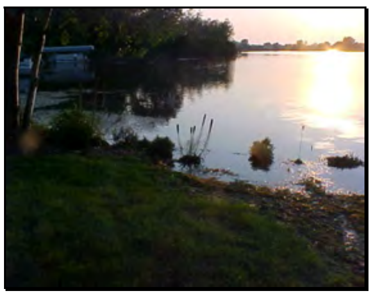
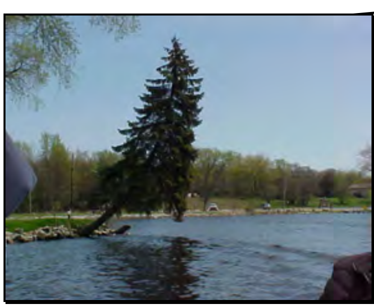
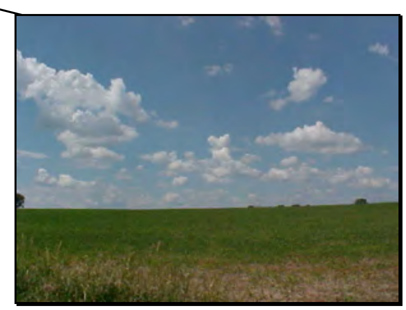
Hodunk-Messenger Chain of Lakes Watershed

WATERSHED MANAGEMENT PLAN







MDEQ # 2006 - 0127

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Section 319 Nonpoint Source Grant 2006-0127

Hodunk-Messenger Chain of Lakes Watershed Management Plan

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This report has been completed as part of the North Chain of Lakes Watershed Project through the Branch County Conservation District. This initiative is designed to reduce erosion and nutrient enrichment, educate the public about water quality issues, and promote sustainable land use in target areas of the Hodunk-Messenger Chain of Lakes Watershed. For more information, visit www.branchcd.org.

Cover Photos:

Top Left – Morrison Lake, facing west at sunset, after flood event in 2008
Top Right – Pair of Great egrets along south shore of Craig Lake, 2007
Bottom Left – Randall Lake shoreline, summer 2007
Bottom Right – Example of scenic vista prevalent in upper watershed, summer 2008

Partnering Organizations

This document was created in cooperation with the following groups:

Algansee Township
ASTI Environmental
Branch Area Careers Center
Batavia Township
Branch County Conservation District
Branch County Drain Commissioner/Department of Public Works
Branch County MSU Extension
Branch County Road Commission
Branch County Tourism Bureau
Branch County GIS
Branch-Hillsdale-St. Joseph Community Health Agency
Bronson Township
Butler Township
Calhoun Conservation District
City of Coldwater
CoCaseCo, LLC
Coldwater Board of Public Utilities
Coldwater Public Schools
Coldwater Township
The Daily Reporter
Fishbeck, Thompson, Carr and Huber, Inc.
Girard Township
Hodunk-Messenger Chain of Lakes Board
Michigan Department of Agriculture
Michigan Department of Environmental Quality – Water Bureau and Land and Water Management Div.
Michigan Department of Natural Resources – Fisheries Division
North Chain Lake Association
Ovid Township
Potawatomi Resource, Conservation & Development Council
Quincy Township
Southwestern Michigan Planning Commission
St. Joseph County Conservation District
Union Township
USDA – Farm Service Agency
USDA – Natural Resources Conservation Service
US Fish and Wildlife Service
Wal-Mart Distribution Center
Wal-Mart Transportation Center
WTVB AM

Executive Summary

This comprehensive Watershed Management Plan (WMP) for the Hodunk-Messenger Chain of Lakes Watershed is designed to improve, protect and enhance the stocks of surface water (liquid derived from precipitation) present in the Hodunk-Messenger Chain of Lakes Watershed in Branch County, Michigan. This WMP is the result of a Michigan Department of Environmental Quality (MDEQ) Watershed Planning Project, conducted between February 26, 2007 and July 31, 2009 by the Branch County Conservation District (BCCD). The watershed planning project was designed to serve as the necessary first step toward improvement of the Hodunk-Messenger Watershed. Once adopted and accepted by MDEQ and local stakeholders, this WMP can then be advanced to the next phase- implementation. During a watershed implementation project the recommended management activities in this WMP can be put into motion and applied to the landscape of the watershed.

This WMP details the conditions of the Hodunk-Messenger Chain of Lakes Watershed and the factors causing degradation of water quality within the watershed between the years of 2007 and 2009. A summary of project development efforts, research components and water quality data gathered during the project are included in this plan. Most importantly, this WMP presents a recommended course of action for reducing nonpoint source (NPS) pollutant loads and enhancing water quality in the watershed based on the information compiled during the planning phase. Recommended implementation activities are presented in the form of **best management practices**, or BMPs. Projected timelines, lead and partnering agencies, funding sources and the potential pollutant load reductions that could be achieved through the implementation of BMPs are also found within this document.

The Hodunk-Messenger Chain of Lakes WMP is meant to serve as a guidance document for the implementation of sound, reasonably-attainable but effective BMPs. Neither this WMP, nor the BCCD has the regulatory authority to enforce any of the recommendations found within. This plan is also intended to provide a framework for future science-based watershed management decisions for improving and enhancing the water quality in the Hodunk-Messenger Chain of Lakes Watershed.

Overall, development of the Hodunk-Messenger Chain of Lakes WMP was guided by the following drivers:

1.) To present measureable and attainable methods for reducing NPS pollutants to satisfy local and state regulatory requirements,
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
4.) Support drinking/source water protection,
5.) Prevent future watershed degradation.

In order for this WMP to qualify for MDEQ approval, it was required to satisfy the following Clean Michigan Initiative (CMI) components as defined by Rule 100.010 of Part 88 of PA 451, otherwise known as Michigan's Natural Resources and Environmental Protection Act of 1994:

- Geographic scope of watershed
- Detailed watershed description that includes land uses, predominant soil types, significant natural features and hydrology information
- Status of designated uses of the watershed

- A listing of desired uses in the watershed
- Methods used to inventory pollutant sources
- Critical area prioritization
- A statement of water quality improvement and protection goals
- Tasks that need to be completed in order to prevent or control critical sources pollution and causes of impairment
- Estimated implementation costs, by category
- A summary of public participation

In addition to meeting MDEQ requirements, this WMP was also required to include the following US Environmental Protection Agency (EPA) nine minimum elements of watershed management:

1.) Identification of causes and sources of impairments and threats to water bodies
2.) Estimated load reductions expected from proposed management measures
3.) Description of management measures needed to achieve proