parameters were exceeded became the highest priority (like 601); catchments where two parameters were exceeded were awarded second priority and the remaining catchments that list agriculture as their primary land use become the third priority.

Preservation: Priority 1: 601, 603, 604, 609, 611, 614 (headwaters)
Priority 2: 602, 607, 608, 610, 612, 613 (areas that connect with other high quality habitat)
Priority 3: 615, 616 (remnant landscapes)

Restoration in Agricultural Areas:
Priority 1: 601, 602, 604, 608
Priority 2: 607, 614
Priority 3: 603, 609, 610, 612, 613

Restoration in Urban-Residential Areas (not the entire catchment)
Priority 1: 602, 603, 612, 615, 616 (Catchments with Impervious Cover (IC) impairments – Table 8-6)
Priority 2: 601, 607, 610, 611, 613, 614 (Single Family Residential is one of the top land uses.)

These priorities appear consistent with the problems perceived by the public (as summarized in Table 4.1).

Table 7-5. Percent estimate of source distributions for sediment (top #) and nutrients (bottom #).

Catchment Number	Catchment (Sources →)	Sewage Discharges	All Other Point Sources	Urban / Residential / Transportation Land	Agricultural / Cultivated Land	On-site Disposal Systems / Septic Systems	Soil Erosion	Illicit Discharges/Spills	Animal Sources (non-agricultural)	All Other Non-Point Sources
601	East Branch Coon Creek Upper	0% 0%	2% 3%	17% 30%	65% 30%	1% 30%	12% 1%	1% 2%	0% 2%	2% 2%
602	East Branch Coon Creek Middle	2% 20%	3% 4%	28% 35%	50% 20%	1% 11%	12% 1%	2% 4%	0% 2%	2% 2%
603	Highbank Creek	0% 0%	3% 4%	23% 32%	60% 32%	1% 24%	12% 1%	1% 2%	0% 2%	3% 3%
604	East Branch Coon Creek Lower	0% 0%	2% 3%	17% 29%	67% 29%	1% 30%	10% 1%	1% 2%	0% 4%	2% 2%
607	Coon Creek Upper	0% 0%	3% 4%	17% 32%	57% 20%	2% 32%	15% 2%	1% 2%	0% 3%	5% 5%
608	Coon Creek Lower	1% 2%	1% 2%	20% 30%	62% 30%	0% 29%	5% 1%	0% 0%	0% 5%	1% 1%
609	North Branch Headwaters	2% 20%	2% 3%	30% 36%	53% 20%	2% 12%	7% 1%	2% 4%	0% 2%	2% 2%
610	North Branch Upper	0% 0%	2% 3%	22% 38%	65% 38%	2% 16%	7% 1%	0% 0%	0% 2%	2% 2%
611	East Pond Creek	0% 0%	1% 2%	40% 38%	47% 14%	2% 37%	7% 1%	1% 2%	0% 4%	2% 2%
612	North Branch Upper Middle	2% 20%	2% 3%	30% 32%	49% 52%	2% 11%	10% 1%	2% 4%	0% 4%	3% 3%
613	North Branch Middle	1% 2%	1% 2%	31% 31%	60% 50%	1% 21%	5% 1%	0% 0%	0% 2%	1% 1%
614	Deer Creek	1% 2%	4% 5%	22% 40%	55% 22%	2% 20%	10% 1%	2% 4%	0% 2%	4% 4%
615	North Branch Lower Middle	1% 2%	4% 5%	48% 50%	30% 16%	1% 16%	10% 1%	2% 4%	0% 2%	4% 4%
616	North Branch Lower	1% 2%	2% 3%	80% 70%	9% 17%	0% 0%	5% 1%	2% 4%	0% 2%	1% 1%

f source distributions for E. coli (top number) and flashiness (bottom number).

Catchment Number	Catchment (Sources →)	Sewage Discharges	All Other Point Sources	Urban / Residential / Transportation Land	Agricultural / Cultivated Land	On-site Disposal Systems / Septic Systems	Soil Erosion	Illicit Discharges/Spills	Animal Sources (non-agricultural)	All Other Non-Point Sources
601	East Branch Coon Creek Upper	0% 0%	2% 0%	20% 25%	55% 75%	15% 0%	0% 0%	2% 0%	4% 0%	2% 0%
602	East Branch Coon Creek Middle	3% 0%	3% 0%	35% 65%	44% 35%	6% 0%	0% 0%	3% 0%	4% 0%	2% 0%
603	Highbank Creek	0% 0%	3% 0%	20% 30%	56% 70%	12% 0%	0% 0%	2% 0%	4% 0%	3% 0%
604	East Branch Coon Creek Lower	0% 0%	2% 0%	15% 30%	56% 70%	15% 0%	0% 0%	2% 0%	8% 0%	2% 0%
607	Coon Creek Upper	0% 0%	3% 0%	25% 30%	41% 70%	16% 0%	0% 0%	2% 0%	8% 0%	5% 0%
608	Coon Creek Lower	3% 0%	1% 0%	15% 30%	55% 70%	15% 0%	0% 0%	0% 0%	10% 0%	1% 0%
609	North Branch Headwaters	3% 0%	2% 0%	39% 40%	40% 60%	7% 0%	0% 0%	3% 0%	4% 0%	2% 0%
610	North Branch Upper	0% 0%	2% 0%	26% 40%	57% 60%	9% 0%	0% 0%	0% 0%	4% 0%	2% 0%
611	East Pond Creek	0% 0%	1% 0%	34% 60%	33% 40%	20% 0%	0% 0%	2% 0%	8% 0%	2% 0%
612	North Branch Upper Middle	3% 0%	2% 0%	26% 50%	50% 50%	5% 0%	0% 0%	3% 0%	8% 0%	3% 0%
613	North Branch Middle	3% 0%	1% 0%	10% 15%	71% 85%	10% 0%	0% 0%	0% 0%	4% 0%	1% 0%
614	Deer Creek	3% 0%	4% 0%	35% 50%	36% 50%	11% 0%	0% 0%	3% 0%	4% 0%	4% 0%
615	North Branch Lower Middle	3% 0%	4% 0%	40% 80%	34% 20%	8% 0%	0% 0%	3% 0%	4% 0%	4% 0%
616	North Branch Lower	3% 0%	2% 0%	77% 66%	10% 34%	0% 0%	0% 0%	3% 0%	4% 0%	1% 0%

Action Category 2: Public Education and Participation

The North Branch of the Clinton River is exhibiting signs of stress as indicated by the load and load reductions just presented. In order to protect this valuable resource from further degradation and for future generations it will be necessary to increase efforts in all action areas including public education and participation.-As with most public projects, the environmental protection and restoration actions of this plan will be most effective when the public understands the environmental challenges and is invested in rectifying them. This understanding and investment ultimately comes through education, outreach, and participation in meaningful activities (involvement). Many programs are available to consider when selecting a method to promote watershed stewardship (see Appendix G.2). The programs currently employed by many of the communities are detailed in the Public Education Plans (PEPs) that many of the communities have developed. These PEPs, many being similar as they were written by the Clinton River Watershed Council (CRWC), define many actions that will form the basis of the public education activities taken in support of this plan (see Chapter 4 for more information).. The SWAG will rely on the materials and messages of existing educational programs, such as the CRWC, the Southeast Michigan Council of Governments (SEMCOG), the Michigan State University Cooperative Extension (MSUE) Program, and the state, to educate and engage the public. By using and adapting existing outreach opportunities and materials, the communities are able to cost-effectively reach a broad audience with a consistent watershed protection message.

As implementation proceeds, the SWAG can use public involvement techniques to guide plan implementation and gauge the effectiveness of certain actions. Such techniques may include stakeholder workshops, community forums, focus group meetings, and increased internet presence.

Action Category 3: Ordinances, Zoning, and Development Standards

Watershed protection requires employing a broad range of environmental protection planning and regulatory options at the local government level. The techniques, designed to minimize negative impacts of land use decisions and development plans, can be used separately or in most cases together, to establish the amount of protection and effort a community is comfortable. This effort can range from simply targeting peak flow reduction of stormwater runoff into waterbodies to attempting total watershed protection. The techniques that are selected need to be crafted with professional planning and legal assistance to fit each community and its natural resources.

There are three levels of planning to consider in watershed protection:

- Coordinated Planning – involves preparing a future land used plan that considers natural resources and environmental features in cooperation with neighborhood jurisdictions; provides the legal foundation for local land use regulations; appropriate planning options are presented in the sidebar

Public Education Details

The SWAG and stakeholders can use a variety of mechanisms, including:

brochures, door hangers, maps, newsletters, kiosks, signs, posters, point-of-sale education programs, municipal services (e.g. recycling bins, building permits), Retired Engineer Technical Assistance Program (RETAP), , presentations, displays, workshops, forums, trainings, volunteer monitoring, clean-ups, mass media, hotlines and a website.

The target audiences for public education are defined in Chapter 4.

Key Planning Strategies

- Prepare future land use plans based on a comprehensive inventory of natural resources;
- Keep density and intensity of land use low near watercourses;
- Avoid developing in sensitive areas like floodplains, wetlands, sand dunes and high risk erosion areas;
- Plan for greenbelts and buffers along watercourses;
- Provide for links between natural areas so wildlife have safe corridors to move within;
- Protect renewable natural resources like farm and forest land in large blocks; and
- Set forth appropriate specific zoning and other land use regulations to support these actions.

Zoning Options

Watershed-based Zoning – this is a zoning methodology designed to consider information presented in a watershed management plan (see www.stormwatercenter.net for additional information).

Prescriptive Zoning – characterized by segregation of land uses into districts; includes very explicit standards and use exclusions.

Mixed-Use Zoning – exemplified by the juxtaposition of different uses to reduce automobile dependence, preserve green space, and promote a sense of community.

Incentive Zoning – a reward-based system to encourage development that meets established development goals.

Performance Zoning – uses goal-oriented criteria to establish review parameters for proposed development projects in any area of a municipality.

Jurisdictional Issues

Pollution prevention efforts are complicated by the fact that various waterbodies fall under the jurisdiction of different agencies. For example:

- The Environmental Protection Agency (EPA) has jurisdiction over navigable waters and their tributaries, interstate waters, and certain intrastate waters related to interstate commerce (as 'waters of the U.S.);
- Michigan enforces federal law for water within its boundaries and extends regulation to groundwater, lakes, rivers, and streams, and all other watercourses and waters, including the Great Lakes, within the jurisdiction of the State; and
- Counties have jurisdiction over waters legally established as 'county drains'.

- Zoning – the principal local tool for guiding land use change; needs to be based on a documented plan; involves defining targets for land use intensity based on environmental impacts and infrastructure needs; zoning options are presented in the sidebar
- Advanced Regulation – tends to provide the most powerful protection authority; complexities require involvement of planners and attorneys; the three options for advanced regulation involve:
    - adopting model ordinance language that specifically addresses stormwater management. These models could be adopted as overlay zones or as a separate ordinance that applies to development in particular locations;
    - adopting a series of brief ordinance provisions that address common natural resource and environmental protection concerns associated with stormwater management; and
    - coordinating land use permit review and approval procedures between the MDNRE and local zoning authorities. This approach is based on refining the local site plan review procedure.

These actions require not only administrative actions by the implementing agencies but may also need the support of a dedicated program. Implementation of such actions (which may include standards, inspection requirements, maintenance requirements, and site requirements) should be coordinated with stakeholders such as the Michigan Townships Association (MTA), planners, developers, homebuilders, and realtors.

Action Category 4: Good Housekeeping and Pollution Prevention

Watershed protection requires that actions be taken to minimize the environmental exposure of pollutants. These actions address a varied array of point and non-point sources (e.g. sanitary sewers, municipal facilities, turf grass, landfills, industrial facilities, septic systems) and an endless number of causes (e.g. mishandled chemicals, failing infrastructure, uncontrolled runoff, improper treatment/disposal of waste). The amount of regulation designed to mitigate problems varies by source and ranges from heavily regulated commercial and industrial facilities to collective problems with an incomplete regulatory/enforcement paradigm, such as septic systems. The range of problems is also wide, encompassing the past improper use of chemicals that now permeate the natural environment (such as PCBs) to emerging pollutants such as pharmaceuticals that are untreated by waste water treatment plants and have effects on aquatic life and other organisms linked to the food cycle.

Priority Actions Related to Public Education and Involvement

- Move to the next stage in the public education process. Respondents indicated they knew what a watershed was but not necessarily which watershed they live in. Also, public education should move towards incorporating more information on impairments and the consequences associated with them; where to purchase eco-friendly products; as well as on techniques available to protect waterways (e.g. no-mow buffers).
- All existing and new programs should be cross referenced with the constraints identified by respondents that have been document in this report and then tailored to help the target audience reach the desired behavior. For example, working with local suppliers to both feature eco-friendly produces, especially when manufactures sales are occurring.
- The distribution of water quality information intended for farm operations should at a minimum be transmitted through MSU Extension, NRCS and the Farm Bureau. For residential land owners, the transmission vehicles should be MSU Extension, The Clinton River Watershed Council and Michigan Department of Agriculture.
- With regard to agricultural producers, the data seems to indicate that they feel that they are already doing a good job. Efforts to work with producers through programs such as Farm-A-Syst and Crop-A-Syst should be increased to help them better understand all the options available to them.
- Certain information sources should distribute certain types of information, especially if it concerns BMPs. Not all information sources (e.g. Farm Bureau) carry equal creditability for all BMPs so the message and delivery mechanism (e.g. internet) should be coordinated so they are the most effective.
- The internet is increasingly becoming the preferred information delivery method. Efforts should be made to strengthen links from the subwatershed program information page and trusted information sources, such as with the Farm Bureau.
- Agricultural sources could be a problem, and based on the survey, maybe MSU extension and/or NRCS could provide some support in educating our farmers.
- Educate appropriate stakeholders about natural and unnatural blockages in waterways, who has responsibility for addressing these, and technical issues related to how to properly deal with them.
- Expand promotion of the "Seven Step" program to reach a larger audience. One way might be to partner with lawn and garden centers to distribute educational materials.
- Expand education on stormwater, especially the stenciling program in residential neighborhoods.
- Implementing an education initiative targeted at commercial/retail, and industrial businesses (it is assumed that the Phase II permit will address the municipal sites). Education should focus on vehicle, material, and waste management and for storm water protection.
- Initiating a beautification program targeted at local business that incorporates storm water management facilities and reduces impervious surfaces.
- Both items 1 and 2 should be priorities by areas in close proximity to connected water features.
- Expand the Farm-A-Syst and Crop-A-Syst programs to reach more riparian farm ownersand focus more on improvements to the riparian corridors.
- Implement a residential riparian land owner education program targeted at improving the management of riparian areas.

Priority Actions Related to Ordinances, Zoning, and Development Standards

- Update or create master plans that specifically refer to the need to preserve open space, sensitive natural areas (e.g. riparian zones and wetlands), and water resources as well recognizes the pollutants contained in stormwater and the need to manage it.
- Update and/or expand ordinances to include water quality and quantity requirements consistent with the Phase II permit. Generally, communities need to close the gap by adopting ordinances that are coordinated with the county and are applicable throughout their jurisdictions.
- Update and/or expand ordinances to require that riparian zones, wetlands and sensitive natural areas not be developed on.
- Prohibit (through ordinances) the introduction of pollutants to storm drains and local waterways. Enable local capability to monitor, investigate, remedy and levy fines for illicit discharges.
- Adopt a procedure to ensure adequate allowance for soil erosion and sedimentation controls on preliminary site plans, as applicable.
- If construction activities are to occur on riparian property, local agencies should consider offering forms of support to property owners if they adhere to best management practices during constructions and implement post construction controls on the site. These can take the form of incentives such as fee reductions or technical support or even physical assistance.
- Lastly, we are concerned about the effects of future development. There is not the pressure that there has been in the past, so now might be a good time to set up for the future.
- Adopt a comprehensive tree ordinance that calls for increased plantings of native types and other appropriate details.
- Adopt/enforce stream buffer requirements in local design standards. Target establishing and/or maintaining a minimum of 100 ft. width and continuous connectivity.

Priority Actions Related to Pollution Prevention and Good Housekeeping

- Undertake an IDEP program within the areas of your community not covered by the Drain Commissioner.
- Adopt standard operation procedures for municipal operations that protect waterways. Key areas of concern are landscape maintenance, street and parking lot sweeping, catch basin cleaning, bridge maintenance, fleet and storage yard maintenance, and hazardous materials handling.
- Institute a septic system maintenance ordinance requiring property owners to demonstrate systems are performing optimally.
- Adopt a procedure for the receipt and consideration of complaints or other information submitted by the public regarding illicit discharges and construction activities discharging wastes to the MS4
- Adopt a procedure to ensure adequate allowance for soil erosion and sedimentation controls on preliminary site plans, as applicable.
- Institute a septic system program aimed at the inspection and maintenance of existing systems.
- In general, plant more trees. Use mechanisms such as the Conservation Districts tree sale, Arbor Day, etc, to encourage the planning of trees. Produce a pamphlet (or promote and existing one) that directs people on where to plant trees, how to plant them, and what native species are recommended under different circumstances.
- Downspout disconnection programs to reduce the volume to storm systems and local waterways.
- Initiate an "adopt a storm sewer" program where residence accept responsibility for keeping debris and pollutants entering the system in their neighborhood.
- Prioritize street sweeping and catch basin cleaning on State Trunklines, County Primary, and City Major roads (total of 459 miles) so the most heavily used receive additional cleanings.
- Prioritize OSDS areas based on E. coli levels
- Conduct IDEP investigation in areas where OSDS are prevalent in order to narrow down failed systems. Dye test suspected failed systems and institute corrective actions
- Undertake a cost-share program aimed at repairing/replacing failed OSDS as a pilot study
- Require scheduled pumpouts and regular maintenance of OSDS
- Install fertilizer application programs at golf courses

Action Category 5: Stormwater Best Management Practices: Soil Erosion and Sediment Control

PART 91, SOIL EROSION AND SEDIMENTATION CONTROL (SESC), of the Natural Resources and Environmental Protection Act (NREPA), 1994 PA 451, as Amended is the reguation designed to protect the waters of the state and adjacent properties by minimizing erosion and controlling off-site sedimentation. SESC can be divided into two distinct components: construction related and non-construction related.

Construction Related SESC

Construction-related SESC is temporary in nature and aims to keep sediment from disturbed lands from leaving the site and entering nearby waterbodies. The State of Michigan has a regulatory structure in place to address construction related SESC with the following requirements:

- County enforcing agents (CEAs) are authorized to require that a permit be obtained for any land disturbance greater than 1 acre or within 500' of a waterbody (except for the plowing or tilling of farm fields) or it may be more restrictive if an ordinance is in place
  - Authorized Public Agencies (APAs) are exempt from obtaining a permit, but must notify the appropriate enforcing agency in advance and must follow the SESC guidelines stipulated.
- The MDNRE requires any land disturbance greater than 5 acres to obtain a Notice of Coverage in addition to a permit from the CEA/MEA.
- Persons engaged in agricultural practices may enter into an agreement with the conservation district instead of obtaining a permit from a CEA or MEA.

Because of the developed regulatory structure surrounding construction related SESC, the limited resources of the subwatershed communities should be focused on enhancing non-construction related SESC.

Non-Construction Related SESC

This type of SESC includes activities that are not related to active construction sites. General activities of non-construction SESC include:

- Repairing bare soil such as on poorly maintained yards or hillsides;
- Repairing and stabilizing stream banks that are eroding with vegetative components (referred to bioengineering) or, in the cases of extremely fast moving water, hard armoring;
- Repairing roads and associated transportation structure that are eroding or causing nearby erosion;
- Excluding sensitive uses from occurring near waterbodies, especially within the riparian corridor;
- Ensuring sediment generating sites install proper controls to prevent sediment from leaving the property;
- Providing controls in sensitive areas to ensure that sediment is not transported by wind;
- Installing structural controls at inlets to, or inside of, the storm sewer system to ensure sediment does not travel to waterbodies;
- Encouraging the implementation of agricultural runoff BMPs that prevent soil particles from traveling to nearby waterbodies; and
- Channel modifications and selective removal of logjams may change the flow profile such that sediment deposition may be achieved.

Other techniques, such as street sweeping, may be considered non-construction SESC or may be considered pollution prevention actions.

SESC-related Agents in the Subwatershed

Cross-Jurisdictional Enforcing Agent
MDNRE, Water Bureau

County Enforcing Agents
Lapeer County Community Development Department
Macomb County Public Works
Oakland County Water Resources Commissioner
St. Clair County Drain Commissioner

Authorized Public Agencies
Lapeer County Drain Commissioner
Lapeer County Road Commission
Macomb County Public Works
Road Commission of Macomb County
Oakland County Water Resources Commissioner
Road Commission for Oakland County
St. Clair County Road Commission
St. Clair County Drain Commissioner
Various State of Michigan Departments (e.g. MDNRE, MDOT)
Lapeer Conservation District
Oakland Conservation District
St. Clair Conservation District

Municipal Enforcing Agents
None

Priority Actions Related to Stormwater Best Management Practices

- Incorporate animal waste handling facilities at farms where the issue has been identified as a problem.
- Implement stormwater best management practices in areas that have been identified to have experienced more frequent flooding and sediment loads / sedimentation.
- Ensure that composting and sludge disposal operations intercept runoff from the processing facilities and provide appropriate treatment before water is discharged to nearby waterbodies or storm sewers.
- Classification of neighborhoods based on their current ability to manage storm water as well as to be retrofitted with storm water facilities. The NSA suggests that the age and type of the neighborhood as well as proximity to connected waterways are key factors.
- Work with volunteer organizations to 'green' neighborhoods that would most benefit from retrofits.
- Expand the Conservation Reserve Program (CRP) and Michigan's Conservation Reserve Enhancement Program (CREP) programs to place more riparian land in easements. Initially focus on areas in first and second order streams.
- Look at opportunities to place riparian easements on farm preservation properties (where appropriate).
- Provide riparian landowners with technical assistance on "Shoreline Landscaping and Erosion Control". An example might be providing access to experts in order to help facilitate change.

Action Category 6: Stormwater Best Management Practices: Other Practices

In contrast to the previous category, this second category of stormwater BMPs deals with runoff (from polluting land uses such as urban area imperviousness, residential lawns, and agricultural areas) that has already collected pollutants as opposed to preventing pollutants from entering the runoff or waterbodies. These actions are also essential to the achievement of pollutant load reductions, especially for pollutants other than sediment. There are five major classes of actions that fall within this category, including:

- Impervious surface mitigation - practices designed to directly reduce impervious surface and/or treat the runoff from impervious areas; a catch-all category that has characteristics of the others but is aimed at retro-fit type applications (e.g. vegetated parking lot islands, road medians and ditches, green roofs, pervious pavement/asphalt; rain barrels, contiguous surface disconnection); also deals with agricultural lands which function in a similar hydrologic nature, especially when coupled with tile drains;
- Infiltration systems - natural or constructed depressions located in permeable soils that capture, store, and infiltrate stormwater runoff in surface or underground facilities (e.g. rain gardens, tree boxes, bioretention facilities, infiltration basins/trenches, porous pipes, dry wells, irrigation);
- Filtration systems - structural controls that capture, temporarily store, and route stormwater runoff though a filter bed to improve water quality; can be off-line systems or designed as pre-treatment before discharging to other stormwater facilities (e.g. sand filters, organic filters);
- Vegetated buffers and natural conveyance - facilities that predominantly use vegetation and natural drainage to control stormwater runoff while transporting it to its discharge point (e.g. filter strips, buffers, grassed channels, swales); and,
- Retention and detention – ponds and wetlands that receive and hold runoff and control the rate of discharge; there are many variants that provide different levels of pollutant removal, flow control, and volume reduction;

This category is meant to cover the physical installation of such practices. Inclusion of requirements to use these practices (such as in ordinances and other standards) falls under the auspices of Action Category 3. Much information about these five practice categories, including their general pollutant removal and flow mitigation characteristics, categories is presented in Appendix G.2.

Action Category 7: Natural Features and Resources Management

While many of the actions under 'Ordinances, Zoning, and Development Standards' serve to protect natural resources, the techniques listed here promote a more active approach that encompasses not only the protection of existing natural features, undeveloped lands, sensitive areas, and those of historical or cultural value, but also their enhancement and restoration, where appropriate.

The actions fall into two distinct classes, including:

- Land reserves – conservation of land (e.g. purchasing land, development rights transfer, conservation easements, land trusts, leases, deed restrictions, and covenants) that helps protect existing water quality from degradation and prevents encroachment into important natural areas; and
- Natural feature protection and restoration - protection and restoration practices must be employed on conserved land and on private land to ensure that the greatest natural functioning is achieved.

There are an enormous number of actions to consider with respect to the protection and restoration of natural features and resources. Various potential actions are listed in no particular grouping or order of importance:

- Purchase farmland development property rights and increase conservation easements through tax benefits and easements to prevent urban sprawl and uncontrolled development;
- Acquire high quality natural areas;
- Restore natural shorelines and stream banks
- Implement waterbody channel stabilization and bank vegetation where erosive conditions cause environmental problems (this must be done after addressing the hydrologic/hydraulic causes of the instability in the waterbody);
- Protecting, constructing, enhancing, and restoring wetlands to preserve existing areas, mitigate impacted sites, and to increase the acreage of wetland in the watershed;
- Augmenting or removing dams or other structures to restore hydraulic conditions in waterbodies to the benefit of the natural environment – alternately providing for the passage of aquatic organisms around the obstruction;
- Habitat restoration and protection (aquatic, forest, and prairie) in all areas of the watershed including urban, suburban, rural, and agricultural areas;
- Restoration of natural processes such as burnings to support prairie lands and organic forest floor cover to support native natural communities;
- Protection and development of aquatic buffer lands in all areas of the watershed to support productive habitats (and protect water quality);
- Tree/shrub planting and management (and protection) in urban and suburban development and redevelopment;
- Establish 'no-mow' zones to allow natural processes to dominate vegetated lands;
- Undertake actions to eliminate exotic and invasive species and control their dispersal;
- Enact measures to further protect threatened and endangered species, especially those of local importance;
- Rehabilitating impacted floodplains by reconnecting waterbodies and providing additional storage; and
- Opening up enclosed drains and waterbodies to allow natural processes to once again flourish.

Vegetation Management Actions to Consider for Natural Features and Resources Management

Some vegetation management actions to consider include:

- Maintaining or introducing native landscaping;
- Critical area plantings;
- Municipal buffer zones;
- Prescribed burnings;
- Reforestation;
- Urban forestry, tree plantings and protection ordinances;
- No mow zones;
- Protecting threatened and endangered species; and
- Eradicating exotic/invasive species.

Priority Actions Related to Natural Features and Resource Management

- Create a watershed-wide landscape restoration plan whose goal is the long-term sustainability of habitat. The Michigan Natural Features Inventory (MNFI) and the recently completed MDNRE Potential Wetland inventory both provide a good foundation from which to build.
- Implement the woody debris management plan (currently being completed) with the initial priority being in reaches where fish passage is a concern. Work with MDNRE to get the management strategy pre-approved.
- Initiate a stream corridor preservation/restoration study that links individual reaches to the entire North Branch and to the stream corridor and surrounding landscape (e.g. the MNFI).

Action Category 8: Recreation Promotion and Enhancement

While recreation may not seem related to the condition of the natural environment, the actions related to the promotion and enhancement of recreational opportunities will also benefit the natural environment. Recreational access to natural areas serves to foster a stewardship ethic through a greater appreciation of the watershed as a resource.

The classes of actions to consider in this category include: developing a comprehensive recreation plan, conserving riparian and other land for use as parks or natural areas, increasing public access to waterways, protecting and restoring fisheries, and increasing the number of trails and other recreational facilities.

Action Category 9: Environmental Monitoring and Other Data Collection

Environmental monitoring and other data collection actions are an essential component of managing environmental conditions. These actions provide the data that are essential for determining environmental problems, assessing whether or not corrective actions are working, and ultimately indicate whether or not goals and objectives (e.g. restoration of beneficial uses) are being achieved.

There are a multitude of parameters that can be, and need to be, measured to be able to successfully perform the assessments related to any given plan. For the sake of efficiency, it is desirable to use existing resources and programs whenever possible. If special data is needed, additional protocols may have to be recommended or new data collection efforts initiated by the stakeholders. Data used in the development of the plan is presented in the early chapters and provides many references to the organizations and programs collecting such information. A more expansive list of existing monitoring programs and additional protocols is presented in Appendix G.2.

The programs and protocols to be utilized are necessarily dependent upon the parameters that are desired to be measured. Stressors can be measured directly or surrogate measures may provide a more cost-effective estimate of a given stressor's impact on the environment. Again, the early chapters of the plan detail the parameters available to analyze, particularly Chapter 5. A number of appendices such as C.1, E.1, and E.3 may also be useful.

The final consideration to make in terms of monitoring and data collection is to ensure that all of the goals and objectives of the plan can be assessed based on the data collected through the plan.

Additional information related to environmental monitoring and other data collection can be found in Chapter 9, especially as it pertains to assessing the effectiveness of the actions and achievement of the goals and objectives of the plan. **(EPA 10.2, 10.3.5)**

Priority Actions Related to Recreation Promotion and Enhancement

- Tailor marketing messages around enjoying the local scenic beauty, family activities and fishing. These are the most important activities to respondents.
- Maintain waterbodies for canoeing and kayaking by providing sufficient ingress and egress points, removing obstructions, constructing portage facilities, and marketing such uses
- Convert existing lands into public campgrounds or purchase land appropriate for such purpose; alternately encourage the opening of a private campground
- Provide trails appropriate for all potential recreational uses, including: equestrian, biking, ORVs/ATVs; alternately encourage trails to be developed on private property

Priority Actions Related to Environmental Monitoring and Other Data Collection

- Assist with monitoring of pollutant levels and activities designed to mitigate TMDLs.
- Undertake DNA testing to better understand the E. coli source (human, , wildlife, farm and domestic animals, etc.)

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8. Actions to Improve Environmental Conditions

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Action Categories
The action categories defined in Chapter 7 include:

1. **Watershed Planning, Institutionalization, and Implementation;**
2. **Public Education and Participation;**
3. **Ordinances, Zoning, and Development Standards;**
4. **Good Housekeeping and Pollution Prevention;**
5. **Stormwater Best Management Practices: Non-Construction Related Soil Erosion and Sediment Control;**
6. **Stormwater Best Management Practices: Other Pollutant Load Reducing Controls;**
7. **Natural Features and Resources Management;**
8. **Recreation Promotion and Enhancement; and**
9. **Environmental Monitoring and Other Data Collection.**

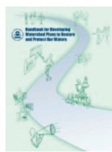
Linkage of Actions to Stressors
Ultimately, the actions of this plan aim to deal with the stressors that impact the subwatershed. The graphic associated with each action explains these relationships:

A	Administrative / planning in nature
E	Educational in nature
S	Directly address sediment
N	Directly address nutrients
P	Directly address pathogens
F	Directly addresses flow

Chapter Purpose

This chapter of the Watershed Management Plan (WMP) details the strategic actions to improve environmental conditions and achieve the goals and objectives set forth in Chapter 6. Each action is presented with essential information including implementation date guidelines. The end of the chapter addresses the pollutant load reductions that can be expected from the actions to achieve the target load reductions. Collectively, the information presented herein is designed to comply with the remaining EPA Section 319 funding requirements: (c) – the management measures to achieve the goals; (d) – implementation schedule; (h) – information/education component; and (i) – technical and financial assistance to implement the plan. Elements (e), (f), and (g) are touched in this chapter but are officially addressed in Chapter 9.

Introduction



In order to meet the goals and objectives of the plan, the Subwatershed Advisory Group (SWAG) utilized the list of priority and potential actions categories presented in Chapter 7 (and Appendix G.2) and selected the appropriate actions using a number of key criteria, including: water quality improvement potential, cost, projected implementation time/expense, future permit requirements, funding requirements, maintenance requirements, acceptability, previous experience, ability to leverage existing programs, and likelihood of success. The actions have been assigned milestone dates based on: prescribed regulatory dates, desires of the public, addressing the most pressing water quality issues first, implementing the most cost-effective measures in the short-term, priority of goals and objectives, when stakeholders could realistically implement a given action, relegating those actions requiring extensive outside funds to the long-term. Note that only the dates are presented in this chapter. The details of the milestones are presented in Chapter 9. **(EPA 10.3.7, 10.3.8)**

Role of the SWAG in Implementing the WMP

In its current capacity as an advisory council, the SWAG has no legal authority. In order to implement the actions advocated in the WMP the SWAG must rely on its constituent members and work through partnerships with other organizations. Specifically, the SWAG facilitates interaction among government representatives as well as other watershed stakeholder groups.

Action Classes and Details of Individual Actions

This section is organized such that each class of actions (denoted with a two number identifier, e.g. 1-1) is presented followed by detailed actions within that class presented in a table. These detailed actions are denoted with a lower case letter, such that their full identifier is in the format #-#-x, e.g. 1-1-a. *<u>Italicized and underlined</u>* statements indicate the critical areas that the class of actions are to be applied to (see Chapter 7), at a minimum. Where specific dates are not important, 'Short Term' is used to refer to anything within 5 years, 'Long Term' is used for anything beyond 5 years. **Specific actions that are in *italics* indicate that they are derived from one or more of the observations from any of three field studies (i.e. the USA, USSR or the Social Survey). (EPA 11.4, 11.5, 12 – refers to entirety of this section)**

Validation; Financial and Technical Assistance

To assist the SWAG and its members in implementing the actions of the plan, sources of financial and technical assistance have been identified. This information is presented in the table associated with each action and in the summary table as a agency/number identifier. The pertinent identifying details for each program are then linked to in a table in Appendix H.1

In an effort to validate the chosen actions, the relationships between each action and goals and objectives as well as the anticipated load reductions can be found in Appendices H.2 and H.3 respectively.

1. Watershed Planning, Institutionalization, and Implementation

These actions are meant to foster a cooperative watershed planning, decision-making, and implementation approach between all levels of government and local stakeholders.

The benefit of these actions is the funding, implementation, and long-term institutionalization of the WMP.

Institutionalization

The institutionalization actions are aimed to ensure that the WMP is recognized, adopted, implemented, and improved.

1-1 Promote and Reconvene Subwatershed Advisory Group

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During the four years following the completion of this WMP, the SWAG will increase the exposure of the SWAG and WMP with an aim towards growing involvement of stakeholders and the general public.

Extensive involvement from a diverse group of stakeholders will be essential in effectively coordinating planning efforts and actions such that implementation occurs sequentially and redundant efforts eliminated.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding and Technical Assistance (Appendix H.1)
1-1	**Promote and Reconvene North Branch Subwatershed Advisory Group (SWAG)**	**SWAG**	**◆ = 2015**	**▪ 150 - 300 hours & ▪ $15,000/year (Promo. Materials)**	**EPA 3, 6, 7, 8, 9, 11, 13, 22, 23, 28 USDA 4, 6 USGS 7**
1-1-a	*Quarterly meetings with members and prospective members about mission, purpose, news, schedule, meetings, contacts*	*SWAG*	*Ongoing Quarterly*		
1-1-b	Yearly formal communications such as newsletter or brochure	SWAG	Ongoing Annually		
1-1-c	*SWAG representatives attend meetings of adjoining watershed groups and encourage reciprocal attendance*	*SWAG*	*Ongoing*		
1-1-d	Assess WMP implementation and reconvene SWAG with appropriate administrative measures to improve implementation effectiveness	SWAG	Long-Term (every 6 yrs)		
1-1-e	*Enhance cooperative relationship with Six Rivers Regional Land Conservancy and promote joint open space preservation efforts*	*SWAG*	*Short Term Ongoing*		
1-1-f	*Expand/Enhance partnerships (Huron-Clinton Metroparks Authority, farming community etc.)*	*SWAG, County*	*Short Term*		

1-2 Develop Funding Program

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The Funding Program determines how WMP stakeholders will implement the actions defined in this plan. Although not specifically mentioned in the narrative associated with the actions, referencing the Funding Program to identify potential funding sources is a task that will be required to successfully implement most of the actions in the WMP.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
1-2	**Develop Funding Program**	**SWAG; All Agencies**	**Ongoing** **◆ = 2011**	**▪ $5,000 / one time** **▪ $2,000 / fifth year (Legal fees)**	**EPA 3, 6,7, 8, 9, 13, 18, 22, 23, 25, 26, 35** **USDA 2, 4, 6** **NOAA 3, 5** **USACE 2** **MDEQ 2, 3**
1-2-a	Determine priority projects for grant applications	SWAG	For actions within 5 year window		
1-2-b	Support SWAG members grant applications.	SWAG	update every year		
1-2-c	Determine potential sources of funding for priority projects.	SWAG: All Agencies	As needed		

1-3 Develop Implementation Plans / Grant Proposals

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Implementation plans for each action should be developed. Ideally, these plans should be prepared by the implementing agencies; however, the SWAG may need to coordinate actions when an implementing organization is doing so independently of the WMP. The SWAG will also need to prepare implementation plans for actions which it wishes to implement directly. The preparation of such should be handled by an appropriate sub-committee.

The implementation plans may be simple one-page descriptions or may be more detailed documents if required for specific grant proposals.

Individual implementation plans should always keep in mind the over all goals of the plan and the vision for the watershed. The Social Survey nicely summarizes the stakeholder vision for the watershed in sections 2 through 4.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
1-3	**Develop Implementation Plans / Grant Proposals**	**SWAG; Action Agencies**	**Ongoing** **◆ = 2011**	**▪ Up to $5000 per application**	**EPA 3, 6, 7, 8, 9, 13, 18, 22, 23, 25, 26, 35,** **USDA 2, 4, 6** **NOAA 3, 5** **USACE 2** **MDEQ 2, 3**
1-3-a	Develop an implementation plan for each action that contains more detail than the WMP and notes any deviations	SWAG: Action Agencies	At least one year before action implementation		
1-3-b	Submit implementation plans to SWAG	Action Agencies	As Needed		

1-4 Regulatory Enforcement and Technical Assistance

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The local, state, and federal regulatory agencies that have jurisdiction in the subwatershed will conduct and enforce the appropriate permitting, monitoring, and penalty procedures. The SWAG will communicate to these agencies the most pressing issues in the subwatershed and ask for assistance in properly implementing the WMP by indicating which actions are desired for each agency to perform. In the event that appropriate regulatory power is not in place, the SWAG will approach the appropriate organizations (e.g. Michigan Legislature, MDNRE chief) to lobby for its development.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
1-4	**Regulatory Enforcement and Technical Assistance**	**SWAG; All Agencies**	**Ongoing** **◆ = 2015**	**▪ $5,000 / yr**	**SeaGrant, Foundations, Universities**
1-4-a	Identify all agencies with jurisdiction in subwatershed	SWAG	Short Term		
1-4-b	Determine jurisdictional scope of each agency; request outside agencies to provide this information if possible	SWAG: All Agencies	Short Term		
1-4-c	*Enact regulatory requirement to provide notice when pollutants are discharged due to construc - tion activities in violation of existing statutes*	*Appropriate Agency*	*Short Term*		
1-4-d	Determine if all necessary regulatory powers exist; determine if existing powers are being enforced	SWAG; All Agency	Short Term		
1-4-e	Contact appropriate entities (e.g. Michigan legislature) to develop, provide, or create necessary regulatory powers	SWAG; All Agency	Short Term		
1-4-f	Identify all agencies with technical knowledge on implementing the actions; seek out as needed	SWAG; Action Agency	Short Term Ongoing		
1-4-g	*Eenforce SESC requirements*	*MEAs/CEAs*	*Ongoing*		

1-5 Implementation Clearinghouse

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In order to efficiently track the implementation of the WMP and to support its evaluation and revision, the SWAG and its partners will track all WMP programs and activities.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
1-5	**Implementation Clearinghouse**	**SWAG-**	**Bi-Annual** **◆ = 2011**	▪ **100 – 250 hrs &** ▪ **$2000/year (Report Copies, Summary Report)**	**EPA 3, 6, 7, 8, 11, 13, 22, 23, 25 26** **USDA 2,4,6** **NOAA 2**
1-5-a	Track information concerning actions that have been implemented (include data, assessments, lessons learned, and other information)	All agencies	Ongoing		
1-5-b	Deliver and log in information to clearinghouse entity (e.g. SWAG implementation committee)	All agencies	Ongoing		
1-5-c	Provide information in clearinghouse to ensure efficacy and effectiveness are optimal	SWAG	Bi-Annual		
1-5-d	Investigate outside organizations to see if things have occurred outside of the SWAG that could be used as implementation credit	SWAG; Stake-holders	Annually		
1-5-e	Explore possibility of utilizing advanced information delivery methods (e.g. online database); implement if feasible	SWAG	Short Term		

1-6 Total Maximum Daily Loads

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When a lake or stream does not meet Water Quality Standards (WQS), a study is led by the MDNRE to determine the amount of a pollutant that can be put in a waterbody from point sources and nonpoint sources and still meet WQS. The result of this study is termed a 'Total Maximum Daily Load' (TMDL) and describes how much of a pollutant a lake or stream can assimilate. The SWAG will support the implementation of TMDLs affecting the subwatershed through modifications to the WMP (e.g. problems and concerns, goal language, opportunities, and actions). The existing and scheduled future TMDLs are listed in Chapter 5.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
1-6	**Total Maximum Daily Loads**	**SWAG; All affected entities**	**Two year** **◆ = 2012**	▪ **200-400 hrs**	**EPA 3, 6, 7, 8, 11, 13, 23** **USDA 4,6**
1-6-a	Identify existing TMDLs and determine the schedule for future TMDLs	SWAG	Every two years		
1-6-b	Participate in development of TMDLs when given opportunity and encourage inclusion of more strict action requirements; especially for *E. coli* TMDLs	SWAG; All affected Agencies	As needed		
1-6-c	Identify TMDL-related information and determine actions to reduce loads to meet the TMDL	SWAG	When TMDL is issued		
1-6-d	Incorporate all new TMDL information into the WMP the next time the plan is updated	SWAG	As scheduled or needed		

1-7 Identify Impacts, Stressors, Sources, and Causes

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As conditions change, the problems (impacts, stressors, sources, and causes) in the subwatershed will need to be re-evaluated. Additionally, specific problems require in-depth (sometimes costly) special investigations. A clear understanding of the problems in the subwatershed is necessary to attain and health watershed.

Identification work will rely heavily on existing assessments, including those in this WMP. Intial efforts should focus on collecting data in areas of the subwatershed that don't have significant information. More distant data collection efforts should consider chages over time too.

This work should utilize all available planning tools such as Geographic Information Systems (GIS), the Integrated Coastal Management (ICM) tool, the Potential Conservation Area Analysis (GLC, 2004), and those developed through the Clinton River Basin Watershed Initiative (CRWI) – the watershed information management system (WIMS), Clinton River model, and site evaluation tool – and consider updating the tools and models if possible.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
1-7	**Identify Impacts, Stressors, Sources, and Causes**	**SWAG**	**Ongoing** **◆ = 2015**	▪ **500 – 760 hrs**	**EPA 1, 3, 4, 6, 7, 8, 9, 13, 17, 18, 19, 22, 23, 25, 26, 30, 31, 32, 39, 41** **USGS 6,7; USACE 3** **NOAA, 2, 3, 4, 6**
1-7-a	Identify gaps in the data presented in the WMP; obtain data if it exists and collect such data if it doesn't	SWAG; CRWC; All Agencies	Short Term; Every plan iteration		

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
1-7-b	Identify and compile data that has been generated since this plan was developed	SWAG	Short Term; Every plan iteration		
1-7-c	Support research into the tracking of bacterial contamination sources	SWAG; All Agencies	Ongoing		
1-7-d	Support research into distinguishing dry vs. wet weather contributions from sources	SWAG; All Agencies	Ongoing		
1-7-e	Conduct stakeholder surveys, field assessments, and utilize any other means necessary to collect data.	SWAG; All Agencies	Ongoing		

1-8 Update WMP

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After completing each WMP Evaluation, the SWAG will update this WMP to address the revision suggestions generated through Action 9-6 – Evaluation and Revision Guidance. The guidelines in Chapter 9 will be followed to ensure the revision is in accordance with established parameters.

WMP updates should rely on the implementation plans prepared under Action 1-3 – Develop Implementation Plans / Grant Proposals to ensure that future WMPs have more detail than what is presently available.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
1-8	**Update WMP**	**SWAG**	**Five Year Cycle** **◆ = 2020**	▪ **250-500 hrs**	**EPA 3, 6, 7, 8, 9, 13, 18, 22, 23, 25, 26** **USDA 2, 4, 6; NOAA 3, 5** **USACE 2; MDEQ 2, 3**
1-8-a	Use evaluation and revision guidance and implementation plans and other information to draft a plan update	SWAG	As needed		
1-8-b	Distribute update to all stakeholders for review and comment	SWAG	After draft completed		
1-8-c	Provide review comments to SWAG	Reviewing Agencies	After draft received		
1-8-d	Provide final version of updated WMP and submit to appropriate agencies (if required or desired)	SWAG	After comments received		

2-1 **Public Education – General Public**

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In general, the community education efforts consist of the following topics: watershed concepts and stewardship, stormwater system knowledge, illicit discharge program, personal actions impacting water quality, waste management / dumping, and riparian land management. Additional education topics include: understanding problems, progress expectations, positive image for the Clinton River, Lake St. Clair, and other waterbodies, habitat conservation and restoration, native and invasive wildlife management, planning and water quality information, registered watercraft owner information, recreation education, sustainability practices, and a rain garden program.

2. Public Education and Participations

These actions are meant to increase public understanding of environmental issues, their impacts on the environment, and investment in rectifying them.

The benefit of these actions is the increase in public and municipal staff knowledge and awareness to facilitate the paradigm shift needed to change adverse behavior affecting the watershed.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
2-1	**Public Education – General Public**	**SWAG**	**Ongoing** **◆ = 2015**	▪ **$10,000 /yr**	**EPA 3, 6, 9, 11, 13, 21, 23, 25, 26, 40** **NOAA 1, 2, 4, 5, 6** **USDA 1, 2, 3, 4, 8, 11, 12** **USGS 1, 2, 3, 4, 5, 9, 10, 11**
2-1-a	Leverage existing programs to provide educational opportunities consistent with the findings of the social survey	SWAG; All Agencies	Short Term Ongoing		
2-1-b	*Supplement educational efforts with information on impairments and consequences, where to purchase enviro-friendly products, and techniques to protect waterbodies*	*SWAG; All Agencies*	*Short Term Ongoing*		
2-1-c	*Communications on adopting BMPs should be delivered through organizations that have public trust (as identified in the social survey such as CRWC, MDA, MSUE)*	*SWAG; All Agencies*	*Short Term Ongoing*		
2-1-d	Utilize internet technology to distribute watershed messages; strengthen links from and to the subwatershed information page	SWAG; All Agencies	Short Term Ongoing		
2-1-e	Provide education about waterbody blockages (e.g. woody debris), who has responsibility; and how to properly deal with them	SWAG; All Agencies	Short Term Ongoing		
2-1-f	*Expand promotion of the 'Seven Step' program; partner with lawn and garden centers to distribute materials*	*SWAG; All Agencies*	*Short Term Ongoing*		
2-1-g	*Implement a residential riparian land owner education program*	*SWAG: All Agencies*	*Short Term Ongoing*		

2-2 Public Education – Business and Agriculture

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Targeted educational efforts aimed at groups with the greatest potential to impact the natural environment should be developed. Businesses (e.g. automotive maintenance centers, restaurants, junk yards, golf courses, lawn care providers, etc) and agricultural enterprises fall into this category.

Business education includes how facilities and operations affect stormwater, pollution prevention activities to minimize this potential, environmentally-friendly construction, sustainability considerations, new ordinance details, and environmental audit assistance.

Agricultural education includes things such as how traditional agricultural practices affect soil erosion and receiving waters, and encouraging the use of state-agency approved Generally Accepted Agricultural Management Practices (GAAMPS)[1].

Agricultural education activities will require the involvement of appropriate agencies including the Natural Resources Conservation Service (NRCS), Farm Service Agency (FSA), the Michigan Department of Agriculture (MDA), soil conservation districts and/or Michigan State University Extension (MSUE).

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
2-2	**Public Education – Business and Agriculture**	**SWAG; All entities**	**Ongoing** **◆ = 2015**	▪ **$10,000 /yr** ▪ **250 – 500 hrs**	**EPA 3, 6, 7, 9, 11, 13, 23, 25, 26, 40** **NOAA 4** **USDA 2**
2-2-a	*Encourage distribution of water quality info for farm operations should be done through MSUE, NRCS, and the Farm Bureau*	*SWAG; All Agencies*	*Short Term Ongoing*		
2-2-b	*Encourage/expand the Farm-A-Syst and Crop-A-Syst programs to help agricultural producers better understand options available for environmental protection, including wetlands; also focus on riparian farm land holders*	*SWAG; All Agencies*	*Short Term Ongoing*		
2-2-c	*All programs should be designed to account for the identified impediments to adoption identified in Section 10 – Management Decision of the Social Survey.*	*SWAG; All Agencies*	*Short Term Ongoing*		
2-2-d	*Start a program targeted at commercial, retail, and industrial businesses and focus on vehicle, material, and waste management*	*SWAG; All Agencies*	*Short Term Ongoing*		
2-2-e	*Institute a beautification program for local businesses that incorporates stormwater facilities and reduce impervious surfaces*	*SWAG; All Agencies*	*Short Term Ongoing*		

Recall from the Social Survey Results

Regardless of people's willingness to adopt BMPs, if the constraints are perceived to be too great for property owners then the BMPs will not be adopted. Survey results indicated that a lack of understanding surrounded many of the BMPs. Public education programs on the BMPs, terminology, and the required skill for implementation will help overcome the perceived barriers.

[1] The Michigan Right to Farm Act, P.A. 93, 1981, provides farmers with protection from nuisance lawsuits and authorizes the development and adoption of Generally Accepted Agricultural and Management Practices for farms in Michigan to promote sound environmental stewardship and help maintain a farmer's right to farm."

2-3 Public Education – Municipal Employees

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Another specialized public education effort involves targeting municipal staff that have the potential to impact the natural environment. Municipal employee training refers to education staff, both in-house and contracted, aware of how their actions affect stormwater, and to demonstrate the correct procedures. While many different departments affect stormwater in some way, a key department is the maintenance department. Maintenance staff maintain fleet vehicles, store chemicals, sweep streets, clean catch basins, conduct lawn care, maintain dumpsters, dispose of solid waste, and de-ice the roads. If not done correctly or regularly, these activities can have an adverse affect on stormwater.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
2-3	**Public Education – Municipal Employees**	**SWAG; All entities**	**Ongoing** **◆ = 2011**	▪ **250 – 500 hrs &** ▪ **$5,000 /yr**	**EPA 3, 6, 9, 11, 13, 23, 25, 26, 40** **NOAA 4** **USDA 2**
2-3-a	Educate appropriate municipal employees on actions they can take to reduce stormwater pollution (e.g. chemical storage, turfgrass care, dumpster maintenance, waste disposal)	All appropriate agencies	Immediate Ongoing		
2-3-b	Provide targeted training to maintenance department staff (e.g. fleet maintenance, street sweeping, catch basin cleaning, road de-icing)	All appropriate agencies	Immediate Ongoing		

2-4 Demonstration Projects

E S N P F

Demonstration projects serve a number of purposes including public education, municipal officials' awareness, promoting acceptance for practices, environmental protection and restoration, and providing implementation experience.

Demonstration projects will be chosen based on their potential to impact to the environment, visibility, innovation, coordination with developer, and cost.

Examples of demonstration projects include watercourse restoration, dam removal or modification, stream bank / eroding road stabilization, wetlands restoration, green roofs, pervious pavement parking lots, zero discharge development, residential rain gardens, and cluster development.

Similar to development and redevelopment demonstration projects, water quality friendly agricultural demonstration projects may be suitable to promote more extensive use of non-traditional techniques by farmers.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
2-4	**Demonstration Projects**	**All Agencies**	**Ongoing** **◆ = 2015**	▪ **500 – 1000 hrs &** ▪ **$30,000 +/yr**	**EPA 1, 3, 4, 6, 7, 9, 11, 13, 18, 19, 25, 37, 38, 40, 42, 43** **NOAA 4** **USDA 2, 9** **USGS 6, 12**
2-4-a	Research actions and public education strategies and select appropriate demonstration projects	All Agencies	Short Term		
2-4-b	Obtain approval from all appropriate persons to implement project(s)	All Agencies	Short Term		
2-4-c	Obtain funding for project(s) and advertise impending project	All Agencies	Long Term		
2-4-d	Construct demonstration project(s) under auspices of appropriate action number (e.g. 6-5 if it is a stormwater detention facility)	All Agencies	Long Term		

2-5 Signage

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Signage refers to educating the public about specific issues through the use of interpretive signs placed strategically throughout the subwatershed. Examples of possible sign uses include:

- to mark watershed boundaries;
- to mark wellhead protection boundaries;
- to point out tips and directives at recreation areas such as "No Dumping" or "Don't Feed the Geese";
- to indicate times, at beaches, when it may not be safe to participate in water-based activities due to the presence of pathogens may reduce the risk of sickness; and
- to provide water quality, vegetation, and wildlife protection tips at boat launches.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
2-5	**Signage**	**SWAG;** **All Agencies**	**Ongoing** **10 signs/yr** **◆ = 2011**	▪ **$2,500 /yr**	**EPA 3, 6, 7, 9, 11, 13, 23, 25, 26, 40** **NOAA 4** **USDA 2**
2-5-a	*Identify types of signs and then determine types of locations to put them (Key Finding from SS)*	All Agencies	Short Term		
2-5-b	Use appropriate tools (e.g. GIS) to analyze the placement of subwatershed signs.	All Agencies	Short Term		

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
2-5-c	Develop a reasonable timetable for installing signs	All Agencies	Short Term		
2-5-d	Determine if any prospective locations require special right-of-way considerations	All Agencies	Short Term		
2-5-e	Address right-of-way and any other legal issues prior to installing signs	All Agencies	Short Term		
2-5-f	Erect signs according to funding availability and timetable	All Agencies	Ongoing		

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2-6 Public Involvement

Volunteer-based watershed programs helps increase the public's involvement and awareness of watershed issues. Examples of public involvement programs that the SWAG may initiate or leverage to foster watershed stewardship and disseminate public education materials include adopt-a-road, Adopt-A-Stream, children's water festival, community focus/planning groups, storm drain marking/door hanger programs, clean-up days, and data collection (water quality, frog and toads, benthic macroinvertebrates).

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
2-6	**Public Involvement**	**SWAG; CRWC; All Agencies**	**Per Activity** **◆ = 2011**	▪ **150 – 300 hrs &** ▪ **$5000 /yr**	**EPA 3, 6, 7, 9, 11, 13, 23, 25, 26, 38, 40, 43** **NOAA 4** **USDA 2**
2-6-a	*Continue/expand existing public involvement programs: Adopt-A-Stream; Adopt-A-Road; Clinton Clean-Up; River Day*	*CRWC; All Agencies*	*Ongoing*		
2-6-b	At events, encourage volunteers to spread messages and materials	SWAG	Short Term Ongoing		
2-6-c	*Expand the storm drain stenciling; revisit areas to be sure markings are intact*	*SWAG; All Agencies*	*Short Term* *10-year cycle*		
2-6-d	Ensure popular subwatershed websites have links to allow for easy submittal of comments to public officials or other environmental professionals	SWAG; All Agencies	Short Term Ongoing		
2-6-e	Encourage the participation of municipal, county, state officials in public events to foster greater community involvement	CRWC; SWAG; All Agencies	Ongoing As possible		

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
2-6-f	Seek buy-in from landowners w/ property in potential wetland restoration areas				See Table 8.1

2-7 Community Forums and Stakeholder Workshops

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Community forums and stakeholder workshops provide a means to mold the ever-evolving WMP. It is critical to have community input in order for the watershed to work together as a whole toward the common goal of protecting and restoring the subwatershed. These meetings should be held periodically to keep the public informed and involved. Forums and workshops may include a report on progress made towards achieving the goals and objectives of the plan. Additionally, involving more private citizens and encouraging them to contact local officials enhances the effectiveness of Action 2-8.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
2-7	**Community Forums and Stakeholder Workshops**	**SWAG**	**Ongoing** **◆ = 2011**	▪ **150 – 300 hrs &** ▪ **$5000 /yr**	**EPA 3, 6, 7, 9, 11, 13, 23, 25, 26, 38, 40, 43** **NOAA 4** **USDA 2**
2-7-a	Tie-in with other popular community events in order to increase exposure and attendance	SWAG	When Appropriate		
2-7-b	Encourage the participation of municipal, county, state officials in public events to foster greater community involvement	CRWC; SWAG; All entities	Ongoing; When Appropriate		

> *<u>Recall from the Social Survey Results</u>*
>
> *If local residents' needs are being met by the currently perceived water quality conditions, then it will be difficult to motivate them to improve conditions. For marketing purposes it would be best to communicate proposed actions as necessary to preserve the current level of amenities for the future rather than improving conditions for activities that may not be supported.*

2-8 Municipal Officials' Involvement and Education

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Locally appointed and elected officials are critical players in allocating resources toward WMP implementation. Involving and educating municipal officials (mayors, city/village councils, township trustees, department heads, zoning boards, planning commissions, etc.) on the existence, reason for, and contents of the WMP helps obtain buy-in to the program and generates support which leads to successful implementation.

Municipal officials may become involved by participating in workshops, demonstration projects, and public speaking engagements on community stormwater issues. Information can also be passed on to officials through letters, informational packets, and meetings. Educational topics may include:

- best management practices and standards that can be used to promote sustainability in the community and reduce point and nonpoint source pollution;
- model ordinances and information on existing programs that provide technical and cost-share assistance; and
- techniques for reviewing each development project for environmental impacts and a fair mechanism for rejecting those that would adversely affect water quality (e.g. violate water quality standards); and
- environmental-related and other curriculum to get feedback on adopting a standard curriculum into the school districts.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
2-8	**Municipal Official's Presentations**	**SWAG**	**Ongoing** **◆ = 2011**	▪ **200 – 400 hrs &** ▪ **$5000 /yr**	**EPA 3, 6, 9, 11, 13, 23, 25, 26, 40** **NOAA 4** **USDA 2**
2-7-a	Establish a regular schedule for present-ations to officials for regular updates, pro-gress reports, and changes in conditions	SWAG; All Agencies	Ongoing		
2-7-b	Encourage officials to participate in subwatershed events if possible	SWAG; All Agencies	Ongoing		
2-7-c	Encourage officials to be the example for their community and implement appropriate actions at their homes/offices	SWAG; All Agencies	Ongoing		
2-7-d	Implement supplemental communiqués with officials on SWAG activities, environmental protection, regulatory needs, need for school curriculum, etc.	SWAG; All Agencies	Ongoing		

3-1 Update / Develop Master Plans

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Having master plans 'on the books' is the basic first step that entities should take to provide the foundation for more advanced environmental protection or regulating of other enterprises (e.g. transportation, stormwater, recreation, sewer systems, solid waste, trails).

3. Ordinances, Zoning, and Development Standards

These actions are meant to give stakeholders better control over environmental conditions as we move into the future by helping control how development is constructed, where development is constructed, and what resources are consumed/ preserved when developments are constructed. These actions also cover other regulatory mechanisms that are aimed at reducing pollution.

The benefit of these actions is an improvement in surface water and groundwater quality through the prevention or minimization of the effects of urbanization or other pollutant sources.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
3-1	**Update / Develop Master Plans**	**Municipalities, Counties**	**Next Five Years** **◆ = 2015**	▪ **$50,000 + legal fees (every update)**	**Foundations**
3-1-a	*Update or develop master plans that specifically refer to the preservation of open space, sensitive natural areas, riparian zones, wetlands, water resources and the need to address stormwater and its myriad pollutants*	All Agencies	*Short Term*		
3-1-c	Prepare master plans and ordinances to support the goals and objectives of the WMP	All Agencies	Short Term		
3-1-d	*In the Master Plan, recognize TMDLs, within the watershed*	All Agencies	*Short Term*		

3-2 Managing Development Patterns

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Because of the varying characteristics of the entities in the subwatershed, they require a wide range of options to implement this class of actions. Options that may be considered include:

- encouraging infill and redevelopment (i.e. relaxing frontage and setback requirements);
- encouraging open space in development and redevelopment projects;
- protecting farmland;
- implementing a site plan and review process;
- limiting future infrastructure expansion (i.e. sewer and water service boundaries);
- restricting the construction of private roads;
- developing urban growth boundaries;
- restricting development in the 100-year floodplain;
- setting large minimum lot sizes for development;
- requiring cluster development;
- implementing forest districts;
- implementing farming districts to preserve farmland;
- incorporating the above and other measures into existing land use / master plans and zoning; and
- developing these if they don't currently exist.

Critical areas for managing development patterns are those currently experiencing development pressures and those yet to be developed.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
3-2	**Managing Development Patterns**	**Municipalities, Counties**	**Next Five Years** **◆ = 2015**	▪ **1000 – 2000 hrs &** ▪ **$30,000 /entity (total)**	**EPA 2, 3, 7, 9, 13, 23, 26** **USDA 1, 2, 3, 4, 6, 7** **USGS 12**
3-2-a	*Encourage Low Impact Development and other best management practices on all new development and redevelopment.*	*All Agencies*	Short Term		
3-2-b	*Expand existing farmland preservation efforts*	*All Agencies*	*Short Term*		
3-2-c	*Implement forest districts to preserve and enhance wooded areas throughout the subwatershed*	*All Agencies; Land Conservancy*	*Short Term*		

3-3 Preserve Natural Areas / Features

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Because of the wide range of natural features to protect in the watershed there is an equally wide-range of considerations. Features to be protected may include: pre-settlement areas, wetlands, waterbodies, riparian areas, headwater areas, groundwater recharge areas, forested areas, and habitat areas.

Measures for their protection may include:

- no net loss policies;
- restricting alterations to these areas (e.g. limiting road crossings);
- restricting disruptive or soil disturbing uses in or near protected areas;
- encouraging their connection to adjacent natural and undeveloped areas; and
- setback ordinances restricting development and significant maintenance from occurring within a specified buffer zone,

Stronger measures are needed for known areas and features in need of protection as well as for including features in the Regional green infrastructure systems. Consideration should be given for the use of some of these areas as passive parks in order to to increase support for action.

Addionally, the SWAG may consider pursuing pollution prevention activities.

<u>*Critical areas for these practices are undeveloped areas.*</u>

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
3-3	**Preserve Natural Areas / Features**	**Municipalities, Counties**	**Ongoing** **◆ = 2015**	▪ **1000 – 2000 hrs &** ▪ **$30,000 + / feature**	**EPA 2, 3, 9, 13, 23** **NOAA 5,** **USDA 1, 2, 3, 8** **USGS 12**
3-3-a	*Adopt stream buffer requirements establishing 100-foot width of continuous connectivity*	*All Agencies*	*Short Term*		

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
3-3-b	*Adopt comprehensive tree ordinance that calls the preservation and planting of native species*	*All Agencies*	*Short Term*		
3-3-c	*Offer incentives for construction on riparian property to those that implement strict construction controls and implement post-construction facilities*	*All Agencies*	*Short Term*		
3-3-d	*Use all planning mechanisms available (e.g. zoning) to preserve high priority natural areas and wetlands**	*All Agencies; Land Conservancy*	*Ongoing*		
** See Table 8.1 for acres of wetland by reach*					

3-4 Stormwater Management Standards

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Because of the varying characteristics of the public entities in the subwatershed, a wide range of options required in this Action Category. Options that may be considered include:

- Discharge Limitations:
  - Of pollutant levels in runoff water (i.e. suspended solids, phosphorus, pathogens); and
  - Of peak flow rates and total runoff volume (i.e. limiting to pre-development levels);
- Infiltration Requirements:
  - Of total volume or percentage of site;
- Impervious Surface Limitations:
  - Of overall site imperviousness (i.e. road widths, cul-de-sacs, parking lots); and
  - Of directly connected impervious areas; and
- Natural Drainage Patterns:
  - Through minimization of site disturbance to retain natural topography;
  - Through restricting slopes to encourage sheet flow; &
  - Through preserving or reintroducing open channel conveyance with natural channel shapes and meanders.

The actions in this category are meant to allow both prescriptive and non-prescriptive approaches in combination. For example, some situations may require certain BMPs while others may require any combination of BMPs to achieve certain targets or limitations.

Critical areas for developing standards are those areas where both new development and significant redevelop are occurring

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
3-4	**Stormwater Management Standards**	**Municipalities, Counties**	**Next Five Years** **◆ = 2015**	▪ **1000 – 2000 hrs &** ▪ **$30,000 / entity (total)**	**EPA 2, 3, 9, 10, 11, 13, 26** **USDA 2** **USGS 2, 3**
3-4-a	*Require that preliminary site plans include SESC actions, including inspection and maintenance*	*All Agencies*	*Short Term*		
3-4-b	*Provide target effluent discharge limits that site designs must meet*	*All Agencies*	*Short Term*		

3-5 Pollution Prevention Ordinances / Programs

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This class of actions involves the legal establishment of requirements, limitations, etc., through which municipalities manage their pollution reduction efforts. This is an extension of providing for the health and safety of the public.

Ordinances or programs that may be considered include:

- Requirements for the maintenance and disposal of wastes from private stormwater infrastructure;
- Requirements for private pavement (e.g. roads, lots) cleaning methods, cleaning schedules, and the disposal of wastes;
- Requirements for the restriction of phosphorus in fertilizers and the proper use of pesticides, herbicides, and fertilizers, including proper disposal of excess product;
- Requirements for waste management at vehicle service stations;
- Requirements for materials storage, spill prevention, and cleanup;
- Requirements for the use and maintenance of dumpsters;
- Requirements for proper solid waste management, including prohibitions against illegal dumping;
- Requirements for proper yard waste disposal; and
- Requirements for septic systems, including: site standards (e.g. exclusion areas, lot size requirements, setbacks), performance standards, point-of-sale inspections, and annual licensing based on proof of inspection.

Strong ordinances and programs will also include provision for gaining access to a premise, monitoring a problem and associated remedies.

The critical areas for ordinances will vary considerably based on intent.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
3-5	**Pollution Prevention Ordinances / Programs**	**Municipalities, Counties**	**Next Five Years** **◆ = 2015**	▪ **1000 – 2000 hrs &** ▪ **$30,000* / entity**	**EPA 2, 3, 9, 13, 23, 26, 30, 31, 32** **USDA 2**
3-5-a	Update /expand ordinances to support goals and objectives of WMP**	All Agencies	Short Term		
3-5-b	Update/expand ordinances to require riparian zones, wetlands, and other sensitive natural areas remain free from development	All Agencies	Short Term		
3-5-c	*Prohibit the introduction of pollutant to storm drains and local waterways; enable local capability to monitor, investigate, remedy, and levy fines for illicit discharges*	*All Agencies*	*Short Term*		
3-5-d	*Require owners of OSDSs to optimally maintain them*	*All Agencies*	*Short Term*		

*annual cost of programs not included
** efforts should be coordinated between municipalities and counties

4-1 Remediate Contaminated Sediments

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Where sediment contamination exists, it is desirable to identify clean-up opportunities that are cost effective and non-threatening to the environment (in terms of contaminant re-suspension). Building on the current knowledge of sediment contaminants research may be conducted to identify existing and emerging technologies to remediate the sediment. This information will be provided to SWAG members, along with identified funding opportunities, for them to explore the possibility of implementing remediation activities and obtaining funding for such (as the actual implementation of such activities is outside of the scope of this plan).

Critical areas to focus this action on are those of existing sediment contamination.(See Map 5-15 for contaminated sites)

4. Good Housekeeping and Pollution Prevention

These actions are meant to reduce the generation of pollutants and prevent those that have been generated from reaching environmentally sensitive areas, including waterbodies.

The benefit of good housekeeping and pollution prevention is the improvement of surface water and groundwater quality by minimizing the impacts of pollution generating activities.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
4-1	**Remediate Contaminated Sediments**	**EPA, MDEQ**	**First Five Years, Every Ten Years Thereafter ◆ = 2015**	**▪ 400 – 700 hrs & ▪ $10,000 (report to prioritize hot spots) (each report)**	**EPA 1, 3, 4, 6, 7, 8, 9, 13, 17, 18, 19, 22, 23, 25, 26, 27, 39, 41 NOAA 2, 3, 4, 6, USDA 2, 4, 9 USGS 6, 7 USACE 3**
4-1-a	Conduct studies to quantify and delineate the problem areas**	Local Agencies/ Responsible Party	Long Term		
4-1-b	Obtain cost estimates for clean-up of each site	Local Agencies/ Responsible Party	Long Term		
4-1-c	Undertake clean-up*,**	All Agencies	Long Term		

* Will vary by size and extent of contamination.

** If funding is available

4-2 Storm Sewer System Maintenance and Operations

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Entities will define procedures to ensure that inspection, maintenance, and cleaning of the storm sewer system are done in such a manner that pollutant discharges from the system are minimized. Additionally, the procedures will include provisions for the proper disposal of wastes generated from these activities.

Storm sewer structures investigated during the Unified Subwatershed and Site Reconnaissance survey indicated that these systems were in generally good condition. The presence of organic matter at the sites was the most frequently cited problem (62%).

Critical areas for these practices include storm sewer systems with identified problems (as per responsible agency).

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
4-2	**Storm Sewer System Maintenance and Operations**	**Municipalities, Counties (Drain Commissioner)**	**Ongoing** **◆ = 2015**	▪ **400 – 800 hrs / entity (annually)**	**EPA, 11, 23, 24** **USDA 13, 14, 16**
4-2-a	*Implement a catch basin and BMP cleaning schedule**	*All Agencies*	*Short Term*		
4-2-b	Conduct an asset inventory to ensure that all infrastructure is accounted for and documented	All Agencies	Long Term		
4-2-c	*Implement a downspout disconnection program*	*All Agencies*	*Short Term*		
4-2-d	*Review/improve maintenance procedures so they minimize impacts*	*Municipalities*	*Short Term*		

* Based on historical records and high traffic areas

4-3 Minimizing Pollution from Roads and Lots

A S N P F

Entities will define procedures to ensure that the discharges of pollutants from streets, roads, highways, and parking lots are minimized.

There are an estimated 1,630 road miles in the watershed under various jurisdictions. Parking lots, because they are ubiquitous, are not as easily quantifiable. The condition of municipal parking lots was identified in the Unified Subwatershed and Site Reconnaissance survey as potentially being problematic.

Critical areas are those with construction problems, those that are degrading, and those that are not receiving routine maintenance.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
4-3	**Minimizing Pollution from Roads and Lots**	**Municipalities, Counties (Road Commission)**	**Ongoing** **◆ = 2015**	▪ **400 – 800 hrs / entity (annually)**	**EPA 3, 7, 9, 13, 23, 26, 30, 31, 32, 39, 41** **USDA 2**
4-3-a	*Prioritize street and parking lot sweeping schedule by the most heavily used areas**	*All Agencies*	*Ongoing*		
4-3-b	*Ensure that SOP** for maintence of roads, and parking lots protect water quality*	*All Agencies*	*Ongoing*		
4-3-c	Optimize pavement de-icing protocol	All Agencies	Ongoing		

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
4-3-d	Optimized fire hydrant flushing protocol	All Agencies	Ongoing		
4-3-e	Inspect associated structural BMPs regularly	All Agencies	Inspection-Yearly Maintenance – As Needed		
4-3-f	*Adopt water quality friendly road-stream crossing maintenance*	*All Agencies*	*Short Term*		

* Based on historical records and high traffic areas
** Standard Operating Procedure

4-4 Minimizing Pollution from Municipal Facilities

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Entities will define procedures to ensure that the discharge of pollutants from maintenance garages is minimized. The USSR estimated there are eight-three (83) municipal facilities in the watershed

There is education material available to facilities managers on this topic. Two good sources are SEMCOG's Municipal Training Modules and Michigan's Storm Water Pollution Prevention Plan (SWPPP) for facilities information. This information can be found online at the respective agencies web sites.

Critical areas include all municipal facilities.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
4-4	**Minimizing Pollution from Municipal Facilities**	**All Agencies**	**Ongoing** **◆ = 2015**	▪ **400 – 800 hrs / entity (annually)**	**EPA 3, 7, 9, 13, 23, 26, 30, 31, 32, 39, 41** **USDA 2**
4-4-a	*Implement fleet management SOP*s to protect water quality.*	*All Agencies*	*Ongoing*		
4-4-b	*Implement/continue to apply hazardous materials handling and storage SOP*s*	*All Agencies*	*Ongoing*		
4-4-c	*Implement structural BMPs, if necessary*	*All Agencies*	*Ongoing*		
* Standard Operating Procedure					

4-5 Landscape Management Practices

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Entities will define procedures (standard operating procedures [SOP*] in most cases) to ensure that the discharge of pollutants such as pesticides, herbicides, and fertilizers from common public areas is minimized.

There is education material available to facilities managers on this topic. One good source is SEMCOG's Municipal Training Modules. This information can be found online at this agency's web site.

Critical areas include publicly maintained outdoor common areas.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
4-5	**Landscape Management Practices**	**All Agencies**	**Ongoing** **◆ = 2015**	▪ **400 – 800 hrs / entity (annually)**	**EPA 7, 9, 13, USDA 4**
4-5-a	*Limit the amounts used of fertilizers pesticides and water*	*All Agencies*	*Ongoing*		
4-5-b	Adopt Water Quality Friendly SOP*s such as mowing less and only in essential areas	All Agencies	Ongoing		
4-5-c	*Preserve existing trees (tree ordinance)* plant native vegetation	Municipalities	Ongoing		
4-5-d	*Encourage the planting of trees e.g. (Conservation District tree sales, Arbor Day)*	*All Agencies*	*Ongoing*		

4-6 Waste Management

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One component of waste management is managing solid waste. SWAG members may choose to implement new or augment existing programs, including:

- A recycling program (e.g. curb-side collection and drop-off);
- A hazardous waste management program (e.g. household hazardous waste collection, electronics drop-off, oil and grease collection, mercury thermometer exchange;
- A dumpster management program that ensures that all trash is inside the dumpster, it is covered, and that it is not discharging contaminated stormwater;
- A yard waste collection and management program (e.g. curb-side collection and drop-off; composting and reuse/selling);
- Support of legislative efforts to reduce pollutant discharges, especially those of concern in the subwatershed, from all sources including air emissions; and
- Regular evaluation of MDNRE data related to point sources.

Critical areas include those with identified problems.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
4-6	**Waste Management**	**All Agencies**	**Ongoing** **◆ = 2020**	▪ **600 – 1200 hrs &** ▪ **$5,000 / entity (annually) (plus one time legal fees**	**EPA 3, 7, 8, 9, 13, 22, 23, 26, 30, 31, 32, 33, 34, 41,** **NOAA 2, 3** **USDA 2, 13, 14, 15, 16**
4-6-a	Institute or expand local recycling programs	All Agencies	Ongoing		
4-6-b	*Promote and expand hazardous waste disposal programs*	*All Agencies*	*Ongoing*		
4-6-c	*Ensure that yard waste collection options are available*	*All Agencies*	*Ongoing*		
4-6-d	*Adopt water quality friendly waste management SOP*s include the disposal of municipal waste*	*All Agencies*	*Short Term*		
4-6-c	*Implement an industrial and commercial program to address waste management***	*Local Agency*	*Mid-term*		

*** Standard Operating Procedures**
****The USSR indicated that waste from these land use categories were potential threats to water quality.**

4-7 Bacterial Waste Control

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Animal and human waste has the potential to contribute to pathogen and nutrient contamination of waterbodies. In order to minimize this potential, the SWAG members may choose to implement new or augment existing programs, including:

- Evaluating the impacts of animals (wild, pet, and livestock) on *E. coli* levels in waterbodies and developing/participating in a regional bacterial source tracking system;
- Requiring the collection and proper disposal of pet wastes;
- Identifying areas where wild animal populations (e.g. geese) contribute to waterbody contamination and prescribing the appropriate measures to deter animals from congregating; and
- Defining and promoting pet run areas away from waterbodies where feasible.

Critical areas for these practices are riparian parks and residential lawns.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
4-7	**Animal Waste Control**	**All Agencies**	**Ongoing** **◆ = 2015**	▪ **600 – 1200 hrs &** ▪ **$5,000 / entity (annually) (plus one-time legal fee)**	**EPA 3, 6, 7, 9, 11, 13, 23, 25, 26, 39, 41** **NOAA 4** **USDA 2**
4-7-a	Conduct a source assessment DNA study to parcel out sources of *E.coli*.*,**	All Agencies	Short Term	$75,000 - $250,000	
4-7-b	Implement corrective actions to address source assessment study's findings.*	All Agencies	Long Term Ongoing		
4-7-c	Implement/continue to enforce pet waste ordinances	Municipalities	Short Term		
4-7-d	Ensure that Agricultural producers are following GAAMPs	NRCS, Concervation District, Farm Bureau			

* Modeling results indicated a need for additional information of sources.
** If funding is available.

4-8 Sanitary and Combined Sewer System Planning and Maintenance

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Planning and maintenance of sanitary and combined sewers is critical in preventing the occurrence of sanitary sewer overflows (SSOs) and combined sewer overflows (CSOs). There are a number of considerations to make in this realm, including:

- Giving high priority to connecting areas of septic service, particularly those areas causing documented problems;
- Ensuring proper plant capacities and interceptor capacities;
- Replacing failing system components;
- Constructing facilities or implementing programs to prevent the occurrence of CSOs, SSOs, and basement backups (e.g. infiltration and inflow programs including downspout disconnection);
- Improving municipal and industrial pretreatment programs (e.g. reduced pollutant concentrations, reduced flows – provides offset capacity for service expansion);
- Defining of future service areas or to guide development and preserve natural areas; and
- Employing operating and maintenance procedures that minimize the generation and discharge of pollutants.

SWAG members may choose to directly address some of these considerations. However, in some cases, the SWAG members may have little direct influence on the decision-making process and must rely on expressing these concerns as recommendations to the appropriate entities. *Critical areas for these practices are sanitary and combined sewer areas that currently experience overflows and older systems.*

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
4-8	**Sanitary and Combined Sewer System Planning and Maintenance**	**All Agencies**	**Ongoing** **◆ = 2015**	▪ **$1000 / entity (annually)**	**EPA 11, 23, 24, 29, 36, USDA 13, 14, 16**
4-8-a	Conduct an asset management study	All Agencies	Short Term	$25,000 to $150,000	
4-8-b	Prioritize maintenance and replacement of system based on 4-9-a	All Agencies	Short Term		
4-8-c	Initiate a downspout disconnection program	All Agencies	Long Term		

4-9 Flood Control Projects

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Entities will define mechanisms for assessing the impacts of flood management projects on water quality and examining water quantity structures for incorporation of additional water quality protection devices or practices.

The mechanisms may include:

- Making recommendations to other entities engaging in flood control management to report the impacts on water quality; and
- Instituting a program to examine water quantity structures under the permittee's jurisdiction, developing a prioritized program to retrofit these structures, and implementing the prioritized program. *Critical areas for these practices are existing flood control project areas.*

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
4-9	**Flood Control Projects**	**All Agencies**	**Ongoing** **◆ = 2015**	▪ **400 – 800 hrs / entity (per project)**	**EPA 9, NOAA 6, USDA 14, 17, USGS 4, USACE 4, 5,**
4-9-a	Assess flood control structures and prioritize maintenance and replacement	All Agencies	Variable		

4-10 Illicit Discharge Elimination Plan Implementation

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IDEPs contain numerous activities for identifying and correcting illicit connections currently being implemented by SWAG entities. This action supports the goals and objectives of this WMP and, as such, this action is included for reference.

The IDEPs contain at least some of the following characteristics:

- dry weather screening of outfalls into waters of the state;
- dye testing municipal facilities, including swimming pools;
- provisions for determining the source and responsibility of the discharge, and ownership and maintenance of the sewer system and drains;
- an integration of outfall inspections and reporting during routine field operations;
- a 24-hour hotline that provides the public an immediate mechanism to report any water quality issues; and
- updates to outfall location maps, when appropriate.

An additional consideration for funding is expanding the scope of the hotlines to be used for: 1) documenting violations of natural features protection (i.e. dumping, tree removal); 2) reporting recreational hazards such as log jams; and 3) providing information for those residents wishing to become more involved or participate in pollution prevention and conservation activities.

Critical areas include older urban areas where illicit connections are more likely, areas not investigated, and those areas where problems have been previously identified.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
4-10	**Illicit Discharge Elimination**	**All Agencies**	**Ongoing** **◆ = 2015**	▪ **150 – 1000 hrs &** ▪ **$2,000+ /entity (annually)**	**EPA 3, 6, 7, 9, 11, 13, 23, 24, 25, 26, 39, 41** **NOAA 4** **USDA 2**
4-10-a	Implement an IDEP on a five year cycle.	All Agencies	Ongoing		
4-10-b	*Prioritize IDEP inspections adjacent to OSDS areas*	*All Agencies*	*Ongoing*		
4-10-c	Provide a 24-hr hotline for water quality issues	All Agencies	Ongoing		

4-11 Septic System Practices

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The SWAG and/or its members should develop a program to minimize pollutant discharges from:

- single and two family residential septic systems;
- commercial and small community septic systems discharging up to 10,000 gallons per day; and
- other On-site Sewage Disposal Systems (OSDS), as appropriate.

In Michigan, the local health departments, with autonomous sanitary codes, are the primary regulators for single and two family residential septic systems. Commercial and small community septic systems discharging up to 10,000 gallons per day fall under the "Michigan Criteria for Subsurface Sewage Disposal". This statewide document is carried out by the local health departments under certification by the MDNRE.

Septic system practices to be implemented may include:

- Technical assistance (clustering systems, maintenance education, maintenance districts, leaching chambers, siting, etc.);
- Inspections (point-of-sale, annual licensing, performance level, identification of failing systems, etc.);
- Enforcement (correction of problems, maintenance checks, etc.);
- Recommendations for alternative technologies in areas where septic systems and sewers are not highly feasible sewage disposal methods; and
- Incentives for septage transfer stations and convenient disposal facilities.

The proper implementation of this action may require revisions to the local health or sanitary code in addition to other legal-based mechanisms.

Critical areas for septic system practices include riparian areas or older developments where failure rates may be higher.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
4-11	**Septic On-site Disposal System Practices**	**All Agencies SWAG**	**Begin Immediately** **◆ = 2015**	▪ **2000 – 4000 hrs / entity (annually)**	**EPA 3, 6, 7, 11, 13, 23, 24, 26, 39, 41** **USDA 13, 14, 16** **USGS 7**
4-11-a	*Adopt a septic system maintenance program/ ordinance*	*All Agencies*	*Short Term*		** Note: This action is in addition to the current time-of-sale ordinance.*
4-11-b	*Prioritize OSDS areas by age and E.coli. levels*	*All Agencies*	*Short Term*		
4-11-c	Undertake a pilot study to cost-share repairing/ replacing OSDS	Local Agency	Mid Term		

4-12 Trash/Debris Reduction

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The SWAG and/or its members may develop a program to identify sites that have excessive trash and debris and to prioritize these sites. An initial list of sites can be developed form the results of the Unified Subwatershed and Site Reconnaissance (USSR) and Unifies Stream Assessment (USA) surveys.

This program may include procedures for removing the trash and debris and will be coordinated with volunteer activities conducted under Action 2-6 (e.g., Adopt-A-Road, Adopt-A-Stream).

Additionally, measures may be instituted to ensure that all events which result in excessive trash, such as festivals and street fairs, are coordinated with the appropriate operations and maintenance (O&M) Departments.

Critical areas are those where debris tends to accumulate and is problematic.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
4-12	**Trash / Debris Reduction**	**All Agencies**	**Ongoing** **◆ = 2011**	▪ **100 – 200 hrs &** ▪ **$1000 / per event**	**EPA 3, 6, 13, 23, 26, 33, 34, 39, 41** **USDA 13, 14, 15, 16** **USGS 7**
4-12-a	*Implement Adopt-A-Road programs (where they don't exist)*	*All Agencies*	*Short Term*		
4-12-b	*Implement Adopt-A-Stream programs*	*CRWC*	*Short Term*		
4-12-c	Partner with volunteer organization to conduct clean-up after events	All Agencies	Ongoing		e.g. CRWC River days and Clinton Clean-up as existing programs

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4-13 Spill Prevention / Notification / Response

The SWAG and/or its members may develop a spill prevention, notification, and response program which may include assistance with investigation of major spills to waterways, fish kills and other emergency water quality issues.

<u>Critical areas for these practices include those with the greatest potential to cause environmental impacts (e.g. businesses handling extremely toxic substances or those in riparian areas).</u>

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
4-13	**Spill Prevention / Notification / Response**	**All Agencies**	**Ongoing** **◆ = 2011**	▪ **200 – 400 hrs to develop system** ▪ **$10,000 annually (shared operating costs)**	**EPA 3, 7, 9, 13, 23, 26, 30, 31, 32, 39, 41** **USDA 2**
4-13-a	Promote the spill notification hotlines*	All Agencies	Ongoing		
4-13-b	Develop a response protocols for various types of spills	All Agencies	Short Term		Note: This should include SESC violations on construction sites

*The hotline should also be capable of handling SESC violations on construction sites too.

4-14 Groundwater

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The SWAG and/or its members may develop a program to prevent the pollution of groundwater and ensure that levels are maintained by ensuring proper recharge and restricting overuse. Components of such a program may include:

- A groundwater inventory to identify areas of groundwater recharge and vulnerable areas, as well as their proximity to potentially polluting activities or land uses. This assessment may consider the needs of future developing areas;
- Wellhead protection areas may be delineated based on the results of the inventory and signage erected to identify the areas. The development of wellhead protection plans may be considered, and if pursued, may be coordinated with the MDNRE's Water Wellhead Protection Program; and
- An abandoned well locating, inspection, and closure program may be implemented. This may include supporting legislation to increase regulatory control at the state and local level thus making the process more cost-effective.

Critical areas for the implementation of these practices are those in which groundwater contamination is possible, especially in those areas where it is used for drinking water.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
4-14	**Groundwater / Drinking Water Protection**	**Municipalities, Counties, Subwatershed Groups**	**Ongoing** **◆ = 2015**	▪ **1000 – 2000 hrs &** ▪ **$50,000 + / entity (annually)**	**EPA 3, 4, 5, 12, 15, 16, 22, 41, 44** **USDA 3** **USGS 7**
4-14-a	*Undertake/Update Well Head Protection Plans to State Standards*	*Applicable Municipalities*	*Short Term*		
4-14-b	Post Wellhead Protection Area Signs	Applicable Municipalities	Short Term		
4-14-c	Implement an abandoned well capping program	Counties	Short Term		

4-15 Agriculture

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This action deals with implementing some of the more procedural Generally Accepted Agricultural Management Practices [GAAMPS], typically these will lack extensive infrastructure or plantings and will deal with things like letting a field lie fallow for a season with roots in place to reduce sediment runoff from the field.

Critical areas are active agricultural lands and facilities.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
4-15	**Agriculture**	**NRCS, MDA, Conservation Districts**	**Ongoing** **◆ = 2015**	▪ **Varies by GAAMP**	**Various NRCS programs**
4-15-a	*Ensure that agricultural producers are following GAAMPs*	*NRCS, Conservation District, MSUE, Farm Bureau*	*Ongoing*		
4-15-b	*Promote water quality friendly management practices on farms*	*NRCS, Conservation District, MSUE, Farm Bureau*	*Ongoing*		

4-16 Emerging Issues

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This action is included to provide a place for to put action for addressing emerging issues that don't fit under any of the old, existing categories.

Critical areas are dependent on the emerging issue but do include the waterbodies downstream of WWTP effluent.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
4-16	**Emerging Issues**	**Counties (Health Departments)**	**Ongoing** **◆ = 2015**	▪ **$10,000 /year to sample suspected pollutants**	**National Institutes for Health** **National Science Foundation**
4-16-a	Track emerging issues, such as the presence of pharmaceuticals and invasive species in order to take appropriate corrective actions	State, Counties, SWAG	Ongoing		

5-1 Bare Soil Repair

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5. Stormwater Best Management Practices: Soil Erosion and Sediment Control

These actions specifically target means to prevent soil erosion, control sediment from various sources, and correct known soil erosion problems and are meant to begin the process of achieving pollutant loading reductions in the short term.

These actions benefit surface water quality by identifying areas of significant soil erosion and utilizing controls to prevent or minimize sediment discharge to waterbodies.

Areas of bare soil have the potential to erode and load sediment into waterbodies. The most problematic bare soil areas are those near waterbodies or those near impervious surfaces. The SWAG and/or its members may take the following steps to repair bare soil areas:

- Repair soil problem areas on public land and contact private landowners to encourage repair;
- Researching the possibility for instituting corrective action on private lands through various enforcement mechanisms; and
- Implementing enforcement mechanism if possible, and correct bare soil problems on private lands.

Efforts to repair bare soil include grass or native vegetation planting, sod placement or the use of containing structures, retaining walls, or terracing. Steep slopes which contribute to the problem may be mitigated with stabilization structures, including vegetation, and grade breaks.

Critical areas for bare soil repair include those areas where specific problems have been identified.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
5-1	**Upland Bare Soil Repair**	**Subwatershed Groups, Municipalities, Counties**	**Ongoing** **◆ = 2015**	▪ **200 – 400 hrs &** ▪ **$5,000 / entity (annually) (plus one-time legal fee)**	**EPA 9** **USDA 3, 4** **GLC 1**
5-1-a	Identify and prioritize bare soils areas in the riparian zone	All Agencies	Long Term		
5-1-b	Develop a plan to address bare soil areas based on 5-1-a on both public and private land.	SWAG, All Agencies	Long Term Ongoing		Note: Coordinate with the Habitat Restoration and Preservation Plan
5-1-c	In agricultural areas use the mechanism outlined in action category 4-18 to address bare soil areas	NRCS, Conservation District, Farm Bureau, MSUE	Short Term Ongoing		
5-1-d	Repair soil in bare areas in accordance with plan to achieve desired load reductions	All Entities	Long Term		

5-2 Streambank / Shoreline Stabilization

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Streambank and outfall erosion are of critical concern because the eroded soil directly enters a waterbody. The USA estimated that there are two-hundred and eleven (211) river miles. The SWAG and/or its members may take the following steps to stabilize streambanks:

- If seeking MDNRE funding for streambank stabilization, obtain documentation that stream hydraulics will not cause the problem to re-emerge;
- Repair eroding streambanks in accessible locations; and
- Seek access to problematic locations through interactions with appropriate stakeholders and repair streambanks when access issues are resolved.

Critical areas for streambank and shoreline stabilization include those areas where specific problems have been identified.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
5-2	**Streambank Shoreline / Stabilization**	**Subwatershed Groups, Municipalities, Counties**	**Ongoing** **◆ = 2015**	▪ **300 – 600 hrs &** ▪ **$10,000 / location**	**EPA 9** **NOAA 1, 2, 6** **USDA 3, 4** **USGS 1, 4, 5** **GLC 1**
5-2-a	Inventory areas needing stabilization for the RHRPP* (7-1-a)	Municipalities, Counties,	Short Term		
5-2-b	*Prioritize and Implement the RHRPP* in riparian areas*	*SWAG, All Agencies*	*Long Term Ongoing*		*Note: Initial sites have been identified either through the USA** or other means.*
5-2-c	Seek external funding for restoration efforts	SWAG; All Agencies	Short Term Ongoing		
5-2-d	*Provide technical assistance to riparian land owners*	*SWAG; All Agencies*	*Short Term*		*Note: This is conceptualized to take the form of expert advise and design assistance.*
5-2-e	*Offer incentives to developers that implement riparian BMPs*	*All Agencies*	*Short Term Ongoing*		
5-2-f	Stabilize streambanks in accordance with plan to achieve desired load reductions	All Entities	Long Term		

* Riparian Habitat Restoration and Preservation Plan ** Unified Stream Assessment

5-3 Road and Ditch Stabilization

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Road and ditch erosion is of critical concern because the eroded materials and soil may directly enter a storm sewer or nearby waterbody (through runoff or by wind action). It was estimated in the USSR that there are about 1,630 road miles in the watershed. The SWAG and/or its members may take the following steps to stabilize roads and ditches:

- Repair failing paved roads, pave or stabilize dirt roads, and stabilize ditches and embankments on public land and contact private landowners to encourage repair;
- Researching the possibility for instituting corrective action on private lands through various enforcement mechanisms; and
- Implementing enforcement mechanism if possible, and correct eroding roads and ditches on private lands.

Critical areas for road and ditch stabilization include those areas where specific problems have been identified.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
5-3	**Road and Ditch Stabilization**	**Subwatershed Groups, Municipalities, Counties (Road Commissions)**	**Ongoing** **◆ = 2015**	▪ **250 – 500 hrs &** ▪ **$10,000 / location** ▪ **Each location**	**EPA 9** **USDA 4** **GLC 1**
5-3-a	Prioritize maintenance and replacement schedules to protect riparian areas	All Agencies	Short Term Ongoing		
5-3-b	Implement and enforce maintenance agreements on private roads and storm water systems	All Agencies	Short Term Ongoing		
5-3-c	Manage public roads in a way that mitigates impacts to the environment*	All Agencies	Short Term Ongoing		
5-3-d	Develop a plan to address road and ditch erosion in accordance with meeting pollutant load reductions	All Agencies	Long Term		
5-3-e	Repair eroding roads and ditches in accordance with the plan to achieve pollutant load reductions	All Entities	Long Term		

* Several gravel road maintenance guides exist.

5-4 Streambank Use Exclusion

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Certain activities in the riparian corridor may exacerbate soil erosion problems. These may include ad hoc walking trails close to a waterbody (as opposed to planned and properly constructed trails) or livestock with access to a stream. The SWAG and/or its members may consider the following to exclude problematic uses from streambank access:

- Installing physical barriers to restrict access where appropriate and feasible;
- Installing educational / informational signage; and
- Engaging in cooperative efforts with riparian landowners to restrict harmful uses.

Critical areas for the implementation of these practices is where specific problems with streambank access are an identified current or potential future problem.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
5-4	**Streambank Use Exclusion**	**Subwatershed Groups, Municipalities, Counties**	**Ongoing** **◆ = 2015**	▪ **250 – 500 hrs &** ▪ **$10,000 / location**	**EPA 9** **NOAA 1, 2, 6** **USDA 4** **USGS 1, 4, 5** **GLC 1**
5-4-a	Educate Riparian Land Owners regarding how their actions may impact the river	Various entities, SWAG	Short Term Ongoing		Note: Private Land Owner Education Programs = 2-1-g , and 5-7-a&b
5-4-b	Develop a plan and seek external funding for a cost-share program to erect barriers to restrict access by livestock and other damaging uses	SWAG, NRCS, Conservation District, MSUE, Farm Bureau	Short Term Ongoing		
5-4-c	Erect barriers in accordance with plan				

5-5 Specific Site Control

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Certain sites in the subwatershed, such as landscaping supply companies, have the potential to generate large amounts of sediment that may unintentionally enter the stormwater drainage system either on-site or by being transported off-site on impervious surfaces. The SWAG and/or its members may consider the following to minimize pollution from sensitive sites:

- Developing appropriate procedures or structural modifications to implement at these sites and working with the sites to realize the improvements (i.e. on-site vehicle washing for vehicles dealing with sediment generating substances); and
- Installing appropriate structures in the public right-of-way (i.e. rock entrances designed to dislodge sediment from vehicle tires).

Critical areas for the implementation of these controls are those in which specific practices are the most warranted for pollution control or cost-effectiveness considerations.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
5-5	**Specific Site Control**	**Subwatershed Groups, Municipalities, Counties**	**Ongoing** **◆ = 2015**	▪ **250 – 500 hrs &** ▪ **$10,000 / location**	**EPA 9** **USDA 3, 4** **USACE 6** **GLC 1**
5-5-a	Emphasis the need to address polluted runoff through structural BMP in the business education program 2-2-c	SWAG, All Agencies	Short Term Ongoing		
5-5-b	*Provide technical assistance to businesses willing to install structural BMPs*	*SWAG*	*Short Term Ongoing*		
5-5-c	Identify sites that require specialized controls	All Entities	Long Term		
5-5-d	Implement specialized controls at sites in accordance with achieving pollutant load reductions	All Entities	Long Term		

Note: The following problem sites were identified during the Social Survey (as reported):
1) The composting and sludge disposal operations on 32 Mile between Omo and Place Rd. may be adding to the DO and E.coli problems in the East Branch of the Coon Creek.
2) The golf course at 31 Mile & Romeo Plank has been a problem in the past, but are more receptive to better fertilizer applications lately.

5-6 Structural Controls

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Where point sources cannot be controlled with sensitive site actions (see 5-5) or non-point sources are a problem, structural controls may be added that intercept sediment either before it enters or before it is discharged from the storm sewer system. The SWAG and/or its members may consider constructing appropriate structures (e.g. catch basin inserts, grit chambers) where necessary to achieve pollutant load reductions. Appling for grant to retrofit neighborhoods with structural controls should be ongoing.

The implementation of structural controls should be coordinated with road or utility work to reduce installation costs.

Critical areas for the implementation of structural controls in these areas are where vegetative controls or managerial controls are not practical or are ineffectual.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
5-6	**Structural Controls**	**All Agencies**	**Ongoing** **◆ = 2015**	▪ **250 – 500 hrs** ▪ **$10,000 / location**	**EPA 9** **USDA 3, 4,**

5-6-a	*Classify neighborhoods based of their ability to manage storm water, if funding is available.*	*All Agencies*	*Short Term*		
5-6-b	Prioritize retrofitting neighborhoods based on 5-6-a	All Agencies	Short Term Ongoing		
5-6-c	Identify all other sites where structural controls are necessary to handle excessive sediment loads	All Entities	Short Term		
5-6-d	Install structural controls at identified locations and plan for long-term maintenance of the controls	All Entities	Long Term		
Note: The USSR indicated that the age and type of neighborhood were key factors. Proximity to water should also be considered. Note: Work with local service organizations to undertake work .e.g. MSUE Master Gardener Program					

5-7 Agricultural BMPs

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Runoff and wind-borne pollutants from agricultural areas have the potential to introduce pollutants into waterbodies. The SWAG and/or its members may consider the following to minimize pollution from agricultural locations:

- Encouraging agricultural land operators to implement appropriate actions and encouraging them to work with appropriate agencies and funding programs;
- Contacting appropriate agencies to begin dialogue with operators and seek implementation of actions; and
- Implementing mechanisms in the public right-of-way in problematic locations where operator cooperation has not been obtained.

Critical areas for the implementation of agricultural controls are agricultural areas in riparian areas.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
5-7	**Agricultural BMPs**	**NRCS, Conservation Districts**	**Ongoing** **◆ = 2015**	▪ **500 – 750 hrs** ▪ **$10,000 / location**	**EPA 3, 8, 9, 14, 25, 39, 31, 32, 41** **USDA 2, 3, 4, 6, 9, 18** **USGS 7**
5-7-a	*Expand the capacity to deliver the Crop-A-Syst and Farm-A-Syst programs*	*NRCS, Conservation District, Local Agencies*	*Short Term*		*Note: Focus of riparian farm lands*
5-7-b	*Expand the capacity to deliver the CRP and CREP programs*	*MDA, NRCS, Conservation District, Local Agencies,*	*Short Term*		
5-7-c	*Explore options to fund Farm Land PDR* in the five*	*MCPDRC, MSUE*	*Short Term*		*Note: Explore partnership with Six River Regional Land*

	partner townships				*Conservancy*
5-7-d	*Prioritize land for preservation currently in riparian areas and agricultural productions*	*Counties, NRCS, Conservation District, MSUE, Farm Bureau*			*Note: this should be done as part of the recommended Riparian Habitat Restoration and Preservation Plan*
5-7-e	Implement new practices and install BMPs to help achieve pollutant load reductions	Farm Operators	Long Term		
* Purchase of Development Rights					

5-8 Construction Sites / SESC Program

Continue to enforce construction site SESC program.

Critical areas are sites where construction is occurring.

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Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
5-8	Construction Sites	Subwatershed Groups, Municipalities, Counties	Ongoing ◆ = 2015	▪ 400 – 800 hrs ▪ $25,000+ / location	EPA 3, 13, 39 NOAA 2
5-8-a	*Continue to enforce SESC regulations*	*County and other MEA and CEAs*	*Ongoing*		
5-8-b	Adopt new Construction SESC requirements as they are released.	County and other MEA and CEAs	Long Term		

6-1 Mitigate Existing Impervious Surfaces

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By managing runoff from impervious surfaces before it enters the storm sewer system or nearby waterbody, peak flow rates, total volume runoff, and pollutant concentrations can be reduced.

The SWAG and/or its members may consider the following to mitigate existing impervious surfaces:

- Vegetated parking lot islands;
- Vegetated road medians;
- Green roofs;
- Pervious pavement / pavers;
- Rain barrels and cisterns (only with timely usage or interim draining protocols being followed); and
- Managing flow from bridge scupper drains;
- Naturalize areas.

Critical areas for these practices are those of intense urbanization.

6. Stormwater Best Management Practices: Other

These actions specifically target the major stressors in the subwatershed and are meant to help with achieving pollutant loading reductions in the long term.

Similar to Category 5, Category 6 actions benefit surface water quality through the implementation of controls to prevent or minimize pollutant discharge to waterbodies.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
6-1	**Mitigate Existing Impervious Surfaces**	**Subwatershed Groups, Municipalities, Counties**	**Ongoing** **◆ = 2015**	▪ **400 – 800 hrs &** ▪ **$25,000 +/ project**	**EPA 3, 13, 39** **NOAA 2**
6-1-a	Adopt the State LID manual to design for storm water issues.	All Agencies	Short Term		
	Review ordinances/ requirements to allow for mitigating impervious surfaces.*	All Agencies	Short Term		Note: This is Action 3-3-d*
	Provide technical assistance to businesses willing to install structural BMPs	All Agencies	Long Term		Note: This is Action 5-5-b*
6-1-b	Identify areas of impervious surface that will be mitigated to achieve load reductions	All Entities	Long Term		
6-1-c	Implement impervious surface mitigation techniques as planned	All Entities	Long Term		

* Water Quality and Channel Protection Peak rate and Volume control requirements.
* An Action Item number has not been assigned in order to avoid duplication

6-2 Infiltration Techniques

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Using infiltration techniques to manage runoff reduces peak flow rates, total volume runoff, and pollutant concentrations that would otherwise enter the storm sewer system and impact a nearby waterbody. Infiltration techniques refer to practices which promote groundwater recharge and where the soils are conducive for infiltration.

The SWAG and/or its members may consider the following to reduce stormwater impacts through infiltration:

- Rain gardens / tree boxes / bioretention;
- Infiltration basins;
- Infiltration trenches;
- Porous pipe and underground infiltration systems; and
- Water spreading.

Critical areas for these practices include those where soil conditions permit and where groundwater contamination is not a concern.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
6-2	**Infiltration Techniques**	**Subwatershed Groups, Municipalities, Counties**	**Ongoing** **◆ = 2015**	▪ **400 – 800 hrs &** ▪ **$25,000 +/ project**	**EPA 3, 9, 11, 13, 24, 39** **NOAA 2, 4** **USDA, 2, 3, 4, 9**
	Adopt the State LID manual to design for storm water issues.	All Agencies	Short Term		Note: This Action 6-1-a*
	Review all ordinances/ requirements to allow for infiltration techniques.*	All Agencies	Short Term		Note: This is Action 3-3-d*
	Provide technical assistance to businesses willing to install structural BMPs	All Agencies	Long Term		Note: This is Action 5-5-b*
6-2-a	Identify areas that will make use of infiltration practices to achieve load reductions	All Entities	Long Term		
6-2-b	Implement infiltration techniques as planned	All Entities	Long Term		

* Water Quality and Channel Protection Peak rate and Volume control requirements.
* An Action Item number has not been assigned in order to avoid duplication

6-3 Filtration Techniques

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Filtration techniques are similar to infiltration techniques in that they reduce peak flow rates, total volume runoff (if bio-filtration is used), and pollutant concentrations. They differ in that filtration is usually used in areas where the soils are not appropriate for infiltration. Subsequently, filtration techniques bring in an alternative filtering media, such as sand, and use an underdrain to direct the treated water to a storm sewer system or waterbody.

The SWAG and/or its members may consider the following to reduce stormwater impacts through filtration:

- Sand/ organic / media filters (surface and underground);
- Pocket filters;
- Intermittent filters;
- Recirculating filters;
- Filter strips; and
- Perimeter sand filters.

Critical areas for these practices include those where water quality improvements are desired but soil conditions prohibit infiltration.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
6-3	**Filtration Techniques**	**Subwatershed Groups, Municipalities, Counties**	**Ongoing** **◆ = 2015**	▪ **400 – 800 hrs &** ▪ **$25,000 +/ project**	**EPA 3, 9, 11, 13, 24, 39** **NOAA, 2, 4** **USDA, 2, 3, 4, 9**
	Adopt the State LID manual to design for storm water issues.	All Agencies	Short Term		Note: This Action 6-1-a*
	Review all ordinances/ requirements to allow for filtration techniques.*	All Agencies			Note: This is Action 3-3-d*
	Provide technical assistance to businesses willing to install structural BMPs	All Agencies			Note: This is Action 5-5-b*
6-3-a	Identify areas that will make use of filtration practices to achieve load reductions	All Entities	Long Term		
6-3-b	Implement filtration techniques as planned	All Entities	Long Term		

* Water Quality and Channel Protection Peak rate and Volume control requirements.
* An Action Item number has not been assigned in order to avoid duplication

6-4 Vegetative Buffers & Natural Conveyance

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Using vegetative conveyance to manage runoff reduces peak flow rates, pollutant concentrations, and in some cases total volume runoff that would otherwise enter the storm sewer system or nearby waterbody.

The SWAG and/or its members may consider the following to reduce stormwater impacts through vegetative buffers and natural conveyance:

- Herbaceous and forested riparian buffers;
- Wet and dry swales; and
- Vegetated channels.

Critical areas for these practices include previously developed areas with amenable topographical conditions.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
6-4	**Vegetative Buffers and Natural Conveyance**	**Subwatershed Groups, Municipalities, Counties**	**Ongoing** **◆ = 2015**	▪ **400 – 800 hrs &** ▪ **$25,000 +/ project**	**EPA 2, 3, 9, 10, 11, 13, 24, 39** **NOAA 2, 4, 5** **USDA, 2, 3, 4, 5, 8, 9** **USGS, 2, 3**
	Adopt the State LID manual to design for storm water issues.	All Agencies	Short Term		Note: This Action 6-1-a*
	Review all ordinances/ requirements to allow for vegetative buffers and natural conveyance.*	All Agencies			Note: This is Action 3-3-d*
	Provide technical assistance to businesses willing to install structural BMPs	All Agencies			Note: This is Action 5-5-b*
6-4-a	Identify areas that will make use of natural conveyance and vegetative buffers to achieve load reductions	All Entities	Long Term		
6-4-b	Implement natural conveyance and vegetative buffers techniques as planned	All Entities	Long Term		

* Water Quality and Channel Protection Peak rate and Volume control requirements.
* An Action Item number has not been assigned in order to avoid duplication

6-5 Retention and Detention

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Using retention and detention to manage runoff reduces peak flow rates, pollutant concentrations, and total volume runoff that would otherwise enter the storm sewer system or nearby waterbody.

The SWAG and/or its members may consider the following to reduce stormwater impacts through vegetative buffers and natural conveyance:

- Detention / retention ponds;
- Pond/wetland systems;
- Extended detention wetlands;
- Shallow wetlands; and
- Submerged gravel wetlands.

Critical areas for retention and detention include previously developed areas with little or no stormwater controls (especially those where land is available).

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
6-5	**Retention and Detention**	**Subwatershed Groups, Municipalities, Counties**	**Ongoing** **◆ = 2015**	▪ **400 – 800 hrs &** ▪ **$25,000 +/ project**	**EPA 3, 9, 11, 13, 24, 39** **NOAA, 2, 4** **USDA, 2, 3, 4**
	Adopt the State LID manual to design for storm water issues.	All Agencies	Short Term		Note: This Action 6-1-a*
	Review all ordinances/ requirements to allow for retention/detention basins.	All Agencies			Note: This is Action 3-3-d*
	Provide technical assistance to businesses willing to install structural BMPs	All Agencies			Note: This is Action 5-5-b*
	Identify areas that will make use of retention and detention practices to achieve load reductions	All Entities	Long Term		
	Implement retention and detention practices as planned	All Entities	Long Term		

* Water Quality and Channel Protection Peak rate and Volume control requirements.
* An Action Item number has not been assigned in order to avoid duplication

Action Category 7

This action category contains the specific action to be undertaken in order to preserve and restore the North Branch of the Clinton River. Below are the general categories with descriptions of the types of action they encompass. Appendix H.4 contains the specific sites identified for preservation and/or restoration activities. The appendix is presented by catchment so that the identified sites can be matched with the priorities set in Chapter 7 (page 7-19). Each site has information on the identified problem, recommended action, and location associated with it.

Identified sites were derived from five sources: 1) a GIS aerial resonance exercise (Site ID are alpha numeric; 2) the USA (Site IDs are numeric); 3) the USSR (Sites IDs are abbreviated names); 4) The Macomb County Public Works Office (Site IDs are names); and 5) the Six Rivers Regional Land Conservancy (Site IDs are names). Sites identified through GIS and the USA and USSR do not overlap.

7-1 Identify Natural Features

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Identifying natural features in the subwatershed is integral to implementing other protection and restoration actions. The natural features identification will be prepared by the SWAG and will rely heavily on the contents of this WMP and should utilize any information generated or updated since this WMP was submitted, input from other state, regional, and local resources, and field verifications. The identification should prioritize locations that should be targeted for protection and restoration (along with noted deficiencies), and also:

- which features are unprotected and which are in imminent danger, including: shoreline areas; amphibians, reptiles, and mussels; endangered/threatened species;
- the most effective method for protecting specific features;
- any limits to preservation and/or restoration (incompatible adjacent land uses and site contamination);
- any factors reinforcing candidacy for preservation and/or restoration, including:
  - proximity to other protected areas or waterbodies;
  - connecting a variety of natural community types;
  - seeking to increase contiguous natural area; and
  - inclusion in existing green infrastructure such as trails or natural corridors;
- the current ownership status;
- the lead organization for implementing the protection measure, including the ultimate owner of the land and/or development rights; and
- maps of appropriate detail.

7. Natural Features and Resource Management

These actions target the identification, protection, and restoration of natural features such as habitat, sensitive waterbodies, geology, and wildlife within the subwatershed

The benefit of these actions is to our natural resources that provide economic and social benefits as well as vital habitat for wildlife and aquatic animals. Critical areas for implementation are those where high quality natural areas currently exist and all riparian areas (including those in highly developed urban areas).

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
7-1	**Identify Natural Features**	**SWAG; Municipalities; Counties**	**Ongoing** **◆ = 2011**	▪ **$50,000 - $150,000/ one-time**	**EPA, 10, 20** **NOAA 5** **USDA 1, 2, 3, 5, 6, 8, 10, 11, 12** **USGS 2, 3, 7, 9, 11, 12**
7-1-a	*Develop a Riparian Habitat Restoration and Preservation Plan (RHRPP)*	*SWAG; Municipalities; Counties*	*Short Term*		*Note: Purpose of the Plan is to document a sustainable habitat network.*

Note: The Macomb County Trailways Master Plan will have overlapping elements it might help to consider this recommendation as a Blueways Plan that has more of a focus on aquatic resources. Also, note that emphasis should be placed on the restoration and preservation of headwater areas due to their significant role in the maintaining the health of downstream areas.

7-2 Natural Land Reserves

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This action deals with the preservation of land as natural area and to add to the green infrastructure. Action 3-3 embodies the passive method of preserving natural areas: passing ordinances and zoning. This action is comprised of active preservation methods, including: purchasing land, purchasing/transferring development rights, conservation easements, land trusts, leases, deed restrictions, and covenants. This action should be implemented mainly through the SWAG members coordinating with and supporting the work of conservancy groups and government agencies, but may be implemented by the SWAG members themselves if appropriate situations arise. Incentives such as tax credits may also be developed for allowing natural features to be restored through such actions as conservation easements or long-term leases.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
7-2	**Natural Land Reserves**	**All entities; Land Trusts**	**Ongoing** **◆ = 2030**	▪ **500 – 1000 hrs &** ▪ **$100,000 +/project**	**EPA 10** **NOAA 5** **USDA 1, 2, 3, 5, 6, 8, 10, 11, 12** **USGS 2, 3, 9, 10, 11, 12**
7-2-a	Undertake actions to preserve* areas identified in the plan (7-1-a) and the Macomb County Trailways Master Plan	All Agencies; Land Trusts	Short Term Ongoing		

* See mechanisms outlined in Action Categories 3-3-d and 5-7 too.
Note: Efforts can proceed before the RHRPP is complete based on existing priorities.

7-3 Natural Feature Protection

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The SWAG and/or its members may consider additional activities that support the protection of natural features. Actions to implement to support natural feature protection may include:

- Ensuring there are buffers around natural areas and waterbodies are established to exclude incompatible land uses and other problem activities;
- Ensuring wetlands and floodplains are hydraulically available to be used for water retention purposes;
- Reducing the practice of straightening and enclosing drains;
- Changing existing dam operations such that minimum flow requirements are established and met and dams are operated as fixed crest structures (not as opened / closed gates);
- Restrict the construction of new dams, in-line detention basins, and lake-level regulators to protect natural water cycles, protect wetlands, and ensure adequate stream flow;
- Remove dams that are no longer used for their original purpose, are a safety hazard, or have failed;
- Restricting new, or focusing mitigation on existing, impervious areas near waterbodies and wetlands;
- Engaging in fisheries and aquatic habitat management activities with sport fishing and conservation groups
- Engaging in threatened and endangered species management;
- Engaging in terrestrial habitat management; and

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
7-3	**Natural Feature Protection**	**MDNRE; SWAG; Municipalities; Counties**	**Ongoing** **◆ = 2030**	▪ **300 – 600 hrs &** ▪ **$10,000 +/project**	**EPA 10** **NOAA 5** **USDA 1, 2, 3, 5, 6, 8, 10, 11, 12** **USGS 2, 3, 9, 10, 11, 12**
7-3-a	*Require buffers around all identified priority natural features.*	*Municipalities; Counties*			
7-3-b	Ensure that water course modifications reflect the needs outlined in the RHRPP*	Municipalities; Counties; MDNRE			
7-3-c	Develop/expand local expertise and programs for managing aquatic habitat and species	SWAG; CRWC			Note: This can be met through volunteer efforts.
7-3-d	Preserve existing wetland	All Agencies	Short Term		Note: See Table 8.1 for existing acres by reach.

* The RHRPP will have hydrologic and hydraulic targets for sustaining aquatic and terrestrial wildlife.

7-4 Natural Feature Restoration

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The SWAG and/or its members may consider restoring natural features in the public domain as well as encouraging and helping facilitate restoration measures on private lands. Example activities to restore natural features include:

- Day-lighting streams;
- Utilizing/encouraging native plantings and management techniques;
- Engaging in or encouraging reforestation and the planting of trees;
- Protecting endangered and threatened species;
- Eradicating invasive and exotic species;
- Advocating the use of backyard conservation programs by private citizens to add valuable habitat in developed areas;
- Supporting the stocking of native fish in streams;
- Managing areas to provide habitat and act as corridors between natural areas (such as utility corridors and roads);
- Incentives for private landowners to allow the reestablishment of vegetated buffers around already impacted waterbodies; and
- A wetland mitigation/expansion program.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
7-4	**Nature Feature Restoration**	**SWAG; Municipalities; Counties**	**Ongoing** **◆ = 2013**	▪ **300 – 600 hrs &** ▪ **$10,000 +/ project**	**EPA 9, 10** **NOAA 5** **USDA 1, 2, 3, 5, 6, 8, 10, 11, 12** **USGS 2, 3, 9, 10, 11, 12** **USACE 1**
7-4-a	Undertake actions to restore areas identified in the plan (7-1-a) and the Macomb County Trailways Master Plan	SWAG; All Agencies; Land Trusts	Short Term Ongoing		
7-4-b	Restore pre-settlement wetland complex	All Agencies	See Table 8.1 for Targets	$1,294/ac wetland restoration or $1,200/ac wetland creation	

Note: Efforts can proceed before the RHRPP is complete based on existing priorities.

8-1 **Recreation Program**

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To enhance and create recreation areas in the subwatershed, the SWAG and its members may coordinate with existing recreation programs to:

- target locations to provide public education;
- minimize the impacts that problematic activities have on water resources; and
- identify locations to provide recreation activities and facilities.

8. Recreation Promotion and Enhancement

These actions are meant to increase recreational opportunities in the subwatershed and provide education within the recreation areas related to habitat, natural features, and the subwatershed / watershed in general (and the efforts of the stakeholders and related groups).

These actions benefit the public by connecting them to their water resources and fostering a stewardship ethic. Critical areas for implementation include those where facilities do not yet exist.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
8-1	**Recreation Program**	**Subwatershed Groups, Municipalities, Counties**	**One-time Next Five Years** **◆ = 2011**	▪ **250 -500 hrs &** ▪ **$1,500 / entity (one-time)**	**USDA 1** **USGS 8, 11**
8-1-a	*Promote recreational amenities both locally and beyond*	*SWAG; Counties, All Agencies*	*Short Term Ongoing*		

8-2 **Riparian Land Conservation for Parks**

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For the SWAG and/or its members, incorporating riparian land into parks is a way to conserve this area and let the community enjoy the resource. When using sensitive riparian land for new parks, consideration should be given to leaving vegetated buffers along the water's edge and keeping parking lots away from the water. Existing riparian parks with modified riparian corridors may consider: utilizing stormwater management techniques, reducing grass mowing and fertilizing, and addressing any other maintenance issues that may affect the waterbody.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
8-2	**Riparian Land Conservation for Parks**	**Subwatershed Groups, All Agencies**	**Ongoing** **◆ = 2030**	▪ **500 – 1000 hrs &** ▪ **$100,000+/ project**	**NOAA 1, 2, 5, 6** **USDA 1, 4, 8, 10, 12** **USGS 1, 4, 5, 8, 9, 10, 11, 12**
8-2-a	Incorporate riparian conservation areas in local parks when appropriate	All Agencies	Short Term		

8-3 Canoe / Boat Landings / Access Sites

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The SWAG and/or its members may consider adding or enhancing existing access sites to help promote recreation. Access sites provide a stabilized area to access the water, thus protecting other locations. Access is also intended to mean in-stream access in order to allow continuous passage (where feasible). They also provide an opportunity to educate the public about the watershed and how their actions can affect water quality and recreational opportunities.

The SWAG may also support legislation to add a recreational component to the definition of navigability. This may help define a public right on streams, especially smaller ones, to use the waterbody for recreational activities.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
8-3	**Canoe / Boat Landings / Access Sites**	**Subwatershed Groups, Municipalities, Counties**	**Ongoing** **◆ = 2030**	▪ **400 – 800 hrs &** ▪ **$25,000+ / project**	**EPA 13** **NOAA 1, 2, 6** **USDA 1, 3** **USGS 1, 4, 5, 8**
8-3-b	*Identify desirable access points.**	*SWAG, CRWC Counties*	*Short Term*		
8-3-b	Undertake woody-debris management** in all reaches of the NB	All Agencies, CRWC	Short Term Ongoing		

* Coordinate with development of the Recreational Plan
** A Woody Debris Management Plan will be available by October 1, 2010.

8-4 Restore Fishing Opportunities

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The SWAG and/or its members may consider restoring natural fisheries that may currently be compromised. While large-scale wildlife management is the function of the Michigan Department of Natural Resources, certain local activities can provide benefits in terms of habitat restoration, migration assistance/blockage removal, and public access that will increase recreational fishing opportunities.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
8-4	**Restore Fishing Opportunities**	**MDNRE**	**Ongoing** ◆ **= 2030**	▪ **500 – 1000 hrs &** ▪ **$15,000+ /project**	**EPA 13** **NOAA 1, 2, 5, 6, 7** **USDA 1, 3, 4, 8** **USGS 1, 4, 5, 11**
8-4-a	Implement recommendations in the RHRPP.	All Agencies	Short Term Ongoing		
8-4-b	Work with the MDNRE to continue to track local population levels	SWAG, CRWC	Ongoing		
8-4-c	Continue to seek opportunities/mechanisms to support maintaining aquatic populations.	SWAG, CRWC	Ongoing		

8-5 Trails / Observation Decks

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Similar to Action 8-3, the SWAG and/or its members may consider adding or enhancing trails and observation decks to help promote recreation. These facilities provide access to natural areas while controlling and minimizing disturbances. They also provide an opportunity to educate the public about natural features and impacts to them. It may be necessary to increase the public right-of-way if seeking to add trails in certain areas.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
8-5	**Trails / Observation Decks**	**Subwatershed Groups, Municipalities, Counties**	**Ongoing** ◆ **= 2030**	▪ **400 – 800 hrs &** ▪ **$25,000+/project**	**USDA 1** **USGS 8, 12** **USDOT 1**
8-5-a	Implement recommendation in the MC Green Trailways Plan as well as the proposed Recreation Plan	All Agencies	Ongoing		

9-1 Implementation Reporting

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The SWAG members are not bound by the Phase II permit, but it is a useful starting point for a number of actions. In this case, the entities should document all of their actions and define their relationship to the goals and objectives of the plan. This not only helps the SWAG keep track of implementation, but also allows the entity to have a firm understanding of what actions it is implementing and the reasons for doing so.

9. Environmental Monitoring and Other Data Collection

These actions are meant to ensure that the minimum amount of data and assessments are conducted to enable evaluation of the WMP and guide revisions to it. The data to be collected should be coordinated with data that is already available to facilitate temporal analyses of conditions at a number of key locations. Collectively, the aim is to find a set of measures that, when assessed together, can define the general environmental health of a particular area.

These actions are beneficial because they help to assess the environmental conditions in the watershed and determine if the implementation of the WMP is progressing effectively.

Critical areas are locations with specific problems and the entire watershed for the standard water quality/ quantity and programmatic measures.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
9-1	**Implementation Reporting**	**SWAG; All Agencies**	**Annual** **◆ = 2015**	▪ **200 – 400 hrs / entity (annually)**	**EPA 3, 6, 7, 8, 9, 13, 18, 22, 23, 25, 26** **USDA 2, 4, 6** **NOAA 3, 5** **USACE 2** **MDEQ 2, 3**
9-1-a	Document all actions related to the WMP that have been initiated during the year and summarize in a report that relates the actions to the goals and objectives	All Agencies	Annual		

9-2 Stressor Monitoring and Assessment

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In addition to activities reported in the implementation reports the SWAG should examine programs such as the CRWC benthic macroinvertebrate monitoring, county surface water quality monitoring, and State/federal water quality monitoring. Where appropriate, the SWAG should make recommendations to organizations collecting data to ensure that the data collected is beneficial to evaluation of the WMP. The SWAG may have to engage in data analysis to ensure that the information is in usable form concerning analyses that will have to be made – e.g. USGS flow data will need to be converted to Flashines Index values to evaluate hydrologic health of waterbodies and trends thereof.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
9-2	**Stressor Monitoring and Assessment**	**SWAG; MDNRE; CRWC**	**Ongoing** **◆ = 2011**	▪ **40 – 150 hrs / entity (annually for research) (does not include the costs**	**Not necessary**

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
				associated with the programs being leveraged)	
9-2-a	Examine data appropriate to evaluate whether goals and objectives are being achieved	SWAG; MDNRE; CRWC	Ongoing		
9-2-b	Examine data appropriate to evaluate progress being made towards achieving TMDLs	TMDL impacted Agencies	Ongoing		
9-2-c	Undertake a street dirt study to determine viability.	MDNRE,	2015	$200,000 to $400,000	GLRI

9-3 Public Education and Involvement Data

A

Although this is not necessary from a regulatory perspective for most of the communities to document PEP-related actions, all the entities should report this information in a similar fashion due to the coordinated nature of the public education in the subwatershed. Some Phase II communities have portions in the North Branch and should report any North Branch information along with their regular regulatory submittals but should clearly indicate which information is associated with the North Branch.

Any sustained education effort undertaken by the SWAG should be evaluated on a regular (five year) basis and aim to measure changes in perception, attitudes and behavior. The SWAG should either leverage existing survey programs or initiate custom surveys or assessment to ensure that public education elements of the WMP are reaching their target audience and that stakeholder behaviors are changing due to the messages.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
9-3	**Public Education and Involvement Data**	**All Entities**	**Ongoing** **◆ = 2015**	▪ **250 – 700 hrs / entity (annually)**	**EPA 3, 6, 7, 8, 9, 13, 18, 22, 23, 25, 26** **USDA 2, 4, 6** **NOAA 3, 5** **USACE 2** **MDEQ 2, 3**
9-3-a	Monitor data appropriate to evaluate whether the public education goal and objectives are being achieved	SWAG; MDNRE; CRWC	Ongoing		
9-3-b	Compile data over five-year period for subsequent evaluation and assessment	TMDL impacted entities	Ongoing		

9-4 Field Data Collection

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The SWAG and other data collection entities should examine programs such as road/stream crossing assessments, stream assessments, unified subwatershed and site reconnaissance. Field data collection programs should include documenting wet weather and dry weather conditions so causes, sources, and stressors can be properly assessed.

As implementation data is collected, the SWAG should:

- Log which actions have been started and which have been completed (and the specific activities supporting each action) and note the specific dates for future reference and inclusion in future WMP updates,
- Make calculations associated with the various actions (e.g. projected pollutant load reductions),
- Consider the organizational structure of the SWAG and its influence on the actions that have been implemented (e.g. what role did the SWAG play in making the action happen),
- Check the milestones to see if they have been met.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
9-4	**Field Data Collection**	**SWAG; MDNRE; Counties**	**Ongoing** **◆ = 2015**	**▪ 250 – 750 hrs / entity (annually)**	**EPA 3, 6, 7, 8, 9, 13, 18, 22, 23, 25, 26** **USDA 2, 4, 6** **NOAA 3, 5** **USACE 2** **MDEQ 2, 3**
	Undertake DNA testing to determine sources of bacterial contamination between human, animal and natural sources, if funds are available.	SWAG; MDNRE; Counties	Ongoing		Note: This is Action 4-8-a
9-4-a	Continue USA and USSR field data collection to build of the base of data that was generated in the development of this plan, if funds are available.	SWAG; Counties	Ongoing		
9-4-b	Collect other data as necessary to fulfill the data requirements necessary to properly assess and evaluate the plan	SWAG; County departments	Ongoing		
9-4-c	Establish three additional volunteer monitoring sites in accordance with the Volunteer Stream Monitoring Grant recently received and include in ongoing monitoring efforts	MCPWO; CRWC	Short Term Ongoing		
9-4-d	Expand the suite of parameters tested on a periodic-basis for all the impairments associated with the associated catchment.	MCHD, CRWC, MDNRE	Short Term Ongoing		

9-5 SWAG Implementation / Evaluation / Effectiveness Assessment

A

As the WMP is being implemented, the SWAG will be documenting implementation. As this implementation data is collected, detailed considerations should be made with respect to this information, as listed in the sidebar.

Every ten years (after an initial 5-year period) the SWAG will evaluate the WMP by conducting an effectiveness assessment. This assessment involves analyzing all of the information and feedback received during the program implementation phase (e.g. institutionalization information, implementation progress and available funding, planning considerations such as TMDLs and modeling input, and monitoring data) and measure these against the delisting criteria. The evaluation will determine what revisions need to be made to the WMP to ensure that goals and objectives are achieved, that the problems and priorities are up to date, and that the actions are effective. The effectiveness assessment paradigm is discussed in detail in Chapter 9.

Action Number	Action	Lead Agency	Schedule / Cycle / Milestones (◆)	Labor / Cost Opinion (details)	Sources of Funding And Technical Assistance (Appendix H.1)
9-5	**WMP Evaluation / Effectiveness Assessment**	**SWAG**	**Ten year cycle** **◆ = 2015**	**▪ 1,000 hrs (work done over ten years with most near end)**	**EPA 3, 6, 7, 8, 9, 11, 13, 22, 23, 28** **USDA 4, 6** **USGS 7**
9-5-a	Conduct a detailed evaluation of the effectiveness of the WMP actions	SWAG	In-term – 5 yrs Ten-year cycle		
9-5-b	Prepare a detailed report the discusses the effectiveness of the WMP and whether or not it is achieving its implementation milestones and its goals and objectives; print and distribute to all stakeholders and the general public	SWAG	In-term – 5 yrs Ten-year cycle - Full Evaluation		

Relationship to Goals and Objectives

The actions discussed in this section have been selected to make progress towards achieving the goals and objectives. The relationship of the actions to the goals / objectives is presented in Table 8-1. The relationship of the actions to other planning elements (e.g. sources, stressors, and critical areas) is presented in Appendix H.2.

The actions are indexed to the goals / objectives as either 'primary' or 'secondary'. Primary actions for a goal / objective are those in which the action language explicitly or implicitly addresses specific wording of the goal / objective or is likely to provide quantifiable load reductions for pollutants related to the goal / objective. Secondary actions may address specifics of a goal / objective but require implementation information that has not been generated at the plan level or may provide load reductions for pollutants related to the goal / objective but the load reductions are non-quantifiable. In this plan, all of the goals / objectives have at least one action supporting them in the primary / secondary category. **(EPA 10.1)**

CMI Requirements in this Chapter

The following CMI requirements are addressed, at least partially, by the information that is presented throughout this chapter, including:.

- A list of systems of BMPs needed for each objective and an estimated cost for those BMPs;
- A list of tasks needed to implement the systems of BMPs for each source in your watershed and their estimated costs;
- A summary of the local projects, programs, and ordinances within your watershed with tasks, responsible parties, milestones, and a timeline for improving or adding to those projects, programs, and ordinances;
- An I/E strategy;
- A description of the process that will be used to evaluate the effectiveness of implementing the plan and achieving its goals; and
- Tasks needed to institutionalize watershed protection.

Wetland Targets

The DNRE has provided four tools to help local stakeholders determine their wetland priorities for the North Branch of the Clinton River. They are:

1) Status and Trends Information (quantifies wetland loss by type)
2) Potential Wetland Restoration Areas Dataset
3) A Landscape Level Wetlands Functional Assessment Tool (LLWFA); and
4) A Prioritization Tool for ranking potential restoration sites (available for the Clinton River Watershed only).

These four tools used in conjunction can assist stakeholders in identifying and ranking wetland preservation and restoration sites and opportunities for specific environmental results or biological impacts.

Status and Trends Information is available on a watershed by watershed basis and consists of an analysis of changes in the area and type of wetlands in a given area. This information is derived from the updated 2005 National Wetland Inventory (NWI) and Hydric soils (used to approximate Pre-Settlement Wetlands) to determine the location, type, and area of past and current wetlands. Changes over time in the status of individual wetlands are compared and emerging trends are noted. In the North Branch of the Clinton River Watershed, the Status and Trends Analysis indicated a 72% loss of the total wetland resource base.

The Landscape Level Wetlands Functional Assessment Tool is a GIS based tool that can be used to identify existing wetlands that should be protected or historic wetlands that should be restored for specific environmental or biological impacts. The DNRE modified this tool (originally created by Ralph Tiner, USFWS for use in the Northeastern United States) specifically for use in Michigan. This allows wetland restoration or protection efforts to be evaluated against other potential Best Management Practices.

The Landscape Level Wetland Functional Assessment (LLWFA) tool is intended to be used as one tool to assist local stakeholders in identifying the historic wetland areas that should be restored based on the ecological function they would perform within the watershed. This tool can also be used to identify and prioritize wetlands for protection based on the functions they currently perform. The tool uses a computer model to integrate wetland maps - updated with current aerial photography - with hydrologic data, site topography, and other ecological information to evaluate the wetland functions provided by each mapped wetland area. The resulting analysis can be used to provide a generalized map of current wetland functions within a watershed, the loss of wetland function associated with past land use changes, and potential wetland restoration areas.

Using the Tool's information, both existing and pre-settlement wetlands were evaluated for thirteen wetland functions ranging from flood storage to nutrient transformation to habitat considerations. Assigning these functions to wetlands in the GIS, allows the user to select the functions that match the local needs. Each wetland area is ranked as High or Medium, in regards to its ability to perform the function in question. For example, catchment 601 is impaired for nutrients, both Total Phosphorous and Total Nitrogen. If stakeholders are looking to identify existing wetlands that should be protected or pre-settlement wetlands that could be restored to assist in mitigating high nutrient loads the LLWFA tool is uniquely suited for this task. Because the wetlands in the GIS are classified as to the functions they perform, stakeholders can hone in on the existing or restorable wetlands specifically suited to addressing the pollutant problems within their target area.

As shown on the Figure 8-1, an interesting side note is that wetland areas that address *sediment retention largely* overlap with wetland areas that address *nutrient transformation*. The ecological requirements of a wetland performing these functions are largely the same.

The next steps in the process, once the high performing wetland areas are identified, is to: 1) overlay the land parcel maps in order to determine ownership and 2) use the Clinton River Prioritization Tool to help further prioritize sites based on their attributes such as size, number of owners, connectivity to other water bodies, etc. By determining ownership, any public sites can be identified and further evaluated using the Prioritization Tool. Similarly, with the aid of local stakeholders determining the ownership of private sites can help identify landowners that may be more willing to undertake restoration efforts.

In summary, the following steps should be followed when identifying sites to be included in funding proposals:

1) Define the local need and/or waterbody impairment
2) Locate all existing and potential wetlands with the Potential Wetland Restoration Areas Dataset
3) Using the LLWFA tool select only those wetland functions that address the local need and/or impairment (turn other functions off)
4) Run program and identify "High" functioning existing and potential sites first.
5) Overlay the "high" functioning sites with parcel data and determine ownership. Only move to "Medium" functioning sites if there are not any good candidate produced by the process so far.
6) Use the Prioritization tool to help select from the remaining candidate sites, ones that are of sufficient size and are connected waterbodies.
7) Select the best candidate(s) for preservation and restoration to include in your proposal.

Additionally, using the results of the assessment together with the reach GIS layer Table 8-1 was created. Only presettlement and hydric soils were considered for target restoration based on the recommendation of the MDNRE (personnel communication April 20, 2010).

Targets of one percent in five years and two-point-five percent in ten years were chosen because they appeared reasonable. The order in which restoration occurs is not reflected and will likely be based on factors such as opportunity and funding. It should be noted that several of the actions previously presented refer to Table 8-1.

The Landscape Functional Evaluation Tool and the Prioritization Tool are available from the Macomb County Public Works Office or the Wetlands, Lakes, and Streams Unit of the DNRE.

Figure 8-1: Catchment 601 - Existing and Potential Wetland Sites (Nutrient Transformation)

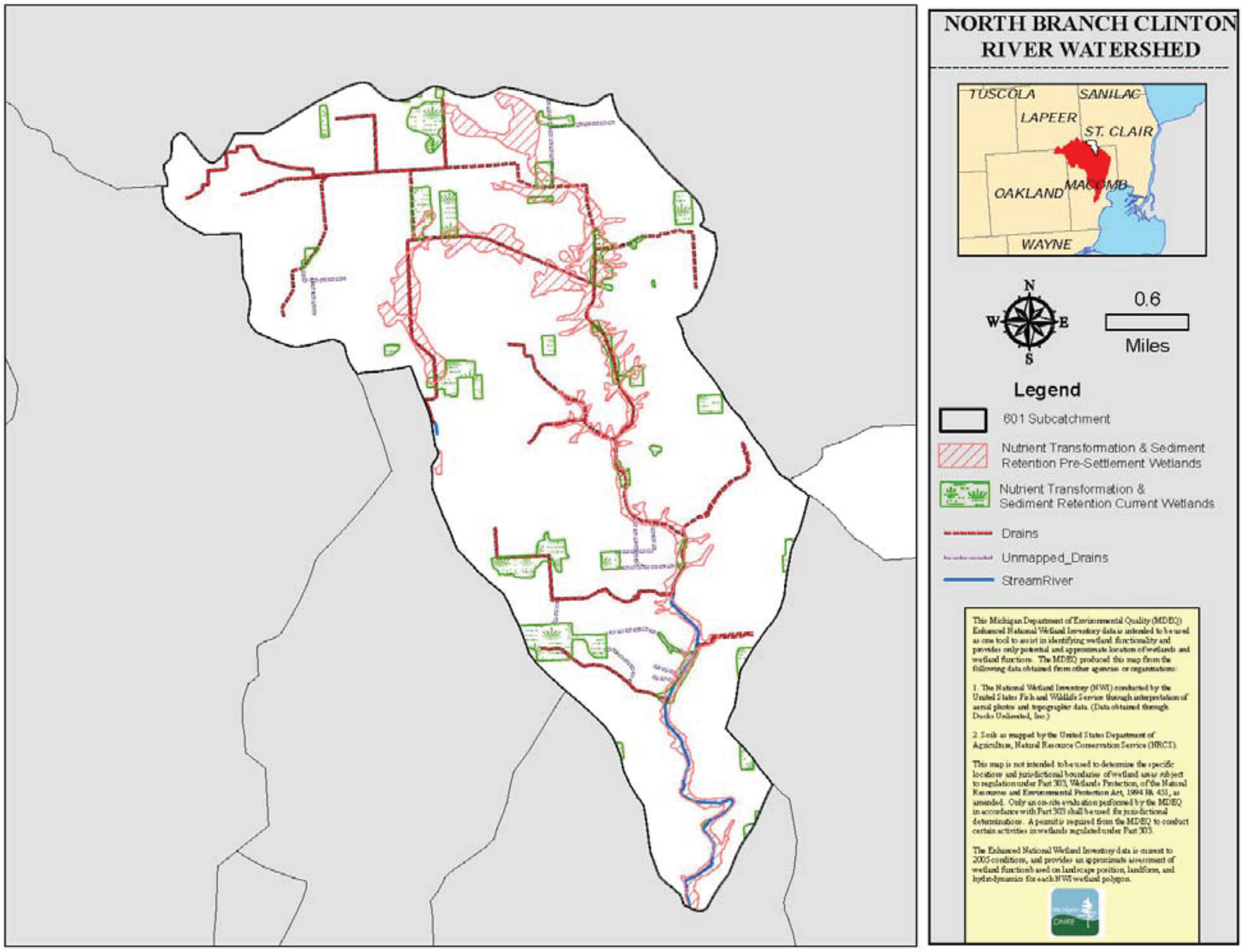

Table 8-1. Wetland and Functional Wetland Targets by Reach

Catch-ment Id	Existing Wetlands* (Acres)	Pre-settlement & Hydric Soils (Acres)	Hydric Soils (Acres)	Total Combined Acres	Five Year Target 1%	Ten Year Target 2.5%
601	541	1635	996	2631	26.31	65.775
602	276	335	634	969	9.69	24.225
603	263	962	2329	3291	32.91	82.275
604	748	449	2849	3298	32.98	82.45
607	1680	954	4456	5409	54.09	135.225
608	178	0	629	629	6.29	15.725
609	1233	860	927	1787	17.87	44.675
610	1846	1297	2236	3533	35.33	88.325
611	1627	241	504	745	7.45	18.625
612	1017	76	2501	2577	25.77	64.425
613	331	0	972	972	9.72	24.3
614	572	1128	2317	3444	34.44	86.1
615	874	843	3437	4281	42.81	107.025
616	156	103	255	358	3.58	8.95
Total	11342	8883	25042	33925	339.24	848.1

* 2009 MDNRE

Achieving Pollutant Load Reductions

319 c

Future Loadings

Changing conditions in the subwatershed, such as land use conversion, may result in higher pollutant loadings than those calculated in Chapter 5. However, it is assumed these increases will be offset by planning actions (see Action Category 3) that are designed to minimize the impacts of development and other activities.

The actions presented in this chapter are designed to address environmental stressors and holistically improve the environmental conditions in the subwatershed. All of the actions, acting in concert, will lead to lower measurable levels of stressors in the natural environment. There are certain actions, specifically the many activities that will comprise these actions, which will lead to direct, calculable load reductions in stressors entering the environment. Of specific interest to this plan, in terms of calculable load reductions, are those actions which will produce measurable load reductions with respect to those stressors that were specifically modeled: sediments, nutrients, pathogens, and hydrologic conditions (measured as the 'R-B Index' [flashiness] or imperviousness). These actions, cross-referenced to the stressors that they will impact, are presented in Appendix H.3. The percentage listed for each stressor is the expected portion of the total required reduction level (presented in Chapter 7) that is being targeted for that specific action. The percentages are universally applicable to all of the catchments as implementation levels will be different in each catchment that is in non-compliance for a particular stressor to match these reduction levels. Note that this represents only one way to calculate achieving load reduction targets and the actions may be implemented at different levels and still receive the overall desired outcome.

In order to estimate the effectivness of the actions just proposed the Clinton River Hydrologic Simulation Program – Fortran (HSPF) model used to simulate current conditions (Chp 5) was used to estimate the anticipated pollutant load reductions for the aforementions stressors. This was accomplished through modeling suites of best management practices known as scenarios. Two scenarios were modeled and are described below.

(EPA 8.3, 8.4, 9.6, 11.1, 11.2, 11.3, – includes the following subsections)

Summary of North Branch Clinton River Scenarios

The HSPF model created to simulate the hydraulics and pollutant loads for the watershed was subsequently modified to incorporate two scenarios demonstrating the effects of various practices to improve water quality. The model scenario predictions of the best management practices provide valuable insight into the relative effectiveness of the practices.

As noted in Chapter 5, sediment and nutrient (TP, NO_3, and TKN) components of the model could not be fully calibrated to watershed conditions due to lack of long term sediment and nutrient monitoring data in the watershed. This limits the ability of the model to estimate the degree of impairments against statistical measures for sediment and nutrients; however, the model representation of the watershed is reasonable and well tied to the types of land uses present in the watershed, and provides a good indication of the degree of difference between catchments. The scenarios discussed here provide beneficial information about the impact of BMPs and other practices on reducing sediment and nutrient loads and concentrations.

On the other hand, the abundance of E. coli monitoring data in the watershed allowed for a full recalibration of the model to the catchment scale. As such, the North Branch HSPF model is an excellent tool for understanding sources of bacteria, and predicting the effects of practices to reduce bacteria.

The two scenarios discussed here do not include projections of future land use change or development. The scenarios were built assuming the practices would be incorporated in watershed in present-day conditions. This assumption is not meant to reflect a reasonable timeframe for implementation, which is likely to take time. Rather, it allows for a better comparison of the effect of the practices. (See Appendix G.3 for the full report)

Scenario 1

The first scenario reflects implementation of a number of practices for agricultural lands. Practices and their implementation in the HSPF model are as follows:

1. 100 ft streamside forest buffers, implemented on 50% of streams that are presently not buffered (applies to row crop and pasture land uses). Represented in the HSPF model as follows:
    a. Newly buffered land is represented in the model as being converted from row crop/pasture to forest. Forested land has lower pollutant loading rates than agricultural land, resulting in reductions due to land conversion.

    b. Agricultural land area within 300 ft of the buffer edges is assumed to be treated by the buffers, resulting in direct pollutant load reduction. Agricultural land beyond 300 ft of the buffer is assumed to generate concentrated flow and bypass the buffer without treatment. Buffer treatment removal rates range from 45% for E. coli to 97% for sediment.

2. Increased use of nutrient management plans. The opportunity for this practice is assumed to be limited, so a 5% reduction in TP and TN generated from agricultural land was assumed. Represented in the HSPF model as follows:
    a. 5% reduction in model parameters used to generate TP and TN in runoff during storm events
    b. 5% reduction in groundwater loading of TN
3. Grazing and manure management plans. While the density of livestock in the watershed is relatively small, agricultural census data indicates that cattle, poultry, and dairy operations are present in Macomb County. Manure is likely disposed of via incorporation into agricultural fields, which can become a source of bacteria in storm event runoff. Bacteria can also wash off feedlots and pasture. Represented in the HSPF model as follows:
    a. 75% reduction in manure application to crop land. Manure is instead diverted to composting.
    b. Increased confinement of grazing cattle to reduce manure loads on pasture
    c. Full cattle exclusion from streams
        i. Increased use of conservation tillage and no-till in the watershed. Present day and scenario assumptions are as follows:
        35% conventional tillage reduced to 10%
        15% conservation tillage increased to 45%
        20% no-till increased to 75%

4. Represented in the HSPF model as follows:
    a. Weighted change in seasonal factors affecting sediment detachment during storm events
    b. Increase in plant cover reducing soil erosivity
    c. Small increase in soil moisture storage capacity in the root zone, resulting in small decrease in runoff.

Scenario 2

Scenario 2 is implemented as an add-on to Scenario 1. In other words, Scenario 2 reflects both Scenario 1 and Scenario 2 practices.

The second scenario focuses on addressing low flow sources of E coli bacteria in the watershed. All of the catchments have low flow sources – including the urbanized, sewered areas in the south. In the rural agricultural areas, the sources are likely from failing onsite septic disposal systems (OSDS). A failing OSDS from a water quality perspective may appear to be functioning perfectly to the operator. Given the low infiltration rates of most of the soils in North Branch and the use of ditches and tile drains, it is likely a large number of systems have short-circuited to drainage ditches or tile drains. In urban areas, it is more likely there is a combination of accidental and illicit connections to the storm drain network, as well as aged sanitary sewer infrastructure that leaches out contaminated water to storm sewers and to streams. Low flow bacteria sources are by far the biggest contributor to water quality impairment throughout the watershed as indicated by the E coli. Standards, manifest in bacteria TMDLs. If low flow sources of bacteria are present, it indicates that poorly treated or untreated sewage is entering the waters of the watershed. Nutrient levels are likely elevated as well in the sewage effluent.

The HSPF model is well calibrated to *E.coli* monitoring data collected in the majority of subbasins. It includes explicit representation of low flow sources, though the model does not distinguish between source types. Scenario 2 was implemented as follows:

> The 90th percentile TSS concentration is a screening level measure used to compare the condition in a watershed to reference (unimpacted) sites in the same ecoregion. It is calculated in this project by ranking all of the daily sediment concentrations from the model from lowest to highest, and selecting the one at the 90% percentile (in other words, 90% of the values in the distribution are lower than this value, while 10% are high than this value). In practice, the value probably represents the upper end of low flow concentrations and/or the lower end of high flow concentrations. The number itself does not connote meaning – the values vary from ecoregion to ecoregion – but is used an indicator of risk of impairment.

> 90% reduction in low flow loads of *E.coli* and nutrients throughout the watershed, both in the rural and urban areas. This would be implemented as programs to encourage/require repair or replacement of failing septic systems, reducing in illicit and cross connections, and repair of aging sewer infrastructure that leaches sewage.

Originally, the intention was to reduce low flow sources dynamically (and variably within catchments) until E coli standards were exceeded 10% or less of the time (note that percent exceedance of standards is only correlated to, but not the same as percent reduction in low flow loads). Upon implementation of the scenario, it was found that even at the 90% reduction level in low flow loads, none of the catchments achieved less than 10% exceedance of both standards. Since 90% is an extremely aggressive (and optimistic) implementation goal for low flow sources, the scenario did not assume a higher level of low flow load reduction. Therefore, although implementation of the modeled scenarios (1 & 2) does not achieve water quality standards all the time, their implementation will make progress toward the long-term goal of achieving the water quality standards including the standards for E. coli.

Scenario Results

The results of the modeled scenarios are presented below. The effects of the proposed BMPs in each of the fourteen reaches on the levels of each of the following stressors are discussed in turn: sediment, nutrients (Total Phosphorous (TP) and Nitrate/Nitrite (NO3)), bacteria (*E.coli.)*, and flow (using impervious cover as a proxy).

Sediment (TSS)

The results of the modeling scenarios are presented in the table below. Two measures are shown; 1) the 90 percentile TSS and 2) tons per year reductions.

Based on values scaled to watershed size from the Huron-Erie Lake Plain ecoregion (from 50 mg/L for headwaters sites for 65 mg/L at the North Branch outlet), all of the Clinton River subbasins meet the criteria. However, as noted previously the North Branch HSPF sediment simulation is based on limited monitoring data. Since many values are elevated and close to the 50 mg/L threshold, there may be sediment impacts to aquatic organisms in the watershed as suggested by the criteria. Also, the regional criteria may not be locally relevant to the North Branch, which is dominated by soils that have very low infiltration rates and likely differ from typical conditions in the Huron-Erie Lake Plain ecoregion.

The 'tons per year' metric provides a slightly different picture. Under this measure, even though the proposed BMPs reduce loads below the desired target for the entire subwatershed, there are five reaches where they are insufficient in being able to meet the targets.

More specifically, Scenario 1 has a substantial impact on land surface generated sediment loads generated from agricultural land. This is not surprising since the practices work to reduce sediment loads generated during storm events, which is when the vast majority of sediment is transported in the watershed. The practices are less effective for reduction lower flow sediment concentration, but they do have an effect.

Table 8-2. Sediment Target and Load Reduction

Catch-ment ID	Name	Catchment Area (ac)	TSS Targets mg/l/day	90th Percentile TSS (mg/l/day)	TSS Targets Tons/yr	Modeled TSS Reductions Tons/yr
601	East Branch Coon Creek	8,190	50	44.6	271.0	654.0
602	East Branch Coon Creek	4,059	50	42.9	411.0	907.0
603	Highbank Creek	10,109	50	22.2	267.0	842.0
604	East Branch Coon Creek	6,561	65	43.1	1210.0	2145.0
607	Coon Creek	16,966	65	32.9	802.0	1121.0
608	Coon Creek	1,162	65	41.1	2301.0	3297.0
609	North Branch Clinton River	13,858	65	45.0	1113.0	197.0
610	North Branch Clinton River	18,099	65	36.7	1192.0	1235.0
611	East Pond Creek	13,337	65	32.9	537.0	36.0
612	North Branch Clinton River	11,559	65	42.2	2246.0	1778.0
613	North Branch Clinton River	2,644	65	40.0	2308.0	1918.0
614	Deer Creek	9,375	50	30.8	333.0	550.0
615	North Branch Clinton River	10,533	65	46.2	6053.0	6162.0
616	North Branch Clinton River	1,630	75	51.1	6500.0	6185.0
	Total North Branch	**128,082**			**25544.0**	**27027.0**

Priority target areas include high loading sites, such as areas with streambank erosion, road-stream crossings and land with bare soil. Extrapolating from the results of the USA the following are the estimated impacted number of by miles by individual reach.

Nutrients

The results of the modeling scenarios for nutrients (Total Phosphorous (TP) and Nitrate/Nitrite (NO_3)) are presented in the table below. Two measures are shown; 1) percent of time that a target concentration is exceeded 2) tons per year reductions.

Recall from Chapter 5 that the sediment and nutrient (TP, NO_3, and TKN) components were not revised due to insufficient water quality monitoring data for a recalibration of these parameters. In addition, there was limited monitoring data in the North Branch for sediment and nutrients during the original calibration – a handful of low flow measurements occurring during 2004 a few miles upstream of the mouth. Much of the model parameterization in the North Branch is tied to the larger Clinton River HSPF model where there were more monitoring data for a stronger calibration. As such, the North Branch HSPF model predictions are reasonable and well tied to the types of land uses present in the watershed, and the model provides a good indication of the degree of difference between catchments, and will provide beneficial information about the impact of BMPs and other practices on reducing loads. Therefore, model results are only a gauge for determining nutrient impairments against statistical measures.

Table 8-3. Estimated impacted stream miles

Catchment ID	Name	Stream Miles	Stream Orders					Est. Impacted stream miles*
			1	2	3	4	5	
601	East Branch Coon Creek	9.1	5.3	3.8				3.8
602	East Branch Coon Creek	13.3	6.2	7.1				5.4
603	Highbank Creek	19.9	12.9	4.6	2.4			8.2
604	East Branch Coon Creek	14.8	8.2		6.6			4.9
607	Coon Creek	32.7	20.5	11.8	0.4			14.0
608	Coon Creek	3.6		1.0		2.6		1.6
609	North Branch Clinton River	7.9	6.1	1.8				3.6
610	North Branch Clinton River	30.4	16.6	10.4	3.4			12.0
611	East Pond Creek	13.3	5.1	8.2				5.2
612	North Branch Clinton River	18.1	3.1	7.1	7.9			4.7
613	North Branch Clinton River	4.5			4.5			0.5
614	Deer Creek	15.6	8.8	6.8				6.5
615	North Branch Clinton River	24.0	12.4	5.0		6.5		8.2
616	North Branch Clinton River	3.4				3.0	0.4	0.2
	Total North Branch	211	105	68	25	12	0	78.8

* Impacted stream miles was calculated as by using the summary of impacted miles contained in the USA – Table 60.

Total Phosphorous (TP)

The Table of nutrient modeling results clearly shows that seven (7) of the reaches exceed the target concentration for TP of 0.01 mg/l for more than ten percent of the time. The 'tons per year' metric paints a better picture with only one reach (609) not meeting the load reduction targets. In fact, according to the modeling results, if the recommended BMPs are implemented the reduction in TP would be over one order of magnitude greater than the targeted loads.

As is the case for sediment, Scenario 1 has a substantial impact on land surface generated TP loads generated from agricultural land. TP is represented in the model as being attached to sediment on agricultural land (as well as all pervious lands), so the TP results mimic sediment in this regard. Likewise, the influence on TP concentration is limited. However, Scenario 2 has a substantial impact on reducing TP concentration, though limited roles in reducing load. This indicates that low flow sources of poorly treated/untreated sewage also have a significant impact on background TP concentrations. While low flow nutrient concentration has little influence on watershed-scale loads (which are dominated by storm events) to receiving water bodies such as Lake St. Clair, it is often the case that elevated nutrient concentrations impair biological function in stream channels themselves. Mats of benthic algae in streams are frequently an indicator of elevated low flow nutrients.

Nitrate/Nitrite (NO3)

The Table of nutrient modeling results clearly shows that thirteen (13) of the reaches exceed the target concentration for TP of 0.2 mg/l for more than ten percent of the time. The 'tons per year' metric paints a similar picture with ten reaches not meeting the load reduction targets., although the overall reduction for the subwatershed essentially meets the targeted load reduction.

In terms of the scenarios, nitrate/nitrite loading and concentrations show a trend similar to TP – Scenario 1 works to reduce overall loading rates, while Scenario 2 affects low flow concentrations. However, the influence on both loading rates and concentrations is somewhat less than for TP.

Table 8-4. Nutrient Target and Load Reduction

Catch-ment ID	Name	Catch-ment Area (ac)	% of Time TP > 0.01 mg/l	Target TP Tons/yr	Modeled TP Reductions Tons/yr	% of Time NO3 > 0.2 mg/l	Targeted NO3 Tons/yr	Modeled NO3 Reductions Tons/yr
601	East Branch Coon Creek	8,190	22%	0.19	2.00	54%	2.39	2.30
602	East Branch Coon Creek	4,059	11%	0.23	2.70	44%	3.29	3.10
603	Highbank Creek	10,109	12%	0.15	2.60	34%	1.70	3.35
604	East Branch Coon Creek	6,561	14%	0.49	6.15	45%	7.84	7.10
607	Coon Creek	16,966	15%	0.28	3.35	46%	4.11	3.85
608	Coon Creek	1,162	15%	0.74	9.15	46%	11.71	10.45
609	North Branch Clinton River	13,858	10%	1.94	0.90	8%	3.04	0.55
610	North Branch Clinton River	18,099	7%	0.01	4.15	20%	0.00	4.35
611	East Pond Creek	13,337	4%	0.00	0.25	13%	0.00	0.20
612	North Branch Clinton River	11,559	5%	0.00	5.75	23%	2.53	6.10
613	North Branch Clinton River	2,644	5%	0.00	5.95	22%	3.73	6.20
614	Deer Creek	9,375	16%	0.23	1.70	48%	2.37	1.95
615	North Branch Clinton River	10,533	5%	0.14	15.10	30%	21.73	16.95
616	North Branch Clinton River	1,630	5%	0.00	13.80	31%	23.46	15.60
	Total North Branch	128,082		4.40	73.55		87.90	82.05

Bacteria (*E.coli.*)

The complex nature of pathogens requires analyses that do not rely on achieving quantified load reductions but instead target a concentrations-based water quality standard. This is in accordance with the MDNRE developed approach for pathogen based TMDLs in the State and in the Clinton River Watershed.

The approach involves implementing pathogen reducing actions to address all sources (especially those present in reaches 601, 602, 604 and 614) and continuously monitoring to determine if progress is being made.

The table below shows the results of the modeling scenario through two measures; 1) the percentage of time that it is anticipated that the 30-day geometric mean will exceed 130 col/100 ml and 2) the percentage of time that the daily maximum of 300 col/100 ml is expected to be exceeded.

It is clear from the scenario results that if reasonable (i.e. to practicable extent possible) BMPs are implemented that all but three reaches in the North Branch will have difficulty meeting water quality standards.

More specifically, scenario 1 has a small but measurable effect on compliance with the E. coli standards. The practices in this scenario affect only storm event concentrations, which are reflected in high values within the long-term distribution of E coli values. Reducing high flow values is an important component for meeting standards, but the low flow values still dominate. Scenario 2 on the other hand results in a significant reduction in exceedances of the E. coli standards. However, even with the aggressive implementation level, none of the waterbodies meet the standards all the time. There is a lack of knowledge regarding the sources of *E.coli.* in the North Branch; does it emanate from human, agricultural or natural sources and within these broad categories what are the specific sources. Until the sources are better determined it doubtful that the North Branch of the Clinton River will achieve the Michigan *E. coli.* standards. However, reduction of *E coli*. bacteria may achieve other goals such as reduction of Lake St. Claire beach closings. The most important message is that improvement in ambient bacteria levels is best addressed with programs that aggressively target low flow sources of bacteria.

Table 8-5. Bacteria Target Reduction

Catchment ID	Name	Catchment Area (ac)	E coli % of time exceeding 30-day Geometric Mean	E coli % of time exceeding daily max
601	East Branch Coon Creek	8,190	74%	24%
602	East Branch Coon Creek	4,059	77%	21%
603	Highbank Creek	10,109	29%	15%
604	East Branch Coon Creek	6,561	56%	19%
607	Coon Creek	16,966	46%	19%
608	Coon Creek	1,162	47%	18%
609	North Branch Clinton River	13,858	33%	14%
610	North Branch Clinton River	18,099	9%	13%
611	East Pond Creek	13,337	25%	14%
612	North Branch Clinton River	11,559	3%	12%
613	North Branch Clinton River	2,644	3%	11%
614	Deer Creek	9,375	55%	19%
615	North Branch Clinton River	10,533	27%	13%
616	North Branch Clinton River	1,630	34%	15%
	Total North Branch	128,082		

Hydrologic Flow

The complex nature of hydrologic flow requires an analysis that relies on consideration of impervious surfaces.

Based on the analysis in Chapter 5, the following table shows the amounts of currently directed impervious area must be mitigated to return to 1980 hydrologic conditions.

The model results indicate that there are four reaches that currently exceed the five percent target at which a stream begins to exhibit signs of stress due to impervious cover. Although this is a difficult standard to achieve, it thought to be necessary to strive for so that stream health is maintained. The four reaches, 602,612, 615, and in particular 616 should be given high priority in terms of mitigating the existing effective impervious surface while the remaining watersheds should concentrate on ensuring that best management practices such as LID practices are implemented on all new construction and significant redevelopment.

Modeling Conclusions

The modeling results show that the North branch has indeed been impacted by human activity but is at a stage that stream heath should be able to be returned to if management measures are implemented. This is true for the four of the five stressors analyzed. With regard to *E.coli.* it is less certain what is required to achieve water quality standards. It is strongly recommended that a source assessment study be undertaken in order to better understand the origins of the bacteria on which to base additional implementation of best management practices to meet water quality standards.

This section of the plan does describe in some detail how pollutant load reductions can be achieved but does not prescribe in detail how this implementation has to occur. This is to provide the greatest flexibility for the entities implementing the plan and so they can select actions that are appropriate based on cost, opportunity and other factors such as up-dating and load analysis.

The ultimate goal of the actions presented in the subsections is to collectively achieve the desired load reductions in each reach of the subwatershed.

Table 8-6. Impervious Cover Reduction Targets

Catchment ID	Name	Catchment Area (ac)	Targeted % reduction in IC*
601	East Branch Coon Creek	8,190	0.0
602	East Branch Coon Creek	4,059	5.3%
603	Highbank Creek	10,109	0.0
604	East Branch Coon Creek	6,561	0.0
607	Coon Creek	16,966	0.0
608	Coon Creek	1,162	0.0
609	North Branch Clinton River	13,858	0.0
610	North Branch Clinton River	18,099	0.0
611	East Pond Creek	13,337	0.0
612	North Branch Clinton River	11,559	6.6%
613	North Branch Clinton River	2,644	0.0
614	Deer Creek	9,375	0.0
615	North Branch Clinton River	10,533	3.2%
616	North Branch Clinton River	1,630	39.4%
	Total North Branch	128,082	

* Target is 5% based on Schueler et al, 2009 Reformulated Impervious Cover Model

9. Evaluation and Revision

Introduction

This chapter establishes the evaluation procedures (including monitoring protocols selected from Chapter 5 and Appendix E.3) and lists suggestions for steps to guide revision of the WMP. The procedures and suggestions reflect the importance of an on-going iterative process. Portions of this chapter are based on "A Framework for Assessing the Effectiveness of Jurisdictional Urban Runoff Management Programs" developed by the San Diego Municipal Storm Water Co-Permittees (2003).

(EPA 12.5, 12.6, 12.9, 12.10 – refers to entire chapter)

Measures of Success

Measures of success, or 'evaluation mechanisms', are essential to gauge implementation status and assess the effectiveness of the overall program. Identification of quantifiable measures provides both measurability and accountability within the program. Certain parameters to be measured are addressed throughout the WMP in Chapters 3, 4, 5, 6, 7, and 8 and numerous appendices. The evaluation mechanisms can be classified based on the data that is required as discussed in the following sub-sections. Additionally, measures that are used to assess the effectiveness of WMP implementation can be referred to as 'indirect' while those that assess change in water quality are 'direct'. All of the measures associated with the actions are presented in Table 9-1.

Measure of Activity Completion

Measure of Activity Completion mechanisms require only an indication of whether or not an activity has been completed. These measures are used to assess implementation and include the 'Implementation Milestones' which are discussed in a later section.
Most of the actions can be assessed on the basis of whether or not they are complete and on schedule (some cannot as they are ongoing).

Measure of Usage

These mechanisms require data concerning how much a facility has been used or how much material has been distributed or collected in order to assess implementation.

Most of the actions can be assessed on the basis of measure of usage. And many may have multiple measures associated with them.

Measure of Change

These mechanisms require data concerning baseline and post-action levels of knowledge or water quality. These measures are used to assess effectiveness.

Italicized actions were formulated to address observation made in the field during one or more of the field data collections efforts (i.e. the USA, USSR, and Social Survey). This is the same convention used in Chapter 8.

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Final Evaluation Measures Guidance

In accordance with the Water Quality Management Plan (SEMCOG, 1999) for Southeast Michigan, the final evaluation measures for this plan should:

- Be understandable;
- Reflect changes over time; and
- Reflect the unique characteristics of the study area.

Also, each stressor has a dedicated appendix that summarizes its information from Chapters 5 through 9 (Appendix C.1).

Acronyms and Terms

A complete list of acronyms and terms and their respective definitions can be found in Appendix A.1.

CMI Requirements in this Chapter

The following CMI requirements are addressed, at least partially, by the information that is presented throughout this chapter, including:.

- A description of the process that will be used to evaluate the effectiveness of implementing the plan and achieving its goals.

Table 9-1. Measures of success.

Action		Measure of Usage	Measure of Change
Action Category & Number	Title	Data requirement	Data requirement
1-1	Promote and Reconvene North Branch SWAG	Average percentage of SWAG members represented at meetings	Diverse membership; strong programmatic activities; Increase in membership
1-2	Develop Funding Program	Develop funding strategy document based on information contained in this WMP	Implementation of funding strategies/ secure funding
1-3	Develop Implementation Plans / Grant Proposals	The number of grant proposals submitted	Number of grants received
1-4	Regulatory Enforcement and Technical Assistance	The number of technical assistance efforts made in the watershed. The number of enforcement activities that occur by municipality	Technical assistance topics are more robust; Enforcement activities decline as the required activities become SOPs
1-5	Implementation Clearinghouse	Percentage of municipalities members reporting to clearinghouse	Number of inquiries for information
1-6	Total Maximum Daily Loads	Percentage of completed TMDLs addressed	Implementation of TMDL plans
1-7	Identify Impacts, Stressors, Sources, and Causes	Documentation of new or adjusted Impacts, Stressors, Sources, and Causes reaches clearinghouse	Updates to procedures reflecting new information
1-8	Update WMP	MDNRE Updates continue on a regular basis	New WMP Update
2-1	Public Education – General Public	SEMCOG and other efforts continue; Number of education materials distributed	Percentage of target audience indicating increased awareness (social survey update)
2-2	Public Education – Business and Agriculture	Efforts to partner with Agricultural and Business community have occurred	Percentage of target audience indicating increased awareness (social survey update)
2-2	Riparian and Business Owner Education	Number of riparian landowners and businesses receiving information	Percentage of riparian miles with improved management
2-2	Riparian and Business Owner Technical Assistance	Number of riparian landowners and businesses receiving technical assistance	Number of participants that institute the recommended changed in whole or in part.
2-3	Public Education – Municipal Employees	Number of training sessions; Number of people trained.	Percentage of target audience indicating increased awareness (social survey update)
2-4	Demonstration Projects	Plans for, and implementation of demonstration projects occurs	Decline in the demand for storm water demonstration projects
2-5	Signage	Number of watershed signs increases	Decline in the demand for new storm water signs
2-6	Public Involvement	Attendance at Public venues/ volunteer numbers increase	Percentage of attendees/volunteers providing positive feedback
2-7	Community Forums and Stakeholder Workshops	Implementation projects include forums and workshops.	Percentage of attendees providing positive feedback
2-8	Municipal Official's Presentations	Number of presentation made to public officials	Percentage of municipal officials familiar with WMP
3-1	Update / Develop Master Plans	Number of Master Plans updated to incorporate water quality protection goals	Storm water is referred to/managed in master plans
3-2	Managing Development Patterns	Percentage impervious per development decreases; NPDES Phase II standards are met.	Percentage of municipalities managing development
3-3	Preserve Riparian and Natural Areas / Features	i) For new development riparian and natural feature areas are protected. ii) Number of projects initiated	Percentage of municipalities members: protecting riparian and natural features
3-4	Stormwater Management Standards	Number of communities adopting standards	Percentage of municipalities members adopting standards
3-4	Stormwater management classification	Number of neighborhoods classified	List of priority neighborhoods for retrofits
3-5	Pollution Prevention Ordinances / Programs	Number of communities adopting ordinances	Percentage of other municipalities adopting ordinances/programs

Table 9-1. Measures of success. (continued)

Action		Measure of Usage	Measure of Change
Action Category & Number	Title	Data requirement	Data requirement
4-1	Remediate Contaminated Sediments	Studies of problem continue, remediation plans developed	Remediation of contaminated sediment occurs
4-2	Storm Sewer System Maintenance and Operations	Number of municipalities where O&M procedures change to address stormwater	Pollutant load reductions
4-3	Minimizing Pollution from Roads and Lots	Identify prioritized areas; Percentage of total pollutant loads removed from roads. Percentage of Road-stream crossing upgraded.	Pollutant load reductions; Number of road-stream crossings upgraded/repaired
4-4	Minimizing Pollution from Municipal Facilities	Number of municipalities where O&M procedures change to address stormwater	Pollutant load reductions
4-5	Turf Management Practices	Number of municipalities where O&M procedures change to address stormwater	Pollutant load reductions
4-6	Waste Management	Number of municipalities improving waste management practices.	Pollutant load reductions
4-7	Fecal Matter	Source assessment study has been conducted and implementation has begun	Pollutant load reductions
4-8	Sanitary and Combined Sewer System Planning and Maintenance	Enforcement of SSO and CSO procedures and improvements.	Reduction of basement backups / CSOs / SSOs
4-9	Flood Control Projects	Number of projects initiated	Percentage of municipal officials familiar with CRPAC/Restoration Plan
4-10	Illicit Discharge Elimination	Number of illicit discharges corrected.	Amount of pollutants removed.
4-11	Septic On-site Disposal System Practices	Number of failed systems found by the OSDS time of sale ordinance;	Number of systems fixed as a result of the OSDS time of sale ordinance.
4-12	Septic On-site Disposal System Practices	Number of communities requiring a regular OSDS maintenance	Percentage of septic systems voluntarily maintained on a regular basis
4-12	Trash / Debris Reduction	Bi-annual river clean up continues	Number of volunteers participating
4-13	Spill Prevention / Notification / Response	Illicit discharge procedures adopted / Number of spills recorded	Pollutant load reductions
4-15	Agriculture Action (GAAMPS)	Number of GAAMPS installed	Pollutant load reductions
4-15	Agriculture Action Farm & Crop-A-Syst	Farm-A-Syst and/or Crop-A-Syst programs are expanded	Number of agricultural producers reached; Number of plans and action implemented
4-15	Agriculture Action CREP & CRP	CREP & CRP programs are expanded	Number additional miles of riparian easements
4-16	Emerging Issues	Health Department/Regional Monitoring project identify emerging issues	Monitoring of and/or corrective action on emerging issues
5-1	Upland Bare Soil Repair	Number of projects undertaken (Public and Private sites)	square feet of repairs done by private landowners; pollutant load reductions
5-2	Streambank Shoreline / Stabilization	Square feet of streambank stabilization, (Public and Private sites)	square feet of repairs done by private landowners; pollutant load reductions
5-3	Road and Ditch Stabilization	Linear feet stabilized, (Public and Private sites)	square feet of repairs done by private landowners; pollutant load reductions
5-4	Streambank Use Exclusion	Linear feet excluded, (Public and Private sites)	square feet of repairs done by private landowners; pollutant load reductions
5-5	Specific Site Control	Number of sites where controls are installed, (Public and Private sites)	Number of controls installed by private owners; pollutant load reductions

Table 9-1. Measures of success. (continued)

Action		Measure of Usage	Measure of Change
Action Category & Number	Title	Data requirement	Data requirement
5-6	Structural Controls	Number of sites where controls are installed	Number of controls installed by private owners; pollutant load reductions
5-7	Agricultural BMPs	Number of BMPs adopted, (Public and Private sites)	Number of controls installed by private owners; pollutant load reductions
5-8	Construction Sites	Number of construction sites monitored by each municipality	Decline in enforcement actions
6-1	Mitigate Existing Impervious Surfaces	Total square feet of mitigated imp. Surface, (Public and Private sites)	square feet of mitigation done by private landowners; pollutant load reductions
6-2	Infiltration Techniques	Total square feet of area treated with infiltration, (Public and Private sites)	square feet of infiltration techniques done by private landowners; pollutant load reductions
6-3	Filtration Techniques	Total square feet of area treated with filtration, (Public and Private sites)	square feet of filtration techniques done by private landowners; pollutant load reductions
6-3	Tree Planting Program	Identify prioritized areas for retrofits; Arbor day promotion; CD tree sale promotion, (Public and Private programs)	Number of trees planned
6-3	Downspout disconnection programs	Establish local ordinance; Identify prioritized areas for disconnection	Number of neighborhood targeted, number of houses converted. Reduced flashiness
6-3	Adopt a storm-sewer	Identify prioritized areas; number of participants	Reduced debris; sediment originating from residential areas
6-4	Vegetative Buffers and Natural Conveyance	Total linear feet of natural conveyance implemented, (Public and Private sites)	square feet of natural conveyance done by private landowners; pollutant load reductions
6-5	Retention and Detention	Total square feet of area subject to retention or detention, (Public and Private sites)	square feet of retention; detention done by private landowners; pollutant load reductions
7-1	Identify Natural Features Stream Corridor study	Comprehensive stream corridor study; inventory is undertaken.	Consideration of new Natural Features in County Green Plans
7-2	Natural Land Reserves	Total acres of land protected	Number of inquiries about programs
7-3	Natural Feature Protection	Number of protections installed / undertaken, (Public and Private sites)	Number of protections installed by private owners
7-4	Nature Feature Restoration	Number of restorations undertaken, (Public and Private sites)	Number of protections installed by private owners
8-1	Recreation Program	Percentage of municipalities members participating	Number of municipalities participating
8-2	Riparian Land Conservation for Parks	Percentage of municipalities implementing action	Number of municipalities implementing action
8-3	Canoe / Boat Landings / Access Sites	Number of landings / access sites added	Number of municipalities implementing action
8-4	Restore Fishing Opportunities	Number of fishing opportunities restored	Number of municipalities implementing action
8-5	Trails / Observation Decks	Number of trail miles established; decks constructed	Number of municipalities implementing action
9-1	Implementation Reporting	SWAG collect reports	Write White paper summarizing result
9-2	Stressor Monitoring and Assessment	SWAG to annually review monitoring results and assess against delisting criteria	Write White paper summarizing result; Street Dirt Study is undertaken
9-3	Public Education and Involvement Data	SWAG to collect	Evaluation of program
9-4	Field Data Collection	SWAG to annually review monitoring results and assess	White paper summarizing result
9-5	SWAG Evaluation / Effectiveness Assessment	SWAG to review progress on plan after 2 - 3 years	White paper summarizing result

Pollutant Load Reductions

SEDIMENT

The preferred way to determine if sediment loading reductions are being achieved is to quantitatively analyze water chemistry data.

Alternatively, or in addition to analyzing water quality data, reductions may be qualitatively shown through: improved macroinvertebrate and fish communities; reduced time between dredging; and a decrease in the number/severity of bank erosion problems.

PHOSPHORUS

The preferred way to determine if phosphorus loading reductions are being achieved is to quantitatively analyze water chemistry data.

Alternatively, or in addition to analyzing water quality data, reductions may be qualitatively shown through a reduced prevalence of algae and macrophytes.

PATHOGENS

The preferred way to determine if pathogen loading reductions are being achieved is to quantitatively analyze water chemistry data.

Alternatively, or in addition to analyzing water quality data, reductions may be qualitatively shown through: continued progress in correcting illicit connections; decreased occurrences of sanitary and combined sewer overflows (i.e. SSO, CSOs); and fewer beach closings.

HYDROLOGIC FLOW

The preferred way to determine if hydrologic flow flashiness reductions are being achieved is to quantitatively analyze actual flow data.

Alternatively, or in addition to analyzing flow data, reductions may be qualitatively shown through reduced levels of impervious cover.

Effectiveness Assessment

The process of evaluation the effectiveness of a program is reliant upon the quality and appropriateness of the data it is based on. The effectiveness assessment phase consists of a program assessment, a water quality assessment, and an integrated assessment, as discussed in the following sub-sections.

Program Assessment

Program assessment involves reviewing the attainment of the indirect evaluation mechanisms. This review involves checking that implementation has occurred on schedule and that program effectiveness can be shown. Milestones are an important building block in the program assessment process as they provide intermediate programmatic goals against which to measure progress. Program assessment is an ongoing task that will be reported in the periodic progress reports. One useful way of reporting periodic progress is an 'report card' that cross-references municipalities and other agencies with the actions of the plan they are responsible for in order to gauge the levels of implementation that have been achieved over given period of time.

Water Quality Assessment

Assessing water quality is necessary to determine if there have been any changes in the conditions of the watershed and receiving waters as a result of the actions undertaken. Assessing water quality is a direct evaluation mechanism and as such, long-term data is necessary to ensure that seasonal, annual, and other variables can be identified and are considered when interpreting the results.

Almost simultaneous with the submission of this plan, the twenty-five page Clinton River Monitoring Plan (2010) was submitted to the DNRE – Municipal Program/MS4 Compliance Assistance program for approval. It contains measures to address both specific impaired stretches and general trends. Since the monitoring plan had yet to be approved, it is not presented here. The approved monitoring plan will be available from MCPWO upon request. Below is a summary of monitoring activities.

Summary Current Monitoring Activities

Monitoring the health of the North Branch is conducted by different governmental agencies and the Clinton River Watershed Council. The parameters monitored vary by the program. The following summarizes the current monitoring activities by entity. These programs form the basis for evaluating the health of the North Branch, both now and into the future. They will also be used to evaluate the effectiveness of implemented actions (Chapter 8) by assessing the change in water quality over times. Figure 9-1 is a map of the available monitoring sites for the various entities.

Clinton River Watershed Council (CRWC)

Twice a year (in May and October), through its Adopt-A-Stream program, volunteer teams visit specific sites and collect data, including physical information (such as streambank erosion and surrounding land use) as well as collect and identify macroinvertebrates ("bugs") that live in the streambed and submerged vegetation. Information on the program can be found at http://www.crwc.org/programs/adoptastream/monitoring.html (last accessed January 12, 2011). The Michigan Clean Water Corp protocols are followed to ensure the quality of the data collected.

The program has operated from Fall 2005 and data analyzed from May 2006 to the present. In 2007, the number of sites grew from forty-seven (47) to include fifty-two (52) monitoring sites for the entire Clinton River Watershed with two in the North Branch. Sites for the North Branch are shown in Figure 9-1. All individual site scores are averaged together to arrive at an overall score for the subwatershed. Adopt-A-Stream monitoring data appears to be consistent with other studies (primarily chemical monitoring), suggesting that Adopt-A-Stream monitoring efforts reliably evaluate stream quality, provided enough sites and seasons are represented.

State of Michigan Department of Natural Resources and Environment (MDNRE)

The State Surface Water Quality Monitoring Strategy consists of activities that together help form a comprehensive assessment of water quality in Michigan's surface waters. This strategy is contained in "A Strategic Environmental Quality Monitoring Program for Michigan's Surface Waters" (1997, 2005) and guides Michigan's monitoring program implementation. It consists of nine interrelated elements: fish contaminants, water chemistry, sediment chemistry, biological integrity, wildlife contaminants, bathing beaches, inland lake quality and eutrophication, stream flow, and volunteer monitoring. The Strategy specifically identifies four monitoring goals:

1. Assess the current status and condition of waters of the state and determine whether water quality standards are being met;
2. Measure spatial and temporal water quality trends;
3. Evaluate the effectiveness of water quality prevention and protection programs; and
4. Identify new and emerging water quality problems.

Each year, DNRE biologists conduct surveys in selected watersheds to identify waters that are and are not attaining standards. Watersheds are assessed according to a 5-year rotating basin design, with a target of assessing 80% of the river/stream miles in each watershed. The Clinton River was last assessed in 2009 and the eight North Branch Sites can be seen in Figure 9-1.

The surveys consist of monitoring for a combination of biological (benthic invertebrates and/or fish), habitat, water, sediment, and fish tissue indicators in wadable streams. Aquatic macrophytes and algae also are assessed, primarily to determine whether nuisance plant levels are present. Historically, a targeted approach to site selection has been used, whereby sites were chosen for a specific reason (e.g. known/suspected contamination, evaluate program effectiveness, lack of data, etc.). In 2004, however, a probabilistic approach to site selection was tested in several watersheds and may be used in the future. Random site selection allows results to be extrapolated to unmonitored locations in the watershed. Available information and data from other federal, state, and local agencies also are used as appropriate to assist with these determinations. Additional Information can be found at:

http://www.michigan.gov/deq/0,1607,7-135-3313_3686_3728---,00.html (last accessed July 14, 2010)

Macomb County

The Macomb County Health Department (MCHD), Macomb County Public Works Office (MCPWO), Road Commission of Macomb County (RCMC) have all separately initiated long term, in-stream monitoring programs that document the water quality of the Clinton River, Lake St. Clair, and their respective tributaries under a variety of flow conditions. Under the County's NPDES permit, the MCHD is conducting dry weather screening on all the outfalls into the waters of the state; the MCPWO is conducting dry weather screening on legally established county drains and nested jurisdictions' outfalls; and RCMC is screening all outfalls under its jurisdiction. It is estimated that the cooperative work of all the three county departments has eliminated approximately 75 Million gallons per year of pollution from entering the Clinton River and Lake St. Clair. The current permit requires that MS4 discharge points be inspected on a rotating five-year basis. The information/data gathered by future IDEP activities in the North Branch will continue to be used as a part of the watershed monitoring and evaluation effort.

The Macomb County Health Department (MCHD) In-Stream Monitoring

The Macomb County Health Department (MCHD), has initiated a long term, in-stream monitoring program which documents the water quality of the Clinton River, Lake St. Clair, and their respective tributaries under a variety of flow conditions. The surface water monitoring effort has grown to 57 sites watershed-wide, three of which are in the North Branch, where samples are collected once per week and tested for *E. coli* bacteria (see Figure 9-1). Samples are also collected at selected sites in response to rainfall events, especially in areas where combined sewer overflows have occurred or are anticipated. The data collected is entered into a database. Information is reviewed closely for trends that might indicate problems requiring further investigation and for reductions in pollution levels that result from corrective efforts.

Macomb County Public Works Office (MCPWO)

To date, initial dry weather screenings are complete for approximately 816 outfalls and 65 nested schools throughout the entire Macomb County jurisdiction. Figures specifically for the North Branch are not readily available. Outfalls investigations included testing for *E. coli*, conductivity, odor, coloration, temperature, oil sheens, floatables, bacteria sheens, algae, slimes, surfactants and staining of the banks and unusual vegetative growth. Follow-up investigations on 163 suspected illicit discharges have been conducted. Thirty-two (32) found problems have been corrected and six (6) additional problems are in the corrective action stage.

Macomb County Health Department (MCHD) Illicit Discharge Program

Since 2001, the MCHD has conducted drain walks on all county drains within the North Branch Clinton River to identify illicit connections from residential, commercial and industrial sources. As a direct result of past work throughout Macomb County, over 6,000 facilities have been evaluated and 731 illicit connections identified resulting in 46.5 million gallons per year of sanitary waste no longer fouling Macomb County surface waters. Teams are currently planning work to evaluate a minimum of 750 commercial, industrial and institutional facilities in Sterling Heights and Clinton Township (part of which is in the lower North Branch) over the next two-year grant period.

Road Commission Macomb County (RCMC) Illicit Discharge Program

The Road Commission has approximately 2,225 outfalls associated with its system. They have all been screened by the end of 2006. One-hundred and thirty-nine (139) follow-up investigations were conducted, resulting in the identification of 23 problems.

The current monitoring activities are summarized in Table 9-2 below and Figure 9-1.

Table -2: Summary of impairments monitored for by catchment.

Catchment	Monitored	Parameter Monitored (from Table 7-4)	Parameter Not Monitored
601	MCHD	*E.coli.*	TP, NO3
602	MCHD	*E.coli.*	TP, NO3, IC
603	MCHD	*E.coli.*	TP, NO3, IC
604	MCHD, MDEQ	Sediment, TP, NO3, *E.coli.* D.O.	
607	MCHD-Trend, MDEQ	TP, NO3, *E.coli.*	
608	MCHD, MDEQ	Sediment, TP, NO3, *E.coli.*	
609	MCHD	*E.coli.*	Sediment
610	MCHD-Trend	Sediment, NO3	
611	MCHD	*E.coli.*	Sediment, NO3
612	MCHD, MDEQ, CRWC	Sediment, NO3	IC
613	MCHD, MDEQ	Sediment, NO3	
614			TP, NO3, E.coli.
615	MCHD, MDEQ	Sediment, NO3, *E.coli.*	IC
616	MCHD, MDEQ, CRWC	Sediment, NO3, *E.coli.*	IC

MONITORING DEFICIENCIES

It is evident from Table 9-2 that thirteen of the fourteen catchments are being monitored for one or more of the priority pollutants. The gaps are primarily because of not sampling for some of the pollutants associated with catchments as opposed to the geographic placement of the current programs: only one catchment does not have a monitoring station in it. Sediment loads, surfactants, dissolved oxygen, and other parameters are only being measured on an as needed basis (when a problem has been identified).

Based on the observations it is recommended that funding be sought to periodically expand the suite of parameters sampled to include the impairments associated with each catchment. Furthermore, catchment 614 should have a sampling site associated with it due to its size and isolated hydrology. This last recommendation is case-specific and should not be misconstrued to imply that all sub-catchments need to be monitored.

If an additional site is to be added to one of existing monitoring programs, there are several factors to consider. The following should be considered in selecting a monitoring site:

Benefits of Street Dirt

The proposed measurement of street dirt overcomes many of the limitations cited for discharge monitoring. Detection limits are not an issue. The collection equipment is simple and inexpensive. A modest technical background is needed to use the equipment and to make judgments as to the sampling points. Properly supervised interns can conduct the sampling. Sampling can occur during good weather. Nothing is left in the field that may be vandalized.

The cost of equipment per outfall for discharge monitoring is on the order of $10,000. The cost of equipment for dirt sampling is on the order of $1,500. Equipment includes traffic cones and personnel vests, a portable generator, extensive cord, a stainless steel shop vacuum, a 2.5-micron Dacron filter cloth cover, vacuum hoses, a paint brush, resealable plastic zipper storage bags, and a weighing scale.

The cost of discharge monitoring for one outfall over the period of a year is on the order of $50,000 to $100,000 for labor, exclusive of sample analyses. Consider that a crew of two collecting street dirt samples can perform about six samplings of street dirt per day. At normal labor and analytical unit costs, the cost per dirt sample is on the order of $500 to $1,000. Hence, for the cost of monitoring one outfall over the period of a year, about 1,000 samples of street direct can be collected within a watershed of interest. Because the sampling is not constrained by weather, these 1,000 samples can be collected over a period of a few months by several crews, rather than a year for an outfall.

Minton, G.R. and R.C. Sutherland (2010), *Street Dirt*, Stormwater, Vol. 11, No. 3, Forester, Santa Barbara, CA

- Access to site: Personnel should be able to access the center of the stream without disturbing the area.
- Catchment location: The site should be as close to the catchment outlet as possible.
- Linear: The course of the stream is straight for about 300 feet upstream and downstream.
- Safety: Personnel will be safe to access the stream unencumbered.
- Condition of Immediate Vicinity: The following should be noted and accounted for:
  - Adjacent land use(s) immediately up and down stream;
  - Physical characteristics of the channel (slope, substrate): Is it stable?
- Security: If equipment is to be left behind/installed the site should be able to be secured.

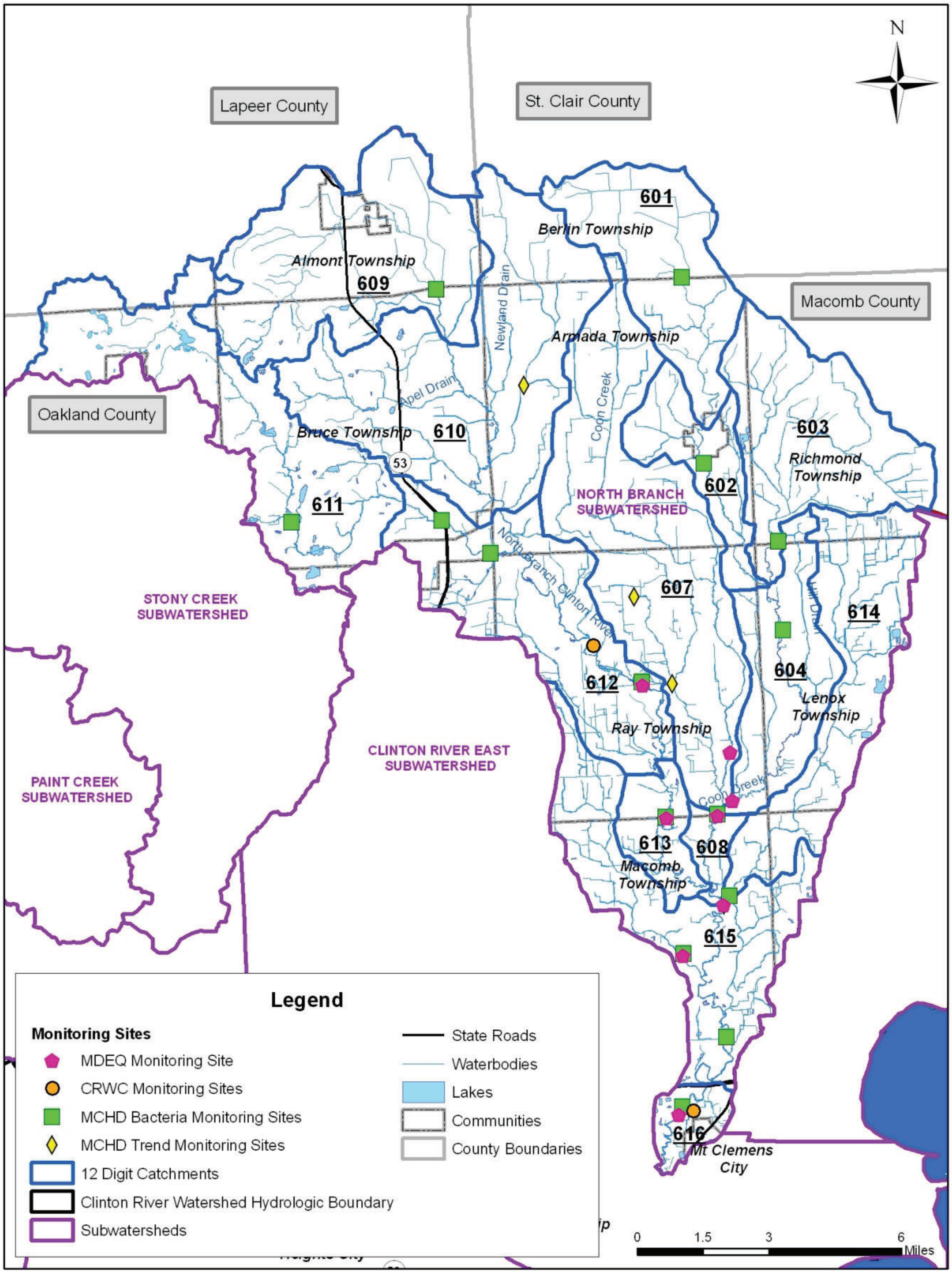
Given these considerations, the ideal spot is on a bridge or overpass (with a sidewalk).

One alternative to conventional in-stream monitoring is to use street dirt as a proxy, as proposed by Minton and Sutherland (2010). Understanding of the chemistry of street dirt, how the chemistry is affected by land use, and factors within each land use is in its infancy. Extrapolating from the fifteen studies published as of 2010, it appears that the analysis of street dirt for nutrients, metals and *E.coli*. show promise, primarily in residential and urban areas where the sources of these parameters are ubiquitous.

The measurement of the composition of street dirt overcomes many of the limitations cited for discharge and in-stream monitoring procedures. Detection limits are not an issue. The collection equipment is simple and inexpensive. A modest technical background is needed to use the equipment and to make judgments as to the sampling points. Properly supervised interns can conduct the sampling. Sampling can occur during good weather. Nothing is left in the field that may be vandalized. All these benefits make the analysis of street dirt a potentially viable proxy for in-stream monitoring.

The second shortcoming is the number and geographic extent of monitoring sites. The cost of in-stream monitoring limits the number of sites that can be monitored. A review by Tetra Tech of the current MCHD sites concluded that the current locations were appropriate. The current limitation of the number of sites throughout the watershed could possibly be overcome by lowering the cost of monitoring, as is anticipated by using street dirt as a proxy for in-stream results.

Figure 9-1: Monitoring sites in the North Branch Clinton River



Integrated Assessment

The integrated assessment incorporates assessing water quality with program assessment and evaluates the entire watershed management plan as a whole. The integrated assessment involves investigating failures and making recommendations to update the plan update, including continuing the implementation of certain actions, modifying some, and ceasing others – as well as the reasons behind the recommendations. The integrated assessment also identifies and addresses data gaps in the water quality monitoring program, finds causal relationships between actions and changes in load reductions, as well as assesses discharge and receiving water quality.

Generally, determining the effectiveness of the actions is a qualitative process that relies on both the assessments showing at least minimal improvement, over time, in:

- awareness and knowledge,
- behavioral changes / BMP implementation levels,
- pollutant loads (reductions) / discharge quality, and
- receiving water quality.

These summary assessments are used to revise the plan such that the problems and priorities are up to date and that the actions are effective.

Model Evaluation Criteria Useful in the Future

A number of criteria were used in evaluating the modeling results. These criteria may prove useful in evaluating water quality conditions in the future (especially considering the projected conditions from the modeling effort). The criteria include:

- The number of days *E. coli* water quality standards are met,
- Average nitrate concentrations and annual nitrate loadings;
- Average total phosphorus concentrations and annual total phosphorus loadings,
- Average total suspended solids (TSS) concentrations and annual total suspended solids loadings,
- The RB Index. (Flashiness)

Implementation Milestones

This sub-section lists out and expands upon the implementation milestones initially presented in Chapter 8's action tables. Milestones are presented to gauge progress and are not meant to indicate commitments for any of the actions, as many of the actions are highly dependent on the availability of funding that the SWAG has limited control over.

The primary function of the milestones is to act as a mechanism for guiding realistic revisions to actions and schedules in future versions of the WMP. Milestones associated with completion of activities and measures of usage were detailed in Figure 9-2 whereas a general schedule of milestones is shown in Figure 9-3. In Figure 9-2, milestones associated with achieving delisting of impaired waterbodies are also provided; these are presented in **bold** text. Milestones beyond the ten year time frame are not provided since it is recommended that a major evaluation that will establish future milestones be conducted at that time.

The Figure 9-3 shows the suggested planning, implementation and evaluation schedule for each action. Figure 9-3 is linked to Figure 9-2 through the **bolded** dates in the individual timelines that reflect the timing that a milestone is to occur.

Goals and Objectives Evaluation

In addition to evaluating actions, it is beneficial to evaluate progress towards achieving the WMP goals / objectives. This evaluation will help define changes to be made to the WMP when it is revised.

Guidance for Revision of the Watershed Management Plan

The plan will be updated regularly for both regulatory (EPA/MDNRE) purposes and to reflect changing conditions in the watershed.

The SWAG may opt to do an integrated assessment to look at all of the data collected holistically and may include:

- Examining collected data and assessments to identify gaps;
- Looking for causal relationship between the actions taken and the results documented; and
- Examining the goals and objectives (see Chapter 6) for achievement status, modification, omission, or addition.

The SWAG may wish to collect additional data or implement other assessment that they deem necessary to successful watershed management planning, implementation and assessment. Examples of assessment ideas can be found throughout the plan (Chapters 3, 4, 5, 6, 7, 8, and 9 and numerous appendices). Any additional assessments to be implemented should be added to the appropriate action presented in Chapter 8.

The results of this and other assessments will inform the final recommendations for the WMP modifications and may include:

- Updating actions to reflect current implementation levels;
- Modifying goals and objectives;
- Modifying actions; and
- Modifying evaluation mechanisms and monitoring protocols.

Notes on Evaluating Goals and Objectives

There are a number of considerations to make when documenting whether or not goals and objectives have been met, including:

- The plan sets specific imperviousness mitigation targets that are related to reducing the flashiness of the streams in the watershed to 1980 levels.
- The evaluation of total body contact goals and objectives requires focusing on the 16-week total body contact recreation period at beaches and other critical locations.

Figure 9-2. Implementation milestones.

Year	Action No.	Milestone
2011	1-1	Promotion of the SWAG will have begun. The SWAG will continue to convene.
	1-2	A funding program for the actions of the SWAG will have been developed.
	1-3	Implementation plans will have been developed for all of the actions in this WMP.
	1-5	An implementation clearinghouse for the WMP will have been developed.
	2-1	WMP-centric general public education will have begun.
	2-2	**WMP-centric public education for business and agriculture will have begun.**
	2-3	**Municipal employees education will have been conducted for all stakeholders.**
	2-5	Twenty WMP-related signs will have been erected in the sub watershed
	2-6	WMP-related public involvement activities will have been conducted.
	2-7	WMP-related forums and workshops (Riparian landowners) will have been conducted.
	2-8	WMP-related presentations will have been given to municipal officials.
	4-12	Trash/debris reduction events will have been held.
	4-13	**Spill prevention / notification / response procedures will have been updated.**
	7-1	An in-depth identification of natural features will have been conducted.
	8-1	WMP-integrated recreation programs will have been developed.
	4-8	***E.Coli.*** **Source Assessment study has been scheduled**
	5-8	The regulation of sediment discharge from all construction sites will have achieved both in principle and in practice.
	9-2	The MDNRE five year monitoring program was conducted in 2009. The SWAG should take the monitoring results and measure the past water quality conditions to determine if progress has been made.
	9-3	Public education and involvement data will have been collected.
	9-4	Baseline percentage levels for indicator benthic species will be agreed upon with the MDNRE. Protocol for assessing toxicity of pore space water will be established too.
	9-4	**Protocols for estimating impervious surfaces with in the watershed should be established and agreed upon by stakeholder. This should include updating procedures.**
	9-6	Evaluation and revision guidance for the WMP will have been developed.
2015	**1-6**	**Assess TMDLs that were established prior to 2010 to determine effectiveness. Take corrective action if necessary. Consider new source allocation techniques to clarify origin**
	1-7	A detailed problem identification study will have been conducted to guide future actions.
	2-4	**The construction of demonstration projects will have begun.**
	3-1	Master plans will have been developed and/or updated for all stakeholders.
	3-2	Mu**nicipalities will have begun managing development patterns.**
	3-3	**Natural area / feature protection ordinances and programs will have been adopted / established.**
	3-3	Details for natural features preservation/restoration programs have been established.
	3-4	**Municipalities will have adopted stormwater management standards.**
	3-5	**Pollution prevention ordinances and programs will have been adopted / established**.
	4-1	The remediation of contaminated sediments will have begun.
	4-2	**Updated storm sewer system maintenance and operations protocols will have been adopted.**
	4-3	**Updated road and parking lot pollution reduction protocols will have been adopted.**
	4-4	**Updated pollution reduction protocols for municipal facilities will have been adopted.**

Figure 9-2. Implementation milestones. (continued)

Year	Action No.	Milestone
2015	**4-5**	**Turf management practices will have been adopted by municipalities.**
	4-7	**An E.coli. source assessment study will have been conducted.**
	4-15	**Agricultural BMPs will have begun to be implemented / adopted.**
	4-16	Emerging environmental issues will have been addressed and a preliminary plan developed to address them in the future.
	7-1	Riparian and Natural Features Plan will be developed.
	5-2	**Streambank / shoreline stabilization plans will have been developed and will have been started to be implemented.**
	5-5	**Specific sites discharging sediment to waterways will have been identified and will have begun to be addressed.**
	5-6	**Structural controls to control sediment will have been implemented in problem sediment areas where other practices are not appropriate.**
	6-1	**The mitigation of existing impervious surfaces will have begun.**
	6-2	**Infiltration techniques will have begun to be implemented.**
	6-3	Filtration techniques will have begun to be implemented.
	6-4	Vegetative buffers and natural conveyance will have begun to be incorporated into previously developed sites.
	6-5	Updated retention and detention standards will have been developed and will have begun to be utilized in the construction of retention and detention facilities.
	7-4	The restoration of degraded natural features will have begun.
	9-1	All reports and annual reports from the previous years will have been provided to the SWAG. The SWAG will also have given guidance for making these documents more WMP-friendly.
	9-2	The MDNRE five year monitoring program is due to be conducted in 2014. The SWAG and its partners should provide guidance to MDNRE on hot spots that should receive special consideration for additional monitoring.
	9-2	Street Dirt study is undertaken to determine if it is a good substitute for in-stream monitoring.
	9-4	Additional studies on contaminated sediment have been conducted to better understand the sources of contaminated sediment (especially of PCBs). Remedial actions to be recommended.
2020	1-4	Enhanced regulatory enforcement and increased technical assistance will have been instituted in the watershed.
	4-6	**Improved waste management protocols will have been developed and implemented**.
	4-8	**Improved sanitary and combined sewer planning and maintenance will have been implemented.**
	4-9	**Procedures for ensuring that flood control projects address water quality issues will have been developed, adopted, and implemented.**
	4-101	**All illicit discharges will have been identified and corrected.**
	4-11	**Appropriate regulatory authority will have been extended to cover on-site disposal systems and appropriate pollution reducing regulations will have been adopted.**
	5-1	**The repair of bare soil in upland areas will have begun.**
	5-3	**The stabilization of eroding roads and failing ditches will have begun.**
	5-4	**The exclusion of use of streambanks by humans and domestic animals, especially in sensitive areas, will have begun.**
	5-7	**Agricultural BMPs related to sediment reduction will have begun to be implemented / adopted**

Figure 9-2. Implementation milestones. (continued)

Year	Action No.	Milestone
2025	**3-2**	**Impervious surface coverage is on target to remain at or below an equivalent of 10% average throughout the watershed. Equivalent imperviousness is a combination of actual imperviousness within the watershed and apparent imperviousness due to the installation of appropriate BMPs. Delisting criteria for impervious surfaces are being met.**
	3-3	Delisting criteria for natural features preservation/restoration impairments are being met.
	9-2	Baseline population levels for indicator fish species will be agreed upon with the MDNRE. A monitoring plan will be established that is consistent with MDNRE guidance.
	9-2	Sediment levels should not have elevated appreciably if all actions have been fully implemented. If it has elevated then additional corrective actions need to be considered
	9-5	The evaluation and effectiveness assessment of the WMP will have begun.
2030	1-8	A major evaluation of the WMP and its effectiveness should be planned for at this time. Major programmatic adjustments should be made based on the evaluation and future milestones established.
	7-2	Reserves of natural land in the subwatershed will have increased.
	7-3	All natural features previously identified for protection will have been protected.
	8-2	**Riparian park land will have increased.**
	8-2	The number of boat lands and stream access sites will have increased.
	8-4	The MDNR will have begun restoring fishing opportunities in the subwatershed.
	8-5	The number of trails and observation decks will have increased.

Figure 9-3. General timeline with milestones.

Planning Stage	Implementation	Evaluation	Key		
Action Category and Action Class				2011	2015
1. Watershed Planning, Institutionalization, and Implementation					
1-1. Institutionalization			1-1	2011_1-1	
1-2 Funding Program			1-2	2011_1-2	
1-3. Implementation			1-3	2011_1-3	
1-4 Regulatory Enforcement and Technical Assistance			1-4		2015_1-4
1-5 Implementation Clearinghouse			1-5	2011_1-5	
1-6 Total Maximum Daily Loads			1-6		2015_1-6
1-7 Identify Impacts, Stressors, Sources, and Causes			1-7		2015_1-6
1-8 Update WMP			1-8		
2. Public Education and Participations					
2-1. Public Education – General Public			2-1		2015_2-1
2-2. Public Education – Business and Agriculture			2-2	2011_2-2	
2-3 Public Education – Municipal Employees			2-3	2011_2-3	
2-4 Demonstration Projects			2-4		2015_2-4
2-5 Signage			2-5	2011_2-5	
2-6 Public Involvement			2-6	2011_2-6	
2-7 Community Forums and Stakeholder Workshops			2-7	2011_2-7	
2-8 Municipal Officials' Involvement and Education			2-8	2011_2-8	
3. Ordinances, Zoning and Development Standards					
3-1. Update / Develop Master Plans			3-1		2015_3-1
3-2. Managing Development Patterns			3-2		
3-3. Preserve Natural Areas / Features			3-3		2015_3-3
3-4 Stormwater Management Standards			3-4		2015_3-4
3-5 Pollution Prevention Ordinances / Programs			3-5		2015_3-5
4. Good Housekeeping and Pollution Prevention					
4-1 Remediate Contaminated Sediments			4-2		2015_4-2
4-2. Storm Sewer System Maintenance and Operations			4-3		2015_4-3
4-3 Minimizing Pollution from Roads and Lots			4-4		2015_4-4
4-4 Minimizing Pollution from Municipal Facilities			4-5		2015_4-5
4-5 Landscape Management Practices			4-6		2015 4-6
4-6 Waste Management			4-7		
4-7 Bacterial Waste Control			4-8		2015_4-8
4-8 Sanitary and Combined Sewer System Planning and Maintenance			4-9		2015_4-9
4-9 Flood Control Projects			4-10		2015_4-10
4-10 Illicit Discharge Elimination Plan Implementation			4-11		2015_4-11
4-11 Septic System Practices			4-12		2015_4-12
4-12 Trash/Debris Reduction			4-13	2011_4-13	
4-13 Spill Prevention / Notification / Response			4-14	2011_4-14	
4-14 Groundwater			4-16		2015_4-16
4-15 Agriculture Management			4-18		2015_4-18
4-16 Emerging Issues			4-19		2015_4-19

Figure 9-3. General timeline with milestones. (rows continued across from previous page)

2020	**2025**	**2030**	**2035**	**2040**	**2045**
Minor		2030 1-8			
	2025 3-2				
	2025 3-3				
		2020 4-1			
2020 4-7					

Figure 9-3. General timeline with milestones. (lower half)

Planning Stage	Implementation	Evaluation	Key		
Action Category and Action Class				2011	2015
5. Stormwater Best Management Practices and SESC					
5-1. Bare Soil Repair			5-1		2015 5-1
5-2 . Streambank / Shoreline Stabilization			5-2		2015 5-2
5-3. Road and Ditch Stabilization			5-3		2015 5-3
5-4 Streambank Use Exclusion			5-4		2015 5-4
5-5 Specific Site Control			5-5		2015 5-5
5-6 Structural Controls			5-6		2015 5-6
5-7 Agricultural BMPs			5-7		2015 5-7
5-8 Construction Sites			5-8	2011 5-8	
6. Stormwater Best Management Practices - Other					
6-1. Mitigate Existing Impervious Surfaces			6-1		2015 6-1
6-2 Infiltration Techniques			6-2		2015 6-2
6-3 Filtration Techniques			6-3		2015 6-3
6-4 Vegetative Buffers & Natural Conveyance			6-4		2015 6-4
6-5 Retention and Detention			6-5		2015 6-5
7. Natural Features and Resource Managment					
7-1 Identify Natural Features			7-1		2011 7-1
7-2. Natural Land Reserves			7-2		
7-3 Natural Feature Protection			7-3		
7-4 Natural Feature Restoration			7-4		2015 7-4
8. Receation Promotion and Enhancement					
8-1 Recreation Program			8-1		2011 8-1
8-2. Riparian Land Conservation for Parks			8-2		
8-3 Canoe / Boat Landings / Access Sites			8-3		
8-4 Restore Fishing Opportunities			8-4		
8-5 Trails / Observation Decks			8-5		
9. Environemtal Monitoring and Other Data Collection					
9-1. Implementation Reporting			9-1		2015 9-1
9-2 Stressor Monitoring and Assessment			9-2	2011 9-2	2015 9-2c
9-3. Public Education and Involvement Data			9-3	2011 9-3	
9-4 Field Data Collection			9-4	2011 9-4	2015 9-4
9-5 SWAG Implementation / Evaluation / Effectiveness Assessment			9-5		

Figure 9-3. General timeline with milestones. (lower half rows continued across from previous page)

2020	**2025**	**2030**	**2035**	**2040**	**2045**
		2030 7-2			
		2030 7-3			
		2030 8-2			
		2030 8-3			
		2030 8-4			
		2030 8-5			
	2025 9-2				
	2025 9-5	3030 9-6			

Table 9-3. Goals / objectives evaluation questions.

Goal / Objective	Evaluation Questions
<u>Goal I: To make progress towards achieving water (and sediment) quality standards for pollutants and parameters that affected the designated, desired, and beneficial uses in the subwatershed.</u>	Are objectives (A - F) below, being addressed? Has water quality deteriorated in any part of the subwatershed? Has water quality been restored or enhance in any part of the subwatershed?
A. Reduce sediment discharges to waterbodies	80 mg/l are the Phase II permit requirement. Have currently loads been reduced by 50% in 10 yrs? Have target reduction loads been achieved in 25 yrs?
B. Reduce nutrient discharges to waterbodies	Have currently loads been reduced by 50% in 5 - 10 yrs? Have target reduction loads been achieved in 10 - 15 yrs?
C. Reduce discharge of oxygen demanding substances to waterbody	Have currently loads been reduced by 50% in 10 yrs? Have target reduction loads been achieved in 25 yrs?
D. Reduce pathogen discharges to waterbodies	Have currently loads been reduced by 50% in 10 yrs? Have target reduction loads been achieved in 25 yrs?
E. i. Reduce discharges of elevated-temperature runoff to waterbodies ii., Address sources of in-stream temperature increases	Have currently loads been reduced by 50% in 5 - 10 yrs? Have target reduction loads been achieved in 10 - 15 yrs? Have currently loads been reduced by 50% in 5 - 10 yrs? Have target reduction loads been achieved in 10 - 15 yrs?
F. i. Reduce discharges of toxic compounds (includes inorganic, organic, and heavy metals stressors) to waterbodies; ii. Address areas of existing sediment contamination – prevent re-suspension of contaminants, remove highly contaminated sediments	Have currently loads been reduced by 50% in 15 - 25 yrs? Have target reduction loads been achieved in 25 - 50 yrs? Have currently loads been reduced by 50% in 5 - 10 yrs? Have target reduction loads been achieved in 25 yrs?
<u>Goal II: To stabilize hydrology of the subwatershed including both high flow and low flow conditions</u>	Are objectives (A - E) below, being addressed? Have flow conditions deteriorated in any part of the subwatershed? Have flow conditions been restored or enhance in any part of the subwatershed?
A. Prevent waterbodies in the subwatershed from exhibiting increases flashiness characteristics	Have current levels been maintained over the last 5 -10 yrs? Note: Realistically, this is an even flashier watershed than previously thought. A target of no increase in flashiness is probably reasonable. Have flashiness levels been reduce over the last 25 + yrs?
B. i. Limit / reduce impervious surface coverage ii. Limit / reduce impervious surface coverage and agricultural land in the 100-foot riparian buffers	Maintain impervious cover less than 10%: 5-10 yrs Reduce impervious cover: 15 to 25+ years If ever:
C. i. Increase wetlands coverage in catchments ii. Increase wetlands coverage in the 100-foot riparian buffers	See (wetland catchments restoration targets I previously sent you)
D. Reduce the number of flow obstructions in the subwatershed	Are woody debris management activities occurring and ongoing as need?
E. Reduce water withdrawals	Are agricultural water withdrawals being managed in a sustain way?

Table 9-2 Goals/objectives evaluation questions (continued)

Goal / Objective	Evaluation Questions
Goal III: To protect and restore suitable, high-quality habitat to support aquatic life, wildlife, and fisheries.	Are objectives (A - C) below, being addressed?
A. i. Preserve existing terrestrial habitat and restore degraded terrestrial habitat ii. Reduce the fragmentation of terrestrial habitat iii. Improve quality of existing terrestrial habitat	Has the Riparian Habitat Restoration and Preservation Plan (RHRPP; habitat plan) assessment study been conducted within 5 yrs? Has the habitat plan been implemented? - 25+ yrs
B. i. Preserve existing riparian habitat and restore degraded riparian habitat (with special focus on riparian wetlands and forested areas) ii. Improve the quality of existing riparian habitat	Has the RHRPP (habitat plan) (terrestrial and riparian) assessment study been conducted within 5 yrs? Has the habitat plan been implemented? - 25+ yrs
C. i. Preserve and enhance existing aquatic habitat ii. Improve areas of degraded aquatic habitat	Is the aquatic habitat is relatively good shape? Have legal measures been taken to preserve aquatic habitat?– 5 – 10 yrs Have upland conditions been enhanced and restored? (Obj A & B). (This is an immediate need 5 yrs – 10 yrs and then ongoing.)
Goal IV: To protect and enhance existing natural features of the subwatershed.	Are objectives (A - F) below, being addressed?
A. Maintain natural geologic conditions in the subwatershed and restore those conditions that have been degraded	Has the RHRPP (habitat plan) assessment study been conducted within 5 yrs? Has the habitat plan been implemented? - 25+ yrs
B. Protect sensitive waterbodies in the subwatershed and restore those that have been degraded	Has the RHRPP (habitat plan) assessment study been conducted within 5 yrs? Has the habitat plan been implemented? - 25+ yrs
C. Protect groundwater resources in the subwatershed and restore those that have been degraded	Have the number of State approved Ground Water Protection Plans increase for communities with ground water derived drinking water supplies?
D. Protect and restore wetlands and floodplain	Has the RHRPP (habitat plan) assessment study been conducted within 5 yrs? How many acres of wetland have been protected and restored in each catchments? Are wetland efforts on schedule? Has the habitat plan been implemented? - 25+ yrs
E. Support healthy native plant, wildlife, and aquatic life populations	Has the RHRPP (habitat plan) assessment study been conducted within 5 yrs? Has the habitat plan been implemented? - 25+ yrs
F. Protect other existing natural features	Has the RHRPP (habitat plan) assessment study been conducted within 5 yrs? Has the habitat plan been implemented? - 25+ yrs
Goal V: To maintain, protect, and enhance greenways through riparian buffers and green corridors.	Are objectives (A - B) below, being addressed?
A.i. Improve riparian buffer conditions ii. increase the amount of riparian areas with intact green corridor	Has the RHRPP (habitat plan) assessment study been conducted within 5 yrs? Has the habitat plan been implemented? - 25+ yrs
B. Increase the number of trails and the green corridors associated with them	Have the number of Greenway corridors and trails increase over a 10 year period? Are efforts coordinating with the RHRPP?

Table 9-2 Goals/objectives evaluation questions (continued)

Goal / Objective	Evaluation Questions / Achievement Milestones
Goal VI: To preserve the rural character of the subwatershed for local citizens and visitors seeking a 'rural Michigan' experience	Are objectives (A - D) below, being addressed?
A. Preserve appropriate land uses to maintain rural character of subwatershed	Have local units of government (LUGs) adopted the RHRPP (habitat plan) (5 -8 yrs)? Has the agricultural preservation effort secured sustainable funding? – 5 to 10 yrs
B. Balance desirable new development and redevelopment with rural character	Are LUGS directing new to development to serviced areas? 5yrs Are LUGs requiring the implementation of LID techniques? – 5yrs
C. i. Minimize construction of new roads to those needed to support desired increases in the number of automobile trips ii. Ensure new roads are constructed using impact minimizing techniques	Are LUGs adopting a form based planning code? – 5yrs
D. Preserve general aesthetics of the natural environment	Have local units of government (LUGs) adopted the RHRPP (habitat plan) (5 -8 yrs)?
Goal VII: To preserve and enhance recreational opportunities in the subwatershed for local residents and visitors	Are objectives (A – I) below, being addressed?
A. Increase public lands to be used for general recreation purposes	Have LUGs to adopted regional greenways plan? – 5yrs
B. Increase the number of campsites in the subwatershed	As the number of campsites in the watershed been increased? 5 – 10 yrs
C. Ensure the fisheries in the subwatershed are healthy for both sport anglers and fish consumption	Have fish advisories been downgraded? 20 – 25 yrs
D. Increase the number of trails available for recreation	Have LUGs to adopted regional greenways plan? – 5yrs Have the number of Greenway corridors and trails increase over a 10 year period? (10yrs to achieve a 10% increase)
E. Ensure that waterbodies in the subwatershed that can support boating do not have impediments to doing so	Have the number of public access points increase by 50%? – 10 yrs Are woody debris management activities occurring and ongoing as need?
F. Ensure wading and swimming is safe for waterbodies throughout the subwatershed	Have the impairments for full and partial body contact been removed? - 25 + yrs
G. i. Ensure native wildlife populations are healthy and can support hunting, as appropriate ii. Ensure endangered and threatened species can find habitat in the subwatershed	Are yearly hunting statistics being recorded? - ongoing Has the RHRPP (habitat plan) assessment study been conducted within 5 yrs? Has the habitat plan been implemented? - 25+ yrs
H. Maintain and restore valuable cultural and historical resources	Have local cultural and historic resources been identified and prioritized for preservation and restoration? - 5 yrs Are measures being taken to preserve cultural and historic resources? - ongoing
I. Increase low impact tourism in the subwatershed	Has a tourism plan for the North Branch been developed? - 5yrs Have tourism plans/actions been implemented? – 5 – 10 yrs

Table 9-2 Goals/objectives evaluation questions (continued)

Goal / Objective	Evaluation Questions / Achievement Milestones
GOAL VIII – Cultivate an aware, informed, engaged, and involved public.	Are objectives (A) and (B), below being addressed? Does the public know what catchment it lives in? Is the public involved in projects? Do survey results indicate the public is becoming aware of watershed management problems and management activities?
A. Increase the knowledge levels among key subwatershed constituents	Is there an increasingly sophisticated understanding of watersheds and the actions required to protect water resources? - 5 yrs and ongoing
B. A. Increase the participation levels among key subwatershed constituents	Has the number of volunteers increased? Has the number of organization participating increased? - 5 yrs and ongoing
GOAL IX– Institutionalize an informed collaborative planning and implementation approach to manage the subwatershed.	Are objectives (A), (B), (C), (D), and (E) below, being addressed? Has the institutional SWAG framework been sustained? Has the institutional SWAG framework been strengthened?
A. Expand SWAG membership beyond current levels	Has the number of SWAG participants increase?
B. Adopt an institutional mechanism that clearly defines that structure and legal responsibilities of the SWAG	Has the SWAG developed a stakeholder engagement framework? Has action 1-1 been implemented?
C. Define clear funding source(s) that allow the SWAG to operate as a distinct entity and have sufficient influence in the subwatershed	Have general and project specific funding strategies been developed? Implemented?
D. The implementation schedule defined in this plan should be followed	Have resources requirements been determined? By action?
E. The SWAG should implement the plan in the most efficient manner possible	Has the SWAG established a technical subcommittee?

Note: also, for each goal and objective, refer to the table in Chapter 8 to determine if actions appropriate for the goal/objective have been taken.

Conclusion

319 efg

Collectively, the information presented herein is designed to comply with the remaining EPA Section 319 funding requirements: (e) – develop interim milestones to track implementation of management measures; (f) – develop criteria to measure progress toward meeting watershed goals; and (g) – develop a monitoring component.

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Appendix A.1: Definition of Terms

This appendix contains the acronyms encountered in the watershed management plan (WMP), phrases that may not be common to the average reader and the defintions for both.

A	
ACOE	Army Corps of Engineers
AOC	Area of Concern
B	
Benthos	organisms that live on or in the bottom sediments of a water body
BMP	Best Management Practice
BOD	Biological Oxygen Demand
BRC	Blue Ribbon Commission
BUI	Beneficial Use Impairment
C	
CAFO	Animal Feeding Operations
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CMI	Clean Michigan Initiative
CMOM	Capacity, Management, Operations, and Maintenance
CMP	Comprehensive Management Plan
CNMP	Comprehensive Nutrient Plan
CREP	Comprehensive Reserve Enhancement Program (Federal)
CREW	Clinton River East Watershed
CRP	Comprehensive Reserve Program (Michigan)
CRPAC	Clinton River Public Advisor Council
CRBWI	Clinton River Basin Watershed Initiative
CRWC	Clinton River Watershed Council
CSO	Combined Sewer Overflow
CZM	Costal Zone Management
CWA	Clean Water Act (Federal)
D	
DO	Dissolved Oxygen
E	
EPA	Environmental Protection Agency
Eutrophication	process by which large additions of nutrients causes an overgrowth of algae and subsequent depletion of oxygen.
EQIP	Environmental Quality Improvement Program
F	
FEMA	Federal Emergency Management Agency
FORTRAN	FORmula TRANslating system – a computer programming language
FSA	Farm Service Agency
G	
GAAMP	Generally Accepted Agricultural Management Practice
GIS	Geographical Information System
GLC	Great Lakes Commission
GLEAS	Great Lakes and Environmental Assessment Section
GLNPO	Great Lakes National Program Office
GLPF	Great Lakes Protection Fund
GLWQA	Great Lakes Water Quality Agreement
H	
HUC	Hydrologic Unit Code
I	
IJC	International Joint Commission
J, K	

L	
LaMP	Lake Management Plan
LEED	Leadership in Energy and Environmental Design
LID	Low Impact Development
LSCDDS	Lake St. Clair Direct Drainage Subwatershed
M	
MCPWO	Macomb County Public Works Office
MCPEDS	Macomb County Planning and Economic Development
MGD	Millions of Gallons per Day
mg/l	Milligrams per liter
MDA	Michigan Department of Agriculture
MDEQ	Michigan Department of Environmental Quality
MDNR	Michigan Department of Natural Resources
MDNRE	Michigan Department of Natural Resources and Environment (supersedes MDEQ and MDNR)
MNFI	Michigan Natural Features Inventory
MS4	Municipal Separate Storm Sewer System
MSU	Michigan State University
MSUE	Michigan State University Extension
MTA	Michigan Townships Association
N	
NF	Natural Features
NGO	Non-governmental Organizations
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service (f.k.a. soil conservation service)
NWI	National Wetland Inventory
O	
O&E	Operation and Maintenance
OCDC	Oakland County Drain Commissioner
OCPEDS	Oakland County Planning and Economic Development Services
OSDS	On-site Disposal System
P	
PAC	Public Advisory Council (Clinton River)
PAH	Polyaromatic Hydrocarbons
PCB	Polyclorinated Biphenyls
pH	Hydrogen ion concentration – a measure of acidity
PRP	Potentially Responsible Party
Q	
R	
RAP	Remedial Action Plan
RB Index	'Richards-Baker' Index – used as a relative measure of flashiness for watercourses
RCRA	Resource Conservation Recovery Act
RETAP	Retired Engineer Technical Assistance Program
Riparian	Pertaining to anything connected with or immediately adjacent to the banks of a stream.
S	
SEMCOG	South East Michigan Council of Governments
SESC	Soil Erosion and Sediment Control
SMDA	South Macomb Disposal Authority
SOP	Standard Operating Procedure
SPAC	State Public Advisory Council
SSO	Sanitary Sewer Overflow
SWPP	Source Water Protection Plan
SWPPI	Storm Water Pollution Prevention Initiative

T	
TMDL	Total Maximum Daily Load
U	
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Service
UST	Underground Storage Tank
V	
W	
WMP	Watershed Management Plan
WQS	Water Quality Standards
WRDA	Water Resources Development Act
WRP	Wetland Reserve Program
WWTP	Waste Water Treatment Plant
X,Y,Z	

Appendix A.2: Supported Plans and Programs

Existing Planning and Technical Resources

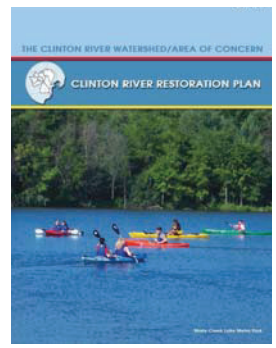
A successful watershed plan is one that is integrated with existing planning and technical resources. In developing this WMP, there are a number of plans and programs that influenced the contents. Integrating these other efforts ensures a cohesive management strategy from the large scale to the small and fosters eventual progress towards implementing all of the plans.

St. Clair River and Lake St. Clair Comprehensive Management Plan

The *St. Clair River and Lake St. Clair Comprehensive Management Plan* was issued in 2004 (USACE, 2004) by the United States Army Corps of Engineers (USACE) with assistance from the Great Lakes Commission (GLC). This joint effort between U.S. federal, state, and local, and Canadian federal and provincial authorities does four things with respect to the Lake St. Clair Regional Sub-basin:

- identifies the causes and sources of environmental degradation;
- addresses the continuous monitoring of contamination levels;
- provides for timely dissemination of information; and
- includes recommendations for potential restoration measures.

Clinton River Restoration Plan



The Remedial Action Plan (RAP) for the Clinton River Watershed was first developed by the Michigan Department of Natural Resources (MDNR) in 1988 (MDNR, 1988) in response to the Clinton River being listed as an Area of Concern (AOC) by the Great Lakes Water Quality Board of the International Joint Commission (IJC) in 1985 (one of 13 in Michigan) due to a number of environmental problems: elevated fecal coliforms, nutrients, dissolved solids; contaminated sediments; and impacted biota (MCHD, 2002) (CRPAC, 2000). The initial AOC was limited specifically to the Clinton River and the nearshore area of Lake St. Clair impacted by the Clinton River and the Clinton River Spillway. The Clinton River Public Advisory Council (CRPAC) - formed in 1991 – has commissioned three updates to improve the plan and account for changes through time:

- The 1995 update (CRPAC, 1995) is called a *Remedial and Preventative Action Plan* and it expanded the AOC boundaries to include the entire watershed and includes an update of environmental conditions and discusses ongoing and recommended actions;
- The 1998 update (CRPAC, 2000) expanded the list of proposed actions and updated implementation progress; and
- The 2008 update (CRPAC, 2008) is called the *Clinton River Restoration Plan* and it is a complete reworking of the RAP into a watershed management plan format.

The most recent update of the RAP was a complete rethinking and retooling of the program designed to increase the likelihood of successful implementation. Some of the highlights include:

- defining the appropriate place of the RAP in the planning hierarchy – a unifying framework for the WMPs;
- including information to make RAP actions fundable;
- describing the interaction of priority stressors and the conditions of the natural environment;
- including all recent public concerns and scientific data to develop goals and objectives;
- defining a detailed implementation plan that defines future and existing partnerships and programs to be leveraged; and
- establishing a monitoring program that informs an evaluation and revision structure to ensure plan success.

On a specific level of integration, this plan supports restoring the eight beneficial uses that are impaired in the Clinton River AOC:

- Restrictions on fish and wildlife consumption;
- Degradation of fish and wildlife populations;
- Degradation of benthos;
- Restrictions on dredging activities;
- Eutrophication or undesirable algae;
- Beach closings and other 'full body contact' restrictions;
- Degradation of aesthetics; and
- Loss of fish and wildlife habitat.

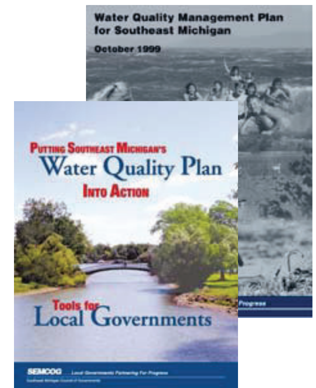
Acronyms and Terms

A complete list of acronyms and terms and their respective definitions can be found in Appendix A.1.

Where the impairments are not specifically manifested in the North Branch Subwatershed (NBW), the plan supports maintaining the uses and reducing stressor contributions to eliminate downstream impairments (where, and if, appropriate).

For more information about the Clinton River Area of Concern, refer to the following web site: http://www.epa.gov/grtlakes/aoc/clintriv.html. Additionally, refer to the 2008 Clinton River Restoration Plan

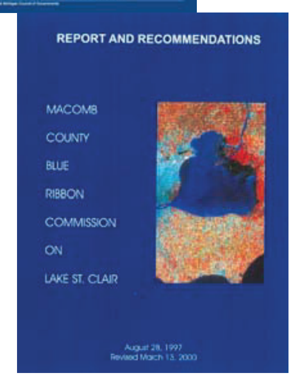
Water Quality Management Plan for Southeast Michigan



The *Water Quality Management Plan (WQMP) for Southeast Michigan* was first prepared by the Southeast Michigan Council of Governments (SEMCOG) in 1978 and subsequently amended in 1979, 1981, and 1999. SEMCOG is the designated Areawide Water Quality Planning Agency for Southeast Michigan under the CWA and prepared the WQMP to assist the agencies and organizations that have a role in the stewardship of the region's water resources. To this end, the plan contains water quality management policies on a broad range of issues, including: infrastructure, monitoring, management, non-point source pollution, stormwater, pollution prevention, and public education.

The plan also contains regional goals and includes a guide to implementation. Additional implementation guidance was provided in the 2000 document *Putting Southeast Michigan's Water Quality Plan into Action: Tools for Local Governments* (SEMCOG, 2000).

Blue Ribbon Commission on Lake St. Clair



The 2000 *Lake St. Clair Blue Ribbon Commission* (BRC) *Report* (MCBRC, 2000) spearheaded by Macomb County documents four basic concerns with respect to the waters of the lake, including: being safe to drink, being safe to swim in, supporting fishing and hunting of animals that can be safely consumed, and being sufficiently free of weeds so as to not encumber boating. The report lists a number of key elements that are essential to solving the problems that face Lake St. Clair, including needs with respect to: monitoring, education, voluntary actions, and regulation/enforcement. Additional content of the report was considered with respect to setting the goals and objectives and the action plan.

Other Watershed Management Plans

There are six existing watershed management plans that address subwatersheds in the Clinton River Watershed and the area of Lake St. Clair near the discharge of the Clinton River and the Clinton River Spillway:

- The *Upper Clinton Subwatershed Management Plan* (UCSCG, 2005);
- The *Stony / Paint Creek Subwatershed Management Plan* (SPCSWAG, 2005) – a single plan that was developed for the two listed subwatersheds;
- The *Clinton Main Subwatershed Management Plan* (CMSWAG, 2006);
- The *Red Run Subwatershed Management Plan* (RRSWAG, 2006);
- The *Clinton River East Subwatershed Management Plan* (CRESWAG, 2006); and
- The *Lake St. Clair Direct Drainage Subwatershed Management Plan* (LSCDDSWAG, 2006).

Although these plans do not address the same geographic area as this plan, many of the same municipalities involved in this plan are also involved in one of these plans. Additionally, because the environmental problems are similar throughout the watershed, the actions being taken in other subwatersheds are considered in this plan. In general, these plans were consulted to provide regional continuity in the planning approach.

Planning Guidance

This WMP was developed to comply with EPA's Clean Water Act (CWA) Section 319 National Nonpoint Source Monitoring Program grant requirements. Additionally, other planning requirements and guidance handbooks were utilized to ensure this WMP is as robust as possible.

EPA's Clean Water Act (CWA) Section 319 National Nonpoint Source Monitoring Program

As described in EPA's Clean Water Act (CWA) Section 319 National Nonpoint Source Monitoring Program grant requirements, the WMP shall, at a minimum, contain the following:

- Identification of the causes and sources of stressors that need to be controlled and other goals for the watershed;
- Determination of the required reduction in stressor discharges to the natural environment to meet load reduction requirements and achieve other goals;
- Management measures to be implemented to achieve stressor load reductions and other goals;
- An implementation schedule for the management measures;
- Interim milestones to track implementation of the measures;
- Criteria to measure progress towards meeting stressor load reductions and achieving other goals;
- A monitoring program to obtain the data with which to evaluate the progress-measuring criteria;
- An educational component designed to help meet load reduction requirements and achieve other goals; and
- Identification of technical and financial assistance required to implement the elements of the plan.

National Pollutant Discharge Elimination System

Although there is very little area of the watershed that is regulated under Phase II of the National Pollutant Discharge Elimination System's (NPDES) stormwater rules, the requirements of the program are informative in the development of any watershed management plan. The MDEQ has developed two permits to meet these requirements, one based on developing a watershed management plan (Permit No. MIG610000), and the other requiring specific actions of the permitted entity (Permit No. MIS049000). Although the programs are structurally different, the fundamentals common to both highlight important elements to consider in watershed planning:

- any nested jurisdictions for which the permittee is assuming responsibility for permit requirements;
- identification of receiving waters and stormwater discharge locations (including a map and latitude/longitude);
- approved Total Maximum Daily Loads (TMDLs) and the pollutants applicable to the receiving waters and storm water discharges:
    - For E. coli and total phosphorus TMDLs, a sampling protocol is to be followed that leads to the development and prioritization of actions to reduce discharges;
- development of a public education program (PEP) to promote, publicize, and facilitate watershed education for encouraging the public to reduce the discharge of pollutants in stormwater
    - includes distinct topical public education efforts each with a target audience, key message, delivery mechanism, timetable, and responsible party;
    - including a method for determining effectiveness;
- Development, implementation, and enforcement of an illicit discharge elimination program (IDEP) to remove existing and prevent future non-stormwater related pollutant discharges through the storm sewer system;
- Development, implementation, and enforcement of post-construction stormwater controls for new development and redevelopment projects that address:
    - A minimum treatment volume standard to minimized water quality impacts;
    - Channel protection criteria to prevent resource impairment resulting from flow volumes and rates;
    - Operation and maintenance requirements;
    - Enforcement mechanisms with record-keeping procedures;
    - A requirement for the developer to prepare and implement site plans; and
    - Structural BMP design standards that consider the above elements; and

- Procedures for integrating existing state and local programs for soil erosion and sediment control into the overall stormwater program;
- Development, implementation, and compliance with programs aimed at preventing or reducing pollutant levels in stormwater discharging from municipal facilities; and
- Submittal of progress reports that document compliance with the various requirements of each permit and include implementation, water quality, stressor (e.g. total suspended solids), goal/objective, programmatic, and document updates.

The watershed-based permit also requires:

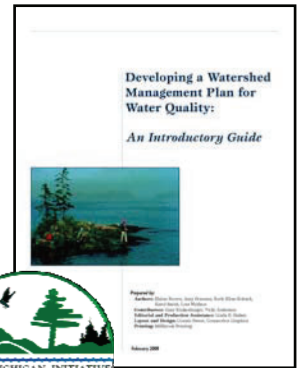
- identification of watershed boundaries and urbanized area;
- development (or revision of) and implementation of a public participation process (PPP) to facilitate involvement of the watershed jurisdictions and the public by:
    - identifying the agent responsible for coordinating the WMP development;
    - focusing on methods of educating the public on the needs and goals of the WMP and involving them in its update and implementation;
    - ensuring all stakeholders are invited;
    - including a timeline for public involvement in developing/revising and implementing the WMP; and
    - including any changes reflective of current conditions;
- the development (or revision of) and implementation of a WMP, the purpose being to identify and execute the actions needed to resolve water quality and quantity concerns by fostering cooperation among various private and public entities (or demonstration that no revision is needed to an existing WMP); the WMP will include (additional details are identified in the permit):
    - a summary of the PPP;
    - an assessment of the nature and status of the watershed;
    - identification of priority problems and opportunities;
    - identification of the goals and environmental objectives based on the condition or vulnerability of resources, the needs of the aquatic ecosystem, and the people within the community;
    - specific management options and action plans;
    - commitments to implement the action plan;
    - methods for evaluation of effectiveness;
    - identification of disagreements among watershed partners; and
    - procedures for plan revisions and updates; and
- The development of a Storm Water Pollution Prevention Initiative (SWPPI) that presents all of the stormwater program elements in addition to a program assessment and implementation schedule.

The permit requiring specific actions of communities (in the following categories: 1) Public Education and Outreach, 2) Public Participation / Involvement, 3) Illicit Discharge Detection and Elimination, 4) Construction Site Runoff Control, 5) Post- Construction Runoff Control, and 6) Pollution Prevention / Good Housekeeping) requires:

- The labeling of discharge locations constructed after March 10, 2004;
- Public notification of plan development and implementation, formation of citizen advisory committee to influence the process, and cooperation with local non-governmental organizations;
- The development (or revision), implementation, and enforcement of a Stormwater Management Plan (SWMP), the purpose being to reduce the discharge of pollutants to the maximum extent practicable and to comply with approved TMDLs; the SWMP will include:
    - Implementing BMPs
    - Demonstrating that measurable goals were met for individual BMPs (in terms of implementation and/or results);
    - Demonstrating the effectiveness of the PEP and IDEP;
    - A discussion of the status of the water quality of receiving bodies;
    - An identification and prioritization of the stressors impacting environmental conditions;

The permits can be obtained from the MDEQ website: http://www.michigan.gov/deq/0,1607,7-135-3313_3682_3716-24366--,00.html.

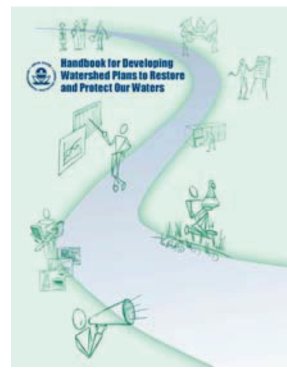
Developing a Watershed Management Plan for Water Quality: An Introductory Guide



The MDEQ prepared this guide to help local units of government, nonprofit organizations, and citizens to develop watershed management plans. It outlines a process for gathering people, information, and resources together to protect and improve Michigan's water resources. Following this handbook ensures that the plan will be compliant with non-point source administrative rules (part 88) for the Clean Michigan Initiative (CMI) watershed plan implementation funding that was authorized through 1998 Public Act 284.

Where these requirements are addressed throughout the plan, the icon on the right appears with a description of the requirement being met.

Handbook for Developing Watershed Plans to Restore and Protect Our Waters



The Environmental Protection Agency's (EPA's) 'Handbook for Developing Watershed Plans to Restore and Protect our Waters' (cover icon at right) has been utilized in developing this plan as it provides: a step-by-step guide through the watershed planning and implementation efforts, numerous tools to assist in the many analyses required, links to invaluable resources, guidance on where to focus efforts to get the greatest return on investment, milestones for assessing progress in conducting the analyses and developing the plan, and assistance in meeting the requirements of Clean Water Action (CWA) section 319 guidelines to develop effective watershed plans for threatened and impaired waters (with actions that are fundable through appropriate grants) .

This WMP has been developed as a companion example plan that can be used in conjunction with the handbook. This will increase the exposure of the WMP and help garner recognition for the Clinton River Watershed and the environmental protection and restoration efforts that the stakeholders will be implementing. To make sure that the linkage between the handbook and this plan is completely transparent, the handbook elements that are utilized are inserted into this plan at the appropriate locations (as discussed in the 'Organization of the Plan' section at the beginning of the plan, and shown with bold numbers) and the contents of the plan that correspond to the handbook sections are presented in the sidebar on the following page.

Description of Handbook

Because of the importance of the handbook to the development of this plan, a significant amount of the introductory text from handbook is included below.

> This handbook provides information on developing and implementing watershed management plans that help to restore and protect water quality… A watershed management plan defines and addresses existing or future water quality problems from both point sources and nonpoint sources of pollutants. Experience over the past decade has shown that effective watershed management includes active participation from stakeholders, analysis and quantification of the specific causes and sources of water quality problems, identification of measurable water quality goals, and implementation of specific actions needed to solve those problems.
>
> … Although [the handbook] is comprehensive in terms of providing resources and tools for each step of the watershed planning process, it is laid out in an easy-to-read format with shortcuts and road maps along the way so you can flip to specific sections for more in-depth information…
>
> This handbook is intended to serve as the basis for developing and implementing watershed plans to meet water quality standards and protect water resources. Although watershed plans are useful for all watersheds to protect and restore water resources, as well as to meet other community resource goals, they are critical for impaired or threatened waterbodies… This handbook is designed to provide a framework to help you develop a scientifically defensible plan that will lead to measurable results and an overall improvement in the water quality and watershed conditions that are important to your community.

Developing watershed plans does not have to be an exhaustive, expensive endeavor. This handbook shows you how to effectively and efficiently collect the information you need to answer the right questions. The level of effort you expend preparing a watershed plan will depend on several factors, such as the available information, the size of the watershed, and the pollutants of concern.

Federal, state, and local organizations have developed many watershed guides. EPA intends for this handbook to *supplement*, rather than *replace*, those guides… **(1.1)**

This handbook is more rigorous and goes into greater detail than most watershed planning guides. It describes processes and tools used to *quantify* existing pollutant loads, *develop estimates* of load reductions needed to meet water quality criteria, and *identify* the management measures appropriate for achieving the needed load reductions.

Using these tools will enable you to then develop effective management measures to reduce the loads. The handbook also provides tools to *track progress* once you implement the plan to ensure that the management measures are helping to improve water quality. **(1.1.1)**

…This handbook…is specifically intended for those agencies and organizations working in a watershed where there are impaired or threatened waters. Recognizing that a certain level of technical expertise is required to develop watershed plans, EPA has included information in this handbook on how to engage and involve a wide variety of professionals and other interested parties in plan development. To use this handbook effectively, you should have a basic level of understanding about watersheds, their processes, and the major components of a watershed management plan. If your watershed issues are technically complex, you might have to enlist the support of experienced professionals like engineers, hydrologists, statisticians, biologists, and database managers that have a variety of skills and can provide specific information for your watershed plan.

The primary audiences that will benefit from this handbook are the following:

Watershed organizations that are developing new plans, updating existing plans to meet funding requirements, or considering other watershed issues.

Local agencies that are developing or updating a watershed plan or need references to research a particular subject related to watershed planning.

State and tribal environmental agencies that are developing and reviewing watershed plans, participating as stakeholders on watershed planning committees, or providing guidance to watershed associations.

Federal environmental agencies that have similar planning programs to help identify overlapping activities, provide sources of data, and offer other kinds of financial and technical assistance. **(1.1.2)**

Handbook Contents and Linkage to the WMP

Handbook	WMP Chapter
1.1	A
1.2	A
1.3	A
2.1	1
2.2	1,5
2.3	1
2.4	2,5
2.5	2,6
2.6	1
3.1	1
3.2	1
3.3	3,4
3.4	1,4
4.1	6
4.2	4
4.3	2,4,6
4.4	1
4.5	6
4.6	6
4.7	6
5.1	5
5.2	5,6
5.3	1,2,5
5.4	1,2
5.5	5,C
5.6	2,5
5.7	2,5,C
5.8	5
5.9	5
5.10	5
6.1	5
6.2	5
6.3	5
6.4	5
6.5	5
7.1	5
7.2	2,4,5
7.3	2
7.4	2
8.1	7
8.2	7
8.3	8
8.4	8
8.5	7
9.1	6
9.2	6
9.3	6
9.4	6,7
9.5	7
9.6	7,8
10.1	8
10.2	7
10.3	7,8
11.1	8
11.2	8
11.3	7,8
11.4	8
11.5	8
12.1	8
12.2	4,8
12.3	8
12.4	8
12.5	8,9
12.6	8,9
12.7	8
12.8	8
12.9	8,9
12.10	8,9
12.11	4
13	as actions in Chp. 8

Handbook Chapters

Chapter 1: Introduction includes the purpose, intended audiences, and usage guidelines.

Chapter 2: Overview of Watershed Planning Process provides an overview and highlights features of watershed planning processes.

Chapter 3: Build Partnerships provides guidance on involving interested parties.

Chapter 4: Define Scope of Watershed Planning Effort discusses information on defining concerns, developing preliminary goals, and identifying indicators.

Chapter 5: Gather Existing Data and Create an Inventory discusses this first step in watershed assessment.

Chapter 6: Identify Data Gaps and Collect Additional Data if Needed discusses the next step in watershed assessment.

Chapter 7: Analyze Data to Characterize the Watershed and Pollutant Sources discusses the data analyses needed to support development of the plan.

Chapter 8: Estimate Pollutant Loads provides guidance on using watershed models and other tools to estimate pollutant loads.

Chapter 9: Set Goals and Identify Load Reductions discusses how to set goals, develop objectives, and determine load reductions needed

Chapter 10: Identify Possible Management Strategies gives an overview of various management measures that might be selected.

Chapter 11: Evaluate Options and Select Final Management Strategies discusses how to screen and select research management options.

Chapter 12: Design Implementation Program and Assemble Watershed Plan provides guidance on establishing milestones and assembling the plan.

Chapter 13: Implement Watershed Plan and Measure Progress gives guidance on data monitoring and assessing progress **(1.2.1)**

EPA recognizes that many states and local groups already have in place or are developing watershed plans and strategies at varying levels of scale, scope, and specificity that might contribute significantly to the process of developing and implementing watershed plans using the approach outlined in this handbook.

These existing plans and strategies should be adapted as appropriate or used as building blocks for developing and implementing watershed plans that contain the nine minimum elements that EPA recommends including in watershed plans that address impaired or threatened waterbodies. This can be accomplished by adapting existing plans to include the omitted components, incorporating by reference existing assessments or other information in a newly developed plan, or merging existing information into an updated plan that includes all the basic components.

Where existing plans and strategies have been developed at a basin-wide or other large geographic scale, they usually need to be refined at the smaller watershed scale to provide the information needed to develop a watershed plan. The assessment, monitoring, and other data collection requirements for larger basin studies typically are not as detailed as those for watershed plans or assessments generated for site-level work plans. **(1.1.3)**

The handbook is divided into 13 chapters that move through the watershed planning and implementation process. Each chapter includes information that addresses the key issues for each step, along with highlights to illustrate how to apply these concepts to your own situation. In addition, the appendices provide more detailed information on additional resources and worksheets that can be used as part of your watershed planning efforts. **(1.2)**

Although there is no cookie-cutter approach to developing a watershed plan, plans that seek to identify and address threats or impairments to water quality have some common elements.

This handbook provides various tools … to consider when developing a watershed plan and includes many web links for more in-depth information. The document is structured so you can proceed step by step through the watershed planning process or can go directly to a section that highlights a specific technical tool for use in your watershed planning effort.

Some common themes are repeated throughout the handbook to reinforce the concepts presented, provide shortcuts, and help you to focus your efforts. These tips are identified in the following categories:

Nine Elements of Watershed Plans. One of the purposes of this handbook is to show how the nine elements presented in the Clean Water Act section 319 guidelines are used to develop effective watershed plans for threatened and impaired waters. Many organizations already have plans that include some of these elements but might require additional information on other elements. Note that most of the nine elements are presented in chapters 10–13.

Targeting Your Efforts. Although the handbook includes various options to be considered in each step of the watershed planning process, planners must target their efforts to move the process forward to achieve measurable progress in reducing specific pollutant loads.

You might already have a good idea of the problems in your watershed and want to identify targeted management measures to address them. Or perhaps your watershed has only one pollutant of concern. This category includes places in the planning process where it makes sense to target your efforts so you can focus your resources to identify the most likely problems and solutions for your watershed.

Watershed planning is not an exact science. Often we have to make decisions based on our best professional judgment to move the process forward. There are, however, several places along the way where you should stop and assess what you know, what information you have, and what additional information you need. If you see the stop sign, take a minute to read the information to make sure you're going down the right path with the right information.

This icon indicates where the topic is discussed elsewhere in the document, or where more information is provided in the text, the Resources appendix (appendix A), other documents, or the Internet.

Worksheets and Checklists. Worksheets and checklists are provided throughout the handbook to help you work through the watershed planning process with the stakeholders.

A complete set is provided in Appendix B to facilitate photocopying. **(1.3)**

Handbook Appendices

Appendix A: Resources is an expanded list of resources provided to guide you to more detailed information on various aspects of the watershed planning process.

Appendix B: Worksheets provides a complete set of all the worksheets and checklists included in the handbook as full-size sheets that you can photocopy and use with your planning group.

A ***Glossary*** is provided after Appendix B to define key terms used in the handbook.

Appendix C: List of State Nonpoint Source and Watershed Planning Contacts can help get you in touch with people that can help in your watershed planning effort.

A ***Bibliography*** that lists the sources used to prepare the handbook is included. **(1.2.2)**

Appendix A.3: The Nine Minimum Elements

Because of its importance to this WMP, the content of this appendix is taken directly from the *Handbook for Developing Watershed Plans to Restore and Protect Our Waters* (EPA, 2008).

2.6 Nine Minimum Elements to Be Included in a Watershed Plan for Impaired Waters Funded Using Incremental Section 319 Funds

Although many different components may be included in a watershed plan, EPA has identified nine key elements that are critical for achieving improvements in water quality. (Go to **www.epa.gov/owow/nps/cwact.html** for a copy of the FY 2004 *Guidelines for the Award of Section 319 Nonpoint Source Grants to States and Territories*).

What Does This Mean?

Shows you where one or more of the nine minimum elements are specifically discussed.

EPA requires that these nine elements be addressed in watershed plans funded with incremental Clean Water Act section 319 funds and strongly recommends that they be included in all other watershed plans intended to address water quality impairments. In general, state water quality or natural resource agencies and EPA will review watershed plans that provide the basis for section 319-funded projects. Although there is no formal requirement for EPA to approve watershed plans, the plans must address the nine elements discussed below if they are developed in support of a section 319-funded project.

In many cases, state and local groups have already developed watershed plans for their rivers, lakes, streams, wetlands, estuaries, and coastal waters. If these existing plans contain the nine key elements listed below, they can be used to support section 319 work plans that contain projects extracted from the plan. If the existing plans do not address the nine elements, they can still provide a valuable framework for producing updated plans. For example, some watershed management plans contain information on hydrology, topography, soils, climate, land uses, water quality problems, and management practices needed to address water quality problems but have no quantitative analysis of current pollutant loads or load reductions that could be achieved by implementing targeted management practices. In this case, the plan could be amended by adding this information and other key elements not contained in the original plan. If separate documents support the plan and the nine elements listed below but are too lengthy to be included in the watershed plan, they can be summarized and referenced in the appropriate sections of the plan. EPA supports this overall approach—building on prior efforts and incorporating related information—as an efficient, effective response to the need for comprehensive watershed plans that address impaired and threatened waters.

Figure 2-3 highlights where the nine key elements fit into the overall watershed planning process. Once the plan has been developed, plan sponsors can select specific management actions included in the plan to develop work plans for nonpoint source section 319 support and to apply for funding to implement those actions (chapter 12).

The nine elements are provided below, listed in the order in which they appear in the guidelines. Although they are listed as *a* through *i*, they do not necessarily take place sequentially. For example, element *d* asks for a description of the technical and financial assistance that will be needed to implement the watershed plan, but this can be done only after you have addressed elements *e* and *i*.

Explanations are provided with each element to show you what to include in your watershed plan. In addition, chapters where the specific element is discussed in detail are referenced.

Nine Elements of Watershed Plans

a. Identification of causes of impairment and pollutant sources or groups of similar sources that need to be controlled to achieve needed load reductions, and any other goals identified in the watershed plan. Sources that need to be controlled should be identified at the significant subcategory level along with estimates of the extent to which they are present in the watershed (e.g., X number of dairy cattle feedlots needing upgrading, including a rough estimate of the number of cattle per facility; Y acres of row crops needing improved nutrient management or sediment control; or Z linear miles of eroded streambank needing remediation).
(Chapters 5, 6, and 7.)

What does this mean?

Your watershed plan should include a map of the watershed that locates the major causes and sources of impairment. To address these impairments, you will set goals that will include (at a minimum) meeting the appropriate water quality standards for pollutants that threaten or impair the physical, chemical, or biological integrity of the watershed covered in the plan.

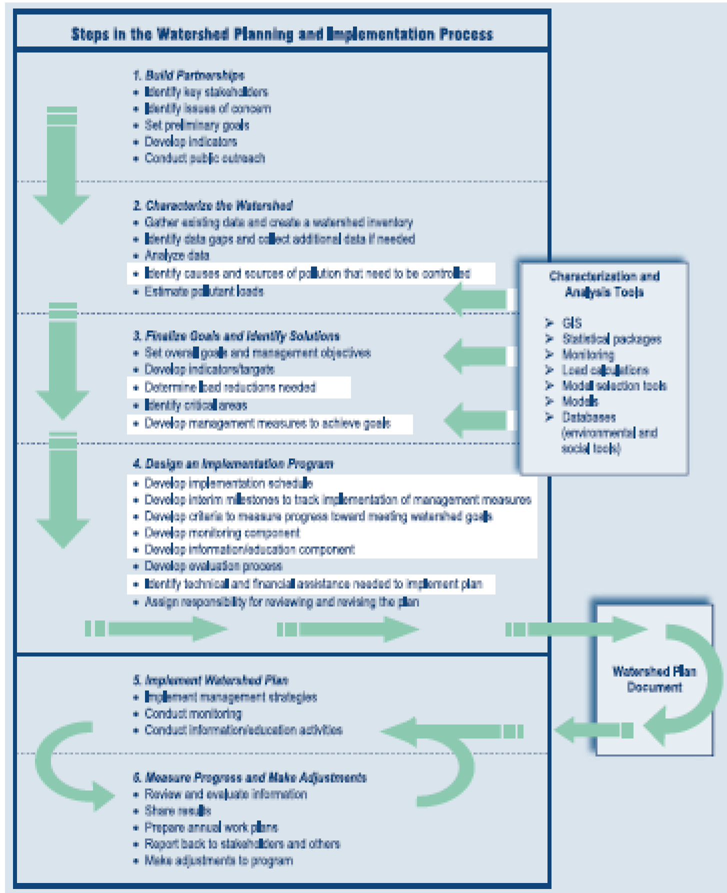


Figure 2-3. Incorporating the Nine Minimum Elements into Your Watershed Plan

This element will usually include an accounting of the significant point and nonpoint sources in addition to the natural background levels that make up the pollutant loads causing problems in the watershed. If a TMDL exists, this element may be adequately addressed. If not, you will need to conduct a similar analysis to do this. The analytical methods may include mapping, modeling, monitoring, and field assessments to make the link between the sources of pollution and the extent to which they cause the water to exceed relevant water quality standards.

b. An estimate of the load reductions expected from management measures.

What does this mean?

On the basis of the existing source loads estimated for element *a*, you will similarly determine the reductions needed to meet the water quality standards. You will then identify various management measures (see element *c* below) that will help to reduce the pollutant loads and estimate the load reductions expected as a result of these management measures to be implemented, recognizing the difficulty in precisely predicting the performance of management measures over time.

Estimates should be provided at the same level as that required in the scale and scope component in paragraph *a* (e.g., the total load reduction expected for dairy cattle feedlots, row crops, or eroded streambanks). For waters for which EPA has approved or established

TMDLs, the plan should identify and incorporate the TMDLs. Applicable loads for downstream waters should be included so that water delivered to a downstream or adjacent segment does not exceed the water quality standards for the pollutant of concern at the water segment boundary. The estimate should account for reductions in pollutant loads from point and nonpoint sources identified in the TMDL as necessary to attain the applicable water quality standards. (↳ Chapters 8 and 9.)

c. A description of the nonpoint source management measures that will need to be implemented to achieve load reductions in paragraph 2, and a description of the critical areas in which those measures will be needed to implement this plan.

What does this mean?

The plan should describe the management measures that need to be implemented to achieve the load reductions estimated under element *b*, as well as to achieve any additional pollution prevention goals called out in the watershed plan (e.g., habitat conservation and protection). Pollutant loads will vary even within land use types, so the plan should also identify the critical areas in which those measures will be needed to implement the plan. This description should be detailed enough to guide implementation activities and can be greatly enhanced by identifying on a map priority areas and practices. (↳ Chapters 7, 8, 9, 10, and 11.)

d. Estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan.

What does this mean?

You should estimate the financial and technical assistance needed to implement the entire plan. This includes implementation and long-term operation and maintenance of management measures, I/E activities, monitoring, and evaluation activities. You should also document which relevant authorities might play a role in implementing the plan. Plan sponsors should consider the use of federal, state, local, and private funds or resources that might be available to assist in implementing the plan. Shortfalls between needs and available resources should be identified and addressed in the plan. (↳ Chapter 12.)

e. An information and education component used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the nonpoint source management measures that will be implemented.

What does this mean?

The plan should include an I/E component that identifies the education and outreach activities or actions that will be used to implement the plan. These I/E activities may support the adoption and long-term operation and maintenance of management practices and support stakeholder involvement efforts. (↳ Chapters 3 and 12.)

f. Schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious.

What does this mean?

You should include a schedule for implementing the management measures outlined in your watershed plan. The schedule should reflect the milestones you develop in *g*. (↳ Chapter 12.)

g. A description of interim measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented. (↳ Chapter 12.)

What does this mean?

You'll develop interim, measurable milestones to measure progress in implementing the management measures for your watershed plan. These milestones will measure the implementation of the management measures, such as whether they are being implemented on schedule, whereas element *h* (see below) will measure the effectiveness of the management measures, for example, by documenting improvements in water quality.

h. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standards.

What does this mean?

As projects are implemented in the watershed, you will need water quality benchmarks to track progress. The *criteria* in element *h* (not to be confused with *water quality criteria* in state regulations) are the benchmarks or waypoints to measure against through monitoring. These interim targets can be direct measurements (e.g., fecal coliform concentrations) or indirect indicators of load reduction (e.g., number of beach closings). You should also indicate how you'll determine whether the watershed plan needs to be revised if interim targets are not met. These revisions could involve changing management practices, updating the loading analyses, and reassessing the time it takes for pollution concentrations to respond to treatment. (↳ Chapters 12 and 13.)

i. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item h *immediately above.*

What does this mean?

The watershed plan should include a monitoring component to determine whether progress is being made toward attaining or maintaining the applicable water quality standards. The monitoring program should be fully integrated with the established schedule and interim milestone criteria identified above. The monitoring component should be designed to determine whether loading reductions are being achieved over time and substantial progress in meeting water quality standards is being made. Watershed-scale monitoring can be used to measure the effects of multiple programs, projects, and trends over time. Instream monitoring does not have to be conducted for individual BMPs unless that type of monitoring is particularly relevant to the project. (↳ Chapters 6, 12, and 13.)

The remainder of this handbook proceeds through the watershed planning process, addressing these elements in detail to show you how to develop and implement watershed plans that will achieve water quality and other environmental goals.

The level of detail (figure 2-4) needed to address the nine key elements of watershed management plans listed above will vary in proportion to the homogeneity or similarity of land use types and variety and complexity of pollution sources. Urban and suburban watersheds will therefore generally be planned and implemented at a smaller scale than watersheds with large areas of a similar rural character. Similarly, existing watershed plans and strategies for larger river basins often focus on flood control, navigation, recreation, and water supply but contain only summary information on existing pollutant loads. They often generally identify only source areas and types of management practices. In such cases, smaller subbasin and

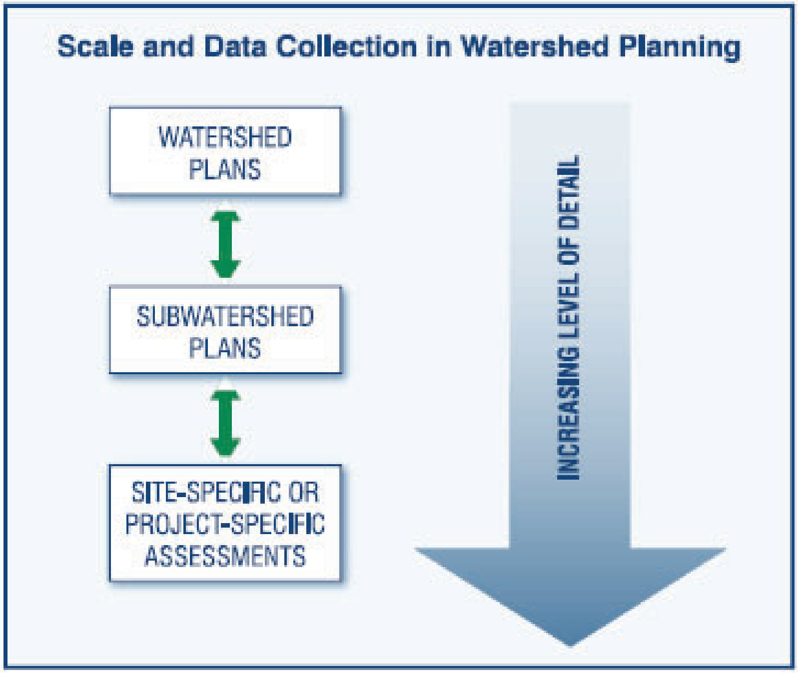


Figure 2-4. Level of Detail for Watershed Management Plans

watershed plans and work plans developed for nonpoint source management grants, point sources, and other stormwater management can be the vehicles for providing the necessary management details. A major purpose of this manual is to help watershed managers find planning tools and data for managing watersheds at an appropriate scale so that problems and solutions can be targeted effectively.

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Appendix A.4: North Branch SWAG Agreement

This appendix contains the North Branch Subwatershed Advisory Group's signed operational agreement.

OPERATING AGREEMENT
NORTH BRANCH OF THE CLINTON RIVER WATERSHED GROUP

The municipalities and non-municipal organizations ("agencies") listed on Exhibit A hereby constitute the North Branch of the Clinton River Watershed Group. The North Branch of the Clinton River Watershed Group has been formed to write a watershed management plan (WMP). The North Branch of the Clinton River Watershed Group is responsible for providing community specific information necessary to develop a WMP, reviewing and commenting on draft elements of the WMP and assisting with Public Participation Activities.

The undersigned acknowledge that membership in the North Branch of the Clinton River Watershed Group is voluntary and that the North Branch of the Clinton River Watershed Group is formed for the convenience of its member participants and for the purpose of collective efforts to create a WMP for the North Branch of the Clinton River Watershed Group as it pertains to each member's jurisdiction.

Accordingly, the following constitutes the agreement for the operation of the North Branch of the Clinton River Watershed Group:

1. Meetings shall be held monthly or more or less frequently as the majority of the members may decide.
2. Meetings will be conducted informally and Robert's Rules of Orders will be utilized when informal procedures do not work.
3. Meetings shall be run by a Chairperson, as deemed by the Group. The Chairperson shall call the meeting and establish subcommittees, as necessary.
4. Meetings shall follow an agenda established by the Chairperson and distributed to the North Branch of the Clinton River Watershed Group prior to each meeting.
5. Minutes shall be written of the activities of each meeting and provided to the North Branch of the Clinton River Watershed Group members for review and approval.
6. Each community shall be entitled to one vote.
7. Each member shall have a representative and alternate(s) appointed by their Chief Executive.
8. Each representative shall serve in an advisory capacity to its respective member and express their views to the other representatives of the North Branch of the Clinton River Watershed Group.

9. The vote of any representative shall be binding on its respective member only after concurrence of their Chief Executive or Legislative Body.

10. The North Branch of the Clinton River Watershed Group shall have no power to levy any tax or create any indebtedness on any party to this agreement or any other person except as expressly provided by law.

11. Financial participation by voting members shall be subject to and conditioned upon concurrence of the respective voting member and the Legislative Body of each.

12. The members of the North Branch of the Clinton River Watershed Group agree that their participation in this Lake St. Clair Watershed Group shall not be for profit.

13. Any member may withdraw from the North Branch of the Clinton River Watershed Group at any time. Upon withdrawal, all rights and future liability between the withdrawing member and the North Branch of the Clinton River Watershed Group shall end.

14. The North Branch of the Clinton River Watershed Group may be dissolved upon the majority vote of the parties then members, but not upon the withdrawal of any single or more than one member.

15. This agreement may be amended by the written agreement of all the members. The North Branch of the Clinton River Watershed Group shall review the operating agreement a minimum of every 2 years.

16. This agreement shall be effective as of the date of the last member's signature affixed hereto.

Bob Koski, Supervisor
Addison Township

Date: Oct 8, 2003

Gary Groesbeck, Supervisor
Almont Township

Date: Oct. 13, 2003

Steve Schneider, President
Village of Almont

Date: October 21, 2003

Monica Job, Supervisor
Armada Township

Date: Sept. 26, 2003

Nancy Parmenter, President
Village of Armada

Date: July 10, 2003

Martin Smith, Supervisor
Berlin Township

Date: Oct. 23, 2003

Gary Schocke, Supervisor
Bruce Township

Date

Robert Cannon, Supervisor
Clinton Township

Date: 8-14-03

Tina Papineau, Supervisor
Dryden Township

Date: 11-11-03

Pat Betcher, President
Village of Dryden

Date: 11-22-03

Lapeer County Storm Water Program Manager (Represented by the Lapeer County Drain Commission)

Date 9/23/04

10/2/03

John Gardner, Supervisor
Lenox Township

Date 10/2/03

Eugene Mallia, President
Village of Leonard

Date 11-30-03

John Brennan, Supervisor
Macomb Township

Date 3/19/04

Macomb County Storm Water Program Manager (Represented by the Office of Macomb County Public Works)

Date 10/3/04

Richard Lessner, City Manager
City of Mount Clemens

Date 3/26/04

Charles Bohm, Supervisor
Ray Township

Date 7/14/03

Gordon Fuerstenau, Supervisor
Richmond Township

Date 3-30-04

Paul Reiz, President
Village of Romeo

Date 4/3/04

Kristen O'Reilly

St. Clair County Storm Water Program Manager (Represented by the St. Clair County Health Department)

September 29, 2004

Date

Gary R Kirsh

Gary Kirsh, Supervisor
Washington Township

Sept 21. 04

Date

Updated 5/29/03
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Appendix A.5: SubwatershedAdvisory Group Members

The Subwatershed Advisory Group is also referred to as the SWAG.

	Telephone	Fax	E-Mail Address
Addison Township			
Bob Koski, Supervisor	(248) 628-3317	(248) 628-2207	
Pauline Bennett, Clerk	(248) 628-3317	(248) 628-2207	
Almont Township			
Gary Groesbeck, Supervisor	(810) 798-8521	(810) 798-7097	
Carol Hoffner, Clerk	(810) 798-8521	(810) 798-7097	
Almont Village			
Steve Schneider, President	(810) 798-2545	(810) 798-3397	
Gerald Oakes, Manager	(810) 798-8528	(810) 798-3397	
Russell Kelley, DPW Supervisor	(810) 798-8655	(810) 798-3397	
Anderson, Eckstein & Westrick, Inc.			
Jeff Bednar, P.E.	(586) 726-1234	(586) 726-8780	
Hala Baroudi, P.E.	(586) 726-1234	(586) 726-8780	
Armada Township			
Don Eison, Supervisor	(586) 784-5200	(586) 784-5211	
Margaret Ruthenberg, Clerk	(586) 784-5200	(586) 784-5211	
Armada Village			
Lyle Ballard, President	(586) 784-9151	(586) 784-9153	lballard113@comcast.net
Michelle Poulous, Clerk	(586) 784-9151	(586) 784-9153	
Ed Serwatowski, DPW Director	(586) 784-9151	(586) 784-9153	
Kathleen Stork, Trustee	(586) 784-9151	(586) 784-9153	
Berlin Township			
Koleen McVeigh, Supervisor	(586) 784-9969	(586) 784-9717	
Karen Klos, Clerk	(586) 784-9969	(586) 784-9717	
Bruce Township			
Gary Schocke, Supervisor	(586) 752-4585	(586) 752-3870	
Clinton River Watershed Council			
Anne Vaara	(248) 601-0606	(248) 601-1280	anne@crwc.org
Michele Arquette-Palermo	(248) 601-0606	(248) 601-1280	michele@crwc.org
Clinton Township			
Mary Bednar, Engineer	(586) 286-9387	(586) 228-1770	m.bednar@clintontownship-mi.gov
Dryden Township			
Tina Papineau, Supervisor	(810) 796-2248	(810) 796-2250	
Bonnie Rumley, Clerk	(810) 796-2248	(810) 796-2250	
Dryden Village			
Pat Betcher, President	(810) 796-2291	(810) 796-3618	
John Ihrke, DPW Supervisor	(810) 796-2207		
Lapeer County Drain Commission			
John E. Cosens, Drain Commissioner	(810) 667-0371	(810) 667-0375	
Lapeer County Health Department			
Stephanie Mercer, Director	(810) 667-0391	(810) 667-0232	
Mitch Caskey, Environmental Health Director	(810) 667-0392	(810) 667-0283	

	Telephone	Fax	E-Mail Address
Lapeer County Planning Department			
Ian Kempf, Chairman	(810) 667-0201	(810) 667-0369	
Lenox Township			
John Gardner, Supervisor	(586) 727-2085	(586) 727-3188	
Cam Trombly, DPW Director	(586) 749-0230	(586) 749-0231	ctrombly@lenoxtwp.com
Leonard Village			
Eugene Mallia, President	(248) 628-7380	(248) 628-8673	
John Verse, DPW Supervisor	(248) 628-7380	(248) 628-8673	
Macomb County Department of Planning & Economic Development			
John Crumm, Program Manager	(586) 469-5285	(586) 469-6787	john.crumm@macombcountymi.gov
Gerard Santoro, Senior Planner	(586) 469-5285	(586) 469-6787	gerard.santoro@macombcountymi.gov
Macomb County Farm Bureau			
Glenn Haack, President	(586) 727-0025	(586) 727-0335	
Dawn Eschenburg	(586) 72709925	(586) 727-0335	deschen@ctyfb.com
Macomb County Health Department			
Cole Shoemaker	(586) 469-5236	(586) 469-6534	cole.shoemaker@macombcountymi.gov
Laura Pobanz	(586) 469-5236	(586) 469-6534	laura.pobanz@macombcountymi.gov
Macomb County Public Works Commissioner			
Lynne Seymour, P.E., Environmental Engineer	(586) 307-8229	(586) 469-7693	lynne.seymour@macombcountymi.gov
Lara Sucharski, Supervisor, Soil Erosion Division	(586) 307-8271	(586) 307-8264	lara.sucharski@macombcountymi.gov
Macomb County Soil Conservation District			
Alane Rowley	(586) 727-2666	(586) 727-2621	macombcd@klondyke.net
Macomb Township			
Jerome Schmeiser, Planner	(586) 992-0710	(586) 992-0721	pattyandjerry@comcast.net
Jack Dailey	(586) 992-0710	(586) 992-0721	jtrm54590@msn.com
Gerry Wangelin, Asst. Director – Water and Sewer Department	(586) 598-0687	(586) 598-9172	
Michigan Department of Environmental Quality			
Bretton Joldersma	(586) 753-3719	(586) 753-3751	joldersmab@michigan.gov
Carol Panagiotides	(586) 753-3700		panagioc@michigan.gov
Michigan State University			
Mary Gerstenberger	(586) 469-5180	(586) 469-6948	
Terry Gibb	(586) 469-5180	(586) 469-6948	
Mount Clemens			
Chuck Bellmore, Utilities Director	(586) 469-6889	(586) 469-7698	cbellmore@cityofmountclemens.com
Oakland County Drain Commission			
Amy Ploof	(248) 858-5264	(248) 858-1066	ploofa@co.oakland.mi.us
Oakland County Health Department			
Liz Braddock, Chief of Land & Water Technology	(248) 424-7097	(248) 424-7115	
Oakland Township			
Joan Fogler, Supervisor	(248) 651-4440	(248) 651-1510	

Ray Township			
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Ken Artman	(586) 749-5171	(586) 749-6190	clerk@raytwp.org
Rita Harman	(586) 749-5171	(586) 749-6190	
Richmond City			
Troy Jeschke, Planner	(586) 727-7571	(586) 727-2489	cityplanner@comcast.net
Richmond Township			
Gordon Fuerstenau, Supervisor	(586) 727-8998	(586) 727-8997	
Cindi Greenia, Planner	(586) 727-8998	(586) 727-8997	
Sharon Jusko	(586) 727-8998	(586) 727-8997	
Road Commission of Macomb County			
Joe Pacella, Development Manager	(586) 463-8671	(586) 463-8683	jpacella@rcmcweb.org
Romeo Village			
Marian T. McLaughlin, Clerk	(586) 752-3565	(586) 752-5205	villageofromeo@yahoo.com
Roy Trouse, Director – DPW	(586) 752-3565	(586) 752-5205	
St. Clair County Drain Commission			
Fred Fuller, Drain Commissioner	(810) 364-5369	(810) 364-7240	ffuller@stclaircounty.org
Jim Kneebone, Deputy Drain Commissioner	(810) 989-6985	(810) 364-7240	jkneebone@stclaircounty.org

	Telephone	**Fax**	**E-Mail Address**
St. Clair County Planning			
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Geoff Donaldson, Environmental Planner	(810) 989-6950	(810) 987-5931	
Six Rivers Regional Land Conservancy			
Donna Folland, Executive Director	(248) 601-2816		dfolland@sixriverslc.org
Southeast Michigan Council of Governments			
Amy Mangus	(313) 324-3350	(313) 961-4869	mangus@semcog.org
Angela Riess	(313) 324-3348	(313) 961-4869	riess@semcog.org
Spalding DeDecker Associates, Inc.			
Brian McKissen	(248) 844-5400	(248) 844-5404	bmckissen@spaldingdedecker.com
Washington Township			
Steve Hohensee, Water & Sewer Dept.	(586) 752-1052	(586) 752-6463	
Rob Mair, Water & Sewer Dept.	(586) 752-1052	(586) 752-6463	mairr@washngtontownship.org

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Appendix A.6: Plan Considerations and Contents

Planning Considerations

The planning process had to address numerous considerations to produce an effective watershed management plan. These are addressed in various parts of the WMP and include:

- clearly understanding and evaluating past and existing planning efforts and remedial measures and local history in order to direct future strategies and tie them into past and existing efforts;
- assessing the conditions of the natural environment to the extent necessary (e.g. watershed ecosystem) to ensure the plan is rooted in reality and that any analyses presented are scientifically sound;
- utilizing an all-encompassing framework in which to identify stressors to the watershed and the sources of these stressors (and the causes of the sources);
- summarizing the elicited concerns of stakeholders to ensure that the plan is responsive to those it serves;
- assessing past and present data to define the current environmental conditions in the watershed and consider them from a historical perspective;
- defining the current environmental conditions in terms of programmatic elements such as designated uses and beneficial uses and documenting the severity and geographic extent of impairments to these elements (e.g. impaired, threatened);
- detailing the reasons for impairment (i.e. stressors and their impacts) and a description / evaluation of all known, and other possible sources of, stressors (i.e. pollutants);
- developing long-term goals for the subwatershed (including the protection of designated uses and beneficial uses and the attainment of compliance with established Total Maximum Daily Loads – TMDLs) that address the concerns of stakeholders and support the purpose(s) of the plan and also reference not only environmental conditions but also those that address the citizenry or programmatic elements themselves (e.g. an informed and engaged public, installing collaborative planning and implementation mechanisms, and effective information dissemination);
- developing short-term measurable objectives for the subwatershed that are specific and support the achievement of the long-term goals;
- generating a master list of the various programs and entities that exist or can be leveraged in the future (considering the generic set of actions that these embody) to improve environmental conditions the subwatershed, meet the short-term measurable objectives of the plan, and obtain the long-term goals;
- from the master list of programs (and potential actions), determining the specific actions, within a systematic and comprehensive ecosystem approach, needed to achieve the short-term measurable objectives and long-term goals with certain implementation details clearly stated for each action, including scope, benefit, timeline, responsible party, cost requirements, funding opportunities, and relationship to planning components (e.g. impacts, stressors, sources, objectives, goals);
- establishing a separate set of surveillance actions that aim to implement the methods by which to monitor and measure the environmental impacts of stressors, assess the levels of stressors, quantify the sources of the stressors, define (and desirably quantify) the causes of the sources, and otherwise obtain data by which to evaluate attainment of the short-term objectives and long-term goals;
- establishing an additional set of managerial actions that embody the methods by which to evaluate progress and determine the success level of the plan;
- establishing an additional set of managerial actions that embody the revision mechanisms that define when and how to update the plan to increase its effectiveness;
- establishing an additional set of managerial actions that define the procedures to be utilized to document all efforts and results associated with planning and implementation such that there is a continual historical record of actions, environmental conditions, and state of planning to ensure that future efforts utilize the foundations established by this plan;
- identifying enforceable commitments, or non-binding partnership agreements, for the responsible party(ies) associated with each action to ensure that they are implemented by the specified dates and thus that short-term objectives and long-term goals are achieved in a reasonable amount of time; and
- defining the metrics by which to directly or indirectly measure the achievement of planning parameters (i.e. uses, objectives and goals), the implementation of actions (e.g. implementation milestones), and the effectiveness of the actions (e.g. levels of stressors in the environment, biological conditions, public awareness).

Plan Contents

All of the above considerations are combined in the streamlined narrative that is the WMP. The WMP presents all of this information in a limited number of defined chapters that contain all of the significant information for the general public audience. The chapters of the WMP include:

- Chapter 1 – This introductory chapter discusses background science important to understanding the plan, introduces the Clinton River Watershed and the North Branch Subwatershed, and describes the approach used to develop the plan (e.g. processes, partners, drivers) and its contents.
- Chapter 2 - This chapter introduces the reader to the general environmental conditions in the subwatershed, including: climate; geology, topography, and soils; drainage; and ecosystem attributes and functions (flora, fauna, and habitat). This information defines the baseline conditions for assessments.
- Chapter 3 – This chapter introduces the reader to environmental stressor and their impacts on the natural environment, the sources of the stressors and the causes of these sources, and defines the basic conceptual model that defines the framework relationship between these elements.
- Chapter 4 – This chapter identifies the stakeholders involved in development of the plan, the efforts undertaken to engage them and the input they provided, and public education efforts in the past and those considered for the future.
- Chapter 5 – This chapter presents broad data and programmatic information that defines an assessment framework, describes existing data, defines the data gaps and the initiatives to fill the gaps, presents data with respect to assessment parameters in order to gauge subwatershed conditions, summarizes the conditions based on numerous criteria, discusses critical areas, presents a conceptual model for stressors and sources, and presents a 'scorecard'.
- Chapter 6 – This chapter defines the main purpose of the plan and lists the goals of the plan along with the objectives associated with each goal. The chapter also cross-references the goals and objectives with other important planning elements.
- Chapter 7 – This chapter presents a prioritization of numerous plan elements including goals and objectives, problems (impacts, stressors, sources, causes), and the categories of actions.
- Chapter 8 – This chapter defines the categories of actions to be taken to improve environmental conditions, presents the implementation options within these categories, and presents the final selected action plan along with specific details about each action to be taken.
- Chapter 9 – This chapter establishes the monitoring protocols to collect data, the protocols to assess conditions, and evaluation considerations to track progress, and the revision mechanisms to guide changes to the plan.
- Chapter 10 – This final chapter simply contains the references utilized throughout the plan.

Where appropriate, the WMP references appendices, other technical documents developed during the planning process, or outside documents for readers that desire additional information.

Planning Processes

The processes and tasks utilized to develop the plan were defined previously in the proposal to perform the work and are presented here (with modifications for changes in the work that was performed based on decisions made during the planning process). Certain essential external information has been included in the content of the plan or as appendices to the plan to, as much as was feasibly possible, make this plan the one singular "go to" reference for all available data and information concerning the subwatershed.

The process involved enthusiastic stakeholders from seventeen municipalities and four counties (specifically, Macomb, Oakland, Lapeer, and St. Clair) acting in concert to address issues related to numerous programs and requirements (e.g. Areas of Concern program, State of Michigan water quality standards, TMDLs for pathogens and dissolved oxygen) and environmental problems arising from numerous sources (e.g. point source discharges, various land uses – primarily agricultural and increasing urbanization – through stormwater runoff, soil erosion, loss of habitat). The development of this plan is the most recent activity undertaken by the North Branch Subwatershed Advisory Group (NBSWAG); and organization that has been involved in stewardship of the subwatershed in recent years and has been involved in numerous other activities including coordination meetings, organizing and participating in river clean ups, applying for an illicit discharge elimination program grant, and performing environmental assessments (e.g. road-stream crossing surveys). The Macomb County Public Works Office (MCPWO) has been leading the SWAG and continued to do so during development of the plan by monitoring project progress and reviewing products developed throughout. Local stakeholders, primarily personnel from the governmental entities (e.g. planners, engineers, and public works employees) and other interested parties (e.g. Macomb County Farm Bureau, Southeast Michigan Council of Governments, Clinton River Watershed Council), participated throughout the project to assist the process (by helping with data collection, and conducting surveys) and ensure that proposed actions were acceptable at the local level and that there was the buy-in required for successful implementation.

The MCPWO was the natural lead for the project for a number of reasons: 1) most of the subwatershed lies within Macomb County; 2) the MCPWO has extensive environmental stewardship responsibilities; and 3) much of the staff had prior MDEQ and other grant experience. The MCPWO oversees the county-wide storm water permit compliance program and participates in a number of subwatershed advisory groups (facilitating four of them). There is also a Pollution Patrol team that conducts an illicit discharge elimination program (IDEP) and an educational program throughout the county. Lynne Seymour, an environmental engineer, was the chief grant administrator and project implementation manager, while Lara Sucharski, the Soil Erosion and Sedimentation Control Division chief, assisted with these efforts. Other MCPWO staff involved with the grant project (and with prior grant experience) included: Barb Saile (administrative assistant), Barb Matthews (environmental educator), Gene Schabath (deputy drain commissioner), Claudette Wizniak, Jim Amato (engineering coordinator), and several inspectors. These staff were involved in various aspects of the project, based on their areas of expertise, from typing meeting minutes and preparing documents for public dissemination to engaging in field work such as uplands conditions assessment and stream corridor surveys.

The prior, recent MDEQ grants that the MCPWO staff were involved with include: Illicit Connection Elimination Grant, TC#2001-0060 (closed out) – the only other grant with geographic scope that included the North Branch Subwatershed; Clinton River Hydrologic Project, TC#2002-0100 (closed out); Bear Creek Bacterial Source Tracking Study, TC#480795-03 (cancelled); Middle Branch of the Clinton River Streambank Stabilization Project, TC#1999-0052 (closed out); New Baltimore Park Beach & Crapau Creek Monitoring Grant, TC#481024-05 (closed out); Illicit Discharge Elimination Project, TC#2002-0247; and the Middle Clinton River LID Demonstration Project, TC#2000-0182. In addition to MDEQ grants, the MCPWO staff have administered grants from other organizations including the Great Lakes Commission (GLC) and the United States Army Corps of Engineers (USACE), among others. Macomb County's internal payment system was utilized in concert with the MDEQ's electronic financial status reports (FSR) to provide timely cost reimbursement and proof of payment and ensured that financial data was accurately tracked throughout the project.

The Macomb County Planning and Economic Development (MCPED) department was an essential internal partner, due to their role as the data clearinghouse for the county, and provided three staff members to assist with the project: Gerard Santoro (senior planner), Jeff Schroder (program manager), and Joe Gilberg (planner). Mr. Santoro was previously involved with numerous grant projects administered by the MCPED and assisted with administration of this grant. He and the other staff were involved with data, mapping, and analytical portions of this project.

The contractor selected to spearhead the development of the plan (Tetra Tech) was selected in part because they assisted in the creation of three other 319-approved subwatershed management plans in the Clinton River Watershed / Lake St. Clair Direct Drainage area in addition to the *Clinton River Restoration Plan* (also known as a Remedial Action Plan). Additionally, Tetra Tech provided the hydrologic and pollutant modeling that formed the basis for the actions suggested in the Restoration Plan and was in a unique position to refine this modeling in the North Branch area to support this project.

The primary goal of the planning process was to develop a watershed management plan that would ultimately lead to meeting water quality standards and other environmental indicators through remedial and protective measures (until this plan was finished, the North Branch was the only subwatershed in the Clinton River Watershed without a specific subwatershed management plan). The plan was developed to comply with Clean Water Act (CWA) section 319 requirements so that the actions defined in the plan can be funded in the future through related grants from the Michigan Department of Environmental Quality (MDEQ). The 319 requirements are defined extensively in the plan but generally involve: identifying sources, causes, and loads for each pollutant leading to impairment;

defining target load reductions to alleviate impairments; proposing a plan of action to address the impairment, including an estimate of load reductions for each individual action (and also including public participation and education strategies); establishing costs and a schedule for each action; identifying sources of funding and technical assistance; and presenting an evaluation plan that contains milestones for assessing implementation progress. In addition to 319 requirements, the actions in the plan address other important considerations including the identification of key areas for preservation, as well as other management procedures designed to ensure the future health of the North Branch. The plan is not only important to the subwatershed itself, but as the largest of the subwatersheds, the North Branch Subwatershed has significant impact on the lower reach of the Clinton River and also Lake St. Clair (near the mouth of the Clinton River and Clinton River Spillway). As one of the least developed areas in the Southeast Michigan region, the subwatershed offers myriad opportunities for innovative and environmentally integrated solutions to restoring and preserving environmental quality.

The grant project, specifically the development of the watershed management plan, was guided by an adaptive management process that had nine distinct tasks (1-9). These tasks were generally sequential in nature, but some had elements that were applicable throughout the grant project timeline. They were largely conducted by the project consultant with oversight and supervision from the MCPWO and integral participation by many of the stakeholders and SWAG representatives. The tasks are discussed in the following subsections.

Task 1: Project Initiation

At the beginning of the project, the essential partners for the development of the management plan were identified and invited to participate through the SWAG. A stakeholder contact list was created based on the SWAG contact list. The driving forces behind the plan were identified and summarized so as to define the procedural and content requirements of the plan and its development (e.g. designated uses) and to inform the prioritization and decision-making processes essential to focusing the limited resources of the project toward the development of an effective plan. Outreach activities associated with the project were initiated. A regular SWAG meeting schedule was defined

Task 2: Gather Existing Data and Create an Inventory

Existing data related to the subwatershed was collected from historical data stores, published reports (e.g. TMDLs) and by contacting organizations involved in recent planning and assessment efforts to obtain recent information. The data collection was nominally conducted at the beginning of the project, but data continued to be obtained throughout the project. The collected data (e.g. natural environment conditions – hydrology, topography, soils, climate, habitat, wildlife; land use and population – land cover, demographics, regional history; infrastructure – roads, industrial sites, other pollutant sources; environmental conditions – assessed stressor levels in waterbodies, natural features; and regulations – water quality standards, defined impairments, protected resources) was inventoried in a specific spreadsheet and summarized in narrative, tabular, and spatial format (i.e. map) as it was processed for inclusion in the plan.

Task 3: Identify Data Gaps and Collect Additional Data

Upon completion of the data collection, the data was analyzed to determine where essential data were missing (even before the project was started, it was believed that data about the sources of stressors and their causes was insufficient). Most of the missing physical data was obtained through: 1) assessment of the riparian corridors, and 2) assessment of the uplands areas. Assessment of the riparian corridors followed the Center for Watershed Protection's (CWP's) Unified Stream Assessment (USA) protocol (CWP, 2005a) and focused on the TMDL reaches and those areas upstream and a representative sample of different land uses throughout the subwatershed (with further subdivisions based on subtypes – e.g. low and high density residential, agricultural types), taking into account identified priority areas such as wetlands. A total of 20 linear miles was assessed. Assessment of the upland areas followed the CWP's Unified Subwatershed and Site Reconnaissance (USSR) protocol (CWP, 2005b) and focused on urban areas, park lands, and agricultural areas (with priority being placed on areas tributary to the TMDL areas). A total of 6 square miles was assessed. Prior to conducting the field surveys, Tetra Tech conducted a training exercise to ensure that the volunteers conducting the surveys understood the protocols, thus establishing some consistency between the data collected by different volunteers. In some agricultural areas, interpretations of aerial photographs and discussions with knowledgeable officials were used to gain a greater understanding of sources and causes for these areas.

Additional data was collected by conducting a statistically significant social survey (approximately 365 respondents) by mail with phone call follow-up. The survey was based on the *Step-by-Step Guide to Conducting a Social Profile for Watershed Planning* (UIUC, 2001) and assessed: public awareness, perception, and knowledge of watersheds and storm pollution issues; current activities impacting water resources; willingness to take action to protect water resources; and mechanisms to best receive information.

A quality assurance project plan (QAPP) was developed to guide data collection, inform quality reviews of the data, and address comments about the data. As such, it contains a sampling plan, data collection and management procedures, training and logistical considerations, and QA/QC considerations. QAPP protocols conform to both MDEQ and EPA specifications, ensuring that the data is collected consistently and reliably and that the data is robust in its applicability.

The gap analysis, the background information and results of the field data collection, the background information and results of the social survey, and the QAPP exist as appendices to the plan.

Task 4: Data Analysis and Pollutant Load Estimates

All data gathered and collected was summarized and analyzed to characterize subwatershed conditions, identify the stressors of concern, the sources of the stressors, and the causes of the sources. Combinations of analyses were used but common elements include temporal and geographic considerations. Simple types of assessments simply presented data in terms of the temporal/geographic parameters. More complex analyses involved extensive relational considerations such as the impervious cover analysis that utilized a number of sources of land use data (and pre-determined impervious cover percentages, where necessary) and then compared values to those generated through independent research to predict the relative health of a waterbody at a particular point and the expected health of the waterbodies throughout a given drainage area. The assessments included not only environmental type analyses, but also the consideration of actions and policies (e.g. regulations, ordinances) and their impacts on environmental conditions. Extrapolation/interpolation techniques were used to determine conditions for locations were significant amounts of data were not available.

Additionally, data was also used to aid the refinement and calibration of the hydrologic and water quality models developed in support of the *Clinton River Restoration Plan*. These models were used to estimate loads for a number of stressors, categorized by source, and to assess the impacts of these stressor levels. A number of models were used to consider existing and various future conditions with varied land use configurations and changed configurations for other sources (e.g. future septic system areas, sewer overflow frequencies). The modeling results were used in concert with all of the other data collected to determine the critical areas with respect to pollutant loads. Critical areas for natural resource protection activities were also identified.

Analyses were also conducted with respect to regulatory standards such as determining the status of the designated uses.

Task 5: Set Goals and Identify Load Reductions

Based on all of the previous summarized and analyzed information, a preliminary set of goals and objectives was defined and presented to stakeholders. These preliminary goals and objectives were selected by also considering those presented in the *Clinton River Restoration Plan*, those in existing subwatershed plans that address problems that are also present in the North Branch Subwatershed, and the information gathered from the social survey. The preliminary goals and objectives were presented along with the summarized and analyzed data to allow them to select those goals and objectives that should be included in the plan. The loading reductions required to meet these final selected goals and objectives were then calculated.

Task 6: Identify and Select Strategies

An overview of the different management strategies available to achieve the goals and objectives of the plan was prepared and presented to the stakeholders. The strategies evaluated ranged from structural improvements, to managerial programs, to educational considerations (to enhance public understanding and encourage their participation in the watershed activities). This summary indicated which strategies are currently being undertaken and discussed the benefits and deficiencies of each, along with implementation opportunities and constraints. Specific effectiveness, efficiency, cost, and other information (where available) was included to facilitate the evaluation of strategies. Those determined to be most promising were selected by the stakeholders for inclusion in the plan (based on acceptability, ability to implement, likelihood of success, and other factors).

Task 7: Design Implementation Program and Assemble Watershed Plan

Once selected, the implementation effort associated with each strategy was defined, along with the expected load reductions expected from each practice. An overall implementation plan for the entire set of selected strategies was defined and included specific cost, financial and technical assistance required and potential sources, citing (urban, rural, agricultural), abundance, timeline, milestones, responsibility/commitments, permit requirements, relationship to goals/objectives, benefits, effectiveness evaluation, and other specific details. Additionally, the overall implementation plan was designed to include actions related to collecting monitoring data, evaluating the progress and success of the other actions, and revising the plan in the future. Finally, the long-term institutionalization of the plan was considered by providing a list of organizational and funding considerations (including maintaining the current voluntary SWAG structure), in addition to related programs that have similar goals and implementation priorities (e.g. the Blue Ribbon Commission on Lake St. Clair), to ensure that the actions of the plan are addressed in the future and that the plan is updated as necessary.

Once the above components of the plan were completed, a draft version of the entire watershed management plan was assembled (and included development of front end items such as the table of contents and other additional plan components including some appendices). This draft was reviewed by the SWAG and other stakeholders and a list of comments to address was generated. These comments were addressed and a final draft of the plan was developed and submitted to the MDEQ for reviews related to Clean Michigan Initiative (CMI) and section 319 program compliance. Once the MDEQ comments were received, the plan was revised to address the comments and a final version of the plan was prepared and distributed for public consumption.

Task 8: Project Communication and Coordination

Throughout the project, regular meetings were held to coordinate the various activities occurring under the project tasks. Preparation for the meetings was the joint responsibility of the MCPWO and Tetra Tech. Numerous mechanisms were employed to engage the public and encourage attendance at stakeholder events and meetings, including: e-mail, press releases, newsletter articles, websites, surveys, and displays. It was made clear throughout the project that: 1) public input would influence decisions with respect to development of the plan; 2) parties affected by the plan should provide input to the process; 3) the primary routes of communication for the public were utilized to maximize input; and 4) the public impact on the contents of the plan was summarized after the plan was finalized.

Task 9: Grant Administration and Close Out

The MCPWO was responsible for a number of tasks related to administration of the grant. Where requested, Tetra Tech and others assisted these efforts. The tasks included:

- Developing and submitting quarterly status reports following ESSD guidance within 30 days of the end of each quarter;
- Developing and submitting a draft final report following ESSD guidance at least 45 days prior to the end of the project, incorporating MDEQ comments and submitting a final report within 30 days of the end of the grant;
- Submitting a release of claims statement on letterhead with the final report;
- Submitting in both hard copy and electronic format a draft (30 days prior to the end of the project) and final project fact sheet (submitted with the final report) utilizing the ESSD template;
- Submitting an electronic copy of all before and after photos and other project-related photos with the final report; and
- Providing draft and final products and deliverables in both hard copy and electronic format with a minimum of five hand copies and one electronic copy of all final products and deliverables submitted to the MDEQ.

The project was considered complete once the above criteria were met with the final prepared version of the watershed management plan having addressed the MDEQ section 319 comments. After this, all of the actions in the plan were eligible to receive section 319 grant funds through the MDEQ.

Appendix A.7: Environmental Protection

Environmental Protection in Michigan and the U.S.

The establishment of the International Joint Commission (IJC) – a binational organization, established by the Boundary Waters Treaty of 1909 to advise the governments of the United States and Canada on preventing or resolving problems along their common border – is the earliest example of an organization addressing environmental concerns that still exists today. The IJC becomes involved in transboundary issues such as water and air quality, lake levels, and power generation when requested to do so by the governments. Federal and state attempts to address environmental issues took much longer to solidify.

The first formal water pollution control efforts came at the state level with the passage of Public Act 98 of 1913 which established the Health Department and required large communities to: 1) control and treat sewage, and 2) treat and distribute drinking water. The Conservation Department (today's Department of Natural Resources) was created by Public Act 17 of 1921 to help deal with flagrant and gross pollution of water as well as to protect other natural resources (Sweet, 2006).

The state established the Stream Control Commission in 1929 (Public Act 245) as the official pollution control agency of the state. However, the agency had little influence and any progress made during the 1930s was generally in response to outcries from urban populations that had to deal with the conditions caused by rampant pollution and raw sewage discharge into nearby waterbodies. The Commission wasn't recognized as a strong force until it won two court orders for enforcement in 1939 and 1940. The Commission was renamed the 'Water Resources Commission' in 1949 by Public Act 245 which also expanded the definition of pollution and required approval for all new uses of state waters (Sweet, 2006).

At the federal level, water pollution control programs were initiated by the **1948 Water Pollution Control Act**, which focused on protection of human health, not the environment. The Act allotted funds to state and local governments for water pollution control, placing emphasis on the States' role in controlling and protecting water resources, with few, if any, federal goals, objectives, limits, or guidelines.

Congress became increasingly interested in water quality degradation from 1956 through 1966, and passed four laws to strengthen the federal role in water pollution control, including the **Water Pollution Control Act Amendments of 1956** and the **Federal Water Pollution Control Act Amendments of 1961**. These initiatives focused on giving additional funding to municipalities for constructing wastewater treatment works.

During this time, the State's Water Resources Commission instituted the first periodic water quality monitoring program. In addition, the Water Resources Commission was incorporated into the newly renamed Department of Natural Resources in 1965 and the legislature amended Act 245 to further regulate pollution and raw sewage discharge (Sweet, 2006).

The federal **Water Quality Act of 1965** represented a major regulatory advancement in water pollution control by requiring States to develop water quality standards for interstate waters by 1967. Michigan established minimum water quality standards for other state waters in 1968. The Water

Goals and Principles of the Clean Water Act

The ambitious goals of the Clean Water Act include:

- "it is the national goal that the discharge of pollutants into navigable waters be eliminated by 1985";
- "it is the national goal that wherever attainable an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved by July 1, 1983"; and
- "it is the national policy that the discharge of toxic pollutants in toxic amounts be prohibited".

Other important principles include:

- The discharge of pollutants to navigable waters is not a right;
- A discharge permit is required to use public resources for waste disposal and limits the amount of pollutants that may be discharged;
- Wastewater must be treated with the best treatment technology economically achievable, regardless of the condition of the receiving water; and
- Effluent limits must be based on treatment technology performance, but more stringent limits may be imposed if the technology-based limits do not prevent violations of water quality standards in the receiving water.

Source: (EPA, No Date).

Quality Act also called for States to develop waste load allocations to quantify pollutant loadings that could be discharged without exceeding the water quality standards. Despite increasing public concern and increased public spending, only about half of the States developed water quality standards by 1971. Furthermore, enforcement of the federal legislation was minimal and there were no criminal or civil penalties to enforce the regulation.

The lack of success in developing adequate water quality standards programs, along with growing concern about the environment, prompted President Nixon to form the United States Environmental Protection Agency (EPA) in 1970 to enforce environmental compliance and consolidate federal pollution control activities. In 1972, the United States and Canada signed the Great Lakes Water Quality Agreement establishing the Great Lakes Water Quality Board, committing to providing a coordinated cleanup effort on phosphorus and the resulting eutrophication of the Great Lakes, and to 'restore and maintain the chemical, physical, and biological integrity of the waters of the Great Lakes Basin Ecosystem'. The agreement was later revised (in 1978) to further define phosphorus controls, to focus on toxic substances using an ecosystem approach utilizing an integrated and comprehensive perspective to restoring and protecting water quality throughout the Great Lakes. In November of 1972, Congress passed a comprehensive recodification and revision of federal water pollution control law, known as the **Federal Water Pollution Control Act Amendments of 1972** (more commonly known as the 'Clean Water Act' or CWA), marking a distinct change in the philosophy of water pollution control in the United States. The Amendments contained requirements for water quality-based controls, with an emphasis on technology-based, or end-of-pipe, control strategies (EPA, No Date). Michigan updated its water quality standards in 1973 to fully reflect the requirements of the CWA (Sweet, 2006).

Subsequent enactments modified some of the earlier CWA provisions. Revisions in 1981 streamlined the municipal construction grants process, improving the capabilities of treatment plants built under the program. Changes in 1987 replaced the construction grants program with the State Water Pollution Control Revolving Fund, more commonly known as the SRF. This new funding strategy addressed water quality needs by building on EPA-State partnerships. Additionally in 1987, amendments were added to the GLWQA to re-emphasize the ecosystem approach, requiring the development of specific programs to achieve the goals previously listed in the 1978 agreement, and establishing guidelines for the three-stage preparations of Remedial Action Plans (RAPs) that will guide federal, state, and local governments along with business, industry, citizens, and academia to address the problems in the Areas of Concern and restore beneficial uses.

Since passage of the CWA, numerous international, federal, state (e.g. water quality standard updates), regional, and local programs have worked to enhance environmental conditions in the county, Great Lakes region, state, region, county, watershed, and subwatershed. These programs are discussed in detail elsewhere in the WMP, but some important programs are discussed briefly in the following sections.

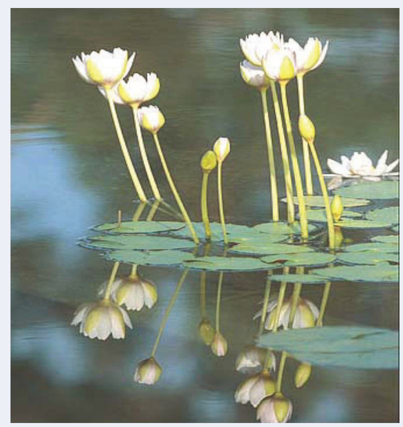
Waters of the U.S.

The EPA defines these as:

- Navigable waters;
- Tributaries of navigable waters;
- Interstate waters; and
- Intrastate lakes, rivers, and streams which are:
  - Sources of fish or shellfish sold in interstate commerce;
  - Used by interstate travelers for recreation and other purposes; or
  - Utilized for industrial purposes by industries engaged in interstate commerce.

Source: (EPA, No Date)

State of Michigan Symbol of Water Quality



Effective April 21, 2004, the State of Michigan, by Public Act 78 of 2004, officially designated the American lotus blossom (*Nelumbo lutea*) as the state symbol for clean water. The American lotus is a showy plant that proliferates in shallow wetland areas during the summer months. Micro and macro invertebrates inhabit submerged portions of the plant, which in turn are used as food for fish and other wildlife. The adoption of this symbol demonstrates Michigan's commitment to wetland protection and clean water.

National Pollutant Discharge Elimination System

The National Pollutant Discharge Elimination System (NPDES) is a cornerstone of environmental protection at the federal level. When the NPDES was established in 1972 (under the Clean Water Act), only one third of our rivers, lakes, and coastal waters were considered fishable and swimmable. Today, approximately two thirds of our waters are healthy. This is due in no small part to the regulation of more than 50 categories of industry (including several hundred thousand businesses) and the nation's network of more than 16,000 municipal sewage treatment systems. The NPDES permits that regulate discharges from these facilities have resulted in the prevention of billions of pounds of conventional pollutants (e.g. suspended solids) and millions of pounds of toxic pollutants (e.g. dissolved heavy metals) from being discharged into 'waters of the United States' (EPA, 2001).

In 1990, the Environmental Protection Agency (EPA) promulgated Phase I of the stormwater rules of the NPDES. This required municipal separate storm sewer systems (MS4s) in areas with 100,000 or more people to regulate the quality of stormwater discharges to waters of the United States.

In 1999, the EPA promulgated Phase II of the NPDES stormwater rules. The Phase II requirements expand the coverage of MS4s to include those in urbanized areas (as defined by the U.S. Census) not previously covered under Phase I. Although the subwatershed does not have any Phase I areas, there are portions of some communities that are considered to be urbanized area and therefore regulated under Phase II. However, the communities are addressing these areas by including them under the adjacent WMPs that have been developed to meet Phase II requirements.

Michigan is one of forty-five states and territories authorized to implement the NPDES program. In implementing the Phase II requirements, the MDEQ has developed and now refined the NPDES Wastewater Discharge General Permit No. MIG610000 (Watershed General Permit) for covering Storm Water Discharges from Municipal Separate Storm Sewer Systems (MS4s). This is one of a few instances where a watershed-based permitting approach has been used under the NPDES program. The MDEQ has also developed and now refined a jurisdictional-based approach: NPDES Wastewater Discharge General Permit No. MIS049000 (Jurisdictional General Permit) for covering Storm Water Discharges from Municipal Separate Storm Sewer Systems. This approach involves communities working independently to address stormwater discharges through: 1) Public Education and Outreach, 2) Public Participation / Involvement, 3) Illicit Discharge Detection and Elimination, 4) Construction Site Runoff Control, 5) Post- Construction Runoff Control, and 6) Pollution Prevention / Good Housekeeping.

Relevant State Laws

Natural Resources and Environmental Protection Act

Act 451 of 1994, the Natural Resources and Environmental Protection Act (NREPA), is designed to protect the environment and natural resources of the state by: regulating pollutant discharges; regulating land, water, and resource use; and prescribing penalties and remedies for violations.

Notable parts of the act relating to stormwater include: Part 17 – Environmental Protection; Part 31 – Water Resources Protection; Part 41 –

Special Laws / Programs

Specific situations may invoke numerous other federal, state, and local programs that directly or indirectly relate to storm water issues, including:

- The National Environmental Policy Act sets national policy for the environment and requires impact statements;
- The federal Safe Drinking Water Act establishes wellhead protection provisions that are implemented at the state or local level (MDEQ Water Wellhead Protection program);
- Coastal / shoreline areas have numerous federal laws such as the Coastal Zone Act and the Shoreline Erosion Protection Act, and state laws / programs such as Coastal Management, Sand Dune Protection, and Shoreland Management;
- Commercial/industrial sites have numerous laws and regulations to minimize environmental impacts. Laws include: the Surface Mining Control & Reclamation Act, the Resource Conservation and Recovery Act, the Federal Insecticide, Fungicide, and Rodenticide Act, and the Toxic Substances Control Act;
- The control of excessive aquatic plants and algae is regulated the Michigan Public Health Code;
- The River and Harbor Act of 1899 sets protocols for structural modifications to navigable waters;
- The federal Clean Air Act establishes state-enforceable emission standards of pollutants (some of which can degrade water quality);
- The federal 'Superfund' deals with the cleanup of abandoned hazardous waste sites;

Sewerage Systems; Part 87 – Groundwater and Freshwater Protection; Part 91 – Soil Erosion & Sedimentation Control; Part 301 – Inland Lakes and Streams; Part 303 – Wetland Protection; Part 305 – Natural Rivers Act; Part 307 – Inland Lake Levels; Part 309 – Inland Lake Improvement; Part 315 – Dam Safety; and Part 323 – Shorelands Protection and Management.

Public Act 40 of 1956 – The Drain Code

The Drain Code sets forth procedures for the creation, maintenance and financing of county and inter-county drains in Michigan. It establishes the office and prescribes the duties and powers of the county drain commissioner. County drains are important to Phase II efforts because many of them are waters of the state, and most of them discharge directly or indirectly to waters of the state (Pratt, 2005). It should be noted that the Macomb County Public Works Office (MCPWO) contends that county drains established before 1973 are exempt from certain state permits even though they are waters of the state.

Relevant State Programs and Regulations

Water Quality Standards

Under the auspices of the CWA and NREPA, the MDEQ defines water quality standards "to protect the Great Lakes, the connecting waters, and all other surface waters of the state" (MDEQ, 2006). Water quality standards are discussed in greater detail in Chapter 5.

The Total Maximum Daily Load Program

MDEQ regulations (as authorized by the EPA under the CWA section 303(d)) require that "when a lake or stream does not meet water quality standards, a study must be completed to determine the amount of a pollutant that can be put in a waterbody from point sources and nonpoint sources and still meet water quality standards, including a margin of safety" (MDEQ, 2006). Any Total Maximum Daily Loads (TMDLs) relevant to this subwatershed are addressed in Chapter 5.

Permits

Despite the NPDES permitting process that covers stormwater-specific issues, other permits may be required for a specific cases. Many state and federal permits are covered under the MDEQ/USACE Joint Permit Application package. The application covers activities relating to: wetlands, floodplains, marinas, dams, inland lakes and streams, great lakes bottomlands, critical dunes, and high-risk erosion areas. Other permits not included in the application include: the Sewerage System Construction Permit and the Groundwater Discharge Permit.

Other Programs

State programs that directly enforce and assist in compliance with federal and state stormwater regulations include the following MDEQ Water Division groups: Storm Water, Soil Erosion and Sedimentation Control, NPDES Permits, and Nonpoint Source Pollution. State-level funding programs that support stormwater related projects include: the SRF, the Strategic Water Quality Initiative Fund, and the CMI.

(EPA 3.2.1)

Special Laws / Programs (continued)

- The Oil Pollution Act authorizes federal response mechanisms designed to prevent catastrophic oil spills and requires submittal of plans to the Coast Guard and EPA;
- The Water Resources Development Act provides for the conservation and development of water and related resources and authorizes studies and construction of improvement projects for navigation, flood damage reduction, dredging, ecosystem restoration, and water supply;
- The Endangered Species Act is a wide ranging law designed to protect endangered and threatened species from extinction as a 'consequence of economic growth and development untendered by adequate concern and conservation; and
- The regulation of dams in the United States is split between the federal and state governments. Federal laws and programs concerning dams include the National Dam Inspection Act, the Dam Safety Act(s), the Federal Emergency Management Agency, and U.S. Army Corps of Engineers, and the U.S Fish and Wildlife Service. At the state level, the MDEQ has a Dam Safety Program that handles the bulk of dam related issues. In some cases, dams that are on interstate waters may be regulated by interstate compacts between the states.

Appendix C.1: ESS Framework Details

Notes on Stressor and Source Framework

Not all of the stressors or sources listed in the table impact the subwatershed, nor are they necessarily at a scale appropriate for watershed planning. However, defining this framework allows one to see how this plan fits into an overall planning picture that includes the watershed-level Clinton River Restoration Plan, a comprehensive Lake St. Clair basin management plan, and myriad other programs and plans.

Impacts of Nutrients

Excessive levels of phosphorus can cause accelerated plant growth and algae blooms that can interfere with aesthetic and recreational uses of water (e.g. swimming and boating). Decay of algae blooms and aquatic plants can cause odors and the suspended particulate matter can lead to increased turbidity, which reduces light penetration and increases water temperature.

The decay of plant and animal tissue requires oxygen, resulting in decreased in-stream dissolved oxygen (DO) concentrations (which is itself a stressor).

Cumulative impacts (in concert with other stressors) result in degraded aquatic life and fisheries.

The same cumulative impacts can interfere with industrial, agricultural, and drinking water intakes physically and elevated nitrates cause human health problems and potentially interfere with industrial processes.

Stressor and Source Framework

There are many different stressors that can impact the environment. However, one can define a general set of stressors that encompass those most often encountered. These are presented in Table C.1-1 and are cross-referenced to potential sources.

Stressors and Impacts

This section describes the most common stressors which can impact the natural environment and is a truncated version of the one found in the Clinton River Restoration Plan. To facilitate the analyses associated with the stressors (presented in Chapter 5), the stressors have been grouped according to 'type': chemical, physical, biological, and radiological. The individual tables of specific potential sources and their potential causes for each stressor of concern have been replaced with a master source/cause table at the beginning of the 'Causes' section. The sources associated with each stressor can still be cross-referenced through Table C.1-1.

Chemical Stressors

These are the chemicals and associated conditions that are components of, or negatively impact, a healthy natural environment. Some are necessary for life while others cause severe problems with biota or desired human activities.

Many toxic chemicals adhere to tiny particles that are taken up by plankton and benthos animals (bioaccumulation). These plankton and benthos are consumed by larger predators and the toxins concentrate upward within aquatic food chains (biomagnification); ultimately affecting birds, fish, and mammals. Impacts include lower hatching success and deformities in birds and amphibians as well as the loss of recreational fisheries and associated revenue, loss of food supply, impairment of drinking water supplies, and the potential for long term health impacts from ingesting contaminated organisms for humans (GLC, 2006).

I. Nutrients

Nutrients, both nitrogen (N) and phosphorus (P), are essential to aquatic ecosystems and occur naturally in varying amounts (e.g. components of soil, nutrient rich rocks). For example, the ratio of N to P in a healthy lake system is typically 10:1. Nutrients stimulate the growth of phytoplankton and other aquatic plants that are consumed by fish and other animals and are necessary for a productive and diverse aquatic ecosystem. However, high levels of nutrients – usually due to human activities – can have a negative impact on water quality. Of the two nutrients, phosphorus is typically in short supply in fresh water and has the greatest potential to cause adverse impacts.

Phosphorus can either be dissolved in water or suspended in water by attaching to particulate matter (e.g., sediment). As it cycles through water, phosphorus usually moves downstream as decomposing plant and animal tissue. Phosphorus attached to particulate matter settles in bottom sediment where it is used by benthic organisms or covered by additional sediment, only to re-enter the water column when the bottom is stirred. Too much phosphorus in a water body causes a myriad of problems from increased turbidity to lower oxygen levels (see sidebar).

Table C.1-1. General stressors and potential major sources.

 Stressor Type	Stressors For a given stressor, the table indicates the potential for the given source to be a primary contributor as per the legend: ● = likely; ◉ = somewhat likely; ○ = not likely but possible; and X = very unlikely. The table also works when interpreted from a source perspective. For a given source, the table indicates the likelihood of a stressor being associated with it.	Sources															
		Point Sources					Non-point Sources										
		A. Industrial Sites	B. Waste Management Sites	C. Contaminated Sites	D. Sewage Discharges	E. Other Businesses	F. Illicit Discharges/Spills%	G. Urban and Residential Land*	H. Transportation Infrastructure*	I. Agricultural / Cultivated Land*	J. On-site Disposal Systems %	K. Contaminated Sediments	L. Atmospheric Deposition (wind transport)	M. Soil Erosion	N. Other Human Activities%	O. Animal Sources (Non-agricultural)	P. Natural Occurrences & Disturbances
Chemical	I. Nutrients (N, P)	◉	◉	○	●	◉	◉	●	○	●	●	○	●	●	●	●	●
	II. Inorganic Compounds	◉	◉	●	●	◉	◉	◉	◉	◉	●	◉	○	○	◉	X	○
	III. Heavy Metals	◉	◉	●	◉	◉	◉	●	●	◉	○	●	◉	○	◉	X	○
	IV. Organic Compounds	◉	◉	●	◉	◉	◉	●	◉	●	○	●	○	○	◉	X	◉
	V. Oxygen Demand	○	●	◉	●	◉	◉	◉	◉	●	●	◉	○	○	○	◉	◉
	VI. pH	◉	◉	◉	◉	◉	◉	○	○	○	○	◉	○	X	○	X	○
	VII. Dissolved Solids	◉	●	◉	●	◉	◉	◉	◉	◉	◉	○	○	◉	○	X	◉
Physical	VIII. Suspended Solids / Sediment	○	◉	○	◉	◉	◉	●	●	●	●	X	◉	●	◉	X	◉
	IX. Debris	○	●	X	◉	◉	◉	●	◉	○	○	X	◉	X	◉	X	◉
	X. Temperature	●	○	○	●	◉	◉	●	◉	◉	◉	X	X	2	1	X	○
	XI. Hydrologic / Hydraulic Characteristics	○	○	X	○	○	○	●	●	●	○	X	X	◉	●	X	◉
	XII. Natural Feature / Habitat Degradation	○	○	○	◉	◉	◉	●	●	●	○	◉	○	●	◉	◉	X
Bio-logical	XIII. Invasive Species	○	X	X	X	○	X	X	X	◉	X	X	○	X	◉	◉	○
	XIV. Pathogens	○	●	○	●	◉	◉	◉	○	●	●	X	X	○	○	●	◉
Radio-logical	XV. Radiation	○	○	◉	X	○	○	○	○	X	X	○	○	X	◉	X	◉

* Includes associated land, infrastructure and activities (and stormwater runoff).

% There are limited circumstances where a source in this category could be considered a point source.

1 Other human activities such as channel widening (which leads to shallow waters) – Stressor XI – or removal of riparian shading – Stressor XII – can subsequently be the source of elevated temperature

2 Soil erosion is the source of suspended solids / sediment in water which can subsequently be the source of elevated temperature (due to increased absorption of heat by the more turbid water)

A Note on Impacts

In this chapter, environmental impacts are discussed along with the stressors that lead to them. However, multiple stressors may have similar impacts and some may act in concert to produce other impacts. While not related generally to water stressors (although the stressors may come from the same sources, e.g. automobiles), climate change is a consequence of human activity and the multiple stressors it produces (not necessarily those presented in the above table) and is of note due to the changes in weather patterns (temperature and precipitation) that it will engender.

Nitrogen in aquatic systems generally occurs in the forms of ammonia (NH_3), nitrites (NO_2^-), and nitrates (NO_3^-). Nitrogen gas (N_2) is fixated into proteins primarily by microbes associated with plants. When plants are consumed or decay, NH_3 is released or excreted. While plants can use NH_3 directly, nitrifying bacteria tend to oxidize most of it into NO_2^- and subsequently into NO_3^- (which is also used by plants). N_2 is returned to the atmosphere, and the cycle is completed, by denitrifying bacteria in anaerobic conditions that generate it from NO_3^-. Lightning will transform N_2 directly into NO_3^-. Although nitrates are a concern with respect to eutrophication, excessive levels of any of these compounds can be toxic to animals.

II. Inorganic Compounds

An inorganic compound is a chemical compound that does not contain hydrocarbon groups (hydrogen bonded to carbon), although cyanide salts, carbon oxides, and carbonates are also considered inorganic. Metals are addressed as a separate stressor in this plan (metalloids are included here). Inorganic compounds are common elements of many household products. Those of environmental concern include cyanides, chlorine compounds, sulfur compounds, arsenic (odorless and tasteless), and silicates such as asbestos. Certain compounds are essential to life in trace amounts but toxic in large quantities. While some compounds of concern occur in nature in quantities that may be problematic (e.g. cyanides produced by plants), most environmental contamination is the result of synthetic compounds and/or concentrated discharges – e.g. pesticides, treated lumber, use of compounds for disinfection (Wikipedia, 2007). Examples of naturally occurring inorganic compounds include: chlorine as an ionic component of salt, sulfur in the form of sulfide or sulfate, natural deposits of arsenic.

An emerging concern is the presence of antibiotics in surface waters. Antibiotics are primarily man-made and are designed to kill or inhibit bacteria. Through over-use (in humans and in livestock), they have found their way into water environments where they are causing normally susceptible bacteria to become immune to their effect. This has lessened the medical effectiveness of antibiotics and has the potential to negatively affect human health.

III. Heavy Metals

Metals occur naturally in the environment and can be released through natural processes (e.g. mercury is released through the weathering of the Earth's crust), but human activities (such as industrial processes and mining) can dramatically alter their concentration and distribution. Metals are also common components of many household and commercial products. For example, mercury is used in bactericides, insecticides, and fungicides; lead is used in batteries and pigments; cadmium is used in plating and plastics; copper is an essential component of consumer electronics; and zinc is used to galvanize steel, as a wood preservative, and as a rodenticide (WG, 2007).

Some metals such as mercury, lead, and cadmium exhibit toxicity at very low concentrations while other metals like zinc and copper are problematic at higher concentrations. Metals bind to sediment, aiding in their transport and persistence in the environment. Heavy metals are known to be present in many sediment contamination sites.

Impacts of Inorganic Compounds

Because the range of compounds that are classified as inorganic is broad, so are the impacts associated with these compounds.

Cyanides are highly toxic and can cause nerve damage or thyroid problems.

Certain chlorine compounds are powerful oxidizers that can disrupt processes in the natural environment.

Atmospheric sulfur oxides (and nitrogen oxides, both by-products of combustion) react with atmospheric water to form acids (e.g. sulfuric acid), that are essential components of acid rain (see 'pH' stressor).

Arsenic is toxic to all organisms generally through energy production cycle disruption. Parts of Michigan are known to have significant concentrations due to natural deposits of arsenic in the soil.

Widespread overuse of anti-biotics has lead to the evolution of antibiotic resistant bacteria.

Impacts of Heavy Metals

When metals are released into the environment in higher than natural concentrations they can be highly toxic and cause major disruptions of biological processes and eventually cause population declines due to both acute and chronic impacts (Scorecard, 2007)..

Impacts of concern for humans include contamination of drinking water sources and accumulation in fish and other organisms that are used for food.

IV. Organic Compounds

An organic compound is chemical compound that contains hydrogen bonded to carbon. Many hydrocarbons are synthetic and often persist and accumulate in the environment because they do not readily break down. Some organic contaminants identified in the Clinton River Watershed include organochlorines (OCs); specifically polychlorinated biphenyls (PCBs), and polynuclear aromatic hydrocarbons (PAHs).

Because they have very low water solubilities, most of the OCs occurring in water will adhere to sediments and suspended silts. Many pesticides are organochlorines, including DDT, DDE, atrazine, acetochlor, cyanizine, metolachlor, alachlor, malthion, diazinon, chlordane, and carbofuran.

PCBs are a class of organochlorines comprised of more than 200 individual compounds (with varying levels of toxicity) that were once used in many industrial and commercial applications. The use of PCBs has been banned since the 1970s, but due to their stable structure, they are still present in the environment and are readily bioaccumulated. Eating contaminated fish is a major source of PCB exposure for humans.

PAHs are found in asphalt, fuels, oils, and greases. They are based on the benzene ring structure and exhibit low water solubility and tend to be bound to particles whether in the air (bound to dust) or in the water (bound to sediment).

This stressor classification does not include biomass (e.g. decaying leaves, plants). This is addressed through a number of stressors (e.g. oxygen demand, dissolved solids, suspended solids, and debris).

Impacts of Organic Compounds

Many organic compounds are known or suspected toxins and carcinogens that disrupt the reproduction of aquatic organisms and accumulate in their fatty tissues.

Organochlorines are extremely toxic compounds to most organisms and tend to bioaccumulate.

According to the Environmental Protection Agency (EPA), PCBs are known to cause cancer in animals, cause problems in human immune, reproductive, nervous and endocrine systems and affect intellectual development of children and adults (EPA, 2006).

Exposure to polynuclear aromatic hydrocarbons can cause impacts to biota such as difficulty reproducing, birth defects, stunted growth, tumors, and vulnerability to disease.

V. Oxygen Demand

Dissolved Oxygen (DO) is the amount of oxygen that is available in the water for plants and animals. Sufficient oxygen levels are a basic requirement for a healthy ecosystem. During periods of sunlight, plants photosynthesize and give off oxygen, raising DO levels. During periods when sunlight is not available (e.g. during night or when snow and ice cover is present) plants respire, consuming oxygen and depleting the amount of dissolved oxygen.

Most fish and aquatic insects "breathe" oxygen dissolved in the water column. Some fish and aquatic organisms (such as carp and sludge worms) are adapted to low oxygen conditions while others require high levels of oxygen and cannot survive prolonged low dissolved oxygen conditions.

Oxygen concentrations in the water column fluctuate under natural conditions, but severe depletion usually results from human activities that introduce large quantities of biodegradable organic materials into surface waters. In polluted waters, bacterial degradation of organic materials can result in a net decline in oxygen concentrations in the water. These reactions create what is measured in the laboratory as the biochemical oxygen demand (BOD). Oxygen depletion can also result from chemical reactions that place a chemical oxygen demand (COD) on receiving waters. Other factors (such as temperature and salinity) influence the amount of oxygen dissolved in water. Prolonged hot weather will depress oxygen concentrations and may cause fish kills even in clean waters because warm water cannot hold as much oxygen as cold water (Scorecard, 2007). Additionally, decay of deposited organic sediments can also negatively affect in-stream dissolved oxygen concentrations. This is known as sediment oxygen demand (SOD).

Impacts of Oxygen Demand

Most desirable fish species (such as trout and salmon) suffer if dissolved oxygen concentrations fall below 3 to 4 mg/L. Larvae and juvenile fish are more sensitive and require even higher concentrations of dissolved oxygen.

Prolonged episodes of depressed dissolved oxygen concentrations of 2 mg/L or less can result in "dead" waterbodies.

Impacts of pH

Acidic (< 6.5) or alkaline (> 8) water can adversely affect birds, fish, and other aquatic organisms by interfering with biological processes (e.g. reproduction) – (Scorecard, 2007).. Acidic conditions also aggravate toxic contamination problems because sediments release toxicants in acidic waters.

Impacts of Dissolved Solids

When large amounts of salt enter waterbodies they 'shock' the system with extremely elevated sodium chloride levels. This can negatively impact both macroinvertebrates and coldwater fish species, as they must attempt to seek refuge in deeper pools, ponds, and lakes.

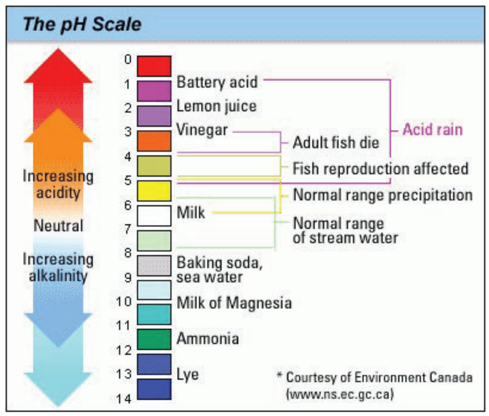
On an aesthetic basis, elevated dissolved solids can cause "mineral tastes" in drinking water. Corrosion or encrustation of metallic surfaces by waters high in dissolved solids causes problems with industrial equipment and boilers as well as domestic plumbing. Indirect effects of excess dissolved solids are primarily the elimination of desirable food plants and habitat-forming plant species, specifically those in wetlands. Agricultural uses of water for livestock operations are limited by excessive dissolved solids. Moreover, high levels of dissolved solids can be a problem in water used for irrigation. At extreme levels, dissolved solids, including chlorides such as salt can render water undrinkable, unusable for agricultural purposes, or incapable of supporting aquatic life (WG, 2007).

VI. pH

pH is the standard measure of the concentration of hydrogen ions. A pH value of 7 represents a neutral condition. A low pH value (less than 5) indicates acidic conditions; a high pH (greater than 9) indicates alkaline conditions.

Acid or alkaline conditions can be induced by the introduction of substances with non-neutral pH values into the water column or through the introduction of substances which will react in the natural environment to alter pH values.

Additionally, pH values will fluctuate with the amount of carbon dioxide in the water, which drops during photosynthesis (pH rises), and rises with plant respiration and organic matter decay (pH falls).



Source, graphic: (EC, 2008).

VII. Dissolved Solids

Dissolved solids are those contained in a liquid (i.e. water) which are present in a molecular, ionized or micro-granular suspended form (smaller than a defined cutoff, typically between 2 and 4.5 micrometers). The most common chemical constituents are inorganic salts of calcium, sodium, potassium, and magnesium with bicarbonate or chloride. For example, in water, sodium chloride (NaCl) will dissolve into its component molecules, each with a charge (Na^+ and Cl^-).

An important separate class of dissolved solids is dissolved organic matter / carbon (DOC). Tannins (a by-product of plant decay) belong to this class of dissolved solids that impart a color to the water. In addition to biomass decay, organic dissolved solids may enter waterbodies directly through organic soils. Most DOC is natural in origin and it is rare for elevated DOC levels to be indicative of human related problems.

Impacts of Dissolved Solids: Dissolved Organic Carbon

The coloration associated with dissolved organic carbon (DOC) results in decreased light penetration and impacts photosynthesis and related processes in the same way as elevated suspended solids (i.e. it reduces photosynthesis and, in turn, plant growth and oxygen production).

DOC is also extremely important in the transport of metals in aquatic systems. Metals form extremely strong complexes with DOC, enhancing metal solubility while also reducing metal bioavailability

Certain components of DOC are a source of energy for microorganisms and play an important role in their growth rates (Wikipedia, 2008).

Physical Stressors

These are the physical characteristics of the natural environment that when altered may result in impacts to biota or desired human activities.

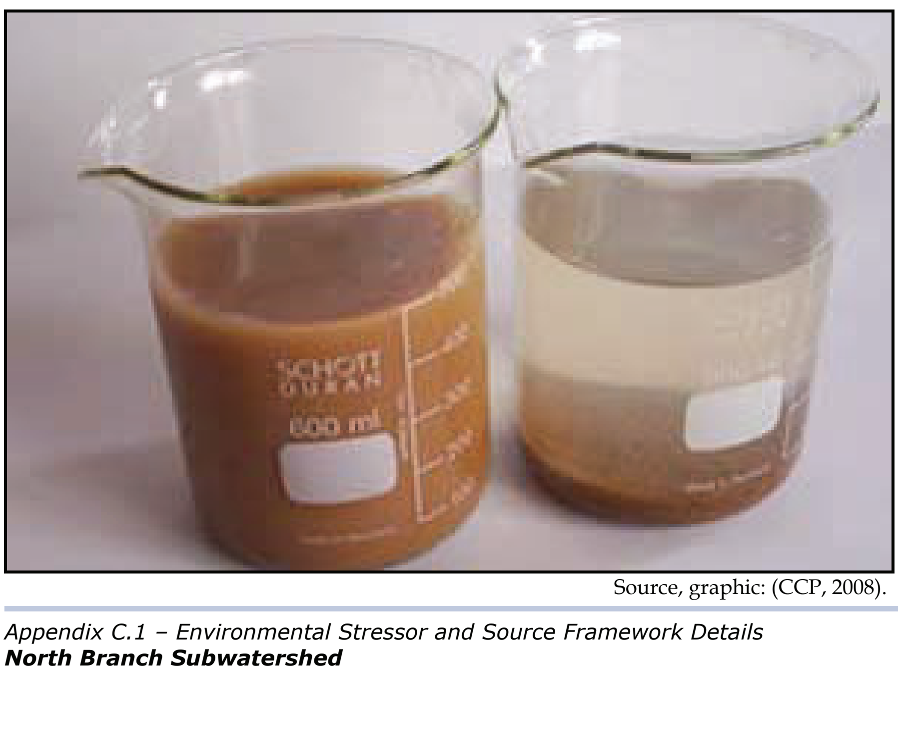
VIII. Suspended Solids / Sediment

Inorganic fine sediments are naturally present to some extent in all streams due to natural soil erosion on the land and in the stream channel. However, in the last half century, excessive sediment of anthropogenic origin has caused enormous damage to streams throughout North America. As such it has been labeled the most important single pollutant in U.S. streams and rivers. Many other stressors may bond to sediment particles meaning that a problem with sediment is often coupled with an additional problem (but this also makes dealing with the problems easier as the two problems can often be addressed by simply addressing the sediment problem) (Waters, 1995).

Sediment transported by moving water is described as either "suspended load" or "bedload." The suspended load is the fraction of sediment that is mixed intimately with the flowing water and tends to make the water appear turbid or muddy. Suspended solids settle through the water based on their own density; however, solids are often sporadically and repeatedly caught in local turbulent eddies and remain suspended. The bedload is comprised of larger particles that are too heavy to be suspended that are pushed along near the streambed. The bedload is essential to the erosive processes in a stream and helps maintain in-stream pool and riffle habitat. Some substrate movement is beneficial because it allows fine sediment to be flushed downstream out of the spaces between larger particles (Leopold, 1994). See Chapter 2 for additional information.

Sedimentation is the settling and deposition of sediment. Sedimentation occurs in the areas where the current is slower; (e.g. in floodplains, where the water is deeper, where tributaries enter a lake, behind dams, and in areas where the shape of the shoreline results in slower water flow). These areas also tend to be critical for fish habitat and spawning.

Refer to Appendix B.4 for an in-depth discussion of sediment transport and sedimentation.



Source, graphic: (CCP, 2008).

Impacts of Suspended Solids / Sediment

Suspended sediment, through turbidity, reduces light penetration through the water thus reducing photosynthesis. Suspended particles cause fish and other aquatic plants and animals to starve (by reducing the ability to see prey) or suffocate by adhering to gills and lodging in feeding or breathing organs. Fish tend to avoid streams or stream reaches with high suspended sediment levels creating environments just as devoid of fish as if they had been killed (and thus degrades fisheries). Suspended silt can also interfere with recreational activeties and aesthetic enjoyment by reducing water clarity.

Sediment fills in voids created by woody debris, rocks, and gravel, (i.e. it increases the embeddedness of the stream bed and reduces oxygen transfer to the sediment) and also fills in the deeper 'pool' habitat in the streams. This decreases invertebrate populations, reduces the food available to fish, and destroys habitat and cover for young fish and other aquatic species, leaving them vulnerable to predators (USACE, 2004). Extreme sedimentation can impact the navigability of waterbodies.

It was the sedimentation of contaminated particles in the past that is responsible for the contaminated sediment problems we experience today. Additionally, extreme sedimentation can clog storm drains or other drainage infrastructure. Also, sedimentation can impact recreational areas and damage public water supplies and cause taste/odor problems (USACE, 2004).

Impacts of Debris
This may be excessive trash in a waterbody that causes aesthetic problems, degrades habitat quality, or directly kills wildlife (e.g. entanglement), or increased logjam frequency and size (due to hydrologic changes) that restrict navigation / recreation.

Impacts of Temperature
As the temperature of water increases, the level of dissolved oxygen in the water decreases. Water with less oxygen is less habitable for aquatic life including fish and amphibians. Compounding this is the fact that increased temperatures reduce the permeability of cells to oxygen (making it harder to absorb by organisms) and increase the metabolic rate of aquatic plants and animals. Primary producers are affected by thermal pollution because higher water temperature increases plant growth rates and photosynthesis, resulting in a shorter lifespan and species over-population (and decomposing plants deplete oxygen). Algae blooms may occur and further reduce the oxygen levels during peak respiration hours (i.e. night) - (Wikipedia, 2008). For animals, the increased metabolic rate means that these organisms will consume more food and oxygen in a shorter time. Generally, elevated temperatures also make organisms more susceptible to disease. At its extreme, elevated temperature (and extremely cold temperatures for that matter) becomes directly lethal to organisms through tissue damage. The compound effect of these problems will be to decrease localized organism populations due to decreased vitality and migration and to decrease biodiversity due to food chain alterations. Large-scale temperature changes also affect regional migration patterns.

IX. Debris

Debris refers to large items in a waterbody. In general, debris refers to trash, litter, and other items from human activities (e.g. shopping carts, BBQ grills) but it also refers to natural items such as tree branches and logs – a certain amount of which are required to maintain healthy, natural habitats.

In the context of this plan, debris as a stressor can refer to any of these items that are present to such an extent that impacts are manifested.

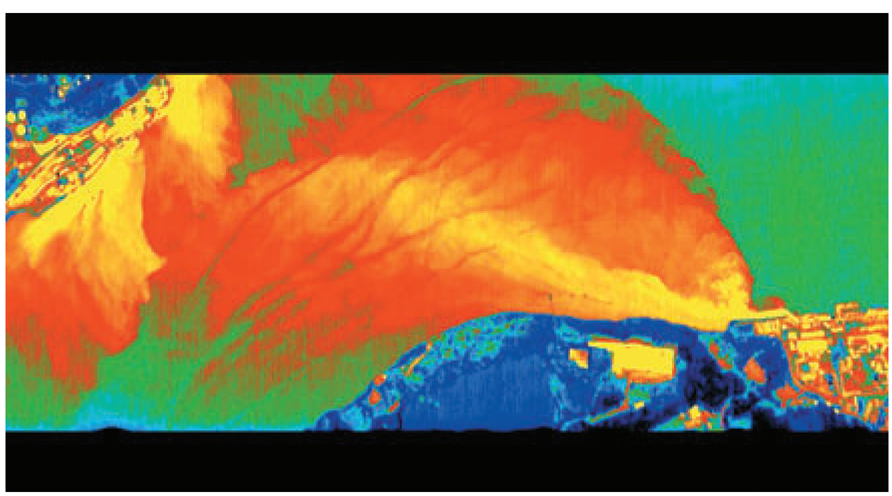
Source, graphic: (FC, 2008).

X. Temperature

Most organisms are adapted to live within a certain temperature range. This is especially true of aquatic organisms. Even small deviations in waterbody temperatures can have dramatic impacts on the natural community.

Temperature is a relative measure of energy and the hotter something is, the more energy it has stored. In nature, the sun is the primary energy source that imparts thermal energy to waterbodies. Waterbodies with abundant shade, those fed by groundwater, and those portions that are deeper tend to be cooler than those that are shallow and unshaded. Due to numerous natural circumstances, certain waterbodies will be significantly warmer than others.

Dams have the potential to alter temperature profiles in waterbodies.



Source, graphic: (SS, 2008).

XI. Hydrologic / Hydraulic Characteristics

A discussion of hydrologic and hydraulic characteristics could encompass myriad possible considerations about how water moves in the natural environment. In terms of stressors appropriate for this plan, the discussion is focused on channel flows and water levels.

Channel Flows

As discussed in Chapter 2, stream flows vary in characteristic ways over time frames ranging from hours and days to seasons and years. The flow regime of a stream reflects the operation of the hydrologic cycle within its watershed and is influenced by such factors as climate, topography, geology, soils, vegetation, wetland health, floodplain connectivity, watershed size and shape, stream pattern, land use, water use, and modifications (e.g. dams). Many of these are a function of natural feature and habitat health (see discussion under the following stressor).

Altered stream flow is not a stressor in the terms of heavy metals or organic compounds, but does affect biota and stability of streams.

The problematic conditions associated with stream flow include increased discharge volumes, increased peak discharges, longer peak discharge durations, shorter response times (with respect to rainfall) between base flow rates and peak flow rates, increased frequency of bankfull or peak discharges, and reduced base discharges (especially during the dry season). The manifestation of these conditions is often described as increased 'flashiness' of the waterbody.

Channel flow changes typically result either from hydrologic changes (e.g. land use) and storm sewer infrastructure that affect how water gets to the channels or hydraulic changes (e.g. dams) that affect how water moves in the channels. For example, straightened channels and those with modified banks have greater flow capacities and enclosed streams or culverts can restrict flows. These types of changes also affect the water levels in the channels (addressed under the following 'Water Levels' discussion). Many open-channel waterways in Michigan are 'county drains' that are typically altered and maintained by drain commissioners to provide maximum channel capacity. The coupling of imperviousness and storm sewers also increases the amount of chemical and physical stressors that reach water-bodies by removing natural barriers to and filters of the flow of water.

Water Levels

Water level fluctuations are important to maintaining healthy natural habitat (i.e. floodplain ecosystems, wetlands, and near shore areas in lakes) in that they help create greater diversity among plants and animals that adapt to, and depend on, a changing environment (USACE, 2004) High, stable water levels benefit fish by providing spawning and nursery areas, whereas low conditions rejuvenate stands of wetland plants and benefit wetland fauna (USACE, 2004).

Modified flow characteristics, coupled with modified channels or obstructions, may alter the regime of these fluctuations by reducing base water levels and/or increasing the magnitude / frequency of high water levels or flooding. Flood control measures may reduce flooding in one location but cause increased flooding elsewhere or lead to water quality problems.

As noted above, water level fluctuations are important to inland lakes. However, for some lakes, normal levels are legally set (when appropriate for flood control, recreational enhancement, and /or property protection) and enforced by drain commissioners under Public Act 59 of 1995.

Impacts of Hydrologic / Hydraulic Characteristics

Increased flashiness (i.e. peak velocities and associated shear forces) may literally 'flush' benthic macroinvertebrates, fish, amphibians and vegetation downstream. It may also make the stream less habitable during low flow conditions due to lost physical habitat or modified water characteristics, including increased temperatures (and lower dissolved oxygen concentrations) and higher relative concentrations of chemical stressors (e.g. phosphorus, heavy metals, dissolved solids) – (Scorecard, 2007).

Increased flashiness may also disrupt the equilibrium of channel forming forces, causing a complex chain of events in which: 1) stream bank and down-cutting erosion is increased; 2) sediment load in the water rises; 3) more extensive sedimentation occurs along the stream bottom and where new banks are forming; and 4) the channel actively changes size & configuration – in some places becoming wider and shallower which increase the potential for flooding and temperature regime modifications (GLC, 2006).

Particularly in lakes, small changes in water depth can drastically change the surface area of the lake available for submersed aquatic plant communities – vital habitat for fish and migrating waterfowl (LSCCSR, 2000).

Increased flood levels and frequency of floods, with many impacts such as property damage can result from hydrologic / hydraulic changes (see discussion in text).

Increased runoff may also lower groundwater levels by reducing infiltration.

Impacts of Natural Feature and Habitat Degradation

Short of outright destruction, fragmentation of terrestrial habitat (e.g. roads, agricultural fields) results in myriad negative effects. The size and shape of fragments, the distance and type of barriers by which they are separated, and the existence of connections or corridors between them can all affect the value of habitat fragments (GLC, 2006). Animal collissions with buildings, automobiles, and towers become common when habitat is fragmented.

Modification of transition zones leads to the loss of woody debris that provides physical habitat and substrate for decomposers, less gradually sloping shores that do not absorb wave energy as efficiently, and form a barrier to the migration of organisms that leads to reduced genetic diversity.

In aquatic habitats, fragmentation can be an issue as enclosed reaches of waterways (e.g. culverts) or dams often prevent passage of fish and other organisms. More of an issue, however, is the impact that physical (e.g. sediment) and chemical (e.g. dissolved oxygen) pollutants / conditions have on the water's and substrate's ability to support life.

The resultant impact of 'Natural Feature and Habitat Degradation' as a stressor is to degrade ecosystem function and habitat quality through lower species diversity and abudance and reduced genetic diveristy within communities. Ultimately, extreme habitat degradation can lead to species becoming endangered, extirpated, and potentially extinct if the degradation is severe and widespread.

Additionally, humans are affected directly by the loss of services that many natural features provide (e.g. flood control, water supply).

XII. Natural Feature and Habitat Degradation

Of all the stressors related to land development the most direct is the destruction of complex functioning natural communities (characterized by healthy populations and high biodiversity) and their replacement with ecologically barren landscapes (e.g. parking lots, buildings, lawns). Healthy natural features and habitat provide a multitude of services for both humans and wildlife, including erosion control, sediment retention, soil formation, nutrient cycling, waste treatment, pollination, food supply, groundwater recharge, water supply, and water regulation. See Chapter 2 for a discussion of the natural environment.

The transition zones between land and water, riparian zones and wetlands, are extremely important for the reasons discussed in Chapter 2, which are summarized in the services listed above. In addition to protecting the quality of aquatic habitats, these natural features are important habitat in their own right and are too often destroyed when wetlands, shoreline areas, or streambank lands are developed.

In addition to the numerous impacts of natural feature and habitat degradation discussed in the sidebar, the impacts of other stressors with respect to natural feature and habitat degradation are also important. The impacts associated with the following stressors are discussed in detail elsewhere in the chapter, but how they contribute to the 'Natural Feature and Habitat Degradation' stressor is briefly presented here:

- Sediment – When suspended in the water, sediment interferes with the gill function of fish thus making the habitat less desirable for high quality species. It reduces light penetration, which impacts macrophyte productivity. When sediment becomes embedded in the substrate of waterbodies, it reduces its ability to support macroinvertebrates and hinders the reproductive cycles of fish.
- Oxygen Demand – Oxygen demanding substances in the water column and sediment reduce the DO levels thus making the habitat less desirable for high quality species.
- Hydrologic / Hydraulic Characteristics – In addition to resulting in increased sediment load (vis-à-vis soil erosion), increased peak flow rates have the ability to 'wash out' benthic or fish communities. Low flow conditions reduce the amount of physical habitat that is available and exacerbate the effects of oxygen demanding substances and the likelihood that phosphorus levels will reach levels to cause algal blooms and further reduce dissolved oxygen levels. These conditions will manifest primarily due to increased imperviousness and tiled crop land. Additionally, exacerbated erosion and sedimentation will often first impact the most sensitive formations such as pool and riffle habitat (GLC, 2006).
- Temperature and pH – Thermal and acidic / alkaline stressors alter the temperature and pH conditions of the water column, making it less suitable habitat for many species.

Other stressors also contribute to natural feature and habitat degradation.

Degradation of natural features such as animal and fish populations can also be due to very direct means such as over-hunting and over-fishing.

Even in urban areas, natural features are important as the lack of tree canopy or vegetative cover leads to the urban heat island effect. The unnatural habitats that result (e.g. turf grass) can attract nuisance wildlife populations such as geese (which are a source of pathogens).

Biological Stressors

These are the living components of the natural environment that can cause problems for other living components, including humans.

XIII. Invasive Species

When non-native species (those encountered beyond their known historical natural ranges) are introduced into an environment in which they did not evolve, there often is no natural predator available to control their population. Due to this lack of a natural control, they tend to displace and diminish native species. Invasive non-native organisms are one of the greatest threats to the natural ecosystems of the U.S., the Great Lakes, and the Clinton River Watershed.

These species are typically transported from other parts of the world (including other parts of the U.S. and other parts of the state, where the invasive species is already present), intentionally and unintentionally (sometimes knowing and sometimes not) and disrupt the ecology of natural ecosystems, displacing native plant and animal species. Ballast water of ships is a common way that aquatic organisms are transported over long distances. Some exotics may simply be released into the wild.

For example, certain invasive submergent plants grow in dense stands, out competing native species, interfering with recreation, and reducing habitat for aquatic organisms (Francis, 2006). Invasive animals stress fisheries, or, in some cases, change the character and quality of the water itself.

XIV. Pathogens

Pathogens are disease-causing microorganisms that include bacteria, protozoans, and viruses. Their potential for infection relates to numerous factors, including: temperature, sunlight, moisture, and soil /sediment conditions (EPA, 2001). Some pathogens occur naturally in waterbodies, but others are introduced through sewage discharges, discharge of contaminated rain water, or leaking household septic systems. Water-borne pathogens pose a serious public health risk and have historically caused everything from cholera outbreaks to beach closings.

Radiological Stressors

This category includes only radiation, a form of energy that can impact natural biota or humans.

XV. Radiation

Radiation is energy that travels in the form of waves or high speed particles and has enough energy to break chemical bonds in molecules or remove tightly bound electrons from atoms, thus creating charged molecules or atoms (ions) – thus the term 'ionizing radiation'. In the natural environment, many elements may exist in radioactive forms, such as cesium, uranium, thallium, strontium, and radium.

Most drinking water sources have very low levels of radioactive contaminants, which are not considered to be a public health concern.

Of the small percentage of drinking water systems with radioactive contaminant levels high enough to be of concern, most of the radioactivity is naturally occurring (EPA, 2007).

Impacts of Invasive Species

Aggressive invaders reduce the amount of light, water, nutrients and space available to native species, alter hydrological patterns, soil chemistry, moisture-holding capacity, and erodability, and change fire regimes (Randall, 1996). Some contain toxins that are lethal to native organisms. Some are capable of hybridizing with native organisms, resulting in unnatural changes to genetic makeup; others have been found to harbor pathogens (McElrone, 1999).

With no natural enemies, these species act in an invasive manner and displace native species, spread disease, and alter eco-system dynamics (GLC, 2006).

Impacts of Pathogens

The presence of pathogens in water has the potential to negatively affect public health and can impair recreational and drinking water uses (in addition to increasing treatment costs). Primary (i.e. ingestion) and secondary contact with water contaminated by pathogens presents an elevated risk for gastrointestinal, respiratory, eye, ear, nose, throat, and skin diseases. These concerns lead to beach closings and suspension of other recreational activities, which impact the local economy. Additional concerns relate to contamination of crops from irrigation water and non-human outbreaks in aquatic and wildlife populations.

Impacts of Radiation

The major concern with ingesting radioactive substances at the level they occur in drinking water is an increased risk of cancer.

Secondary Source Classification Scheme

This classification scheme is not used extensively throughout the plan, but is useful in terms of understanding the sources.

Land Use Related
Industrial Discharges (Sites)
Waste Management Sites
Other Businesses
Urban / Residential Land
Transportation Infrastructure
Agricultural / Cultivated Land
Animal Sources

Mechanism Related
Industrial Discharges (Sites)
Waste Management Sites
Contaminated Sites*
Sewage Discharges
Other Businesses
Illicit Discharges / Spills
On-site Disposal Systems
Contaminated Sediments*
Atmospheric Deposition
Soil Erosion
Other Human Activities
Animal Sources
Natural Occurrences

* These sources deal with existing (legacy) environmental contamination.

Other Considerations

Additional groupings of sources may be required to facilitate prioritization, load calculations, management efforts, geographic location, or other assessment considerations. These groupings are utilized as appropriate in the data assessment chapter (Chapter 5) and the prioritization chapter (Chapter 7).

Sources

As indicated in Table C.1-1, the stressors can be introduced through a wide variety of sources. The sources are discussed in this section. The source framework divides the sources into two main categories as discussed at the beginning of the chapter:

- Point sources – from an easily identifiable location, and
- Non-point sources – from an undistinguishable, hidden, or expansive area.

The sources can further be grouped in a number of ways. An additional way to group the stressors that is useful to the planning process in terms of land use-based versus mechanism-based. This classification scheme is discussed in the sidebar.

Additionally, the sources are invariably linked to their causes (and in some cases, the sources and causes are difficult to distinguish or separate). It is difficult to discuss the sources without at least alluding to the causes behind them. Therefore, this section will contain some discussion of causes, although the bulk of discussion of the causes is reserved for that particular section of this chapter. **(5.7)**

As with other elements of the stressor and source framework, there is uncertainty as to exactly what constitutes a point source or a non-point source. Some sources are easily classified. For example, the effluent from a WWTP is a point source. The stormwater runoff the WWTP could also be classified as a point source (because it has a separate permit associated with it) but what about the stormwater runoff from a landscaping business. If the business is considered singularly, it could be considered either. Landscaping businesses collectively could be either a non-point source or a collection of point sources (particularly if one was able to determine the location of all the landscaping businesses). Generally speaking, whether a source is a point source or a non-point source is best done on a case-by-case basis, but the remainder of this section discusses various point and non-point sources as classified generically.

It is worthwhile to note that although municipal separate storm sewer systems (MS4s) are regulated, require a discharge permit, and have distinct outfalls where pollutants are discharged (although unknown in nature and quantity), they are included under the discussion of urban and residential land as a non-point source because the actual sources of stressors in the urban environment are typically not precisely known and/or quantified.

Point Sources

Point sources are generally those discharges that come from pipes, outfalls, and conveyance channels. These types of point sources are generally required to have a permit through the National Pollutant Discharge Elimination System (NPDES). The definition of point sources for this plan is broader and includes contaminated sites and businesses handling hazardous materials even if there are no permitted or otherwise known discharges.

(cont'd)

A. Industrial Sites

Industrial sites are the classic example of a point source. The initial wave of environmental degradation in the United States (throughout the early 1900's) occurred primarily due to unregulated discharges from factories and other sites. This early environmental degradation was met with strict regulatory policies in the 1960s and 1970s and resulted in the regulation of these and other point sources. Today, there are hundreds of facilities that categorically require permits to discharge into waterbodies (and many of these facilities have elected to discharge into sanitary sewers and provide for pre-treatment of wastes to make them compatible with WWTPs). These same facilities are also required to have a separate permit that covers any stormwater that will discharge from their site.

The Clean Water Act and its supporting regulations list a number of primary activities and standard industrial classifications that are required to have discharge permits. The regulated primary activities include:

- hazardous waste treatment, storage, or disposal facilities;
- landfills;
- recycling facilities (scrap yards, battery reclaimers, salvage yards, auto junkyards);
- steam electric power generating facilities;
- transportation activities; and,
- WWTPs.

The regulated standard industrial classifications include:

- mines, including;
    - metals;
    - coal;
    - oil/gas extraction; and
    - non-metallic ores;
- manufacturing;
    - (from food processing to clock-making; see sidebar for details);
- transportation; and
    - transportation activities;
    - railroad;
    - local and suburban transit and interurban highway;
    - motor freight transport and warehousing;
    - post office;
    - water transportation;
    - air transportation; and
- goods;
    - durable (e.g. used vehicle parts, scrap / waste); and
    - non-durable (e.g. petroleum bulk stations and terminals).

(EPA cont'd)

There are some additional facilities that are regulated but not listed above, such as: animal feeding operations, and asbestos, phosphate, batteries, and plastic manufacturing, among others. The facilities included in this source category all have numerous distinct sources and causes associated with them. As such, some on the list are included in more appropriate source categories presented later in the chapter. For example, hazardous waste treatment facilities, landfills, and recycling facilities are included under 'waste management facilities'; WWTPs are included under 'sewage discharges'; and transportation activities are included under the 'transportation infrastructure' source category. On a case-by-case basis, specific facilities may be appropriately included in this source category.

NPDES Regulated Manufacturing Facilities

The following manufacturing facilities are most of those that are specifically regulated under the NPDES:

- food processing;
- tobacco;
- textiles;
- apparel;
- lumber and wood;
- furniture and fixtures;
- paper and allied products;
- printing and publishing;
- chemicals and allied products;
- petroleum refining;
- rubber;
- leather and leather products;
- stone, clay, glass, and concrete;
- primary metal industries;
- fabricated metal products;
- industrial and commercial machinery and computer equipment;
- electronic and other electrical equipment and components;
- transportation equipment;
- measuring analyzing and controlling instruments;
- photographic;
- medical and optical goods;
- watches and clocks; and
- miscellaneous manufacturing.

Proximity to Waterbodies

In general, facilities and land uses that generate pollutants are more likely to contribute to water pollution if they are in close proximity to waterbodies. For example, open pit mines and sand/gravel extraction activities that are near waterbodies or actually physically alter the waterbodies themselves have a high likelihood of contributing pollutants to the water. Special cases exist for areas that are not near waterbodies if they are served by storm sewer systems or in groundwater recharge areas. These sources are generally harder to pinpoint.

Landfill Classifications

Landfills are generally classified into the following categories:

1. Dumps are disposal areas that are not engineered with any special protective measures. This was the historical practice of waste disposal and is generally not utilized today. However, ad hoc dumps may persist in rural, remote, and developing areas. Historical dumping sites can be significant sources of pollutants.
2. Inert waste landfills are waste disposal units that receive wastes which are chemically and physically stable and do not undergo decomposition, such as sand, bricks, concrete or gravel.
3. Sanitary, or 'Class D' landfills usually have physical barriers such as liners and leachate collection systems, and procedures to protect the public from exposure to the disposed wastes.
4. Hazardous waste, or 'Class C' landfills are waste disposal units constructed to be secure repositories for material that present a serious hazard to human health, such as extremely toxic substances. They are restricted, by permit or law, to the types of waste that they may handle. (Wikipedia, 2007)

B. Waste Management Sites

Waste management site is a general term to describe an active facility that handles or disposes of various types of waste. One common type, a landfill, is a site for the disposal of waste materials by burial. Landfills may be classified based on the waste type that is disposed within them as indicated in the sidebar.

Modern waste handling facilities are designed, constructed and regulated to prevent pollutants from leaving the site. Such measures include daily cover, wind fences, spill containment liners, leachate (the liquid produced when rain percolates through the waste) collection systems and treatment (or sewerage to WWTP), and stormwater control facilities designed to keep pollutants from entering groundwater or surface water (Wikipedia, 2007). However, despite these measures, landfills can potentially contaminate the environment through surface runoff or leachate seepage into groundwater. This is problematic as leachate is typically anoxic, acidic, and contains organic compounds, sulfates, ammonia, and dissolved and suspended materials (Wikipedia, 2007). Other environmental concerns at landfills include pathogenic vectors, odor, and trash.

Other facilities considered in this class of sources include:

- hazardous waste generators and transporters; and,
- waste transfer stations.

Unlicensed 'dumps' are considered 'contaminated sites'.

C. Contaminated Sites

Contaminated sites are typically inactive facilities that have historical contamination problems that are either impacting or could impact the natural environment. It is possible that these sites could be operating facilities, but they could then likely be classified under a different source category. There are countless reasons that a site may have become contaminated, including: abandonment (e.g. mines), historic dumping, improper industrial waste handling and disposal, and leaking storage facilities.

Contaminated sites are commonly inventoried under a number of programs and a considerable number of them may be associated with no known responsible party. Remediation activities at these sites are typically funded by federal and/or state agencies. It is common to classify a contaminated site based on the program or legislation that impacts it. Some classifications for contaminated sites include:

- the National Priorities List (for the EPA's Superfund program);
- brownfields - land previously used for industrial or commercial uses, and contaminated by low concentrations of hazardous waste or pollution
- Part 201 sites (referring the section of NREPA) where the MDEQ oversees investigations and cleanup of contaminants; and
- Leaking underground storage tanks (LUSTs).

At any of these known contamination sites and at other numerous unknown sites, various stressors have the potential to directly impact the environment and be transported through various media to cause impacts in other locations

Many of these sites have the potential to be reused once the waste is cleaned up (Wikipedia, 2007). **(EPA cont'd)**

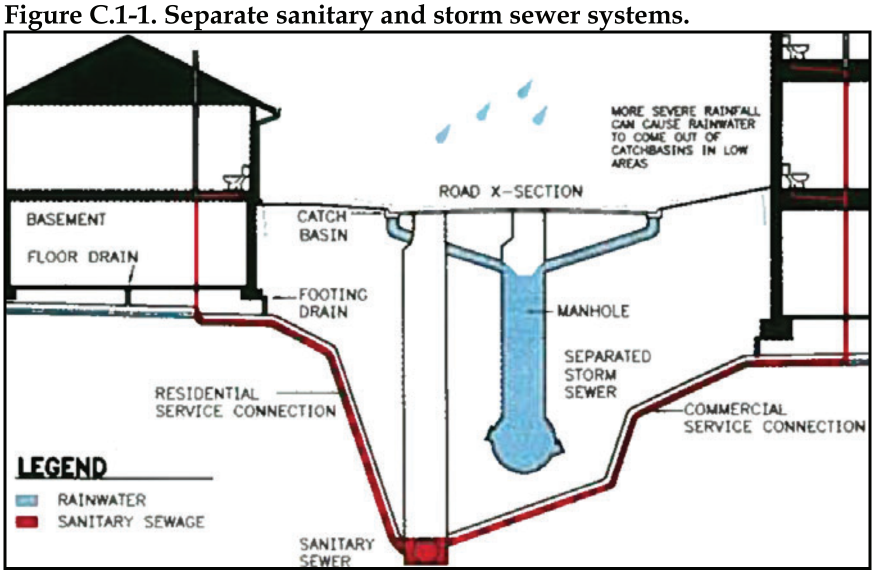
D. Sewage Discharges

Waste Water Treatment Plants (WWTPs) use a series of processes to remove pollutants (e.g. pathogens, suspended solids, nutrients, oxygen demand) from water that has been used in homes, small businesses, industries, and other facilities. Because municipal wastewater includes treated industrial waste and household chemicals, sewage may also contain low levels of metals, inorganic and organic pollutants (USACE, 2004).

Municipal governments are required to obtain permits for discharging effluent from WWTPs. However, even when in compliance with regulations, these sources can be problematic due to seasonal variations in stream flow. These facilities may contribute a substantial load because they discharge a large volume of treated wastewater on a constant basis. Large volumes of low pollution concentrations have the potential to significantly impact the ecosystem when discharged over long periods (USACE, 2004).

Not only are the WWTPs themselves sources of stressors, but so are the sewers that deliver the waste water to the WWTPs (see Figure C.1-1).

Figure C.1-1. Separate sanitary and storm sewer systems.



Graphic Courtesy of Tetra Tech

These sewers rely on gravity flow and in some cases pumped flow. Ideally, if they are properly designed and constructed, only sewage enters the system and all of this sewage is transported to the WWTP for treatment.

Unfortunately there are many problems that can occur and negatively impact the delivery system. A primary concern is stormwater entering the sanitary sewers and overloading the capacity of the system and WWTP. These problems are exacerbated over time as the system ages and new users are added. Other problems are presented in the sidebar.

Such occurrences are referred to as sanitary sewer overflows (SSOs) and are prohibited by state and federal law and subject to enforcement actions to correct them when discovered. The MDEQ have been working for over 25 years with municipalities to identify and correct SSO. However, neither the numbers of communities that have overflow problems nor the frequency and duration of these overflows are well known. **(EPA cont'd)**

Combined Sewers and Overflows

A combined sewer system refers to a sewer system that jointly conveys sanitary sewage and stormwater in a common transport system. These systems transport the sewage / stormwater to a WWTP (same as ional migration patterns. omovide for untreated or treated outflow from the system either at the WWTP or at specifically engineered locations throughout the system to protect the biological processes at the plant, prevent basement backups, and/or prevent surface flooding when flow rates exceed design conditions. These outflow locations are known as combined sewer overflows (CSOs) and are often found in older urban areas.

There are currently no combined sewers or CSOs in the subwatershed, but there are a couple of locations where CSOs used to exist and there may be legacy environmental problems due to these historical pollutant sources.

Sanitary Sewer System Problems

Some of the problems include:

- lack of capacity causing surcharged conditions and resultant overflow at a low point, causing untreated sewage to discharge to nearby waterbodies (similar occurrences may result from blockages in the system or failure of pumps); and
- operators having to bypass flows directly to waterbodies in order to protect the biological treatment processes from being 'washed out' or prevent basement flooding.

E. Other Businesses and Activities

There are myriad other commercial businesses that have the potential to introduce stressors in to the natural environment. These include, but are not limited to, dry cleaning facilities, marine industries, automotive service stations, concentrated animal feeding operations, and water treatment plants. A few of these are discussed below.

A Marina

Source, graphic: (AMCMP, 2008).

Dry Cleaning

Dry cleaning uses non-water-based solvents to remove dirt and stains from clothes. The most common chemical used today is tetrachloroethylene (TCE). It is stable, nonflammable, and has excellent cleaning power. However, TCE is toxic, and chronic exposure may cause liver and kidney damage Alternative cleaning solvents also pose distinct concerns (Wikipedia, 2007) Improperly stored and disposed chemicals and wastes have the potential to contaminate the natural environment, most commonly soil and groundwater.

Marine Industries

Marinas are waterfront facilities which provide launching, storage, maintenance, fueling, waste removal, and other services for boats of varying sizes (limited by the physical configuration of the marina). The construction of marinas and boat launches is often the source of natural feature and habitat degradation due the necessary displacement of riparian sites that are rich in plant communities and often spawning habitat for fish. Additionally, hydrodynamic changes may result due to the placement of docks, breakwalls, or other structures. The operation of such facilities may be the source of spills of solid and liquid pollutants (e.g. sewage, fuel) that can enter the water.

Automotive Service Stations and Storage Tanks

Service stations are facilities which provide fuels and lubricants for motor vehicles. These and many other facilities store products in underground storage tanks. The chief causes of pollutant release from these sources are spills and storage tank leaks. Because of this risk, most (underground) storage tanks now have extensive measures in place to detect and prevent any such leaks. Other pollutants associated with auto-motive service stations include chemicals such as leaking antifreeze (caused by leaks or spills) and detergents from car washes (caused by uncontrolled drainage into the storm sewer system) – (Wikipedia, 2007).

Landscaping Companies

Landscaping companies store, deliver, and install landscaping supplies, many of which (e.g. sediment, organic mulch) have the potential to impact water quality.

Water Treatment Plants

Water treatment plants are important facilities that take in either surface or groundwater and utilize numerous chemicals to treat water so that it is safe to be consumed. These facilities generate significant amounts of byproduct waste that may be discharged or stored on-site for later delivery to a landfill. The presence of chemicals and by-products creates the potential for degradation of the natural environment. **(EPA 5.7.1)**

Non-Point Sources

Non-point sources are generally those discharges that are from diffuse sources. These are often times the result of rainfall or snowmelt moving over and through the ground. There are some natural background sources to consider, but man-related sources are typically the most important.

An important category of the non-point sources are those related to land use. The land uses (together with the natural characteristics) influence the hydrologic and physical conditions of the subwatershed and are an indicator of the types of sources to be expected. Evaluation of the land use is an important step in understanding the activities in the area of interest and thus determining the stressor conditions and source dynamics. Sources are often specific to land use and thus land use provides a logical basis for source identification and evaluation (e.g. livestock are associated with agricultural land). Together with land use characteristics, population data can help one understand the potential growth of the area and possible changes in land uses and sources. Not only is this effort useful for source identification, but also facilitates identifying future implementation efforts as management practices are often specific to land use type.

(5.5, 5.5.1, 5.7.2 – applicable for the entire section although not explicitly indicated as was done for the previous section)

F. Illicit Discharges / Spills

An illicit discharge is the introduction of polluting materials (e.g., sewage or sediment) into a pipe that drains to surface water or the spilling, dumping, or mishandling of materials in a manner that allows those materials to drain to a watercourse. Common illicit discharges are listed in the sidebar.

Spills can involve industrial, municipal, commercial and agricultural sources. Although the number and size of spills or releases has reduced dramatically over the last several years due to measures implemented by industries, historical spills have had a large impact on water and sediment quality (USACE, 2004). Spills associated with distinct point sources should be considered under that particular source. All others can be included here.

Source, graphic: (EPA, 2008).

Common Illicit Discharges

Common illicit discharges include:

- Pipes intended for a sanitary sewer connected instead to a storm drain;
- Intentional dumping of wastes such as paint or motor oil into storm drain catch basins by individuals (due to a lack of knowledge or disregard for the environment) or barrels / truckloads into waterways by unscrupulous businesses to avoid disposal costs; and
- Soapy water from outdoor cleaning activities (such as car washing) discharging to a storm drain.

Urban and Residential Activities

It is not just the land that supports human settlement that is problematic to the health of the environment. Many activities and substances have the potential to harm the environment if not executed or utilized in accordance with regulations.

For example, many household compounds are toxic in the environment (paint thinner, cleaners, polishes, glues), but the laws that control the use of these substances are not known of or are not enforced and, as such, can leak if not properly stored or are disposed of in the municipal trash (where they can leak from curb-side bags or from the collection trucks once the containers are punctured).

Even seemingly innocuous items such as televisions, plastic, or rubber products may contain harmful compounds (e.g. PCB).

Many construction materials may decompose or otherwise give off pollutants (e.g. treated lumber, asphalt shingles, etc.).

There are innumerable other activities and compounds associated with urban and residential land (and other land uses for that matter). Some are included under the other sources and others can be added to the plan in the future if appropriate.

G. Urban and Residential Land

Population and Land Use

Through time, as humans have settled in a given area, they have made use of natural resources and molded the land to suit their needs. In the history of the United States, this settlement and land development has been of an enormous scale. The utilization of resources that accompanies permanent human settlement has brought great change to the landscape (e.g. forests cleared and wetlands drained to provide land for farming, settlement, and transportation; urban development; dams; river relocation; channelization; and dredging). The demographics of a population in a specific area are the driver for the land uses that are seen.

In modern times, expansive development leads to a loss of rural character, light pollution, the urban heat island effect, less exercise and more pollution (due to increased driving), and tax burdens (Appel, 2003). Most importantly, in terms of watershed management planning, are the impacts of increased impervious surfaces, especially how these interact with stormwater to cause increased pollutant loadings and hydrologic changes.

There are innumerable distinct causes for urban and residential land being a source of stressors, however, the way the land is developed is starting to be recognized as one of the major problems. Behind the development strategies are the local regulatory and planning organizations and the ordinances and master plans associated with them. Aside from the development of land directly consuming areas that were once natural habitats that provided important environmental services (e.g. riparian areas filtering pollutants, mitigating temperatures, slowing runoff, and providing deadfall for fish habitat and microbiological food), there are myriad ancillary factors that tend to exacerbate environmental degradation beyond the area that is directly developed, such as: extensive road networks, above ground utilities (e.g. power lines), modification of nearby wetlands and waterbodies.

Despite the methods being used to conduct the development, the main driver for the development itself is the people. As such it is important to understand characteristics of the population (e.g. number of persons / households, commuting patterns, household structure, age, gender, race, economic conditions, employment, education). Not only does this information help define the motives of the population, but it also gives insight into the distribution of pollutant sources, and is useful in developing outreach strategies, identifying specific populations to target during the implementation of the plan, and helping determine future trends and needs of the population. Most of this data can be obtained through the United States Census Bureau or through SEMCOG.

Another key piece of information to know about an area of interest is the ownership of the land. This data can provide insight into identifying pollutant sources or stakeholders that can provide additional information. Additionally, the condition of many waterbodies is directly affected by the land directly adjacent to it. Finally, the ownership of land near waterbodies and throughout the watershed is important in terms of defining the actions to take to protect and restore environmental conditions and the details of its implementation (e.g. if public entities own a significant amount of riparian land, it will be much easier to use that land to establish vegetative buffers than if the land is help by private citizens). **(EPA 5.5.1, 5.5.2, 5.5.3)**

Increased Imperviousness and Stormwater Runoff

Stormwater runoff is a natural event that occurs when the rate of rainfall exceeds the ability of the ground to absorb the rainfall. In undeveloped areas, most rainwater, as well as springtime snowmelt, soaks into the ground, recharges aquifers, and slowly makes its way to nearby river systems. Unfortunately, increased development in some areas of the subwatershed has altered natural drainage patterns (USACE, 2004)

The conversion of natural landscapes into urban landscapes (e.g. rooftops, streets, parking facilities) results in surfaces impervious to the infiltration of stormwater. These surfaces increase the:

- Frequency of rainwater runoff reaching waterbodies;
- Total volume of runoff; and
- Peak flow rate of runoff.

It is not solely the 'hard' impervious surfaces (e.g. pavement) that contribute to the runoff problems. The heavy machinery used during development compacts soils and makes them less pervious, thus causing the post-construction pervious areas (e.g. yards) to generate more runoff than would be expected. Compounding this is the fact that storm sewers are often utilized in these areas to quickly route water, with no natural attenuation or pollutant filtering opportunities, directly to receiving waters.

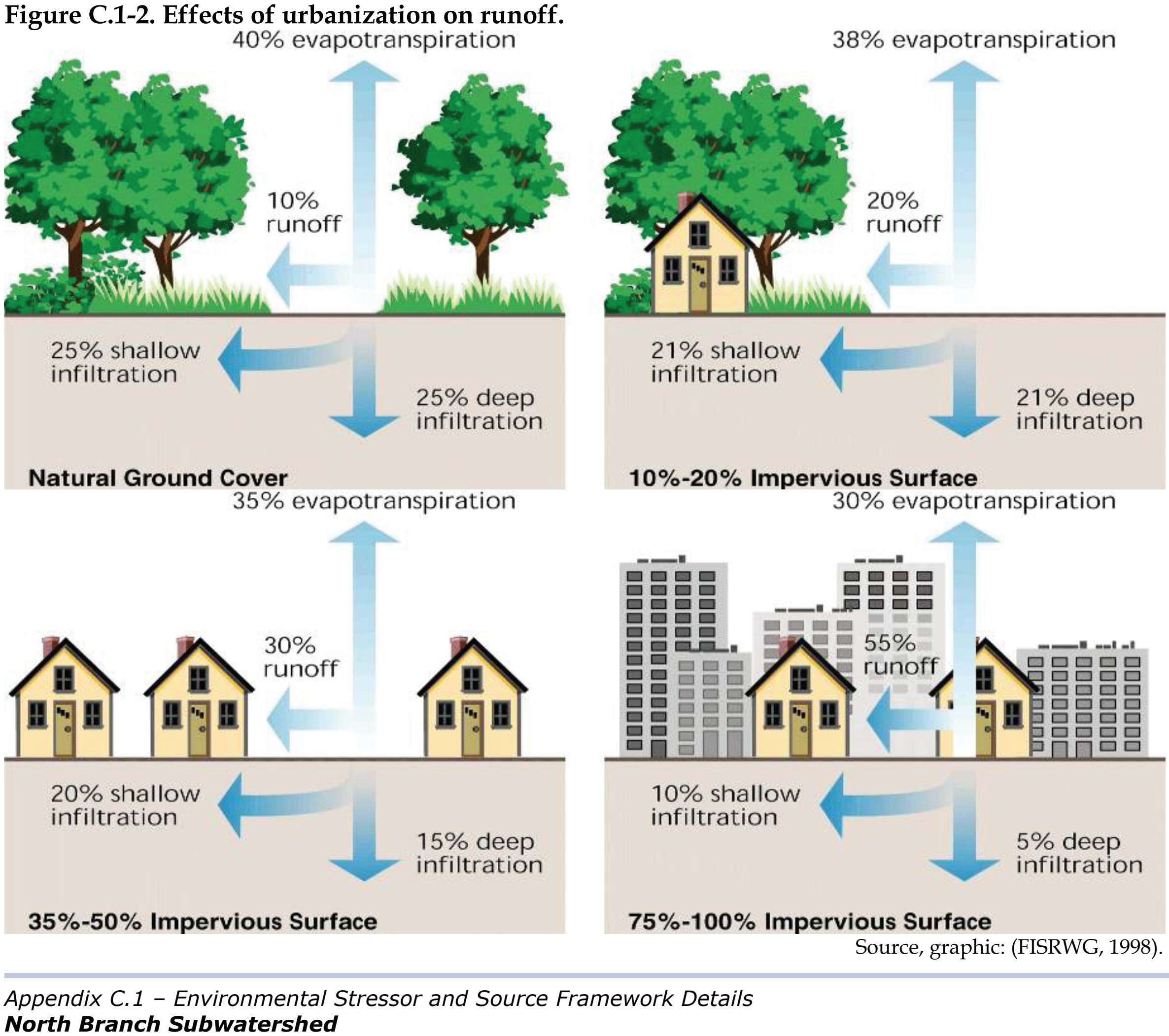
Figure C.1-2 illustrates the effects of urbanization on runoff.

Groundwater Issues

While the excess runoff associated with impervious surfaces (and urban development) is problematic both from a hydrologic and water quality perspective, some of the same compounds that affect surface waters can also impact groundwater through the remaining amounts of infiltration. Some other compounds may have a greater potential to contaminate groundwater due to a number of factors.

There are innumerable examples of pollutants that fall into either of these categories. Pesticides, fertilizers, and construction materials are just few to consider.

Figure C.1-2. Effects of urbanization on runoff.



Source, graphic: (FISRWG, 1998).

Modifications to Waterbodies as Sources

Many changes in land from natural cover to urban, residential, or agricultural use are accompanied by modifications to waterbodies such as: creating new channels (which alter drainage patterns increase sediment loads and degrade wetlands), straightening (i.e. the removal of meanders) which shortens the effective flow length (i.e. increases the slope) and intensifies erosive actions; modification and degradation of banks and shore-lines and damage to vegetation that usually retains soils; and changes that can modify wave characteristics including the addition of docks, breakwalls, and shoreline/bank hardening (which deflect and concentrate wave energies). Recreational and commercial boats create waves that can cause shoreline problems.

In addition to being the source of hydraulic changes in the water-bodies, these types of changes have significant and typically direct consequences with respect to habitat conditions. For example, channel straightening and 'cleaning' destroys riffle and pool habitat and the riparian corridor, the use of hard armored banks (typically concrete) reduces the ecological value of the waterbody, inhospitable reaches are created when waterbodies pass through culverts or are enclosed for extensive lengths, in-line obstructions (dams and lake-level controls) fragment aquatic communities and impact the dis-tributions of other stressors such as temperature and sediment, and disconnection from the floodplain degrades communities that inhabit these areas. Many of these changes also prevent a waterbody from naturally filtering pollutants (thus further degrading habitat).

Since impervious cover prevents rainfall from infiltrating into the soil, less rainwater is available to recharge groundwater. Consequently, during extended periods without rainfall, baseflow levels are often reduced.

The effect of impervious surfaces on the volume of storm water runoff is dramatic. For example, a one-inch rainstorm on a 1-acre natural meadow produces approximately 218 cubic feet of runoff. The same rainstorm on a 1-acre paved parking lot would produce almost 16 times that volume, 3,450 cubic feet of runoff (Maumee, 2006).

Impervious surfaces also generate runoff that carries warmer water with increased sediments, nutrients, and other pollutants. Today, this runoff is considered one of the single greatest water quality threats. This issue is of particular concern to areas where development is expected to increase. Also problematic is the fact that this development is continuing to encroach upon sensitive headwater areas (Appel, 2003). The impacts of development, especially with respect to altered hydrology, are discussed in "Hydrologic Impacts Due to Development: The Need for Adequate Runoff Detention and Stream Protection" (MDEQ, 2002).

H. Transportation Infrastructure

Transportation infrastructure has the potential to impact water resources through the effects of impervious surfaces compounded with vehicle pollutant deposition (e.g. tire and brake dust containing copper and zinc), surfaces/treatments (e.g. asphalt, sealants), and spills. Automobiles contribute a number of different types of pollutants to urban runoff. High levels of metals are found in tire wear, used motor oil and grease, diesel fuel and vehicle rust. Engine coolants and antifreeze containing glycols are toxic and contribute to high biochemical oxygen demand in receiving waters. Generally, fossil fuel combustion emits greenhouse gasses and is the largest contributor of nitrogen to the waters in urbanized areas. Salts are used to keep facilities free of ice, but in large volumes can be toxic to fish and other wildlife. Sand is often applied to road surfaces to provide traction during winter ice conditions. These pollutants accumulate on the impervious surfaces during dry weather conditions, only to form a highly concentrated first flush during storm events (Maumee, 2006). Even dirt roads and driveways are little more pervious than paved ones because the excessive, repetitive compaction drastically reduces the soil permeability. Additionally, these roads may be direct sources of sediment that reaches waterbodies, especially if severe erosion problems exist.

The presence of roads and other land consuming transportation facilities also causes habitat degradation through fragmentation.

Source, graphic: (NGIA, 2008).

I. Agricultural / Cultivated Land

Agriculture is a significant source of a large number of pollutants. Livestock sites, such as dairy, beef, swine, and poultry, plus intense cultivation of crops, such as corn and soybeans can be the source of numerous stressors including pathogens, nutrients, and oxygen demand from manure, excessive particulates from increased soil erosion, and toxic compounds (e.g. fertilizers, pesticides, and herbicides that may contain organic, inorganic constituents and/or metals), many of which will bind to the sediment particles. Additionally there is some concern that agriculture may be a source of hormones and endocrine mimics that could impact fish, wildlife, and source water intakes. (USACE, 2004)

Crop cover makes soil up to four times less permeable than it would be with natural ground cover. Coupled with tile drains that keep the agricultural lands well drained, agricultural land (just as impervious land) imparts modified flow characteristics due to increased runoff to nearby waterbodies, although to a lesser extent. This increase flow also carries increased amounts of pollutants (JFNEW, 2007)

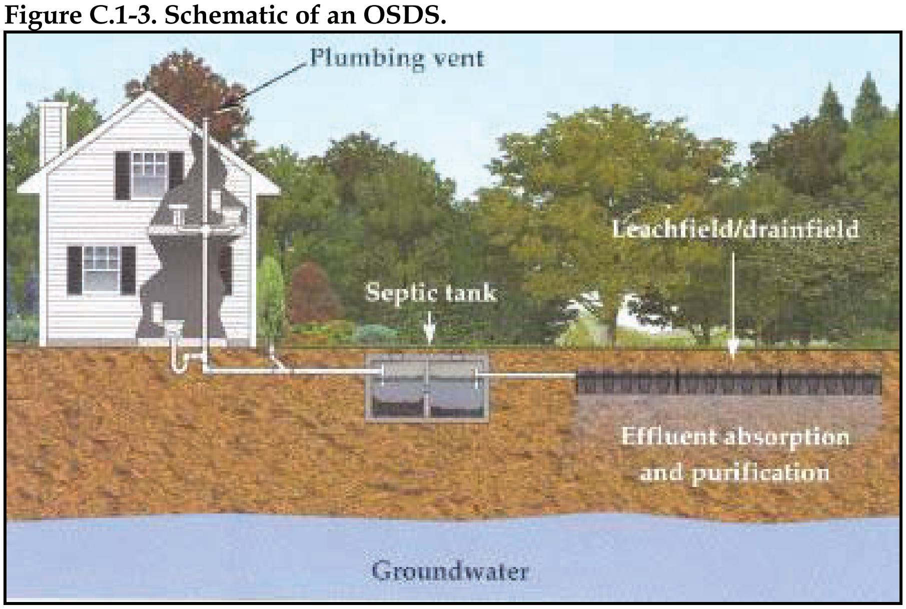
J. On-site Sewage Disposal Systems

Where sewer service is not available, facilities generally rely on on-site sewage disposal systems (OSDS) or septic systems to treat sewage. Figure C.1-3 provides a schematic of an OSDS. OSDSs are small underground systems consisting of a tank in which waste collection and treatment occurs and a drain field which disperse the effluent. OSDS systems typically serve one facility, but may serve more depending on size.

If properly located, constructed, used, and maintained, these systems can provide reliable service over many years. However, clay soils present a particular concern for the proper design and construction of septic systems, and many systems built in these improper soil types fail within a relatively short period of time.

Additional factors, such as increased water usage where piped municipal water is available, can contribute to septic system failure (USACE, 2004)

Figure C.1-3. Schematic of an OSDS.



Source, graphic: (InfiltratorSystems, 2006).

More on Agriculture

The impacts of agricultural stressors in the Clinton River Watershed tend to be localized and generally result from the following causes (USACE, 2004)

- Cattle with unlimited access to the tributary areas, causing bank erosion (over grazing destroys vegetation root systems and soils are cleaved by hooves) ,and direct deposition of pathogens and nutrients in the form of manure, and
- A lack vegetated buffer strips to isolate tilled acreage or grazing areas from waterways resulting in stream bank erosion and the entrance of more sediment and higher levels of agricultural chemicals and nutrients.

Silviculture involves managing and harvesting forest materials and has similarities with agri-culture as a source of stressors. Removing trees leads to excessive erosion and sediment / organic matter discharge into water-bodies. Access roads bring problems similar to those related to other transportation facilities. There are many other potential problems that are not addressed here but can be researched more.

More on OSDS

The discharge of poorly treated sewage from faulty septic systems can be a significant source of bacterial and nutrient pollution in local waterbodies. The effluent from a failed disposal system can seep through the ground or flow across the ground or be directly connected by pipe to a stream or storm sewer. To put the issue in perspective, the average residence uses 200 to 500 gallons of water daily, meaning that each failing system could contribute thousands of gallons of polluted wastewater each year (USACE, 2004)

Pathogens in Sediment

Recent research has shown that some pathogens are able to survive in the sediment of river banks, lake shorelines, and the bottom sediment of both. There are likely problematic locations near the sources of pathogens themselves that harbor elevated levels of pathogens in the sediment. The same physical mechanisms that lead to the resuspension of chemical stressors (as discussed in the text to the right) – e.g. boats, dredging, storms – will cause pathogens to re-enter the water column (LSCCSR, 2000).

Atmospheric Deposition - Mercury

In the Great Lakes region, the stressor most associated with atmospheric deposition is mercury. Mercury enters the atmosphere through the release of geologically bound mercury by natural processes and human activities, such as waste incinerators, coal-fired power plants, and base metal smelting plants as well as others. In addition, the global reservoir of atmospheric mercury makes long-range transportation of mercury a concern. Sediments in the Clinton River Watershed contain some of the highest concentrations of mercury in the Great Lakes. Airborne deposition directly to the Clinton River represents a minor source because of the small surface area relative to its large flow (USACE, 2004).

K. Contaminated Sediments

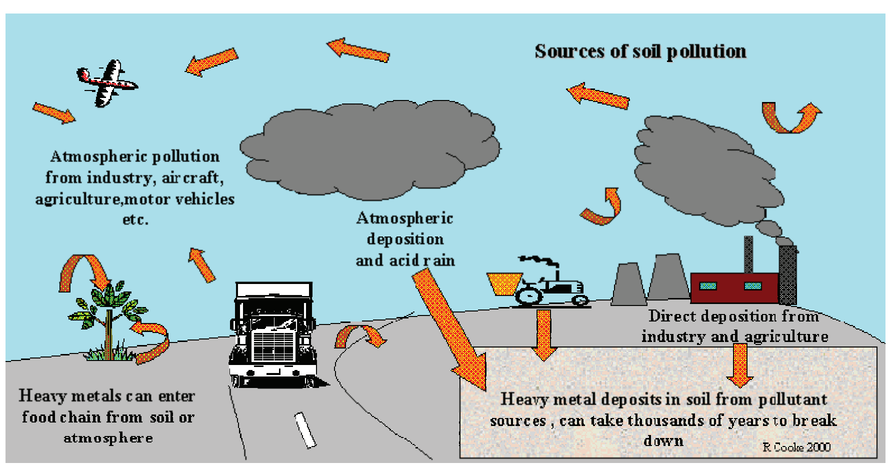
Many of the sediments in our rivers and lakes have been contaminated by toxic pollutants such as organochlorines (e.g. PCBs) and heavy metals (e.g. mercury). Some of these pollutants are directly discharged by industrial plants and municipal sewage treatment plants, others come from polluted runoff in urban and agricultural areas, some may be from waste management (e.g. landfill) or contaminated sites (e.g. LUSTs), but most are the result of historical contamination. Although 'contaminated sediments' by themselves may be considered and impact of the contaminating stressors, they are treated in the plan as a source because it is the resuspension of these contaminants that poses the biggest environmental problems – not the formation of new contamination sites.

Contaminated sediments can threaten creatures in the benthic environment, exposing worms, crustaceans and insects to hazardous concentrations of toxic chemicals. Reduced benthic populations subsequently reduce the food available to larger animals such as fish. Some contaminants in the sediment are taken up by benthic organisms in a process called bioaccumulation. When larger animals feed on these contaminated organisms, the toxins are taken into their bodies, moving up the food chain in increasing concentrations. As a result, fish and shellfish, waterfowl, and mammals may accumulate hazardous concentrations of toxic chemicals (Scorecard, 2007)

Contaminated sediments do not always remain at the bottom of a water body. Anything that stirs up the water, such as dredging, can resuspend sediments. Resuspension may mean that all of the animals in the water, and not just the bottom-dwelling organisms, will be directly exposed to toxic contaminants (Scorecard, 2007)

L. Atmospheric Deposition

Atmospheric deposition – directly on structures, in waterbodies, or in precipitation – can potentially be the source for myriad stressors, including low pH (i.e. as acid rain), inorganic compounds (e.g. sulfate), nutrients (e.g. nitrogen and phosphorus compounds), cations (i.e. dissolved solids), heavy metals (e.g. mercury), and sediment (e.g. particulate matter).



Source, graphic: (UR, 2008).

M. Soil Erosion

Soil erosion is a process through which wind, water, and other forces dislodge and displace soil particles. Impacts of soil erosion are diverse and are influenced by complex hydrological, physical, chemical, and biological factors. While soil erosion occurs naturally, it is accelerated by human activities, such as those discussed in the sidebar.

The detailed processes of in-stream soil erosion are discussed in-depth in Appendix B.4. This brief section deals with upland soil erosion.

While normal overland flows can potentially erode and transport small amounts of sediment, the problematic upland soil erosion types are:

- sheet and rill erosion - the removal of layers of soil from the land surface by the action of rainfall and runoff, and
- gully erosion - when concentrated flows of water scour along flow routes and cause sharp sided entrenched channels.

These erosive characteristics may manifest themselves due to agricultural practices (e.g. plowing), construction of roads and buildings, and the removal of trees. During these, or other similar processes, unprotected soils are vulnerable to erosion.

Soil erosion does not occur by water alone, but may also involve normal movement due to winds or extreme movements associated with storms.

Erosion is not just a source of sediment but may also increase the amount of pollutants in waterways, especially heavy metals, fertilizers, and pesticides, because these pollutants adhere to soil and are transported along with the detached soil (USACE, 2004)

Sedimentation, the process through which water transports dislodged soil particles and deposits them somewhere else (on land or in streams, rivers, lakes, or wetlands), is discussed in the previous section, under the 'Sediment' stressor (USACE, 2004)

N. Other Human Actions

There are numerous other human actions which can be considered sources of stressors. For example, ballast water which is carried in freight ships for stability, may originate in distant locations and be discharged locally – introducing any number of pollutants and/or invasive organisms. This has been the source of many invasive species found in the Great Lakes, including: zebra mussels, round goby, spiny water flea, and ruffe (MDEQ, 2007). The presence of ships and boats repels various organisms, the motion of ships and recreational boats generate wake that can erode shorelines, and the propellers scour bottomlands or injure organisms.

Dredging destroys benthic habitat and, in concert with contaminated sediments, can release contaminants into the water column. Dredging also causes temporarily elevated turbidity and nutrient levels and long-term changes in loading regimes of these (GLC, 2006) (USACE, 2004).

Another human activity that stresses the environment is the withdrawal of water from either surface or groundwater sources. These withdrawals have the potential to impact hydraulic and hydrologic conditions.

Although construction sites are regulated by specific location, the time-limited nature of construction activities does not allow for its classification as a point source. As such, construction activities are treated generally and as a non-point source. Construction sites are notorious sources of sediment and may also contribute debris, among other compounds.

Human Causes Contributing to Soil Erosion as a Source of Sediment

While soil erosion occurs naturally, it is accelerated by human activities, such as:

- straightening of waterways (i.e. removal of meanders) which shortens the effective flow length (i.e. increases the slope) and intensifies erosive action,
- modification and degradation of banks and shorelines and damage to vegetation that usually retains soils (e.g. beach grooming), and
- things that can modify wave characteristics, including:
  - wake from recreational and commercial boats, and
  - docks, breakwalls, and shoreline hardening (which deflect and concentrate wave energies).

Source: (USACE, 2004).

Waterbody Modifications

Although waterbody modifications are often associated with development, they can occur independently of such activities. Typical modifications include: straightening, enclosure, modification with armored banks, 'cleaning' (to maximize hydraulic capacity), restrictions through culverts and bridge openings, construction of in-line obstructions such as dams and lake level controls, and disconnection of the waterbody from the floodplain either through intentional down-cutting or the construction of dikes to contain floodwaters. The changes range from passive actions that are inconsequential as isolated events and are easily repairable to specific activities that are very serious and hard to reverse (Waters, 1995).

O. Animal Sources (Non-Agricultural)

Animals can be significant sources of pathogens and nutrients as their wastes are often excreted directly into waterbodies or nearby, where they contaminate runoff that eventually enters waterbodies. Aside from livestock (which are included under the 'Agricultural Land' source), the two most recognized sources are domestic pets and waterfowl, specifically geese.

Geese

Source, graphic: (MLIVE, 2008).

Many parks that attract dog owners are near waterbodies. Dog droppings that are not disposed of properly can be problematic for the reasons stated above (i.e. contaminated runoff). The problem is not limited to nearby waterbodies, however, as droppings in urban areas have the potential to contaminate runoff into the storm sewers that eventually is discharged to waterbodies.

With geese, or other waterfowl, the problem is particularly acute when great numbers of the birds congregate in one area. This is common in urban areas that offer lakes and ponds as these settings provide the food, water, and protection the geese are looking for. The droppings can contaminate waterbodies either directly, when the birds are in the water, or through runoff, when rain washes the concentrated droppings off of nearby lawns and open spaces where the birds congregate.

Although wildlife inputs typically represent natural background sources of pollutants, they can be important (bacteria, nutrients) in forested or less-developed areas of a watershed. These are often uncontrollable but important to consider in the overall scheme.

P. Natural Occurrences and Disturbances

In general, natural sources (e.g. natural soil erosion) are included under those sources that are appropriate – only if they can potentially cause environmental impacts. Others, such as insect infestations and extreme storm events, are included here.

A Forest Fire

Source, graphic: (FF, 2008).

Natural occurrences and disturbances, as a source of stressors, range from extremely destructive events such as earthquakes, to gentle, long-term fluctuations in lake levels, to deposits of potentially harmful compounds in the soil that can leach into groundwater (e.g. the inorganic compound arsenic). They are primarily due to natural phenomena with a minimal level of human influence. However, most natural disturbances are at least indirectly influenced by humans. For example, global warming (due in part to greenhouse gasses from human activity) has been attributed to changes in the frequency and intensity of storms (e.g. hurricanes), melting of glaciers, changes in heating and cooling patterns, and changes in rates of precipitation and evaporation (GLC, 2006).

Natural disturbances are an integral part of healthy ecosystem dynamics as certain plants require disturbances to proliferate. Disturbances, which often expand available habitat types, provide opportunities for exist species to persist, other species to exploit, and all species to continue along their natural evolutionary path (GLC, 2006)

In the past, fire (often caused by lightning) was extremely important source of habitat alterations that maintained certain natural communities (e.g. prairie) in the region. It kills or stunts woody plants, coverts dead plant material to nutrients, promotes seed contact with soil, warms the soil to promote seed germination, triggers certain seeds (e.g. resinous pine cones), and stimulates herbaceous plant growth. Today, fires are often suppressed due to the potential for extensive damage to human life and infrastructure (GLC, 2006)

Ice storms continue to be significant disturbances in hardwood forests. These storms prune small branches, break large branches, and snap entire trees to open gaps in the forest canopy and allow other species to proliferate. Damaged trees are often subsequently infected by decomposers and/or insects and eventually die standing or are wind thrown (GLC, 2006)

The weather characteristics of the region also make windthrow an important disturbance in forests. Severe low-pressure storms frequently create gaps in forest canopy that are typically larger than those caused by ice storms. Windthrow events are the primary source of forest turnover and result in the mosaic of different age and species of trees encountered in forest stands (GLC, 2006)

In aquatic settings, flooding moves sediment and debris downstream, causing bank erosion and changing vegetation composition within the floodplain. Prolonged flooding can kill woody plants and trees, thus transforming their habitat characteristics and prevents tolerant woody plants from establishing in the understory. Flooding creates vernal pools which are important for amphibian reproduction and temporary pools for waterfowl and fish, which may use the areas for spawning (GLC, 2006)

Additionally, lake level fluctuations (and shifting ice cover) play an important role in maintaining the health of adjacent marsh lands by uprooting established plants at high levels and eventually allowing re-colonization of affected areas at low levels. These fluctuations tend to discourage the succession of these wetlands into upland habitat types, accelerate nutrient cycling, and increase habitat diversity (GLC, 2006)

Causes

Although some specific causes for the various sources were presented in the previous section, there are innumerable causes associated with any given source. A master list of the potential causes associated with each category of stressor, and organized based on specific stressors within each category, is presented in Table C.1-2 through Table C.1-8

As described at the beginning of the chapter, the definition of the terms that comprise the conceptual model (causes, sources, stressors, impacts) can be ambiguous and sometimes confusing. In this case, the sources and causes that are listed in the following tables are generally categorized as:

- Source = where a given stressor is coming from (e.g. a waste water treatment plant discharging phosphorus); and
- Causes = how the given stressor is coming from the source (e.g. poor design of the waste water treatment plant leads to it discharging phosphorus at higher levels than allowed in the plant's permit).

'Lack of knowledge' and similar statements can be construed as causes that are in some associated with most sources and, as such are not included in the tables. Additionally, 'lax regulations' are a common cause for many sources of pollution and are only included where deemed especially important. Finally, a 'lack of monitoring' reduces the ability to gauge the extent of problems or to discover unknown problems.

Additional Information on Causes

The causes listed in the following tables are those that can be addressed and corrected today. For example, contaminated sites may have resulted from a number of improper practices in the past (historic dumping, improper disposal practices, etc) but these are not included as causes of current discharges because the past cannot be changed to alleviate these problems. The current causes include contaminated runoff and groundwater seepage and it is these that must be addressed to address discharges that are occurring today.
Certain past events for currently operating facilities (e.g. poor design and construction) are included as causes as the potential may exist to correct such errors).

Other past actions that have lead to modern problems include: the use of lead in gasoline and its combustion causing it to be dispersed in automobile exhaust (in addition to the use of lead additive in paints and in plumbing fixtures).

Table C.1-2. Potential sources and causes of nutrients.

Sources	Causes
Industrial Discharges	Effluent Limits Operational Accidents Lax Regulatory Enforcement
Waste Management Sites	
Active Sites	Poor Design (e.g. landfill surface runoff) Lack of Maintenance and Monitoring Operational Accidents Lax Regulatory Enforcement
Abandoned Sites	Uncontrolled / Unknown Discharges
Sewage Discharges	
Waste Water Treatment Plants (WWTPs)	Plant Effluent Limits Poor Design Poor Maintenance
Leaky Sanitary Sewer	Poor Design; Poor Construction; Poor Maintenance
Sanitary Sewer Overflows (SSOs)	Poor Design (e.g. infiltration, elevations) Poor Construction (e.g. infiltration) Poor Maintenance / Aging System (e.g. blockages, infiltration)
Combined Sewer Overflows (CSOs)	Limited Treatment / Conveyance / Storage Capacity Poor Maintenance
Other Businesses	
Dumpsters	Poor Construction; Poor Maintenance
Landscaping Companies	Improper Material Storage
Illicit Discharges / Spills	Function of Design Criteria Unnecessary Inflow Poor Maintenance Accidents
Urban and Residential Land	Lack of Collection of Yard Waste (i.e. drains to storm sewers) Poor Maintenance / Design of Yard Waste Facilities Fertilizer Selection / Application (e.g. residences, golf courses)
Transportation Infrastructure	Lack of Street Sweeping (e.g. decaying leaves wash into waterbodies)
Agricultural Land	
Crop Land	Fertilizer Selection / Improper Application / Over-watering Planting and Harvesting Practices (e.g. lack of conservation tillage, no buffer zone)
Livestock	Unrestricted Access to Streams Overextended Grazing Land (e.g. no buffer zone)
Manure Storage and Application	Poor Design / Protocols; Poor Construction; Poor Maintenance
On-site Disposal System Failure	Poor Design; Poor Construction; Poor Maintenance
Atmospheric Deposition	Wind Transport of Eroded Sediment – see 'Soil Erosion' below
Soil Erosion	<see the causes of soil erosion for the 'Sediment' stressor>
Other Human Activities	< See the causes for the sources of the 'Natural Feature and Habitat Degradation' stressor (i.e. the destruction of wetlands and buffers) >
Animal Sources (Non-Agricultural)	Pet Owners Not Picking Up Waste Pet Access to Waterbodies / Riparian Areas Uncontrolled Wildlife Populations
Natural Occurrences and Disturbances	
Fire (release nutrients)	Lightning Accidental or Prescribed Burns
Windthrow (of trees into waterbodies)	Wind Weak Root Systems (a function of stream bank erosion)

Table C.1-1. Potential sources and causes of toxic / heavy metals.

Sources	Causes
Industrial Discharges	Effluent Limits Operational Accidents Lax Regulatory Enforcement
Waste Management Sites	
Active Sites	Poor Design (e.g. landfill surface runoff) Lack of Maintenance and Monitoring Operational Accidents Lax Regulatory Enforcement
Abandoned Sites	Uncontrolled / Unknown Discharges
Contaminated Sites	Containment Failure – Age, Maintenance, Monitoring
Sewage Discharge	
Waste Water Treatment Plants (WWTPs)	Plant Effluent Limits Poor Design Poor Maintenance
Leaky Sanitary Sewer	Poor Design Poor Construction Poor Maintenance
Sanitary Sewer Overflows (SSOs)	Poor Design (e.g. infiltration, elevations) Poor Construction (e.g. infiltration) Poor Maintenance / Aging System (e.g. blockages, infiltration)
Combined Sewer Overflows (CSOs)	Limited Treatment / Conveyance / Storage Capacity Poor Maintenance
Other Businesses	Operational Accidents Lax Regulatory Enforcement
Illicit Discharges / Spills	Intentional Dumping of Contaminants Substandard Spill Prevention Protocols / Systems Lax Regulatory Enforcement
Urban and Residential Land	Automotive Components (e.g. zinc released from rubber as tires wear down, copper from brake dust) Roofs / Fences Landscaping Materials and Compounds (e.g. leaching from wood preservatives) Improper Pesticide Practices Fertilizer Selection / Improper Application / Over-watering
Transportation Infrastructure	Automotive, Rail, Airplane Components / Compounds Marine Components / Compounds Road Treatments / Paint
Agricultural Land	Improper Pesticide Practices Fertilizer Selection / Improper Application
On-site Disposal Systems	Improper Disposal of Compounds into System
Contaminated Sediments	Resuspension (e.g. natural, due to dredging, due to boating)
Atmospheric Deposition	< Causes are numerous but not covered by this plan >
Other Human Actions	Dredging Contaminated Sediments Improper Disposal of Metal-containing Items (e.g. mercury thermometers, old furnace switches, rat poison)

Table C.1-2. Potential sources and causes of organic / inorganic compounds.

Sources	Causes
Industrial Discharges	Effluent Limits Operational Accidents Lax Regulatory Enforcement
Waste Management Sites	
Active Sites (e.g. landfills, incinerators)	Poor Design (e.g. landfill surface runoff) Lack of Maintenance and Monitoring Operational Accidents Lax Regulatory Enforcement
Abandoned Sites	Uncontrolled / Unknown Discharges
Contaminated Sites	Containment Failure – Age, Maintenance, Monitoring
Sewage Discharge	
Waste Water Treatment Plants (WWTPs)	Plant Effluent Limits Poor Design Poor Maintenance
Leaky Sanitary Sewer	Poor Design Poor Construction Poor Maintenance
Sanitary Sewer Overflows (SSOs)	Poor Design (e.g. infiltration, elevations) Poor Construction (e.g. infiltration) Poor Maintenance / Aging System (e.g. blockages, infiltration)
Combined Sewer Overflows (CSOs)	Limited Treatment / Conveyance / Storage Capacity Poor Maintenance
Other Businesses	Operational Accidents Lax Regulatory Enforcement
Illicit Discharges / Spills	Intentional Dumping of Contaminants Substandard Spill Prevention Protocols / Systems Lax Regulatory Enforcement
Urban and Residential Land	Automotive Compounds Improper Pesticide Practices Fertilizer Selection / Improper Application
Transportation Infrastructure	Automotive, Rail, Airplane Compounds Marine Components / Compounds Road Treatments
Agricultural Land	Improper Pesticide Practices Fertilizer Selection / Improper Application / Over-watering
On-site Disposal Systems	Improper Disposal of Compounds into System
Contaminated Sediments	Natural Resuspension Dredging Resuspension Boating-induced Resuspension
Atmospheric Deposition	< Causes are numerous but not covered by this plan >
Other Human Actions	Dredging Contaminated Sediments Improper Disposal of Organic Compounds
Natural Occurrences and Disturbances	
Fire	Lightning Accidental or Prescribed Burns

Table C.1-3. Potential sources and causes of oxygen demand.

Sources	Causes
Industrial Discharges	Effluent Limits Operational Accidents Lax Regulatory Enforcement
Waste Management Sites	
Active Sites (e.g. landfills, incinerators)	Poor Design (e.g. landfill surface runoff) Lack of Maintenance and Monitoring Operational Accidents Lax Regulatory Enforcement
Abandoned Sites	Uncontrolled / Unknown Discharges
Contaminated Sites	Containment Failure – Age, Maintenance, Monitoring
Sewage Discharges	
Waste Water Treatment Plants (WWTPs)	Plant Effluent Limits Poor Design Poor Maintenance
Leaky Sanitary Sewer	Poor Design Poor Construction Poor Maintenance
Sanitary Sewer Overflows (SSOs)	Poor Design (e.g. infiltration, elevations) Poor Construction (e.g. infiltration) Poor Maintenance / Aging System (e.g. blockages, infiltration)
Combined Sewer Overflows (CSOs)	Limited Treatment / Conveyance / Storage Capacity Poor Maintenance
Other Businesses	
Dumpsters	Poor Construction Poor Maintenance
Landscaping Companies	Improper Material Storage
Illicit Discharges / Spills	Function of Design Criteria Unnecessary Inflow Poor Maintenance
Urban and Residential Land	Lack of Collection of Yard Waste (i.e. drains to storm sewers) Poor Maintenance / Design of Yard Waste Facilities
Transportation Infrastructure	Lack of Street Sweeping (e.g. decaying leaves wash into waterbodies)
Agricultural Land	
Livestock	Unrestricted Access to Streams Overextended Grazing Land (e.g. no buffer zone)
Manure Storage and Application	Poor Design / Protocols Poor Construction Poor Maintenance
On-site Disposal System Failure	Poor Maintenance Poor Construction Poor Design
Animal Sources (Non-Agricultural)	Pet Owners Not Picking Up Waste Pet Access to Waterbodies / Riparian Areas Uncontrolled Wildlife Populations
Natural Occurrences and Disturbances	
Fire (release nutrients)	Lightning Accidental or Prescribed Burns
Windthrow (of trees into waterbodies)	Wind Weak Root Systems (a function of stream bank erosion)
Algae Blooms / Excessive Plant Growth	< see the causes of phosphorus sources >

Table C.1-6. Potential sources and causes of suspended solids / sediment.

Sources	Causes
Industrial Discharges	Effluent Limits Operational Accidents Lax Regulatory Enforcement
Sewage Discharges	
Waste Water Treatment Plants (WWTPs)	Plant Effluent Limits; Poor Design; Poor Maintenance
Leaky Sanitary Sewer	Poor Design; Poor Construction; Poor Maintenance
Sanitary Sewer Overflows (SSOs)	Poor Design (e.g. infiltration, elevations) Poor Construction (e.g. infiltration) Poor Maintenance / Aging System (e.g. blockages, infiltration)
Combined Sewer Overflows (CSOs)	Limited Treatment / Conveyance / Storage Capacity Poor Maintenance
Other Businesses	
Landscaping Companies	Improper Material Storage
Soil and Gravel Extraction	Inadequate Protective Measures
Illicit Discharges / Spills	Function of Design Criteria Unnecessary Inflow Poor Maintenance Accidents
Urban and Residential Land	
Paved Surfaces	Directly Connected Impervious Areas (i.e. no buffers) Infrastructure Degradation (e.g. cracked concrete) Sediment Deposition (e.g. from car tires, wind)
Loss of Material Around Storm Sewer System	Poor Construction Poor Maintenance
Transportation Infrastructure	
Paved Surfaces	Directly Connected Impervious Areas (i.e. no buffers) Infrastructure Degradation (e.g. cracked concrete) Sediment Deposition (e.g. from car tires, wind) Improper Application or Clean-up of Winter Sand
Gravel / Dirt Surfaces	Lack of Buffer Poor Maintenance
Agricultural Land	
Crop Land	Planting and Harvesting Practices (e.g. lack of conservation tillage, no buffer zone)
Livestock	Unrestricted Access to Streams Overextended Grazing Land (e.g. no buffer zone)
Manure Storage and Application	Poor Design / Protocols; Poor Construction; Poor Maintenance
On-site Disposal Systems	Poor Design; Poor Construction; Poor Maintenance
Atmospheric Deposition	Wind Transport of Eroded Sediment – see 'Soil Erosion' below
Soil Erosion	
Construction Sites	Inadequate Soil Erosion and Sedimentation Controls
Road-Stream Crossings	Poor Design; Poor Construction; Poor Maintenance Human Access
Streambanks	< see the causes associated with all of the sources associated with 'hydrologic/hydraulic modifications' to waterbodies > Human Access
Drainage Ditches	Ditch Cleanout without Soil Stabilization
Other Human Activities	
Destruction of Vegetation	Unrestricted Off-Road Vehicle Access Ad Hoc Stream Side Trails

Table C.1-7. Potential sources and causes of thermal pollution.

Sources	Causes
Industrial Discharges	Effluent Limits
Waste Management Sites	Poor Design (e.g. landfill surface runoff) Lack of Maintenance and Monitoring (i.e. leachate discharge) Lax Regulatory Enforcement
Sewage Discharges	
Waste Water Treatment Plants (WWTPs)	Plant Effluent Limits
Leaky Sanitary Sewer	Poor Design Poor Construction Poor Maintenance
Sanitary Sewer Overflows (SSOs)	Poor Design (i.e. infiltration, elevations) Poor Construction (i.e. infiltration) Poor Maintenance / Aging System (i.e. blockages, infiltration)
Combined Sewer Overflows (CSOs)	Limited Treatment / Conveyance / Storage Capacity Poor Maintenance
Urban and Residential Land	Lack of Shade Lack of Infiltration Waterbody Modifications (see sources and causes associated with hydrologic / hydraulic characteristic modifications)
Transportation Infrastructure	Lack of Shade Lack of Infiltration Waterbody Modifications (see sources and causes associated with hydrologic / hydraulic characteristic modifications)
Agricultural Land	Lack of Shade Lack of Infiltration Waterbody Modifications (see sources and causes associated with hydrologic / hydraulic characteristic modifications)
On-site Disposal System Failure	Poor Maintenance Poor Construction Poor Design

Table C.1-4. Potential sources and causes of modified hydrologic / hydraulic conditions.

Sources	Causes
Industrial Discharges	Effluent Limits
Sewage Discharges	
Waste Water Treatment Plants (WWTPs)	Plant Effluent Limits
Leaky Sanitary Sewer	Poor Design Poor Construction Poor Maintenance
Sanitary Sewer Overflows (SSOs)	Poor Design (e.g. infiltration, elevations) Poor Construction (e.g. infiltration) Poor Maintenance / Aging System (e.g. blockages, infiltration)
Combined Sewer Overflows (CSOs)	Limited Treatment / Conveyance / Storage Capacity Poor Maintenance
Urban and Residential Land	Loss of Infiltration (e.g. compaction, turf grass instead of native plants, directly connected impervious area) Lack of Buffers (e.g. drain cleaning) Loss of Storage (i.e. wetlands, floodplain – from development or disconnection) Stream Channelization / Bank Armoring Enclosed / Sewered Drainage Restrictive Culverts Dams / Lake Level Controls
Transportation Infrastructure	Loss of Infiltration (e.g., compaction, directly connected impervious area) Lack of Buffers (e.g. waterbody modifications) Loss of Storage (i.e. wetlands, floodplain – from development or disconnection) Stream Channelization / Bank Armoring Enclosed / Sewered Drainage Restrictive Culverts
Agricultural Land	Loss of Infiltration (e.g. crops instead of native plants) Lack of Buffers (e.g. crops planted to waterbody edge) Loss of Storage (i.e. wetlands due to tile drains) Stream Channelization Restrictive Culverts
Other Human Activities	Water Withdrawals
Natural Occurrences and Disturbances	
Increase in Precipitation	Natural Variation Climate Change (not appropriate for this plan)
Drought	Natural Variation Climate Change (not appropriate for this plan)
Extreme Storms	Natural Variation

Table C.1-9. Potential sources and causes of natural features and habitat degradation.

Sources	Causes
Industrial Discharges	< see the causes for other stressors – releases of other stressors will degrade aquatic habitat >
Waste Management Sites	< see the causes for other stressors – releases of other stressors will degrade aquatic habitat >
Contaminated Sites	< see the causes for other stressors – releases of other stressors will degrade aquatic habitat >
Sewage Discharges	< see the causes for other stressors – releases of other stressors will degrade aquatic habitat >
Other Businesses	
Marine Industries	Construction Practices
Other	< see the causes for other stressors – releases of other stressors will degrade aquatic habitat >
Illicit Discharges / Spills	< see the causes for other stressors – releases of other stressors will degrade aquatic habitat >
Urban and Residential Land	Construction / Development Practices (e.g. filling / draining wetlands, disconnection from / development in floodplain) Loss of Native Vegetation (e.g. turf grass instead of native plants) Lack of Buffers (e.g. drain cleaning) Stream Channelization (i.e. loss of pool and riffle habitat) / Bank Armoring (i.e. inhospitable to life) Enclosed / Sewered Drainage (i.e. inhospitable to life, obstruction to the passage of organisms) Dams / Lake Level Controls (i.e. obstructions to the passage of organisms)
Transportation Infrastructure	Construction / Development Practices (e.g. filling / draining wetlands, disconnection from / development in floodplain) Loss of Native Vegetation (e.g. turf grass instead of native plants) Lack of Buffers (e.g. drain cleaning) Stream Channelization (i.e. loss of pool and riffle habitat) / Bank Armoring (i.e. inhospitable to life) Enclosed / Sewered Drainage (i.e. inhospitable to life, obstruction to the passage of organisms) Dams / Lake Level Controls (i.e. obstructions to the passage of organisms)
Agricultural Land	Land Use Practices (e.g. draining wetlands) Loss of Native Vegetation (e.g. crops instead of native plants) Lack of Buffers (e.g. crops planted to waterbody edge) Stream Channelization (i.e. loss of pool and riffle habitat)
On-site Disposal System Failure	< see the causes for other stressors – releases of other stressors will degrade aquatic habitat >
Atmospheric Deposition	< see the causes for other stressors – releases of other stressors will degrade aquatic habitat >
Soil Erosion	< see the causes for other stressors – releases of other stressors will degrade aquatic habitat >
Other Human Activities	
In-water Disturbances	Boating / Shipping (e.g. wake; propeller turbulence) Dredging
Shoreline Degradation	Shoreline Hardening Beach Grooming
Animal Sources (Non-Agricultural)	< see the causes associated with the 'invasive species' stressor >

Table C.1-10. Potential sources and causes of pathogens.

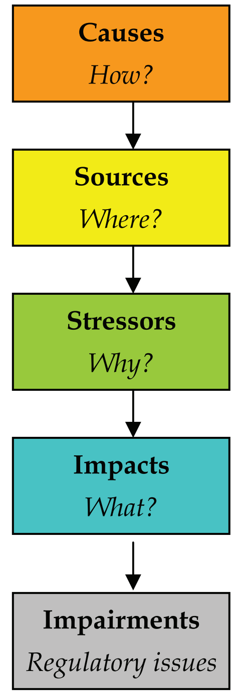
Sources	Causes
Industrial Discharges	Effluent Limits Operational Accidents Lax Regulatory Enforcement
Waste Management Sites	Poor Design (e.g. landfill surface runoff) Lack of Maintenance Lax Regulatory Enforcement
Sewage Discharges	
Waste Water Treatment Plants (WWTPs)	Plant Effluent Limits Poor Design Poor Maintenance
Leaky Sanitary Sewer	Poor Design Poor Construction Poor Maintenance
Sanitary Sewer Overflows (SSOs)	Poor Design (e.g. infiltration, elevations) Poor Construction (e.g. infiltration) Poor Maintenance / Aging System (e.g. blockages, infiltration)
Combined Sewer Overflows (CSOs)	Limited Treatment / Conveyance / Storage Capacity Poor Maintenance
Illicit Discharges / Spills	Function of Design Criteria Unnecessary Inflow Poor Maintenance Accidents
Urban and Residential Land	-- not a direct source of pathogens but many of the causes associated with the other stressors exacerbate pathogen problems (e.g. destruction of buffers and wetlands which filter out pathogens from other sources)
Agricultural Land	
Crop Land	Fertilizer Selection / Improper Application / Over-watering Planting and Harvesting Practices (e.g. lack of conservation tillage, no buffer zone)
Livestock	Unrestricted Access to Streams Overextended Grazing Land (e.g. no buffer zone)
Manure Storage and Application	Poor Design / Protocols Poor Construction Poor Maintenance
On-site Disposal System Failure	Poor Maintenance Poor Construction Poor Design
Animal Sources(Non-Agricultural)	Pet Owners Not Picking Up Waste Pet Access to Waterbodies / Riparian Areas Uncontrolled Wildlife Populations (e.g. creation of congregation areas for geese such as lawns near lakes or football fields) Wildlife Habitation of Storm Sewer System

Conclusion

The relationship between the causes of sources, sources of stressors, stressors that impact the natural environment, and the impacts themselves is a complex one. This chapter has defined a framework in which to understand and assess these stressors, etc, with respect to the natural environment.

The content of this chapter is reflected in Chapter 5, except the general discussion of impairments, impacts, stressors, sources, and causes is replaced with specific data and analyses. The conditions discussed therein are framed by the assessment standards and parameters presented at the end of this chapter and the public input that is summarized in Chapter 4. Chapter 6 goes on to define the goals and objectives aimed at addressing the environmental issues that become apparent from the analyses.

Conceptual Model Framework for Causes, Sources, Stressors, Impacts, and Impairments



(EPA 4.3.1)

Appendix E.1: Gap Analysis

Introduction

This appendix documents the list of data generating programs used to prepare this plan. It is necessary step in the preparation of the plan and also allows for an assesment of the quality of the data used in plan preperation.

The Clinton River, and by extention the North Branch is a data rich environment to work in. Not only is there an abundance of data but it is of a high quality (i.e. quality assurance pals and protocalls have been followed). This is evidenced by the list of accessed programs below. There were not any limiting informational or temporatl gaps that were appearent or that could reasonably be expected to exist. One could have wished for more flow monitoring stations, but with three in the watersehed it is doing better than most plans. There was one spatial gap that was identified. The Lapeer County section of the watershed had limited data on a few of the nalysis catagores (e.g. sewered areas). Since the Lapeer County portion of the watershed constitues less that three percent othe watershed this was not deemed as critical to the development of the plan.

Still, there are existing gaps in information. These gaps did not impact plan prepartion but it was through anlayes of the existing data that new needs were identified. Specifically there are two field study needs: 1) the need for additional information on bacteria sources in order to base implementation of additional BMPs on, and 2) the need for a filed study to document good habitat so that a habitat plan for preservation and restoration can be created and implemented. The latter should be based on ecological 'island population' management for terrestial and aquatic wildlife and was beyound the scope of this plan.

This remainder of this appendix contains the list of data generating programs that were used to prepare this plan. Existing resources range from drinking water and surface water quality monitoring at the county level to databases of collected data maintained by federal agencies. It does not contain references to the three field studies conducted for the WMP. These are reported out under separate cover.

Existing Data Collection and Dissemination Programs

The programs listed in this sub-section are currently being implemented by their respective organizations. This list is by no means exhaustive and there are many other programs that can provide data to be used in assessing the various parameters associated with this RAP. Although included in this list, the Great Lakes Commission maintains a web-based monitoring inventory that can be searched by organization, project title, description, monitoring medium, monitoring category, frequency, and parameters. The on-line inventory is available at http://www.glin.net/gis/lkstclair/ and also provides information on the organization of interest, the project manager, various program descriptions, and (when possible) a map of sampling stations. Many of the programs discussed in this section were identified in the Great Lakes Commission's *Lake St. Clair Monitoring Gap Analysis and Strategic Plan* (2004). In addition to water quality monitoring, air quality and atmospheric deposition are important considerations as these are both environmental health indicators as related to the State of the Lakes Ecosystem Conference.

Drinking Water Monitoring

The municipalities or other entities involved in treating and distributing drinking water sometimes monitor influent water to determine treatment requirements and evaluate effectiveness and efficiency of water treatment processes (and to identify whether additional treatment is necessary to maintain compliance with standards).

For obvious reasons, monitoring drinking water is important and it is worthwhile to note that the drinking water quality, specifically its ability to be ingested safely by humans, is an omnibus human health indicator related to the State of the Lakes Ecosystem Conference.

County Drains

As part of their normal duties with respect to drain commissioner activities, the counties may collect data with respect to their drains which at a minimum likely includes maps showing drain and outfall locations.

Illicit Discharge Elimination Programs

As an MDEQ-defined permit requirement under the NPDES Phase II stormwater regulations, county departments (e.g. health, public works, drain commissioner's office) and municipal governments are conducting field work to identify illicit connections (and illegal dumping) to, including seepage from sanitary sewer systems or septic systems, and discharges from the storm sewer infrastructure. A significant portion of this work involves walking waterbodies and roadside ditches and sampling outfalls (or storm sewer connections to enclosed drains) for a number of pollutants (e.g. E. coli, temperature, surfactants, ammonia). These programs should be kept in mind for leveraging and combining field work and data collection

County Level Surface Water Quality Monitoring

There are numerous county run programs that evaluate the quality of surface water. Macomb, Oakland, St. Clair, and Wayne counties (through the health departments) have beach monitoring programs that operate during the summer months and document (on at least a weekly basis) *E. coli* levels and beach status (open or closed). To facilitate dissemination of this data, the individual counties typically post this data on-line and make historical data available (e.g. Macomb County has *E. coli* data since 2001 available). Additionally, the MDEQ hosts a website (http://www.deq.state.mi.us/beach/ public/default.aspx) where health departments from around the state can post beach testing and closing information. The EPA also hosts an additional website: http://oaspub.epa.gov/beacon/beacon_national_page.main.

Macomb County conducts extensive surface water quality and sediment testing through its Lake St. Clair Assessment program (with 13 open Lake St. Clair sites, 12 near shore sites, and 16 inland sites – some with wet weather sampling) and additional inland surface water testing for *E. coli* at over 60 locations. St. Clair County also conducts *E. coli* monitoring at inland locations.

Sewer Overflows

Municipalities and counties that have CSOs or SSOs are required to report discharge amounts to the MDEQ. This reporting only captures those overflows that are known (some SSOs may be undocumented) and only a few locations, such as the George W. Kuhn Retention and Treatment Basin (Oakland County), actually monitor for pollutants such as fecal coliforms or *E. coli*. The MDEQ posts the information it receives on a publicly accessible website. Specialized field work and hydraulic modeling could be required to identify SSO locations and quantify overflow occurrences and stressor loads.

County Geographic Information System Data

Macomb, Oakland, Wayne, and St. Clair County, and some municipalities, have Geographic Information System (GIS) spatial data available for numerous environmentally related subjects. Typical information available includes: current and future land use, transportation infrastructure, waterbodies, natural features and areas, aerial photography, municipal boundaries, watershed boundaries, parks and trails, natural tree rights-of-way, beaches, wetlands, soils, master planning data, floodplains, parcel and easement information, elevation contours, dams, landfills, geology, sanitary sewer infrastructure, combined sewer infrastructure, storm sewer infrastructure, and storm water BMP locations (e.g. detention basins). These entities, and others without electronic data capabilities, can often provide this or other data in paper formats.

Public Education Plan Evaluation

The public education plans (PEPs) – a requirement of the MDEQ-defined permit under the NPDES Phase II stormwater regulations – for all of the permittees in the watershed are currently being implemented (since 2004), including an assessment of the measures of success associated with the PEP actions. The data for these assessments should also be considered with respect to achievement of the goals of the RAP.

Clinton River Watershed Council - Stream Leaders Program

At more than 40 sites throughout the watershed, students and teachers act as water quality monitors two times a year, in May and October. They analyze water samples for dissolved oxygen, nutrients, pH, temperature, turbidity, BOD, and fecal coliform; evaluate the health of stream habitats and aquatic biological communities (macro-invertebrates); inventory physical stream-side (riparian) conditions and land uses that may affect water quality; catalog and collect river, lake and beach debris; and restore degraded habitats. Monitoring results are summarized using the WQI.

Clinton River Watershed Council - Adopt-A-Stream

Twice a year, teams visit their adopted sites and collect data, including physical information (such as extent of streambank erosion and surrounding land use) and chemical information (such as water temperature and pH). They collect and identify benthic macroinvertebrates that live in the streambed and surrounding vegetation.

The Clinton River Coldwater Conservation Project

This is a joint program between the Clinton River Watershed Council, MDNR, and Trout Unlimited that aims to restore appropriate cold water fishing opportunities in the Clinton River Watershed. In working towards this goal, team members are involved in data collection for fish habitat and macroinvertebrate community assessments (e.g. temperature, flow, riparian habitat conditions).

Other Non-profit Organizations

Various non-profit organizations may be involved in project-specific or long-term monitoring efforts in the watershed/AOC. The Nature Conservancy often partners with the Michigan Natural Features Inventory to conduct surveys of natural communities. Recently, they have been involved in a study/survey of mussel populations to determine if chronic low levels of zebra mussel infestation has a long-term impact on freshwater mussel populations in a small river habitat that supports two globally rare mussels. Additionally, the Wildlife Habitat Council monitors certain bird populations (e.g. nest boxes, number of eggs, nesting cycle, number of fledglings) throughout the Lake St. Clair basin in order to measure reproductive success.

Educational Institutions

By their very nature, educational institutions are involved in data collection and analysis.

At the primary and secondary school level, many are involved in the CRWC Stream Leaders program. Other institutions, such as Lake Shore Public Schools, have independent programs that integrate data collection (e.g. macroinvertebrate surveys and water testing) and analysis with educational activities.

The various universities in the state are often involved with projects in the Clinton River Watershed from time to time. Additionally, there are certain on-going projects that related to the Clinton River Watershed/AOC. For example, Michigan State University's Cooperative Extension Service for St. Clair County organizes an Adopt-A-Stream program that has a macroinvertebrate and chemical water quality testing component. Researchers at the University of Michigan maintain a Lake St. Clair weather buoy that collects wind and water data with an aim of predicting beach closures and refining water sampling strategies. In the watershed, researchers at Oakland University conduct a program of stream water and sediment quality and macroinvertebrate conditions of Clinton River Watershed waterbodies (and others throughout the state).

Southeast Michigan Council of Governments

The Southeast Michigan Council of Governments (SEMCOG) is involved with numerous data collection and analysis programs for its constituent members in the region. SEMCOG obtains aerial photography for the entire region (since 1966 – every five years starting from 1970). In addition to its inherent value, the aerial photography is also utilized to develop spatial land use data for the region. Another major SEMCOG function is to develop demographic data such as yearly population and household estimates (based on the most recent U.S. census data and up-to-date localized data), residential building permit summaries, and development forecasts. SEMCOG also develops or summarizes data related to the environment, including precipitation data from a rain gauge network (with 75 gauges) in Wayne, Oakland, Macomb, Livingston, and Washtenaw; and sewer system coverage areas (both existing and estimated future).

Southeast Michigan Council of Governments – Social and Municipal Surveys

SEMCOG conducted a social survey to establish a baseline level of knowledge among the residents in the region, including the subwatershed. Additionally, SEMCOG conducts surveys with respect to its municipal training and other educational activities. These data, and data from future surveys, can be used in assessing achievement of the goals of the RAP.

Michigan Department of Environmental Quality

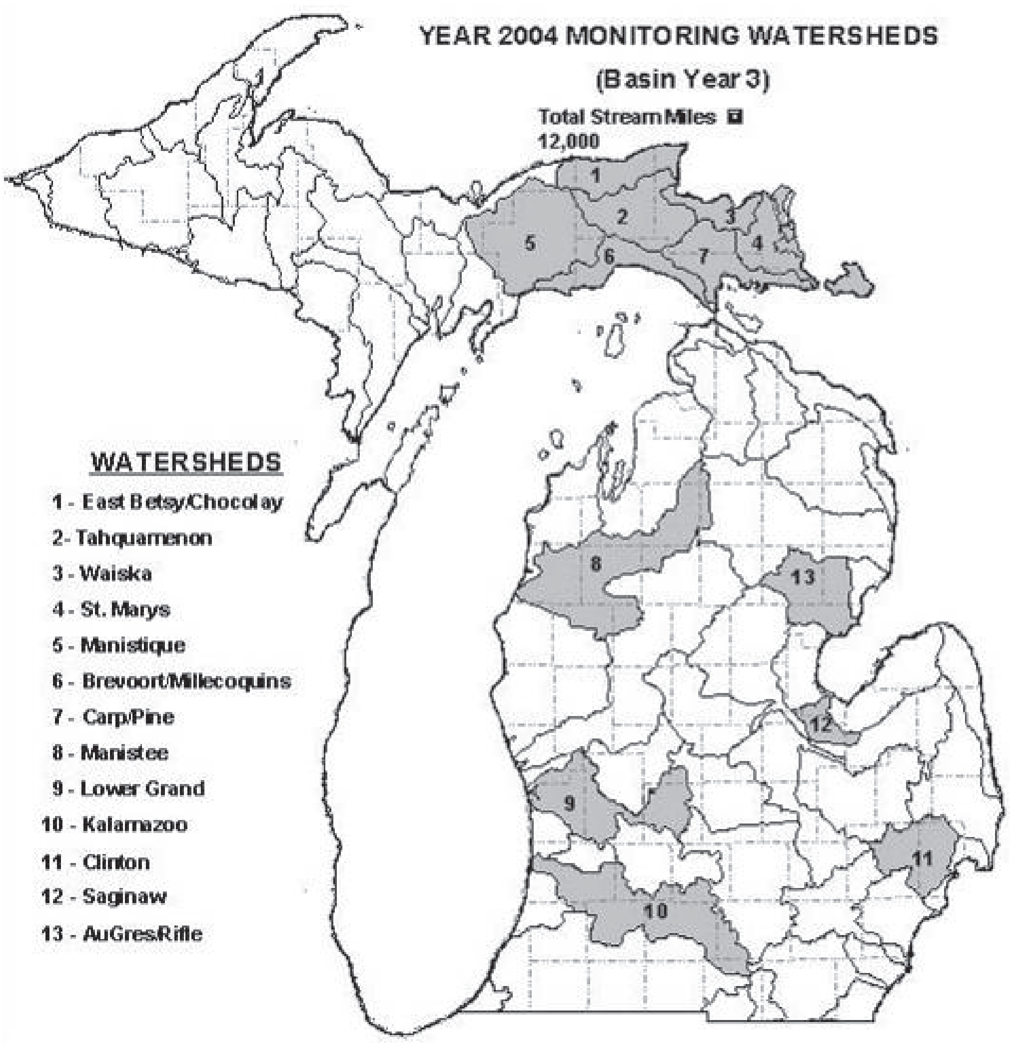
The Michigan Department of Environmental Quality (MDEQ) has an extensive number of programs that monitor environmental conditions throughout the State. The MDEQ's monitoring goals are defined in the 1997 document (updated in 2005) "A Strategic Environmental Quality Monitoring Program for Michigan's Surface Waters". This document defines the MDEQ's monitoring goals as:

- Assessing the current status and condition of waters of the state and determining whether WQS are being met (i.e. identify water that are high quality as well as those not meeting standards such as supporting aquatic life, wildlife, human health, and agricultural use);
- Measuring spatial and temporal water quality trends;
- Evaluating the effectiveness of water quality protection programs (for both conventional [e.g. nutrients] and toxic pollutants); and
- Identifying new and emerging water quality problems (e.g. MTBWE, PFOS, PBDEs, antibiotics, pharmaceuticals, household personal care products).

This document also describes a paradigm shift in the MDEQ's monitoring philosophy from a historically targeted approach to site selection (focusing on problem areas) to a probabilistic method that will allow for more reliable interpolation and extrapolation of data throughout the state, although targeted studies are still needed to address certain waters not attaining standards. As appropriate, the MDEQ will upload water quality and other data into the U.S. EPA's STORET database (as discussed later in this section).

Water quality data collection occurs on a 5-year rotating watershed schedule. Basin year 3 includes the Clinton River Watershed as depicted in Figure E.1-1.

Figure E.1-1. MDEQ basin monitoring cycle (year 3).



Source: Michigan Department of Environmental Quality. Water Quality and Pollution Control in Michigan 2006 Sections 303(d), 305(b), and 314 Integrated Report. 2006.

During these watershed-based assessment periods, the MDEQ will address known minimally impacted sites to ensure that water quality is not deteriorating, selected NPDES permit locations to make sure of compliance (and reevaluate discharge limits based on acute and chronic toxicity assessments by the Aquatic Toxicology Laboratory) and determine enforcement activities, if any), locations where grant monies are being spent to see if any water quality impact can be seen, and where problems are uncovered to quantify the extent of the problem and identify known and/or suspected causes and sources. In addition, the MDEQ also maintains a number of fixed stations for continuous monitoring (one is on the Clinton River) and also annually samples the Great Lakes connecting channels (e.g. Lake St. Clair).

The five year rotating basin watershed monitoring activities include habitat evaluations, fish population studies, fish contamination studies, macroinvertebrate evaluations, water and sediment chemistry studies, aquatic nuisance species (e.g. algae, slimes) evaluations – monitoring existing and assessing impacts of, and wildlife contamination studies. Studies may also be conducted in response to complaints.

A major parallel monitoring track in the MDEQ is those conducted as part of the non-point source (NPS) group. The four main categories of non-point source monitoring include: statewide trend monitoring, problem identification monitoring, total maximum daily load (TMDL) development (i.e. identifying causes and sources and determining the assimilative capacity of the waterbody for pollutants of concern) and effectiveness monitoring (after implementation), and NPS control effectiveness monitoring. The NPS group also works with NPS grant receivers to develop and implement monitoring programs. The integration of the NPS monitoring program with the regular MDEQ water quality monitoring program is presented in Figure C.5-6.

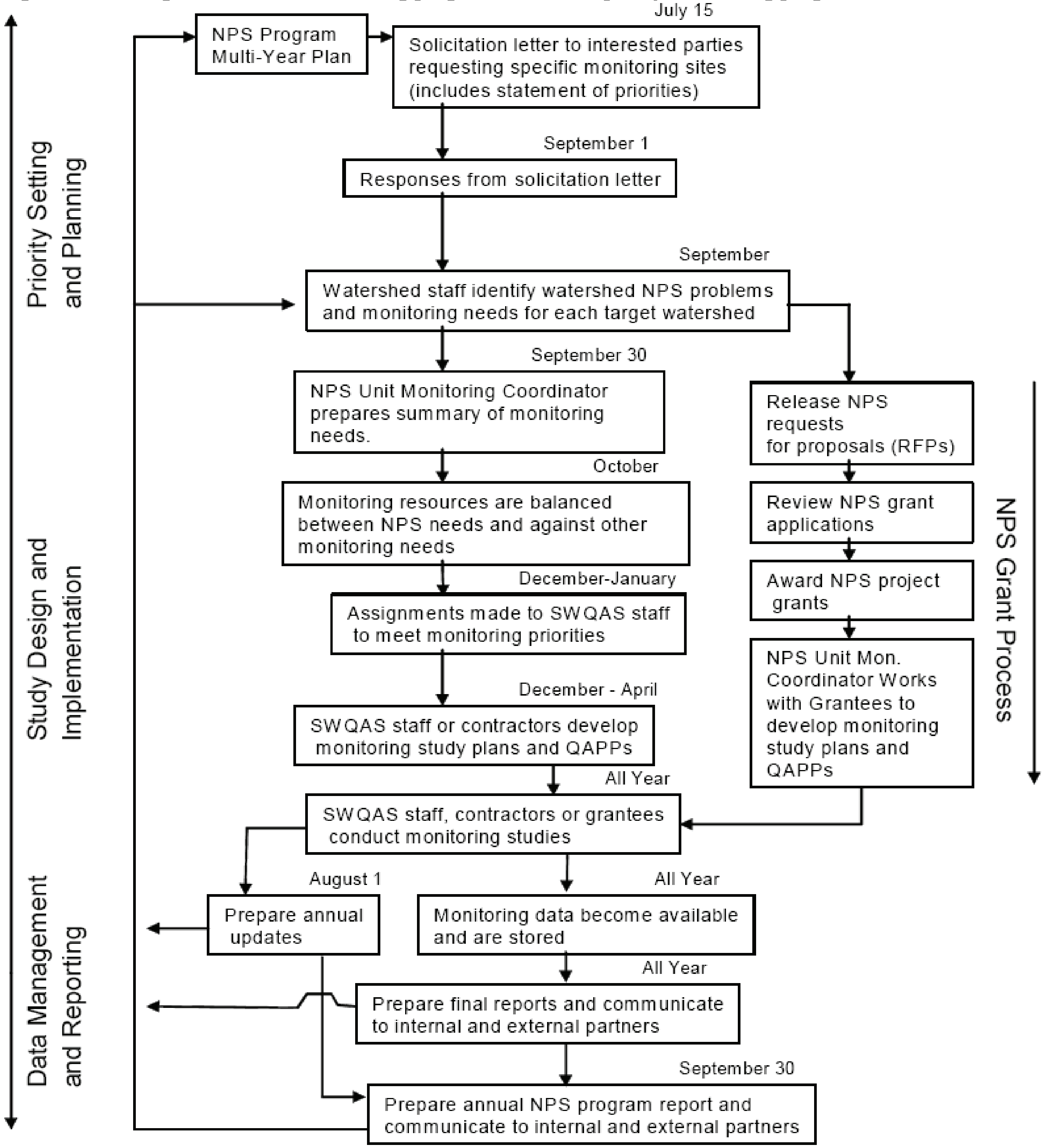
Various additional NPS monitoring tools include:

- enhanced local water quality and beach monitoring efforts through CMI grants;
- fish contaminant monitoring (in addition to meeting the goals of the sampling program, this data is also used by the Michigan Department of Community Health to issue consumption advisories);
- caged fish contaminant monitoring (to detect contaminants present in persistently low levels);
- contaminant monitoring (PCBs, mercury, DDT, and other pesticides) in bald eagle blood and feathers and herring gull eggs;
- volunteer monitoring (e.g. road stream crossing surveys) by various organizations (the Michigan Clean Water Corps);
- section 319 and CMI NPS grants (to properly document load reductions achieved through the implementation of BMPs);
- monitoring related to specific complaints (e.g. sewage contamination) and spills;
- hydrologic analysis and modeling;
- channel morphology monitoring;
- lake sediment core monitoring (through and MSU project) to identify trends and pinpoint sources (regional vs. local);
- the Michigan Mercury Deposition Network (since 1994 a joint program with the University of Michigan) which monitors speciated mercury in air and precipitation at rural and urban sites;
- the Cooperative Lakes Monitoring Program (since 1974 a program that also utilized volunteer monitoring) that monitors lakes randomly selected within appropriate 5-year schedule watersheds) which focuses on trophic state indicators such as sechi disk depth, phosphorus, chlorophyll a, dissolved oxygen, temperature and other chemical parameters and occasional aquatic plant identification and mapping; and
- Conservation Reserve Enhancement Program (CREP) monitoring (documented in annual reports) for those watersheds where CREP actions have been implemented (through the Michigan Department of Agriculture).

The MDEQ is involved with many additional monitoring programs, including:

- The drinking water contamination investigation program (testing in areas with known or suspected environmental contamination);
- A source water assessment program (SWAP) that identifies public drinking water sources and inventories contaminants and susceptibility to contamination;
- Sediment remediation effectiveness monitoring utilizing the various methodologies discussed previously to document before and after conditions such as toxicity levels and the extent of contamination; and
- Wetlands studies (from state-wide inventories using rapid assessment procedures to intensive site investigations) to classify and assess the status and trends with respect to wetland acreage and, in the future, to focus on water quality conditions.

Figure C.5-6. Integration of NPS monitoring program into water quality monitoring program.



In addition to fulfilling the goals of the MDEQ's monitoring program, the data collected is useful for calculating contaminant loads related to the AOC to support RAP implementation, other planning and pollution prevention/mitigation activities, and the development of analytical methodologies to address environmental stressors and their impacts.

Much of the data collected by the MDEQ and other state organizations such as the Department on Natural Resources is hosted on the Surface Water Information Management System (SWIMS) at http://www.mcgi.state.mi.us/miswims/MapPage.aspx. The following data is displayable in the system (and where appropriate links are provided to more detailed information): aerial photography, topographic, land use, environmental monitoring data, beach/river *E. coli*, wastewater discharges, fish contaminant studies, USGS gaging stations, NPS grant locations, septage haulers, high and low flow calculations from, valley segments, coldwater streams, natural rivers, basins, waterbodies, soils, lake contours, roads, and state house and senate boundaries.

Michigan Department of Natural Resources

The Michigan Department of Natural Resources (MDNR) routinely collects data similar to that of the MDEQ but with a greater focus on macroinvertebrates and especially fish studies (including habitat – aquatic plants abundance and distribution, species diversity of fish, abundance of fish, contaminants in fish tissue, and taste and odor tests). A wildlife action plan was generated for Michigan to identify and prioritize conservation needs of native species and habitats. The plan gives a greater emphasis on species of greatest conservation needs. Other monitoring and management programs include the Lake St. Clair assessment (yellow perch, juvenile game fish, various forage species), the Lake Sturgeon assessment program (population parameters, spawning locations, movement), sport fish monitoring (trends in catch rates), fish identification programs, and amphibian surveys. The MDNR also maintains maps of coldwater / trout streams and lakes in the state, an omnibus 'Fish Atlas' of the current and historical species found in Michigan and their respective distributions, and locations of fish stocking activities along with associated numbers of fish.

Michigan Center for Geographic Information

The Michigan Center for Geographic Information provides leadership, technical expertise and policy for the acquisition, development, use, dissemination, promotion, and sharing of geographic information in the State of Michigan. In addition to pre-processed mapping products and services such as a state-wide subdivision plat locator, the center also hosts the Michigan Geographic Data Library that contains spatial data on over 60 unique categories including: aerial photography, geology, surface water features, groundwater features, well locations, land ownership, topography, census boundaries, land cover / land use, and transportation infrastructure.

Michigan Natural Features Inventory

The Michigan Natural Features Inventory (MNFI) is the only comprehensive single source of data on Michigan's endangered, threatened, or special concern plant and animal species, natural communities, and other natural features. The MNFI tracks changes in such things as vegetation / land cover and wetlands coverage.

Great Lakes Commission (GLC)

The Great Lakes Commission is a binational agency that promotes the orderly, integrated and comprehensive development, use and conservation of the water and related natural resources of the Great Lakes basin. In furthering its objectives, the commission is involved in many projects that collect and analyze data; it also serves to make readily available information from outside organizations that is important to the mission. Topics of studies and programs that generate and analyze data include: water use, nuisance species, habitat, beaches, coastal wetlands (through the Great Lakes Coastal Wetlands Consortium), dredging, great lakes air deposition program, air toxic emissions inventory, central air emission repository on-line, regional air pollutant inventory development system, great lakes basin program for soil erosion and sediment control, and great lakes biohydrologic information system. Data related to these topics and others (e.g. newspaper articles) can be accessed through the Great Lakes Information Network (GLIN). The GLIN Data Access Clearinghouse provides spatial datasets that are current with the National Spatial Data Infrastructure.

Great Lakes Observing System

The Great Lakes Observing System is a non-profit corporation dedicated to providing wide community access to real-time and historic data on the hydrology, biology, chemistry, geology, and cultural resources of the Great Lakes. The system is primarily a link to outside data sources and currently relies on GLIN to provide most of the information and links.

Environmental Protection Agency

The Environmental Protection Agency (EPA) is involved in collecting, storing, and analyzing large amounts of diverse data related to environmental conditions. Some data collection/analysis programs include:

- The Integrated Atmospheric Deposition Network which measures toxic constituents (e.g. PCBs, pesticides, PAHs, trace metals, dioxins, furans, mercury, PBDEs) in the air and precipitation at sites around Great Lakes Basin;
- Great Lakes Aquatic Contaminant Surveillance which monitors various chemicals (PCBs, organochlorine pesticides, PAHs, mercury, dioxins, and furans, and pollutants of emerging concern (PBDEs and PFOS/PFOA) with a focus on the basin of one Great Lake per year (through the Great Lakes National Program Office – GLNPO); and
- The GLNPO Great Lakes Fish Monitoring Program which monitors: 1) contaminants in whole lake trout to assess temporal trends in open waters as well as to assess the risks of such contaminants on the health of the fishery and the wildlife that consume them; and 2) contaminants in skin-on fillets of popular sport fish, Coho and Chinook salmon to assess human exposure.

Much of the data utilized and/or hosted by the EPA is generated through approved implementing agencies (of federal regulations) – such as state Departments of Environmental Quality (or the equivalent) or tribal governments – or through the regulated entities which often are charged with self-monitoring their operations and reporting appropriate data. Some of the systems which store and disseminate this data include:

- The Permit Compliance System (PCS) which tracks permit history (issuance and expiration), discharge limits, monitoring data, and any enforcement actions (and their associated status);
- The Toxic Release Inventory (TRI) which contains information on toxic chemical releases and other waste management activities reported annually by certain covered industry groups as well as federal facilities;
- The Safe Drinking Water Information System which contains information about public water systems and EPA drinking water regulation violations at each of the facilities (data about water influent to the water system may not necessarily be available, but certain violations will be indicative of influent water conditions);
- The Air Quality System (AQS) which is a repository of ambient air quality data from over 10,000 monitors, 5000 of which are currently active;
- AirData which presents annual summaries of air pollution data in terms of ambient concentrations and emissions from sources;
- The Aerometric Information Retrieval System / Air Facility Subsystem (AIRS/AFS) contains compliance and permit data for stationary sources regulated by EPA, state and local air pollution agencies;
- The National Listing of Fish Advisories which summarizes the various consumption advisories issued by states, tribes, territories, and other entities (including Canada) that may be of interest to citizens of the United States;
- RCRA Online is designed to enable users to locate documents, including publications and other outreach materials, that cover a wide range of RCRA issues and topics focusing on generators, transporters, treaters, storers, and disposers;
- The Superfund website which contains topical information for the general public and for those involved in the Superfund program, such as information about local Superfund sites, the health effects of contaminants, cleanup efforts, and local involvement;
- The Beaches Monitoring and Notification website (http://oaspub.epa.gov/beacon/beacon_national_page.main) which presents beach conditions and supporting monitoring data for those states that have reported and have been supplied with local beach monitoring data;
- The Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) system which is a multi-purpose environmental analysis system that integrates a geographical information system (GIS), watershed data (e.g. water quality, bacteria monitoring, weather stations, USGS gaging stations, fish consumption advisories, sediment contaminant evaluations, shellfish classifications, and point source data), and state-of-the-art environmental assessment and modeling tools into one convenient package;
- STORET (short for STOrage and RETrieval), which is a repository for water quality, biological, and physical data used by state environmental agencies, EPA and other federal agencies, universities, private citizens, and many others. The database may be accessed at http://www.epa.gov/storet/ and contains detailed raw data about water samples but also contains metadata about the sampling such as why it was gathered, the methods used, the laboratory used for analysis, quality control systems, and chain-of-custody procedures. Modern STORET data (since 1999) indicates 43 locations in the Clinton River Watershed and another 14 locations in the area tributary to Lake St. Clair (only some of which are in the AOC) that have water quality data. Legacy STORET data contains over 220 data locations in the Clinton River Watershed alone.

For locating the desired environmental data at the EPA, the Environmental Data Registry (EDR) is a powerful tool. The EDR is a comprehensive, authoritative source of reference information about the definition, source, and uses of environmental data. The EDR is a part of the centralized Systems of Registries (SoR), which provides access to the Environmental Protection Agency's (EPA) core registry systems. The EDR catalogs the Agency's major data collections, helps locate environmental information of interest, and provides information for interpreting the data. The EDR does not contain the environmental data itself, but rather information that describes the data to make it more meaningful. The EDR serves to document the diversity of data representations across information systems through central storage of application metadata. This information can be used to support initiatives to identify duplication of data, streamline information collection, and achieve information consistency and sharing across the programs.

United States Geological Survey

The United States Geological Survey (USGS) is the primary federal agency for water-resource information. It provides reliable scientific information to describe and understand the Earth; and manage water, biological, energy, and mineral resources by collecting, monitoring, analyzing, and providing scientific understanding about natural resource conditions, issues, and problems (e.g. water quantity, water quality, sources and fate of contaminants). Some USGS programs that may be of interest in the context of this RAP include:

- The Biological Informatics Program which addresses biological data and information related to wildlife and the environment, as well as wildlife-human interactions; and deals with the collecting, linking, storage, organization, integration, analysis, synthesis, delivery, and application of this data;
- The Contaminant Biology Program investigates the effects and exposure of environmental contaminants to the Nation's living resources.
- The Aquatic and Endangered Resources Program focuses on the study of aquatic organisms (invertebrates, mussels, fishes) and aquatic habitats – species diversity, health and disease, ecology, habitat requirements, etc. Endangered species and those that are imperiled receive special research interest.
- The Invasive Species Program provides, in part, for the monitoring of invading populations.
- The Land Remote Sensing Program satellites (Landsat 5 and 7) monitor the Earth providing information that is broad, precise, impartial, and easily available. The USGS also provides the Nation's portal to the largest archive of remotely sensed land data in the world, supplying continuous access to current and historical land images worldwide;
- The National Water Information System presents historical and real-time (where available) data collected by the USGS in terms of daily, monthly, and annual statistics; instantaneous and maximum values; and field measurements. Available data include surface water levels and flows, groundwater levels, and water quality conditions. Data for this system come primarily from the Hydrologic Network and Analysis Program, the National Streamflow Information Program, and the Groundwater Resources Program.
- The National Water Quality Assessment Program provides an understanding of water-quality conditions and how those conditions may vary locally, regionally, and nationally; whether conditions are getting better or worse over time; and how natural features and human activities affect those conditions through sampling of general water chemistry, pesticides, contaminants in bed sediments, and contaminants in fish and benthic invertebrates.
- The State Water Resources Research Institute Program which establishes the 54 bodies that comprise the National Institutes for Water Resources, including the institute at Michigan State University, which collects and analyses data to address state, regional, and local water quality issues.
- The Status and Trend of Biological Resources Program supports and provides for the collection and analysis of biological data to be used in understanding the changing and stressed living resources in the natural environment, including: what they are, where they are, how many exist, productivity levels, population health, and trends.
- In part, the Terrestrial, Freshwater and Marine Ecosystems Programs examine how human activities modify ecosystems.
- The Toxic Substances Hydrology Program provides objective scientific information on environmental contamination.
- The Wildlife and Terrestrial Resources Program conducts research on diverse natural resource topics involving migratory wildlife, marine mammals, threatened and endangered species, wildlife disease, terrestrial plants, and amphibians.

The USGS installed a Mercury Deposition Network station near Sterling Heights, Mich. This is only the second station installed in Michigan and one of few located in an urban area. Weekly wet-deposition samples have been collected by the Macomb County Health Department, and the analyses of these samples have been paid for by USGS. Data can be used to evaluate mercury entering the watershed owing to atmospheric deposition and may be useful to decision makers seeking to address the source and magnitude of mercury contamination in the Clinton River Watershed.

The USGS is the primary source for terrain data such as digital elevation models (DEMs), digital orthophoto quadrangles (DOQs), digital raster graphics (DRGs), and watershed boundaries based on the Hydrologic Unit Code (HUC) system (also the NRCS, especially for the 10-digit and 12-digit HUC levels). USGS data can be obtained through *The National Map* (http://nationalmap.gov) – a consistent framework for geographic knowledge. The map provides public access to high-quality, geospatial data and information from multiple partners to help support decision making by resource managers and the public.

United States Army Corps of Engineers

The United States Army Corps of Engineers (USACE) is responsible for investigating, developing and maintaining the nation's water and related environmental resources. The USACE has numerous divisions and programs that are responsible for conducting routine and specialized data collection and analyses. For example, sediment and water quality sampling and analysis, morphologic documentation, and hydrologic and hydraulic conditions assessments are performed as part of its program(s) to maintain navigable waterways (including dredging). USACE programs that may be involved in data collection and analysis fall into such categories as: navigation, flood and storm damage, environmental restoration, permitting, and hydropower.

National Oceanic and Atmospheric Administration

The National Oceanic and Atmospheric Administration (NOAA) is a source of accurate and objective scientific data that pertains to the oceans and atmosphere. NOAA generally analyses data from three perspectives: climate and weather (e.g. the National Weather Service), ecosystem, and commerce. Some of the programs that generate and analyze data include:

- The National Weather Service (NWS) which provides weather, hydrologic, and climate forecasts and warnings;
- The National Ocean Service (NOS) which works to observe, understand, and manage coastal and marine resources;
- CoastWatch which provides timely access to near real-time satellite data (e.g. maps of water temperature, water color, chlorophyll-a content, and winds) to protect, restore, and manage U.S. coastal resources and understand climate variability and change;
- The Comprehensive Large Array-data Stewardship System (CLASS) which is the premier on-line facility for accessing the NOAA electronic library of environmental data and derivatives from polar and geostationary satellites;
- The National Climatic Data Center*, which is the world's largest active archive of weather data, produces numerous climate publications and responds to data requests from all over the world;
- The National Geophysical Data Center* which provides scientific stewardship, products, and services for geophysical data from the Sun to the Earth and Earth's sea floor and solid earth, including observations from space;
- The National Oceanographic Data Center* and National Coast Data Development Center* which archive and provide public access to global oceanographic and coastal data, products, and information;
- The Office of Oceanic and Atmospheric Research which assists other NOAA entities in producing high quality scientific products and coordinates certain OAR-specific NOAA components such as the National Sea Grant College Program (e.g. Michigan Sea Grant through UM and MSU), Research Laboratories (e.g. the Great Lakes Environmental Research Laboratory), the Climate Program Office, and Cooperative Institutes (e.g. Cooperative Institute for Limnology and Ecosystems Research – Ann Arbor, Michigan);
- The National Marine Fisheries Service which documents and analyzes fishery related data, including those related to the Great Lakes; and
- The National Data Buoy Center which provides access to data (e.g. wind, waves, pressures, temperatures, water levels, visibility) from its buoys as well as those of the NWS, NOS, GLERL, Canadian organizations, and other (e.g. the University of Michigan).

Much of the data generated by these and other program can be accessed through specialized portals associated with the appropriate program or publications related to specific research or documentation conducted through a given program. NOAA as a whole also maintains a 'central library' that is accessible at http://www.lib.noaa.gov/. NOAA also has a National Environmental Satellite, Data, and Information Service (NESDIS) that is dedicated to providing timely access to global environmental data from satellites and other sources. NESDIS consists of many NOAA offices (those with a * above and nine others) that work together to manage collection devices (e.g. satellites), provide information services, and conduct research.

United States Fish and Wildlife Service

The U.S. Fish and Wildlife Service (FWS) helps protect a healthy environment for people, fish, and wildlife with an emphasis on protecting migratory birds, endangered species, rare marine mammals, and freshwater anadromous fish. Studies in support of the service's mission may include those related to bird populations, habitat (e.g. wetlands, forest lands) assessments – distribution and quality, cultural resources (e.g. archaeological sites), ecosystem conditions (e.g. pollinators), endangered and threatened species, environmental quality – biological (e.g. amphibian conditions, invasive species), environmental quality – chemical/physical (e.g. endocrine disruptors, oil spills, pesticides, nutrients), and fisheries (e.g. hatcheries, stocking, passage) such as the Lake Sturgeon Monitoring program.

Natural Resources Conservation Service

The Natural Resources Conservation Service (NRCS) is primarily a technical and financial assistance organization that helps private land owners (e.g. farmers), communities, state government, local government, and other federal agencies in planning and implementing actions to conserve soil, water, and other natural resources. In support of the assistance programs, the NRCS also has certain programs and develops appropriate data resources, including: original soil surveys (which are out-of-date or needing maintenance for all counties represented in the watershed/AOC) , the soil survey geographic (SSURGO) database, the state soil geographic (STATSGO) database, the parameter-elevation regressions on independent slopes model (PRISM) and other climate data, soil and water conservation district boundaries, the national plants database, the national plants data center, the integrated taxonomic information system, the national agricultural imagery program, watershed boundary data, and the national resources inventory (NRI) - a statistical survey of land use and natural resource conditions (e.g. soil erosion and wetlands) and trends non-Federal lands which is also being used to assess the effectiveness of conservation activities being implemented on private lands.

The NRCS hosts the United States Department of Agriculture's powerful data gateway at http://datagateway.nrcs.usda.gov/ where the data listed above and other natural resources and environmental information can be obtained.

United States Census Bureau

The United States Census Bureau (USCB) is the government entity that performs the decennial census of America's population – in addition to other research into the population. The USCB produces an abundance of data related to population characteristics (e.g. income, education), households, development, and business which can be addressed at various levels of aggregation, from the size of a city block in some cases to the entire United States.

Federal Emergency Management Agency

The Federal Emergency Management Agency implements the National Flood Insurance Program (NFIP). In terms of data, the NFIP oversees the development of flood hazard maps that identify areas that are likely to be flooded under certain conditions and how often these conditions are likely to occur.

Multi-Resolution Land Characteristics Consortium

The Multi-Resolution Land Characteristics Consortium (MRLC) is a partnership between six federal agencies operating together to cost-effectively acquire and analyze a consistent set of satellite-based remotely-sensed data for environmental programs. The effort is spearheaded by the USGS and the EPA and includes NOAA, the United States Forest Service, the National Aeronautic and Space Administration, and the Bureau of Land Management. Consortium programs, data, or data derived primarily from it, include: 1992 national land cover data (the first national land-cover data set produced since the early 1970s), 2001 national land cover data, regional vulnerability assessment for priority-setting, the environmental monitoring and assessment program, the earth resource and observation science (EROS) center, the gap analysis program (GAP), the North American landscape characterization (NALC), the global land cover characterization (GLCC), the coastal change analysis program (CCAP), the forest inventory and analysis (FIA), and the landscape analysis and assessment (LAA).

National Geospatial Programs Office – Federal Geographic Data Committee

The Federal Geographic Data Committee (FGDC) is an interagency committee – headed by the USGS – that promotes the coordinated development, use, sharing, and dissemination of geospatial data on a national basis. This nationwide data publishing effort is known as the National Spatial Data Infrastructure (NSDI). The NSDI is a physical, organizational, and virtual network designed to enable the development and sharing of this nation's digital geographic information resources.

As well as the FGDC, the National Geospatial Programs Office oversees other geospatial programs of national importance such as the Geospatial One-Stop portal (http://geodata.gov).

International Joint Commission

The International Joint Commission (IJC) is involved in numerous programs that deal with water quality issues in trans-boundary waters. In support of these numerous programs, targeted projects dealing with both the collection of data and its analysis have been, and continue to be, implemented. A list of IJC publications can be searched at: http://www.ijc.org/php/publications/biblio_library.php?language=english. Notable publications by the IJC include the biennial reports on Great Lakes water quality and annual reports discussing activities taken and studies conducted during the previous year.

Additional Protocols for Data Collection

The protocols listed below are not currently implemented by regulatory agencies on a regular basis (although they may be regularly implemented as volunteer activities) but should be considered as methods to obtain appropriate data for conducting assessments. These protocols, and others like them, are not just data collection exercises, but will also contain an assessment and ranking mechanism that can provide consistency in rating sites throughout the watershed/AOC and throughout the years of programmatic data collection.

Road-Stream Crossing Surveys

The stream crossing watershed survey is an approach used to collect information about the quality of a stream. A standard data collection form is used to ensure uniformity throughout the watersheds. The physical habitat of the site including water characteristics, stream characteristics, plant life, foam and trash presence, substrate type, stream morphology, land use, and corridor description are recorded. Also potential sources of pollution upstream and downstream of the site are identified if apparent.

The MDEQ maintains a statewide database and standard protocol set that can easily be implemented. The MDEQ may provide training upon request.

Stream Assessment

During this effort the participants traverse (e.g. walk, canoe) reaches of a stream looking for and recording issues potentially impacting the waterbody such as outfalls, bank erosion, buffer, channel modifications, trash and debris, and impacts from utilities. Issues such as substrate, water clarity, plant and wildlife, shade cover can also be noted.

This method is similar to the Road-Stream Crossing Surveys but is conducted on entire stretches of stream as opposed to discrete sites where streams and roads cross. Example methodologies include that which is developed by the Center for Watershed Protection (CWP) and outlined in 'Unified Stream Assessments: A User's Manual' Version 2.0 and the method developed by the U.S. EPA.

Unified Subwatershed and Site Reconnaissance

The Unified Subwatershed and Site Reconnaissance (USSR) survey, developed by the CWP (2005), involves conducting quick but thorough characterizations of upland areas. The goal of the USSR is to identify major source types and areas that potentially contribute pollutants to waterbodies. The four major components of this survey include: neighborhood source assessments, hotspot site investigations (e.g. brownfields, abandoned landfills), pervious area assessments, and street and storm drains assessments.

Appendix E.2: Pollutant Load Calculations

Table E.2-1. Allowable loads, current loads, and target load reductions for: (a) total suspended solids and (b) *E. coli*.

Load	Rch 601	Rch 602	Rch 603	Rch 604	Rch 607	Rch 608	Rch 609	Rch 610	Rch 611	Rch 612	Rch 613	Rch 614	Rch 615	Rch 616
Allowable Load (t/y)	@50 mg/L	@50 mg/L	@50 mg/L	@65 mg/L	@65 mg/L	@65 mg/L	@65 mg/L	@65 mg/L	@65 mg/L	@65 mg/L	@65 mg/L	@50 mg/L	@65 mg/L	@75 mg/L
High Flows (0-10%)	2,312	3,532	3,094	11,013	6,901	19,599	3,124	10,110	3,183	18,216	19,004	2,863	43,254	53,869
Moist Conditions (10-40%)	472	632	694	2,217	1,094	3,776	1,394	2,738	1,333	5,024	5,586	577	11,190	12,668
Mid-range Flows (40-60%)	71	138	105	472	284	757	845	1,141	793	2,444	2,330	112	3,570	4,080
Dry Conditions (60-90%)	20	54	17	96	39	134	501	594	433	1,442	1,362	19	1,606	1,809
Low Flows (90-100%)	4	17	6	35	16	53	224	224	162	507	511	8	613	733
Modeled Current Load (t/y)														
High Flows (0-10%)	5,888	8,737	6,899	25,523	14,372	47,520	9,686	20,611	6,011	38,534	41,298	6,268	105,298	118,457
Moist Conditions (10-40%)	749	1,050	977	3,683	2,526	6,335	2,450	4,153	1,909	7,780	7,733	1,034	19,221	21,944
Mid-range Flows (40-60%)	93	193	11	638	410	1,234	1,483	1,553	1,131	2,958	2,826	194	4,745	5,145
Dry Conditions (60-90%)	34	76	26	132	47	167	722	737	543	1,821	1,906	27	2,079	2,367
Low Flows (90-100%)	6	19	1	43	18	57	262	27	17	66	54	9	64	68
Targeted Load Reduction (t/y)														
High Flows (0-10%)	3,576	5,206	3,805	14,511	7,472	27,922	6,562	10,501	2,829	20,318	22,294	3,405	62,045	64,588
Moist Conditions (10-40%)	277	418	284	1,467	1,432	2,559	1,057	1,415	576	2,756	2,147	457	8,030	9,276
Mid-range Flows (40-60%)	22	55	0	166	126	477	638	412	339	515	495	82	1,176	1,065
Dry Conditions (60-90%)	14	22	8	37	8	33	222	143	110	379	545	8	473	558
Low Flows (90-100%)	2	2	0	8	1	4	37	0	0	0	0	1	0	0
Total Allowable Load	2,879	4,373	3,915	13,833	8,334	24,319	6,088	14,806	5,903	27,633	28,793	3,579	60,232	73,160
Total Modeled Current Load	6,770	10,076	7,913	30,020	17,374	55,313	14,603	27,081	9,612	51,159	53,817	7,532	131,408	147,981
Net Targeted Load Reduction	3,890	5,703	3,998	16,188	9,039	30,994	8,515	12,275	3,709	23,526	25,024	3,953	71,175	74,821
Total Targeted Load Reduction[1]	**3,890**	**5,703**	**4,097**	**16,188**	**9,039**	**30,994**	**8,515**	**12,471**	**3,853**	**23,968**	**25,481**	**3,953**	**71,724**	**75,487**

1 - if the flow categories are considered separately

Load	Rch 601	Rch 602	Rch 603	Rch 604	Rch 607	Rch 608	Rch 609	Rch 610	Rch 611	Rch 612	Rch 613	Rch 614	Rch 615	Rch 616
Allowable Exceedances (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Modeled Current Exceedances (%) - 30 day geometric mean	99%	99%	76%	92%	74%	84%	100%	99%	98%	96%	99%	94%	99%	100%
Modeled Current Exceedances (%) -summer daily maximum	81.0%	82.3%	37.6%	64.5%	43.6%	58%	71%	33%	41%	29%	31%	56%	47%	52.3%
Modeled Current Exceedances (%) -winter daily maximum	16%	15%	14%	10%	12%	8%	6%	11%	2%	7%	6%	10%	7%	8%
Targeted Exceedance Reductions (%) - 30 day geometric mean	99%	99%	76%	92%	74%	84%	100%	99%	98%	96%	99%	94%	99%	100%
Targeted Exceedance Reductions (%) -summer daily maximum	81%	82%	38%	65%	44%	58%	71%	33%	41%	29%	31%	56%	47%	52%
Targeted Exceedance Reductions (%) -winter daily maximum	16%	15%	14%	10%	12%	8%	6%	11%	2%	7%	6%	10%	7%	8%

Table E.2-2. Allowable loads, current loads, and target load reductions for nutrients: (a) phosphorus and (b) nitrogen.

Load	Rch 601	Rch 602	Rch 603	Rch 604	Rch 607	Rch 608	Rch 609	Rch 610	Rch 611	Rch 612	Rch 613	Rch 614	Rch 615	Rch 616
Allowable Load (t/y)	@0.1 mg/L	@0.1 mg/L	@0.1 mg/L	@0.1 mg/L	@0.1 mg/L	@0.1 mg/L	@0.1 mg/L	@0.1 mg/L	@0.1 mg/L	@0.1 mg/L	@0.1 mg/L	@0.1 mg/L	@0.1 mg/L	@0.1 mg/L
High Flows (0-10%)	3.3	4.9	3.9	11.7	6.7	19.2	4.1	10.9	4.0	19.2	20.3	3.9	48.6	50.5
Moist Conditions (10-40%)	0.6	0.9	0.7	2.1	1.2	3.4	2.1	3.5	2.0	6.7	7.0	0.7	12.3	12.7
Mid-range Flows (40-60%)	0.2	0.3	0.2	0.6	0.4	1.0	1.3	1.7	1.2	3.5	3.6	0.2	5.2	5.4
Dry Conditions (60-90%)	0.0	0.1	0.0	0.2	0.1	0.2	0.7	0.9	0.6	1.8	1.8	0.0	2.4	2.5
Low Flows (90-100%)	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.3	0.2	0.8	0.8	0.0	0.9	1.0
Modeled Current Load (t/y)														
High Flows (0-10%)	3.5	5.1	2.2	12.4	5.5	16.6	0.9	8.1	0.8	12.1	11.8	3.4	41.5	38.5
Moist Conditions (10-40%)	0.1	0.2	0.1	0.4	0.2	0.6	0.5	0.7	0.3	1.2	1.2	0.2	2.0	2.0
Mid-range Flows (40-60%)	0.1	0.2	0.1	0.3	0.2	0.4	0.9	0.5	0.2	0.8	0.8	0.1	1.1	1.0
Dry Conditions (60-90%)	0.1	0.2	0.1	0.4	0.2	0.6	1.3	0.4	0.2	0.7	0.7	0.2	1.1	1.0
Low Flows (90-100%)	0.1	0.2	0.1	0.4	0.2	0.6	1.9	0.4	0.2	0.7	0.7	0.2	1.1	0.9
Targeted Load Reduction (t/y)														
High Flows (0-10%)	0.3	0.2	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Moist Conditions (10-40%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mid-range Flows (40-60%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dry Conditions (60-90%)	0.1	0.1	0.1	0.2	0.1	0.3	0.6	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Low Flows (90-100%)	0.1	0.1	0.1	0.3	0.2	0.5	1.6	0.0	0.0	0.0	0.0	0.2	0.1	0.0
Total Allowable Load	4.1	6.2	4.9	14.6	8.4	23.9	8.4	17.3	8.0	32.0	33.4	4.8	69.4	72.0
Total Modeled Current Load	4.0	5.9	2.7	13.8	6.4	18.7	5.5	10.1	1.7	15.7	15.2	4.0	46.8	43.3
Net Targeted Load Reduction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Targeted Load Reduction[1]	**0.5**	**0.5**	**0.2**	**1.3**	**0.3**	**0.8**	**2.2**	**0.0**	**0.0**	**0.0**	**0.0**	**0.3**	**0.1**	**0.0**

1- if the flow categories are considered separately

Load	Rch 601	Rch 602	Rch 603	Rch 604	Rch 607	Rch 608	Rch 609	Rch 610	Rch 611	Rch 612	Rch 613	Rch 614	Rch 615	Rch 616
Allowable Load (t/y)	@0.3 mg/L	@0.3 mg/L	@0.3 mg/L	@0.3 mg/L	@0.3 mg/L	@0.3 mg/L	@0.3 mg/L	@0.3 mg/L	@0.3 mg/L	@0.3 mg/L	@0.3 mg/L	@0.3 mg/L	@0.3 mg/L	@0.3 mg/L
High Flows (0-10%)	9.8	14.8	11.8	35.1	20.2	57.7	12.2	32.6	11.9	57.7	60.8	11.6	145.7	151.4
Moist Conditions (10-40%)	1.8	2.8	2.1	6.3	3.5	10.2	6.3	10.5	6.0	20.2	20.9	2.1	36.9	38.0
Mid-range Flows (40-60%)	0.5	0.9	0.6	1.9	1.1	3.1	3.9	5.2	3.6	10.5	10.7	0.6	15.7	16.2
Dry Conditions (60-90%)	0.1	0.2	0.1	0.5	0.2	0.7	2.0	2.6	1.8	5.4	5.5	0.1	7.1	7.4
Low Flows (90-100%)	0.0	0.1	0.0	0.1	0.1	0.2	0.9	1.0	0.7	2.3	2.4	0.0	2.8	2.9
Modeled Current Load (t/y)														
High Flows (0-10%)	54.0	77.7	43.7	185.1	97.5	281.0	10.7	15.8	3.6	108.3	135.4	55.0	580.3	620.7
Moist Conditions (10-40%)	1.0	1.5	0.8	3.1	1.7	4.5	2.9	3.0	1.3	5.4	5.5	1.1	13.9	14.5
Mid-range Flows (40-60%)	0.3	0.4	0.3	0.6	0.4	0.9	3.2	1.6	0.8	2.5	2.3	0.3	3.4	3.2
Dry Conditions (60-90%)	0.2	0.3	0.2	0.6	0.3	0.9	3.6	0.8	0.4	1.3	1.2	0.2	2.2	2.0
Low Flows (90-100%)	0.1	0.2	0.1	0.4	0.2	0.6	2.9	0.4	0.2	0.7	0.6	0.2	1.2	1.1
Targeted Load Reduction (t/y)														
High Flows (0-10%)	44.1	62.9	31.9	150.1	77.3	223.3	0.0	0.0	0.0	50.6	74.7	43.4	434.6	469.3
Moist Conditions (10-40%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mid-range Flows (40-60%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dry Conditions (60-90%)	0.1	0.1	0.0	0.1	0.1	0.2	1.6	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Low Flows (90-100%)	0.1	0.1	0.1	0.3	0.2	0.4	2.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Total Allowable Load	12.2	18.7	14.7	43.9	25.1	71.8	25.3	51.9	24.0	96.1	100.2	14.5	208.2	215.9
Total Modeled Current Load	55.5	80.1	45.1	189.8	100.2	287.8	23.2	21.6	6.3	118.3	145.2	56.7	601.0	641.5
Net Targeted Load Reduction	43.3	61.3	30.4	146.0	75.1	216.0	0.0	0.0	0.0	22.1	44.9	42.2	392.8	425.6
Total Targeted Load Reduction[1]	**44.3**	**63.0**	**32.0**	**150.4**	**77.6**	**223.9**	**3.5**	**0.0**	**0.0**	**50.6**	**74.7**	**43.6**	**434.6**	**469.3**

Table E.2-3. Allowable loads, current loads, and target load reductions for hydraulic / hydrologic characteristics.

Trend Analysis / Regression Data	North Branch[3] (USGS gage = 04164500)	Comment
Desired Level: 1980 R- B Index (from trend analysis)	0.330	From 1980 to 2009 regression.
Desired Level: 1980 Imperviousness – based in GIRAS[1] data with SEMCOG impervious % (Chapter 5)	4.7%	Geographic Information Retrieval and Analysis System data from the USGS / EPA.
2009 R-B Index (from trend analysis)	0.374	From 1980 to 2009 regression.
2009 Imperviousness – from the NLCD	6.5%	National Land Cover Data from the EPA. The two imperviousness estimates rely on different methods and therefore direct comparison between them may not be applicable in all situations. However, the data is provided and compared to allow for the setting of general targets and not for precise data analysis.
Target Imperviousness Mitigation (2009 -1980 Imperviousness)	1.8%	
Expected Resultant R-B Index Reduction (2009 R-B Index – 1980 R-B Index)	0.044	
Although the targets set are for the entire watershed, mitigation efforts should be directed to those reaches and land uses previously identified in the Impervious Cover Analysis (Chapter 5). Recall that the impervious cover analysis findings indicated that efforts to mitigate the effects of imperviousness should focus on reaches 602, 612, 615 and in particular 616 as well as on other more isolated urbanized areas in the other reaches. The four reaches rated greater than 'sensitive' should implement watershed protection activities that focus on reducing bacterial contamination and implementing pollutant load reducing BMPs.		

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Appendix E.3: Water Quality Standards

This appendix contains the Michigan Department of Environment Quality's (MDEQ's) water quality standards (WQS) for vaious toxic compounds (inorganic chemicals, metals, and organic chemicals).

Rule 57 Water Quality Values
Surface Water Assessment Section
Michigan DEQ

4/25/2007

NOTES:
All chemical specific values are in ug/L and expressed as total unless otherwise indicated
EXP = exponent in log base e
H = hardness (in mg/L)
ID = insufficient data to derive value
NLS = no literature search has been conductec
NA = not applicable
@ = Bioaccumulative Chemical of Concern
# = carcinogen
* = the lowest HNV, WV, HCV or FCV given for this chemical will
adequately protect the uses identified with "ID*"
CFa = acute conversion factor for cadmium = 1.136672-[(lnH)(0.04184)]
CFb = chronic conversion factor for cadmium = 1.101672-[(lnH)(0.04184)]
CFc = acute and chronic conversion factor for lead = 1.46203-[(lnH)(0.14571)]
D = value is expressed as dissolved
Modifications/additions to this spreadsheet compared to the previous one dated 12/11/06 are shaded

		HNV Drink		HNV Non-drink		WV		HCV Drink		HCV Non-drink		FCV		AMV		FAV	
CAS #	PARAMETER NAME	Value	verif date	Value	verif date	Value	verif date	Value	verif date	Value	verif date	Value	verif date	Value	verif date	Value	verif date
50000	Formaldehyde	5000	1199807	390000	1199807	NA		NA		NA		120	2199807	1000	2199807	2100	2199807
50293	DDT # @	0.002	1199707	0.002	1199707	0.000011	1199707	0.00015	1199707	0.00015	1199707	0.0032	2199708	0.029	2199708	0.057	2199708
50328	Benzo(a)pyrene #	NLS		NLS		NA		NLS		NLS		ID	199712	ID	199712	ID	199712
51285	2,4-Dinitrophenol	55	1199707	2800	1199707	NA		NA		NA		19	2200301	130	2200301	270	2200301
53703	Dibenz(a,h)anthracene #	NLS		NLS		NA		NLS		NLS		ID	199712	ID	199712	ID	199712
56235	Carbon tetrachloride #	18	1200209	140	1200209	NA		5.6	1200209	45	1200209	89	2200210	800	2200210	1600	2200210
56382	Parathion	NLS		NLS		NA		NA		NA		0.013	1199707	0.065	1199707	0.13	1199707
56553	Benzo(a)anthracene	NLS		NLS		NA		NLS		NLS		ID	200002	ID	200002	ID	200002
57125	Cyanide, free	600	1199707	48000	1199707	NA		NA		NA		5.2	1199707	22	1199707	44	1199707
57556	Propylene glycol	580000	1200202	47000000	1200202	NA		NA		NA		290000	2200203	1000000	2200203	2100000	2200203
57749	Chlordane # @	0.0014	1199707	0.0014	1199707	NLS		0.00025	1199707	0.00025	1199707	0.029	2199705	0.27	2199705	0.53	2199705
58899	Lindane # @	0.47	1199707	0.5	1199707	0.026	1199809	0.025	2199809	0.027	2199809	0.07	2199706	0.95	1199707	1.9	1199707
58902	2,3,4,6-Tetrachlorophenol	120	2200301	150	2200301	NA		NA		NA		1.2	2200301	11	2200301	22	2200301
59507	4-Chloro-3-methylphenol	6900	1200103	39000	1200103	NA		NA		NA		7.4	2200103	67	2200103	130	2200103
60297	Ethyl ether	14000	1199707	1000000	1199707	NA		NA		NA		ID	200605	ID	200605	ID	200605
60571	Dieldrin # @	0.00041	1199707	0.00041	1199707	0.000071	1199704	0.0000065	1199707	0.0000065	1199707	0.056	1199707	0.24	1199707	0.48	1199707
62533	Aniline #	190	1199809	13000	1199809	NA		21	1199809	1500	1199809	4	2199907	18	2199907	36	2199907
64175	Ethanol	1500000	1199810	120000000	1199810	NA		NA		NA		NLS		NLS		NLS	
64186	Formic acid	38000	1199905	3100000	1199905	NA		NA		NA		ID	199905	ID	199905	ID	199905
64197	Acetic acid (includes acetate)	16000	2199807	1300000	2199807	NA		NA		NA		EXP(0.2732*(pH) + 7.0362)	2200506	EXP(0.2732)*(pH) + 9.2333)	2200506	EXP(0.2732*(pH) + 9.9265)	2200506
67561	Methanol	14000	1199810	1100000	1199810	NA		NA		NA		590000	2200307	1300000	2200307	2700000	2200307
67630	2-Propanol	28000	1200202	2200000	1200202	NA		NA		NA		57000	2200203	500000	2200203	1000000	2200203
67641	Acetone	5600	1199710	450000	1199710	NA		NA		NA		1700	2199711	15000	1199711	30000	1199711
67663	Chloroform #	350	1200508	11000	1200508	NA		*	200508	*	200508	630	2200505	5700	1200505	11000	1200505
67685	Dimethylsulfoxide	830000	1199807	67000000	1199807	NA		NA		NA		190000	2199709	1700000	2199709	3400000	2199709
67721	Hexachloroethane #	6	1199707	7.6	1199707	NA		5.3	1199707	6.7	1199707	13	2200512	110	2200512	210	2200512
71432	Benzene #	19	1199707	510	1199707	NA		12	1199707	310	1199707	200	2200608	950	2200608	1900	2200608
71501	Acetate (includes acetic acid)	16000	2199807	1300000	2199807	NA		NA		NA		EXP(0.2732*(pH) + 7.0362)	2200407	EXP(0.2732)*(pH) + 9.2333)	2200407	EXP(0.2732*(pH) + 9.9265)	2200407
71556	1,1,1-Trichloroethane	1900	1200407	42000	1200407	NA		NA		NA		89	2200309	800	2200309	1600	2200309
72208	Endrin	NLS		NLS		NA		NA		NA		0.036	1199707	0.086	1199707	0.172	1199707
74839	Bromomethane	39	1199708	2600	1199708	NA		NA		NA		35	2199801	320	2199801	640	2199801
74873	Chloromethane #	18000	1199708	1300000	1199708	NA		110	2199708	7300	2199708	ID	199710	ID	199710	ID	199710
74895	Methylamine	ID	199805	ID	199805	NA		NA		NA		ID	199807	ID	199807	ID	199807
74931	Methylmercaptan	140	1200107	11000	1200107	NA		NA		NA		ID	200107	ID	200107	ID	200107
74975	Bromochloromethane	1000	1200108	59000	1200108	NA		NA		NA		ID	200109	ID	200109	ID	200109
75003	Chloroethane #	500000	1199806	27000000	1199806	NA		170	1199806	9400	1199806	1100	2200409	10000	2200409	20000	2200409
75014	Vinyl chloride #	83	1200609	4400	1200609	NA		0.25	1200609	13	2200609	930	2200609	8400	2200609	17000	2200609
75047	Ethylamine	740	1199712	60000	1199712	NA		NA		NA		ID	199807	ID	199807	ID	199807
75070	Acetaldehyde	1200	2200107	93000	2200107	NA		NA		NA		130	2200107	1200	2200107	2400	2200107
75092	Methylene chloride #	1600	1199707	90000	1199707	NA		47	1199707	2600	1199707	1500	2200508	8500	2200508	17000	2200508
75150	Carbon disulfide	1000	1199809	34000	1199809	NA		NA		NA		ID	200511	ID	200511	ID	200511
75252	Bromoform #	470	1199801	8100	1199801	NA		52	1199801	890	1199801	ID	199712	ID	199712	ID	199712
75274	Dichlorobromomethane #	170	1199803	4500	1199803	NA		6.8	1199803	180	1199803	ID	199802	ID	199802	ID	199802
75343	1,1-Dichloroethane	1500	1199802	62000	1199802	NA		NA		NA		740	2200005	6600	2200005	13000	2200005

		HNV		HNV				HCV		HCV							
		Drink		Non-drink		WV		Drink		Non-drink		FCV		AMV		FAV	
CAS #	PARAMETER NAME	Value	verif date	Value	verif date	Value	verif date	Value	verif date	Value	verif date	Value	verif date	Value	verif date	Value	verif date
75354	1,1-Dichloroethylene	1200	1200209	33000	1200209	NA		NA		NA		130	2200302	1200	2200302	2300	2200302
75434	Dichlorofluoromethane	2500	2199910	130000	2199910	NA		NA		NA		150	2199910	1300	2199910	2600	2199910
75569	Propylene oxide #	ID*	199711	ID*	199711	NA		2.3	1199711	180	1199711	220	2199709	2000	2199709	4000	2199709
75718	Dichlorodifluoromethane	2900	1199905	90000	1199905	NA		NA		NA		ID	199905	ID	199905	ID	199905
76131	1,1,2-Trichloro-1,2,2-trifluoroethane	444000	1200007	1834000	1200007	NA		NA		NA		32	2200007	280	2200007	570	2200007
76448	Heptachlor #	0.071	2200007	0.072	2200007	NA		0.0017	2200007	0.0018	2200007	0.07	2200012	0.42	1200012	0.85	1200012
77474	Hexachlorocyclopentadiene	140	1199904	450	1199904	NA		NA		NA		ID	199904	ID	199904	ID	199904
77769	2,2-Dimethoxypropane	ID	199810	ID	199810	NA		NA		NA		ID	199812	ID	199812	ID	199812
78591	Isophorone #	4100	1199811	110000	1199811	NA		310	1199811	8200	1199811	1300	2200207	4600	2200207	9200	2200207
78875	1,2-Dichloropropane #	12000	1200309	380000	1200309	NA		9.1	1200309	290	1200309	230	2200309	2000	2200309	4000	2200309
78933	Methyl ethyl ketone	49000	1199808	3800000	1199808	NA		NA		NA		2200	2199810	20000	2199810	40000	2199810
79005	1,1,2-Trichloroethane #	110	1200207	3000	1200207	NA		12	1200207	330	1200207	500	2200209	2800	2200209	5600	2200209
79016	Trichloroethylene #	44	1199709	550	1199709	NA		29	1199707	370	1199707	200	2200509	1800	2200509	3500	2200509
79061	Acrylamide #	28	1200506	2200	1200506	NA		0.12	1200506	10	1200506	NLS		NLS		NLS	
79094	Propionic acid	50000	1199807	3900000	1199807	NA		NA		NA		ID	199709	ID	199709	ID	199709
79345	1,1,2,2-Tetrachloroethane #	10000	1200203	240000	1200203	NA		3.2	1200203	78	1200203	380	2200203	910	2200203	1800	2200203
80057	Bisphenol A	NLS		NLS		NLS		NLS		NLS		20	2200212	180	2200212	350	2200212
80466	Dimethylpropyl phenol	ID	199707	ID	199707	NA		NA		NA		ID	199710	ID	199710	ID	199710
83329	Acenapthene	580	2199903	890	2199903	NA		NA		NA		38	1200206	100	1200206	200	1200206
84662	Diethyl phthalate	14000	1200101	40000	1200101	NA		NA		NA		110	2200101	980	2200101	2000	2200101
84742	Di-n-butyl phthalate	640	2199808	690	2199808	NA		NA		NA		9.7	2199809	38	2199809	75	2199809
84764	Dinonyl phthalate	ID*	200501	ID*	200501	NA		NA		NA		140	2200501	1200	2200501	2500	2200501
85018	Phenanthrene	ID*	199706	ID*	199706	NA		NA		NA		2.4	2199703	21	2199703	43	2199703
85687	Butyl benzyl phthalate	6.9	1199902	160	1199902	NA		NA		NA		67	2200207	310	1200207	630	1200207
86737	Fluorene	140	2199901	160	2199901	NA		NA		NA		12	2199809	110	1199809	220	1199809
86748	Carbazole#	ID*	199809	ID*	199809	NA		19	1200001	41	1200001	4	2199905	36	2199905	72	2199905
87616	1,2,3-Trichlorobenzene	55	1200609	73	1200609	NA		NA		NA		ID	200609	ID	200609	ID	200609
87683	Hexachlorobutadiene # @	0.093	1199704	0.098	1199704	0.053	1199906	0.33	2199704	0.35	2199704	1	2199904	7	2199904	15	2199904
87821	Hexabromobenzene	81	1199903	6500	1199903	NA		NA		NA		ID	199903	ID	199903	ID	199903
87865	Pentachlorophenol #	300	1199710	450	1199710	NA		1.8	1199710	2.8	1199710	EXP(1.005*(pH)-5.134)	1199707	EXP(1.005*(pH)-4.869)	1199707	(EXP(1.005*(pH)-4.869))*2	1199707
88062	2,4,6-Trichlorophenol #	1900	1200612	14000	1200612	NA		41	1200612	290	1200612	5	2200609	39	2200609	79	2200609
88697	2-Isopropylphenol	ID	200212	ID	200212	NA		NA		NA		36	2200212	320	2200212	650	2200212
88755	2-Nitrophenol	ID	199805	ID	199805	NA		NA		NA		ID	199804	ID	199804	ID	199804
88857	Dinoseb	28	1200006	1900	1200006	NA		NA		NA		0.48	2200005	4.8	2200005	9.5	2200005
91203	Naphthalene	540	1199707	1200	1199707	NA		NA		NA		13	2199708	100	2199708	200	2199708
91576	2-Methylnaphthalene	600	2199801	1000	2199801	NA		NA		NA		ID	200407	ID	200407	ID	200407
91941	3,3'-Dichlorobenzidine #	650	2199709	950	2199709	NA		0.14	2199709	0.2	2199709	4.5	2199710	41	2199710	81	2199710
92524	Biphenyl	460	1200108	690	1200108	NA		NA		NA		13	2200110	54	2200110	110	2200110
92875	Benzidine #	74	1199712	3700	1199712	NA		0.0015	1199712	0.073	1199712	ID	200206	ID	200206	ID	200206
93721	Silvex	83	2200301	140	2200301	NA		NA		NA		30	2200301	270	2200301	540	2200301
93765	2,4,5-T	490	1200301	1200	1200301	NA		NA		NA		ID	200301	ID	200301	ID	200301
94757	2,4-D	240	1199804	1900	1199804	NA		NA		NA		220	2199802	1400	2199802	2900	2199802
95487	2-Methylphenol	1400	1199802	44000	1199802	NA		NA		NA		82	2199805	740	2199805	1500	2199805
95498	o-Chlorotoluene	360	1200010	970	1200010	NA		NA		NA		ID	200010	ID	200010	ID	200010
95501	1,2-Dichlorobenzene	2000	1200609	11000	1200609	NA		NA		NA		13	2200609	120	2200609	240	2200609
95512	2-Chloroaniline	270	1199811	9300	199811	NA		NA		NA		ID	199906	ID	199906	ID	199906
95578	2-Chlorophenol	190	2200703	400	2200703	NA		NA		NA		24	2200111	210	2200111	430	2200111
95636	1,2,4-Trimethylbenzene	190	2200101	330	2200101	NA		NA		NA		17	2200102	150	2200102	310	2200102
95943	1,2,4,5-Tetrachlorobenzene	2.8	1199902	2.9	1199902	NA		NA		NA		3	2199905	23	2199905	46	2199905
98066	tert-Butylbenzene	ID	200109	ID	200109	NA		NA		NA		ID	200109	ID	200109	ID	200109
98828	Isopropylbenzene	1700	1199709	3800	1199709	NA		NA		NA		ID	199709	ID	199709	ID	199709
98862	Acetophenone	ID	200108	ID	200108	NA		NA		NA		ID	200109	ID	200109	ID	200109
98953	Nitrobenzene #	19	1199812	730	1199812	NA		4.7	1199812	180	1199812	220	2199903	1000	2199903	2100	2199903
99876	p-Isopropyltoluene	ID	200011	ID	200011	NA		NA		NA		ID	200010	ID	200010	ID	200010
99898	4-Isopropylphenol	ID	200212	ID	200212	NA		NA		NA		20	2200212	180	2200212	360	2200212
100027	4-Nitrophenol	680	1199810	18000	1199810	NA		NA		NA		60	2199707	540	2199707	1100	2199707
100414	Ethylbenzene #	2100	1199704	8900	1199704	NA		25	1200409	110	1200409	18	2200309	160	2200309	320	2200309
100425	Styrene #	4200	1199809	18000	1199809	NA		20	1199809	80	1199809	160	2199802	1400	2199802	2900	2199802
100618	N-methylaniline	ID	200607	ID	200607	NA		NA		NA		ID	200607	ID	200607	ID	200607
101848	Diphenyloxide	44	2200109	78	2200109	NA		NA		NA		2.9	2200109	26	2200109	52	2200109
102829	Tributylamine	ID	199707	ID	199707	NA		NA		NA		ID	199710	ID	199710	ID	199710
103231	Di(2-ethylhexyl)adipate	ID	200201	ID	200201	NA		ID	200201	ID	200201	4.6	2200404	41	2200404	83	2200404
103651	N-propyl benzene	ID	200011	ID	200011	NA		NA		NA		ID	200609	ID	200609	ID	200609

		HNV		HNV				HCV		HCV							
		Drink		Non-drink		WV		Drink		Non-drink		FCV		AMV		FAV	
CAS #	PARAMETER NAME	Value	verif date	Value	verif date	Value	verif date	Value	verif date	Value	verif date	Value	verif date	Value	verif date	Value	verif date
103695	N-ethylaniline	ID	199902	ID	199902	NA		NA		NA		1.8	2199709	16	2199709	32	2199709
104518	n-Butylbenzene	ID	200011	ID	200011	NA		NA		NA		ID	200010	ID	200010	ID	200010
104767	2-Ethylhexanol #	8700	1200201	68000	1200201	NA		86	1200408	660	1200408	130	2200402	1100	2200402	2300	2200402
105679	2,4-Dimethylphenol	450	1199707	8700	1199707	NA		NA		NA		380	2199909	1300	1199909	2700	1199909
106445	4-Methylphenol	1400	1199802	45000	1199802	NA		NA		NA		25	2200204	230	2200204	450	2200204
106467	1,4-Dichlorobenzene #	1100	1200609	11000	1200609	NA		24	1200609	240	1200609	17	2200610	100	2200610	210	2200610
106478	4-Chloroaniline #	30	1199809	1100	1199809	NA		1.9	1199809	66	1199809	ID	199909	ID	199909	ID	199909
106489	4-Chlorophenol	ID	199805	ID	199805	NA		NA		NA		15	2199804	140	2199804	270	2199804
106934	1,2-Dibromoethane #	250	1200607	8200	1200607	NA		0.17	1200607	5.7	1200607	15	2200607	140	2200607	280	2200607
107062	1,2-Dichloroethane #	6900	1200512	420000	1200512	NA		6	1200512	360	1200512	2000	2200409	8200	2200409	16000	2200409
107131	Acrylonitrile #	58	1200112	320	1200112	NA		0.89	1200112	5	1200112	66	2200204	590	2200204	1200	2200204
107211	Ethylene glycol	56000	1200003	4500000	1200003	NA		NA		NA		190000	2200003	1700000	2200003	3400000	2200003
108101	4-Methyl-2-pentanone	NLS		NLS		NA		NA		NA		ID	199801	ID	199801	ID	199801
108203	Diisopropylether	22000	1200008	1200000	1200008	NA		NA		NA		ID	200008	ID	200008	ID	200008
108394	3-Methylphenol	2700	1199912	89000	1199912	NA		NA		NA		71	2199912	636	2199912	1271	2199912
108601	Bis(2-chloroisopropyl)ether #	990	1199711	47000	1199711	NA		6	1199711	290	1199711	ID	199709	ID	199709	ID	199709
108678	1,3,5-Trimethylbenzene	2000	1200101	4200	1200101	NA		NA		NA		45	2200102	410	2200102	810	2200102
108883	Toluene	5600	1199707	51000	1199707	NA		NA		NA		270	2200510	1300	1200510	2600	1200510
108907	Chlorobenzene	470	1199707	3200	1199707	NA		NA		NA		25	2200707	220	2200707	450	2200707
108952	Phenol	1100	2200310	1200	2200310	NA		NA		NA		450	2200303	3400	1200303	6800	1200303
109739	Butylamine	ID	199805	ID	199805	NA		NA		NA		57	2199805	510	2199805	1000	2199805
109897	Diethylamine	310	1199712	24000	199712	NA		NA		NA		20	2199807	180	2199807	350	2199807
109999	Tetrahydrofuran	350	2199802	26000	2199802	NA		NA		NA		11000	2199806	74000	2199806	150000	2199806
110816	Diethyl disulfide	ID	199710	ID	199710	NA		NA		NA		ID	199710	ID	199710	ID	199710
110827	Cyclohexane	ID	200607	ID	200607	NA		NA		NA		ID	200607	ID	200607	ID	200607
111444	Bis(2-chloroethyl)ether #	ID*	200012	ID*	200012	NA		0.79	2200012	15	2200012	ID*	200012	ID	200012	ID	200012
111466	Diethylene glycol	170000	1199708	14000000	1199708	NA		NA		NA		ID	199801	ID	199801	ID	199801
111922	Dibutylamine	ID	199712	ID	199712	NA		NA		NA		ID	199802	ID	199802	ID	199802
112265	1,2-Bis(2-chloroethoxy)ethane	ID	200012	ID	200012	NA		NA		NA		1500	2200012	13000	2200012	26000	2200012
115297	Endosulfan	85	1200103	170	1200103	NA		NA		NA		0.029	2200107	0.13	1200107	0.27	1200107
117817	Bis(2-ethylhexyl)phthalate #	120	1199711	160	1199711	NA		25	1199711	32	1199711	ID*	199809	285	2199809	285	2199809
117840	Di-n-octyl phthalate	240	2199902	300	2199902	NA		NA		NA		ID	199808	ID	199808	ID	199808
118741	Hexachlorobenzene # @	0.046	1199707	0.046	1199707	0.0003	1199704	0.00045	1199707	0.00045	1199707	ID*	199801	ID	199801	ID	199801
120127	Anthracene	1900	2199901	2400	2199901	NA		NA		NA		ID	200407	ID	200407	ID	200407
120821	1,2,4-Trichlorobenzene	80	1199802	99	1199802	NA		NA		NA		30	2199802	100	2199802	200	2199802
120832	2,4-Dichlorophenol	220	1200609	1100	1200609	NA		NA		NA		19	2200204	160	2200204	320	2200204
120956	2,4-Di-tert-pentylphenol	ID	199712	ID	199712	NA		NA		NA		NLS		NLS		NLS	
121448	Triethylamine	4000	1199708	230000	1199708	NA		NA		NA		260	2199710	1100	2199710	2100	2199710
121824	RDX #	83	1199908	6100	1199908	NA		5.8	1199908	420	1199908	85	2199908	400	2199908	790	2199908
122349	Simazine	140	1200604	4000	1200604	NA		NA		NA		17	2200604	160	2200604	310	2200604
123911	1,4-Dioxane #	4000	1199806	320000	1199806	NA		34	1199806	2800	1199806	22000	2199806	200000	2199806	390000	2199806
124174	Diethylene glycol butyl ether acetate	330	1200501	13000	1200501	NA		NA		NA		260	2200501	2300	2200501	4600	2200501
124481	Dibromochloromethane #	570	1199803	12000	1199803	NA		6.8	1199803	150	1199803	ID	199802	ID	199802	ID	199802
126863	2,4,7,9-Tetramethyl-5-decyne-4,7-diol	ID	200112	ID	200112	NA		NA		NA		350	2200410	3100	2200410	6200	2200410
127184	Tetrachloroethylene #	320	1199705	1800	1199705	NA		11	1199705	60	1199705	190	2200405	1400	1200405	2900	1200405
127195	N,N-dimethylacetamide	700	1199711	57000	1199711	NA		NA		NA		4100	2199709	37000	2199709	74000	2199709
128370	4-Methyl-2,6-di-T-butylphenol #	3	2199805	3	2199805	NA		0.25	2199805	0.25	2199805	ID	199803	ID	199803	ID	199803
129000	Pyrene	15	2199807	15	2199807	NA		NA		NA		ID	200106	ID	200106	ID	200106
132649	Dibenzofuran #	ID*	199902	ID*	199902	NA		NA		NA		4	2199902	36	2199902	72	2199902
333415	Diazinon	12	1200408	37	1200408	NA		NA		NA		0.004	2200410	0.064	1200410	0.13	1200410
135988	sec-Butylbenzene	ID	200011	ID	200011	NA		NA		NA		ID	200010	ID	200010	ID	200010
140669	Octylphenol	NLS		NLS		NA		NA		NA		2	2199708	13	2199708	26	2199708
140807	N,N-diethyl-1,4-pentanediamine	ID	199807	ID	199807	NA		NA		NA		ID	199801	ID	199801	ID	199801
144627	Oxalic acid	4500	1199906	360000	1199906	NA		NA		NA		250	2200008	2300	2200008	4600	2200008
149735	Trimethylorthoformate	ID	199710	ID	199710	NA		NA		NA		ID	199709	ID	199709	ID	199709
156592	cis-1,2-Dichloroethylene	880	1199708	36000	1199708	NA		NA		NA		620	2200007	5500	2200007	11000	2200007
156605	trans-1,2-Dichloroethylene	470	1200306	19000	1200306	NA		NA		NA		1500	2200007	14000	2200007	28000	2200007
193395	Indeno (1,2,3-cd) pyrene #	NLS		NLS		NA		NLS		NLS		ID	199712	ID	199712	ID	199712
205992	Benzo(b)fluoranthene #	NLS		NLS		NA		NLS		NLS		ID	199712	ID	199712	ID	199712
206440	Fluoranthene	18	2199901	18	2199901	NA		NA		NA		1.6	2199806	14	1199806	28	1199806
208968	Acenaphthylene	ID	199803	ID	199803	NA		NA		NA		ID	200407	ID	200407	ID	200407
218019	Chrysene #	ID	199903	ID	199903	NA		ID	199903	ID	199903	ID	200106	ID	200106	ID	200106
309002	Aldrin #	0.00012	1200011	0.00012	1200011	NA		0.0000087	1200011	0.0000087	1200011	0.017	2200011	0.15	2200011	0.3	2200011

		HNV		HNV				HCV		HCV							
		Drink		Non-drink		WV		Drink		Non-drink		FCV		AMV		FAV	
CAS #	PARAMETER NAME	Value	verif date	Value	verif date	Value	verif date	Value	verif date	Value	verif date	Value	verif date	Value	verif date	Value	verif date
319857	beta-Hexachlorocyclohexane # @	0.091	1200011	0.098	1200011	ID*	200011	0.024	2200011	0.026	2200011	ID	200011	ID	200011	ID	200011
319868	delta-Hexachlorocyclohexane @	ID	200011	ID	200011	ID	200011	NA		NA		ID	200011	ID	200011	ID	200011
495487	Azoxybenzene	ID	199811	ID	199811	NA		NA		NA		ID	199812	ID	199812	ID	199812
526738	1,2,3-Trimethylbenzene	290	1200609	650	1200609	NA		NA		NA		ID	200609	ID	200609	ID	200609
540590	1,2-Dichloroethylene	ID	199902	ID	199902	NA		NA		NA		1100	2200007	9600	2200007	19000	2200007
541731	1,3-Dichlorobenzene	37	2200309	65	2200309	NA		NA		NA		28	2200309	100	2200309	200	2200309
575371	1,7-Dimethylnaphthalene	ID	200007	ID	200007	NA		NA		NA		ID	200007	ID	200007	ID	200007
585342	3-tert-Butylphenol	ID	200210	ID	200210	NA		NA		NA		29	2200212	260	2200212	530	2200212
591786	2-Hexanone	9700	1200409	630000	1200409	NA		NA		NA		ID	200409	ID	200409	ID	200409
594207	2,2-Dichloropropane	ID	199803	ID	199803	NA		NA		NA		ID	199802	ID	199802	ID	199802
608935	Pentachlorobenzene # @	0.38	1200206	0.38	1200206	0.019	1200206	NA		NA		1.2	2200206	11	2200206	21	2200206
611143	2-Ethyltoluene	ID	200109	ID	200109	NA		NA		NA		ID	200109	ID	200109	ID	200109
618451	3-Isopropylphenol	ID	200212	ID	200212	NA		NA		NA		26	2200212	240	2200212	470	2200212
620144	3-Ethyltoluene	ID	200109	ID	200109	NA		NA		NA		ID	200109	ID	200109	ID	200109
624920	Dimethyl disulfide	480	2199707	20000	2199707	NA		NA		NA		ID	199709	ID	199709	ID	199709
625456	Methoxyacetic acid	ID	200102	ID	200102	NA		NA		NA		270	2200008	2400	2200008	4800	2200008
625503	N-ethyl acetamide	ID	199807	ID	199807	NA		NA		NA		ID	199710	ID	199710	ID	199710
630206	1,1,1,2-Tetrachloroethane #	680	1200203	3500	1200203	NA		19	1200203	100	1200203	ID	200203	ID	200203	ID	200203
632224	1,1,3,3-Tetramethylurea	ID	200605	ID	200605	NA		NA		NA		ID	200605	ID	200605	ID	200605
637923	Ethyl tert-butyl ether	2500	1200703	130000	1200703	NA		NA		NA		ID	200609	ID	200609	ID	200609
685916	Diethylacetamide	ID	199707	ID	199707	NA		NA		NA		ID	199710	ID	199710	ID	199710
706785	Octachlorocyclopentene	ID	199903	ID	199903	NA		NA		NA		ID	199904	ID	199904	ID	199904
872504	N-Methyl pyrrolidone	25000	1200402	2000000	1200402	NA		NA		NA		ID	200402	ID	200402	ID	200402
927628	N,N-dimethyl-1-butamine	ID	199805	ID	199805	NA		NA		NA		ID	199803	ID	199803	ID	199803
950107	Mephosfolan	2.5	1200103	170	1200103	NA		NA		NA		0.37	2200112	3.3	2200112	6.6	2200112
1024573	Heptachlor epoxide #	0.0075	2200008	0.0076	2200008	NA		0.0021	2200008	0.0021	2200008	ID	200008	ID	200008	ID	200008
1330207	Xylene	3800	1200601	16000	1200601	NA		NA		NA		41	2200509	370	2200509	730	2200509
1336363	PCB # @	NLS		NLS		0.00012	1199707	0.000026	1199707	0.000026	1199707	ID*	199706	ID	199706	ID	199706
1634044	Methyl tert butyl ether (MTBE) #	920	1200001	63000	1200001	NA		100	1200001	7100	1200001	730	2199708	6500	2199708	13000	2199708
1702176	3,6-Dichloropicolinic acid	4100	1199806	200000	1199806	NA		NA		NA		ID	199809	ID	199809	ID	199809
1746016	2,3,7,8-TCDD # @	6.7E-08	1199707	6.7E-08	1199707	3.1E-09	1199707	8.6E-09	1199707	8.6E-09	1199707	ID*	199709	ID*	199709	ID*	199709
1912249	Atrazine	880	1200309	8600	1200309	NA		NA		NA		7.3	2199712	50	2199712	100	2199712
1918021	Picloram	5500	1200301	180000	1200301	NA		NA		NA		46	2200301	290	2200301	570	2200301
2385855	Mirex # @	ID*	199904	ID*	199904	0.000016	1199904	0.000042	1199904	0.000042	1199904	ID*	199905	ID	199905	ID	199905
2691410	HMX	1400	1199908	110000	1199908	NA		NA		NA		250	2199908	2300	2199908	4600	2199908
2764729	Diquat	61	1200212	4900	1200212	NA		NA		NA		ID	200306	ID	200306	ID	200306
2921882	Chlorpyrifos	*		*		NA		NA		NA		0.002	2200301	0.027	1200301	0.053	1200301
4684940	6-Chloropicolinic acid	410	1199806	22000	1199806	NA		NA		NA		26	2199809	230	2199809	460	2199809
4860031	1-Chlorohexadecane	ID	200007	ID	200007	NA		NA		NA		ID	200007	ID	200007	ID	200007
7439921	Lead	14	1200210	190	1200210	NA		NA		NA		(EXP(1.273*(LnH)-3.296))*CFc[D]	1199708	(EXP(1.273*(LnH)-1.1098))*CFc[D]	1199708	(EXP(1.273*(LnH)-1.1098))*CFc*2[D]	1199708
7439932	Lithium	720	2200602	58000	2200602	NA		NA		NA		96	2200008	870	1200008	1700	1200008
7439965	Manganese	1300	1200612	59000	1200612	NA		NA		NA		EXP(0.8784(lnH)+3.5199)	1200110	EXP(0.8784(lnH)+4.2889)	1200110	EXP(0.8784(lnH)+4.9820)	1200110
7439976	Mercury @	0.0018	1199707	0.0018	1199707	0.0013	1199707	NA		NA		0.77[D]	1199707	1.4[D]	1199707	2.8[D]	1199707
7439987	Molybdenum	120	1200605	10000	1200605	NA		NA		NA		3200	2200604	29000	2200604	58000	2200604
7440020	Nickel	2600	1199706	210000	1199706	NA		NA		NA		(EXP(0.846*(LnH)+0.0584))*0.997[D]	1199707	(EXP(0.846*(LnH)+2.255))*0.998[D]	1199707	(EXP(0.846*(LnH)+2.255))*0.998*2[D]	1199707
7440224	Silver	130	1199705	11000	1199705	NA		NA		NA		0.06	1199710	0.54	1199710	1.1	1199710
7440246	Strontium	ID*	199808	ID*	199808	NA		NA		NA		8300	2200110	75000	1200110	150000	1200110
7440280	Thallium	1.2	1200501	3.7	1200501	NA		NA		NA		7.2	2200508	47	2200508	94	2200508
7440326	Titanium	NLS		NLS		NA		NA		NA		ID	200205	ID	200205	ID	200205
7440360	Antimony	1.7	1199807	130	1199807	NA		NA		NA		240	2200106	1100	2200106	2300	2200106
7440382	Arsenic	50	1199709	280	2199709	NA		NA		NA		150	1199707	340	1199707	680	1199707
7440393	Barium	1900	1199705	160000	1199705	NA		NA		NA		EXP(1.0629*(lnH)+1.1869)	2200508	EXP(1.0629*(lnH)+2.2354)	2200508	EXP(1.0629*(lnH)+2.9285)	2200508
7440417	Beryllium	160	1199704	1200	1199704	NA		NA		NA		EXP(2.5279(LnH)-10.7689)	2199709	EXP(2.5279(LnH)-8.572)	2199709	EXP(2.5279(LnH)-7.8785)	2199709
7440428	Boron	1900	1199711	160000	1199711	NA		NA		NA		1900	2199903	16000	2199903	31000	2199903
7440439	Cadmium	2.5	1199706	130	1199706	NA		NA		NA		(EXP(0.7852*(LnH)-2.715))*CFb[D]	1199707	(EXP(1.128*(LnH)-3.6867))*CFa[D]	1199707	(EXP(1.128*(LnH)-3.6867))*CFa*2[D]	1199707
7440473	Chromium	120	1199706	9400	1199706	NA		NA		NA		(EXP(0.819*(LnH)+0.6848))*0.86[D]	1199707	(EXP(0.819*(LnH)+3.7256))*0.316[D]	1199707	(EXP(0.819*(LnH)+3.7256))*0.316*2[D]	1199707
7440484	Cobalt	ID*	199807	ID*	199807	NA		NA		NA		100	2199804	370	2199804	740	2199804
7440508	Copper	470	1200512	38000	1200512	NA		NA		NA		(EXP(0.8545*(LnH)-1.702))*0.96[D]	1199707	(EXP(0.9422*(LnH)-1.7))*0.96[D]	1199707	(EXP(0.9422*(LnH)-1.7))*0.96*2[D]	1199707
7440622	Vanadium	220	1199807	2200	1199807	NA		NA		NA		12	2199804	110	2199804	220	2199804
7440666	Zinc	3300	1200510	16000	1200510	NA		NA		NA		(EXP(0.8473*(LnH)+0.884))*0.986[D]	1199707	(EXP(0.8473*(LnH)+0.884))*0.978[D]	1199707	(EXP(0.8473*(LnH)+0.884))*0.978*2[D]	1199707
7664417	Ammonia, unionized coldwater	ID*	199711	ID*	199711	NA		NA		NA		29	1199710	160	1199710	320	1199710
7664417.1	Ammonia, unionized warmwater	ID*	199711	ID*	199711	NA		NA		NA		53	1199710	210	1199710	420	1199710
7722647	Potassium permanganate	NLS		NLS		NA		NA		NA		*	2200308	29	2200308	58	2200308

		HNV		HNV				HCV		HCV							
		Drink		Non-drink		WV		Drink		Non-drink		FCV		AMV		FAV	
CAS #	PARAMETER NAME	Value	verif date	Value	verif date	Value	verif date	Value	verif date	Value	verif date	Value	verif date	Value	verif date	Value	verif date
7722841	Hydrogen peroxide	ID*	199903	ID*	199903	NA		NA		NA		10	2199710	92	2199710	180	2199710
7726956	Bromine	ID*	199903	ID*	199903	NA		NA		NA		0.27	2199709	2.4	2199709	4.8	2199709
7758192	Chlorite	830	1200601	67000	1200601	NA		NA		NA		0.72	2200601	6.5	1200601	13	1200601
7782492	Selenium & inorganic salts	120	1199704	2700	1199704	NA		NA		NA		5	1199707	62	1199808	120	1199808
7782505	Chlorine	NLS		NLS		NA		NA		NA		*	1199709	19	1199709	38	1199709
7783064	Hydrogen sulfide	160	1200401	13000	1200401	NA		NA		NA		0.088	2200611	0.8	2200611	1.6	2200611
8001352	Toxaphene # @	0.021	1199710	0.021	1199710	0.00014	1199710	0.000068	1199707	0.000068	1199707	0.005	2199706	0.15	2199706	0.3	2199706
10028156	Ozone	NLS		NLS		NLS		NLS		NLS		0.065	2200112	0.58	2200112	1.2	2200112
10222012	DBNPA	ID*	199804	ID*	199804	NA		NA		NA		7.8	2199804	71	2199804	140	2199804
14797558	Nitrate	10000	1200309	NLS		NA		NA		NA		NLS		NLS		NLS	
15972608	Alachlor #	270	1199802	6900	1199802	NA		3.5	1199802	91	1199802	11	2199803	150	2199803	300	2199803
15541454	Bromate #	100	1200505	8200	1200505	NA		0.5	1200505	40	1200505	760	2200505	6900	2200505	14000	2200505
16984488	Fluoride	NLS		NLS		NA		NA		NA		2700	2200703	9800	2200703	20000	2200703
18540299	Chromium, hexavalent	120	1199706	9400	1199706	NA		NA		NA		11[D]	1199707	16[D]	1199707	32[D]	1199707
21725462	Cyanazine #	190	1199805	12000	1199805	NA		0.93	1199805	56	1199805	110	2199804	1000	2199804	2000	2119804
25154523	n-Nonylphenol (mixed isomers)	NLS		NLS		NA		NA		NA		2	1199902	7	1199902	14	1199902
26628228	Sodium azide	330	2200307	27000	2200307	NA		NA		NA		7.3	2200306	65	2200306	130	2200306
38836394	N-(1-methylpropylidene)-2-propanamine	ID	199805	ID	199805	NA		NA		NA		ID	199803	ID	199803	ID	199803
40360449	3,5,6-Trichloropicolinic acid	ID	199809	ID	199809	NA		NA		NA		ID	199805	ID	199805	ID	199805
40596698	Methoprene	21	2200401	21	2200401	NA		NA		NA		2.9	2200401	26	2200401	51	2200401
51207319	Tetrachlorodibenzofuran, 2,3,7,8-	NLS		NLS		NA		NA		NA		ID	199706	ID	199706	ID	199706
51218452	Metolachlor	3300	1200603	14000	1200603	NA		78	1200603	340	1200603	15	2200604	110	2200604	210	2200604
59756604	Fluridone	2200	1200212	80000	1200212	NA		NA		NA		1	2200304	3	2200304	250	2200301
64741668	Isopar C	ID	200402	ID	200402	NA		NA		NA		1.9	2200402	17	2200402	35	2200402
67774327	PBB #	0.00031	1199904	0.00031	1199904	NA		0.00013	1199904	0.00013	1199904	NLS		NLS		NLS	
84852153	4-Nonylphenol	130	2199811	200	2199811	NA		NA		NA		ID	199902	ID	199902	ID	199902
168316958	Spinosad	620	1200505	7500	1200505	NA		NA		NA		60	2200507	540	2200507	1100	2200507

The reformulated ICM includes three important changes to the original conceptual model proposed by Schueler (1994). First, the IC/stream quality relationship is no longer expressed as a straight line, but rather as a "cone" that is widest at lower levels of IC and progressively narrows at higher IC. The cone represents the observed variability in the response of stream indicators to urban disturbance and also the typical range in expected improvement that could be attributed to subwatershed treatment. In addition, the use of a cone rather than a line is consistent with the findings that exact, sharply defined IC thresholds are rare, and that most regions show a generally continuous but variable gradient of stream degradation as IC increases.

Second, the cone width is greatest for IC values less than 10%, which reflects the wide variability in stream indicators scores observed for this range of streams. This modification prevents the misperception that streams with low subwatershed IC will automatically possess good or excellent quality. As noted earlier, the expected quality of streams in this range of IC is generally influenced more by other watershed metrics such as forest cover, road density, riparian continuity, and cropping practices. This modification suggests that IC should not be the sole metric used to predict stream quality when subwatershed IC is very low.

Third, the reformulated ICM now expresses the transition between stream quality classifications as a band rather than a fixed line (e.g., 5 to 10% IC for the transition from sensitive to impacted, 20 to 25% IC for the transition from impacted to non-supporting, and 60 to 70% IC for the transition from non-supporting to urban drainage). The band reflects the variability in the relationship between stream hydrologic, physical, chemical, and biological responses and the qualitative endpoints that determine stream quality classifications. It also suggests a watershed manager's choice for a specific threshold value to discriminate among stream categories should be based on actual monitoring data for their ecoregion, the stream indicators of greatest concern and the predominant predevelopment regional land cover (e.g., crops or forest).

The ICM differs from most other models in that it provides a broader focus on a group of stream responses, yet focuses on only one stressor, impervious cover. The focus on IC allows watershed managers to use the ICM both to predict stream response and to manage future impacts by measuring and managing IC.

Figure E.4-1: ICM information.

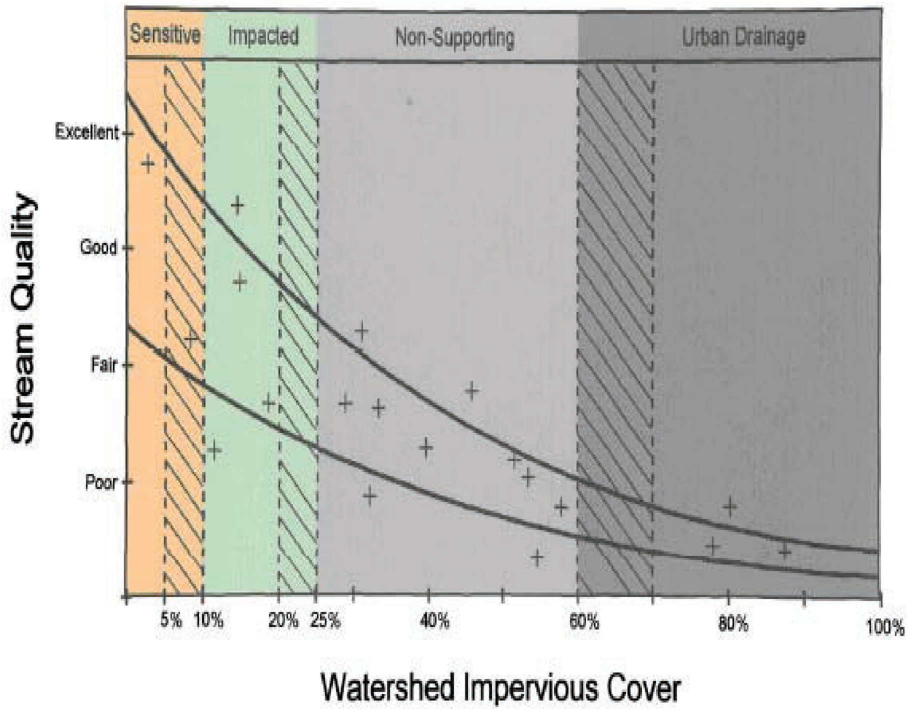


Figure 5-A.1. Reformulated Impervious Cover Model Reflecting Changes in Stream Quality in Response to Percent Impervious Cover in the Contributing Watershed. (Source: Chesapeake Stormwater Network, 2008)

Table E.4-1: ICM information.

Prediction	Impacted (IC = 11-25%) [8]	Non-Supporting (IC = 26-60%)	Urban Drainage (IC = ≥ 60%)
Runoff as a fraction of annual rainfall [1]	10 to 20%	25 to 60%	60 to 90%
Frequency of bankfull flow per year [2]	1.5 to 3 per year	3 to 7 per year	7 to 10 per year
Fraction of original stream network remaining	60 to 90%	25 to 60%	10 to 30%
Fraction of riparian forest buffer intact	50 to 70%	30 to 60%	Less than 30%
Crossings (roads/utilities, etc.) per stream mile	1 to 2	2 to 10	None left
Ultimate channel enlargement ratio [3]	1.5 to 2.5 times larger	2.5 to 6 times larger	6 to 12 times larger
Typical stream habitat score	Fair, but variable	Consistently poor	Poor, often absent
Increased stream warming [4]	2 to 4 °F	4 to 8 °F	8+ °F
Annual nutrient load [5]	1 to 2 times higher	2 to 4 times higher	4 to 6 times higher
Wet weather violations of bacteria standards	Frequent	Continuous	Ubiquitous
Fish advisories	Rare	Potential risk of accumulation	Should be presumed
Aquatic insect diversity [6]	Fair to good	Fair	Very poor
Fish diversity [7]	Fair to good	Poor	Very poor

1 Based on annual storm runoff coefficient ranges from 2 to 5% for undeveloped systems.
2 Predevelopment bankfull flood frequency is about 0.5 per year, or about one bankfull flood every two years.
3 Ultimate stream channel cross-section compared to typical predevelopment channel cross section.
4 Typical increase in mean summer stream temperature in degrees Fahrenheit compared with shaded rural stream.
5 Annual unit area stormwater phosphorus and/or nitrogen load produced from a rural subwatershed.
6 As measured by benthic index of biotic integrity. Scores for rural streams range from good to very good.
7 As measured by fish index of biotic integrity. Scores for rural streams range from good to very good.
8 IC is not the strongest indication of stream health below 10% IC, so the sensitive streams category is omitted from this table

Source: CWP, 2004

Appendix G.1: Subwatershed Protection Practices

Purpose

This appendix kdefines the current subwatershed protection practices, comments on their effectiveness, and identifies potential new practices.

Current Subwatershed Protection Practices

The subwatershed conditions discussed in the previous sections of this chapter are in large part a result of local/county/regional plans, programs, projects, and ordinances. As such, an analysis was performed to identify and critique the status of these various documents with regard to their effectiveness in managing water quality and quantity (excluding those documents that were not publicly available). An analysis of this nature was conducted for both the 2008 Remedial Action Plan and three 2007 subwatershed plans (Clinton River East, Red Run, and Lake St. Clair Direct Drainage – including 35 municipalities plus Macomb County) and the results from this inquiry in-part rely on the previous findings.

Analysis Details

As with previous analyses the framework was based on work by SEMCOG and the CWP. Both SEMCOG's *Opportunities for Water Resource Protection in Local Plans, Ordinances, and Programs* (2002) and CWP's Eight Tools of Watershed Protection (2002) were used to guide the inquiry. The following eight categories were considered when reviewing practices in the North Branch:

- Watershed Planning - The application of regulatory measures and/or planning techniques that are designed to maintain or limit future impervious cover, redirect development, and protect sensitive areas;
- Land Conservation - Programs or efforts to conserve undeveloped, sensitive areas or areas of particular historical or cultural value;
- Aquatic Buffers - The protection, restoration, creation, or reforestation of stream, wetland, and urban lake buffers.
- Better Site Design - Local ordinances and codes to incorporate techniques to reduce impervious cover and/or redirect runoff onto pervious surfaces in the design of new development and redevelopment projects.
- Erosion and Sediment Control - The use of erosion control, sediment control, and dewatering practices at all new development and redevelopment sites;
- Stormwater Management - The incorporation of structural practices into new development, redevelopment, or the existing landscape to help mitigate the impacts of stormwater runoff on receiving waters;
- Non-Stormwater Discharges - Locating, quantifying, and controlling non-stormwater pollutant sources in the watershed. May also include operation and maintenance practices that prevent / reduce pollutants from entering the natural/municipal drainage system; and
- Watershed Stewardship Programs - Stormwater and watershed education or outreach programs targeted towards fostering human behavior that prevents or reduces pollution over a range of land uses and activities.

A full audit of each community was not conducted. There were several reasons leading to the decision not to conduct a full audit. They are:

1. The two previous audits (mentioned above) indicated that "none of the communities have all the recommended stormwater policies and procedures in place". The previous audits concluded that:

   > "In general, these communities lack a comprehensive approach toward land management and, in particular, environmental management (including stormwater). This patchwork approach primarily stems from updating an out-of-date ordinance model on an as needed - basis as opposed to integrating communities' ordinances with their Master Plan."

   These audits were recent and little is expected to be different for the communities of the North Branch

2. None of the communities in the NB are subject to NPDES Phase II permit requirements. Therefore, there is not a regulatory reason for communities to change their current behavior.
3. The 2008 Phase II permit raised the standard for stormwater quantity and quality requirements. Communities previously evaluated would (and are having) a difficult time demonstrating that their existing measures are capable of meeting the new permit requirements.
4. Anecdotal evidence from the SWAG and other key informants supported the above conclusions regarding the current state of protection measures in the watershed.
5. The current fiscal climate in the state has limited development and local municipalities are struggling to balance their budgets. It is unlikely that any major changes have occurred since the 2008 audit due to fiscal constraints.
6. When asked to supply their current stormwater protection measures a majority of communities either could not produce documents or chose not to.
7. Information gathered from the municipal administrator interviews indicated that some of the communities were in the process of updating their ordinances. It was therefore not fair to audit their current measures since they were in a state of transition.
8. Information collected from the Unified Stream Assessment (USA) and Unifies Subwatershed Site Reconnaissance (USSR) serves as a proxy as to the effectiveness of the current efforts.

Based on previous analysis within the Clinton River watershed and other supplemental information specific to the subwatershed, the following characterizes the current state of watershed management efforts in the North Branch.

- Fewer than twenty percent (20%) of the communities have Community Master Plan and/or one that addressed the impacts of stormwater;
- Ordinances, including zoning ordinances are based on a template created in the 1970s and have been only updated on an as-needed-basis. Some glaring deficiencies include:
    1. They have not adopted overlay zoning districts for riparian areas and greenways even if they may be available at the county level;
    2. In general, the only reference made to stormwater in the ordinances is that buildings within 200 feet of the stormwater sewer system must be hooked into it;
    3. Most but not all serviced communities did not allow septic systems within urban areas;
    4. Most communities do not have a tree ordinance;
    5. There is not likely to be any local references to clustering or open space development in community master plans or ordinances; and
    6. There is likely to be a reference to floodplains and/or stream corridors, wetlands, and natural area/greenway preservation in their ordinances;
- Most preservation and improvement efforts occur at the site plan review level and there is not strong support for them at the ordinance or master plan level;
- There is general lack of ability by communities to strictly and uniformly enforce standards due to not having formally adopted them. Current methods are not defensible in court and must be codified to provide true watershed protection.
- Communities in the watershed will likely defer regulating soil erosion and sediment control to the Macomb County Public Works Office.
- The 2008 NPDES Phase II permit has very specific water quality and quantity (rate and volume) requirements that permittees must meet for new development and redevelopment. It is doubtful that any of the NB communities are adhering to these standards.
- The 2008 NPDES Phase II permit also has requirements for municipal maintenance, Illicit Discharge Elimination (IDEP), as well as public participation and education. It is doubtful that any of the NB communities are meeting all the minimum requirements set forth in the permit.

There will be variation from the above characterization from community to community but in general this represents an accurate depiction of the state of watershed management measures in the watershed.

Worthy of note is that there exists a farm preservation agreement for parts of the upper reaches of the North Branch. Specifically, Armada, Richmond, Bruce and Ray townships in the watershed and Lennox outside the watershed passed an Intergovernmental Urban Cooperation agreement (Act of 8 of 1967) that enables them to enter into a contract with each other providing for the transfer of functions or responsibilities between themselves. In 2003, under this authority, the group known as the Macomb Agricultural PDR Committee (MAPDRC) concluded the first interlocal agreement associated with land use for the purpose of preserving farmland through purchase of development rights. In 2006 - 2007 the MAPDRC executed the first purchase of development rights on a local farm. The major obstacle to undertaking PDR is finding funds to purchase the properties.

The MAPDRC promotes four ownership options for conservation and restoration easements. They are:

1. Retention of private ownership through a conservation easement without public assess;
2. Retention of private ownership through a conservation easement with public access;
3. Surrender of land to a public entity for conservation; and
4. Surrender of land to a private entity or foundation for conservation.

State Permit Requirements

State NPDES storm water permit elements:

The State NPDES storm water permit requires that permittees develop programs that shall include the following general requirements:

- A *minimum treatment volume standard* to minimize water quality impacts
- *Channel protection criteria* to prevent resource impairment resulting from flow volumes and rates
- Operation and maintenance requirements
- Enforcement mechanisms with recordkeeping procedures
- A requirement for the project developer to write and implement site plans, which shall incorporate the requirements of this section of the permit
- The permittee shall retain the records associated with this activity in accordance with Part II.C.3. of this permit.

State Treatment Volume requirements

The *minimum treatment volume standard* shall be either:

(1) One inch of runoff from the entire site, or ½ inch of runoff from the entire site if the permittee demonstrates technical support for it in the WMP, or

(2) The calculated site runoff is from the 90 percent annual non-exceedance storm for the region or locality, according to (a) or (b) below, respectively.

(a) The statewide analysis by region for the 90 Percent Annual Non-Exceedance Storms is summarized in a Department memo dated March 24, 2006, which is available on the Internet at: www.michigan.gov/deqstormwater; under Information, select "Municipal Program/MS4 Permit Guidance," then go to the Storm Water Control Resources heading.

(b) The analysis of at least ten years of local published rain gauge data following the method in the memo "90 Percent Annual Non-Exceedance Storms" cited above. This approach is subject to approval by the Department.

Treatment methods shall be **designed** on a site-specific basis to achieve the following:

• A minimum of 80 percent removal of total suspended solids (TSS), as compared with uncontrolled runoff, or

• discharge concentrations of TSS not to exceed 80 milligrams per liter (mg/l).

A minimum treatment volume standard is not required where site conditions are such that TSS concentrations in storm water discharges will not exceed 80 mg/l.

State Channel Protection Requirements

The *channel protection criteria* established in this permit is necessary to maintain post-development site runoff volume and peak flow rate at or below existing levels for all storms up to the 2-year, 24-hour event. "Existing levels" means the runoff flow volume and rate for the last land use prior to the planned new development or redevelopment. Where more restrictive channel protection criteria already exists or is needed to meet the goals of reducing runoff volume and peak flows to less than existing levels on lands being developed or redeveloped, permittees are encouraged to use the more restrictive criteria than the standard permit requirements.

(1) An acceptable source of rainfall data for calculating runoff volume and peak flow rate is: *Rainfall Frequency Atlas of the Midwest*, Huff & Angel, NOAA Midwest Climate Center and Illinois State Water Survey, 1992.

(2) Methods for estimating pre- and post-development runoff shall follow curve number evaluations as described in Computing Flood Discharges for Small Ungaged Watersheds, dated July 2003, which is available on the Internet at: www.michigan.gov/deqstormwater; under Information, select "Municipal Program/MS4 Permit Guidance," then under "Storm Water Control Resources" select "Guidance for Calculating Runoff Volume and Peak Flow Rate."

(3) The permittee shall request approval from the Department to use other rainfall data sources and runoff models.

State BMP Maintenance Requirements

All structural and vegetative BMPs installed as a requirement under this section of the permit shall include a plan for maintaining maximum design performance through long-term operation and maintenance (O & M). The permittee shall develop, track, and enforce a program, through an ordinance or other regulatory mechanism, to ensure long-term O & M plans for the *water quality treatment* and *channel protection* controls the permittee requires.

Appendix G.2: Managing Environmental Conditions

CMI Requirements in this Chapter

The following CMI requirements are addressed, at least partially, by the inform-ation that is presented throughout this appendix, including:.

- A list of systems of BMPs needed for each objective and an estimated cost for those BMPs;
- A list of tasks needed to implement the systems of BMPs for each source in your watershed and their estimated costs;
- A summary of the local projects, programs, and ordinances within your watershed with tasks, responsible parties, milestones, and a timeline for improving or adding to those projects, programs, and ordinances;
- An I/E strategy;
- A description of the process that will be used to evaluate the effectiveness of implementing the plan and achieving its goals; and
- Tasks needed to institutionalize watershed protection.

Purpose

The purpose of this appendix is to present the myriad management entities, programs, and potential actions that are available to address conditions in the subwatershed. To make the discussion more manageable and to ease the process of selecting measures to implement in the subwatershed, the resources are grouped into nine primary categories (based in part on the Center for Watershed Protection's *Tools of Watershed Protection*, 2002), including:

1. Watershed Planning, Institutionalization, and Implementation;
2. Public Education and Participation;
3. Ordinances, Zoning, and Development Standards;
4. Good Housekeeping and Pollution Prevention;
5. Stormwater Best Management Practices: Soil Erosion and Sediment Control;
6. Stormwater Best Management Practices: Other Practices;
7. Natural Features and Resources Management;
8. Recreation Promotion and Enhancement; and
9. Environmental Monitoring and Other Data Collection.

These tools are discussed in the following sections.

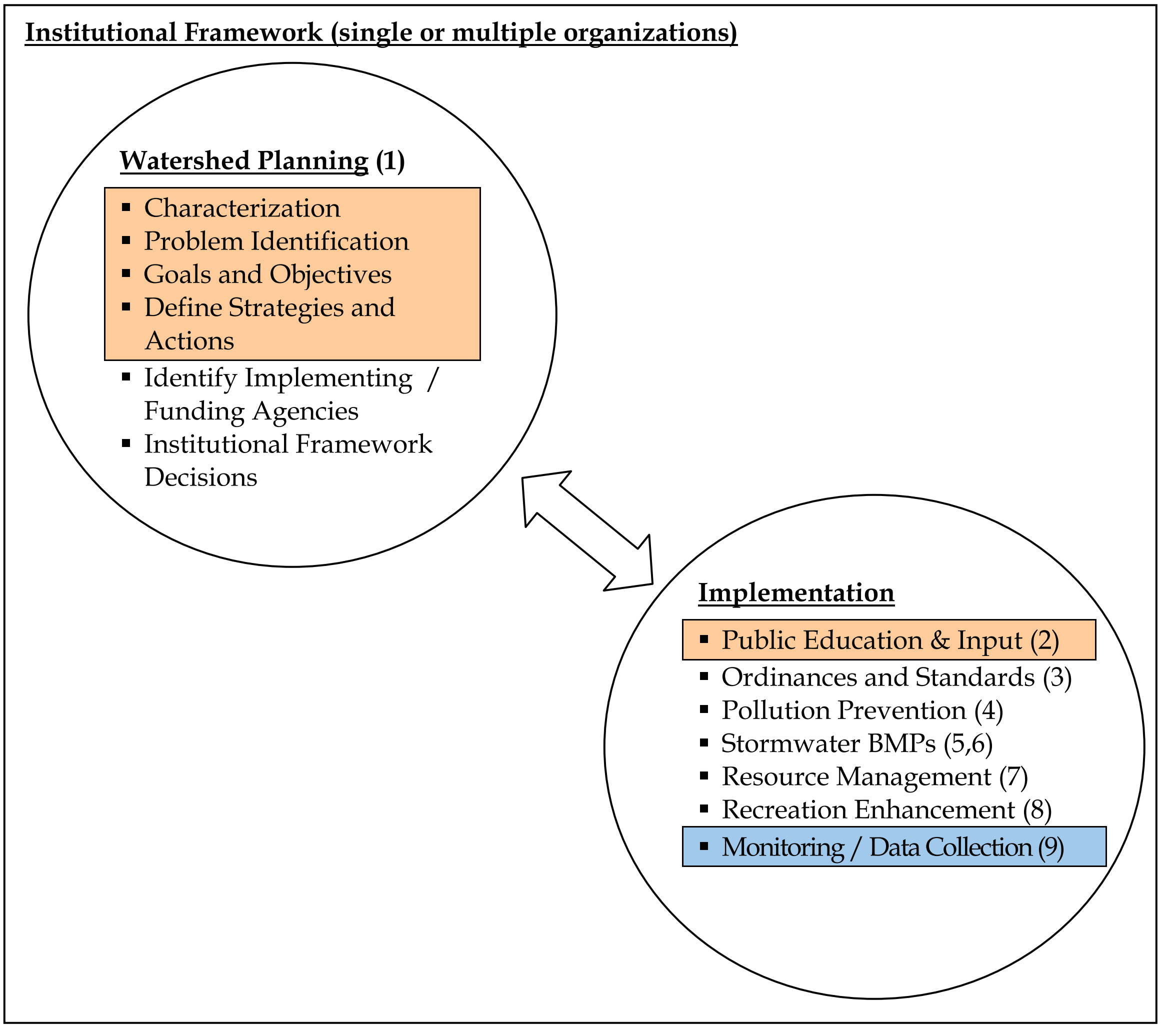
(1) Watershed Planning, Institutionalization, and Implementation

This category of actions is a comprehensive embodiment of a watershed approach to water quality management – addressing problems in a holistic manner and considering the input of local stakeholders. It consists of a series of cooperative, iterative steps, including:

- **Characterizing** the existing watershed geology, hydrology, land use, development, demographics and water quality (Chapter 2, Chapter 3 and Chapter 5);
- **Identifying and prioritizing problems** (Chapter 4 and Chapter 5);
- Eliciting **public input** on involvement supporting plan development and implementation (Chapter 4);
- Setting **goals and objectives** (Chapter 6);
- Evaluating and **selecting strategies** to address problems and meet goals / objectives – based in part on modeling efforts(Chp 7 & 8);
- Developing an **action plan** to guide implementation of selected strategies (Chapter 8);
- Identifying the **implementation and funding agents** (Chapter 8);
- Defining the **institutional framework** for sustainable watershed management, including plan revision procedures (Chapter 7, Chapter 8, and Chapter 9);
- Implementing the **actions** (Chapter 8 and Chapter 9);
- Engaging in **monitoring** and analysis to assess individual action and overall plan effectiveness (Chapter 8 and Chapter 9); and
- **Revising the plan** by repeating the process (Chapter 9).

Figure G.2-1 provides a graphical representation of the watershed approach to water quality management:

Figure G2-1.The elements of watershed planning and their relationship.



The institutional framework, whether it be a single organization or a collection of them, and whether it operates under strictly defined relationships or a loose confederation, is the backbone for the planning and implementation activities that are related to the plan.

The planning phase and implementation phases are generally sequential with the planning activities setting the framework for implementation and the final implemented actions feeding results back into the planning process (monitoring and data collection – indicated by - inform the effectiveness assessment). However, the relationship is more complex than that. Many of the planning activities such as characterization, problem identification, goals and objectives development, and defining the actions require a significant amount of public input (also indicated in the figure by). .

Details concerning the three elements are presented in the following subsections.

Watershed Planning

Initial Phase

The initial phase of watershed planning consists of: characterizing the watershed, identifying problems, developing goals and objectives, and defining strategies and actions for implementation and the details associated with those actions. Decisions concerning the institutional framework to guide the planning and implementation process may also be made at this time. This initial phase has resulted in the RAP and its contents as discussed under the following topics.

<u>Subwatershed Characterization</u>
The SWAG has summarized all available information about the subwatershed and developed a characterization of its natural environment that is largely the contents of Chapter 2.

<u>Problem Identification</u>
The SWAG analyzed environmental conditions (e.g. water quality) data, public input, and other appropriate sources to identify and prioritize the problems in the subwatershed (see Chapter 5).

<u>Goal and Objective Development</u>
Based on the problem identification above and public input, the SWAG developed a detailed list of goals and objectives for the plan (see Chapter 6).

<u>Defining Strategies and Actions</u>
To achieve the goals and objectives of the plan, general strategies and specific actions were developed. The actions were assigned numerous details including a schedule, responsible party, cost, and assessment considerations.

Concurrent Phase

Once the initial phase of watershed planning is complete, the plan is ready to be implemented. Even during implementation, there are planning decisions that need to be made.

<u>Identification of Implementing and Funding Agencies</u>
Even if some of this information is identified in the plan, implementation often occurs long after the plan has been developed and situations have changed. As such, it is often necessary to identify new sources of funding or new stakeholders to implement the actions.

<u>Institutional Framework Decisions</u>
A plan is generally developed by an organization with an interest in the outcome of the plan. In some cases, an organization may be established simply for the purpose of plan development (in which case these decisions may be conducted during the initial phases of plan development). In either case, certain decisions must be made during the implementation of the plan to either develop or modify an institutional framework such that implementation is timely, efficient, and, ultimately, effective.

Assessment Phase

Once the implementation of actions associated with a plan has ended (either due to implementation of all actions or at certain regular or triggered intervals) the plan is subject to an assessment.

Assess Plan Effectiveness
The effectiveness of the plan can be assessed in various ways. The actions can be looked at individually or in groups or the plan can be looked at as a whole. Assessment data is gathered primarily through monitoring and other data collection efforts and is compared to 'measures of success' that have been defined for the actions and other guidance that has been prepared (e.g. questions designed to determine if the goals/objectives have been met).

Plan Revision
Based on the assessments that are conducted (and any other data generated since the plan was first developed), the plan should be modified as necessary. In general, this involves re-conducting the steps in the initial phase of watershed planning to develop an updated plan that is more likely to address updated problems and achieve goals and objectives, original or updated.

Institutionalization

Institutionalization involves defining a mechanism to implement the plan once it is complete, including essential adaptive management measures such as provisions for updating and improving the plan. Defining the actual mechanism will involve researching the alternatives that are available and evaluating how successful the implementation is under the current mechanism. This will be included as an action (in Chapter 8) but is discussed in detail here due to its relevance in the overall planning paradigm. Regardless of the mechanism that is ultimately chosen, the inner workings of a cooperative approach must be defined.

This purpose of this sub-section is to first define these inner workings, provide options for the institutionalization mechanism, and then explore how these options and some additional programs can fund implementation of the plan.

The information in this chapter is not exhaustive. The focus is on the enabling statutory provisions most likely to be used. While SWAG members are likely to focus on programs related to the new regulations for addressing pollution from stormwater, the information in this report includes other water quality initiatives.

In large part, this sub-section is an updating and reorganization of the Southeast Michigan Council of Governments' (SEMCOGs) *Options for Local Government Funding of Water Quality Activities (2003)*.

Structure

The development of this plan has occurred under the direction of a voluntary group structure known as the Subwatershed Advisory Group– see Chapter 1. As one of the actions of the plan, the SWAG will evaluate how the current structure is able to implement the plan. Specifically, how voluntary membership with ad hoc committees can implement and track the various actions and results and the ability for the SWAG to facilitate a watershed approach to addressing water quality and environmental issues; as opposed to merely being a commentator for isolated and independent actors in the watershed.

Some of the actions in the plan may be implemented by the SWAG at large. Others may be solely actions of the individual entities with little or no SWAG involvement. However, some of the actions may require

Funding: Fees – the Bolt Decision

In the *Bolt* decision, the court established a three-part test for distinguishing a valid user fee from a tax:

- The fee must serve a *regulatory purpose* rather than a revenue raising purpose;
- A user fee must be *proportionate* to the necessary costs of the service; &
- A user fee must be *voluntary* – users must be able to refuse or limit their use of the commodity or service.

These criteria are being used to distinguish whether a government-imposed charge is a fee or a tax. As noted above, this distinction is important because there are constitutional and statutory limitations on a government's authority to impose taxes. A charge which is determined to be a tax is subject to those limitations. The *Bolt* decision and subsequent court decisions have far reaching implications for both state and local governments. While the *Bolt* case dealt with a fee imposed by a local government for a sewer project, the fee versus tax test laid out by the *Bolt* court has been applied in a number of cases beyond water and sewer fees at both the state and local level. The result of the *Bolt* decision has been a lack of necessary certainty and predictability with regard to using fees as a mechanism to fund the provision of essential governmental services.

Potential Committees

Technical Resource
This committee may be responsible for: providing technical guidance for the planning and implementation of pollution prevention activities and stormwater BMPs, and providing technical guidance to stakeholders or other committees to help them fully implement other actions.

Implementation and Evaluation
This committee may oversee: the implementation of some of the planning actions, the integration of much of the data collected as part of the RAP evaluation process, the analysis of the data (measures of completion, usage/attainment, and change), and making recommendation for modifications to the RAP.

Ordinance/Standards
This committee may provide guidance for: development of language for ordinances, standards, and pollution prevention programs; review of existing ordinances, standards, and programs of the stakeholders; and recommendations for each stakeholder to appropriately implement an action.

Public Education
This committee may be responsible for planning and implementing portions of the public education and participation actions.

Budget and Funding
This committee may be charged with developing the funding plan for CRPAC operations and handling requests from stakeholders as to the appropriate funding considerations to explore.

Conservation/Recreation
This committee may be in charge of developing programs and implementing actions related to conservation and recreation.

focused attention of stakeholders to provide a coordinated watershed approach. This has will be dealt with through either the standing committee structure of the SWAG or through the formation of ad hoc committees that meet for specific purposes for a set period of time.

This committee and other potential ad hoc committees, to be formed on an as-needed basis (or as standing committees, depending on the organizational structure implemented) with chairs and members serving on a voluntary basis, are discussed in the sidebar. All committees are to give regular reports to the entire SWAG on a regular basis or as requested by the SWAG.

Legal Relationship Options for Institutionalization

Considering various methods for institutionalization is a critical component of this RAP and to sustain CRPAC efforts-to-date.

Michigan has a number of different methods available for the CRPAC to form into a legal entity. At least seven approaches are available under Michigan statutes to lead and assign funding responsibilities for RAP implementation. These options include the following:

1) Drain Code – Public Act 40 (1956);
2) County Department and Board of Public Works – Public Act 185 (1957);
3) Inter-Municipal Committee Act – Public Act 200 (1957);
4) Municipal Sewerage and Water Systems - Public Act 233 (1955);
5) County Public Improvement Act – Public Act 342 (1939);
6) Watershed Alliance Act – Public Act 517 (2004); and
7) Voluntary Cooperation.

Table G.2-2 provides a brief summary of each of these options, how each of these options can be used (including a working example in the state, if possible), and some advantages or disadvantages for using each option. Any of these options could be used independently or in combination to handle a specific project area.

Funding

When looking to cooperatively implement the plan, it is important to consider how costs will be divided and paid. A common method for funding allocations is to use a formula that is a function of land area and population. Funding formulas based on other factors include, number of parcels, impervious area, land use, diversity of development, opportunity for new development, and community resources. Furthermore, not every task must use the same formula. Different work initiatives may use different formulas. For example, funding allocations for illicit discharge elimination program (IDEP) may be based on land area and the number of outfalls, whereas funding for public education may be based on population.

Independent of which allocation approach is selected is the issue of raising the funds to pay for the activity. Local governments have three basic means of raising revenues – special assessments, taxes, and fees – as discussed in the sidebars on this, the previous, and the next page.

Table G.2-2. Legal relationship options.

	Description
The Drain Code	**PA 40(1956).** The watershed drainage district created under chapter 20 could include an area within a single municipality or more than one municipality, depending upon the type of agreement to be used. A watershed drainage district established under the Drain Code petition process can be accompanied by a contract between the municipality and the Drainage Board through the execution of an agreement under section 471 or 491. These agreements would describe the services the Drainage Board would provide for each community in the drainage district, identify the process of assessing charges for those services, and establish a mechanism for identifying and approving needed projects. In the case of a section 471 agreement, a watershed committee would be established with a representative from each municipality in the drainage district. Before a proposed project could go to the Drainage Board for consideration, it would need the approval of the watershed committee. Each municipality in the watershed drainage district would be apportioned their share of the cost of the projects. Municipalities could cover their costs either through their general fund or levy those costs to the individual properties within the drainage district through ad valorem taxes, rates/fees, or special assessments.
Public Works Act	**PA 185(1957).** Gives county departments of public works broad authority to provide a range of services, including the collection and transport of stormwater. These county departments may also contract with other units of government to provide specific facilities or services. Funding mechanisms for these services includes property taxes, special assessments, and user charges/rates.
Inter-Municipal Committee	**PA 200(1957).** Allows participating municipalities to adopt resolutions for the establishment of a study committee. Funding is provided by the participating municipalities. However, activities of the committee are limited to study and planning. Construction, operation, maintenance of facilities or implementation of projects beyond studies is not permitted under this legislation.
Municipal Sewerage & Water Syst.	**PA 233(1955).** Municipalities can jointly create an Authority which then contracts with individual municipalities to provide specific facilities or services. Once established, activities of the Authority are limited to those related to owning and operating a sewage disposal system, including storm sewers. Contracting municipalities use a variety of mechanisms to pay for the facilities or services they receive from the Authority, including property taxes, special assessments, and user charges/rates. PA 233 authorities can issue bonds for capital improvements.
County Public Improvement Act	**PA 342(1939).** For purposes of water quality activities, this legislation is similar to the Public Works Act. It authorizes the County Board of Commissioners to designate a county agency to provide specific services, including the collection and transport of stormwater. County agencies eligible to serve as the designated agency include the Board of Public Works, Road Commission, or Drain Commissioner. Rates, charges, or assessments are paid based on the facilities or services provided and the agency can contract with other units of government for the cost of such facilities or services. Again, property taxes, special assessments, and user charges/rates can be used by the contracting governments to pay for the facilities or services they receive.
Watershed Alliance Act	**PA 517(2004).** Two or more communities can form a watershed alliance if they adopt bylaws with the approval of the governing body. Through by-laws, Alliances establish boundaries, assessments to members, structure, and decision-making process. The law provides for authority to receive grant funding, manage its own money, contract its own staff and services, and implement plans and projects. Alliances *can not* levy taxes or assess individuals, businesses, or property. They do not have the authority to regulate or issue permits. Membership is voluntary and can include municipalities, counties, school districts, colleges and universities, or other local or regional public agencies.
Voluntary Cooperation	It is possible to work voluntarily without any contracts or legal agreements. To accomplish this, affected units of government must voluntarily agree to work together cooperatively. This requires trust and accountability. There are many different ways to implement a cooperative agreement, with reliance upon committees being one of the dominant structures. Different structures can be considered prior to organizing a committee. Regardless of what structure is decided upon, leadership is a critical component. Some committees elect chairman, others have series of subcommittees. Many committees use Roberts Rules of Order to manage committee operations.

Table G.2-2. Legal relationship options. (rows continue across from previous page)

Advantages	Disadvantages
• Flexibility in paying apportioned share (property taxes, rates/fees, special assessments, or general fund); such property taxes may not be subject to the Headlee Amendment. • Define the scope of the work to be performed, responsibilities, active participation by local governments and various agencies involved; allows for use of in-kind services in lieu of cash payments.	• Petition needs to be carefully drafted to include implementation activities. • Agreements with multiple municipalities can be difficult and time consuming. • May limit the role of local government in decision making.
• Allows use of various funding mechanisms.	• Absent companion agreements, may limit the role of local government in decision making.
• Simple to start. • Municipal support can be funds or in-kind services, equipment, etc.	• For study purposes only.
• Allows use of various funding mechanisms. • Can provide services to non-member municipalities at same or greater fee.	• Creates a separate authority. • Primarily intended for water and wastewater services, but can include stormwater. • Contracts between county and municipality(ies) are subject to a right of referendum.
• Allows use of various funding mechanisms.	• Absent companion agreements, may limit the role of local government in decision making. • Contracts between the county and participating municipality(ies) are subject to a right of referendum.
• Specifically written to allow communities to undertake water quality activities. • Allows for the planning/design and implementation of multi-jurisdictional projects. • Can receive and administer external funding. • Equitable membership. • Auditing of finances required by State.	• Still must submit separate permits, IDEPs, SWPPIs, etc. • Does not solve the funding problem.
• Raising revenue is each community's responsibility which allows for flexible approaches. • Direct relationship between cost and benefit to each community.	• Requires trust and individual accountability. • Absence of leadership can limit implementation • Not a reliable stream of funding.

Summary of Funding Mechanisms

This subsection briefly lists the means (e.g. taxes, special assessments, fees, grants) that can be used to generate funding. The mechanisms include:

1) Stormwater Utility[1];
2) Sewer Rates;
3) Special Assessment;
4) Natural Resources and Environmental Protection Act;
5) Revised Municipal Finance Act (RMFA);
6) State Revolving Fund; and
7) Other grant and loan programs (e.g. state, federal), which may validly be used for the contracted purpose[2].

For certain programs (e.g. recreation) specific use fees may also be an appropriate funding mechanism. The individual mechanisms are discussed in Table G.2-3.

Implementation

Stakeholders are faced with implementing a wide range of actions associated with this plan. While many of these are related to compliance with the Watershed-based Permit, others, such as recreation enhancement are not. With the recognition that land use activities directly impact water quality, stakeholders are now faced with a broad range of new water quality responsibilities, particularly those that are experiencing significant development pressure.

In this chapter, the actions to be taken by stakeholders are grouped into two different categories: 1) planning and program implementation activities and 2) capital projects. The first category includes activities such as development of a stormwater management plan and implementation of non-capital programs (e.g. public education programs and ordinance development and enforcement).

Financial Considerations

Planning and program implementation activities are on-going in nature, and, for the most part, do not require the outlay of large financial resources. Nonetheless, they do require a commitment to long-term, stable sources of funding. Capital projects, on the other hand, are usually short-term construction projects that often require borrowing and a long-term commitment of dedicated funding to repay the loan.

Planning and Program Implementation Activities

Many of the actions that stakeholders will be implementing may go beyond their technical and financial resources. Additionally, there are significant cost efficiencies that may be realized by developing programs that meet the need of several stakeholders instead of a collection of independent programs. Therefore, the stakeholders may opt to contract with other government agencies for specific planning and program implementation activities.

[1] In Michigan, the B*olt* decision has caused municipalities to be weary of instituting stormwater utilities. Many organizations have urged the legislature to clarify legal issues related to stormwater utilities.

[2] In the State of Michigan, entities receiving grants through the 'Cool Cities' program (http://www.coolcities.com/) receive preferred consideration for other grants that are part of the program.

Funding: Special Assessments

Special assessments are assessments imposed on real property which benefits especially from a government expenditure or service. Special assessments are limited in amount to no more than the increase in value which the real property gains because of the expenditure. Local street and sewer projects are often paid for by special assessments on the real property served by the street or sewer.

Funding: Taxes

Local governments' power to tax is limited to those taxes expressly authorized by constitution or statute. Local government taxing authority is primarily limited to ad valorem taxes on real and personal property and to personal income tax. The rate of these taxes is also limited by statute. In general, local governments do not have the authority to tax on any other basis and cannot impose a sales tax or a tax on consumption like state and federal taxes on gasoline. Thus, a local government does not have the authority to impose a tax on sewer or water use in order to pay for providing those services. Taxes may be imposed to raise revenues for general governmental purposes or for specific projects or objects. The Headlee Amendment requires a local vote of approval for any tax not authorized by law at the time the amendment was enacted. In addition, some authorizing statutes also require a local vote before a tax is imposed under certain circumstances.

Funding: Taxes (cont'd)

A recent SEMCOG study (*Land Use Change in Southeast Michigan: Causes and Consequen*ces, March 2003) has shown that because Proposal A limits taxable value increases for properties remaining in the same ownership to five percent or the rate of inflation, whichever is less, communities without much land available for development are severely limited in taxable value growth. Without new construction to bring more State Equalized Valuation (SEV) and its full taxable value, municipal revenues from ad valorem taxes often do not keep pace with increases in SEV.

Funding: Fees

Fees are charges for services offered or carried out pursuant to a local government's "police" power, meaning government's authority to undertake or regulate actions to promote public health, safety, and welfare. Building inspection fees paid for city building inspection services conducted as a part of the city's program to maintain safe housing are one example of a fee. The *Bolt* decision, together with many other court decisions, puts bounds on the circumstances under which a local government can impose a valid fee. Because fees are the most common financing method in Michigan the provision of safe water and sewerage services, any changes in the law which affect how a local government can impose a fee are of great import to both a local government and its residents.

Capital Projects

Capital projects to address water quality concerns, such as extension of sanitary sewer service or the construction of septage receiving facilities have traditionally been the responsibility of local governments. These projects usually require a significant investment over a short period of time with a repayment schedule that can extend several years beyond the actual construction schedule. Municipalities that own or operate wastewater collection and/or treatment systems are required to develop capital improvement plans (CIP), usually on an annual basis. The CIP identifies the major capital projects expected in the next several (5 to 10) years, as well as the anticipated funding mechanism.

Capital projects are paid through some combination of either a pay-as-you-go basis as revenues are available or from the proceeds of indebtedness (bonds), with revenues dedicated to debt retirement. In either case, the revenues supporting the CIP may include some or all of tax revenues, user rates and charges, special assessments, connection fees, and capital reserve funds.

Summary

In summary, the range of actions stakeholders are responsible for implementing under this plan is expansive. There are a variety of alternatives for funding these activities that need to be evaluated in choosing a course of action for any particular activity.

Error! Reference source not found. lists a number of actions communities may implement and the institutional mechanisms available for funding them. This table was prepared to use as a tool to compare and contrast the desirability of the different mechanisms with respect to any particular activity. For example, communities could use this table to rank the alternatives low, medium, or high as part of narrowing options and focusing discussion in the decision making process.

Guiding Principle: Clinton River Basin Watershed Initiative

The goal of the CRBWI was to support coordinated decision-making and action that will improve, restore, and protect the Clinton River Watershed by giving watershed stakeholders access to the information they need to identify and implement solutions. There were three main products developed as a part of the project, including:

- Watershed Information Management System (WIMS) - an on-line database that centralizes and integrates all watershed data and information for easy access;
- Clinton River Watershed Model (CRWM) – a model that allows planners to evaluate the potential water quality benefits of a range of implementation measures, including facility improvements and urban, suburban, and rural stormwater best management practices; and
- Site Evaluation Tool (SET) – a spreadsheet based tool that is available to assist stakeholders in selecting best management practices for pollution reduction and to assist in achieving the pollutant load reductions.

Table G.2-3. Funding mechanisms.

	Description
Stormwater Utility	Like other utilities, stormwater utilities are established to charge a fee for providing a service, and typically are accounted for as an enterprise fund. This fund is used to cover the operation and maintenance of the stormwater system and, in some cases, finance capital improvements. Fees are paid periodically, often quarterly, and included on the water and sewer billing. Fee structures often include a flat rate charge and a land area charge, generally with a minimum per parcel fee. The land area charge may vary, based on such factors as the parcel's total impervious area, ratio of impervious to pervious surface area, the ratio of retention to impervious surface, or the installation of approved best management practices (BMPs).
Sewer Rates	Sewer rates are simply charges to residents and businesses for services associated with being connected to the municipal sewer systems. Sewer charges must be attributable to the service provided. Typically, sewer rates include the cost of operating and maintaining the infrastructure necessary to collect and treat the sewage, along with debt service for capital projects and, in some cases, funding for future capital projects identified in the capital improvement plan. Connection fees are commonly used as a means of funding the capital expenditures needed to provide new or expanded sewer service. Sewer rates and charges, like other user fees, must be established so as not to be a tax.
Special Assessment	Special assessments are levied against individual properties benefiting from the program/project through the establishment of a special assessment district (SAD) to cover the cost of specific activities/improvements. While the authority to establish special assessment districts varies by the type of governmental unit, special assessments must always be directly related and proportional to the benefit received from the improvement and funds can only be used to pay for the cost of the improvement.
Natural Resources and Env. Prot.Act	**PA 451 (1994).** Part 43 of the Natural Resources and Environmental Protection Act authorizes cities, villages and townships to borrow to pay the cost of improvements to waterworks systems or sewage systems in those instances in which the DEQ, State Department of Public Health or a court of competent jurisdiction has ordered the installation, construction and/or improvement of such systems or the DEQ has issued a permit for the installation, construction, alteration, improvement or operation of such a system and the plans for such improvements or system have been prepared and approved by the State department or agency having the authority to grant such approval.
RMFA	**PA 34 (2001).** Section 517 of the Revised Municipal Finance Act authorizes counties, cities, villages and townships to borrow for capital improvement items that will improve or protect water quality.
User Fees/ Charges	User fees and charges are financial charges for services provided or activities undertaken, such as sewer rate charges or sewer connection fees, which provide a benefit to the ratepayer and not the general public. User fees, however, have been the subject of recent litigation and must meet the criteria established by Michigan law so as not to be determined a tax: a user fee must serve a regulatory purpose (not a revenue raising purpose), be proportional to the cost of the service provided, and be voluntary (the user must be able to limit or avoid the use of the service in order to reduce or avoid paying the fee).
State Revolving Fund	The state and federal governments have made limited financial assistance available to municipalities for capital projects. Municipalities can obtain low-interest loans through the state revolving fund (SRF). In order to obtain a loan, the municipality issues bonds which are sold to the Michigan Municipal Bond Authority in amounts approved by the MDEQ. All of the applicable procedures and requirements for issuing bonds under state and federal law continue to apply. One further condition of these loans is a demonstration that the municipality has the ability to repay the loan. Used almost exclusively in Michigan to finance large sewer treatment works and sewer separation projects, the loan repayments are financed through a combination of rates, connection fees, special assessments, and property taxes.
Other Grant & Loan Programs	The Michigan Department of Environmental Quality administers a range of grant and loan programs aimed at assisting local governments develop and implement pollution abatement programs. Information on MDEQ grant and loan programs can be obtained from the MDEQ Assistance and Support Services. Additionally, there are numerous other local, state, federal, and international entities that operate myriad grant programs providing funds to implement most of the actions identified in this WMP. See Chapter 8 for additional information regarding these grant programs.

Table G.2-3. Funding mechanisms (rows continue across from previous page)

Advantages	Disadvantages
• Fee based on runoff; assessed against all properties. • Is equitable; directly related to benefit received. • Not based on property value. • Consistent funding stream. • Use existing billing system; reduces costs. • Fee can be reduced through implementation of BMPs. • Can contract with other governmental units.	• Must be set up to withstand challenges under *Bolt* - this may add complexity to the utility and increase costs. • Determining ratio of impervious surface area for parcels may be difficult/ costly. • Risk of financial liability for refunds in the event a user fee is determined later to be a tax.
• Equitable - direct relationship between cost and service. • Users have some control over costs they incur. • Not dependent upon property ownership. This may be especially important in municipalities where tax exempt entities have significant land holdings.	• Can be difficult to set rates sufficient to meet *future* capital improvement needs. • Difficult to include stormwater and other *nonpoint* source activities.
• Direct relationship between benefit and assessment. • No property tax limitations. • Assessments are against all properties (certain tax-exempt entities are also exempted by the General Property Tax Act from paying special assessments).	• Municipality may incur additional administrative costs. • Difficult to achieve consensus for the allocation of benefits.
• Municipality can borrow in response to court or regulatory order with respect to water quality.	• Borrowing is subject to a right of referendum. • Borrowing is limited to the purposed set forth in the order.
• Use more than one funding mechanism to pay debt. • No need to have MDEQ or court order to borrow.	• Borrowing is subject to a right of referendum. • Borrowing is limited to 5% of municipality's State.
• Direct relationship between cost and service. • User can limit or avoid the fee. • Not bound by Headlee limits. • Includes capital cost recovery. • Fees and charges are paid by all system users; this may be especially important in municipalities where tax exempt entities have significant land holdings.	• The *Bolt* decision has cast a cloud over traditional means. of setting / imposing user fees. • Can be administratively complex. • Risk of financial liability for refunds in the event a user. fee is determined later to be a tax.
• Low-interest. • Significant amounts. • Can now be used for planning infrastructure projects.	• Must still pay State back. • May require bond issue to cover repayment. • Limited pool of funds. • Competitive program.
• Many programs are grants. • Many programs require inter-governmental cooperation. • Municipality does not have to draw on general fund for program/initiative.	• Programs tend to be focused. • Limited funds available. • Many programs are competitive. • Local match funding is usually required. • Many programs require inter-governmental cooperation.

Table G.2-4. Examples of action types and potential funding mechanisms.

Notes

1 - Includes Illicit Discharge Elimination Plans and Catch Basin Cleaning/Street Sweeping (although the latter is not fundable through the Inter-Municipal Committee Act).

2 - Includes Stormwater Control Facilities, Sanitary Sewer Overflow Control, Combined Sewer Overflow Control, Sewer Rehabilitation, and Sewer Extension.

3 - While the Drain Code is primarily used for generating funding for capital projects, other activities can be funded if included in a petition and inter-municipal agreements.

4 - Most of these activities will include both a planning and an implementation component, e.g.: an illicit discharge elimination program will require developing a plan, which may include new ordinances, periodic assessment of program effectiveness, etc, as well as implementation activities, such as surveying commercial/industrial facilities to identify cross-connections or inspecting residential septic systems on a periodic basis.

Action	**Drain Code[3]**	**County Department and Board of Public Works Act**	**Inter-Municipal Committee Act**	**Municipal Sewer and Water Authorities**	**County Public Improvement Act**	**Watershed Alliance**	**Stormwater Utilities**	**Sewer Rates**	**Special Assessment Districts**	**Natural Resources and Environmental Protection Act**	**Revised Municipal Finance Act**	**State Revolving Fund**	**Other Grant Programs**
Planning and Implementation Activities[4]	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**					**X**
Planning, Institutionalization, and Implementation	X	X	X	X	X	X	X	X					X
Ordinances, Zoning, and Development Standards	X	X		X	X	X	X	X					X
Public Education and Participation	X	X	X	X	X	X	X	X					X
Good Housekeeping and Pollution Prevention[1]	X	X	X	X	X	X	X	X					X
Stormwater Best Management Practices: SESC	X	X		X	X	X	X	X					X
Stormwater Best Management Practices: Other	X	X		X	X	X	X	X				X	X
Natural Features and Resource Management	X	X		X	X	X	X		X	X			X
Recreational Promotion and Enhancement		X			X	X	X			X			X
Environmental Monitoring and Data Collection	X	X		X	X	X	X	X					X
Capital Improvement Projects[2]	**X**	**X**		**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**

Clinton River Basin Watershed Initiative Modeling Results for the North Branch

The following statements are the major findings of the CRBWI model as applies to the North Branch Subwatershed:

- Flashiness is correlated with urban areas due to the high percentage of impervious surfaces and in agricultural areas because of the underlying clay/silt soils and agricultural tiles;
- Sediment loading rates are high most likely due to the agricultural activity, re-suspension due to high flows and, in small pockets of the subwatershed, the high percentage of impervious surface;
- Most waterbodies exhibit a seasonal pattern for E.coli levels, with the summer months producing higher levels;
- E. coli levels had long-term geometric means that exceed full-body contact standards but meet the lower partial body contact standards;
- Elevated total phosphorus loading rates are present throughout the subwatershed most likely due to the liberal application of fertilizers, the presence of waste water treatment facilities, and isolated urbanized areas.

The WIMS was utilized to define the data available for analyses of current conditions in the subwatershed. The SET will be utilized during the implementation phase as specific sites are studied to determine the specifics of BMPs to be employed. For the development of the plan, the CRWM (or 'model') was the most useful element of the CRBWI. The results of the modeling project are defined in a final report and presented in the *Clinton River Restoration Plan* (the Remedial Action Plan for the Clinton River Area of Concern) but the major results with respect to the North Branch Subwatershed are reported in a sidebar on the following page. Pollutant load calculations and required reductions for the entire subwatershed were also defined. However, in support of this plan, the inputs to the model have been updated and the analyses refined such that updated pollutant load calculations and reduction targets are now defined for all of the catchments in the subwatershed. The inclusion of this data in the plan is essential for it to meet the EPA Section 319 grant funding element 'b': a determination of the load reductions needed.

The loading and reduction calculations are provided for five stressors: suspended solids (as total suspended solids), nutrients (phosphorus as total phosphorus and nitrogen as nitrate), pathogens (as *E. coli*), and hydraulic / hydrologic characteristics (as flashiness). For each specific stressor, allowable loads were based on standards, current loads were estimated using the model, and target load reductions were calculated as the difference between the allowable and current loads. **Error! Reference source not found.** presents a summary of this information (for the full analysis by flow levels refer to Appendix E.2).

Immediately after the pollutant load reduction tables there are two tables that present the percentage distribution of the stressors broken down by contributing source. In other word, the tables attempt to allocate the percent of total loads based on origin. The numbers in the tables are estimates based on careful consideration of all of the data analyzed for the plan, including: natural environment characteristics (Chapter 2), stressor and source characteristics (Chapter 3), details of environmental quality conditions (Chapter 5) and information generated by the model on load rates, target loads, and required reductions.

(2) Public Education and Participation

In 1986, a public meeting was held to seek public comments to facilitate the development of the first Clinton River Remedial Action Plan (MDNR, 1988). Many of these public concerns and comments reflect present day issues, including:

- The need for watershed-based permitting and modeling;
- Sedimentation;
- Cooperative approach between governmental entities and other stakeholders;
- Stormwater runoff issues – quality and quantity;
- High and low flow issues in the Clinton River;
- Floodplain development;
- Polluted lands and other historic pollution sources;
- Sewer overflows;
- Wetland protection;
- Fish contaminants and health; and
- Other pollutants.

The persistence of these problems suggests that environmental protection and restoration efforts over that time span have been ineffectual. A major flaw of many of these programs is the failure to include a robust public education and involvement component.

As such, the environmental protection and restoration actions of this plan will be most effective when the public understands the environmental challenges and is invested in rectifying them. This understanding and investment ultimately comes through education, outreach, and participation in meaningful activities (aka involvement). Many programs are available to consider when selecting a method to promote watershed stewardship.

The main targets for education and participation include: businesses, municipal employees, the general public, and the youth. If the public can be successfully influenced to modify their behaviors to pollute less, environmental conditions will improve.

Public involvement played a key role in the development of this WMP. The actions in this plan were developed with considerate public input guided by public participation plans (PPP) that:

- Identified key stakeholders in the subwatershed;
- Included a wide variety of agencies and interests;
- Presented a process for effective stakeholder involvement;
- Developed materials to educate stakeholders and constituents; and
- Gathered useful, measurable social feedback.

The various desired uses for the watershed – including the restoration and protection of designated uses – were elicited from the various public input sources and assisted in the development of the goals and objectives of the RAP as detailed in Chapter 5.

As implementation proceeds, it is recommended that the SWAG use public involvement techniques to guide plan implementation and gauge the effectiveness of certain actions. Such techniques may include Stakeholder Workshop, Community Forums, Focus Group Meetings, and increased Internet presence.

Before the public is interested or willing to participate, they need to have a basic understanding of the issues. To address this, many of the communities in the watershed have Public Education Plans (PEPs) that were designed to promote, publicize, and facilitate education to help raise the public's awareness and motivate positive behavior in the watershed (with respect to the individual WMPs).

The CRWC provided assistance in the design and implementation of educational activities related to the PEPs. Details concerning each community's activities are available in their respective PEP, but some common elements are presented in the sidebars on this and the next page.

These activities optimize existing programs and materials from regional organizations currently conducting public education such as the CRWC, the Southeast Michigan Council of Governments (SEMCOG), and the Michigan State University Cooperative Extension (MSUE) Program. By using and adapting existing outreach opportunities and materials, the communities are able to cost-effectively reach a broad audience with a consistent watershed protection message.

Continuing public education efforts will follow the same paradigm (unless data and assessments indicate that a changed approach is needed). The

Common PEP Elements

- A 'Personal Watershed Stewardship Program' with the following key messages:
  - Definition of a watershed;
  - Knowledge of what watershed an individual lives in and has an impact on;
  - Importance of protecting watersheds; and,
  - Ways that individuals can impact the watershed through their activities;
- An 'Ultimate Storm Water Discharge Location and Potential Impacts' program with the following key messages:
  - Storm drains discharge to waterbodies;
  - Stormwater discharged from separate storm sewer systems does not receive treatment prior to discharge;
  - The environmental impacts of stormwater pollutants in the watershed; and,
  - Knowledge of the separate stormwater drainage system in an individual's neighborhood and the waterbody to which the stormwater is discharged;
- A 'Reporting of Illicit Discharges' program with the following key messages:
  - Definition of an illicit discharge and what to look for;
  - Promotion of the illicit discharge reporting system and how to report an illicit discharge;
  - Water quality impacts associated with illicit discharges and improper waste disposal;
  - Identification of failing on-site sewage disposal systems – physical symptoms to watch for;
  - Consequences/penalties associated with illicit discharges and improper waste disposal; (continued)

Common PEP Elements (continued)

- A 'Personal Actions that Can Impact the Watershed' program with the following key message:
  - Best management practices for each of the following actions:
    - Car, pavement, and/or power washing (preferred cleaning materials and practices);
    - Pesticide use, fertilizer use, and their disposal;
    - Management of grass clippings, leaf litter, and animal wastes;
    - Residential de-icer use; &
    - Native vegetation on residential properties as an alternative to turf grass.
    - The impacts of residential car, pavement, and power washing on water quality; &
  - Effects of residential wastes on our water bodies;
- A 'Waste Management Assistance' program with the following key messages:
  - Identification of household hazardous wastes and available alternatives; and
  - Disposal locations, requirements, and availability for household hazardous wastes and other chemicals, including motor vehicle fluids, travel trailer sanitary wastes, recreational boating sanitary wastes, and yard wastes; and
- A 'Management of Riparian Lands' program with the following key messages:
  - Importance of riparian corridors; and
  - Best management practices for riparian lands, including:
    - Protection through use of conservation easements;
    - Lawn maintenance for water quality (no-mow and no-chemical application areas);
    - Landscaping for water quality;
    - Shoreline stabilization techniques;
    - Proper septic system maint. &
    - Proper management of grass clippings, leaf litter, animal wastes, and other wastes.

CRPAC and stakeholders will use a variety of mechanisms, including: brochures, door hangers, maps, newsletters, kiosks, signs, posters, point-of-sale education programs, disseminating materials with municipal services (e.g. recycling bins, building permits), utilizing the Retired Engineer Technical Assistance Program (RETAP), providing multi-lingual materials to capture a broad audience, presentations, education materials/ guides, displays, workshops/forums/trainings, volunteer monitoring/ clean-ups/marking, mass media content, hotlines and a website.

Many other programs currently exist to educate the public and to help foster public involvement with watershed awareness, stormwater management, and water quality protection. The programs are discussed in the following subsections.

Agencies and Programs

In order to develop a public education / involvement approach that covers all elements of sustainability (e.g. economic, environmental, social), a holistic approach will be taken that will be inclusive of various viewpoints when selecting agencies and programs to leverage and include in the process.

Clinton River Watershed Council

The Clinton River Watershed Council (CRWC) is a non-profit organization dedicated to protecting, enhancing and celebrating the Clinton River, its watershed and Lake St. Clair. The council was formed in 1972 as an association of local governments under the authority of the Michigan Local Rivers Management Act of 1964. For more than 30 years, CRWC has served to coordinate the efforts of local governments, businesses, community groups and individuals in improving water quality, promoting innovative watershed management techniques, and celebrating the river as a natural and recreational resource. The council's website can be found at http://www.crwc.org/.

Adopt-A-Stream

A volunteer-based program that empowers community members to protect local streams and rivers by monitoring their health. Twice a year, volunteers are teamed up, assigned sites, given equipment, data sheets and protocols, and sent out to gather physical information such as extent of streambank erosion and surrounding land use, chemical information such as water temperature and pH, and biological information such as the benthic macroinvertebrates that live in the streambed and surrounding vegetation.

River Day / Clinton Clean Up

Days intended for river cleanup, celebration, recreation, and education throughout the entire Clinton River watershed.

Southeast Michigan Council of Governments

The Southeast Michigan Council of Governments (SEMCOG) is a regional planning agency in Southeast Michigan. SEMCOG plans in areas that cross jurisdictional boundaries in the Southeast Michigan region that encompasses Livingston, Macomb, Monroe, Oakland, St. Clair, Washtenaw, and Wayne counties. SEMCOG supports local government planning in the areas of transportation, environment, community and economic development, and education. The council's website can be found at http://www.semcog.org/.

SEMCOG, partnering with other organizations through the 'Southeast Michigan Partners for Clean Water' program, conducts municipal training and heads up the 'Our Water. Our Future. Ours to Protect' campaign which includes: the 'Seven Simple Steps to Clean Water' materials, community involvement activities, and informational materials.

Michigan Turfgrass Environmental Stewardship Program

The mission of the Michigan Turfgrass Environmental Stewardship Program is to advance the environmental stewardship of Michigan's golf industry by increasing the awareness and understanding of environmental issues, ensure regulatory compliance, and recognize stewardship achievements. The program's website is at http://www.mtesp.org/.

Michigan Audubon Society

The mission of Michigan Audubon Society and local chapters is to instill in people an interest, knowledge, and appreciation of birds and other wildlife. The Audubon Society promotes sound conservation methods by helping restore wildlife habitat, helping prevent pollution, preserving outstanding wildlife areas, and educating the public. The society's website is http://www.michiganaudubon.org/.

Michigan Nature Centers

Nature Centers are either privately or locally funded entities that focus on research, recreation, and, education. The State of Michigan has approximately 72 nature centers. The MDEQ lists the nature centers in the state, which can be found at http://www.michigan.gov/deq/ under "Key Topics" → "Environmental Education".

The Groundwater Foundation

The Groundwater Foundation focuses on educating people and communities about the importance of groundwater and how to protect it. The foundation's Groundwater Guardian program assists communities in organizing a team and developing result-oriented activities that focus on education, pollution prevention, public policy, conservation, and best management practices. More information about the Groundwater Foundation can be found at http://www.groundwater.org/.

Southeast Michigan Sustainable Business Forum

The Southeast Michigan Sustainable Business Forum (SMSBF) is a resource for the development and implementation of sustainable business practices. It will promote practices through awareness of global trends, identification of best environmental practices, education and mentoring. The forum's website is available at http://www.smsbf.org/.

The Michigan Department of Agriculture

Information on the following programs can be obtained through the Michigan Department of Agriculture's (MDA's) website at http://www.michigan.gov/mda/.

Right to Farm Act

The Michigan Right to Farm Act, P.A. 93, was enacted in 1981 to provide farmers with protection from nuisance lawsuits. This state statute authorizes the Michigan Commission of Agriculture to develop and adopt Generally Accepted Agricultural and Management Practices for farms and farm operations in Michigan. These voluntary practices are based on available technology and scientific research to promote sound environmental stewardship and help maintain a farmer's right to farm.

Generally Accepted Agricultural and Management Practices

The MDA has developed a number of standard practices for farmers that encourage environmentally responsible practices, including: irrigation, site selection, manure management, pesticide utilization, nutrient utilization, animal care, and cranberry production. The various GAAMPs that have been developed can be accessed from the MDA's website by selecting 'Farming' → 'Environment' → 'GAAMPs' in the link list on the left-hand side of the page.

Public Education Vehicles

The numerous potential public education messages can be disseminated in myriad ways. Some possibilities include: brochures, door hangers, maps, Websites, newsletters, kiosks, signs, posters, and point-of-sale education.
Additional considerations include: disseminating materials with municipal services (e.g. recycling bins, building permits), utilizing the Retired Engineer Technical Assistance Program (RETAP), and providing multi-lingual materials to capture the broadest possible audience.

<u>Michigan's Biosolids Program</u>
When treated and processed, sewage sludge ('biosolids') can be safely recycled and applied as fertilizer to sustain, improve, and maintain productive soils and stimulate plant growth. This program encourages the use of biosolids to enhance agricultural and silvicultural[3] production in Michigan. Biosolids are also used to provide nutrients and soil conditioning in mine reclamation projects, tree farms, and forest lands.

<u>Michigan Agriculture Environmental Assurance Program</u>
Michigan's Agriculture Environmental Assurance Program teaches effective land stewardship practices that comply with state and federal regulations and shows producers how to find and prevent agricultural pollution risks on their farms. The program is designed as a multi-year program allowing producers to meet personal objectives, while best managing both time and resources.

<u>Organic Farming</u>
Organic farming is widely recognized as an alternative to conventional or farming that relies on chemicals. It is a restorative, sustainable management system that emphasizes a partnership with, rather than control over, nature. In organic farming the use of synthetic chemicals, genetically modified organisms, and ionizing radiation is prohibited. Such an approach enhances biodiversity, biological cycles, and soil biological activity to produce healthy plants and animals and foster human and environmental health. In September, 1998, the MDA Director created the Michigan Organic Advisory Committee. This Committee was charged with developing a strategic plan: serving as a framework for advancing a system of production, processing and marketing organic products in Michigan.

The Michigan Department of Environmental Quality

Information on the following programs can be obtained through the MDEQ's website at http://www.michigan.gov/deq/:

- Environmental Education - This section hosts and links to a variety of simple and dynamic information about the environment; and
- Surface Water: Nonpoint Source Program (NSP) - The NSP offers grants and technical assistance and develops information and educational materials to help protect and improve Michigan's water.

The Michigan Department of Transportation

The Michigan Department of Transportation is required by the MDEQ to have a comprehensive stormwater discharge permit that covers its road network (specifically in urbanized areas with separated sewer systems). As a part of this program, the MDOT maintains a website that provides extensive information for the public concerning the important elements of stormwater management. The MDOT website is located at: http://www.michigan.gov/stormwatermgt.

Michigan Environmental Council

The Michigan Environmental Council (MEC) provides a collective voice for the environment at the local, state and federal levels. Working with member groups and their collective membership of nearly 200,000

[3] Silviculture is the science, art, and practice of caring for forests with respect to human objectives.

residents, MEC is addressing the primary assaults on Michigan's environment; promoting alternatives to urban blight and suburban sprawl; advocating for a sustainable environment and economy; protecting Michigan's water legacy; promoting cleaner energy; and working to diminish environmental impacts on children's health. The MEC website is located at http://www.mecprotects.org/.

Michigan State University Cooperative Extension

Since its beginning, Michigan Extension has focused on bringing knowledge-based educational programs to the people of the state to improve their lives and communities. Today, county-based staff members, in concert with on-campus faculty members, serve every county with programming focused on agriculture and natural resources; children, youth and families; and community and economic development.

MSU Extension extends the University's knowledge resources to all Michigan citizens and assists them in meeting their learning needs through a variety of educational strategies, technologies and collaborative arrangements.

In St. Clair County, the MSU Extension office coordinates an Adopt-A-Stream program that includes macroinvertebrate and chemical testing, river clean ups, and streambank stabilization.

Specialized Programs: Youth Education

It is especially important to start educational activities when people are young so as to pave the way for watershed protection to become a societal value. Some sources of environmental curriculum schools are listed below Additional programs are presented in the sidebar.

Clinton River Watershed Council – 'Stream Leaders' Program

The Stream Leaders program is intended to provide students with an educational experience in water quality monitoring, data interpretation, and citizen action, as well as provide general information to local officials concerning water quality. First, students and teachers get in the river and examine the chemical constituents of the river (e.g. DO, pH, nutrients, temperature), inventory physical stream-side conditions and land uses that may affect water quality, and sample the aquatic biological communities to evaluate the health of the river. Second, students and teachers analyze their data to locate any possible sources of pollution problems within the river. In the final part, students and teachers identify and complete a civic action project such as collecting and cataloging river, lake and beach debris, restoring degraded habitats, or making community presentations.

Adopt-A-Watershed

Adopt-A-Watershed (AAW) is a non-profit organization that promotes educational enhancement, environmental stewardship, and community development. AAW works with schools, youth education programs, community groups, and environmental organizations, guiding them through 'The 5-Steps to Leadership in Place-Based Learning'. The website is http://www.adopt-a-watershed.org/.

Center for Global Environmental Education

For over a decade, teachers, students, community leaders, and concerned citizens have come to Center for Global Environmental Education (CGEE) for inspired instruction and outstanding educational resources. CGEE's

MSU Extension – Water Network

The MSU Extension operates a 'water network' that incorporates water related information into programs in agriculture, natural resources, public policy, home economics, and youth education. As an 'Area of Expertise' it seeks to:

- Assist in preventing degradation of surface and groundwater with an emphasis on nonpoint sources of pollution, by providing educational programs and materials;
- Enable clientele to adopt or refine practices to protect water quality and quantity, and;
- Establish strong ties with other organizations and agencies working on water quality and quantity issues.

Other Youth Education Programs

Macomb County – offers three programs for teachers
The Center for Improved Engineering and Science Education
Freshwater Wetlands Teaching Guide
Enviroscapes®
Izaak Walton League – American Wetlands Campaign and Save Our Stream Curriculum
North American Association for Environmental Education
USGS Water Resources Outreach Program
Yahara Watershed Education Network

pioneering work in environmental education is grounded in the tradition of progressive learning that has been a hallmark of Hamline University's Graduate School of Education. The Center's strategic use of technology creates and supports global communities of learners committed to the stewardship of local environments. The center's website can be accessed at: http://cgee.hamline.edu/about_cgee/index.html.

Environmental Protection Agency – Office of Wetlands, Oceans, and Watersheds

This Environmental Protection Agency (EPA) office provides activities, projects, information magazines, and curricula on wetlands, water resources, ecosystems, watersheds, wildlife, and more. Links to educational resources produced by other organizations are also provided. The office's website can be found at http://www.epa.gov/owow/.

Earthforce Global Rivers Environmental Education Network

The Global Rivers Environmental Education Network (GREEN) is a national network of schools and communities working together to meet critical water resource challenges through a combination of environmental education and civic action. GREEN builds on national academic standards and teaches elementary, middle and high school-aged youth essential skills including critical thinking, teamwork, problem solving and the application of science to real world problems. Additional information can be found at http://www.earthforce.org/section/ programs/green/.

Michigan Department of Environmental Quality

The Michigan Department of Environmental Quality (MDEQ) has spent $1 million of the Clean Michigan Initiative funds working with the Department of Education to develop and disseminate sound science-based supplementary environmental curriculum materials for use by Michigan educators. The five unit topics include: Air Quality, Ecosystems, Energy and Resources, Individuals' Impact on the Land, and Water Quality.

Additional information (classroom resources, grant opportunities, and speaker request forms) can be found at http://www.michigan.gov/deq/ under "Key Topics" → "Environmental Education".

United States Department of Agriculture

This website features links to wetlands information for middle and high school students. Links to education programs used in different states and programs produced by the EPA are also available. The website can be accessed by visiting http://www.usda.gov/ and selecting "Education and Outreach" from the 'Browse by Subject' menu.

(3) Ordinances, Zoning, and Development Standards

Watershed protection requires employing a broad range of environmental protection planning and regulatory options at the local government level. The techniques, designed to minimize negative impacts of land use decisions and development plans, can be used separately or in most cases together, to establish the amount of protection and effort a community is comfortable with. This effort can range from simply targeting peak flow reduction of stormwater runoff into waterbodies to attempting total watershed protection. The techniques that are selected need to be crafted with professional planning and legal assistance to fit each community and its natural resources.

The remainder of this section presents three levels of planning that need to be considered in watershed protection: 'Coordinated Planning', 'Zoning', and 'Advanced Regulation'. Coordinated Planning and Zoning are the most familiar options, but Advanced Regulation tends to provide the most powerful protection authority. These three levels are discussed in the following subsections, along with some additional considerations.

Coordinated Planning

The first step for a local government to protect its watershed is to prepare a future land use plan in cooperation with neighboring jurisdictions. Future land use plans (also known as Comprehensive Plans or Master Plans) should be based on a comprehensive inventory of natural resources and environmental features. Because the environment knows no jurisdictional boundaries, the most effective plans are developed when communities work together, as this prevents competing or incompatible actions. If one community along a river approves development in a floodplain, downstream communities are likely to be flooded. If one community on a lake adopts keyhole development regulations, but other communities abutting the same lake do not, then achieving the objective of preventing overuse of the surface of the lake is not likely to be achieved. If one community establishes a buffer zone around sensitive environmental areas, but abutting jurisdictions do not, then the benefits of the buffer zone will be limited. These examples demonstrate the importance of communities working cooperatively in the development of plans and the implementation of programs to protect our natural resources.

A future land use plan sets forth the desired pattern of land uses in the community for the next 20 to 30 years. It shows where agricultural and forest land should be retained and where new residences, commercial and industrial areas should be constructed. It creates the basis for planning for new roads, sewers and water infrastructure to meet the needs of the land uses displayed on the map. Future land use can work with nature, or against it.

Communities can plan to keep development out of floodplains and population density low along waterbodies. Communities can plan to preserve greenbelts for wildlife and vegetation along waterbodies to help filter stormwater runoff and provide space for trees to shade streams, keeping them cold enough for sportfish like trout. By planning with nature, they can preserve the characteristics of nature that immeasurably add to our quality of life. A number of key planning strategies to help

The Development Cycle

The actions under 'Ordinances, Zoning, and Development Standards' cover stormwater issues in the first two phases of the development cycle: land use planning and site design. Some stormwater management BMPs deal with the construction phase, where soil erosion is of primary concern. Many of the actions from the other categories focus on the final phase: home ownership and building occupation.

Key Planning Strategies

Following is a list of key strategies that communities can follow in the development of local future land use plans to help protect the environment and natural resources for use and enjoyment by both present and future generations:

- Prepare local future land use plans based on a comprehensive inventory of natural resources;
- Keep density and intensity of land use low near and along watercourses;
- Avoid developing in sensitive areas like floodplains, wetlands, environmental areas, sand dunes and high risk erosion areas;
- Plan for greenbelts and buffers along watercourses;
- Provide for links between natural areas so wildlife have safe corridors to move within;
- Protect renewable natural resources like farm and forest land in large blocks; and
- Set forth the specific zoning and other land use regulations that should be adopted to promote wise natural resource management and environmental protection.

protect the environment and natural resources are presented in the sidebar.

The future land use plan provides the legal foundation for local land use regulations. If the community wishes to protect natural resources and the environment through local land use regulations, then it must have a basis for these regulations in the future land use plan and then adopt zoning and related regulations consistent with the plan. However, to realize the maximum benefit, communities must coordinate the future land use plan with the planning efforts of adjoining communities.

More on Zoning

An enforceable zoning ordinance requires that it be based on some type of plan for a given community, such as a land use master plan.

ZONING OPTIONS

Watershed-based Zoning – this is a zoning methodology designed to consider information presented in a watershed management plan (refer to www.stormwatercenter.net for additional information).

Prescriptive Zoning – characterized by segregation of land uses into districts; includes very explicit standards and use exclusions.

Mixed-Use Zoning – exemplified by the juxtaposition of different uses to reduce automobile dependence, preserve green space, and promote a sense of community.

Incentive Zoning – a reward-based system to encourage development that meets established development goals.

Performance Zoning – uses goal-oriented criteria to establish review parameters for proposed development projects in any area of a municipality.

Macomb County Stormwater Standards

The Macomb County Public Works Office (MCPWO) is in the process of updating its design standards manual for the control of post-construction runoff from new development and significant redevelopment. The design standards are expected to be adopted in 2007.

Zoning

Zoning is the principal local tool for guiding land use change in a community. Zoning classifies land uses into zones or districts generally on the basis of land use intensity ranging from "high" (e.g. industrial) to "low" (e.g. nature preserve) intensity. The range of intensity is based largely on environmental impacts and infrastructure needs of the land use. A zoning map illustrates the location of various zones or districts within a given jurisdiction. Within each zone, a range of land uses are permitted by right, or after some special review and approval process. The zoning ordinance establishes development standards for each mapped district. This includes the uses permitted, building height, bulk, lot size, setback, minimum yard and related standards. If the zoning ordinance has appropriate standards to protect our waterways and minimize harm to them as new development occurs, then not only the present generation, but also future generations will benefit.

Advanced Regulation

There are many regulatory options communities may consider in protecting the watershed. This section describes three regulatory options that are available to communities to better protect their local lakes and streams. These options are not mutually exclusive nor are they interdependent; communities could adopt some or all of the measures in the first option as well as some or all of the second or third options, or vice versa. Because of this flexibility and the potential complexity, it is important that properly trained planners and attorneys be involved in adapting sample ordinance language to a community's planning and regulatory structure. The options are discussed below:

- The first option is model ordinance language that specifically addresses stormwater management. These models could be adopted as overlay zones in the zoning ordinance, or as a separate ordinance that applies to development in particular locations, in addition to zoning;
- The second option is a series of brief ordinance provisions that address common natural resource and environmental protection concerns associated with stormwater management. These provisions are commonly found in zoning ordinances across the state; and
- The third option focuses on coordinating land use permit review and approval procedures between the MDEQ and local zoning authorities. This approach is based on refining the local site plan review procedure (as are some of the techniques in the second option).

Additional measures to consider are presented at the end of this subsection. Refer to the Natural Features and Resource Management section of this chapter for ideas on how to identify the environmental assets to be protected through the following measures.

Option 1 – Adopt Model Ordinance Language

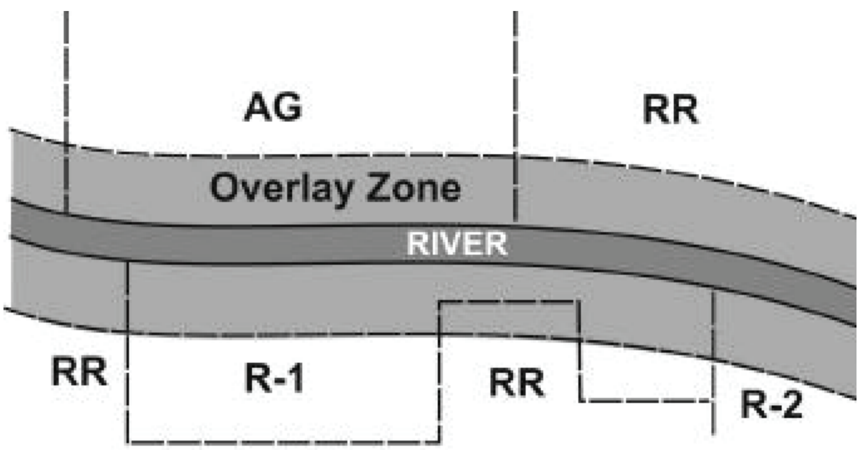
Separate statutory authority exists for local units of government to adopt regulations to protect the following natural resources:

- Wetlands;
- Environmental areas (e.g. sand dunes, submerged lands, forests);
- Soil erosion and sedimentation control;
- Inland lakes and streams;
- Natural rivers;
- Floodplains;
- High risk erosion areas; and
- Landmark trees.

The Michigan Department of Natural Resources (MDNR) in 1996, prepared model ordinance language to guide local governments in the preparation of ordinance language applicable to each of these natural resources – except for environmental areas. There are many variations of some of these models. All but the soil erosion and sedimentation model ordinance language is structured as an overlay zone.

An example of an overlay zone is illustrated in Figure C.2-2. The letter designations in the figure refer to existing zoning types (e.g. AG = agriculture; RR = rural residential).

Figure C.2-2. Example of an overlay zone.



In an overlay zone, the special environmental provisions only apply in a limited area which is usually depicted on a map. For example, the floodplain regulations only apply to the area defined as a floodplain. This is usually an area that may be inundated by a flood with an average frequency of being equaled or exceeded once each 100 years.

Model ordinance language can be incorporated into a separate section or article of the local zoning ordinance or adopted as an independent police power ordinance. Cities, villages, townships, and, to a lesser extent, counties in Michigan have authority to adopt police power regulations. The public purpose of the regulation must be stated in the ordinance and must advance one or more aspects of the public health, safety and general welfare. Some communities adopt environmental regulations as separate

Macomb County Model Ordinances

The Macomb County Department of Planning and Economic Development (MCPED) has developed a number of model ordinances for use by local communities. The currently available model ordinances are:

- Storm Water Management;
- Floodplain Management;
- Wetlands Ordinance;
- Overlay District;
- Natural Feature Setback;
- Native Vegetation; and
- Woodlands and Trees.

Due to the initial success of this program, the MCPED is working with Southeast Michigan Council of Governments to further explore the implementation and application of the more pertinent ordinances.

The ordinances are available on-line at:

http://macombcountymi.gov/planning/index.html

Source: MCPED, 2005.

Storm Water Center Model Ordinances

The Storm Water Center (www.stormwatercenter.net) has numerous model and example ordinances and other zoning and regulatory devices on the following subjects:

- Post-Construction Stormwater Management;
- Stream Buffers;
- Illicit Discharge and Elimination Program;
- Erosion and Sediment Control;
- Open Space Design;
- Operations and Maintenance for Stormwater Practices; and
- Groundwater Protection.

Source: SWC, 2006.

ordinances outside of the local zoning ordinance in order to "shelter" the zoning ordinance from any legal attacks that may be directed at the ordinance. Should a court find that the community had adopted or was administering the ordinance improperly, the judge could invalidate all or part of the ordinance without in any way affecting or undermining the integrity of the local zoning ordinance. Another reason why some communities choose to adopt separate police power ordinances is because they do not have to protect nonconforming uses (unless the statute they are operating under specifically requires protecting them). A nonconforming use is one that pre-existed the zoning ordinance or an amendment to the zoning ordinance. Such a use is considered "grandparented" and is allowed to continue in the future in the same manner and to the same extent as it did when it became nonconforming. When nonconforming uses are not protected, then even without a proposed change to the property, it could be required to be brought into conformance with the new regulations.

Option 2 – Zoning Ordinance Provisions that Cover a Wide Range of Environmental Issues

Many local units of government are unwilling to take on the significant administrative responsibilities and potential liability associated with implementation of some or all of the model ordinance language described in the first option above. Nevertheless, they cherish protection of Michigan's environment and natural resources as much as the next community and want to do their part in ensuring it is protected. Short, simple approaches to environmental and/or natural resource protection are presented below.

Macomb County Natural Features Inventory

The Macomb County Maps page at

http://macombcountymi.gov/GIS/Maps.asp

has many resources that may be useful for local planning efforts. The page has links for a wetland indicator map, watershed boundaries, and the Macomb County Natural Features Inventory Report and Map.

The Macomb County Natural Features Inventory is a resource that documents and prioritizes local potential conservation areas and natural areas.

<u>Environmental Assessment Requirements</u>

When projects are proposed in or adjacent to sensitive natural resources, some communities require applicants to submit an environmental assessment which details the impact of the proposed development on natural resources. Communities that have plans and zoning regulations based on a solid environmental inventory are able to set the threshold for future environmental assessments at a defensible level. Without such a basis, an environmental assessment may be considered arbitrary as there is little context for the requirement. An environmental assessment can be a valuable source of information, and in some cases an important tool for ensuring that new development is designed in such a way that unavoidable environmental impacts are properly mitigated. Environmental assessments can also be viewed as an affirmative tool for helping a local government meet its responsibility for preventing pollution, impairment or destruction of the environment.

<u>Shoreline Protection Provisions</u>

More refined shoreline provisions may address a host of other environmental protection issues such as the application of fertilizers or weed killers in near shore and stream bank areas, the trimming of shoreline vegetation for views, prohibitions on removal or replacement of natural shoreline vegetation with grass or ornamental landscaping, or requiring restoration of damaged natural vegetation on stream banks. These regulations tend to vary dramatically across the state, but for the most part, provide some measure of protection from overuse or removal of natural vegetation near the shore. These may also be called buffer strip or greenbelt provisions.

Groundwater Protection Standards

The Michigan Department of Public Health and MDNR, and more recently the MDEQ, have widely collaborated with hundreds of Michigan communities to develop and implement groundwater protection standards as a part of the local site plan review process. In most cases, communities adopting sample ordinance language also included standards to ensure protection of surface waters from land uses that had the potential to pollute, impair or destroy soil and water resources. These standards have many parallels to stormwater protection and the cooperative effort between the state and local governments on this issue has piloted the way for continuing this approach on a wider scale. Groundwater protection standards are fundamental public health and safety measures that should be adopted by local governments throughout the state.

Sensitive Area Protections

Instead of targeting specific natural resources for protection by means of a single regulatory approach, many communities have folded basic separation distances (setback provisions) into sensitive area or natural features provisions. These regulations list a set of sensitive areas or natural features in the community and require that all new structures or intensive use areas of the proposed development be set back at least a certain distance from the identified natural feature. Such provisions have been applied to shoreline, waterfront, floodplain, wetland, woodland, sand dune, and high risk erosion areas. Because of a Michigan Attorney General opinion (No. 6892, March 5, 1996) that says setbacks from wetlands may not be required under a wetland ordinance, but may be required if properly crafted as part of a zoning ordinance regulating natural features, it is important for communities to be very careful about how natural features are defined and how such regulations are crafted. In some ordinances these provisions are called buffer strip or greenbelt provisions.

Planned Unit Developments and Cluster Developments

Planned unit developments (PUDs) and cluster developments are forms of land design that usually focus on integration of the natural features of a site with the new development to be constructed on the site. Most PUDs are largely residential, although increasingly they are mixed use–usually commercial and residential. The combination of a golf course with a residential subdivision or site condominium is the most common form of PUD in Michigan. Commercial, office and industrial PUDs are also becoming common, especially in urban and suburban locations along freeways. In suburban and rural Michigan, PUDs are increasingly designed around a sensitive natural feature like a small pond or wetland. Good design with a large natural vegetation buffer area around the sensitive resource can result in its protection as an asset to the PUD.

A cluster development is a form of PUD that is usually exclusively residential and surrounded by large amounts of open space. An example of a conventional subdivision compared with a cluster development is shown in Figure C.1-6.

Figure C.1-3. Conventional subdivision (left) versus cluster development (right).

Recent amendments to Michigan's zoning enabling acts require many communities to adopt cluster development provisions that permit projects with at least 50% open space in townships and counties and 20% open space in cities and villages by "right" (i.e., without any special review and approval process). Communities can define what constitutes permissible open space, but it cannot include land in a golf course. See for example MCL 125.286h in the Township Zoning Act, MCL 125.584f in the County Zoning Act, and MCL 125.584f in the City-Village Zoning Act.

The combination of a PUD and cluster development can be a very effective way for communities to permit some development in areas with sensitive natural resources without seriously undermining the integrity of the natural features. This takes careful design, attention to mitigation, good site plan review standards and experienced professionals reviewing the proposed site plans to get the best result. There are many different sample PUD and cluster development ordinances in use throughout Michigan.

Site Plan Requirements / Better Site Design

Next to using zoning districts, site plan review is the most powerful planning and watershed protection tool. Easily enforced, site plan review is a way for communities to ensure what is approved on a site plan is what will be built. A site plan is a plan, drawn to scale, showing the layout of proposed uses and structures. Site plans include lot lines, streets, building sites, existing structures, open space, utilities, and any other required information. The Center for Watershed Protection (www.cwp.org) and the Low Impact Development Center (www.lowimpactdevelopment.org) have additional information.

Communities can require a number of sustainable development best management practices such as landscaping standards, use of native plant species, on-site stormwater best management practices, percentage of allowable impervious coverage, and a host of other environmental design elements through the use of site plan requirements / reviews.

Most ordinances automatically call for site plan review of industrial, office, commercial, and multi-family uses. But communities can require that other uses, even uses allowed by legal right, go through a site plan review.

For example, proposed single family home construction in areas where wetlands, critical habitat, or other unique natural features exist can be regulated to protect these features through the site plan review process. Communities can also adopt provisions addressing preservation of mature trees, preventing light pollution, and other design mechanisms which in turn protect community character.

For environmental, as well as aesthetic concerns in a community, site plan review (of both drawings and written requirements) is one of the best overall zoning tools that can be implemented by local governments. Site plan requirements are a good way of eliminating any development "surprises" and also serve as a mechanism for working with a community's natural features.

Option 3 – Coordinated Permit Review and Approval Procedures

An effective way to combine the strength of local zoning with the weight of state environmental permitting and enforcement is for local governments to coordinate zoning decisions with the MDEQ and MDNR when sensitive natural features are involved. When local governments have appropriate, but limited environmental protection standards in the zoning ordinance, they can condition final development approval on receipt of necessary permits from the state government. This type of coordinated review and approval process helps ensure key environmental and natural resources are protected as new development occurs. Many communities have informally been working with the MDEQ/MDNR this way for years. In some cases, more formal coordinated review procedures are desirable and can be beneficial to all involved parties. One form for such an agreement is a memorandum of understanding that spells out state and local responsibilities.

This approach is possible because all three zoning enabling acts permit local governments to condition approval of zoning permits generally and site plan review specifically, on approvals under statutes administered by other governmental agencies (see for example MCL 125.286e(4) and (5), the Township Zoning Act; MCL 125.216.e (4) and (5) of the County Zoning Act and MCL 125.584d (4) and (5) of the City-Village Zoning Act).

This approach is especially desirable because local governments can be additional "eyes and ears" for natural resource protection, while leaving the environmental permit and enforcement decisions to the state agencies that have the technical wherewithal, the statutory responsibility and the ability to absorb any liability for the decisions made. For small and rural communities especially, these are huge considerations. In the end, development proposals that do not meet both state environmental standards, and local zoning standards are not approved. Projects whose site plans do meet the standards of both local zoning ordinance and state regulations must be approved.

Better Site Design Options

Some options for better site design include:

- Decreased number of parking lots;
- Providing compact car parking spaces and minimizing stall dimensions;
- Encouraging shared parking;
- Minimizing required street pavement width based on need to support travel lanes, street parking, and emergency, maintenance, service vehicle access;
- Optimizing street layout to minimize total roadway length;
- Minimizing required street right-of-way widths to accommodate travel-way, sidewalk, and vegetated open channels;
- Minimizing the number of street cul-de-sacs and reducing cul-de-sac radius to accommodate emergency and maintenance vehicles;
- Considering alternative turnarounds, including the use of mountable curbing and grass shoulders for occasional access by fire trucks and other large commercial trucks;
- Promoting flexible design standards for residential subdivision sidewalks such as locating sidewalks on only one side of the street and providing common walkways linking pedestrian areas; and
- Relaxing side yard setbacks and allowing narrower frontages to reduce total road and driveway lengths within the community.

Small Towns and Rural Townships

Small towns and rural townships rarely have the kind of professional staff available to perform a thorough technical review of all the complex elements of many contemporary development proposals. Everything from issues associated with stormwater retention, sewage disposal or water supply, or the impacts on wetland species from partially filling a wetland for an access road, may be beyond the scope of local zoning staff. In these cases, a community needs to hire outside professionals to perform reviews of development applications to ensure conformance with ordinance requirements. Communities are often unwilling to hire outside experts because they don't want the cost to be borne by existing taxpayers. A recent appellate court decision has demonstrated that a community can collect fees in escrow to pay for the cost of professional reviews, provided the community has a provision enabling such fees in its zoning ordinance, and it returns to the applicant any unused fees (see Cornerstone Investments v. Cannon Township, 459 Mich 908 (1998); after remand, 239 Mich App98, 1999). This ruling means no community need go without the professional expertise necessary to ensure a project meets ordinance requirements.

Additional Measures to Consider

In addition to the options discussed under the previous topics, there are additional measures that can be considered to address environmental issues in terms of ordinances, zoning, and development standards.

Addressing Nonconforming Uses

Uses of land that pre-date the zoning ordinance or an ordinance amendment that no longer comply with zoning regulations are called nonconforming uses. Essentially, these uses are protected from changes created by new zoning regulations. Local governments are permitted to restrict or prohibit expansion or structure additions of nonconforming land uses or structures, with the long-term goal of eventually phasing them out. In riparian areas, local planning officials have an opportunity to address the rapidly changing dynamic of their shoreline through the manner in which nonconforming uses are regulated. For example, if a nonconforming structure exists on a property and is demolished, a new structure cannot replace it without conforming to the current zoning or other applicable regulations. This situation has become increasingly common in recent years as small coastal cottages are torn down and replaced by much larger single family or multifamily dwellings. This presents an opportunity to gain conformance with ordinance requirements, which should be sensitive to watershed protection considerations.

Addressing Rezoning Requests

The process of changing from one zoning district classification to another is called rezoning. The most fundamental question which must be asked regarding a rezoning request is whether the area proposed to be rezoned is an appropriate area for the permitted uses in the proposed zone. Typically, rezoning requests are made for the purpose of increasing the intensity of the use of a parcel. In riparian areas, where there are significant, fragile natural features such as critical habitats and wetlands, rezoning from a low-intensity use classification to a high-intensity use classification could have significant ecological impacts.

Addressing Special Land Uses

Special land uses, also called conditional uses or special exception uses, are uses of land that are allowable within a particular zone only when the proposed activity meets a defined set of standards that are particular to that use and are included in the zoning ordinance. Site-specific issues can be addressed using these designations as opposed to the more general considerations typical of a zoning district.

The dominant land use in a district is usually a use "by right", such as farmland in an agricultural district. Special use provisions can provide communities with the opportunity to control certain activities not allowed "by right", but commonly associated with "by right" uses. Typical special land uses include communication towers, churches, junkyards, private airfields, etc.

Marinas are another type of activity that can be controlled through special land use permits. A community can establish provisions for dock length, number of allowable slips, types of boats, setbacks, and a number of other environmental considerations. By defining special use standards for such activities, local governments can determine what type of marina will be allowed in their community prior to development. Special land uses often prompt concerns from the public regarding potential effects on surrounding property values, traffic, noise, litter, and neighborhood character. It is very important for planning officials to consider if a special land use is consistent with the character of the area and is also consistent with the future land use element of the master plan before permitting them.

Addressing Variance Requests

A variance is a legally granted action to waive a requirement in a zoning ordinance. If a community grants a variance, it permits one property owner to do something that is otherwise not permitted in the zoning ordinance. As a result of the zoning enabling acts, most zoning ordinances and court cases have a very narrow set of circumstances that must exist before a variance can be lawfully granted. In most cases, if a property owner can use the land for the desired use, or place a structure or addition elsewhere on the land without a variance, then the variance is not appropriate. As is apparent, the improper granting of a variance can quickly undermine the integrity of the zoning ordinance. This is even more consequential when the variance has the effect of undermining the integrity of natural resources. In general, if communities adopt zoning measures to protect natural resources and prevent pollution, impairment or destruction of the watershed, they should consider variance requests very carefully and only grant them when not doing so would preclude the land owner from otherwise exercising a lawful property right. Even then, the community should consult with environmental professionals and attorneys familiar with zoning and environmental law.

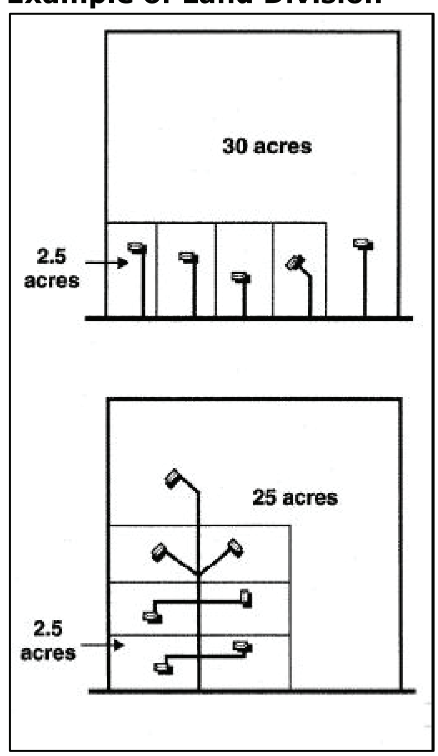
Land Division and Subdivision Ordinances

Two of the local regulatory tools with the greatest potential to minimize harm in sensitive environmental areas are regulations that apply to land divisions and subdivisions. These are usually two separate ordinances that are linked to the zoning ordinance, but because the authority for them derives from a statute different from the zoning enabling acts, they are adopted as separate ordinances. The first is usually known as a land division ordinance. The second is usually called a subdivision or plat ordinance.

A land division ordinance may be adopted by a local unit of government pursuant to Section 109 of the Land Division Act, Public Act 288 of 1967, as amended (MCL 560.109). A land division ordinance regulates the creation of lots and bounds splits of a parcel of land. A statutory formula in Section 108 specifies the maximum number of splits that are permitted from a "parent parcel" without platting. Bonus lots are permitted for shared access and preservation of open space. Minimum standards for lot size, width-to-depth ratio and relationship to access are provided by statute. All parcels splits smaller than 40 acres in size are required to be reviewed and approved locally before they can be recorded with the county register of deeds. Land divisions being created must also conform to local zoning regulations, provided those regulations are not in conflict with the land division provisions of the Land Division Act.

A subdivision ordinance is adopted by a local unit of government to regulate the creation of more splits than are permitted under the land division provisions of the Land Division Act. Section 105 of P.A. 288 of 1967, as amended, provides authority for the adoption of local subdivision ordinances. Developers of platted subdivisions are required to put in

Example of Land Division

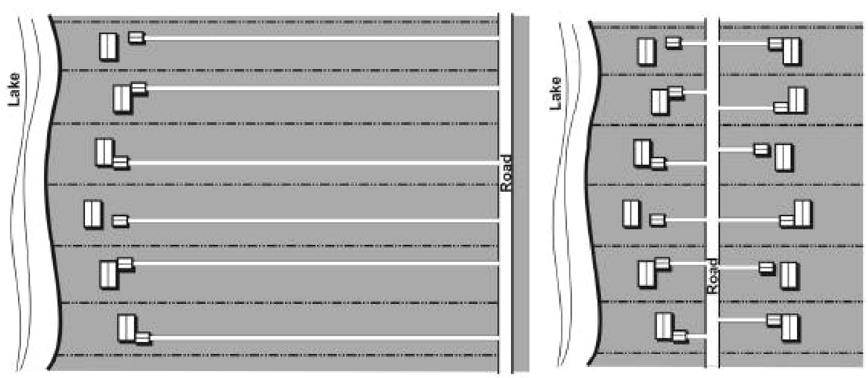


Source: John Warbach,
Planning and Zoning Center, Inc.

public infrastructure such as paved streets, curb, gutter, stormwater, sewer and water pipe, unless exempted by local ordinance. Lots being created must also conform to local zoning regulations, provided those regulations are not in conflict with the platting provisions of the Land Division Act.

The primary environmental issues associated with land divisions and plats relate to lot width, depth, area, access and "buildability". Proper review and approval of land divisions and plats can dramatically reduce future problems associated with use of the lots. The process is similar to site plan review described earlier, except that in the case of plats, there are many statutorily required reviews by different entities, including the local government, the county road commission, drain commissioner, Michigan Department of Transportation (MDOT), and MDEQ, depending on the location and characteristics of the parcel being platted. For example, deep narrow frontage lots along shorelines will often result in long driveways and many structures close to the water. This often translates into considerable impervious surface and water runoff which can carry pollutants, nutrients and warm water into the lake, river, stream or pond. Shallow lots also often have considerable impervious surface and leave little room to site a structure farther from the shoreline. This may be critical in the case of a high risk erosion area, wetland, or floodplain. See Figure C.1-4 a comparison of long and short, narrow waterfront lots.

Figure C.1-4. Long vs. short waterfront lots.

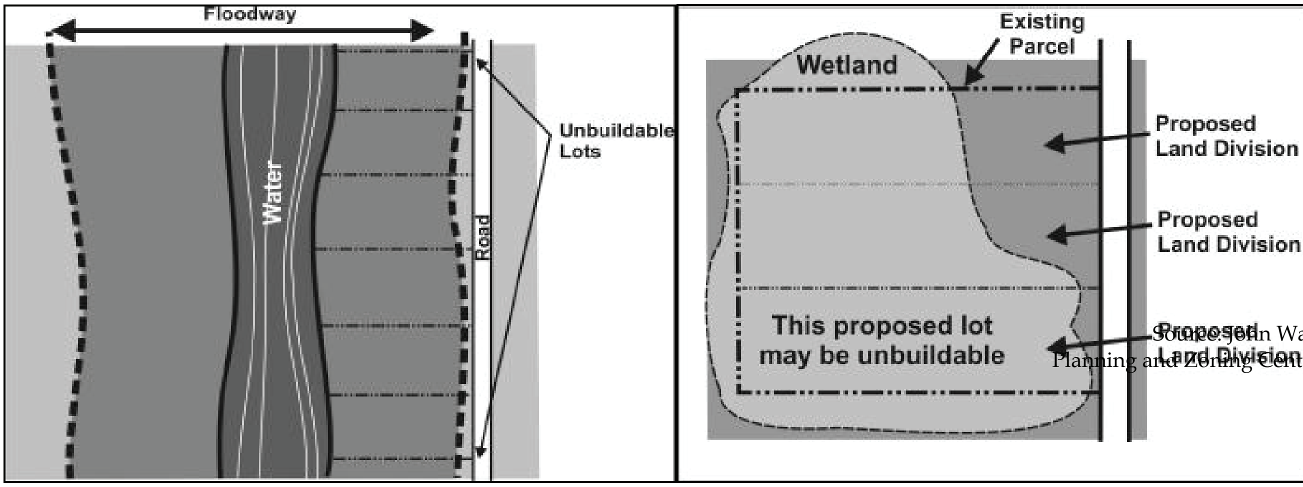


Source: John Warbach, Planning and Zoning Center, Inc.

A parcel size between the two types is more desirable, especially if each lot is wider along the lake. This will result in less impervious surface and adequate room to locate a structure outside of a floodplain.

Total area is a function of lot width and depth, so if one or both are short, then the total area of the parcel will often be small, leaving few options to mitigate potential environmental impacts, such as trying to avoid siting structures in a floodplain/floodway (see Figure C.1-5).

Figure C.1-6. Unbuildable lot issues.



Source: John Warbach, Planning and Zoning Center, Inc.

Access is an issue linked to connecting a driveway between a structure and the public or private road leading to the lot. Especially on long narrow lots, such as those in a designated environmental area, it may be difficult to site an access road without seriously and negatively impacting the sensitive natural features in the area. "Buildability" relates to the issue of whether a proposed lot of a certain size and shape results in an area of land on which a permanent residence or other structure may be built under existing environmental regulations.

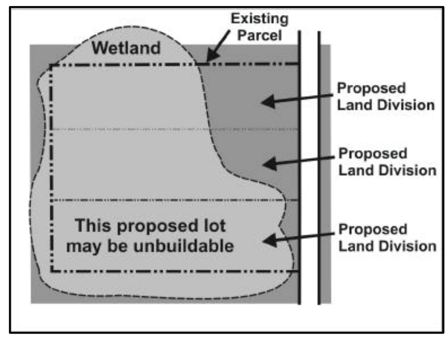
For example, a proposed land division of a parcel that is largely wetland and that includes no high ground, may have no place on which a residence and a septic field could be legally sited. Approval of such land divisions undermines the integrity of the environment, of environmental enforcement and sets up multiple governmental agencies for potential takings claims.

On the other hand, ensuring that a lot is "buildable" under all applicable regulations prior to approval, not only protects the environment, but also plays an important consumer protection function—people can buy a lot that is "buildable".

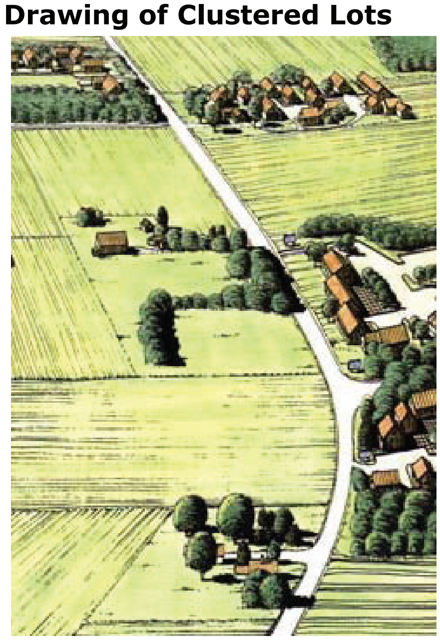
Unfortunately, the land division provisions of Section 109 of the Land Division Act can be read to prohibit a community from denying approval of a proposed land division on the environmental regulations. As a result, many communities feel obliged to approve such land divisions, but then file a notice with the County Register of Deeds that such a lot does not conform to other applicable regulations. If it were purchased for a building use, such as for a residence or business, the land division request would be denied. This is a very awkward way to protect the consumer, but appears to be the only lawful way to do so under Section 109. Michigan appellate courts have upheld a township zoning regulation prohibiting counting unbuildable area on a site due to wetlands when calculating permitted density. See Frericks v. Highland Twp. 228 Mich App 575, appeal denied, 459 Mich 66 (1999).

Example of Buildability

Source: John Warbach, Planning and Zoning Center, Inc.



Drawing of Clustered Lots



Source: NCSP, 2005.

The best proactive measures a community can take to prevent the creation of lots that do not undermine the integrity of the environment and are "buildable", are listed below:

- Adopt and consistently administer land division regulations;
- Adopt and consistently administer subdivision regulations;
- Try to persuade landowners who propose to create "unbuildable" lots not to do so. If unsuccessful, file a notice with the County Register of Deeds that runs with "unbuildable" parcels that informs purchasers of the unique status of such lots; and
- Put provisions in the shoreline district provisions or shoreline overlay provisions of the zoning ordinance which:
    - Require wide and deep lots with shared access; or
    - Ensure lots are clustered with all the common open space along the shoreline, sensitive environmental areas are avoided and all access is shared.

Public Spending and Capital Improvement Programs

Another important way to protect sensitive natural features is to watch how, where and when the public spends money on public facilities. Where new public facilities are constructed and where they are not can have profound effects on natural resources. The extension of sewer and water lines into a sensitive environmental area or the construction of a new road along a large wetland will have significant long term impacts–many of which could be negative. At the same time, the construction of a sewer line around an inland lake being contaminated by leaking septic tanks can help restore water quality in the lake. Communities that work with nature avoid creating the conditions which promote intensive development in areas with a large area of sensitive natural features.

Large capital improvements should be planned to meet future needs and should be based on the future land use plan or master plan–just as zoning should be. When the master plan has a solid foundation on a natural features inventory, future land uses will be planned in locations to avoid negative impacts on sensitive natural features. Subsequently, future capital improvements will then be located to accommodate needed community growth in locations that don't negatively affect sensitive natural features. The best tool for planning for future public improvements is the capital improvement program (CIP). This is a schedule of proposed capital improvements for future years. It specifies where the facilities are proposed to be located, what their cost will be, the means of financing and when they will be constructed. Each year the CIP is updated. This process permits plenty of time to examine the CIP for its environmental friendliness and to ensure that public investments aid, rather than diminish, the quality of local natural resources.

Environmental Protection Options for Local Governments

The MDEQ maintains a web site that hosts the document "Filling the Gaps: Environmental Protection Options for Local Governments". This document helps local governments sift through the maze of protecting the environment from a top down approach: applicable federal laws, applicable state laws, how these apply to various environmental features, and options for local governments authorized by federal and state law to protect the various environmental features.

The site can be accessed by going to http://www.michigan.gov/deq/ then selecting "Water", then "Great Lakes", then "Coastal Management". The document is listed in the "Information" section.

Source: MDEQ, 2003.

Sustainability Concepts

There are numerous concepts of sustainability that can be promoted through the adoption of various ordinances, zoning, and development standards. A protracted discussion of sustainability is not warranted in this RAP but some ideas for potential actions (and suggested future reading) include: land cover / impervious cover thresholds (including lot densities, right-of-way widths), low impact design (or hydrologic source control which strives to retain pre-development hydrologic regimes and reduce non-point source pollution from wet weather flows and the subsequent treatment needs), stormwater as a resource (reuse), green buildings, preservation of natural drainage and infiltration (and baseflows), water use limits, and sewerage paradigms (on-site disposal systems, etc). There are myriad other sustainability concepts with goals ranging from biodiversity enhancement to social well being. Many of these concepts are unfamiliar to those able to implement them and to the general public. As such, public education, input, and involvement are critical aspects of any programs related to increasing the use of sustainable practices.

Summary

Regardless of the measures adopted by each stakeholder, it is paramount that they be consistent with the goals of this RAP. Adopting ordinances, zoning, and development standards allows each stakeholder to prevent future degradation to, and in some cases reverse degradation of, a wide variety of environmental characteristics (e.g. aquatic buffers). This is essentially done by addressing the first two phases of the development cycle – land use planning and site design – by providing developers options such as 'better site design' protocols and, where necessary, mandates to ensure protections are achieved.

Addressing pollutant concerns related to the construction and post-construction (e.g. home ownership, building occupation) phases of development is done through stormwater best management practices that reduce soil erosion and mitigate impervious surfaces that are necessary. These types of practices are addressed in the following sections of this chapter.

Programs Administered through MGSP

The programs discussed under the following headings are administered through the MGSP:

*Home*A*Syst*
Home*A*Syst is a household assessment tool that can be used to help identify risks and provide information on how to lower your risks to groundwater contamination around the home. Home*A*Syst helps protect your drinking water, the environment, your health, and the health of your family.

*Farm*A*Syst*
Farm*A*Syst identifies potential risks posed by farmstead operations. Technical assistance with completing Farm*A*Syst evaluations is available free of charge from the Michigan Groundwater Stewardship Program.

*Crop*A*Syst*
Crop*A*Syst is an assessment tool that helps develop and implement a management plan that prevents contamination of groundwater and surface water resources and maintains economic crop production. Just like Farm*A*Syst, the Crop*A*Syst program is voluntary and confidential.

(4) Good Housekeeping and Pollution Prevention

Watershed protection requires that actions be taken to minimize the environmental exposure of pollutants. These actions include preventing the generation of potential pollutants, implementing procedures to ensure that existing compounds are handled and disposed of in such a way that they never become pollutants (e.g. through stormwater runoff), and inspecting infrastructure that handles pollutants to ensure it is working correctly. These pollutant loads are related to both non-point (e.g. stormwater) sources and point sources. Some examples for which pollution prevention and good housekeeping apply include: the storm sewer system (including illicit discharges), the sanitary sewer system, municipal facilities, managed and manicured turf, solid waste management facilities, commercial facilities (e.g. chemical spills), and septic systems. Some of these sources such as commercial and industrial facilities have a high level of regulation and enforcement at state/federal levels and require little local resources commitment to address. However, some sources, such as septic systems, exist in a regulatory and enforcement 'gray area' and may require significant local resources to adequately address associated problems. Additionally, emerging water quality problems need to be addressed and dealt with as appropriate (e.g. methyl t-butyl ether – MTBE, perfluoroalkane sulfonates – PFOS, polybrominated diphenyl ethers – PBDEs, antibiotics, pharaceuticals, and household personal care products).

Another factor which clouds the issues surrounding pollution control is the jurisdiction of the various levels of government over the various waterbodies. For example, at the federal level, the Environmental Protection Agency (EPA) has regulatory oversight of 'water of the United States' which it defines as: navigable waters, tributaries of navigable waters, interstate waters, and intrastate lakes, rivers, and streams which are: sources of fish or shellfish sold in interstate commerce, used by interstate travelers for recreation and other purposes, or utilized for industrial purposes by industries engaged in interstate commerce. At the state level, the Natural Resources and Environmental Protection Act (NREPA – Act 451 of 1994) is designed to protect the environment and natural resources of the state (e.g. water resources, groundwater and freshwater, inland lakes and streams, wetlands, natural rivers, shorelands) by regulating, for example: pollutant discharges; land, water, and resource use; soil erosion and sedimentation; dams; and prescribing penalties and remedies for violations. Through the Environmental Remediation portion of NREPA (and other federal and state laws) the MDEQ is authorized to conduct and oversee investigations and cleanup activities at contaminated sites including review and approval of site cleanup plans and oversight of processes when performed by private parties.

Some agencies and programs that can provide assistance in this area are discussed in the following subsections.

The Michigan Department of Agriculture

Information on the following programs can be obtained through the)MDA's website at http://www.michigan.gov/mda/.

The Michigan Groundwater Stewardship Program

The goal of the Michigan Groundwater Stewardship Program (MGSP) is to provide information and assessment tools (e.g. nitrate testing, sprayer tips, rotational grazing, backflow devices, manure testing, spill kits) for pesticide and nitrogen fertilizer users. The MGSP helps them identify risks to groundwater associated with their pesticide and nitrogen fertilizer use practices and to coordinate local, state, and federal resources to help individuals reduce those risks. The MGSP is designed to be voluntary, to be locally driven, to address the concerns of individuals, and to maintain a focus on financial and technical constraints which guide decision making.

Abandoned Well Closures

The objective of abandoned well closure is to reduce the risk of contaminants moving down an abandoned well and contaminating groundwater supplies. Stewardship Teams determine local cost-shares, which are often as high as 75 to 90 percent of the total cost. A statewide identification and plugging program has achieved the 2nd highest plugging rate in the nation through direct action, in cooperation with local health departments (which includes field inspections, reviews of plugging records, monitoring of compliance, and enforcement), and through grants. The program also targets wellhead protection areas and includes training and public education elements. Elements of the program also involve the MDEQ, the Attorney General, and the Office of Criminal Investigations.

MDEQ – Water Programs

The MDEQ, under the auspices of the CWA and NREPA, defines water quality standards (WQS) "to protect the Great Lakes, the connecting waters, and all other surface waters of the state" (MDEQ, 2006b). The criteria are discussed in detail in Chapter 6 (note that numeric nutrient criteria are in the process of being developed). The MDEQ also has myriad programs that aim to ensure that these WQS are met through a mix of permitting, enforcement, and assistance-type functions. Information on the following programs that support WQS can be obtained through the MDEQ's website at http://www.michigan.gov/deq/.

Biosolids & Industrial Pretreatment Program

To further preserve and protect Michigan's water resources, the MDEQ encourages and enforces the use of wastewater treatment systems through the use of Biosolids (in agriculture and silviculture) and the Industrial Pretreatment Program. The land application of biosolids is regulated through the NPDES and state groundwater discharge permits to prevent contamination of ground and surface water by the high nutrients or other pollutants. The MDEQ inspects facilities of generation and application and requires a residuals management program be in place.

Drinking Water

The MDEQ has primary enforcement authority in Michigan for the Federal Safe Drinking Water Act (of 1974) under the legislative authority of the Michigan Safe Drinking Water Act, both of which establish numerous requirements of drinking water systems and wellhead protection provisions to be implemented at the state or local level. Regulations and standards related to such acts are determined by the EPA and MDEQ. The MDEQ investigates abandoned wells, drinking water well contamination, and oversees remedial activities at sites of groundwater contamination affecting drinking water wells. The MDEQ is also completing a Source Water Assessment Program (SWAP) that identifies public drinking water sources; inventories contaminants and water's susceptibility to contamination; and informs the public of the results. More information on the SWAP is available at http://www.michigan.gov/deq/0,1607,7-135-3313_3675_3693---,00.html.

The issuance of drinking water facility and well construction permits are primarily the responsibility of local government. The Oakland County Health Division manages the Drinking Water Supply Program and Well Protection and Education Code. Wayne County administers a Cross Connection Control program that monitors contamination of potable water through connections with non-potable sources.

The MDEQ has a Wellhead Protection Program that assists local communities utilizing groundwater for their municipal drinking water supply systems in protecting their water source. However, private wells are not required not monitor for water quality although the monitoring of such is surely beneficial given the potential to provide for early detection of environmental contaminants and is therefore encouraged.

Groundwater Discharge

Groundwater Discharge Program

The Groundwater Program regulates discharge to groundwater under Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451 and Part 22 Rules.

Groundwater Modeling

Groundwater Modeling Program

The Groundwater Modeling Program (GMP) has provided groundwater modeling support on a department-wide basis since 1980 when an EPA grant was used to fund groundwater models for site remediation. The MDEQ has recently completed a groundwater mapping project in conjunction with the USGS and Michigan State University to better understand the extent and features of the groundwater environment in the state. More information is available at http://www.michigan.gov/deq/0,1607,7-135-3313_21698---,00.html.

Spill Response

While the MDEQ is generally responsible for implementing spill response activities for the waters of the state, the U.S. Coast Guard has the primary responsibility for spills on Lake St. Clair and in the nearshore area of the lake.

Emergency Response

Emergency Response

The MDEQ operates the Pollution Emergency Reporting System (PEAS), a unified 24-hour hotline for reporting environmental emergencies, including those related to the twenty-six state and federal regulations requiring chemical release notification. The MDEQ is also responsible for implementing the Part 5 Rules - Spillage of Oil and Polluting Materials. The Part 5 Rules deal with the storage and release of oil, salt, and polluting materials.

Inland Lakes & Streams

Inland Lakes and Streams

The State's water resources are monitored by the MDEQ and partnering organizations to determine water quality, the quantity and quality of aquatic habitat, and the health of aquatic communities, and compliance with state laws. Regulated areas include shore protection, boat docks and hoists, beach modification and sanding, dredging and excavation,

"Joint Permit Application"

This package covers permit requirements pursuant to state and federal (MDEQ and USACE[4]) rules and regulations for construction activities where the land meets the water and including: wetlands, floodplains, marinas, dams, inland lakes and streams, great lakes bottomlands, critical dunes, and high-risk erosion areas.

Surface Water

The MDEQ is committed to protecting and preserving Michigan's water resources. There are numerous programs supporting this goal as discussed under the following headings.

<u>Enforcement</u>
The Surface Water Enforcement Unit is responsible for conducting all escalated enforcement actions taken by the division. These actions are conducted in response to violations of state water pollution control statutes and rules, violations of surface water discharge permits, and any violations of administrative or judicial orders.

<u>NPDES Permits</u>
The MDEQ administers the federal NPDES permitting program at the state level. This program restricts pollutant discharges to waterbodies and sets strict effluent concentration and loading limitations on those facilities that must discharge to waterbodies, such as waste water treatment plants.

<u>Water Quality Trading Program</u>
The State of Michigan may develop a statewide water quality trading program. Water quality trading would allow facilities facing high pollution control costs to meet their regulatory obligations by purchasing environmentally equivalent pollution reductions from another source at lower cost, thus achieving the same water quality improvement at lower overall cost.

<u>Septage</u>
The MDEQ enforces rules for the handling of domestic septage and licenses the haulers wishing to do so. The program provides technical assistance as well as contacts for staff, haulers, and end-users.

<u>Sanitary and Combined Sewer Overflow</u>
The MDEQ has broad regulatory authority to deal with SSOs and CSOs. The SSO/CSO program includes setting policy, collecting reports of occurrences from offending parties, publicizing occurrence information, identifying sources, responding to complaints, collecting data at suspected sewage release locations, and initiating enforcement actions against offending entities. However, many sewage discharge locations may still be undocumented and require specialized field work or hydraulic modeling to identify them. CSOs are permitted under the NPDES program, but SSOs are considered illegal discharges and all known SSOs are subject to enforcement actions (e.g. consent decrees) that will ultimately result in their elimination.

Water Management

The MDEQ regulates activities that may have potential impacts to the public trust, riparian rights, or may impair or destroy the waters or other

[4] The USACE is the permitting agency for Clean Water Act Section 404 permits that regulate the dredging or filling of wetlands. In Michigan, the USACE jointly administers this program with the MDEQ.

natural resources of the state, including inland lakes and streams, the Great Lakes, wetlands, and groundwater.

Water Quality Monitoring

Michigan Water Quality Monitoring

The MDEQ has several water quality monitoring programs that assist in keeping all of Michigan's waters clean. These programs include Beach Water Monitoring, Assessment of Michigan Waters, Inland Lakes Monitoring, and Public Swimming Pool Monitoring.

The Total Maximum Daily Load Program

MDEQ regulations (as authorized by the EPA under the CWA) require that "when a lake or stream does not meet water quality standards, a study must be completed to determine the amount of a pollutant that can be put in a waterbody from point sources and nonpoint sources and still meet water quality standards, including a margin of safety" (MDEQ, 2006a).

Other Water Programs

The MDEQ has numerous other programs that deal with such things as sewerage system construction, environmental health (e.g. trailer park, campground, and swimming pool regulations), stormwater, and nonpoint source pollution (which include watershed plan development assistance, information and education activities, implementation grants, monitoring and investigations, and compliance enforcement). Funding is available for many of these and the aforementioned programs including the state revolving fund, the strategic water quality initiative fund, and the CMI.

MDEQ – Other Programs

Land Development

> **Decentralized Treatment**
>
> Emerging decentralized technologies for the treatment of sewage should be considered in developing areas to avoid the water quality problems associated with septic systems and the need for extensive sewer infrastructure.

Land Development: On-Site Sewage Disposal Systems

The MDEQ has promulgated rules for on-site sewage disposal systems (OSDS) as they apply to the Land Division Act. The MDEQ also issues numerous reports regarding the status of OSDS in the state and provides technical assistance. Septic systems are an important issue in many areas of the watershed but there is a perceived lack of authority and funding at both the state and local levels to identify and remediate failing septic systems. As such, addressing septic system issues is an important consideration in the context of this RAP.

Waste and Hazardous Materials Division

The Waste and Hazardous Materials Division (WHMD) administers a diverse number of prevention programs to protect the environment and the public's health through proper management of hazardous products; solid, liquid, medical, and hazardous waste; and radioactive materials.

The Michigan Department of Transportation

Information on the following programs can be obtained through the MDOT's website at http://www.michigan.gov/stormwatermgt/.

Educational Materials

MDOT provides educational and outreach materials that describe how pollution prevention and good housekeeping can be implemented on transportation, and related, structures. Available information includes the types of BMPs that can be implemented on or near roads and car care tips to prevent pollution.

Drainage Manual

The MDOT Drainage Manual defines specific practices and the standards thereof that are implemented to minimize the pollutant-related impacts of transportation infrastructure.

The Environmental Protection Agency

The U.S. Environmental Protection Agency (EPA) is charged by Congress with protecting the Nation's land, air, and water resources. Under a mandate of national environmental laws, the Agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life. The EPA fulfills numerous regulatory and research roles to control and solve environmental problems, mange ecological resources, understand how pollutants affect human health, and prevent or reduce future environmental risks.

National Pollutant Discharge Elimination System

The NPDES is a cornerstone of environmental protection at the federal level. When the NPDES was established in 1972 (under the Clean Water Act), only one third of our rivers, lakes, and coastal waters were considered fishable and swimmable. Today, approximately two thirds of our waters are healthy. This is due in no small part to the regulation of more than 50 categories of industry (including several hundred thousand businesses) and the nation's network of more than 16,000 municipal sewage treatment systems. The NPDES permits that regulate discharges from these facilities have resulted in the prevention of billions of pounds of conventional pollutants (e.g. suspended solids) and millions of pounds of toxic pollutants (e.g. dissolved heavy metals) from being discharged into 'waters of the United States' (EPA, 2001a). The NPDES also covers stormwater discharges from industrial facilities. Recently, the MDEQ has heightened its mercury discharge criteria to deal with the widespread contamination of that particular contaminant throughout the Great Lakes basin, particularly in urban rivers and inland lakes.

In 1990, the Environmental Protection Agency (EPA) promulgated Phase I of the stormwater rules of the NPDES. This required municipal separate storm sewer systems (MS4s) in areas with 100,000 or more people to regulate the quality of stormwater discharges to waters of the United States.

In 1999, the EPA promulgated Phase II of the NPDES stormwater rules. The Phase II requirements expand the coverage of MS4s to include those in urbanized areas (as defined by the U.S. Census) not previously covered under Phase I.

Michigan is one of forty-five states and territories authorized to implement the NPDES program. In implementing the Phase II requirements, the MDEQ has developed the NPDES General Permit No. MIG619000 for Coverage of Storm Water Discharges for Municipal Separate Storm Sewer Systems Subject to Watershed Plan Requirements. To date, this is the only instance of a watershed-based permitting approach under the NPDES program. The MDEQ has also developed a jurisdictional-based approach: NPDES General Permit No. MIS040000 for Coverage of Storm Water Discharges from Municipal Separate Storm Sewer Systems with Controls Based on Six Minimum Measures. This approach involves communities working independently to address stormwater discharges through: 1)

EPA Regulatory Authority

The EPA has regulatory authority over Waters of the United States, which are defined as (EPA, no date):

- Navigable waters;
- Tributaries of navigable waters;
- Interstate waters; and
- Intrastate lakes, rivers, and streams which are:
  - Sources of fish or shellfish sold in interstate commerce;
  - Used by interstate travelers for recreation and other purposes; or
  - Utilized for industrial purposes by industries engaged in interstate commerce.

Many of the regulatory duties of the EPA in Michigan are authorized to be implemented through the Michigan Department of Environmental Quality which often extends these regulations, under state power, to waters not covered under the EPA's definition. Examples of this enforcement authority include drinking water, nonpoint source pollutions and NPDES permitting.

Public Education and Outreach, 2) Public Participation / Involvement, 3) Illicit Discharge Detection and Elimination, 4) Construction Site Runoff Control, 5) Post- Construction Runoff Control, and 6) Pollution Prevention / Good Housekeeping. It should be noted that the MDEQ is in the process of refining the permit language.

The Phase I and Phase II programs currently cover many jurisdictions in the watershed. The actions that the various permittees are undertaking in support of their NPDES permits provide benefits with respect to the RAP and should be leveraged where possible. Once the revised permits are issued, the RAP and its actions will need to be reevaluated with the appropriate considerations. The actions of the various Phase I and Phase II communities are addressed further in the Action Plan presented in Chapter 8.

The United States Geological Survey

The United States Geological Survey coordinates the Cooperative Water Program which provides reliable, impartial, and timely information needed to understand the Nation's water resources through a program of shared efforts and funding with State, Tribal, and local partners to enable decision makers to wisely manage the Nation's water resources.

Other Programs

There are countless other programs and agencies that deal with pollution prevention issues either through wide-reaching regulatory considerations or related to specific sites or locales under distinct jurisdictions. For example, the Department of Defense regulates its installations such as the Selfridge Air National Guard Base and does so in accordance with the provisions of CERCLA (including a community relations plan as part of the Installation Restoration Program). The site is of important to the local community due to its numerous spills, landfill areas, tank locations, and training areas.

Actions to Consider

The aforementioned agencies and programs can provide invaluable resources and guidance towards implementing a number of actions designed to prevent pollution from entering the natural environment and causing impairment thereof. Potential actions that are considered in the context of this RAP include: stressor and source identification; storm and sanitary sewer and treatment system design, construction, and maintenance (e.g. footing drain / sump pump disconnection, catch basin cleaning, enhanced treatment facility processes); transportation facility design, construction, and maintenance (e.g. street sweeping); solid waste management; turf management (e.g. fertilizer limitations, no-phosphorus fertilizer ordinances); animal waste control (e.g. pets, geese, pigeons, raccoons, rats); flood control and water quality considerations; septic system practices (e.g. periodic inspections, required maintenance, elimination through increase sewerage); groundwater protocols; marina guidelines, and agricultural practices (e.g. manure management through storage, land application, and livestock stream restrictions).

A key action being implemented under the NPDES permit program is 'illicit discharge elimination' which involves detailed investigations to ensure that no illegal pollution sources, such as cross-connected sanitary sewers, are discharging from storm sewer outfalls.

(5) Stormwater Best Management Practices: Soil Erosion and Sediment Control

As described by the US EPA, stormwater nonpoint source pollution diminishes water quality in the United States. To reduce the impact, it is important that watershed protection measures include examination of best management practices (BMPs) in new development, redevelopment, and existing landscape to reduce the amount of pollution entering receiving water bodies. Since development causes hydrological changes in the watershed, BMPs must also be chosen to mitigate this effect.

Good soil erosion and sediment control (SESC) is a critical watershed protection tool that protects surface waters from the effects of sedimentation, flooding, and other property damage. SESC can be divided into two distinct components: construction related and non-construction related.

Construction Related SESC

In the State of Michigan, county enforcing agents (CEAs) are authorized under Part 91 of Public Act 451 to require that a permit be obtained for any land disturbance greater than 1 acre or within 500' of a waterbody (except for exempted crop production practices). Authorized Public Agencies (APAs) are exempt from obtaining a permit, but must notify the appropriate enforcing agency in advance and must follow the SESC guidelines stipulated in the Act.

The MDEQ, through Part 31 of Public Act 451 (a.k.a., 'Permit by Rule'), requires any land disturbance greater than 5 acres to obtain a Notice of Coverage in addition to a soil erosion control permit from the local county enforcing agents (CEA) or municipal enforcing agents (MEA).

Persons engaged in agricultural practices may enter into an agreement with the conservation district instead of obtaining a permit from a CEA or MEA.

Additional information can be obtained from:

Michigan Department of Environmental Quality
Water Bureau, Storm Water Administration
PO Box 30657
525 West Allegan, 2nd Floor, Lansing, MI 48909-8157

Potential Construction Related SESC Actions

There are numerous actions, mostly temporary in nature, that can be used to prevent the erosion of sediment on construction sites and to prevent any erosion that occurs from leaving the site. A brief treatise on these actions follows:

- Phasing and sequencing involves conducting the construction practice to limit the exposure of soils to erosive potential.
- Mulching is the application of plant material such as hay and straw to the soil surface. This reduces erosion by shielding the soil from the force of raindrop impact and reducing the velocity of runoff flowing over the soil. Mulch can also aid in seed growth by conserving moisture and shielding the young plants from extremes of heat, cold, or dry conditions
- Matting is similar to mulching except that a manufactured product is used. The matting may be made from jute, coconut fiber, or a

SESC-related Agents in the AOC/Watershed

Cross-Jurisdictional Enforcing Agent
MDEQ, Water Bureau

County Enforcing Agents
Lapeer County Community Development Department
Macomb County Public Works
Oakland County Drain Commissioner
St. Clair County Public Works
Wayne County Department of Environment

Authorized Public Agencies
Lapeer County Drain Commissioner
Lapeer County Road Commission
Macomb County Public Works
Road Commission of Macomb County
Oakland County Drain Commissioner
Road Commission for Oakland County
City of Novi (Oakland County)
St. Clair County Road Commission
St. Clair County Drain Commissioner
Wayne County Department of Public Service
Detroit Water and Sewerage Department (Wayne County)
Wayne County Department of Environment / Department of Public Works
Various State of Michigan Departments (e.g. MDEQ, MDOT)

Conservation District
Lapeer Conservation District
Macomb Conservation District
Oakland Conservation District
St. Clair Conservation District
Wayne Conservation District

(continued on following page)

SESC-related Agents in the AOC/Watershed (continued)

Municipal Enforcing Agent
City of Fraser (Macomb County)
City of St. Clair Shores (Macomb County)
City of Sterling Heights (Macomb County)
City of Birmingham (Oakland County)
City of Lake Angelus (Oakland County)
City of Pontiac Department of Public Works (Oakland County)
City of Southfield (Oakland County)
City of Troy (Oakland County)
Orion Charter Township (Oakland County)
Charter Township of West Bloomfield (Oakland County)
White Lake Township (Oakland County)
City of Grosse Pointe Woods (Wayne County)

BMP Resources

Additional resources for stormwater BMPs include:

- The Stormwater Manager's Resource Center's *BMP Fact Sheets* (www.stormwatercenter.net).
- *Stormwater Management Guidebook*. Menerey, B.E., et al. (1999). MDEQ Land and Water Management Division;
- *Guidebook of Best Management Practices for Michigan Watersheds*. Peterson, A., et al. (1998). MDEQ Surface Water Quality Division; and
- EPA's *National Menu of BMPs*; cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm

Some of these resources have been consulted in the development of this section.

combination of natural and synthetic fibers. Matting should be used in areas where mulch would wash off such as channels and long and/or steep slopes.

- Diversion is a practice in which the contractor constructs an earth channel and/or berm up-slope of the work area with a supporting ridge on the lower side across the slope. Diversions intercept and divert clean water before it flows onto the construction site.
- A vegetated filter strip consists of a well-vegetated strip through which the runoff flows before leaving the work area. Vegetated filter strips remove sediment by filtering the water as it flows through the vegetation and slowing the velocity of flow allowing the sediment to settle.
- Temporary seeding is the practice of seeding grass or small grains on a disturbed area for a limited period. The seeding will replace the vegetation removed and will provide similar erosion control benefits.
- Silt fencing or hay bale barriers are the most common types of erosion control measures and are often improperly applied, installed and/or maintained. These devices function by slowing the water velocity allowing the sediment to settle behind the device.
- Temporary grade stabilization structures are hay bales or similar measures installed in ditches and swales. In this application they function by slowing the velocity of water in the ditch, making it non-erosive. These structures may also be constructed of rock or timber.
- A sediment trap is a small temporarily ponded area with a stable outlet. The sediment trap intercepts sediment laden runoff from small disturbed areas and detains it long enough for most of the sediment to settle out.

Additional information on construction-related SESC measures from the appropriate agents as discussed previously.

Non-Construction Related SESC

This type of SESC includes any activity that is not undertaken in relation to an active construction site. General activities of non-construction SESC include:

- Repairing bare soil such as occurs on poorly maintained yards or eroding hillsides;
- Repairing and stabilizing stream banks that are eroding with vegetative components (referred to bioengineering) or, in the cases of extremely fast moving water, hard armoring (this option must be weighed with natural feature considerations)
- Repairing roads and associated transportation structure that are eroding or causing nearby erosion;
- Excluding sensitive uses from occurring near waterbodies, especially within the riparian corridor;
- Insuring sediment generating sites install proper controls to prevent sediment from leaving the property;
- Providing controls in sensitive areas to ensure that sediment is not transported by wind;
- Installing structural controls at inlets to, or inside of, the storm sewer system (e.g. swirl separators, sediment traps) to ensure sediment does not travel to receiving waterbodies; and

- Encouraging the implementation of agricultural runoff BMPs that prevent soil particles from traveling to nearby waterbodies (e.g. animal access restrictions, conservation tillage, conservation cover, crop sequencing, contouring, critical area plantings, crop residue use, diversions, field borders, filter strips, grade stabilization),
- Channel modifications and selective removal of logjams (with natural resource considerations) may be used to change the flow profile such that sediment deposition may be achieved.

Many other techniques, such as street sweeping, may be considered non-construction SESC. Many of these techniques have been included under other headings (e.g., street sweeping is considered pollution prevention).

(6) Stormwater Best Management Practices: Other Practices

As described by the US EPA, stormwater nonpoint source pollution diminishes water quality in the United States. To reduce the impact, it is important that watershed protection measures include examination of best management practices (BMPs) in new development, redevelopment, and existing landscape to reduce the amount of pollution entering receiving water bodies. Since development causes hydrological changes in the watershed, BMPs must also be chosen to mitigate this effect.

Impervious Surface Mitigation

Impervious surface mitigation is a broad category comprised of practices designed to directly reduce impervious surface and/or treat the runoff from impervious areas. Some of these practices have the characteristics of the practices discussed in the following subsections ('Infiltration Practices', etc.) This category focuses on retro-fit implementation, but the practices herein can be implemented on new development and/or incorporated into ordinances, zoning, or development standards (discussed previously in this chapter). These practices can be major contributors to reducing stream flashiness through slowing down runoff and promoting infiltration and evapotranspiration. The decrease in imperviousness also reduces that amount of pollutants that can be picked up by runoff. However, agricultural areas exhibit increased runoff characteristics that make them function hydrologically like impervious areas. Practices such as disconnecting tile drains from nearby watercourses, or collapsing them, can address this issue and contribute to improved streamflow characteristics.

Common mitigation practices include:

- Vegetated Parking Lot Islands – vegetated depressions receiving runoff from parking lots and other impervious surfaces for infiltration into ground and filtration before discharging to storm sewer system or waterbody;
- Vegetated Road Medians and Side Ditches – vegetated channels in the median or along the side of a road, functioning similar to parking lot islands except they also convey runoff;
- Green Roofs – building roofs that are covered with vegetation and soil planted over a waterproof membrane to retain and evaporate rainfall and slow its runoff;
- Pervious Pavement and Asphalt / Paving Bricks – alternative paving types that allow for the percolation of water into subgrade

Additional Considerations

Mitigating impervious surfaces can also be addressed by: 1) cutting out concrete and planting trees or constructing planter boxes; 2) placing planter boxes on top of existing impervious surfaces; and 3) utilizing native vegetation wherever possible.

Impervious Surface Mitigation Scorecard

Impervious surface mitigation practices provide wide-ranging water quality and water quantity benefits. The information presented below is for comparative purposes only. Values to be used for design purposes or to calculate pollutant load reductions should be determined through additional research.

WATER QUALTIY CATEGORY	REMOVAL EFFICIENCY*
TSS	60%
Phosphorus	45%
Metals (Cd, Cu, Pb, Zn)	55%
Nitrogen	50%
Pathogens	50%
Toxins	50%

* *Efficiency = % removal of influent concentration (median)*

Source: Winer, 2000.

WATER QUANTITY CATEGORY	APPLIC.**
Channel Protection	H/M/L
Overbank Flood Protection	M/L
Extreme Flood Protection	L
Recharge Volume	M/L

** *Applicability = suitability of practice for given purpose; H=High, M=Medium, L=Low*

Source: Minnesota, 2005.

Infiltration Systems Scorecard

Infiltration practices provide wide-ranging water quality and water quantity benefits. The information presented below is for comparative purposes only. Values to be used for design purposes or to calculate pollutant load reductions should be determined through additional research.

WATER QUALTIY CATEGORY	REMOVAL EFFICIENCY*
TSS	95%
Phosphorus	65%
Metals (Cd, Cu, Pb, Zn)	95%
Nitrogen	50%
Pathogens	n/a
Toxins	n/a

* *Efficiency = % removal of influent concentration (median)*

Source: Winer, 2000.

WATER QUANTITY CATEGORY	APPLIC.**
Channel Protection	M
Overbank Flood Protection	M/L
Extreme Flood Protection	L
Recharge Volume	H

** *Applicability = suitability of practice for given purpose; H=High, M=Medium, L=Low*

Source: Minnesota, 2005.

soils or an engineered sub-base that facilitates infiltration and/or slow discharge to the storm sewer system;
- Rain Barrels and Cisterns – storing of rooftop runoff for later use as irrigation or other non-potable applications, these only provide benefits if water is used or drained between rainfall events;
- Bridge Scupper Drain Treatment – install piping on bridge scupper drains to ensure runoff does not directly drop into waterbody, but instead is treated through natural and/or structural means; and
- Impervious Surface Disconnection – altering drainage systems such that adjacent pervious areas are not hydraulically connected (i.e. routing rooftop downspouts to discharge onto grass instead of onto a driveway).

Benefits of impervious surface mitigation include:
- Reduced stormwater runoff volume;
- Increased groundwater recharge;
- Improved runoff water quality; and
- Simulation of pre-development hydrology.

Limitations of impervious surface mitigation include:
- May fail if not properly maintained; and
- May consume land or surfaces available for other uses.

Due the wide array of possible actions that fall in this category, cost and maintenance requirements range from low cost / low maintenance, such as impervious surface disconnection, to high cost / high maintenance, such as intensive green roof systems.

Infiltration Systems

In general terms, infiltration systems can be described as natural or constructed depressions located in permeable soils that capture, store, and infiltrate stormwater runoff. These depressions can be located at the surface of the ground or they can be designed as underground facilities. Common infiltration practices include:
- Rain gardens – small depressions typically planted with native vegetation, no structural infrastructure;
- Tree boxes – ground-level or raised vegetation-filled boxes with open bottoms connected to soils;
- Bioretention facilities – large depressed areas with engineered soils and native planting, typically with supporting infrastructure such as overflows to the storm drain system;
- Infiltration basins – natural or constructed impoundment;
- Infiltration trenches – shallow excavated trenches, 3 to 12 feet deep, backfilled with coarse stone aggregate;
- Porous pipe – underground pipes made of porous substance or with weep holes that allow infiltration as water flows;
- Dry wells – smaller variation of infiltration trench;
- Underground systems – typically pre-manufactured structures that are buried in space-limited locations; and
- Water spreading / irrigation – involves the reuse of stored runoff water for land-based functions such as crop irrigation.

Benefits of infiltration systems include:
- Reduced stormwater runoff volume;
- Increased groundwater recharge;
- Improved surface water quality;

- Thermal protection; and
- Simulation of pre-development hydrology.

Limitations of infiltration systems include:
- Unusual construction considerations;
- Potential for groundwater contamination;
- May lose effectiveness over time if not maintained;
- Not recommended in areas with steep slopes; and
- May require landscaping for drought/inundation conditions.

Infiltration systems require semi-annual inspections (clogging, vegetation health, structural elements), regular removal of accumulated trash and vegetation maintenance (mowing, pipe auguring for roots), and extensive rehabilitation upon failure. Construction costs range from 2$ to 7$ per cubic foot of stormwater treated with annual maintenance costs ranging from 5% to 10% of construction costs.

Filtration Systems

In general, filtration systems are structural controls that capture, temporarily store, and route stormwater runoff though a filter bed to improve water quality. Filtration systems can be off-line systems or designed as pre-treatment before discharging to other stormwater features. Common filtration practices include:
- Sand Filters – systems designed to route runoff through sand to remove pollutants, variations include: surface, pocket, underground, and perimeter;
- Organic Filters – generally a surface or pocket variant of sand filter that utilizes an organic media either alone or mixed with sand to increase filtration efficiency; and
- Re-circulating Variant – involves add-on structural components such as a holding tank and pump to store runoff greater than filter capacity for later treatment and to recirculate treated runoff for greater removal efficiency.

Benefits of filtration systems include:
- Good for highly impervious areas with low sediment/high pollutant load (e.g. urban land use and retrofit scenarios);
- High pollutant removal rates;
- May be used in a variety of soil types; and
- Good for the treatment of hotspots because it can be isolated from ground water if contamination concerns exist.

Limitations of filtration systems include:
- Some applications may require indoor location (e.g. dedicated heated building) to ensure proper functioning in Michigan's cold-weather climate;
- Higher maintenance requirements (facility should be kept dry before it freezes in late fall);
- Some installations (media filters) have higher construction costs;
- Potential to cause odor problems;
- Minimal treatment of soluble nutrients; and
- Potential for nitrification in media filters where aerobic conditions exist.

Filtration systems require monthly inspections to ensure that tributaries areas are stabilized and that the structural components are free of debris. Annual maintenance involves inspecting for clogging and sediment filling, checking the concrete walls, looking for signs of bypassing flow, and correcting these problems, if documented. Costs range from 2$ to 7$ per ft^3 with average annual maintenance costs near 5% of construction costs.

Filtration Systems Scorecard

Filtration practices provide wide-ranging water quality and water quantity benefits. The information presented below is for comparative purposes only. Values to be used for design purposes or to calculate pollutant load reductions should be determined through additional research.

WATER QUALTIY CATEGORY	REMOVAL EFFICIENCY*
TSS	85%
Phosphorus	50%
Metals (Cd, Cu, Pb, Zn)	50%
Nitrogen	35%
Pathogens	35%
Toxins	80%

* *Efficiency = % removal of influent concentration (median)*

Source: Winer, 2000.

WATER QUANTITY CATEGORY	APPLIC.**
Channel Protection	M
Overbank Flood Protection	L
Extreme Flood Protection	L
Recharge Volume	M/L

** *Applicability = suitability of practice for given purpose; H=High, M=Medium, L=Low*

Source: Minnesota, 2005.

Vegetated Buffers and Natural Conveyance

In general, vegetated buffers and natural conveyance predominantly use vegetation and natural drainage to control stormwater runoff. Depending on the circumstances, some practices may require a minimal amount of structural features. These practices provide runoff reduction and water quality benefits in similar fashion to the infiltration and filtration practices, but do so as they provide water transport, as opposed to storage. These practices can be beneficial in many land use settings including urban and agricultural. Common practices include:

- Filter Strips - vegetated surfaces designed to treat sheet flow from adjacent surfaces, function by slowing runoff velocities and filtering out sediment and other pollutants, and by providing some infiltration into underlying soils;
- Buffers – areas of natural vegetation (grass, native vegetation, and forest) that filter stormwater as it drains overland, especially useful for treating runoff before it enters sensitive environmental areas such as groundwater recharge areas or streams, wetlands, and lakes;
- Grassed Channels – simple drainage ditches with flat bottoms and shallow slopes, a main alternative to curb and gutter in residential areas; and
- Swales – drainage ditches with enhanced natural vegetation types, compost, and/or rip-rap to enhance pollutant removal, two types include:
  - Dry Swales – incorporate engineered underdrains that route percolated runoff, which is treated, to the storm sewer system; and
  - Wet Swales – eventually intersect the ground water table.

The benefits of vegetated buffers/natural conveyance systems include:

- Reduced stormwater runoff volume;
- Increased groundwater recharge;
- Improved runoff water quality; and
- Simulation of pre-development hydrology.

The limitations of vegetated buffers/natural conveyance systems include:

- Pollutant removal may be limited;
- Space requirements;
- If not properly designed, they can change the natural flow of surface water and adversely affect downstream waters;
- If the design capacity is exceeded by a large storm event, the vegetation might not be adequate to prevent erosion and the channel might be destroyed. Clogging with sediment and debris reduces the effectiveness of for stormwater conveyance; and
- Ponding can allow mosquitos to breed.

The maintenance requirements of vegetated buffers/natural conveyance systems include:

- Mowing
- Litter and sediment removal
- Spot vegetation repair

The costs for these practices range from 0.25$ to 0.70$ per square foot with annual maintenance costs averaging $350/acre.

Vegetated Buffers / Natural Conveyance Scorecard

Vegetated buffers and natural conveyance practices provide wide-ranging water quality and water quantity benefits. The information presented below is for comparative purposes only. Values to be used for design purposes or to calculate pollutant load reductions should be determined through additional research.

WATER QUALTIY CATEGORY	REMOVAL EFFICIENCY*
TSS	55%
Phosphorus	50%
Metals (Cd, Cu, Pb, Zn)	50%
Nitrogen	50%
Pathogens	50%
Toxins	50%

* *Efficiency = % removal of influent concentration (median)*

Source: Winer, 2000.

WATER QUANTITY CATEGORY	APPLIC.**
Channel Protection	M
Overbank Flood Protection	M
Extreme Flood Protection	L
Recharge Volume	M

** *Applicability = suitability of practice for given purpose; H=High, M=Medium, L=Low*

Source: Minnesota, 2005.

Retention and Detention

Retention and detention[5] are generally accomplished through the use of stormwater ponds and/or stormwater wetlands. Both provide similar water quality benefits, but ponds generally provide more effective water quantity control. These practices are discussed below:

- Stormwater ponds – constructed basins that: 1) receive and hold runoff to improve water quality through settling and biological uptake; and 2) prevent downstream channel degradation or flood damage through peak flow reduction (detention[6]) and total runoff reduction (retention); variation include:
  - Dry Detention – primarily designed for flood control; generally grass-lined so pollutant removal by settling only;
  - Wet – include a permanent pool of water which supports vegetation to enhance biological pollutant removal;
  - Wet Detention – a combination of a wet pond for water quality treatment and detention above the permanent pool for extreme runoff events;
  - Evaporation Basin – similar to a wet pond, but generally shallower to facilitate evaporation; and
  - Reuse – pond which acts as a source for water, primarily irrigation; and
- Stormwater wetlands – constructed shallow marshes that: 1) receive and hold runoff to improve water quality through settling and biological uptake; 2) provide detention and retention benefits similar to, but less effective than, stormwater ponds; and 3) provide additional benefits such as aesthetics and wildlife habitat; variation include:
  - Wetland/Marsh – provide shallow wetland areas and deep marsh areas for different biological treatment types;
  - Extended Detention – similar to the wetland/marsh but with extended storage above the normal water surface;
  - Wetland/Pond – the wet pond situated near the inlet allows pollutants to settle out prior to entering the more environmentally sensitive shallow wetland area; and
  - Submerged Gravel – more like a filtering system in which runoff is treated as it flows through a submerged bed of gravel that incorporates wetland vegetation.

Benefits of retention/detention systems include:

- Able to effectively reduce pollutant loads and control runoff;
- Relatively straightforward pond design procedure; and
- Potential wildlife habitat, aesthetic or recreational enhancement.

Limitations of stormwater ponds include:

- Relatively large space requirement;
- Increase water temperature / cause downstream thermal impact;
- Potential nuisance for insects or odor;
- Poor in areas of low slope, high water table, and shallow bedrock;
- More complicated wetland design procedure; and
- Water quality behavior can change seasonally.

Maintenance includes annual vegetation and sediment accumulation inspections, monthly debris removal, and 5-year to 20-year sediment removal. Construction costs range from $11,000-$57,000/acre-foot. Annual maintenance costs equal 3% to 5% of construction costs.

Retention / Detention Scorecard

Retention / detention practices provide wide-ranging water quality and water quantity benefits. The information presented below is for comparative purposes only. Values to be used for design purposes or to calculate pollutant load reductions should be determined through additional research.

WATER QUALTIY CATEGORY	REMOVAL EFFICIENCY*
TSS	75%
Phosphorus	40%
Metals (Cd, Cu, Pb, Zn)	50%
Nitrogen	35%
Pathogens	70%
Toxins	80%

* *Efficiency = % removal of influent concentration (median)*

Source: Winer, 2000.

WATER QUANTITY CATEGORY	APPLIC.**
Channel Protection	H/M
Overbank Flood Protection	H/M
Extreme Flood Protection	H/M
Recharge Volume	L

** *Applicability = suitability of practice for given purpose; H=High, M=Medium, L=Low*

Source: Minnesota, 2005.

[5] Detention is simply the delay of stormwater runoff. Retention is similar to detention but also involves a decrease in total runoff volume.

[6] The use of detention facilities is appropriate to reduce the peak discharge however these types of facilities do not generally reduce the total volume of runoff discharged and therefore are not as effective as some other means.

Summary

To minimize impacts of nonpoint source pollution and associated costs of control (storage and treatment) associated with wet-weather flows (WWFs), stormwater runoff volumes and pollutant loads must be reduced. The Clinton River Watershed Model and

Site Evaluation Tool can be used to select appropriate stormwater best management practices. However, additional modeling (with cost considerations) may be beneficial to help planners derive the least-cost combination for dealing with wet weather flows. Some of this modeling is relegated to the future after data related to RAP implementation (e.g. actual performance characteristics) is obtained or more refined modeling of the flow and pollutant reducing capabilities of the BMPs is achieved. However, the available models and resources are sufficient to guide RAP implementation of BMPs during the initial years.

(7) Natural Features and Resources Management

While many of the actions under 'Ordinances, Zoning, and Development Standards' serve to protect natural resources, the techniques listed here promote a more active approach that encompasses not only the protection of existing natural features, undeveloped lands, sensitive areas, and those of historical or cultural value, but also their enhancement and restoration, where appropriate.

Vegetation Management Actions to Consider for Natural Features and Resources Management

Some vegetation management actions to consider include:

- Maintaining or introducing native landscaping;
- Critical area plantings;
- Municipal buffer zones;
- Prescribed burnings;
- Reforestation;
- Urban forestry, tree plantings and protection ordinances;
- No mow zones;
- Protecting threatened and endangered species; and
- Eradicating exotic/invasive species.

Land Reserves

Conservation of land helps protect existing water quality from degradation and prevents encroachment into important natural areas such as riparian corridors, wetlands, or critical habitat. Methods for conserving land include: purchasing land, development rights transfer, conservation easements, land trusts, leases, deed restrictions, and covenants.

Many programs are available that conduct or assist with land conservation efforts that can be implemented by any organization, including the stakeholders. Many of these programs, listed below, also provide assistance for natural feature protection and restoration (discussed in the next sub-section).

The Nature Conservancy

The Nature Conservancy's (TNC) mission is to preserve the plants, animals and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive. TNC has developed a strategic, science-based planning process, called Conservation by Design, which helps them to identify the highest-priority places that, if conserved, promise to ensure biodiversity over the long term. In other words, Conservation by Design allows TNC to achieve meaningful, lasting conservation results. The TNC website is located at http://nature.org/

Michigan Natural Resources Trust Fund

The Michigan Natural Resources Trust Fund (MNRTF) has been in place since 1976. It provides financial assistance to local governments and the Department of Natural Resources (DNR) to purchase land or rights in land for public recreation or protection of land because of its environmental importance or its scenic beauty. It also assists in the appropriate development of land for public outdoor recreation.

The Trust for Public Land

The Trust for Public Land (TPL) is a national, nonprofit, land conservation organization that conserves land for people to enjoy as parks, community gardens, historic sites, rural lands, and other natural places, ensuring livable communities for generations to come. The TPL website is located at http://www.tpl.org/.

Michigan Nature Association

The Michigan Nature Association, established in 1952, is a conservation organization dedicated to protecting Michigan's most exceptional natural habitats and extraordinary or endangered species. Our mission is not only to preserve exceptional land and natural flora, but also to carry on programs of conservation education and scientific study. With the help of our members, MNA now has 163 nature sanctuaries throughout the state for people to enjoy today and forever. The association's website is located at http://www.michigannature.org/.

Southeast Michigan Land Conservancy

Southeast Michigan Land Conservancy is a non-profit organization dedicated to the preservation and stewardship of natural and agricultural land in the southeast Michigan counties of Livingston, Macomb, Monroe, Oakland, St. Clair, Washtenaw, and Wayne. They also work to educate the public and public policy makers about land conservation issues.

SMLC protects land by purchasing it, by accepting donations of land, and by holding conservation easements to preserve natural features on private parcels. Their focus is on open spaces close to home, and their activities also include participation in coalition efforts to coordinate land use policy, protect open space, preserve scenic beauty, and defend watersheds from harmful development and pollution. The conservancy's website is located at http://www.southeastmichiganlandconservancy.org/.

Six Rivers Regional Land Conservancy

The Six Rivers Land Conservancy (formerly the Oakland Land Conservancy and the Macomb Land Conservancy) is dedicated to the preservation of forests, wetlands, wildlife habitats, farmlands, rivers, and streams in the region through: identification and preservation significant natural areas and habitats, supporting the preservation of farmland and the agricultural economy, assisting local communities to plan for growth and development, and conducting public education programs that encourage residents and communities to become stewards of public and private land. The conservancy's website can be found at http://www.oaklandlandconservancy.org/.

Michigan Department of Agriculture

The MDA has a 'Farmland and Open Space Preservation Program' that consists of 5 methods for preserving farmland and open space, including: Farmland Development Rights Agreements, Conservation Easement Donations, an Agricultural Preservation Fund, Local Open Space Easements, Designated Open Space Easements, and Purchasing of Development Rights.

Natural Feature Protection and Restoration

Not only is conserving land important, but protection and restoration practices must be employed on this land and on private land to ensure that the greatest natural functioning is achieved. Many programs are available that directly participate in these types of activities or provide technical and financial assistance to implement them. As one of the most significant natural feature – related problems today, significant efforts at all levels of government are underway to prevent and control the spread of invasive species. Given interstate commerce protections, international trade agreements, and the geographic scope of the Great Lakes, many believe that action at the federal level in the United States is the only means to effectively address this issue.

County Level Government

County level governments have tremendous opportunities for impacting the environment for the positive. Many governments engage in master planning and can pass measures such as ordinances and standards, or provide their municipalities with templates for such, that protect various environmental components. Additionally, the county government is responsible for the transportation infrastructure in non-incorporated rural areas of their county, for the construction and maintenance of waterbodies that are legally defined as 'drains'[7], and for the maintenance of water levels for those lakes which have a normal level established for flood control, recreation enhancement, and/or property protection. Some governments also have extensive water quality monitoring programs.

Michigan Department of Natural Resources

The Michigan Department of Natural Resources (MDNR) is responsible for the stewardship of Michigan's natural resources and for the provision of outdoor recreational opportunities; a role it has relished since creation of the original Conservation Department in 1921. Federal funds support programs for wildlife and fisheries habitat and development, forest management, recreation and other natural resource efforts. The MDNR, under powers derived from Part 365 of Public Act 451 of 1994, sets regulations with respect to threatened and endangered species. The MDNR's website is located at http://www.michigan.gov/dnr/.

The Southeast Michigan Planning Team of the Michigan Department of Natural Resources began an ecosystem management planning process in 1995 that primarily addresses public lands in the watershed.

<u>Landowner Incentive Program</u>

The primary goal of the Landowner Incentive Program is to help private landowners and non-profit organizations create, restore, protect, enhance, and manage habitat for species that are rare and/or declining (including wetlands, prairies, savannas, etc.). They do this by providing advice, technical assistance, management plans, and funding to individuals and organizations throughout the state that qualify.

The Landowner Incentive Program in southern Michigan concentrates on creating or maintaining habitat for grassland and wetland wildlife.

Southeast Lower Peninsula LIP Biologists can provide advice on most projects that are greater than 12 acres and fall within priority areas (in the watershed, the townships in Oakland and Lapeer Counties along the border and those in Oakland County immediately to the south of these).

Landowner Incentive Program

Potential projects include:

- Prairie plantings and prescribed burns to restore savanna and grassland habitat;
- Wetland restorations by ditch plugging or tile breaks; and
- Invasive species management (i.e. removal, herbicide application, etc.)

Ineligible projects include:

- Forest management;
- Planting non-native species; and
- Digging fish ponds.

[7] Some government entities throughout the State of Michigan contend that county drains established before 1973 are exempt from certain state permits.

Projects outside the priority areas that provide a direct benefit to a LIP target species within the focus habitats or are greater than 40 acres may be eligible for assistance.

Forest Stewardship Program / Forest Land Enhancement Program

To promote the wise use and stewardship of privately owned forestlands is the goal of the Forest Stewardship Program. Candidates for the program are those landowners who are both interested in and committed to long term management that is economically viable and socially, ecologically and environmentally responsible.

The Forest Land Enhancement Program (FLEP) is intended to promote sustainable forest management on non-industrial private forest lands by offering educational, technical and financial assistance to private forest landowners.

Cost-sharing in the program is available for a number of activities including: management plan development, reforestation, forest stand improvement, water quality improvement, and watershed protection, fish and wildlife habitat improvement, forest health and protection, invasive species control, and wildfire and catastrophic event rehabilitation.

The Michigan Department of Environmental Quality

The MDEQ is involved in numerous programs that are related to natural resources and natural feature protection. Some of the programs that qualify include:

- Aquatic Nuisance Control (regulated under the Michigan Public Health Code) which regulates the use of pesticides to control nuisance plants, algae and swimmer's itch through issuing permits and ensuring the applications comply with permits and other laws, reviewing new chemical products, surveying Michigan lakes to determine community composition and the presence and impact of nuisance or invasive species, and educating riparian owners.
- Beach Protection which provides funding (Beaches Environmental Assessment and Costal Health Act and CMI) mostly to local health departments to support and augment programs such as microbiological monitoring of coastal recreation waters (including the Great Lakes) which are adjacent to beach or other access points used by the public and the development and implementation of programs to notify the public of potential exposure to disease causing agents through public notification on the MDEQ's website (and inclusion in a searchable database) and the posting of signs at monitored beaches.
- Wetlands Protection which enforces state law for the protection of wetlands including the issuance of permits and the alteration of proposed impacts to minimize environmental and wetlands concerns. Isolated wetlands smaller than five acres are not protected – this allows the piecemeal conversion of wetlands to urban and agricultural uses and associated impacts (GLC, 2004).
- Coastal Zone Management which improves the protection of sensitive shoreline resources, identifies coastal areas appropriate and inappropriate for development, and improve public access to the coastline. Financial and technical assistance is provided to local units of government.
- Sand Dune Protection and Shoreland Management programs.

- Contaminated Sediment programs to coordinate and implement remediation at sites that impact the natural environment.
- Concentrated Animal Feeding Operation special permits to prevent nutrient discharges to surface waters.
- Geographic Analysis and Monitoring Program.
- Ballast Discharge Permits that require special reporting requirements from ships using Michigan ports.
- Hydrologic Research and Development.

Michigan Department of Agriculture

The Michigan Department of Agriculture (MDA) has many programs that may be of use for certain stakeholders in the watershed. The MDA not only focuses on farming assistance but also invasive species and pest management and numerous recreation considerations that have an environmental component.

Conservation Reserve Enhancement Program

The MDA's Conservation Reserve Enhancement Program was created to help protect our environment and wildlife. Michigan is partnering with the federal government to implement conservation practices of great significance to the state and value to the nation, in matters of soil erosion, water quality, and wildlife habitat. Landowners, typically farmers, are paid certain rental rates to allow their lands to be used to implement environmental protection practices. Enhancing the effectiveness of the program can be accomplished by increasing the rental rates that are paid for land. Information on the program can be obtained through the MDA website at http://www.michigan.gov/mda/.

Natural Resources Conservation Service

The Natural Resources Conservation Service (NRCS) works hand-in-hand with the American people to conserve natural resources on private lands. They help land-users and communities approach conservation planning and implementation with an understanding of how natural resources relate to each other and to all of us and how our activities affect these resources. More information of the NRCS can be found at http://www.nrcs.usda.gov/.

Grassland Reserve Program

The NRCS, Farm Service Agency and Forest Service coordinate the Grassland Reserve Program (GRP) which is a voluntary program offering landowners the opportunity to protect, restore, and enhance grasslands on their property.

Wildlife Habitat Incentives Program

The Wildlife Habitat Incentives Program (WHIP) is a voluntary program for people who want to develop and improve wildlife habitat primarily on private land. NRCS provides both technical assistance and up to 75 percent cost-share assistance to establish and improve fish and wildlife habitat.

Wetlands Reserve Program

The Wetlands Reserve Program is a voluntary program offering landowners the opportunity to protect, restore, and enhance wetlands on their property. The NRCS provides technical and financial support to help landowners with their wetland restoration efforts.

Conservation Reserve Program

The Conservation Reserve Program (CRP) provides technical and financial assistance to eligible farmers and ranchers to address soil, water, and related natural resource concerns on their lands in an environmentally beneficial and cost-effective manner.

Other notable NRCS programs include: the Watershed Protection and Flood Prevention Operations, Conservation Technical Assistance, the Environmental Quality Incentives Program, the Farm and Ranch Land Protection Program, the Conservation of Private Grazing Land Program, the Conservation Security Program, and the Resource Conservation and Development Program.

Stewardship Network

The Stewardship Network is a grassroots cooperative organization working to protect, restore, and manage Michigan's natural lands and waters. It helps individuals, organizations, and businesses manage specific sites through sharing ideas, resources, and information. The network's website is located at http://www.stewardshipnetwork.org/.

Michigan Conservation Districts

Michigan's Conservation Districts (CDs) are "unique" local resource management agencies that coordinate and implement resource and environmental programs utilizing state, federal and private sector resources. The guiding philosophy of the Conservation Districts is that decision on conservation issues should be made at the local level, by local people and interests, with technical assistance provided by the government. The Conservation Districts carry out many diverse programs, including programs that deal with land management, erosion control, flood prevention, water use, groundwater, farms, forestry, wildlife, water quality, recreation, and community development. The Michigan Association of Conservation Districts can be accessed through http://www.macd.org/.

Lapeer Conservation District

The Lapeer CD was organized in 1942 by a referendum vote of the landowners of Lapeer County. For over 60 years, the conservation district has worked with local landowners, farmers, governmental agencies, and other organizations dealing with environmental problems. We have programs to assist people with forestry, water quality, and wildlife management concerns. We also have educational programs that are presented to all fifth grade students in the county. The Lapeer CD website is http://www.lapeercd.org/.

Macomb Conservation District

The Macomb CD was established in 1950 with the mission of "ensuring that land, water, forest, and wildlife, and all natural resources of the county are managed for sustained use for future generations". The Macomb CD website is http://www.macombcd.com/.

Oakland Conservation District

The Oakland CD's goal is 'to provide natural resource assistance to private landowners, local government and non-profit organizations, to help make managing your natural resources as easy as possible'. The Oakland CD website is http://www.oaklandcd.org/.

St. Clair Conservation District

The St. Clair CD is a local unit of state government established in 1949 to help the land owners of St. Clair County deal with the dramatic soil erosion problems of that era. Since that time, the District's services have been expanded to cover nearly all aspects of natural resource management. The mission of the CD is ‘to provide the citizens of the St. Clair Conservation District with resources, educational programs and materials, and professional services through which to make wise decisions on the management of their natural resources’.

Wayne Conservation District

The Wayne County CD was formed in 1969 to address conservation issues related to soil, water, air, plants, wetland and wildlife habitat preservation and improvement, and environmental quality concerns in the county. The mission of the CD is ‘to assist land owners and county residents with the conservation and management of Wayne County's natural resources’.

U.S. Fish and Wildlife Services

The goal of the U.S. Fish and Wildlife Services (FWS) is to conserve, protect, and enhance fish, wildlife, plants, and their habitats. The FWS works with the public and other government agencies to conduct environmental reviews for habitat protection and restoration, environmental contaminants, and federally threatened and endangered species. The FWS addresses landscape-scale resource objectives using an ecosystem approach. Their Partners for Fish and Wildlife Program provides assistance to landowners to restore wetlands and native prairies. Through its Coastal Program, the service focuses its efforts in bays, estuaries, and watersheds around the U.S. coastline, including Lake St. Clair. The agency’s website is located at http://www.fws.gov/. The FWS, through the Endangered Species Act of 1973, had the authority to define regulations with respect to threatened and endangered species.

Federal Interagency Committee for the Management of Noxious and Exotic Weeds

The committee coordinates information regarding the identification and extent of invasive plants in the U.S. and federal agency management of these species by developing and sharing scientific and technical information, fostering collaborative efforts, providing recommendations for national and regional level management of invasive plants, and sponsoring technical/educational conferences and workshops concerning invasive plants. The committee’s website is located at http://www.fws.gov/ficmnew/.

North American Waterfowl Management Plan

The North American Waterfowl Management Plan is an international action plan to conserve migratory birds throughout the continent. The Plan is a partnership of federal, provincial/state and municipal governments, non-governmental organizations, private companies and many individuals, all working towards achieving better wetland habitat for the benefit of migratory birds, other wetland-associated species and people. The Plan's unique combination of biology, landscape conservation and partnerships comprise its exemplary conservation legacy. Plan projects are international in scope, but implemented at regional levels. These projects contribute to the protection of habitat and wildlife species across the North American landscape. In fact, the North American

Waterfowl Management Plan is considered one of the most successful conservation initiatives in the world. The plan can be accessed on the internet at http://www.nawmp.ab.ca/.

Pheasants Forever

Pheasants Forever is a non-profit conservation organization dedicated to the protection and enhancement of pheasant and other wildlife populations in North America. This mission is carried out through habitat improvement, land management, public awareness, and education. The organization's website is located at http://www.pheasantsforever.org/.

Ducks Unlimited

The Ducks Unlimited Great Lakes/Atlantic Regional Office, located in Ann Arbor, MI and established in 1998, provides comprehensive conservation solutions to help restore and protect diminishing wetlands in 18 states, from Wisconsin to Virginia and north to Maine. The organization's website is located at http://www.ducks.org/.

Trout Unlimited

Trout Unlimited's mission is to conserve, protect and restore North America's trout and salmon fisheries and their watersheds. Trout Unlimited accomplishes this mission on local, state, and national levels with an extensive and dedicated volunteer network. The organization's website is located at http://www.tu.org/.

Michigan Audubon Society

Michigan Audubon Society works to foster the appreciation and protection of birds and their habitats through education, research, and conservation/preservation. The organization's website is located at www.michiganaudubon.org/.

Sierra Club

The Sierra Club is a diverse organization protecting communities and the planet. Their mission statement has four tenets: 1) to explore, enjoy, and protect the wild places of the earth; 2) to practice and promote responsible use of the earth's ecosystems and resources; 3) to educate and enlist humanity to protect and restore the quality of the natural and human environment; and 4) to use all lawful means to carry out these objectives. The club's website is accessible at http://www.sierraclub.org/.

Clean Water Action

Clean Water Action is a national citizens' organization working for clean, safe and affordable water, prevention of health-threatening pollution, creation of environmentally-safe jobs and businesses, and empowerment of people to make democracy work. The group's website is located at http://www.cleanwateraction.org/.

Natural Resources Defense Council

The Natural Resources Defense Council's (NRDCs) purpose is to safeguard the Earth: its people, its plants and animals and the natural systems on which all life depends. They work to restore the integrity of the elements that sustain life (air, land and water); to defend endangered natural places; to establish sustainability and good stewardship of the Earth as central ethical imperatives of human society; and to protect nature in ways that advance the long-term welfare of present and future generations. The council's website is available at http://www.nrdc.org/.

East Michigan Environmental Action Council

The East Michigan Environmental Action Council (EMEAC) works with a broad variety of stakeholders to solve environmental problems. They help residents address community concerns by providing information, research, and tools for working with local government. They also meet with business and political leaders to find practical alternatives to industrial practices that pollute air and water. The council's website can be accessed at http://www.emeac.org/.

Wildlife Habitat Council

The Wildlife Habitat Council (WHC) is a nonprofit, nonlobbying 501(c)(3) group of corporations, conservation organizations, and individuals dedicated to restoring and enhancing wildlife habitat. Created in 1988, WHC helps large landowners, particularly corporations, manage their unused lands in an ecologically sensitive manner for the benefit of wildlife. More than 2 million acres in 48 states, Puerto Rico, and 16 other countries are managed for wildlife through WHC-assisted projects. The WHC (with funding from the EPA and other agencies) was responsible for the "Biodiversity Atlas of the Lake Huron to Lake Erie Corridor" which describes the geology, biodiversity, and sociology of the region, including historical and current natural resource issues

<u>Waterways for Wildlife</u>

At the Ford Utica plant in Shelby Township, a 55-acre site of wildlife habitat was recently integrated into an overall plant stormwater runoff plan. The site consist of two retention ponds, ten acres of newly reforested land, open meadows, and a large stand of 30-foot white pines. Wood duck, bluebird, purple martin, owl nest boxes and bathouses were included in the project. Amenities also exist to allow humans to enjoy the site and wildlife with minimal impact including a wildlife garden, an observation deck, and a hiking/bike path (CRPAC, 2000).

Other Organizations

There are many other organizations dedicated to natural resource conservation and protection that are not specifically discussed in this chapter, including:

- The Izaak Walton League,
- Defenders of Wildlife,
- The Michigan Wildlife Conservancy,
- Friend of Wildlife,
- World Wildlife Fund,
- Conservation International, and
- Windstar Wildlife Institute,

Aquatic Nuisance Species Task Force

The Aquatic Nuisance Species Task Force (ANSTF) is an intergovernmental organization dedicated to preventing and controlling aquatic nuisance species and implementing the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 and the National Invasive Species Act of 1996.

Great Lakes Panel on Aquatic Nuisance Species

Since 1991, the Great Lakes Panel on Aquatic Nuisance Species has worked to prevent and control the occurrence of aquatic nuisance species in the Great Lakes. The Great Lakes Panel on Aquatic Nuisance Species is directed to perform the following tasks:

- Identify Great Lakes priorities;
- Assist / Make recommendations to a national Task Force on Aquatic Nuisance Species;
- Coordinate exotic species program activities in the region;
- Advise public and private interests on control efforts; and
- Submit an annual report to the task force describing prevention, research and control activities in the Great Lakes Basin.

More information on the panel can be obtained at http://www.glc.org/ans/panel.html.

U.S. Department of Agriculture – Animal and Plant Health Inspection Service

Among many other functions, the service works with state and local agencies as well as private landowners and managers to eliminate invasive plants on private lands, as well as regulating importation of biological control agents. The service's website is located at http://www.aphis.usda.gov/.

Michigan Invasive Plant Council

The Michigan Invasive Plant Council (MIPC) is a non-profit organization spanning a wide array of groups from governmental agencies, to commercial enterprises, conservation organizations, educational institutions and the gardening public. The council's website is located at http://forestry.msu.edu/mipc/.

Michigan's Aquatic Nuisance Species Council

The Council was created by the governor of Michigan in 2002. The purpose of the Council is to advise the Office of the Great Lakes and the MDEQ, MDNR, MDA, and MDOT on implementation of the Aquatic Nuisance Species Management Plan, including: the state's efforts to prevent and control aquatic nuisance species' introduction and spread within Michigan; information/education activities about aquatic nuisance species; the coordination of research and monitoring activities pertaining to aquatic nuisance species; and revising and updating Michigan's Aquatic Nuisance Species State Management Plan as necessary.

USDA National Agroforestry Center

The USDA National Agroforestry Center conducts research on how to design and install forested buffers to protect water quality, and develops and delivers technology on a broad set of agroforestry practices to natural resource professionals who directly assist landowners and communities. The center's website is located at http://www.unl.edu/nac/.

Michigan State University Extension

The Michigan State University Extension focuses on bringing educational programs to the people of the state to improve their lives and communities. Today, county-based staff members, in concert with on-campus faculty members, serve every county with programming focused on agriculture and natural resources; children, youth and families; and community and economic development. The program's website is located at http://www.msue.msu.edu/home/.

<u>Michigan Natural Features Inventory</u>

The goal of the Michigan Natural Features Inventory (MNFI) is "to actively contribute to decisions that impact the conservation of biological and ecological diversity by collecting, analyzing, and communicating information about rare and declining plants and animals, and the array of natural communities and ecosystems native to Michigan." The MNFI maintains a continuously updated information base on Michigan's endangered, threatened, or special concern plant and animal species, natural communities, and other natural features. The MNFI also provides information to land managers for many types of permit applications regarding these elements of diversity. The Inventory's website can be found at http://web4.msue.msu.edu/mnfi/.

The MNFI has assisted with detailed inventories in both Macomb and Oakland Counties. As such, both counties have many resources that may be useful for local planning efforts such as maps of potential conservation areas and natural areas including watershed boundaries and wetlands. Macomb County information can be obtained via http://www.macombcountymi.gov/gis/index.htm. Oakland County information can be obtained via http://www.oakgov.com/gis/.

Clinton River Watershed Council

The CRWC operates numerous educational and stewardship programs that seek to enhance and natural resources. These include assessments for wetland protection, restorations of water resources, and educational guides.

Clinton River Coldwater Restoration Project

The CRCRP, a partnership between the CRWC, Trout Unlimited, and the MDNR, seeks to generate public support for the Clinton River watershed as a valued recreational resource through efforts to improve water quality, aesthetics, and access to the Clinton River and its tributaries and explore opportunities to enhance the Clinton River as an urban trout fishery.

The United States Geological Survey

The United States Geological Survey (USGS) serves as an independent fact-finding agency that collects, monitors, analyzes, and provides scientific data about natural resources. The USGS has no regulatory or management mission. Through its National Water Quality Assessment Program (NAWQA), the USGS is conducting water quality investigations throughout the United States. The survey's website is located at http://www.usgs.gov/.

Great Lakes Gap Analysis Program

The goal of the Great Lakes Aquatic GAP Program is to evaluate the biological diversity of aquatic species and their habitats, and to identify gaps in the distribution and protection of these species and their habitats within the Great Lakes basin. This information will provide managers, planners, scientists, and policy makers with the information they need to identify priority areas for conservation before a species is threatened or endangered.

The Environmental Protection Agency

The EPA is involved in many activities related to protecting and restoring environmental quality. The Great Lakes National Program Office coordinates activities specific to the Great Lakes region. GLNPO, through the State of the Lakes Ecosystem Conference, has specifically identified Lake St. Clair as a Biodiversity Investment area in its *Strategic Plan for the Great Lakes Ecosystem* (http://www.epa.gov/glnpo/gls/), with an emphasis on coastal wetlands.

National Oceanic and Atmospheric Administration

NOAA is the federal steward of national coastal and marine environments. In coordination with federal, state, local, tribal and international authorities, NOAA manages the use of these environments, regulating fisheries and marine sanctuaries as well as protecting threatened and endangered marine species. NOAA aims to ensure the sustainable use of resources and balance competing uses of coastal and marine ecosystems, recognizing both their human and natural components. NOAA provides climate research, generates data, and forecasts weather to ensure safe commerce and transportation and support sound science.

The Great Lakes Commission

The Great Lakes Commission regularly supports studies and other programs that relate to the environmental health of the Great Lakes region.

In 2004, the Great Lakes Commission, in cooperation with the U.S. National Oceanic and Atmospheric Administration (NOAA), completed a two-year project to characterize

Lake St. Clair's coastal habitat and develop tools to assist with restoration and conservation. The project consolidated information about the status of and stressors to the lake's coastal habitat and produced:

- A web site focusing on habitat in the study area;
- An integrated coastal management (ICM) tool for use by state, provincial, tribal, non-profit and local coastal resource managers; and
- A coastal habitat restoration and conservation plan.

Water Resources Management Decision Support System for the Great Lakes (WRMDSS)

This large scale binational collaborative effort will yield, in unprecedented detail, a status assessment of Great Lakes water resources, an inventory of the sources and use of Great Lakes water, and enhanced understanding of the ecological consequences of such use.

Actions to Consider

There are an enormous number of actions to consider with respect to the protection and restoration of natural features and resources. Various potential actions are listed in no particular grouping or order of importance:

- Conduct natural features inventories in both areas that haven't yet been surveyed and in previously surveyed areas to quantify trends;
- Encourage and evaluate the use of planning tools to protect natural features and resources (e.g. master plans with environmental protection, cluster development, and native landscaping; zoning decisions that preserve high-quality areas and are consistent with master plans; create incentives and encourage land reuse in urban areas);
- Purchase farmland development property rights and increase conservation easements through tax benefits and easements to prevent urban sprawl and uncontrolled development;
- Acquire high quality natural areas;
- Use native plantings where possible through ordinance and other requirements and through education for private citizens to encourage their implementation; native plantings:
    - are aesthetically pleasing and ecologically friendly;
    - don't need fertilizers, pesticides, or maintenance (e.g. mowing / trimming);
    - promote biodiversity;
    - reduce soil erosion and increase infiltration of stormwater (through their long nebulous root systems);
- Restore natural shorelines and stream banks, to reverse:
    - siltation and nutrient enrichment;
    - physical habitat deterioration (by increasing woody debris and reducing shoreline slopes);
    - loss of aquatic plants and the associated loss of habitat and increased erosion;
- Increase natural resource related public education, through encouraging:

Other Organizations

There are many other organizations that may be utilized or consulted in implementing the RAP, including:

- The Izaak Walton League,
- Defenders of Wildlife,
- The Michigan Wildlife Conservancy,
- Friend of Wildlife,
- World Wildlife Fund, a
- Conservation International,
- Michigan Department of Community Health,
- United States Forest Service,
- Other Interior Department Agencies,
- United States Army Corps of Engineers,
- United States Coast Guard,
- United States Department of Homeland Security,
- United States Department of Transportation, and
- Windstar Wildlife Institute.

- word-of-mouth initiatives;
- involvement in conservancy organizations;
- volunteering in ecological projects and monitoring programs;
- attendance at public and city council meetings to comment on master plan and development issues;

- Implement waterbody channel stabilization and bank vegetation where erosive conditions cause environmental problems (this must be done after addressing the hydrologic/hydraulic causes of the instability in the waterbody);
- Protecting, constructing, enhancing, and restoring wetlands to preserve existing areas, mitigate impacted sites, and to increase the acreage of wetland in the watershed;
- Augmenting or removing dams or other structures to restore hydraulic conditions in waterbodies to the benefit of the natural environment – alternately providing for the passage of aquatic organisms around the obstruction;
- Habitat restoration and protection (aquatic, forest, and prairie) in all areas of the watershed including urban, suburban, rural, and agricultural areas;
- Restoration of natural processes such as burnings to support prairie lands and organic forest floor cover to support native natural communities;
- Protection and development of aquatic buffer lands in all areas of the watershed to support productive habitats (and protect water quality);
- Tree/shrub planting and management (and protection) in urban and suburban development and redevelopment;
- Establish 'no-mow' zones to allow natural processes to dominate vegetated lands;
- Undertake actions to eliminate exotic and invasive species and control their dispersal;
- Enact measures to further protect species of threatened and endangered status and those of local import;
- Conduct detailed studies of impervious cover to ground truth and calibrate remotely-sensed data and properly analyze waterbodies (at various points along them) in the context of the impervious cover model;
- Identify and prioritize areas that should be the focus of land use / land cover actions (e.g. natural land preservation, impervious surface mitigation) noting that it may be more cost-effective (with respect to results) to deal with marginally impacted areas than those severely impacted by imperviousness;
- Rehabilitating impacted floodplains by reconnecting waterbodies and providing additional storage; and
- Opening up enclosed drains and waterbodies to allow natural processes to once again flourish.

(8) Recreation Promotion and Enhancement

While not explicitly a goal or objective of the RAP (or of environmental protection in general), recreation-related actions are important for a number of reasons. First, input from the public generally contains references to increased recreation opportunities. Second, recreational access to natural areas serves to foster a stewardship ethic through a greater appreciation of the watershed as a resource. Third, the implementation of some recreation-related actions provides opportunities to meet some RAP objectives and keep consistency with the various subwatershed management plans in the watershed.

The following programs can provide assistance with recreation-related issues in the subwatershed. The individual subwatershed management plans, the counties, and municipalities in the watershed can also provide additional information related to the existing recreational facilities.

Clinton River Watershed Council

The CRWC hosts many recreation activities in the watershed, including River Day in which individuals, businesses, community groups, and local governments across the watershed join forces to protect, enhance, and celebrate the Clinton River and Lake St. Clair through activities ranging from nature hikes, canoe trips, fishing derbies, and fly-fishing lessons to storm drain stenciling, river clean-ups, habitat restoration, and native landscaping. The CRWC also acts as a clearinghouse for identifying other recreation facilities and activities within the watershed through their Clinton River Watershed Recreation Guide.

Huron-Clinton Metropark Authority

The Huron-Clinton Metropark Authority is a regional special park district encompassing Wayne, Oakland, Macomb, Washtenaw and Livingston counties. Currently, 13 Metroparks covering almost 24,000 acres, serve about 9.5 million visitors annually. The Metroparks are located along the Huron and Clinton rivers, providing a greenbelt around the Detroit metropolitan area. The authority's website is available at http://www.metroparks.com/index.php.

Friends of the Macomb Orchard Trail

The Friends of the Macomb Orchard Trail is involved in promoting and enhancing the Macomb Orchard Trail which runs (for its portion in the subwatershed) through Shelby Township, Washington Township, and Romeo. The Friends' website can be found at http://www.orchardtrail.org/.

Rails-to-Trails Conservancy

The Rails-to-Trails Conservancy is a nationwide organization "creating a nationwide network of trails from former rail lines and connecting corridors to build healthier places for healthier people." The conservancy's website can be found at http://www.railstrails.org/.

Michigan Department of Natural Resources

The MDNR regulates many of the recreational activities throughout the state of Michigan including hunting, fishing, boating, and off-road vehicle use. The department also operates numerous state forest lands, campgrounds, parks, recreation areas, harbors, and trails.

State Historic Preservation Office

Historic preservation enhances the quality of our environment and lives. Urban areas find renewal. Small towns retain the character that set them apart from other communities. Cultural landscapes are protected from uncontrolled development. The office's main function is to provide technical assistance to local communities in their efforts to identify, evaluate, designate, and protect Michigan's historic resources. The State Historic Preservation Office (SHPO) also administers an incentives program that includes state and federal tax credits and pass-through grants available to Certified Local Governments.

(9) Environmental Monitoring and Other Data Collection

Environmental monitoring and other data collection actions are an essential component of managing environmental conditions. These actions provide the data that are essential for determining environmental problems, assessing whether or not corrective actions are working, and ultimately indicate whether or not goals and objectives (e.g. restoration of beneficial uses) are being achieved.

There are a multitude of parameters that can be, and need to be, measured to be able to successfully perform the assessments related to any given plan. For the sake of efficiency, it is desirable to use existing resources and programs whenever possible. If special data is needed, additional protocols may have to be recommended or new data collection efforts initiated by the stakeholders.

The programs and protocols to be utilized are necessarily dependent upon the parameters that are desired to be measured. Stressors can be measured directly or surrogate measures may provide a more cost-effective estimate of a given stressor's impact on the environment.

The final consideration to make in terms of monitoring and data collection is to ensure that those components of a program can be evaluated that are not directly related to environmental conditions. For example, programmatic goals and objectives of a plan may require data relevant to an organization's existence, its facilities, and its impact. Provisions need to be made to ensure that all of the goals and objectives of the plan can be assessed based on the data collected through the plan.

Additional information related to environmental monitoring and other data collection can be found in Chapter 9, especially as it pertains to using the data to assess the effectiveness of the actions and achievement of the goals and objectives of the plan.

The programs listed in this section are currently being implemented by their respective organizations. This list is by no means exhaustive and there are many other programs that can provide data to be used in assessing the various parameters associated with this plan. Although included in this list, the Great Lakes Commission maintains a web-based monitoring inventory that can be searched by organization, project title, description, monitoring medium, monitoring category, frequency, and parameters. The on-line inventory is available at:

http://www.glin.net/gis/lkstclair/ and also provides information on the organization of interest, the project manager, various program descriptions, and (when possible) a map of sampling stations. Many of the programs discussed in this section were identified in the Great Lakes Commission's *Lake St. Clair Monitoring Gap Analysis and Strategic Plan* (2004). In addition to water quality monitoring, air quality and atmospheric deposition are important considerations as these are both environmental health indicators as related to the State of the Lakes Ecosystem Conference.

Drinking Water Monitoring

The municipalities or other entities involved in treating and distributing drinking water sometimes monitor influent water to determine treatment requirements and evaluate effectiveness and efficiency of water treatment processes (and to identify whether additional treatment is necessary to maintain compliance with standards).

For obvious reasons, monitoring drinking water is important and it is worthwhile to note that the drinking water quality, specifically its ability to be ingested safely by humans, is an omnibus human health indicator related to the State of the Lakes Ecosystem Conference.

County Drains

As part of their normal duties with respect to drain commissioner activities, the counties may collect data with respect to their drains which at a minimum likely includes maps showing drain and outfall locations.

Illicit Discharge Elimination Programs

As an MDEQ-defined permit requirement under the NPDES Phase II stormwater regulations, county departments (e.g. health, public works, drain commissioner's office) and municipal governments are conducting field work to identify illicit connections (and illegal dumping) to, including seepage from sanitary sewer systems or septic systems, and discharges from the storm sewer infrastructure. A significant portion of this work involves walking waterbodies and roadside ditches and sampling outfalls (or storm sewer connections to enclosed drains) for a number of pollutants (e.g. E. coli, temperature, surfactants, ammonia). These programs should be kept in mind for leveraging and combining field work and data collection

County Level Surface Water Quality Monitoring

There are numerous county run programs that evaluate the quality of surface water. Macomb, Oakland, St. Clair, and Wayne counties (through the health departments) have beach monitoring programs that operate during the summer months and document (on at least a weekly basis) *E. coli* levels and beach status (open or closed). To facilitate dissemination of this data, the individual counties typically post this data on-line and make historical data available (e.g. Macomb County has *E. coli* data since 2001 available). Additionally, the MDEQ hosts a website (http://www.deq.state.mi.us/beach/ public/default.aspx) where health departments from around the state can post beach testing and closing information. The EPA also hosts an additional website: http://oaspub.epa.gov/beacon/beacon_national_page.main.

Macomb County conducts extensive surface water quality and sediment testing through its Lake St. Clair Assessment program (with 13 open Lake St. Clair sites, 12 near shore sites, and 16 inland sites – some with wet weather sampling) and additional inland surface water testing for *E. coli* at over 60 locations. St. Clair County also conducts *E. coli* monitoring at inland locations.

Sewer Overflows

Municipalities and counties that have CSOs or SSOs are required to report discharge amounts to the MDEQ. This reporting only captures those overflows that are known (some SSOs may be undocumented) and only a few locations, such as the George W. Kuhn Retention and Treatment Basin (Oakland County), actually monitor for pollutants such as fecal coliforms or *E. coli*. The MDEQ posts the information it receives on a publicly accessible website. Specialized field work and hydraulic modeling could be required to identify SSO locations and quantify overflow occurrences and stressor loads.

County Geographic Information System Data

Macomb, Oakland, Wayne, and St. Clair County, and some municipalities, have Geographic Information System (GIS) spatial data available for numerous environmentally related subjects. Typical information available includes: current and future land use, transportation infrastructure, waterbodies, natural features and areas, aerial photography, municipal boundaries, watershed boundaries, parks and trails, natural tree rights-of-way, beaches, wetlands, soils, master planning data, floodplains, parcel and easement information, elevation contours, dams, landfills, geology, sanitary sewer infrastructure, combined sewer infrastructure, storm sewer infrastructure, and storm water BMP locations (e.g. detention basins). These entities, and others without electronic data capabilities, can often provide this or other data in paper formats.

Public Education Plan Evaluation

The public education plans (PEPs) – a requirement of the MDEQ-defined permit under the NPDES Phase II stormwater regulations – for all of the permittees in the watershed are currently being implemented (since 2004), including an assessment of the measures of success associated with the PEP actions. The data for these assessments should also be considered with respect to achievement of the goals of the RAP.

Clinton River Watershed Council - Stream Leaders Program

At more than 40 sites throughout the watershed, students and teachers act as water quality monitors two times a year, in May and October. They analyze water samples for dissolved oxygen, nutrients, pH, temperature, turbidity, BOD, and fecal coliform; evaluate the health of stream habitats and aquatic biological communities (macro-invertebrates); inventory physical stream-side (riparian) conditions and land uses that may affect water quality; catalog and collect river, lake and beach debris; and restore degraded habitats. Monitoring results are summarized using the WQI.

Clinton River Watershed Council - Adopt-A-Stream

Twice a year, teams visit their adopted sites and collect data, including physical information (such as extent of streambank erosion and surrounding land use) and chemical information (such as water temperature and pH). They collect and identify benthic macroinvertebrates that live in the streambed and surrounding vegetation.

The Clinton River Coldwater Conservation Project

This is a joint program between the Clinton River Watershed Council, MDNR, and Trout Unlimited that aims to restore appropriate cold water fishing opportunities in the Clinton River Watershed. In working towards this goal, team members are involved in data collection for fish habitat and macroinvertebrate community assessments (e.g. temperature, flow, riparian habitat conditions).

Other Non-profit Organizations

Various non-profit organizations may be involved in project-specific or long-term monitoring efforts in the watershed/AOC. The Nature Conservancy often partners with the Michigan Natural Features Inventory to conduct surveys of natural communities. Recently, they have been involved in a study/survey of mussel populations to determine if chronic low levels of zebra mussel infestation has a long-term impact on freshwater mussel populations in a small river habitat that supports two globally rare mussels. Additionally, the Wildlife Habitat Council monitors certain bird populations (e.g. nest boxes, number of eggs, nesting cycle, number of fledglings) throughout the Lake St. Clair basin in order to measure reproductive success.

Educational Institutions

By their very nature, educational institutions are involved in data collection and analysis.

At the primary and secondary school level, many are involved in the CRWC Stream Leaders program. Other institutions, such as Lake Shore Public Schools, have independent programs that integrate data collection (e.g. macroinvertebrate surveys and water testing) and analysis with educational activities.

The various universities in the state are often involved with projects in the Clinton River Watershed from time to time. Additionally, there are certain on-going projects that related to the Clinton River Waterhsed/AOC. For example, Michigan State University’s Cooperative Extension Service for St. Clair County organizes an Adopt-A-Stream program that has a macroinvertebrate and chemical water quality testing component. Researchers at the University of Michigan maintain a Lake St. Clair weather buoy that collects wind and water data with an aim of predicting beach closures and refining water sampling strategies. In the watershed, researchers at Oakland University conduct a program of stream water and sediment quality and macroinvertebrate conditions of Clinton River Watershed waterbodies (and others throughout the state).

Southeast Michigan Council of Governments

The Southeast Michigan Council of Governments (SEMCOG) is involved with numerous data collection and analysis programs for its constituent members in the region. SEMCOG obtains aerial photography for the entire region (since 1966 – every five years starting from 1970). In addition to its inherent value, the aerial photography is also utilized to develop spatial land use data for the region. Another major SEMCOG function is to develop demographic data such as yearly population and household estimates (based on the most recent U.S. census data and up-to-date localized data), residential building permit summaries, and development forecasts. SEMCOG also develops or summarizes data related to the environment, including precipitation data from a rain gauge network (with 75 gauges) in Wayne, Oakland, Macomb, Livingston, and Washtenaw; and sewer system coverage areas (both existing and estimated future).

Southeast Michigan Council of Governments – Social and Municipal Surveys

SEMCOG conducted a social survey to establish a baseline level of knowledge among the residents in the region, including the subwatershed. Additionally, SEMCOG conducts surveys with respect to its municipal training and other educational activities. These data, and data from future surveys, can be used in assessing achievement of the goals of the RAP.

Michigan Department of Environmental Quality

The Michigan Department of Environmental Quality (MDEQ) has an extensive number of programs that monitor environmental conditions throughout the State. The MDEQ's monitoring goals are defined in the 1997 document (updated in 2005) "A Strategic Environmental Quality Monitoring Program for Michigan's Surface Waters". This document defines the MDEQ's monitoring goals as:

- Assessing the current status and condition of waters of the state and determining whether WQS are being met (i.e. identify water that are high quality as well as those not meeting standards such as supporting aquatic life, wildlife, human health, and agricultural use);
- Measuring spatial and temporal water quality trends;
- Evaluating the effectiveness of water quality protection programs (for both conventional [e.g. nutrients] and toxic pollutants); and
- Identifying new and emerging water quality problems (e.g. MTBWE, PFOS, PBDEs, antibiotics, pharmaceuticals, household personal care products).

This document also describes a paradigm shift in the MDEQ's monitoring philosophy from a historically targeted approach to site selection (focusing on problem areas) to a probabilistic method that will allow for more reliable interpolation and extrapolation of data throughout the state, although targeted studies are still needed to address certain waters not attaining standards. As appropriate, the MDEQ will upload water quality and other data into the U.S. EPA's STORET database (as discussed later in this section).

A major parallel monitoring track in the MDEQ is those conducted as part of the non-point source (NPS) group. The four main categories of non-point source monitoring include: statewide trend monitoring, problem identification monitoring, total maximum daily load (TMDL) development (i.e. identifying causes and sources and determining the assimilative capacity of the waterbody for pollutants of concern) and effectiveness monitoring (after implementation), and NPS control effectiveness monitoring. The NPS group also works with NPS grant receivers to develop and implement monitoring programs. The integration of the NPS monitoring program with the regular MDEQ water quality monitoring program is presented in Figure C.5-6.

Various additional NPS monitoring tools include:

- enhanced local water quality and beach monitoring efforts through CMI grants;
- fish contaminant monitoring (in addition to meeting the goals of the sampling program, this data is also used by the Michigan Department of Community Health to issue consumption advisories);
- caged fish contaminant monitoring (to detect contaminants present in persistently low levels);
- contaminant monitoring (PCBs, mercury, DDT, and other pesticides) in bald eagle blood and feathers and herring gull eggs;
- volunteer monitoring (e.g. road stream crossing surveys) by various organizations (the Michigan Clean Water Corps);
- section 319 and CMI NPS grants (to properly document load reductions achieved through the implementation of BMPs);
- monitoring related to specific complaints (e.g. sewage contamination) and spills;
- hydrologic analysis and modeling;
- channel morphology monitoring;
- lake sediment core monitoring (through and MSU project) to identify trends and pinpoint sources (regional vs. local);
- the Michigan Mercury Deposition Network (since 1994 a joint program with the University of Michigan) which monitors speciated mercury in air and precipitation at rural and urban sites;
- the Cooperative Lakes Monitoring Program (since 1974 a program that also utilized volunteer monitoring) that monitors lakes randomly selected within appropriate 5-year schedule watersheds) which focuses on trophic state indicators such as sechi disk depth, phosphorus, chlorophyll a, dissolved oxygen, temperature and other chemical parameters and occasional aquatic plant identification and mapping; and
- Conservation Reserve Enhancement Program (CREP) monitoring (documented in annual reports) for those watersheds where CREP actions have been implemented (through the Michigan Department of Agriculture).

The MDEQ is involved with many additional monitoring programs, including:

- The drinking water contamination investigation program (testing in areas with known or suspected environmental contamination);
- A source water assessment program (SWAP) that identifies public drinking water sources and inventories contaminants and susceptibility to contamination;
- Sediment remediation effectiveness monitoring utilizing the various methodologies discussed previously to document before and after conditions such as toxicity levels and the extent of contamination; and
- Wetlands studies (from state-wide inventories using rapid assessment procedures to intensive site investigations) to classify and assess the status and trends with respect to wetland acreage and, in the future, to focus on water quality conditions.

In addition to fulfilling the goals of the MDEQs monitoring program, the data collected is useful for calculating contaminant loads related to the AOC to support RAP implementation, other planning and pollution prevention/mitigation activities, and the development of analytical methodologies to address environmental stressors and their impacts.

Much of the data collected by the MDEQ and other state organizations such as the Department on Natural Resources is hosted on the Surface Water Information Management System (SWIMS) at http://www.mcgi.state.mi.us/miswims/MapPage.aspx. The following data is displayable in the system (and where appropriate links are provided to more detailed information): aerial photography, topographic, land use, environmental monitoring data, beach/river *E. coli*, wastewater discharges, fish contaminant studies, USGS gaging stations, NPS grant locations, septage haulers, high and low flow calculations from, valley segments, coldwater streams, natural rivers, basins, waterbodies, soils, lake contours, roads, and state house and senate boundaries.

Michigan Department of Natural Resources

The Michigan Department of Natural Resources (MDNR) routinely collects data similar to that of the MDEQ but with a greater focus on macroinvertebrates and especially fish studies (including habitat – aquatic plants abundance and distribution, species diversity of fish, abundance of fish, contaminants in fish tissue, and taste and odor tests). A wildlife action plan was generated for Michigan to identify and prioritize conservation needs of native species and habitats. The plan gives a greater emphasis on species of greatest conservation needs. Other monitoring and management programs include the Lake St. Clair assessment (yellow perch, juvenile game fish, various forage species), the Lake Sturgeon assessment program (population parameters, spawning locations, movement), sport fish monitoring (trends in catch rates), fish identification programs, and amphibian surveys. The MDNR also maintains maps of coldwater / trout streams and lakes in the state, an omnibus 'Fish Atlas' of the current and historical species found in Michigan and their respective distributions, and locations of fish stocking activities along with associated numbers of fish.

Michigan Center for Geographic Information

The Michigan Center for Geographic Information provides leadership, technical expertise and policy for the acquisition, development, use, dissemination, promotion, and sharing of geographic information in the State of Michigan. In addition to pre-processed mapping products and services such as a state-wide subdivision plat locator, the center also hosts the Michigan Geographic Data Library that contains spatial data on over 60 unique categories including: aerial photography, geology, surface water features, groundwater features, well locations, land ownership, topography, census boundaries, land cover / land use, and transportation infrastructure.

Michigan Natural Features Inventory

The Michigan Natural Features Inventory (MNFI) is the only comprehensive single source of data on Michigan's endangered, threatened, or special concern plant and animal species, natural communities, and other natural features. The MNFI tracks changes in such things as vegetation / land cover and wetlands coverage.

Great Lakes Commission (GLC)

The Great Lakes Commission is a binational agency that promotes the orderly, integrated and comprehensive development, use and conservation of the water and related natural resources of the Great Lakes basin. In furthering its objectives, the commission is involved in many projects that collect and analyze data; it also serves to make readily available information from outside organizations that is important to the mission. Topics of studies and programs that generate and analyze data include: water use, nuisance species, habitat, beaches, coastal wetlands (through the Great Lakes Coastal Wetlands Consortium), dredging, great lakes air deposition program, air toxic emissions inventory, central air emission repository on-line, regional air pollutant inventory development system, great lakes basin program for soil erosion and sediment control, and great lakes biohydrologic information system. Data related to these topics and others (e.g. newspaper articles) can be accessed through the Great Lakes Information Network (GLIN). The GLIN Data Access Clearinghouse provides spatial datasets that are current with the National Spatial Data Infrastructure.

Great Lakes Observing System

The Great Lakes Observing System is a non-profit corporation dedicated to providing wide community access to real-time and historic data on the hydrology, biology, chemistry, geology, and cultural resources of the Great Lakes. The system is primarily a link to outside data sources and currently relies on GLIN to provide most of the information and links.

Environmental Protection Agency

The Environmental Protection Agency (EPA) is involved in collecting, storing, and analyzing large amounts of diverse data related to environmental conditions. Some data collection/analysis programs include:

- The Integrated Atmospheric Deposition Network which measures toxic constituents (e.g. PCBs, pesticides, PAHs, trace metals, dioxins, furans, mercury, PBDEs) in the air and precipitation at sites around Great Lakes Basin;
- Great Lakes Aquatic Contaminant Surveillance which monitors various chemicals (PCBs, organochlorine pesticides, PAHs, mercury, dioxins, and furans, and pollutants of emerging concern (PBDEs and PFOS/PFOA) with a focus on the basin of one Great Lake per year (through the Great Lakes National Program Office – GLNPO); and
- The GLNPO Great Lakes Fish Monitoring Program which monitors: 1) contaminants in whole lake trout to assess temporal trends in open waters as well as to assess the risks of such contaminants on the health of the fishery and the wildlife that consume them; and 2) contaminants in skin-on fillets of popular sport fish, Coho and Chinook salmon to assess human exposure.

Much of the data utilized and/or hosted by the EPA is generated through approved implementing agencies (of federal regulations) – such as state Departments of Environmental Quality (or the equivalent) or tribal governments – or through the regulated entities which often are charged with self-monitoring their operations and reporting appropriate data. Some of the systems which store and disseminate this data include:

- The Permit Compliance System (PCS) which tracks permit history (issuance and expiration), discharge limits, monitoring data, and any enforcement actions (and their associated status);
- The Toxic Release Inventory (TRI) which contains information on toxic chemical releases and other waste management activities reported annually by certain covered industry groups as well as federal facilities;
- The Safe Drinking Water Information System which contains information about public water systems and EPA drinking water regulation violations at each of the facilities (data about water influent to the water system may not necessarily be available, but certain violations will be indicative of influent water conditions);
- The Air Quality System (AQS) which is a repository of ambient air quality data from over 10,000 monitors, 5000 of which are currently active;
- AirData which presents annual summaries of air pollution data in terms of ambient concentrations and emissions from sources;
- The Aerometric Information Retrieval System / Air Facility Subsystem (AIRS/AFS) contains compliance and permit data for stationary sources regulated by EPA, state and local air pollution agencies;
- The National Listing of Fish Advisories which summarizes the various consumption advisories issued by states, tribes, territories, and other entities (including Canada) that may be of interest to citizens of the United States;
- RCRA Online is designed to enable users to locate documents, including publications and other outreach materials, that cover a wide range of RCRA issues and topics focusing on generators, transporters, treaters, storers, and disposers;
- The Superfund website which contains topical information for the general public and for those involved in the Superfund program, such as information about local Superfund sites, the health effects of contaminants, cleanup efforts, and local involvement;
- The Beaches Monitoring and Notification website (http://oaspub.epa.gov/beacon/ beacon_national_page.main) which presents beach conditions and supporting monitoring data for those states that have reported and have been supplied with local beach monitoring data;
- The Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) system which is a multi-purpose environmental analysis system that integrates a geographical information system (GIS), watershed data (e.g. water quality, bacteria monitoring, weather stations, USGS gaging stations, fish consumption advisories, sediment contaminant evaluations, shellfish classifications, and point source data), and state-of-the-art environmental assessment and modeling tools into one convenient package;
- STORET (short for STOrage and RETrieval), which is a repository for water quality, biological, and physical data used by state environmental agencies, EPA and other federal agencies, universities, private citizens, and many others. The database may

be accessed at http://www.epa.gov/storet/ and contains detailed raw data about water samples but also contains metadata about the sampling such as why it was gathered, the methods used, the laboratory used for analysis, quality control systems, and chain-of-custody procedures. Modern STORET data (since 1999) indicates 43 locations in the Clinton River Watershed and another 14 locations in the area tributary to Lake St. Clair (only some of which are in the AOC) that have water quality data. Legacy STORET data contains over 220 data locations in the Clinton River Watershed alone.

For locating the desired environmental data at the EPA, the Environmental Data Registry (EDR) is a powerful tool. The EDR is a comprehensive, authoritative source of reference information about the definition, source, and uses of environmental data. The EDR is a part of the centralized Systems of Registries (SoR), which provides access to the Environmental Protection Agency's (EPA) core registry systems. The EDR catalogs the Agency's major data collections, helps locate environmental information of interest, and provides information for interpreting the data. The EDR does not contain the environmental data itself, but rather information that describes the data to make it more meaningful. The EDR serves to document the diversity of data representations across information systems through central storage of application metadata. This information can be used to support initiatives to identify duplication of data, streamline information collection, and achieve information consistency and sharing across the programs.

United States Geological Survey

The United States Geological Survey (USGS) is the primary federal agency for water-resource information. It provides reliable scientific information to describe and understand the Earth; and manage water, biological, energy, and mineral resources by collecting, monitoring, analyzing, and providing scientific understanding about natural resource conditions, issues, and problems (e.g. water quantity, water quality, sources and fate of contaminants). Some USGS programs that may be of interest in the context of this RAP include:

- The Biological Informatics Program which addresses biological data and information related to wildlife and the environment, as well as wildlife-human interactions; and deals with the collecting, linking, storage, organization, integration, analysis, synthesis, delivery, and application of this data;
- The Contaminant Biology Program investigates the effects and exposure of environmental contaminants to the Nation's living resources.
- The Aquatic and Endangered Resources Program focuses on the study of aquatic organisms (invertebrates, mussels, fishes) and aquatic habitats – species diversity, health and disease, ecology, habitat requirements, etc. Endangered species and those that are imperiled receive special research interest.
- The Invasive Species Program provides, in part, for the monitoring of invading populations.
- The Land Remote Sensing Program satellites (Landsat 5 and 7) monitor the Earth providing information that is broad, precise, impartial, and easily available. The USGS also provides the Nation's portal to the largest archive of remotely sensed land data in the

world, supplying continuous access to current and historical land images worldwide;

- The National Water Information System presents historical and real-time (where available) data collected by the USGS in terms of daily, monthly, and annual statistics; instantaneous and maximum values; and field measurements. Available data include surface water levels and flows, groundwater levels, and water quality conditions. Data for this system come primarily from the Hydrologic Network and Analysis Program, the National Streamflow Information Program, and the Groundwater Resources Program.
- The National Water Quality Assessment Program provides an understanding of water-quality conditions and how those conditions may vary locally, regionally, and nationally; whether conditions are getting better or worse over time; and how natural features and human activities affect those conditions through sampling of general water chemistry, pesticides, contaminants in bed sediments, and contaminants in fish and benthic invertebrates.
- The State Water Resources Research Institute Program which establishes the 54 bodies that comprise the National Institutes for Water Resources, including the institute at Michigan State University, which collects and analyses data to address state, regional, and local water quality issues.
- The Status and Trend of Biological Resources Program supports and provides for the collection and analysis of biological data to be used in understanding the changing and stressed living resources in the natural environment, including: what they are, where they are, how many exist, productivity levels, population health, and trends.
- In part, the Terrestrial, Freshwater and Marine Ecosystems Programs examine how human activities modify ecosystems.
- The Toxic Substances Hydrology Program provides objective scientific information on environmental contamination.
- The Wildlife and Terrestrial Resources Program conducts research on diverse natural resource topics involving migratory wildlife, marine mammals, threatened and endangered species, wildlife disease, terrestrial plants, and amphibians.

The USGS installed a Mercury Deposition Network station near Sterling Heights, Mich. This is only the second station installed in Michigan and one of few located in an urban area. Weekly wet-deposition samples have been collected by the Macomb County Health Department, and the analyses of these samples have been paid for by USGS. Data can be used to evaluate mercury entering the watershed owing to atmospheric deposition and may be useful to decision makers seeking to address the source and magnitude of mercury contamination in the Clinton River Watershed.

The USGS is the primary source for terrain data such as digital elevation models (DEMs), digital orthophoto quadrangles (DOQs), digital raster graphics (DRGs), and watershed boundaries based on the Hydrologic Unit Code (HUC) system (also the NRCS, especially for the 10-digit and 12-digit HUC levels). USGS data can be obtained through *The National Map* (http://nationalmap.gov) – a consistent framework for geographic knowledge. The map provides public access to high-quality, geospatial data and information from multiple partners to help support decision making by resource managers and the public.

United States Army Corps of Engineers

The United States Army Corps of Engineers (USACE) is responsible for investigating, developing and maintaining the nation's water and related environmental resources. The USACE has numerous divisions and programs that are responsible for conducting routine and specialized data collection and analyses. For example, sediment and water quality sampling and analysis, morphologic documentation, and hydrologic and hydraulic conditions assessments are performed as part of its program(s) to maintain navigable waterways (including dredging). USACE programs that may be involved in data collection and analysis fall into such categories as: navigation, flood and storm damage, environmental restoration, permitting, and hydropower.

National Oceanic and Atmospheric Administration

The National Oceanic and Atmospheric Administration (NOAA) is a source of accurate and objective scientific data that pertains to the oceans and atmosphere. NOAA generally analyses data from three perspectives: climate and weather (e.g. the National Weather Service), ecosystem, and commerce. Some of the programs that generate and analyze data include:

- The National Weather Service (NWS) which provides weather, hydrologic, and climate forecasts and warnings;
- The National Ocean Service (NOS) which works to observe, understand, and manage coastal and marine resources;
- CoastWatch which which provides timely access to near real-time satellite data (e.g. maps of water temperature, water color, chlorophyll-a content, and winds) to protect, restore, and manage U.S. coastal resources and understand climate variability and change;
- The Comprehensive Large Array-data Stewardship System (CLASS) which is the premier on-line facility for accessing the NOAA electronic library of environmental data and derivatives from polar and geostationary satellites;
- The National Climatic Data Center*, which is the world's largest active archive of weather data, produces numerous climate publications and responds to data requests from all over the world;
- The National Geophysical Data Center* which provides scientific stewardship, products, and services for geophysical data from the Sun to the Earth and Earth's sea floor and solid earth, including observations from space;
- The National Oceanographic Data Center* and National Coast Data Development Center* which archive and provide public access to global oceanographic and coastal data, products, and information;
- The Office of Oceanic and Atmospheric Research which assists other NOAA entities in producing high quality scientific products and coordinates certain OAR-specific NOAA components such as the National Sea Grant College Program (e.g. Michigan Sea Grant through UM and MSU), Research Laboratories (e.g. the Great Lakes Environmental Research Laboratory), the Climate Program Office, and Cooperative Institutes (e.g. Cooperative Institute for Limnology and Ecosystems Research – Ann Arbor, Michigan);
- The National Marine Fisheries Service which documents and analyzes fishery related data, including those related to the Great Lakes; and

- The National Data Buoy Center which provides access to data (e.g. wind, waves, pressures, temperatures, water levels, visibility) from its buoys as well as those of the NWS, NOS, GLERL, Canadian organizations, and other (e.g. the University of Michigan).

Much of the data generated by these and other program can be accessed through specialized portals associated with the appropriate program or publications related to specific research or documentation conducted through a given program. NOAA as a whole also maintains a 'central library' that is accessible at http://www.lib.noaa.gov/. NOAA also has a National Environmental Satellite, Data, and Information Service (NESDIS) that is dedicated to providing timely access to global environmental data from satellites and other sources. NESDIS consists of many NOAA offices (those with a * above and nine others) that work together to manage collection devices (e.g. satellites), provide information services, and conduct research.

United States Fish and Wildlife Service

The U.S. Fish and Wildlife Service (FWS) helps protect a healthy environment for people, fish, and wildlife with an emphasis on protecting migratory birds, endangered species, rare marine mammals, and freshwater anadromous fish. Studies in support of the service's mission may include those related to bird populations, habitat (e.g. wetlands, forest lands) assessments – distribution and quality, cultural resources (e.g. archaeological sites), ecosystem conditions (e.g. pollinators), endangered and threatened species, environmental quality – biological (e.g. amphibian conditions, invasive species), environmental quality – chemical/physical (e.g. endocrine disruptors, oil spills, pesticides, nutrients), and fisheries (e.g. hatcheries, stocking, passage) such as the Lake Sturgeon Monitoring program.

Natural Resources Conservation Service

The Natural Resources Conservation Service (NRCS) is primarily a technical and financial assistance organization that helps private land owners (e.g. farmers), communities, state government, local government, and other federal agencies in planning and implementing actions to conserve soil, water, and other natural resources. In support of the assistance programs, the NRCS also has certain programs and develops appropriate data resources, including: original soil surveys (which are out-of-date or needing maintenance for all counties represented in the watershed/AOC) , the soil survey geographic (SSURGO) database, the state soil geographic (STATSGO) database, the parameter-elevation regressions on independent slopes model (PRISM) and other climate data, soil and water conservation district boundaries, the national plants database, the national plants data center, the integrated taxonomic information system, the national agricultural imagery program, watershed boundary data, and the national resources inventory (NRI) - a statistical survey of land use and natural resource conditions (e.g. soil erosion and wetlands) and trends non-Federal lands which is also being used to assess the effectiveness of conservation activities being implemented on private lands.

The NRCS hosts the United States Department of Agriculture's powerful data gateway at http://datagateway.nrcs.usda.gov/ where the data listed above and other natural resources and environmental information can be obtained.

United States Census Bureau

The United States Census Bureau (USCB) is the government entity that performs the decennial census of America's population – in addition to other research into the population. The USCB produces an abundance of data related to population characteristics (e.g. income, education), households, development, and business which can be addressed at various levels of aggregation, from the size of a city block in some cases to the entire United States.

Federal Emergency Management Agency

The Federal Emergency Management Agency implements the National Flood Insurance Program (NFIP). In terms of data, the NFIP oversees the development of flood hazard maps that identify areas that are likely to be flooded under certain conditions and how often these conditions are likely to occur.

Multi-Resolution Land Characteristics Consortium

The Multi-Resolution Land Characteristics Consortium (MRLC) is a partnership between six federal agencies operating together to cost-effectively acquire and analyze a consistent set of satellite-based remotely-sensed data for environmental programs. The effort is spearheaded by the USGS and the EPA and includes NOAA, the United States Forest Service, the National Aeronautic and Space Administration, and the Bureau of Land Management. Consortium programs, data, or data derived primarily from it, include: 1992 national land cover data (the first national land-cover data set produced since the early 1970s), 2001 national land cover data, regional vulnerability assessment for priority-setting, the environmental monitoring and assessment program, the earth resource and observation science (EROS) center, the gap analysis program (GAP), the North American landscape characterization (NALC), the global land cover characterization (GLCC), the coastal change analysis program (CCAP), the forest inventory and analysis (FIA), and the landscape analysis and assessment (LAA).

National Geospatial Programs Office – Federal Geographic Data Committee

The Federal Geographic Data Committee (FGDC) is an interagency committee – headed by the USGS – that promotes the coordinated development, use, sharing, and dissemination of geospatial data on a national basis. This nationwide data publishing effort is known as the National Spatial Data Infrastructure (NSDI). The NSDI is a physical, organizational, and virtual network designed to enable the development and sharing of this nation's digital geographic information resources.

As well as the FGDC, the National Geospatial Programs Office oversees other geospatial programs of national importance such as the Geospatial One-Stop portal (http://geodata.gov).

International Joint Commission

The International Joint Commission (IJC) is involved in numerous programs that deal with water quality issues in trans-boundary waters. In support of these numerous programs, targeted projects dealing with both the collection of data and its analysis have been, and continue to be, implemented. A list of IJC publications can be searched at: http://www.ijc.org/php/publications/biblio_library.php?language=english. Notable publications by the IJC include the biennial reports on Great Lakes water quality and annual reports discussing activities taken and studies conducted during the previous year.

Conclusion

This appendix is meant to serve, as much as possible, as an omnibus presentation of all of the considerations that need to be made for the planto be successful in a watershed management planning context. The elements discussed range from organizational considerations of planning, to the scientific instruments to support planning decisions, to the regulatory decisions and frameworks that affect environmental conditions, to the structural facilities and actions that need to be implemented to achieve goals and objectives, and finally to the organizations and programs that can be leveraged to provide technical and financial assistance to successfully implement the plan.

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Appendix G.3: Model Scenarios

This appendix contains a brief report that discusses the model scenarios that were run in the Clinton River model in support of this North Branch Subwatershed management plan.

North Branch Clinton River Baseline Analysis

The baseline analysis was performed using long –term hydrologic simulation watershed model called Hydrologic Simulation Program – FORTRAN (HSPF). An HSPF model of the entire Clinton River watershed, including North Branch Clinton River was developed during 2007 – 2008 to support decision making and stakeholder processes. The HSPF model used meteorological data spanning 1994 – 2004. Further details about the model and its application are available in Tetra Tech, 2008.

For this project, the North Branch portion of the HSPF model was updated with meteorological data through 2008, and minor updates to model hydrology were made as well. In addition, model output was taken from all of the North Branch model catchments instead of one location as was done for the Clinton River project.

The sediment and nutrient (TP, NO_3, and TKN) components were not revised since there were not sufficient water quality monitoring data for a recalibration of these parameters. In addition, there were limited monitoring data in the North Branch for sediment and nutrients during the original calibration – a handful of low flow measurements occurring during 2004 a few miles upstream of the mouth. Much of the model parameterization in the North Branch is tied to the larger Clinton River HSPF model where there were more monitoring data for a stronger calibration. As such, the North Branch HSPF model predictions are reasonable and well tied to the types of land uses present in the watershed, and the model provides a good indication of the degree of difference between catchments, and will provide beneficial information about the impact of BMPs and other practices on reducing loads. However, it is not appropriate to use the model's results to gauge degree of impairment against statistical measures for sediment and nutrients, since the accuracy of the model is limited by the lack of monitoring data needed for calibration.

On the other hand, the E. coli component of the North Branch model was recalibrated for this project. A large amount of E. coli monitoring data are available in Macomb County, both spatially (11 of the 14 catchments had monitoring data within them), and temporally (2000 – 2008). The monitoring data include both low flow and high flow conditions. The abundance of data allowed for a full recalibration of the model to the catchment scale. As such, the North Branch HSPF model is an excellent tool for understanding sources of bacteria, and predicting the effects of practices to reduce bacteria.

Agricultural land uses dominate in much of the north part of the North Branch, with urbanization increasing towards the south.

The remainder of the tables will show both catchment area and cumulative area. The cumulative area is important because the catchment water quality assessments are performed at the mouth of a catchment's stream or river (called *reach*). The water flowing into a reach includes the runoff from its own catchment, and upstream contribution from other reaches. As one moves farther down in the basin, the upstream contribution tends to take over local impacts. However, the pollutant load in a reach is not equal to the sum of the loads from the upstream catchments. Pollutant are deposited when water moves slowly, and resuspended in reaches during storms; nutrients are taken up or transformed; bacteria die off with time and exposure to sunlight. The impact at a single location is equal to the sum of the parts occurring upstream – and over a long period of time accounting for the range of hydrologic conditions that occur.

The modeling results provide the story of what is contributing to indicator bacteria (E coli) impairment in the North Branch watershed. Practitioners often focus on controlling storm event sources, which provide the high "spikes" that generally lead to statistical impairment according to the standards. Urban BMPs that treat stormwater and agricultural BMPs that reduce runoff from manure lots or manured land are thought of as appropriate treatment options. The North Branch certainly has urban sources, and to some extent, agricultural sources from the relatively small amount of livestock in the watershed. However, E coli levels are elevated *significantly* at low flow conditions in *all* of the North Branch catchments. The typical low flow concentrations are high enough that perfect treatment of storm event sources would not address any of the impairments.

Table G.3-1. HSPF catchments and dominant land uses

Catchment ID	Name	Catchment Area (ac)	Percent Agriculture	Percent Developed	Percent Natural
601	East Branch Coon Creek	8,190	74%	15%	11%
602	East Branch Coon Creek	4,059	61%	18%	21%
603	Highbank Creek	10,109	75%	11%	13%
604	East Branch Coon Creek	6,561	52%	12%	36%
607	Coon Creek	16,966	61%	15%	24%
608	Coon Creek	1,162	33%	16%	51%
609	North Branch Clinton River	13,858	53%	20%	27%
610	North Branch Clinton River	18,099	58%	20%	22%
611	East Pond Creek	13,337	18%	34%	48%
612	North Branch Clinton River	11,559	46%	27%	26%
613	North Branch Clinton River	2,644	59%	13%	29%
614	Deer Creek	9,375	54%	20%	26%
615	North Branch Clinton River	10,533	45%	30%	25%
616	North Branch Clinton River	1,630	14%	60%	26%

Table G.3-2. E coli measures

Catch-ment ID	Name	Catch-ment Area (ac)	Cumulative Catchment Area (ac)	Annual E. coli Load (#/yr x 10^{12})	E. coli Loading Rate (#/ac/yr x 10^{9})	E. coli long-term Geometric Mean (#/100ml)	E coli % of time exceeding 30-day geomean	E coli % of time exceeding daily max
601	East Branch Coon Creek	8,190	8,190	87.6	10.7	454.3	99%	49%
602	East Branch Coon Creek	4,059	12,249	133.6	10.9	437.2	99%	49%
603	Highbank Creek	10,109	10,109	161.2	16.0	181.5	76%	26%
604	East Branch Coon Creek	6,561	28,919	274.3	9.5	240.0	92%	37%
607	Coon Creek	16,966	16,966	174.6	10.3	165.3	74%	28%
608	Coon Creek	1,162	47,047	381.6	8.1	179.9	84%	33%
609	North Branch Clinton River	13,858	13,858	84.5	6.1	261.6	100%	39%
610	North Branch Clinton River	18,099	31,958	375.7	11.8	244.9	99%	22%
611	East Pond Creek	13,337	13,337	52.4	3.9	178.2	98%	22%
612	North Branch Clinton River	11,559	56,854	461.0	8.1	180.3	96%	18%
613	North Branch Clinton River	2,644	59,498	412.0	6.9	197.0	99%	18%
614	Deer Creek	9,375	9,375	76.9	8.2	256.5	94%	33%
615	North Branch Clinton River	10,533	126,452	894.9	7.1	242.1	99%	27%
616	North Branch Clinton River	1,630	128,082	862.6	6.7	269.4	100%	30%

The model was calibrated for both low flow and high flow sources of bacteria. The model cannot distinguish between specific sources, but the catchment land use does provide an indication of what is occurring. All of the catchments have low flow sources – including the urbanized, sewered areas in the south. In the rural agricultural areas, the sources are likely from failing onsite septic treatment systems (OSTS). A failing OSTS from a water quality perspective may appear to be functioning perfectly to the operator. Given the low infiltration rates of most of the soils in North Branch and the use of ditches and tile drains, it is likely a large number of systems have short-circuited to drainage ditches or tile drains. In urban areas, it is more likely there is a combination of accidental and illicit connections to the storm drain network, as well as aged sanitary sewer infrastructure that leaches out contaminated water to storm sewers and to streams.

Annual E coli loads are reported here, but can be difficult to decipher due to the effect of upstream contributing area (as is the case with the remaining pollutants). The E coli annual loading rates provide a better indicator of degree of load (from all sources, including failing septic systems and low flow urban sources), but the decreasing trend as one moves downstream is strongly affected by die-off, which is fairly rapid for bacteria. The long term geometric means provide a better indicator of the trend in each reach. The E coli standards show that impairment is ubiquitous through the North Branch; even the daily max standard (300 #/100 mL May-Oct and 1,000 #/100mL Nov-Apr) are violated much of the time – though more so in the northern rural areas.

Sediment loading rates are highly correlated with the proportion of agricultural land in the catchment. The sediment concentrations are more difficult to decipher; they are fairly uniform, influenced heavily by low flow conditions when sediment settles out. Plots of concentration versus flow show that high concentrations occur during and shortly after storm events. Stream channel erosion is known to be a serious issue in the North Branch watershed.

Table G.3-3. Sediment (TSS) measures

Catch-ment ID	Name	Catch-ment Area (ac)	Cumulative Catchment Area (ac)	Annual Sediment Load (tons/yr)	Sediment Loading Rate (tons/ac/yr)	Average TSS conc. (mg/l)	90th percentile TSS (mg/L)
601	East Branch Coon Creek	8,190	8,190	1,828	0.223	26.3	49.4
602	East Branch Coon Creek	4,059	12,249	2,641	0.216	24.6	46.9
603	Highbank Creek	10,109	10,109	2,258	0.223	16.1	23.4
604	East Branch Coon Creek	6,561	28,919	6,082	0.210	26.4	48.3
607	Coon Creek	16,966	16,966	3,300	0.195	22.4	35.4
608	Coon Creek	1,162	47,047	9,469	0.201	26.3	46.6
609	North Branch Clinton River	13,858	13,858	996	0.072	27.5	49.4
610	North Branch Clinton River	18,099	31,958	4,129	0.129	21.3	39.2
611	East Pond Creek	13,337	13,337	544	0.041	17.3	34.2
612	North Branch Clinton River	11,559	56,854	6,584	0.116	24.6	44.6
613	North Branch Clinton River	2,644	59,498	6,759	0.114	23.5	43.3
614	Deer Creek	9,375	9,375	1,612	0.172	20.5	33.3
615	North Branch Clinton River	10,533	126,452	19,085	0.151	28.9	51.7
616	North Branch Clinton River	1,630	128,082	19,285	0.151	30.5	56.5

Phosphorus loading rates and average concentrations are highly correlated to agricultural land use. The percent > 0.1 mg/L is affected by both high flows (which is expected), and low flow untreated or poorly treated sewage sources (OSTS and urban sources discussed previously). During very low flows in North Branch reaches, the sewage sources begin to dominate as a source contribution. Reducing sewage sources will have a substantial impact on reducing this measure.

Table G.3-4. Total Phosphorus measures

Catch-ment ID	Name	Catch-ment Area (ac)	Cumulative Catchment Area (ac)	Annual TP Load (lbs/yr x 10^3)	TP Loading Rate (lb/ac/yr)	Average TP conc. (mg/l)	% of time TP > 0.1 mg/L
601	East Branch Coon Creek	8,190	8,190	9.8	1.19	0.389	53%
602	East Branch Coon Creek	4,059	12,249	13.7	1.12	0.205	50%
603	Highbank Creek	10,109	10,109	12.3	1.21	0.249	46%
604	East Branch Coon Creek	6,561	28,919	30.6	1.06	0.230	45%
607	Coon Creek	16,966	16,966	16.9	0.99	0.280	49%
608	Coon Creek	1,162	47,047	46.0	0.98	0.241	43%
609	North Branch Clinton River	13,858	13,858	5.4	0.39	0.088	19%
610	North Branch Clinton River	18,099	31,958	22.6	0.71	0.082	23%
611	East Pond Creek	13,337	13,337	2.4	0.18	0.047	9%
612	North Branch Clinton River	11,559	56,854	32.4	0.57	0.067	14%
613	North Branch Clinton River	2,644	59,498	33.7	0.57	0.067	13%
614	Deer Creek	9,375	9,375	8.5	0.91	0.318	52%
615	North Branch Clinton River	10,533	126,452	80.5	0.64	0.075	17%
616	North Branch Clinton River	1,630	128,082	74.0	0.58	0.068	14%

Nitrate/Nitrite loading rates and average concentrations are highly correlated to agricultural land use. The percent > 0.2 mg/L is affected by both high flows (which is expected), and low flow untreated or poorly treated sewage sources. During very low flows in North Branch reaches, the sewage sources begin to dominate as a source contribution. Reducing sewage sources will have a substantial impact on reducing this measure. This effect is not as pronounced in the lower mainstem reaches, as well as reaches 609 and 611 in the northwest part of the watershed, where the soils allow for more infiltration and interflow that tend to reduce the number of days with very low flows.

TKN loading rates and average concentrations are highly correlated to agricultural land use. The percent > 1.2 mg/L is affected by both high flows (which is expected), and to some extent low flow untreated or poorly treated sewage sources. However, the impact of low flow sources on the 1.2 criterion is fairly weak.

Table G.3-5. Nitrate/Nitrite measures

Catch-ment ID	Name	Catch-ment Area (ac)	Cumulative Catchment Area (ac)	Annual NO3 Load (lbs/yr x 10^3)	NO3 Loading Rate (lb/ac/yr)	Average NO3 conc. (mg/l)	% of time NO3 > 0.2 mg/L
601	East Branch Coon Creek	8,190	8,190	34.3	4.19	0.879	70%
602	East Branch Coon Creek	4,059	12,249	49.3	4.03	0.634	67%
603	Highbank Creek	10,109	10,109	42.0	4.15	0.620	62%
604	East Branch Coon Creek	6,561	28,919	106.1	3.67	0.651	63%
607	Coon Creek	16,966	16,966	63.9	3.77	0.703	65%
608	Coon Creek	1,162	47,047	164.0	3.49	0.644	61%
609	North Branch Clinton River	13,858	13,858	9.4	0.68	0.143	10%
610	North Branch Clinton River	18,099	31,958	82.6	2.59	0.294	24%
611	East Pond Creek	13,337	13,337	7.5	0.56	0.129	15%
612	North Branch Clinton River	11,559	56,854	125.5	2.21	0.275	24%
613	North Branch Clinton River	2,644	59,498	127.0	2.13	0.273	24%
614	Deer Creek	9,375	9,375	36.1	3.86	0.750	67%
615	North Branch Clinton River	10,533	126,452	315.7	2.50	0.359	33%
616	North Branch Clinton River	1,630	128,082	297.8	2.33	0.345	34%

Table G.3-6. TKN measures

Catch-ment ID	Name	Catch-ment Area (ac)	Cumulative Catchment Area (ac)	Annual TKN Load (lbs/yr x 10^3)	TKN Loading Rate (lb/ac/yr)	Average TKN concn. (mg/l)	% of time TKN > 1.2 mg/L
601	East Branch Coon Creek	8,190	8,190	38.1	4.65	1.002	28%
602	East Branch Coon Creek	4,059	12,249	54.9	4.48	0.756	14%
603	Highbank Creek	10,109	10,109	45.2	4.47	0.736	16%
604	East Branch Coon Creek	6,561	28,919	120.8	4.18	0.788	17%
607	Coon Creek	16,966	16,966	71.1	4.19	0.827	19%
608	Coon Creek	1,162	47,047	189.5	4.03	0.787	18%
609	North Branch Clinton River	13,858	13,858	13.7	0.99	0.257	1%
610	North Branch Clinton River	18,099	31,958	92.2	2.88	0.412	7%
611	East Pond Creek	13,337	13,337	10.5	0.79	0.216	1%
612	North Branch Clinton River	11,559	56,854	144.5	2.54	0.383	6%
613	North Branch Clinton River	2,644	59,498	149.6	2.51	0.387	7%
614	Deer Creek	9,375	9,375	40.2	4.29	0.856	21%
615	North Branch Clinton River	10,533	126,452	388.9	3.08	0.506	10%
616	North Branch Clinton River	1,630	128,082	379.3	2.96	0.498	10%

Figure G.3-1: E.coli % of time exceeding 30-day geometric mean

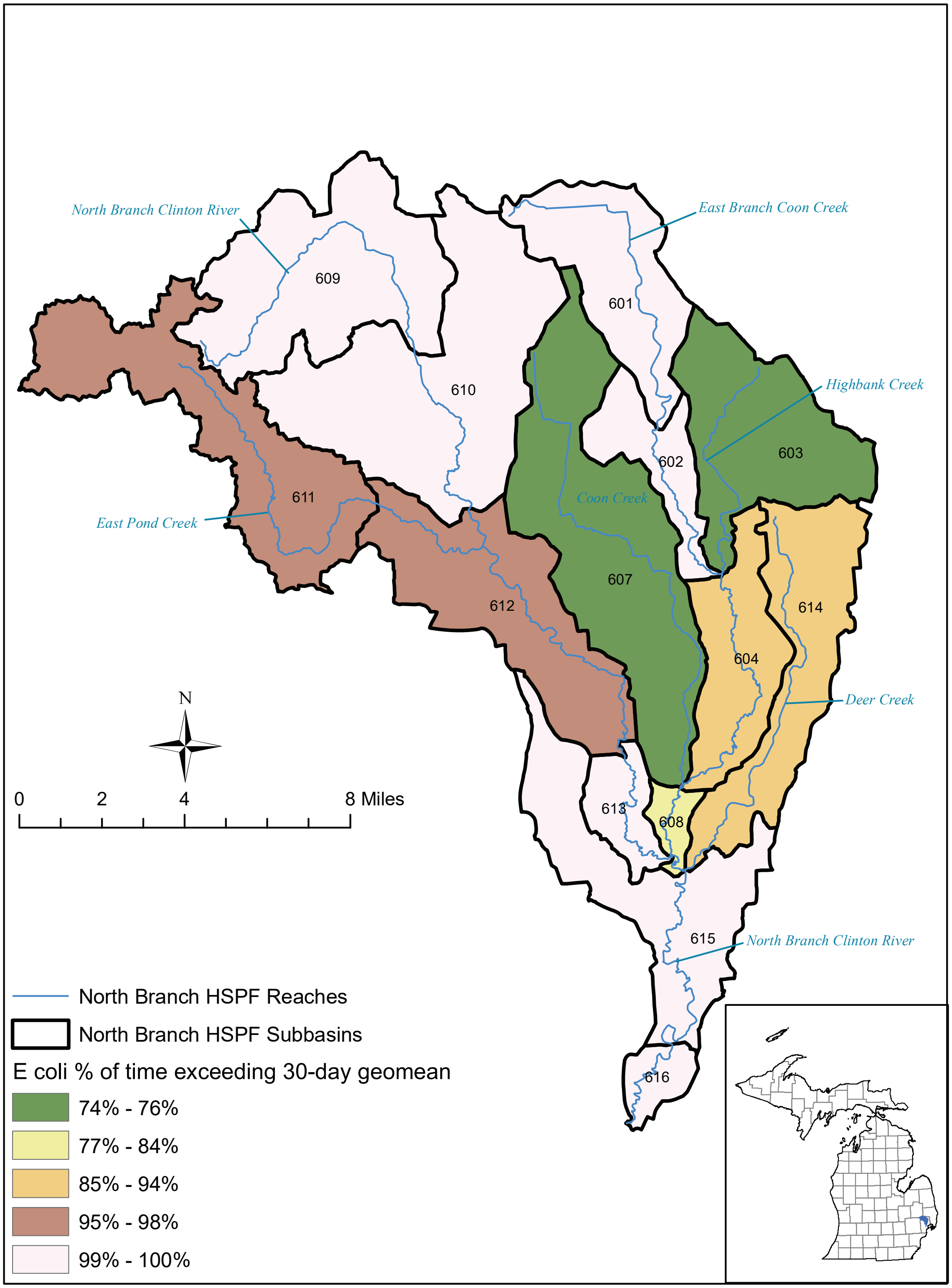


Figure G.3-2: E.coli % of time eceeding daily max

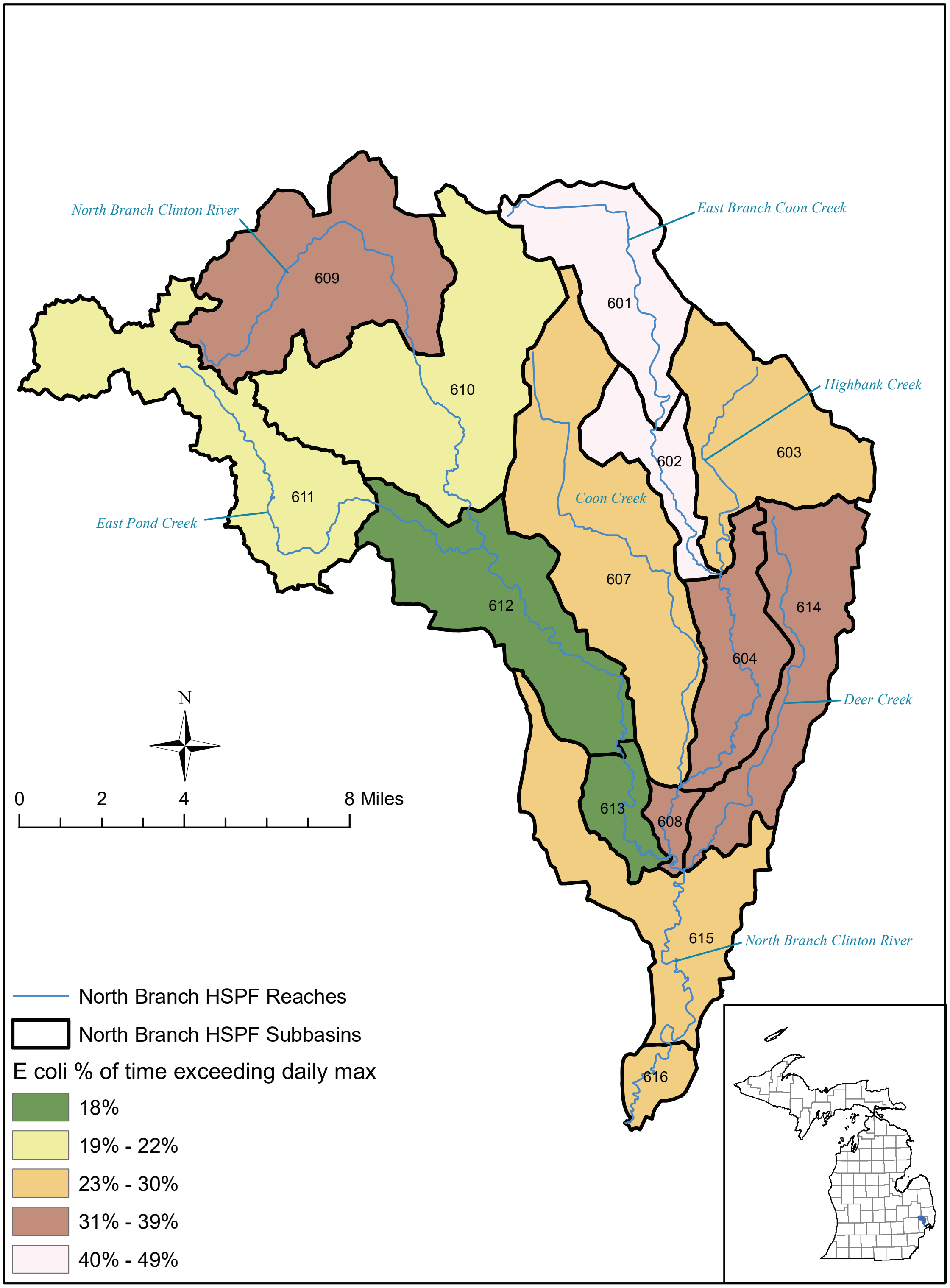


Figure G.3-3: Annual Sediment Loading Rate (tons/ac/yr)

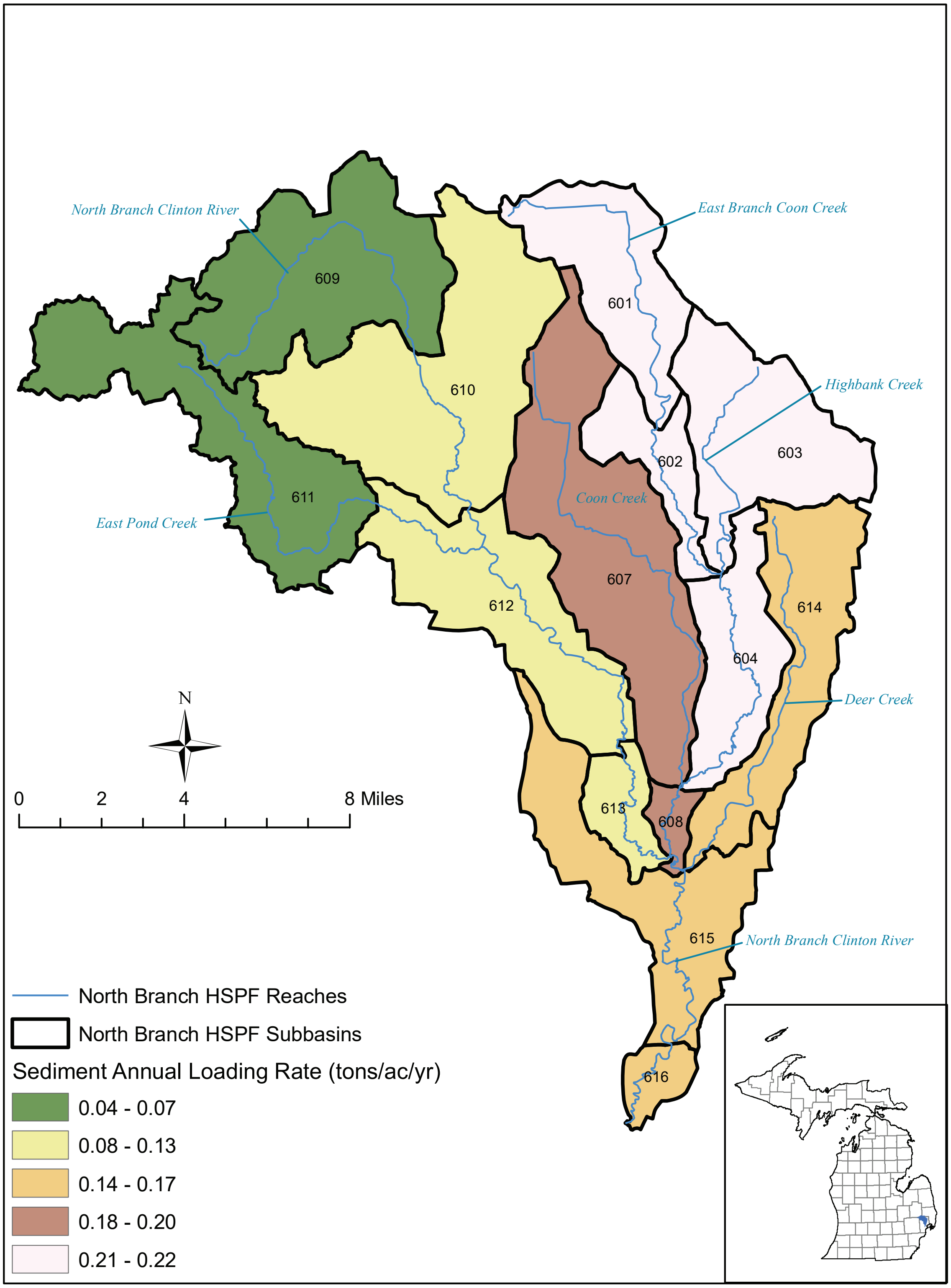


Figure G.3-4: Total Phosphorous Annual Loading Rate (lb/ac/yr)

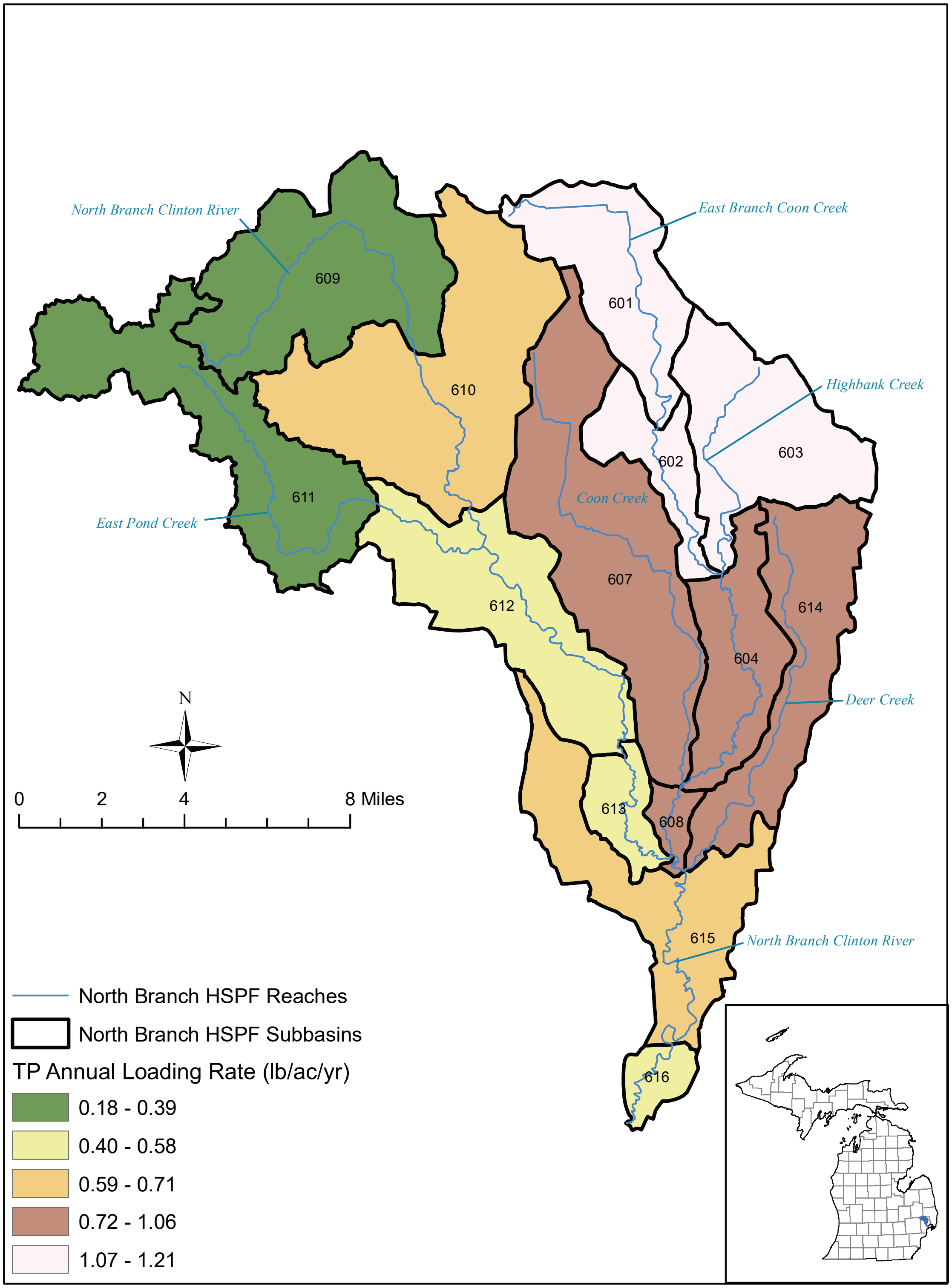


Figure G.3-5: Nitrite and Nitrate Annual Loading Rate (lb/ac/yr)

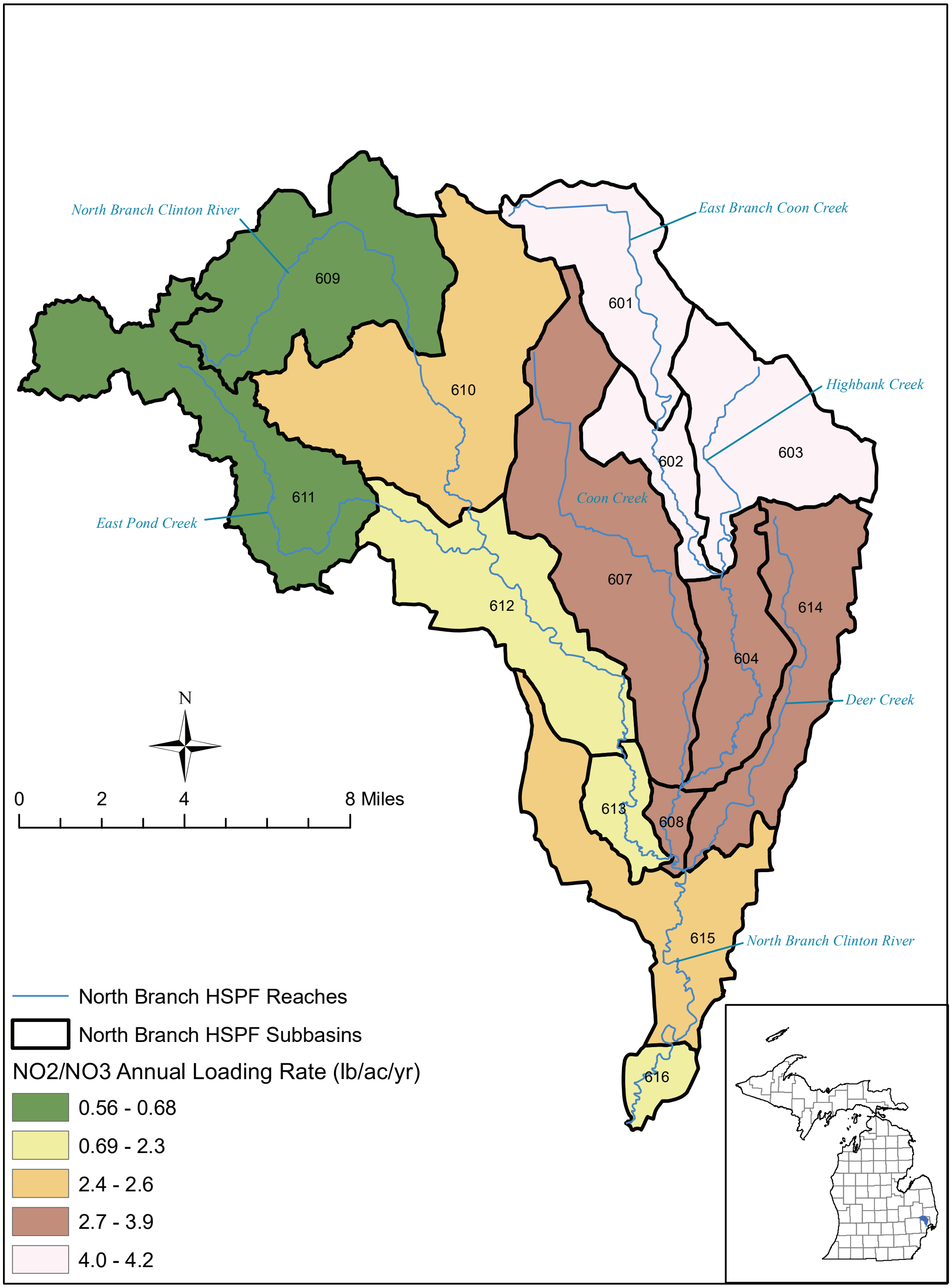
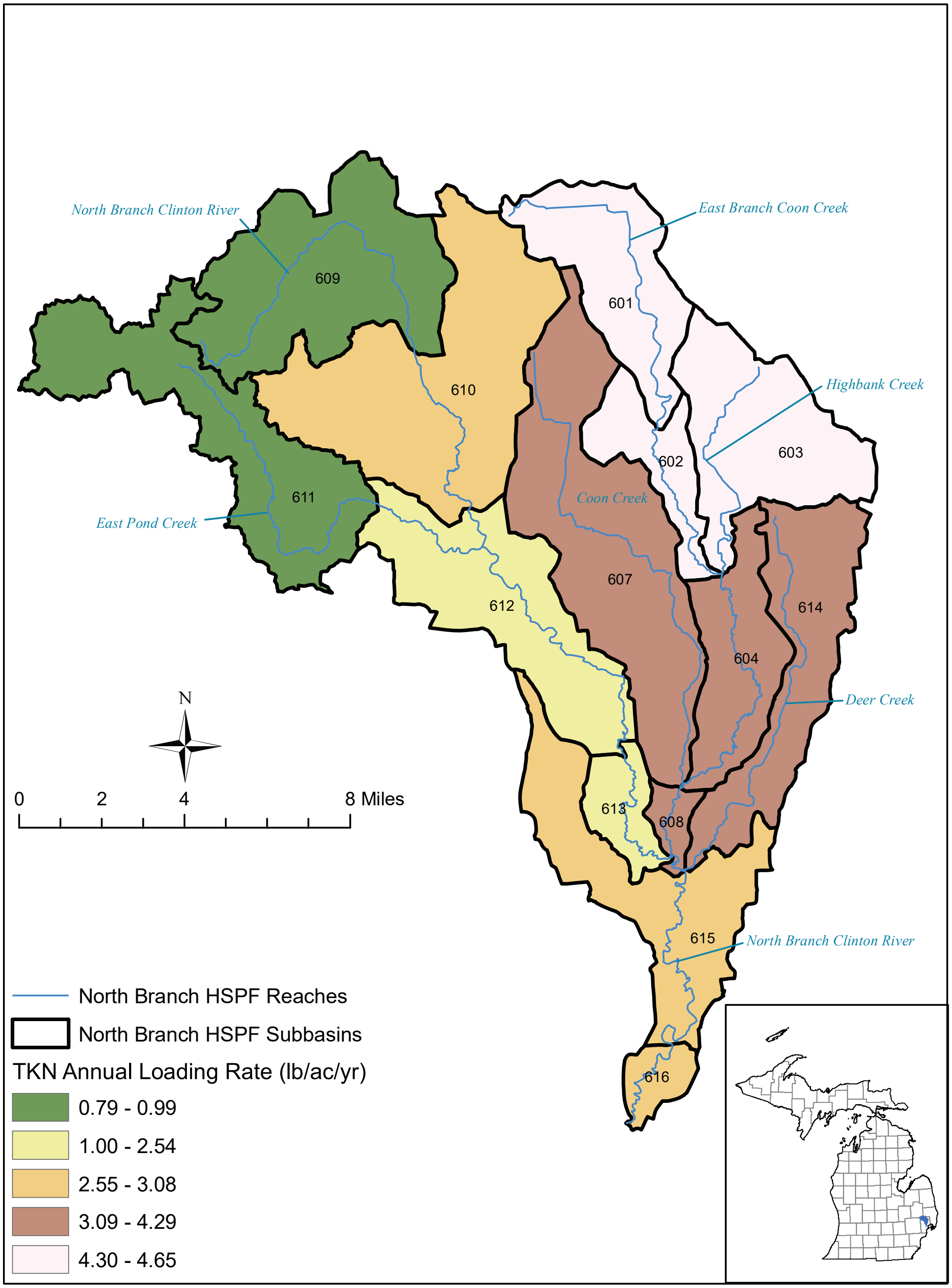


Figure G.3-6: Total Kjeldahl Nitrogen Annual Loading Rate (lb/ac/yr)



Summary of North Branch Clinton River Scenarios

This brief report supplements a previous one entitled “Summary of North Branch Clinton River Baseline Analysis”, which provided the backdrop for the water quality model used to simulate existing conditions in the North Branch watershed. The HSPF model was subsequently modified to incorporate two scenarios demonstrating the effects of various practices to improve water quality. The model predictions of the scenario practices provide valuable insight into the relative effectiveness of the practices.

As noted in the previous brief report, sediment and nutrient (TP, NO_3, and TKN) components of the model could not be fully calibrated to watershed conditions due to lack of long term sediment and nutrient monitoring data in the watershed. This limits the ability of the model to be used as a tool for estimating degree of impairment against statistical measures for sediment and nutrients; However, the model representation of the watershed is reasonable and well tied to the types of land uses present in the watershed, and the model provides a good indication of the degree of difference between catchments, and the scenarios discussed here provide beneficial information about the impact of BMPs and other practices on reducing sediment and nutrient loads and concentrations.

On the other hand, the abundance of E. coli monitoring data in the watershed allowed for a full recalibration of the model to the catchment scale. As such, the North Branch HSPF model is an excellent tool for understanding sources of bacteria, and predicting the effects of practices to reduce bacteria.

The two scenarios discussed here do not include projections of future land use change or development. The scenarios were built assuming the practices would be incorporated in watershed in present-day conditions. This assumption is not meant to reflect a reasonable timeframe for implementation, which is likely to take time. Rather, it allows for a better comparison of the effect of the practices.

Scenario 1

The first scenario reflects implementation of a number of practices for agricultural lands. Practices and their implementation in the HSPF model are as follows:

1. 100 ft streamside forest buffers, implemented on 50% of streams that are presently not buffered (applies to row crop and pasture land uses). Represented in the HSPF model as follows:

    a. Newly buffered land is represented in the model as being converted from row crop/pasture to forest. Forested land has lower pollutant loading rates than agricultural land, resulting in reductions due to land conversion.

    b. Agricultural land area within 300 ft of the buffer edges is assumed to be treated by the buffers, resulting in direct pollutant load reduction. Agricultural land beyond 300 ft of the buffer is assumed to generate concentrated flow and bypass the buffer without treatment. Buffer treatment removal rates range from 45% for E. coli to 97% for sediment.

2. Increased use of nutrient management plans. The opportunity for this practice is assumed to be limited, so a 5% reduction in TP and TN generated from agricultural land was assumed. Represented in the HSPF model as follows:

    a. 5% reduction in model parameters used to generate TP and TN in runoff during storm events

    b. 5% reduction in groundwater loading of TN

3. Grazing and manure management plans. While the density of livestock in the watershed is relatively small, agricultural census data indicates that cattle, poultry, and dairy operations are present in Macomb County. Manure is likely disposed of via incorporation into agricultural fields, which can become a

source of bacteria in storm event runoff. Bacteria can also wash off feedlots and pasture. Represented in the HSPF model as follows:

   a. 75% reduction in manure application to crop land. Manure is instead diverted to composting.

   b. Increased confinement of grazing cattle to reduce manure loads on pasture

   c. Full cattle exclusion from streams

4. Increased use of conservation tillage and no-till in the watershed. Present day and scenario assumptions are as follows:
   35% conventional tillage reduced to 10%
   45% conservation tillage increased to 15%
   20% no-till increased to 75%
   Represented in the HSPF model as follows:

   a. Weighted change in seasonal factors affecting sediment detachment during storm events

   b. Increase in plant cover reducing soil erosivity

   c. Small increase in soil moisture storage capacity in the root zone, resulting in small decrease in runoff

Scenario 2

Scenario 2 is implemented as an add-on to Scenario 1. In other words, Scenario 2 reflects both Scenario1 and Scenario 2 practices.

The second scenario focuses on addressing low flow sources of E coli bacteria in the watershed. All of the catchments have low flow sources – including the urbanized, sewered areas in the south. In the rural agricultural areas, the sources are likely from failing onsite septic treatment systems (OSTS). A failing OSTS from a water quality perspective may appear to be functioning perfectly to the operator. Given the low infiltration rates of most of the soils in North Branch and the use of ditches and tile drains, it is likely a large number of systems have short-circuited to drainage ditches or tile drains. In urban areas, it is more likely there is a combination of accidental and illicit connections to the storm drain network, as well as aged sanitary sewer infrastructure that leaches out contaminated water to storm sewers and to streams. Low flow bacteria sources are by far the biggest contributor to water quality impairment throughout the watershed as indicated by the E coli. Standards, manifest in bacteria TMDLs. If low flow sources of bacteria are present, it indicates that poorly treated or untreated sewage is entering the waters of the watershed. Nutrient levels are likely elevated as well in the sewage effluent.

The HSPF model is well calibrated to E. coli monitoring data collected in the majority of catchments. It includes explicit representation of low flow sources, though the model does not distinguish between source types. Scenario 2 was implemented as follows:

1. 90% reduction in low flow loads of E coli and nutrients throughout the watershed, both in the rural and urban areas. This would be implemented as programs to encourage/require repair or replacement of failing septic systems, reducing in illicit and cross connections, and repair of aging sewer infrastructure that leaches sewage.

Originally, the intention was to reduce low flow sources dynamically (and variably within catchments) until E coli standards were exceeded 10% or less of the time (note that percent exceedance of standards is only correlated to, but not the same as percent reduction in low flow loads). Upon implementation of the scenario, it was found that even at the 90% reduction level in low flow loads, none of the catchments achieved less than 10% exceedance of both standards. Since 90% is an extremely aggressive (and optimistic) implementation goal for low flow sources, the scenario did not assume a higher level of low flow load reduction.

Scenario Results

A full listing of tables showing the scenario results is provided, followed by a comparison of Scenarios 1 and 2 to the Baseline Analysis.

Scenario 1

Table G.3-7: Scenario 1 E. coli measures

				Scenario 1				
Catch-ment ID	Name	Catchment Area (ac)	Cumulative Catchment Area (ac)	Annual E. coli Load (#/yr x 10^{12})	E. coli Loading Rate (#/ac/yr x 10^{9})	E. coli long-term Geometric Mean (#/100ml)	E coli % of time exceeding 30-day geomean	E coli % of time exceeding daily max
601	East Branch Coon Creek	8,190	8,190	36.8	4.5	396.3	98%	44%
602	East Branch Coon Creek	4,059	12,249	60.6	5.0	388.2	99%	45%
603	Highbank Creek	10,109	10,109	59.8	5.9	153.0	71%	20%
604	East Branch Coon Creek	6,561	28,919	111.7	3.9	203.3	88%	33%
607	Coon Creek	16,966	16,966	75.8	4.5	141.0	70%	23%
608	Coon Creek	1,162	47,047	160.3	3.4	152.7	81%	29%
609	North Branch Clinton River	13,858	13,858	66.0	4.8	250.4	99%	38%
610	North Branch Clinton River	18,099	31,958	190.5	6.0	224.8	98%	18%
611	East Pond Creek	13,337	13,337	47.1	3.5	174.2	98%	21%
612	North Branch Clinton River	11,559	56,854	250.9	4.4	166.4	96%	16%
613	North Branch Clinton River	2,644	59,498	221.7	3.7	180.5	98%	16%
614	Deer Creek	9,375	9,375	40.1	4.3	232.2	92%	30%
615	North Branch Clinton River	10,533	126,452	462.6	3.7	215.1	98%	23%
616	North Branch Clinton River	1,630	128,082	466.7	3.6	241.8	99%	26%

Table G.3-8: Scenario 1 Sediment (TSS) measures

Catch-ment ID	Name	Catchment Area (ac)	Cumulative Catchment Area (ac)	Scenario 1 Annual Sediment Load (tons/yr)	Sediment Loading Rate (tons/ac/yr)	Average TSS conc. (mg/l)	90th percentile TSS (mg/L)
601	East Branch Coon Creek	8,190	8,190	1,174	0.143	21.4	44.3
602	East Branch Coon Creek	4,059	12,249	1,734	0.142	19.9	42.9
603	Highbank Creek	10,109	10,109	1,416	0.140	13.6	22.2
604	East Branch Coon Creek	6,561	28,919	3,937	0.136	21.0	42.7
607	Coon Creek	16,966	16,966	2,179	0.128	17.8	32.8
608	Coon Creek	1,162	47,047	6,172	0.131	20.8	40.8
609	North Branch Clinton River	13,858	13,858	799	0.058	24.3	44.3
610	North Branch Clinton River	18,099	31,958	2,894	0.091	18.8	36.4
611	East Pond Creek	13,337	13,337	508	0.038	16.7	32.6
612	North Branch Clinton River	11,559	56,854	4,806	0.085	21.9	42.1
613	North Branch Clinton River	2,644	59,498	4,841	0.081	20.4	39.4
614	Deer Creek	9,375	9,375	1,062	0.113	16.5	30.7
615	North Branch Clinton River	10,533	126,452	12,923	0.102	23.2	45.6
616	North Branch Clinton River	1,630	128,082	13,100	0.102	24.7	50.8

Table G.3-9: Scenario 1 Total Phosphorus measures

Catch-ment ID	Name	Catch-ment Area (ac)	Cumulative Catchment Area (ac)	Scenario 1 Annual TP Load (lbs/yr x 10^3)	TP Loading Rate (lb/ac/yr)	Average TP conc. (mg/l)	% of time TP > 0.1 mg/L
601	East Branch Coon Creek	8,190	8,190	6.0	0.74	0.370	52%
602	East Branch Coon Creek	4,059	12,249	8.6	0.70	0.193	49%
603	Highbank Creek	10,109	10,109	7.3	0.72	0.238	46%
604	East Branch Coon Creek	6,561	28,919	18.8	0.65	0.216	44%
607	Coon Creek	16,966	16,966	10.5	0.62	0.267	48%
608	Coon Creek	1,162	47,047	28.5	0.61	0.227	43%
609	North Branch Clinton River	13,858	13,858	4.2	0.30	0.078	18%
610	North Branch Clinton River	18,099	31,958	15.2	0.48	0.074	22%
611	East Pond Creek	13,337	13,337	2.2	0.16	0.045	9%
612	North Branch Clinton River	11,559	56,854	22.2	0.39	0.060	12%
613	North Branch Clinton River	2,644	59,498	23.0	0.39	0.058	11%
614	Deer Creek	9,375	9,375	5.4	0.58	0.306	51%
615	North Branch Clinton River	10,533	126,452	52.2	0.41	0.063	15%
616	North Branch Clinton River	1,630	128,082	48.1	0.38	0.057	13%

Table G.3-10. Scenario 1 Nitrate/Nitrite measures

Catch-ment ID	Name	Catch-ment Area (ac)	Cumulative Catchment Area (ac)	Scenario 1 Annual NO3 Load (lbs/yr x 10^3)	Scenario 1 NO3 Loading Rate (lb/ac/yr)	Scenario 1 Average NO3 conc. (mg/l)	Scenario 1 % of time NO3 > 0.2 mg/L
601	East Branch Coon Creek	8,190	8,190	29.9	3.65	0.841	68%
602	East Branch Coon Creek	4,059	12,249	43.4	3.54	0.607	66%
603	Highbank Creek	10,109	10,109	35.5	3.51	0.581	60%
604	East Branch Coon Creek	6,561	28,919	92.3	3.19	0.618	62%
607	Coon Creek	16,966	16,966	56.5	3.33	0.673	64%
608	Coon Creek	1,162	47,047	143.8	3.06	0.614	61%
609	North Branch Clinton River	13,858	13,858	8.8	0.63	0.137	10%
610	North Branch Clinton River	18,099	31,958	74.6	2.33	0.280	23%
611	East Pond Creek	13,337	13,337	7.4	0.56	0.128	15%
612	North Branch Clinton River	11,559	56,854	114.4	2.01	0.263	24%
613	North Branch Clinton River	2,644	59,498	115.6	1.94	0.260	24%
614	Deer Creek	9,375	9,375	32.4	3.45	0.722	66%
615	North Branch Clinton River	10,533	126,452	283.4	2.24	0.340	32%
616	North Branch Clinton River	1,630	128,082	268.0	2.09	0.328	33%

Table G.3-11. Scenario 1 TKN measures

Catch-ment ID	Name	Catch-ment Area (ac)	Cumulative Catchment Area (ac)	Scenario 1 Annual TKN Load (lbs/yr x 10^3)	Scenario 1 TKN Loading Rate (lb/ac/yr)	Scenario 1 Average TKN concn. (mg/l)	Scenario 1 % of time TKN > 1.2 mg/L
601	East Branch Coon Creek	8,190	8,190	33.2	4.05	0.947	26%
602	East Branch Coon Creek	4,059	12,249	48.3	3.94	0.716	14%
603	Highbank Creek	10,109	10,109	38.2	3.78	0.678	14%
604	East Branch Coon Creek	6,561	28,919	105.2	3.64	0.740	16%
607	Coon Creek	16,966	16,966	62.8	3.70	0.782	18%
608	Coon Creek	1,162	47,047	166.3	3.53	0.742	17%
609	North Branch Clinton River	13,858	13,858	12.7	0.92	0.242	1%
610	North Branch Clinton River	18,099	31,958	83.3	2.61	0.389	6%
611	East Pond Creek	13,337	13,337	10.3	0.77	0.213	1%
612	North Branch Clinton River	11,559	56,854	131.9	2.32	0.365	6%
613	North Branch Clinton River	2,644	59,498	136.4	2.29	0.367	7%
614	Deer Creek	9,375	9,375	36.0	3.84	0.815	20%
615	North Branch Clinton River	10,533	126,452	349.4	2.76	0.478	10%
616	North Branch Clinton River	1,630	128,082	341.5	2.67	0.472	10%

Scenario 2

(No table shown for sediment since Scenario 2 does not address sediment. Scenario 2 sediment is identical to Scenario 1.)

Table G.3-12: Scenario 2 E. coli measures

				Scenario 2				
Catch-ment ID	Name	Catch-ment Area (ac)	Cumulative Catchment Area (ac)	Annual E. coli Load (#/yr x 10^{12})	E. coli Loading Rate (#/ac/yr x 10^9)	E. coli long-term Geometric Mean (#/100ml)	E coli % of time exceeding 30-day geomean	E coli % of time exceeding daily max
601	East Branch Coon Creek	8,190	8,190	26.4	3.2	104.9	74%	24%
602	East Branch Coon Creek	4,059	12,249	42.9	3.5	112.0	77%	21%
603	Highbank Creek	10,109	10,109	47.4	4.7	62.7	29%	15%
604	East Branch Coon Creek	6,561	28,919	86.3	3.0	67.2	56%	19%
607	Coon Creek	16,966	16,966	55.7	3.3	61.1	46%	19%
608	Coon Creek	1,162	47,047	121.5	2.6	53.3	47%	18%
609	North Branch Clinton River	13,858	13,858	49.6	3.6	68.7	33%	14%
610	North Branch Clinton River	18,099	31,958	137.1	4.3	56.2	9%	13%
611	East Pond Creek	13,337	13,337	36.7	2.8	56.4	25%	14%
612	North Branch Clinton River	11,559	56,854	177.6	3.1	46.3	3%	12%
613	North Branch Clinton River	2,644	59,498	151.7	2.6	44.5	3%	11%
614	Deer Creek	9,375	9,375	25.7	2.7	75.1	55%	19%
615	North Branch Clinton River	10,533	126,452	312.3	2.5	62.1	27%	13%
616	North Branch Clinton River	1,630	128,082	313.4	2.4	70.3	34%	15%

Table G.3-13: Scenario 1 Total Phosphorus measures

Catch-ment ID	Name	Catch-ment Area (ac)	Cumulative Catchment Area (ac)	Scenario 2 Annual TP Load (lbs/yr x 10^3)	Scenario 2 TP Loading Rate (lb/ac/yr)	Scenario 2 Average TP conc. (mg/l)	Scenario 2 % of time TP > 0.1 mg/L
601	East Branch Coon Creek	8,190	8,190	5.8	0.71	0.074	22%
602	East Branch Coon Creek	4,059	12,249	8.3	0.68	0.053	11%
603	Highbank Creek	10,109	10,109	7.1	0.71	0.045	12%
604	East Branch Coon Creek	6,561	28,919	18.3	0.63	0.055	14%
607	Coon Creek	16,966	16,966	10.2	0.60	0.054	15%
608	Coon Creek	1,162	47,047	27.7	0.59	0.054	15%
609	North Branch Clinton River	13,858	13,858	3.6	0.26	0.046	10%
610	North Branch Clinton River	18,099	31,958	14.3	0.45	0.035	7%
611	East Pond Creek	13,337	13,337	1.9	0.14	0.025	4%
612	North Branch Clinton River	11,559	56,854	20.9	0.37	0.033	5%
613	North Branch Clinton River	2,644	59,498	21.8	0.37	0.033	5%
614	Deer Creek	9,375	9,375	5.1	0.55	0.056	16%
615	North Branch Clinton River	10,533	126,452	50.3	0.40	0.034	5%
616	North Branch Clinton River	1,630	128,082	46.4	0.36	0.033	5%

Table G.3-14. Scenario 1 Nitrate/Nitrite measures

Catch-ment ID	Name	Catch-ment Area (ac)	Cumulative Catchment Area (ac)	Scenario 2 Annual NO3 Load (lbs/yr x 10^3)	Scenario 2 NO3 Loading Rate (lb/ac/yr)	Scenario 2 Average NO3 conc. (mg/l)	Scenario 2 % of time NO3 > 0.2 mg/L
601	East Branch Coon Creek	8,190	8,190	29.7	3.63	0.559	54%
602	East Branch Coon Creek	4,059	12,249	43.1	3.52	0.474	44%
603	Highbank Creek	10,109	10,109	35.3	3.49	0.397	34%
604	East Branch Coon Creek	6,561	28,919	91.9	3.18	0.467	45%
607	Coon Creek	16,966	16,966	56.2	3.31	0.471	46%
608	Coon Creek	1,162	47,047	143.1	3.04	0.451	46%
609	North Branch Clinton River	13,858	13,858	8.3	0.60	0.108	8%
610	North Branch Clinton River	18,099	31,958	73.9	2.31	0.246	20%
611	East Pond Creek	13,337	13,337	7.1	0.54	0.111	13%
612	North Branch Clinton River	11,559	56,854	113.3	1.99	0.241	23%
613	North Branch Clinton River	2,644	59,498	114.6	1.93	0.241	22%
614	Deer Creek	9,375	9,375	32.2	3.43	0.486	48%
615	North Branch Clinton River	10,533	126,452	281.8	2.23	0.314	30%
616	North Branch Clinton River	1,630	128,082	266.6	2.08	0.306	31%

Table G.3-15. Scenario 1 TKN measures

Catch-ment ID	Name	Catch-ment Area (ac)	Cumulative Catchment Area (ac)	Scenario 2 Annual TKN Load (lbs/yr x 10^3)	TKN Loading Rate (lb/ac/yr)	Average TKN concn. (mg/l)	% of time TKN > 1.2 mg/L
601	East Branch Coon Creek	8,190	8,190	33.0	4.03	0.720	15%
602	East Branch Coon Creek	4,059	12,249	48.0	3.92	0.609	12%
603	Highbank Creek	10,109	10,109	38.1	3.77	0.531	10%
604	East Branch Coon Creek	6,561	28,919	104.8	3.62	0.617	12%
607	Coon Creek	16,966	16,966	62.6	3.69	0.620	12%
608	Coon Creek	1,162	47,047	165.6	3.52	0.608	12%
609	North Branch Clinton River	13,858	13,858	12.3	0.89	0.217	1%
610	North Branch Clinton River	18,099	31,958	82.6	2.58	0.359	6%
611	East Pond Creek	13,337	13,337	10.1	0.76	0.198	1%
612	North Branch Clinton River	11,559	56,854	130.9	2.30	0.344	6%
613	North Branch Clinton River	2,644	59,498	135.4	2.28	0.348	7%
614	Deer Creek	9,375	9,375	35.8	3.82	0.625	12%
615	North Branch Clinton River	10,533	126,452	347.8	2.75	0.451	10%
616	North Branch Clinton River	1,630	128,082	339.9	2.65	0.448	10%

Comparison to Baseline Analysis and Discussion

Table G.3-16: E. coli comparison

Catch-ment ID	E coli % of time exceeding 30-day geomean					E coli % of time exceeding daily max				
	Baseline Analysis	Scenario 1	Scenario 2	Scenario 1 Reduction	Scenario 2 Reduction	Baseline Analysis	Scenario 1	Scenario 2	Scenario 1 Reduction	Scenario 2 Reduction
601	99%	98%	74%	1%	25%	49%	44%	24%	5%	25%
602	99%	99%	77%	1%	23%	49%	45%	21%	4%	28%
603	76%	71%	29%	5%	47%	26%	20%	15%	5%	11%
604	92%	88%	56%	4%	36%	37%	33%	19%	5%	19%
607	74%	70%	46%	4%	28%	28%	23%	19%	5%	9%
608	84%	81%	47%	3%	37%	33%	29%	18%	4%	15%
609	100%	99%	33%	0%	67%	39%	38%	14%	1%	25%
610	99%	98%	9%	0%	90%	22%	18%	13%	4%	8%
611	98%	98%	25%	0%	73%	22%	21%	14%	1%	8%
612	96%	96%	3%	1%	93%	18%	16%	12%	3%	6%
613	99%	98%	3%	1%	96%	18%	16%	11%	3%	8%
614	94%	92%	55%	2%	39%	33%	30%	19%	3%	14%
615	99%	98%	27%	1%	72%	27%	23%	13%	4%	14%
616	100%	99%	34%	1%	66%	30%	26%	15%	4%	16%

Scenario 1 has a small but measurable effect on compliance with the E. coli standards. The practices in this scenario affect only storm event concentrations, which are reflected in high values within the long-term distribution of E coli values. Reducing high flow values is an important component for meeting standards, but the low flow values still dominate. Scenario 2 on the other hand results in a significant reduction in exceedances of the E. coli standards. However, even with the aggressive implementation level, none of the waterbodies meet the standards. This suggests that achievement of the Michigan E. coli standards may not attainable in the North Branch Clinton River watershed. However, reduction of E coli bacteria may achieve other goals such as reduction of Lake St. Claire beach closings. The most important message is that improvement in ambient bacteria levels is best addressed with programs that aggressively target low flow sources of bacteria.

Table G.3-17: Sediment comparison

Catchment ID	Sediment Loading Rate (tons/ac/yr)			90th percentile TSS (mg/L)		
	Baseline Analysis	Scenario 1	Scenario 1 Reduction	Baseline Analysis	Scenario 1	Scenario 1 Reduction
601	0.223	0.143	36%	49.4	44.3	5.1
602	0.216	0.142	34%	46.9	42.9	4.0
603	0.223	0.140	37%	23.4	22.2	1.2
604	0.210	0.136	35%	48.3	42.7	5.7
607	0.195	0.128	34%	35.4	32.8	2.6
608	0.201	0.131	35%	46.6	40.8	5.7
609	0.072	0.058	20%	49.4	44.3	5.1
610	0.129	0.091	30%	39.2	36.4	2.9
611	0.041	0.038	7%	34.2	32.6	1.6
612	0.116	0.085	27%	44.6	42.1	2.4
613	0.114	0.081	28%	43.3	39.4	3.9
614	0.172	0.113	34%	33.3	30.7	2.6
615	0.151	0.102	32%	51.7	45.6	6.1
616	0.151	0.102	32%	56.5	50.8	5.7

Scenario 1 has a substantial impact on land surface generated sediment loads generated from agricultural land. This is not surprising since the practices work to reduce sediment loads generated during storm events, which is when the vast majority of sediment is transported in the watershed. The practices are less effective for reduction lower flow sediment concentration, but they do have an effect.

As is the case for sediment, Scenario 1 has a substantial impact on land surface generated TP loads generated from agricultural land. TP is represented in the model as being attached to sediment on agricultural land (as well as all pervious lands), so the TP results mimic sediment in this regard. Likewise, the influence on TP concentration is limited. However, Scenario 2 has a substantial impact on reducing TP concentration, though limited roles in reducing load. This indicates that low flow sources of poorly treated/untreated sewage also have a significant impact on background TP concentrations. While low flow nutrient concentration has little influence on watershed-scale loads (which are dominated by storm events) to receiving water bodies such as Lake St. Clair, it is often the case that elevated nutrient concentrations impair biological function in stream channels themselves. Mats of benthic algae in streams are frequently an indicator of elevated low flow nutrients. It is important to note there is a great deal of uncertainty in the HSPF model predictions of low flow nutrient sources, and the magnitude of the effect on concentration is likely over- or under-estimated by a large margin. Even so, the model does indicate the importance of low flow sources of nutrients.

Table G.3-18: Total Phosphorus comparison

Catch-ment ID	TP Loading Rate (lb/ac/yr)					% of time TP > 0.1 mg/L				
	Baseline Analysis	Scenario 1	Scenario 2	Scenario 1 Reduction	Scenario 2 Reduction	Baseline Analysis	Scenario 1	Scenario 2	Scenario 1 Reduction	Scenario 2 Reduction
601	1.19	0.74	0.71	38%	40%	53%	52%	22%	1%	32%
602	1.12	0.70	0.68	37%	39%	50%	49%	11%	1%	39%
603	1.21	0.72	0.71	40%	42%	46%	46%	12%	0%	35%
604	1.06	0.65	0.63	38%	40%	45%	44%	14%	1%	32%
607	0.99	0.62	0.60	37%	39%	49%	48%	15%	1%	34%
608	0.98	0.61	0.59	38%	40%	43%	43%	15%	1%	29%
609	0.39	0.30	0.26	22%	33%	19%	18%	10%	1%	10%
610	0.71	0.48	0.45	33%	37%	23%	22%	7%	1%	16%
611	0.18	0.16	0.14	10%	22%	9%	9%	4%	0%	5%
612	0.57	0.39	0.37	31%	35%	14%	12%	5%	1%	8%
613	0.57	0.39	0.37	32%	35%	13%	11%	5%	1%	7%
614	0.91	0.58	0.55	37%	40%	52%	51%	16%	1%	35%
615	0.64	0.41	0.40	35%	38%	17%	15%	5%	1%	11%
616	0.58	0.38	0.36	35%	37%	14%	13%	5%	1%	9%

Table G.3-19: Nitrate/Nitrite comparison

Catch-ment ID	NO3 Loading Rate (lb/ac/yr)					% of time NO3 > 0.2 mg/L				
	Baseline Analysis	Scenario 1	Scenario 2	Scenario 1 Reduction	Scenario 2 Reduction	Baseline Analysis	Scenario 1	Scenario 2	Scenario 1 Reduction	Scenario 2 Reduction
601	4.19	3.65	3.63	13%	13%	70%	68%	54%	1%	16%
602	4.03	3.54	3.52	12%	13%	67%	66%	44%	1%	23%
603	4.15	3.51	3.49	16%	16%	62%	60%	34%	2%	28%
604	3.67	3.19	3.18	13%	13%	63%	62%	45%	1%	18%
607	3.77	3.33	3.31	12%	12%	65%	64%	46%	1%	19%
608	3.49	3.06	3.04	12%	13%	61%	61%	46%	1%	16%
609	0.68	0.63	0.60	7%	12%	10%	10%	8%	0%	2%
610	2.59	2.33	2.31	10%	11%	24%	23%	20%	1%	4%
611	0.56	0.56	0.54	1%	5%	15%	15%	13%	0%	2%
612	2.21	2.01	1.99	9%	10%	24%	24%	23%	0%	2%
613	2.13	1.94	1.93	9%	10%	24%	24%	22%	0%	2%
614	3.86	3.45	3.43	10%	11%	67%	66%	48%	1%	19%
615	2.50	2.24	2.23	10%	11%	33%	32%	30%	1%	3%
616	2.33	2.09	2.08	10%	10%	34%	33%	31%	1%	3%

Nitrate/nitrite loading and concentrations show a trend similar to TP – Scenario 1 works to reduce overall loading rates, while Scenario 2 affects low flow concentrations. However, the influence on both loading rates and concentrations is somewhat less than for TP.

TKN shows a similar trend to nitrate/nitrite for Scenario 1. However, the influence of TKN reduction in Scenario 2 on concentration is fairly limited. This appears to be an artifact of the 1.2 mg/L target relative to background levels of TKN.

Table G.3-20: TKN comparison

Catchment ID	TKN Loading Rate (lb/ac/yr)					% of time TKN > 1.2 mg/L				
	Baseline Analysis	Scenario 1	Scenario 2	Scenario 1 Reduction	Scenario 2 Reduction	Baseline Analysis	Scenario 1	Scenario 2	Scenario 1 Reduction	Scenario 2 Reduction
601	4.65	4.05	4.03	13%	13%	28%	26%	15%	2%	12%
602	4.48	3.94	3.92	12%	12%	14%	14%	12%	1%	2%
603	4.47	3.78	3.77	15%	16%	16%	14%	10%	1%	5%
604	4.18	3.64	3.62	13%	13%	17%	16%	12%	1%	4%
607	4.19	3.70	3.69	12%	12%	19%	18%	12%	1%	8%
608	4.03	3.53	3.52	12%	13%	18%	17%	12%	2%	6%
609	0.99	0.92	0.89	7%	10%	1%	1%	1%	0%	0%
610	2.88	2.61	2.58	10%	10%	7%	6%	6%	0%	0%
611	0.79	0.77	0.76	2%	4%	1%	1%	1%	0%	0%
612	2.54	2.32	2.30	9%	9%	6%	6%	6%	0%	0%
613	2.51	2.29	2.28	9%	9%	7%	7%	7%	0%	0%
614	4.29	3.84	3.82	10%	11%	21%	20%	12%	1%	9%
615	3.08	2.76	2.75	10%	11%	10%	10%	10%	1%	1%
616	2.96	2.67	2.65	10%	10%	10%	10%	10%	0%	0%

Appendix G.4: Goal-related Information

Table G.4-1. Identification of secondary goals associated with the objectives.

Cross Referenced Goal → The average of the percentages and the resultant **rank** is given in parentheses. **Goal** / **Objective**	**Goal I:** (29%-**6**) **Water Quality**	**Goal II:** (39%-**5**) **Hydrology**	**Goal III:** (61%-**2**) **Habitat**	**Goal IV:** (62%-**1**) **Natural Features**	**Goal V:** (10%-**7**) **Greenways**	**Goal VI:** (53%-**3**) **Rural Character**	**Goal VII:** (51%-**4**) **Recreation**	**Goal VIII: Public Education**	**Goal IX: Institutionalization**	**Total # of Secondary Goals for the Objective with Relative, Absolute Rank (bold)** Half-credit responses, and highest ranked secondary goal, are in parentheses and used for breaking ties*
GOAL I: Water Quality		0%	100%	100%	0%	0%	33%			
A. Sediment		Y/N	Y/Y	Y/Y	Y/N	Y/N	Y/N			2 (4,1) – **3, 17**
B. Nutrients			Y/Y	Y/Y	Y/N	Y/N	Y/N			2 (3,1) – **6, 20**
C. Oxygen Demand			Y/Y	Y/Y	Y/N	Y/N	Y/N			2 (3,1) – **5, 19**
D. Pathogens			Y/Y	Y/Y	Y/N	Y/N	Y/Y			3 (2,1) – **1, 11**
E. Temperature		Y/N	Y/Y	Y/Y	Y/N	Y/N	Y/N			2 (4,1) – **4, 18**
F. Toxic Compounds			Y/Y	Y/Y		Y/N	Y/Y			3 (1,1) – **2, 12**
GOAL II: Hydrology	40%		80%	100%	0%	40%	40%			
A. Flashiness	Y/N		Y/Y	Y/Y	Y/N	Y/N	Y/N			2 (4,1) – **4, 16**
B. Imperviousness	Y/Y		Y/Y	Y/Y	Y/N	Y/Y	Y/N			4 (2,1) – **1, 6**
C. Wetlands	Y/Y		Y/Y	Y/Y	Y/N	Y/Y	Y/N			4 (2,1) – **2, 7**
D. Obstructions	Y/N		Y/N	Y/Y		Y/N	Y/Y			2 (3,1) – **5, 21**
E. Withdrawals			Y/Y	Y/Y			Y/Y			3 (0,1) – **3, 14**
GOAL III: Habitat	0%	66%		100%	33%	66%	100%			
A. Terrestrial	Y/N	Y/Y		Y/Y	Y/N	Y/Y	Y/Y			4 (2,1) – **2, 5**
B. Riparian	Y/N	Y/Y		Y/Y	Y/Y	Y/Y	Y/Y			5 (1,1) – **1, 3**
C. Aquatic	Y/N	Y/N		Y/Y			Y/Y			2 (2,1) – **3, 22**
GOAL IV: Natural Features	50%	66%	66%		17%	66%	33%			
A. Geologic Conditions	Y/N	Y/Y	Y/N		Y/N	Y/N	Y/N			1 (5,5) – **6, 25**
B. Sensitive Waterbodies	Y/Y	Y/Y	Y/Y		Y/N	Y/Y	Y/Y			5 (1,2) – **1, 2**
C. Groundwater	Y/Y	Y/Y	Y/Y		Y/N	Y/N	Y/N			3 (3,2) – **4, 9**
D. Wetlands / Floodplain	Y/Y	Y/Y	Y/Y		Y/Y	Y/Y	Y/N			5 (1,2) – **2, 4**
E. Native Organisms	Y/N	Y/N	Y/Y		Y/N	Y/Y	Y/Y			3 (3,2) – **3, 10**
F. Other	Y/N	Y/N	Y/N		Y/N	Y/Y	Y/N			1 (5,3) – **5, 24**
GOAL V: Greenways	50%	50%	100%	50%		100%	100%			
A. Riparian Buffers	Y/Y	Y/Y	Y/Y	Y/Y		Y/Y	Y/Y			6 (0,1) – **1, 1**
B. Trails / Green Corridors			Y/Y	Y/N		Y/Y	Y/Y			3 (1,2) – **2, 13**
GOAL VI: Rural Character	25%	50%	0%	0%	0%		0%			
A. Land Use	Y/N	Y/N	Y/N	Y/N	Y/N		Y/N			0 (6,-) – **3, 30**
B. Development	Y/N	Y/Y	Y/N	Y/N	Y/N		Y/N			1 (5,5) – **2, 26**
C. Roads	Y/Y	Y/Y	Y/N	Y/N	Y/N		Y/N			2 (4,5) – **1, 18**
D. Aesthetics	Y/N		Y/N	Y/N	Y/N		Y/N			0 (5,-) – **4, 31**
GOAL VII: Recreation	11%	0%	22%	22%	11%	44%				
A. Public Land			Y/N	Y/N	Y/N	Y/N				0 (4,-) – 7, 32
B. Campsites						Y/Y				1 (0,3) – 5, 28
C. Fisheries	Y/N	Y/N	Y/Y	Y/Y	Y/N	Y/N				2 (4,1) – 2, 15
D. Trails				Y/N	Y/Y	Y/Y				2 (1,3) – 3, 23
E. Boating		Y/N								0 (1,-) – 9, 34
F. Wading / Swimming	Y/Y	Y/N	Y/N	Y/N	Y/N	Y/N				1 (5,6) – 4, 27
G. Wildlife – Hunting / Watching	Y/N	Y/N	Y/Y	Y/Y	Y/N	Y/Y				3 (3,1) – 1, 8
H. Cultural / Historical Resources						Y/Y				1 (0,3) – 6, 29
I. Tourism			Y/N	Y/N	Y/N	Y/N				0 (4,-) – 8, 33
GOAL VIII: Public Education										
A. Knowledge										
B. Participation										
GOAL IX: Institutionalization										
A. SWAG Membership										
B. Institutional Mechanism										
C. Funding Source										
D. Implementation Schedule										
E. Implementation Efficiency										
F. Plan Effectiveness										

Notes: - The objectives associated with Goal VIII: Public Education do apply to all of the other goals but have been excluded from the ranking because of their unique nature of being strictly educational in terms of the actions that support it. The actions that support the objectives associated with Goal IX: Institutionalization are administrative in nature and are not considered to have any secondary goals.

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Appendix H.1: Relationship of Actions to Planning Elements & Financial and Technical Assistance

This appendix provides the tables that show the relationship between the WMP actions and the various other planning elements. The following lists provide a cross-reference for the action numbers and names, source letters and names, stressor roman numerals and names, and critical areas and lower case roman numerals.

The action numbers and names are as follows:

1-1	Promote and Reconvene SWAG
1-2	Develop Funding Program
1-3	Develop Implementation Plans / Grant Proposals
1-4	Regulatory Enforcement and Technical Assistance
1-5	Implementation Clearinghouse
1-6	Total Maximum Daily Loads
1-7	Identify Impacts, Stressors, Sources, and Causes
1-8	Update Remedial Action Plan (a.k.a 'Restoration Plan')
2-1	Public Education – General Public
2-2	Public Education – Business and Agriculture
2-3	Public Education – Municipal Employees
2-4	Demonstration Projects
2-5	Signage
2-6	Public Involvement
2-7	Community Forums and Stakeholder Workshops
2-8	Municipal Official's Presentations
3-1	Update / Develop Master Plans
3-2	Managing Development Patterns
3-3	Preserve Natural Areas / Features
3-4	Stormwater Management Standards
3-5	Pollution Prevention Ordinances / Programs
4-1	Remediate Contaminated Sediments
4-2	Storm Sewer System Maintenance and Operations
4-3	Minimizing Pollution from Roads and Lots
4-4	Minimizing Pollution from Municipal Facilities
4-5	Lanscape Management Practices
4-6	Waste Management
4-7	Animal Waste Control
4-8	Sanitary and Combined Sewer System Planning and Maintenance
4-9	Flood Control Projects
4-10	Illicit Discharge Elimination
4-11	Septic / On-site Disposal System Practices
4-12	Trash / Debris Reduction
4-13	Spill Prevention / Notification / Response
4-14	Groundwater / Drinking Water Protection
4-15	Agriculture
4-16	Emerging Issues
5-1	Upland Bare Soil Repair
5-2	Streambank / Shoreline Stabilization
5-3	Road and Ditch Stabilization
5-4	Streambank Use Exclusion
5-5	Specific Site Control
5-6	Structural Controls

5-7	Agricultural BMPs
5-8	Construction Sites
6-1	Mitigate Existing Impervious Surfaces
6-2	Infiltration Techniques
6-3	Filtration Techniques
6-4	Vegetative Buffers and Natural Conveyance
6-5	Retention and Detention
7-1	Identify Natural Features
7-2	Natural Land Reserves
7-3	Natural Feature Protection
7-4	Natural Feature Restoration
8-1	Recreation Program
8-2	Riparian Land Conservation for Parks
8-3	Canoe / Boat Landings / Access Sites
8-4	Restore Fishing Opportunities
8-5	Trails / Observation Decks
9-1	Phase II Reporting SWPPIs and Annual Reports
9-2	Stressor Monitoring and Assessment
9-3	Public Education and Involvement Data
9-4	Field Data Collection
9-5	Remedial Action Plan (Restoration Plan) Evaluation / Effectiveness Assessment

The sources and associated letter are as follows:

A	Industrial Discharges
B	Waste Management Sites
C	Contaminated Sites
D	Sewage Discharges
E	Other Businesses
F	Illicit Discharges / Spills
G	Urban and Residential Land, Infrastructure, and Associated Activities
H	Transportation Infrastructure, Land, and Associated Activities
I	Agricultural Land, Infrastructure, and Associated Activities
J	On-site Disposal Systems
K	Contaminated Sediments
L	Atmospheric Deposition
M	Soil Erosion
N	Other Human Activities
O	Animal Sources (non-agricultural)
P	Natural Occurrences and Disturbances

The stressors and associated Roman numerals are as follows:

I	Nutrients
II	Inorganic Compounds
III	Heavy Metals
IV	Organic Compounds
V	Oxygen Demand
VI	pH
VII	Dissolved Solids
VIII	Suspended Solids / Sediment
IX	Debris
X	Temperature
XI	Hydrologic / Hydraulic Characteristics
XII	Natural Feature / Habitat Degradation
XIII	Invasive Species
XIV	Pathogens

XV Radiation

The critical areas and associated mixed lower-case Roman numerals / numbers are as follows:

- i Impervious / Developed Areas
  - i-1 Roads / Roadside Ditches
  - i-2 Areas Tributary to Streams with Increase Peak Flows
  - i-3 Areas with High Potential for Illicit Discharges
  - i-4 Industrial Areas
  - i-5 Areas Tributary to a WWTP
  - i-6 Areas with Storm Drains
- ii Construction Sites
- iii Riparian Areas
- iv Exposed Soils / Actively Eroding Areas
- v Combined Sewer Overflow Areas
- vi Sanitary Sewer Overflow Areas
- vii Sparsely Developed / Undeveloped Areas
  - vii-1 Michigan Natural Features Inventory Areas
- viii Wetlands
- ix Agricultural Areas
- x Residential Lawns
- xii Areas of Failing Septic Systems
- xiii Superfund/Contaminated Sites / Historic Landfills
- xiv Contaminated Sediment Areas
- xv Wildlife / Pet Areas

The D in the tables indicates that the given action will directly address the associated source / stressor / critical area. Those that are indicated with a D are likely to provide for quantifiable pollutant load reductions for certain of the sources / stressors / critical areas. The I in the tables indicates that the given action will indirectly address the associated source / stressor / critical area. These actions are of the nature such that developing pollutant load reductions for them will be difficult. The M in the tables indicates that the given monitoring action will be applicable to the given source / stressor / critical area.

Figure H.1-1. Relationship of actions to sources.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1-1																
1-2																
1-3																
1-4	D	D	I	D	D	D	I	I	D	D	I	D	D	I	I	
1-5																
1-6	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	
1-7	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
1-8																
2-1					I	I	I		I	I			I	I	I	
2-2	I	I	I	I	I	I	I	I	I	I		I	I	I		
2-3	I	I		I		I		I					I			
2-4	D	D	D	D	D	D	D	D	D	D	I	D	D	D	D	
2-5		I			I	I	I	I	I				I	I	I	
2-6					I	I							I	I	I	
2-7		I		I	I	I	I		I	I			I	I	I	
2-8	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	
3-1	I	I	I		I		I	I	I	I			I	I	I	
3-2	I	I	I	I	I		I	I	I	I			I	I	I	
3-3							I	I	I	I	I		I		I	
3-4				I	I	I	I	I	I			I	I	I	I	
3-5	I	I	I	I	I	I	I	I	I	I		I	I	I	I	
4-1											D					
4-2				D		D	D	D	D				D			
4-3					I	I	I	I				I				
4-4	I	I		D		I	I	I		D		I	I		I	
4-5							I	I					I		I	
4-6		I			I	I			I						I	
4-7									I							
4-8				D		D				I						
4-9							I	I	I				I			
4-10	I	I	I	I	I	D	I	I	I	I						
4-11				I	I	I	I			D						
4-12		I		I			I	I	I					I	I	
4-13	I	I	I	I		I	I	I	I	I	I		I			
4-14	I	I	I	I	I	I	I	I	I	I	I			I	I	
4-15						I			D				D			
4-19	I															
5-1							D		D				D			
5-2									D				D			
5-3							D	D	D				D			
5-4									D				D			
5-5	D	D	D	D	D		D						D			
5-6	D	D	D		D		D	D	D				D			
5-7									D				D	D		
5-8							D						D	D		
6-1				D		I	D	D				D	D		D	
6-2				D		I	D	D	D			D	D		D	
6-3				D		I	D	D	D			D	D		D	
6-4				D		I	D	D	D			D	D		D	
6-5				D		I	D	D	D			D	D		D	
7-1																
7-2							I	I	I			I	I		I	
7-3							I	I	I			I	I		I	
7-4							I	I	I			I	I		I	
8-1																
8-2							I	I					I			
8-3																
8-4																
8-5																
9-1							M	M	M						M	
9-2	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
9-3					M	M	M	M	M	M			M	M	M	
9-4	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
9-5																

Figure H.1-2. Relationship of actions to stressors.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
1-1															
1-2															
1-3															
1-4	D	D	D	D	D	D	D	D	D	D			D	D	D
1-5															
1-6	I	I	I	I	I	I	I	I	I	I	I			I	I
1-7	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
1-8															
2-1	I	I	I	I	I	I	I	I	I			I	I	I	
2-2	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
2-3	I	I	I	I	I	I	I	I	I	I				I	I
2-4	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
2-5	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
2-6					D			D	D		D	D	D		
2-7	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
2-8	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
3-1	I	I	I	I			I	I	I	I	I	I		I	
3-2	I	I	I	I			I	I	I	I	I	I		I	
3-3	I	I	I	I	I		I	I	I	I	I	I	I	I	
3-4	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
3-5	I	I	I	I	I	I	I	I	I	I	I			I	I
4-1		I	I	I											
4-2	I	I	I	I	I	I	I	I	I	I	I	I		I	
4-3	I	I	I	I	I	I	I	I	I	I	I				
4-4	I	I	I	I	I	I	I	I	I	I	I			I	I
4-5	I	I	I	I	I		I	I	I	I	I	I	I		
4-6	I	I	I	I	I	I	I	I	I					I	I
4-7	I				I									I	
4-8	I	I	I	I	I	I	I	I	I	I	I	I		I	I
4-9	I				I	I	I	I	I	I	I	I	I	I	
4-10	I				I	I	I	I	I	I	I			I	
4-11	I				I	I	I	I						I	
4-12									I			I		I	
4-13	I	I	I	I	I	I	I	I				I		I	I
4-14		I	I	I		I	I							I	I
4-15	I	I	I	I	I	I	I	I		I	I			I	
4-16		I	I	I			I						I	I	I
5-1	D							D				I			
5-2	D							D				I			
5-3	D							D				I			
5-4	D							D				I			
5-5	D							D				I			
5-6	D							D				I			
5-7	D							D				I			
5-8	D							D				I			
6-1	D	D	D	D	D	D	D	D	D	D	D	I		I	
6-2	D	D	D	D	D	D	D	D	D	D	D	I		I	
6-3	D	D	D	D	D	D	D	D	D	D	D	I		I	
6-4	D	D	D	D	D	D	D	D	D	D	D	I		I	
6-5	D	D	D	D	D	D	D	D	D	D	D	I		I	
7-1															
7-2	I	I	I	I	I	I	I	I		I	I	I	I		
7-3	I	I	I	I	I	I	I	I		I	I	I	I		
7-4	D	D	D	D	D	D	D	D	D	D	D	D	D	D	
8-1												I			
8-2															
8-3															
8-4															
8-5															
9-1	M				M	M	M	M		M	M			M	
9-2	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
9-3															
9-4	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
9-5															

Figure H.1-3. Relationship of actions to critical areas.

Action	i	i-1	i-2	i-3	i-4	i-5	i-6	ii	iii	iv	v	vi	vii	vii-1	viii	ix	x	xii	xiii	xiv	xv
1-1																					
1-2																					
1-3																					
1-4	D	D	D	D	D		D	D	D	D	D	D	D	D	D	D	D	D			D
1-5																					
1-6																					
1-7																					
1-8																					
2-1	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
2-2	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
2-3	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
2-4	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
2-5	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
2-6	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
2-7	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
2-8	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
3-1	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I					I
3-2	D	D	D	D	D	I	D	D	D	D	D	D	D	D	D	D		D			D
3-3	I								D	D	I	I	D	D	D						D
3-4	D	D	D	D	D		D	D	D	D	D	D	D	D	D		D				D
3-5					D		D		D				D	D	D		D	D			I
4-1											D	D	I	I	I				D	D	I
4-2									D	D	D	D	D	D	D						D
4-3	D	D	D	D	D		D		I	I	D	D		I	D						I
4-4	D	D			D		D		I	I	I	I	I	I	I						I
4-5					D		D		D		I	I	D	D	D		I				I
4-6			D		D		D	D	D								D				I
4-7	D				D	D			D	D	D	D	I	I	I	I					D
4-8									I		D	D	I	I	I			D			I
4-9	D	D	D			D	D		I	I	D	D	I	I	I	I		I			I
4-10			D	D	D	D	D		I		D	D		I	I						I
4-11									I	I			I	I	I	I		D			I
4-12			D		D		D	D	D								D				I
4-13	I	I	I		I		D	D	I	I	D	D	I	I	I				D	D	I
4-14	D	D	I	D	D	D	D	D	I	I	D	D	D	D	D	D	D	D	D	D	D
4-15									I				I	I	I	D					I
4-16			I				I		I	I	I	I	I	I	I						I
5-1			I					D	I	D	I	I	D	I	I						I
5-2			D				D		D	D	I	I	D	I	I						I
5-3	D	D	D	I			D		I	D	I	I	I	I	I	I					I
5-4	D		D		D	D		D	D	D	I	I	I	I	I	D	D				I
5-5	D		D	D	D		D		D	I	I	I	I	I	I						I
5-6	D	D	D	D	D		D		I	I	I	I	I	I	I		D				I
5-7			D							D			I	I	I	D					I
5-8								D	I	D	I	I	I	I	I						I
6-1	D	D	I	I	D	I	D		I		I	I	I	I	I		D				I
6-2	D	D	I	I	D	I	D		I		I	I	I	I	I		D				I
6-3	D	D	I	I	D	I	D		I		I	I	I	I	I		D				I
6-4			D	D	D	D	D		D	D	I	I	I	I	I						I
6-5	D	D	I	I	D	I	D		I		I	I	I	I	I						I
7-1			I	I							I	I	D	D	D						D
7-2			I	I							I	I	D	D	D						D
7-3			I	I							I	I	D	D	D						D
7-4			I	I							I	I	D	D	D						D
8-1			I	I					I				I	I	I						I
8-2			I	I					D		I	I	D	D	D						D
8-3			I	I					D				I	I	I						I
8-4			I	I					D				I	I	I						I
8-5			I	I					D				I	I	I						I
9-1																					
9-2	M			M			M	M	M	M	M	M	M	M	M			M	M	M	M
9-3																					
9-4	M		M	M		M	M	M	M	M	M	M	M	M	M			M			M
9-5																					

Table H.1-4. Numerical cross-reference financial and technical assistance information..

Organization	Program #	Program	Federal Catalog #	Financial Assistance	Technical Assistance
USDA	1	Conservation Reserve Program	10.069	X	
USDA	2	Cooperative Extension Service	10.500	X	
NRCS, USDA	3	Soil and Water Conservation	10.902		X
NRCS, USDA	4	Watershed Protection and Flood Prevention	10.904	X	X
NRCS, USDA	5	Plant Materials Conservation	10.905		X
NRCS, USDA	6	Watershed Surveys and Planning	10.906		X
NRCS, USDA	7	Farmland Protection Program	10.913	X	
NRCS, USDA	8	Wildlife Habitat Incentive Program	10.914	X	
USDA	9	Scientific Cooperation and Research	10.961	X	
NRCS, USDA	10	Resource Conservation and Development	10.901		X
NRCS, USDA	11	Water Bank Program	10.062	X	
NRCS, USDA	12	Wetlands Reserve Program	10.072	X	
USDA	13	Water and Waste Disposal Systems for Rural Communities	10.760	X	
USDA	14	Technical Assistance and Training Grants	10.761	X	
USDA	15	Solid Waste Management Grants	10.762	X	
USDA	16	Water and Waste Disposal Loans	10.770	X	
NRCS, USDA	17	Watershed Rehabilitation Program	10.916	X	X
NRCS, USDA	18	Agricultural Management Assistance	10.917	X	
NOAA	1	Interjurisdictional Fisheries Act of 1986	11.407	X	
NOAA	2	Coastal Zone Management Administration Awards	11.419	X	
NOAA	3	Unallied Management Projects	11.454	X	
NOAA	4	Cooperative Science and Education Program	11.455	X	
NOAA	5	Habitat Conservation	11.463	X	
NOAA	6	Coastal Services Center	11.473	X	
NOAA	7	Anadromous Fish Conservation Act	11.405	X	
NOAA	8	Unallied Science Program*	11.472	X	
NOAA	9	Hydrologic Research*	11.462	X	
NOAA	10	Environmental Sciences, Applications, Data, and Education*	11.440	X	
NOAA	11	Marine Sanctuary Program*	11.429	X	
NOAA	12	Office of Oceanic and Atmospheric Research (OAR) Joint and Cooperative Institutes*	11.432	X	
USACE	1	Aquatic Plant Control	12.100		X
USACE	2	Planning Assistance to States	12.110		X
USACE	3	Remedial Action Plan Program		X	
USACE	4	Emergency Rehabilitation of Flood Control Works or Federally Authorized Coastal Protection Works	12.102		X
USACE	5	Emergency Operations Flood Response and Post Flood Response	12.103	X	X
USACE	6	Beach Erosion Control Projects	12.101	X	X
USFWS	1	Sport Fish Restoration	15.605	X	
USFWS	2	Coastal Wetlands Planning, Protection and Restoration Act	15.614	X	
USFWS	3	North American Wetlands Conservation Fund	15.623	X	
USFWS	4	Coastal Program	15.630	X	
USFWS	5	Partners for Fish and Wildlife	15.631	X	
USGS	6	Assistance to State Water Resources Research Institutes	15.805	X	
USGS	7	U.S. Geological Survey Research and Data Acquisition	15.808	X	
USGS	8	Outdoor Recreation Acquisition, Development Planning	15.916	X	
USFWS	9	Conservation Grants Private Stewardship for Imperiled Species	15.632	X	
USFWS	10	Landowner Incentive	15.633	X	
USFWS	11	Challenge Cost Share	15.642	X	
USGS	12	Rivers, Trails and Conservation Assistance	15.921	X	X
USFWS	13	Wildlife Restoration	15.611	X	
NPS	14	Historic Preservation Fund Grants-In-Aid*	15.904	X	
NPS	15	National Natural Landmarks Program*	15.910		X
NPS	16	National Historic Landmark*	15.912		X
FHA, USDOT	1	Recreational Trails Program	20.219	X	
USEPA	1	Surveys, Studies, Investigations, Demonstrations and Special Purpose Activities Relating to the Clean Air Act	66.034	X	
USEPA	2	Compliance Assistance Support Services to the Regulated Community and Other Assistance	66.305	X	
USEPA	3	Water Pollution Control State and Interstate Program	66.419	X	
USEPA	4	Surveys, Studies, Demonstrations, and Special Purpose Section 1442 of the Safe Drinking Water Act	66.424	X	
USEPA	5	State Public Water System Supervision	66.432	X	
USEPA	6	Surveys, Studies, Investigations, Demonstrations and Training Grants and Cooperative	66.436	X	
USEPA	7	Targeted Watershed Initiative	66.439	X	
USEPA	8	Water Quality Management Planning	66.454	X	
USEPA	9	Nonpoint Source Implementation Grants	66.460	X	
USEPA	10	Wetland Program Development Grant	66.461	X	

Table H.1-4. Numerical cross-reference financial and technical assistance information.. **(continued)**

Organization	Program #	Program	Federal Catalog #	Financial Assistance	Technical Assistance
USEPA	11	Water Quality Cooperative Agreements	66.463	X	
USEPA	12	Capitalization Grants for Drinking Water State Revolving Funds	66.468	X	
USEPA	13	Great Lakes Program	66.469	X	X
USEPA	14	Pesticide Environmental Stewardship Regional Grants	66.714	X	
USEPA	15	Water Protection Grants to the States	66.474	X	
USEPA	16	Water Security Training and Technical Assistance Grant Program	66.478	X	
USEPA	17	Science to Achieve Results (STAR) Program	66.509	X	
USEPA	18	Surveys, Studies, Investigations and Special Purpose Grants Within the Office of Research and Development	66.510	X	
USEPA	19	Office of Research and Development Consolidated Research	66.511	X	
USEPA	20	State Information Grants	66.608	X	
USEPA	21	Protection of Children and the Aging as a Fundamental Goal of Public Health and Environmental	66.609	X	
USEPA	22	Surveys, Studies, Investigations and Special Purpose Grants Within the Office of the Administrator	66.610	X	
USEPA	23	Pollution Prevention Grants Program	66.708	X	
USEPA	24	Capacity Building Grants and Cooperative Agreements for States and Tribes	66.709	X	
USEPA	25	Surveys, Studies, Investigations, Training Demonstrations and Educational Outreach	66.716	X	
USEPA	26	Source Reduction Assistance	66.717	X	
USEPA	27	Toxic Substances Compliance Monitoring Cooperative Agreements	66.701	X	
USEPA	28	International Financial Assistance Projects Sponsored by the Office of International Affairs	66.931	X	
USEPA	29	State Revolving Fund		X	
USEPA	30	The Pollution Prevention Information Network Competition (Pollution Prevention Resource Exchange)		X	
USEPA	31	The Source Reduction Grant Program Competition		X	
USEPA	32	The Pollution Prevention Grant Program		X	
USEPA	33	Solid Waste Management Assistance	66.808	X	
USEPA	34	Hazardous Waste Management State Program Support	66.801	X	
USEAP	35	Capitalization Grants for State Revolving Funds	66.458	X	
USEAP	36	Wastewater Operator Training Grant Program (Technical Assistance)	66.467	X	
USEPA	37	Environmental Protection Consolidated Research	66.500	X	
USEPA	38	Senior Environmental Employment Program	66.508	X	
USEPA	39	Environmental Protection Consolidated Grants Program Support	66.600	X	
USEPA	40	Environmental Justice Grants to Small Community Groups	66.604	X	
USEPA	41	Performance Partnership Grants	66.605	X	
USEPA	42	Surveys, Studies, Investigations and Special Purpose Grants	66.606	X	
USEPA	43	Environmental Policy and Innovation Grants	66.611	X	
USEPA	44	State Underground Water Source Protection	66.433	X	
USEPA	45	Environmental Education Grants*	66.951	X	
USEPA	46	Environmental Education and Training Program*	66.950	X	
USEPA	47	Construction Grants for Wastewater Treatment Works*	66.418	X	
USEPA	48	Beach Monitoring and Notification Program Implementation Grants*	66.472	X	
USEPA	49	Chemical Emergency Preparedness and Prevention (CEPP) Technical Assistance Grants*	66.810	X	
NIH, HSS	1	Biological Response to Environmental Health Hazards*	93.113	X	
ATSDR, HSS	2	Great Lakes Human Health Effects Research*	93.208	X	
MDEQ	1	Beach Act Funds		X	
MDEQ	2	Clean Water Act Section 319 Grant Program		X	
MDEQ	3	Clean Michigan Initiative Environmental Bond		X	
GLC	1	The Great Lakes Basin Program for Soil Erosion and Sediment Control Grant Program		X	

Appendix H.2: Relationships of Actions to Goals/ Objectives

Table 1: Relationship of actions (A) to goals (G) and objectives.

A \ G	I	I.A	I.B	I.C	I.E	I.F	II.A	II.B	II.C	II.D	II.B; VIB	III.A	III.B	III.C	IV	V	V.A	V.B	V.C	V.D	V.E	V.F	V.G.	V.H	VI.A	VI.B	VI.C	VI.D;VII.I	VII.A	VII.B	VII.C	VII.D	VII.E	VII.F	VII.G	VII.H	VII.I
3-1									X													X	X	X					X	X		X			X	X	X
3-2	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		X	X		X				
3-3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
3-4	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X			X		X	X	X	X	X	X	X	X	X		X	X	X		X		X
3-5	X	X	X	X		X				X	X	X	X	X	X	X			X		X	X	X	X	X	X	X	X			X		X	X			
4-1	X					X	X	X		X	X	X	X	X		X			X	X	X						X	X			X		X				
4-2	X	X	X	X	X	X	X			X	X	X	X	X	X	X			X	X	X				X	X	X				X		X	X			
4-3	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X)		X	X	X				X	X	X		X		X	X	X	X	X		X
4-4	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X			X	X	X				X	X	X	X	X		X	X	X	X	X		X
4-5	X	X	X	X		X	X	X			X	X	X	X	X	X			X	X	X	X	X	X	X	X	X		X		X	X	X	X	X		X
4-6	X	X	X	X	X	X					X	X	X	X	X	X			X	X	X				X	X		X			X		X	X			
4-7					X																													X			
4-8	X	X	X	X	X	X						X	X	X	X	X	X		X	X	X				X	X	X				X		X	X			
4-9	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X		X	X	X	X	X	X	X	X	X		X		X	X	X	X	X		X
4-10	X	X	X	X	X	X					X	X	X	X	X	X	X		X	X	X				X	X	X	X			X		X	X			
4-11	X	X	X	X	X	X					X	X	X	X	X	X			X	X	X				X	X					X		X	X			
4-12										X																								X			
4-13	X	X	X	X		X					X	X	X	X	X	X			X	X	X				X	X		X			X		X	X			
4-14					X																													X			
4-15	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X		X	X	X	X	X	X	X	X					X		X	X			
4-16	X	X			X	X						X	X	X	X	X			X	X	X				X	X					X		X	X			
5-1	X	X	X	X	X				X	X		X		X	X	X				X	X	X	X	X			X		X	X	X	X			X		X
5-2	X	X	X	X	X				X	X		X		X	X	X	X			X	X	X	X	X			X		X	X	X	X			X		X
5-3	X	X	X	X	X							X		X	X	X	X			X	X						X		X	X	X	X	X		X		X
5-4	X	X	X	X	X							X		X	X	X	X			X	X				X	X	X		X	X	X	X			X		X
5-5	X	X	X	X	X	X						X		X	X	X				X	X	X	X	X	X	X	X		X		X	X	X		X		X
5-6	X	X	X	X	X	X						X		X	X	X				X	X	X	X	X	X	X	X				X						
5-7	X	X	X	X	X	X			X	X		X		X	X	X				X	X	X	X	X	X	X	X				X						
5-8	X	X	X	X	X	X	X		X			X		X	X	X				X	X				X	X	X				X						
6-1	X)	X	X	X	X	X	X	X			X	X	X	X	X	X	X		X	X	X				X	X	X)		X	X	X	X		X	X		X
6-2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X		X	X	X	X		X	X		X
6-3	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X		X	X	X	X		X	X		X
6-4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X		X	X	X	X		X	X		X
6-5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X				X	X	X		X	X	X	X		X	X		X
7-1																																					
7-2	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X		X	X	X	X	X	X		X	X	X	X	X	X	X
7-3	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X		X	X	X	X	X	X		X	X	X	X	X	X	X
7-4	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X		X	X	X	X	X	X		X	X	X	X	X	X	X
8-1																																					
8-3																																					
8-4	X				X		X		X	X		X		X		X				X	X		X				X	X			X		X				

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Appendix H.3: Load Reductions as a Result of Actions

Table H.3-1: Actions leading to measurable stressor load reductions.

Action Number	**Action** (Table notes: NQ = non-quantifiable; A/NR = applicable but no reduction; P&M = planning and maintenance; 1 – where agriculture or septic systems are not significantly present, the load reductions attributed to these actions should be distributed evenly throughout the remaining actions)	Prevent Future Loads? (Yes/No)	Reduce Current Loads? Quantifiable? (Yes/No)	Total Suspended Solids - Sediment	Nutrients – Phosphorus	Nutrients – Nitrogen (nitrate)	Pathogens – *E. coli*	Hydraulic / Hydrologic Characteristics – as flashiness (R-B Index) with imperviousness as a surrogate measure
1-4	Regulatory Enforcement and Technical Assistance	Y	Y/Y	As other	As other	As other	As other	
1-6	Total Maximum Daily Loads	Y	Y/N	NQ	NQ	NQ	NQ	NQ
1-7	Identify Impacts, Stressors, Sources, and Causes	Y	Y/N	NQ	NQ	NQ	NQ	NQ
2-1	Public Education – General Public	Y	Y/N	NQ	NQ	NQ	NQ	
2-2	Public Education – Business and Agriculture	Y	Y/N	NQ	NQ	NQ	NQ	NQ
2-3	Public Education – Municipal Employees	Y	Y/N	NQ	NQ	NQ	NQ	
2-4	Demonstration Projects	Y	Y/Y	As other	As other	As other	As other	As other
2-5	Signage	Y	Y/N	NQ	NQ	NQ	NQ	NQ
2-6	Public Involvement	Y	Y/Y	As other				As other
2-7	Community Forums and Stakeholder Workshops	Y	Y/N	NQ	NQ	NQ	NQ	NQ
2-8	Municipal Official's Presentations	Y	Y/N	NQ	NQ	NQ	NQ	NQ
3-1	Update / Develop Master Plans	Y	N/N	NQ	NQ	NQ	NQ	NQ
3-2	Managing Development Patterns	Y	N/N	NQ	NQ	NQ	NQ	NQ
3-3	Preserve Natural Areas / Features	Y	N/N	NQ	NQ	NQ	NQ	NQ
3-4	Stormwater Management Standards	Y	N/N	As other	As other	As other	As other	As other
3-5	Pollution Prevention Ordinances / Programs	Y	Y/Y	As other	As other	As other	As other	As other
4-1	Address Atmospheric Contaminants	Y	Y/Y		As other	As other		
4-3	Storm Sewer System Maintenance and Operations	Y	Y/Y	3%	3%	2%	2%	3%
4-4	Minimizing Pollution from Roads and Lots	Y	Y/Y	3%	3%	2%	2%	3%
4-5	Minimizing Pollution from Municipal Facilities	Y	Y/Y	2%	2%	2%	2%	2%
4-6	Turf Management Practices	Y	Y/Y	2%	5%	4%		4%
4-7	Waste Management	Y	Y/Y	2%	2%	2%	2%	
4-8	Animal Waste Control	Y	Y/Y		1%	1%	4%	
4-9	Sanitary and Combined Sewer System P & M	Y	Y/Y	5%	5%	5%	8%	4%
4-10	Flood Control Projects	Y	Y/Y	1%	1%	1%	2%	4%
4-11	Illicit Discharge Elimination	Y	Y/Y	2%	5%	4%	9%	2%
4-12	Septic On-site Disposal System Practices	Y	Y/Y	3%	6%	6%	18%	
4-13	Trash / Debris Reduction	Y	Y/Y				2%	
4-14	Spill Prevention / Notification / Response	Y	Y/N	NQ	NQ	NQ	NQ	
4-15	Marine Industry Activities	Y	Y/Y	1%	2%	2%	4%	
4-16	Groundwater / Drinking Water Protection	Y	Y/N				1%	
4-17	Other Point Sources	Y	Y/Y	3%	3%	3%	3%	1%
4-18	Agriculture Action (GAAMPS)	Y	Y/Y	As 5-7	16%	22%	12%	9%
4-19	Emerging Issues	Y	Y/N				NQ	
5-1	Upland Bare Soil Repair	Y	Y/Y	5%	4%	2%		
5-2	Streambank Shoreline / Stabilization	Y	Y/Y	5%				
5-3	Road and Ditch Stabilization	Y	Y/Y	5%				
5-4	Streambank Use Exclusion	Y	Y/Y	5%				
5-5	Specific Site Control	Y	Y/Y	1%				
5-6	Structural Controls	Y	Y/Y	1%				
5-7	Agricultural BMPs	Y	Y/Y	14%	7%	16%		
5-8	Construction Sites	Y	Y/Y	6%	As 5-1…6	As 5-1…6		
6-1	Mitigate Existing Impervious Surfaces	Y	Y/Y	4%	4%	4%	4%	18%
6-2	Infiltration Techniques	Y	Y/Y	4%	4%	3%	3%	14%
6-3	Filtration Techniques	Y	Y/Y	4%	4%	3%	3%	4%
6-4	Vegetative Buffers and Natural Conveyance	Y	Y/Y	4%	4%	3%	4%	9%
6-5	Retention and Detention	Y	Y/Y	4%	4%	3%	5%	9%
7-2	Natural Land Reserves	Y	N/N	NQ	NQ	NQ		NQ
7-3	Natural Feature Protection	Y	N/N	NQ	NQ	NQ		NQ
7-4	Nature Feature Restoration	Y	Y/Y	6%	5%	5%	5%	9%
9-1	Phase II Reporting: SWPPIs and Reports	Y	N/N	A/NR	A/NR	A/NR	A/NR	A/NR
9-2	Stressor Monitoring and Assessment	Y	N/N	A/NR	A/NR	A/NR	A/NR	A/NR
9-4	Field Data Collection	Y	N/N	A/NR	A/NR	A/NR	A/NR	A/NR
	Total for Non-Quantifiable (NQ) Load Reductions			5%	5%	5%	5%	5%

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Appendix H.4: Sites for Preservation and/or Improvements

Table H.4-1: Sites for preservation and/or improvements.

Catchment	Site_ID	Land_Use	Ownership	Problem	Recommend	Westing/X	Northing/Y	EndPointX	EndPointY	Est. Length_ft
601	601-A	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°54'10.762"W	42°54'5.644"N	82°53'34.448"W	42°53'41.628"N	4000
601	601-B	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°54'0.663"W	42°53'48.792"N	82°53'49.383"W	42°53'49.147"N	870
601	601-C	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°53'34.448"W	42°53'41.628"N	82°53'34.466"W	42°53'34.847"N	670
601	601-D	Agricultural - Row Crop	Private	Degraded Buffer	Restore Existing Buffer	82°53'34.466"W	42°53'34.847"N	82°53'29.532"W	42°53'24.527"N	1250
601	601-E	Residential - Rural	Private	Lack of Buffer	Education / Manage Turf grass / Establish Buffe	82°52'59.159"W	42°53'8.61"N	82°52'52.726"W	42°53'11.27"N	550
601	601-F	Transportation - Road	Public	Degraded Road-Stream Crossing	Upgrade R-S Crossing to Address Issues	82°52'52.726"W	42°53'11.27"N	82°52'51.883"W	42°53'11.403"N	60
601	601-G	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°52'26.653"W	42°53'33.99"N	82°52'47.301"W	42°53'13.67"N	0
601	601-H	Residential - Rural	Private	Lack of Buffer	Education / Establish Buffer	82°54'38.247"W	42°53'10.073"N	82°54'38.067"W	42°53'5.521"N	460
601	601-I	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°53'30.607"W	42°52'40.359"N	82°53'20.014"W	42°52'43.884"N	1000
601	601-J	Agricultural - Row Crop	Private	Degraded Buffer	Restore Existing Buffer	82°53'3.55"W	42°52'50.401"N	82°52'58.728"W	42°52'31.135"N	2290
601	601-K	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°52'27.674"W	42°52'27.427"N	82°52'53.993"W	42°52'23.045"N	2280
601	601-L	Agricultural - Row Crop	Private	Degraded Buffer	Restore Existing Buffer	82°52'57.089"W	42°52'21.496"N	82°53'7.736"W	42°52'8.835"N	1520
601	601-M	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°53'51.643"W	42°52'16.758"N	82°53'20.528"W	42°52'5.206"N	2720
601	601-N	Transportation - Road	Public	Drainage Ditch Bank Erosion	Reinforce Banks at Discharge Location	82°53'4.417"W	42°51'26.391"N	82°53'4.722"W	42°51'25.972"N	50
601	9A-b	Agricultural	Private	Insufficient Buffer	Expand Existing Buffer	753276.795907	263384.259717			
601	9A-1	Agricultural	Public	Degraded Road-Stream Crossing	Upgrade R-S Crossing to Address Issues	753276.795907	263384.259717			
601	9A-4	Agricultural	Public	Degraded Road-Stream Crossing	Upgrade R-S Crossing to Address Issues	753276.795907	263384.259717			
601	32-1	Agricultural	Private	Insufficient Buffer	Education - Homeowner - Bank reforestation	753732.291579	265544.996127			
601	32-1	Agricultural	Public	Lack of Flow	Restore Flow	753732.291579	265544.996127			
602	602-A	Residential - Rural	Private	Storm Drain Connected	Protection - Zoning Ordinance, Site Plan	82°53'40.274"W	42°50'47.913"N	82°53'4.767"W	42°50'1.071"N	6760
602	602-B	Residential - Rural	Private	Storm Drain Connected	Protection - Zoning Ordinance, Site Plan	82°53'5.837"W	42°50'43.249"N	82°53'14.794"W	42°50'41.303"N	775
602	602-C	Residential - Rural	Private	Storm Drain Connected	Protection - Zoning Ordinance, Site Plan	82°53'39.687"W	42°50'33.836"N	82°53'15.744"W	42°50'21.042"N	2600
602	602-D	Transportation	Public	Degraded Road-Stream Crossing	Upgrade Road-Stream Crossing	82°51'37.789"W	42°47'37.42"N	82°51'32.611"W	42°47'37.104"N	390
603	603-A	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°51'31.634"W	42°52'11.898"N	82°51'47.525"W	42°51'50.315"N	2500
603	603-B	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100" Buffer	82°50'50.524"W	42°51'57.581"N	82°51'9.01"W	42°51'32.357"N	3260
603	603-C	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100" Buffer	82°50'8.487"W	42°51'47.39"N	82°51'6.642"W	42°51'10.534"N	5940
603	603-D	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°50'16.454"W	42°51'16.392"N	82°50'31.563"W	42°50'49.041"N	5300
603	603-E	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°49'58.169"W	42°51'18.978"N	82°50'17.987"W	42°50'48.928"N	3700
603	603-F	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°49'43.257"W	42°51'0.43"N	82°50'31.692"W	42°50'48.867"N	4245
603	603-G	Agricultural - Row Crop	Private	Insufficient Buffer	Expand Existing Buffer	82°50'31.692"W	42°50'48.867"N	82°49'41.609"W	42°50'30.645"N	14000
603	603-H	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°47'6.357"W	42°49'37.169"N	82°47'40.966"W	42°49'24.439"N	3920
603	603-I	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°47'32.363"W	42°49'56.921"N	82°48'15.698"W	42°49'35.257"N	4830
603	603-K	Agricultural - Row Crop	Private	Insufficient Buffer	Expand/Establish Buffer	82°49'37.347"W	42°51'47.406"N	82°49'20.928"W	42°50'12.201"N	15300
603	603-J	Agricultural - Row Crop	Private	Insufficient Buffer	Expand Existing Buffer	82°47'35.295"W	42°50'9.828"N	82°48'32.483"W	42°49'47.559"N	5500
603	603-L	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°50'3.56"W	42°50'6.42"N	82°50'14.796"W	42°49'16.81"N	6000
603	603-M	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°49'14.792"W	42°49'1.833"N	82°50'48.486"W	42°49'0.473"N	7960
603	603-N	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°51'44.533"W	42°49'24.137"N	82°51'11.758"W	42°48'55.073"N	5000
603	13-1	Mixed Woodland & Wetlar	Private	Degraded Bank	Education - Homeowner - Bank Stabilization	757225.679771	255482.169749			
603	13-2	Mixed Woodland & Wetlar	Private	Degraded Bank	Education - Homeowner - Bank Stabilization	757225.679771	255482.169749			
603	13-3	Mixed Woodland & Wetlar	Private	Degraded Bank	Education - Homeowner - Bank Stabilization	757225.679771	255482.169749			
603	13-5	Mixed Woodland & Wetlar	Private	Adjacent to Turf Grass	Education - Homeowner - Natural Regeneration	757225.679771	255482.169749			
603	13-17	Mixed Woodland & Wetlar	Private	Adjacent to Turf Grass	Education - Homeowner - Natural Regeneration	757225.679771	255482.169749			
603	13-19	Mixed Woodland & Wetlar	Private	Degraded Bank	Education - Homeowner - Bank Stabilization	757225.679771	255482.169749			
604		Agricultural - Row Crop	Private	Insufficient Buffer	Establishe 100' Buffer	Generally thru out catchment				
604	604-B	Agricultural - Row Crop	Private	Degraded Buffer	Restore/Expand Buffer	82°48'17.129"W	42°48'52.086"N	82°48'0.555"W	42°48'50.361"N	5300
604	604-A	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°49'49.212"W	42°46'1.02"N	82°50'12.863"W	42°45'35.786"N	4000
604	40A-1	Agricultural	Private	Lack of Buffer	Establish 100' Buffer	757923.930450	254755.074538			
604	40A-2	Agricultural	Public	Stream Repair	Remove fish barrier	757923.930450	254755.074538			
607	607-A	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°55'23.916"W	42°53'23.859"N	82°55'22.399"W	42°52'29.892"N	5785
607	607-B	Agricultural - Row Crop	Private	Insufficient Buffer	Expand Existing Buffer	82°54'36.087"W	42°52'17.27"N	82°54'45.883"W	42°51'39.406"N	4725

Table H.4-1: Sites for preservation and/or improvements. (continued)

Catchment	Site_ID	Land_Use	Ownership	Problem	Recommend	Westing/X	Northing/Y	EndPointX	EndPointY	Est. Length_ft
607	607-C	Agricultural - Row Crop	Private	Insufficient Buffer	Expand Existing Buffer	82°56'33.038"W	42°51'59.38"N	82°55'35.134"W	42°50'55.1"N	9700
607	607-D	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°55'3.256"W	42°51'35.44"N	82°55'19.924"W	42°51'8.461"N	3100
607	607-E	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°56'22.366"W	42°50'57.174"N	82°56'47.759"W	42°50'31.792"N	4700
607	607-F	Agricultural - Row Crop	Private	Insufficient Buffer	Establish 100' Buffer	82°56'48.145"W	42°50'17.803"N	82°56'59.919"W	42°49'5.728"N	9400
607	607-G	Agricultural - Row Crops	Private	Insufficient Buffer	Expand Existing Buffer	82°55'5.806"W	42°49'26.809"N	82°55'39.933"W	42°49'0.196"N	3900
607	607-H	Agricultural - Row Crops	Private	Insufficient Buffer	Expand Existing Buffer	82°52'55.4"W	42°48'36.508"N	82°52'55.723"W	42°47'44.361"N	5700
607	607-I	Agricultural - Row Crops	Private	Insufficient Buffer	Expand Existing Buffer	82°55'54.187"W	42°47'19.162"N	82°55'20.837"W	42°47'2.772"N	4000
607	607-J	Agricultural _ Row Crops	Private	Insufficient Buffer	Expand/fill-in Existing Buffer	82°55'6.554"W	42°46'42.341"N	82°54'11.78"W	42°46'3.384"N	7900
607	607-K	Residential - Rural and Ag	Private	Storm Drain Connected	Disconnect paths to drain/ Establish Buffer	82°52'55.956"W	42°46'2.081"N	82°52'47.026"W	42°45'18.676"N	4900
607	14-1	Mixed Agriculture	Private	Incised Drain	Restore Drain	751098.280693	264957.392507			
607	14-1	Mixied Agriculture	Public	Incised Drain	Education - Homeowner - Natural Regeneration	751098.280693	264957.392507			
607	16A-4	Woodland & Wetland	Private	Other - Degraded Bank	Education - Homeowner - Bank Stabilization	752488.819172	252756.688694			
607	16A-7	Woodland & Wetland	Private	Insufficient Buffer	Education - Homeowner - Natural Regeneration	752488.819172	252756.688694			
607	16A-9	Woodland & Wetland	Public	Degraded Road-Stream Crossing	Remove Bridge - 42851 Little Road	752488.819172	252756.688694			
607	17-5	Woodland & Wetland	Private	Degraded Bank	Education - Homeowner - Bank Stabilization	755322.143007	246096.974777			
607	17-9	Woodland & Wetland	Private	Insufficient Buffer	Education - Homeowner - Bank Stabilization	755322.143007	246096.974777			
607	17-10	Woodland & Wetland	Public	Degraded Road-Stream Crossing	Upgrade R-S Crossing to Address Issues	755322.143007	246096.974777			
607	17-13	Woodland & Wetland	Private	Degraded Bank	Education - Homeowner - Bank Stabilization	755322.143007	246096.974777			
607	17-14	Woodland & Wetland	Public	Insufficient Buffer	Expand Existing Buffer - At as Wildlife Barrier	755322.143007	246096.974777			
607	39A-2	Woodland & Wetland	Private	Other - Degraded Bank		754846.677447	253349.513420			
607	39A-20	Woodland & Wetland	Private	Adjacent to Turf Grass	Education - Homeowner - Natural Regeneration	754846.677447	253349.513420			
607	39A-21	Woodland & Wetland	Public	Stream Repair	Remove Pipe	754846.677447	253349.513420			
607	39A-23	Woodland & Wetland	Public	Stream Repair	Remove fish barrier - Dam	754846.677447	253349.513420			
607	39A-26	Woodland & Wetland	Private	Degraded Bank	Education - Homeowner - Bank Stabilization	754846.677447	253349.513420			
607	Orchard Trail	Mixed	Public/Private	Protection and Restoration Needed	Habitat Protection and Restoration	Canal Park	along Coon Creek	Orchard Trail		
607	Orchard Trail	Mixed	Mixed	Lack of Access	Provide access and trails for recreation	Canal Park	along Coon Creek	Orchard Trail		
608		Mixed Woodland & Wetlar	Priavte	Keystone nexus	Preserve buffer in entire catchment	Thru out catchment				
609	609-A	Golf Course	Private	Insufficient Buffer	Establish Buffer/Turf management	83°5'32.988"W	42°52'27.694"N	83°5'11.956"W	42°52'36.341"N	2100
609	609-B	Agriculture - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	83°3'47.862"W	42°52'54.299"N	83°4'3.367"W	42°53'23.218"N	3700
610	610-A	Agricultural - Row Crops	Private	Insufficient Buffer	Expand/fill-in Existing Buffer	82°58'13.359"W	42°52'50.255"N	82°58'48.866"W	42°51'17.968"N	10800
610	610-B	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	83°2'20.414"W	42°51'59.307"N	83°1'46.395"W	42°51'57.528"N	2870
610	610-C	Transportation	Public	Storm Drain Connected	Buffer edges to remove sediment	82°59'25.902"W	42°50'53.33"N	82°58'41.477"W	42°50'56.847"N	3200
610	610-D	Agriculture - Row Crop	Private	Insufficient Buffer	Expand/fill-in Existing Buffer	82°57'31.8"W	42°50'17.727"N	82°57'49.053"W	42°49'41.714"N	4500
610	610-E	Agricultural - Row crop	Private	Lack of Buffer	Establish 100' Buffer	82°58'2.29"W	42°49'28.189"N	82°58'34.253"W	42°49'12.317"N	3300
610	610-F	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°59'51.354"W	42°49'56.89"N	82°59'27.054"W	42°49'39.699"N	2500
610	610-G	Institution	Public?	Storm Drain Connected	Mitigate impervious surfaces	82°59'11.79"W	42°49'2.025"N	82°58'50.098"W	42°49'21.582"N	2700
610	6A-1	Residential	Private	Adjacent to Turf Grass	Education - Homeowner - Natural Regeneration	742699.299808	259379.091578			
610	6A-2	Residential	Private	Adjacent to Turf Grass	Education - Homeowner - Natural Regeneration	742699.299808	259379.091578			
610	6A-3	Residential	Private	Adjacent to Wetland	Education - Homeowner - Natural Regeneration	742699.299808	259379.091578			
610	6A-4	Residential	Private	Adjacent to Wetland	Education - Homeowner - Natural Regeneration	742699.299808	259379.091578			
610	6A-5	Residential	Public	Woody Debris	Remove Woody Debris	742699.299808	259379.091578			
610	6A-6	Residential	Public	Potential Illicit Discharge	Investigate Outfall	742699.299808	259379.091578			
611	611-A	Industrial	Private	Lack of Buffer	Vegetate area next to road and track	83°5'33.473"W	42°51'33.436"N	83°5'25.652"W	42°51'25.926"N	1000
611	611-B	Transportation	Private	Insufficient Buffer	Expand/Fill-in Existing Buffer	83°4'39.244"W	42°50'37.618"N	83°4'15.531"W	42°50'40.887"N	4700
611	611-C	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	83°4'44.615"W	42°49'45.686"N	83°4'16.33"W	42°49'28.85"N	2700
611	611-D	Agricultural - Row Crop	Private	Insufficient Buffer	Expand/Infill Existing Buffer Road/stream cros	83°2'35.199"W	42°49'37.727"N	83°2'15.388"W	42°49'25.761"N	2000
611	1	Woodland & Wetland (Pris	Public	Woody Debris	Remove Woody Debris	736145.055766	262099.816836			
612	612-A	Agricultural - Row Crop	Private	Insufficient Buffer	Expand/fill-in Existing Buffer	82°57'48.537"W	42°48'59.2"N	82°57'25.086"W	42°48'39.585"N	5400
612	612-B	Agricultural - Row Crop	Private	Degraded Buffer	Expand/fill-in Existing Buffer	82°58'34.95"W	42°49'10.867"N	82°58'20.81"W	42°48'18.782"N	6800
612	612-C	Agricultural - Row Crop	Private	Insufficient Buffer	Expand/Fill-in Existing Buffer	82°57'17.778"W	42°48'29.379"N	82°56'16.876"W	42°48'18.631"N	14400
612	612-D	Golf Course	Private	Insufficient Buffer	Establish Buffer/Turf Management	82°57'44.362"W	42°47'43.628"N	82°57'10.894"W	42°47'15.097"N	5350
612	612-E	Agricultural - Row Crop	Private	Insufficient Buffer	Expand/Fill-in Existing Buffer	82°58'14.093"W	42°47'24.056"N	82°58'12.949"W	42°46'56.495"N	2900
612	612-F	Agricultural - Row Crop	Private	Insufficient Buffer	Expand/Fill-in Existing Buffer	82°56'10.428"W	42°47'16.47"N	82°56'18.666"W	42°46'41.214"N	5120
612	612-G	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°59'3.974"W	42°46'47.28"N	82°58'4.061"W	42°46'45.137"N	5600
612	612-H	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°55'12.415"W	42°45'29.553"N	82°54'26.611"W	42°44'39.18"N	7000
612	612-I	Agricultural - Row Crop	Private	Insufficient Buffer	Expand/Fill-in Buffer	82°56'31.687"W	42°45'3.177"N	82°55'34.389"W	42°45'12.272"N	12400

Table H.4-1: Sites for preservation and/or improvements. (continued)

Catchment	Site_ID	Land_Use	Ownership	Problem	Recommend	Westing/X	Northing/Y	EndPointX	EndPointY	Est. Length_ft
612	34A-4	Urban	Public	Stream Repair	Erosion around outfall	746628.470398	255056.805895			
613	613-A	Golf Course	Private	Insufficient Buffer	Turf management	82°54'23.075"W	42°43'49.355"N	82°54'18.195"W	42°43'40.789"N	1000
613	613-B	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°55'2.608"W	42°43'41.896"N	82°54'35.769"W	42°43'34.797"N	2100
613	613-C	Golf Course	Private	Lack of Buffer	Establish buffer / Turf management	82°54'35.71"	42°43'34.796"N	82°54'17.768"W	42°43'34.177"N	1500
613	613-D	Residential	Private	Storm Drain Connected	Education	82°55'27.456"W	42°42'30.139"N	82°55'9.595"W	42°42'20.915"N	1900
613	613-E	Agricultural - Row Crop	Private	Insufficient Buffer	Expand/Fill-in Existing buffer	82°54'51.217"W	42°42'20.213"N	82°54'27.692"W	42°42'14.934"N	2300
613	613-F	Agricultural - Row Crop	Private	Insufficient Buffer	Expand/Fill-in Existing Buffer	82°54'33.751"W	42°41'55.872"N	82°53'56.442"W	42°41'45.644"N	5500
614	614-A	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°47'43.768"W	42°48'28.103"N	82°48'14.193"W	42°48'3.716"N	4275
614	614-B	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°48'9.874"W	42°48'29.311"N	82°48'14.193"W	42°48'3.716"N	3000
614	614-C	Agricultural - Row Crop	Private	Insufficient Buffer	Expand Existing Buffer	82°48'24.739"W	42°48'28.943"N	82°48'51.574"W	42°48'9.879"N	3600
614	614-D	Mining	Private	Storm Drain Connected	Ensure SWPPP exists/is enforced	82°47'26.987"W	42°48'30.381"N	82°47'27.895"W	42°48'4.769"N	2800
614	614-E	Agricultural - Row Crop	Private	Insufficient Buffer	Expand Existing Buffer	82°48'51.672"W	42°48'10.039"N	82°49'0.375"W	42°47'35.994"N	4000
614	614-F	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°47'40.696"W	42°48'3.008"N	82°47'51.665"W	42°47'51.285"N	1850
614	614-G	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°47'56.444"W	42°47'37.421"N	82°48'24.429"W	42°47'22.874"N	3000
614	614-H	Agricultural - Row Crop	Private	Insufficient Buffer	Expand Existing Buffer	82°47'51.665"W	42°47'51.285"N	82°48'55.931"W	42°47'14.557"N	2800
614	614-I	Agricultural - Row Crop	Private	Insufficient Buffer	Expand Existing Buffer	82°50'19.603"W	42°43'46.78"N	82°50'38.893"W	42°43'13.795"N	6600
614	38A-8	Woodland & Wetland	Public	Degraded Road-Stream Crossing	Repair Bridge	761613.004835	253536.754668			
615	615-A	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°56'41.807"W	42°44'39.885"N	82°56'37.133"W	42°44'21.997"N	1890
615	615-B	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°56'24.342"W	42°44'11.177"N	82°56'7.546"W	42°43'52.18"N	2950
615	615-C	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°55'42.871"W	42°43'49.691"N	82°55'57.706"W	42°43'26.475"N	3130
615	615-D	Agricultural - Row Crop	Private	Insufficient Buffer	Expand Existing Buffer	82°56'30.732"W	42°43'43.343"N	82°56'13.735"W	42°43'16.249"N	3690
615	615-E	Agricultural - Row Crop	Private	Insufficient Buffer	Expand Existing Buffer where needed	82°57'3.79"W	42°43'20.489"N	82°56'23.997"W	42°43'21.068"N	4060
615	615-F	Residential	Private	Lack of Buffer	Establish 100' Buffer	82°55'46.794"W	42°43'0.551"N	82°55'46.656"W	42°42'40.829"N	2150
615	612-G	Residential	Private	Enclosed Stream / Storm Sewer	Education	82°57'13.578"W	42°42'45.342"N	82°56'36.91"W	42°42'25.359"N	4000
615	615-H	Residential	Private	Lack of / Degraded Buffer	Establish 100' Buffer / Restore Existing Buffer	82°55'56.682"W	42°42'26.44"N	82°55'12.619"W	42°41'40.957"N	6250
615	615-I	Agricultural	Private	Lack of Buffer	Establish 100" Buffer	82°56'20.068"W	42°41'49.597"N	82°55'42.677"W	42°41'24.738"N	5130
615	615-J	Under Development	Private	Lack of Buffer	Establish 100' Buffer/ Education - Homeowner	82°56'14.684"W	42°41'34.043"N	82°56'1.346"W	42°41'23.625"N	1820
615	615-K	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°56'1.004"W	42°41'23.603"N	82°55'14.126"W	42°41'15.317"N	3900
615	615-L	Residential	Private	Storm Drain Connected	Education - Homeowner	82°54'29.565"W	42°40'43.298"N	82°53'52.711"W	42°40'18.119"N	4000
615	615-M	Transportation	Public	Lack of Buffer	Vegetate banks adjacent to culvert	82°52'46.611"W	42°41'18.401"N	82°52'46.947"W	42°41'16.45"N	200
615	615-N	Residential/Commercial	Private	Storm Drain Connected	Education - up stream	82°53'35.929"W	42°40'57.694"N	82°53'32.668"W	42°40'57.556"N	0
615	615-O	Agriculture	Private	Farm over drain	Implement GAAMPS	82°50'39.175"W	42°42'14.404"N	82°50'37.601"W	42°42'13.351"N	190
615	615-P	Transportation	Public	Degraded Road-Stream Crossing	Upgrade Road-Stream Crossing	82°50'37.61"W	42°42'13.338"N	82°50'37.571"W	42°42'12.739"N	65
615	615-Q	Agriculture - Row Crop	Private	Insufficient Buffer	Expand Existing Buffer	82°50'37.473"W	42°42'12.747"N	82°50'41.819"W	42°41'47.045"N	2750
615	615-R	Agriculture	Private	Lack of Buffer	Expand Existing Buffer	82°51'29.49"W	42°41'5.797"N	82°51'56.284"W	42°40'52.605"N	2620
615	615-S	Agriculture - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°51'54.001"W	42°41'5.496"N	82°51'51.059"W	42°40'59.272"N	700
615	615-T	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°52'27.318"W	42°40'58.092"N	82°52'20.413"W	42°40'45.527"N	1510
615	615-U	Agricultural - Row Crop	Private	Degraded Buffer	Expand/Restore Buffer	82°52'5.245"W	42°40'49.899"N	82°52'5.245"W	42°40'49.899"N	3500
615	615-V	Agricultural - Row Crop	Private	Lack of Buffer	Establish 100' Buffer	82°51'19.77"W	42°40'22.914"N	82°52'17.507"W	42°40'27.432"N	6970
615	615-W	Residential	Private	Storm Drain Connected	Education - Homeowner	82°51'32.273"W	42°40'19.852"N	82°51'48.534"W	42°40'9.592"N	1800
615	615-X	Golf Course	Private	Adjacent to Turf Grass	Education / Establish 100' Buffer	82°52'18.659"W	42°40'25.169"N	82°52'28.595"W	42°39'58.318"N	3000
615	615-Y	Golf Course	Private	Adjacent to Turf Grass	Education / Establish 100' Buffer	82°52'38.557"W	42°39'41.635"N	82°52'48.573"W	42°39'9.293"N	4000
615	615-Z	Residential	Private	Storm Drain Connected	Education - Homeowner	82°53'34.466"W	42°39'5.703"N	82°52'45.474"W	82°52'45.474"W	6475
615	615-AA	Residential	Private	Storm Drain Connected	Education - Homeowner	82°53'18.786"W	42°38'25.344"N	82°53'36.957"W	42°38'2.925"N	2660
615	615-BB	Residential	Private	Storm Drain Connected	Education - Homeowner	82°56'19.039"W	42°42'57.647"N	82°56'10.97"W	42°42'33.821"N	3100
615	20E-T9	Residential	Private	Degraded Bank	Education - Homeowner - Bank Stabilization	750471.271407	243910.059731			
615	20E-T18	Residential	Public	Stream Repair	Need to incise channel	750471.271407	243910.059731			
615	21-4-1	Residential	Private	Greenway Design	remove purple loosestrife	752121.356508	242117.092875			
615	21-4-2	Residential	Public	Stream Repair	Farm tile drains directly to stream	752121.356508	242117.092875			
615	21-4-6	Residential	Public	Degraded Road-Stream Crossing	Upgrade R-S Crossing to Address Issues	752121.356508	242117.092875			
615	21-4-7	Residential	Public	Greenway Design	Establish 100' Buffer	752121.356508	242117.092875			
615	21-4-9	Residential	Public	Stream Repair		752121.356508	242117.092875			
615	22A-1	Urban	Public	Stream Repair		754160.483255	240091.910812			
615	22A-3	Urban	Public	Stream Repair		754160.483255	240091.910812			
615	22A-4	Urban	Private	Degraded Bank	Bank Stabilization	754160.483255	240091.910812			
615	22A-6	Urban	Private	Degraded Bank	Bank Stabilization	754160.483255	240091.910812			

Table H.4-1: Sites for preservation and/or improvements. (continued)

Catchment	Site_ID	Land_Use	Ownership	Problem	Recommend	Westing/X	Northing/Y	EndPointX	EndPointY	Est. Length_ft
615	22A-10	Urban	Public	Stream Repair		754160.483255	240091.910812			
615	22A-14	Urban	Public	Invasives	Remove invasives	754160.483255	240091.910812			
615	22A-15	Urban	Public	Degraded Road-Stream Crossing	headwall repair	754160.483255	240091.910812			
615	22B-25	Urban	Public	Adjacent to Turf Grass	Education - Municipal/ Establish 100' Buffer	754160.483255	240091.910812			
615	22B-26	Golf Course	Private	Adjacent to Turf Grass	Education / Establish 100' Buffer	754160.483255	240091.910812			
615	23-7-3	Residential	Public	Degraded Road-Stream Crossing	Repair bridge	753680.355875	240627.518499			
615	23-7-9	Residential	Private	Degraded Buffer	Education Expand/Restore Buffer	753680.355875	240627.518499			
615	NBCR	Mixed	Mixed	Degraded Bank	Stream Bank Stabilization					
616	616-A	Institutional/Industrial	Unknown	Storm Drain Connected	Mitigate Impervious Surfaces	82°53'9.426"W	42°37'4.979"N	82°53'11.204"W	42°37'19.829"N	1900
616	616-B	Residential	Private	Storm Drain Connected	Expand Buffer/ Education - Owner	82°53'20.426"W	82°53'20.426"W	82°53'49.667"W	42°37'10.729"N	5150
	Allen-1	Playground	Public	Insufficient Buffer	Education - Municipal/ Establish 100' Buffer					
	Alm-1	Park	Public	Insufficient Buffer	Education - Municipal/ Establish 100' Buffer					
	Alm-6	Park	Public	Insufficient Buffer	Education - Municipal/ Establish 100' Buffer					
	Alm-10	School	Public	Insufficient Buffer	Education - Municipal/ Establish 100' Buffer					
	MS-9	Park	Private	Insufficient Buffer	Education - Municipal/ Establish 100' Buffer					
	R-2	Park	Public	Insufficient Buffer	Education - Municipal/ Establish 100' Buffer					
	McBride Drain		Public	Degrades Stream and Buffer	Habitat Restoration					
	Deer Creek Drain		Public	Degrades Stream and Buffer	Habitat Restoration					
	Hart Drain		Public	Degrades Stream and Buffer	Habitat Restoration					
	Jones Drain		Public	Degrades Stream and Buffer	Habitat Restoration					
	Conklin Drain		Public	Degrades Stream and Buffer	Habitat Restoration					
	Corey Drain		Public	Degrades Stream and Buffer	Habitat Restoration					
	Bowman Drain		Public	Degrades Stream and Buffer	Habitat Restoration					
	Nicolson Nature Ctr	Recreational	Public	Degraded Wetlands	Wetland Restoration					
	Entire Watershed		Mixed	Woody Debris	Remove Woody Debris					
	Nicolson Nature Ctr	Recreational	Public	Lack of Access	Provide blue water trail	Nicolson Nature Ctr		Clinton River		
	Entire Watershed		Mixed	Lack of fishing access	Provide 8 - 10 access points for fishing					
	Nicholson Conservation Hub		Mixed	Protection and Restoration Needed	Nicholson Nature Center Project: Addition of parcels to expand Nature Center and trail network and additional open space/easement acquisition to extend reach of conserved area from M-59 (Hall Road) to Canal Park to the south.					
	Nicholson Nature Center and Floodplain Con		Mixed	Protection and Restoration Needed	Key parcels in Conservation Hub					
	Nebel Farm		Mixed	Protection and Restoration Needed						
	Nicholson Acquisition		Mixed	Protection and Restoration Needed						
	Riparian Open Space Acquisitions		Mixed	Protection and Restoration Needed						
	Parcels along North Branch north of Hall Roa		Mixed	Protection and Restoration Needed	One parcel identified and under consideration for acquisition with MDEQ funding. Other parcels being researched.					
	Hall Road / Wolcott Mill Linkage		Mixed	Lack of Access						
	Wolcott Mill Conservation Hub		Mixed	Protection and Restoration Needed	Large complex of conserved parcels – goal to link additional conservation to Metropark or add to Metropark.					
	Wolcott Mill Metropark		Mixed	Protection and Restoration Needed						
	Wolcott Mill / Wetzel State Park Linkage		Mixed	Lack of Access	Macomb County project to expand trail network – Six Rivers partnership to acquire or obtain conservation easements					
	Wetzel State Park		Mixed	Lack of Access	Trail destination					
	Wolcott Mill / Boardman Road Linkage		Mixed	Lack of Access						
	Macomb Orchard Trail – North Branch Clinto		Mixed	Protection and Restoration Needed	Potential conservation easements bordering Macomb Orchard Trail					
	Coon Creek Linkage		Mixed	Protection and Restoration Needed						

Table H.4-1: Sites for preservation and/or improvements. (continued)

Catchment	Site_ID	Land_Use	Ownership	Problem	Recommend	Westing/X	Northing/Y	EndPointX	EndPointY	Est. Length_ft
	Consumers Energy Wetlands		Mixed	Protection and Restoration Needed	In communication with landowner. Currently not a candidate for conservation by Six Rivers – will stay in touch as conservation partner					
	East Pond Creek Conservation Hub		Mixed	Lack of Access	Conservation Corridor with parcel bordering on Mill Lake as the southern end and Lake George Nature Preserve to the northwest limit. Area under consideration for a federal bird conservation grant. Research on bird populations and habitats underway.					
	Mill Lake and Adjacent Properties		Mixed	Protection and Restoration Needed	Potential conservation easements					
	Lake Secord Properties		Mixed	Protection and Restoration Needed	Potential conservation easements					
	Lake George Nature Preserve		Mixed	Protection and Restoration Needed	Six Rivers preserve with MDEQ conservation easement					
	Lake George Adjacent Properties		Mixed	Protection and Restoration Needed	Acquisition targets – communication established					
	Watershed Preserve		Mixed	Protection and Restoration Needed	Addison Township Park					

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NORTH BRANCH CLINTON WATERSHED

OURS TO PROTECT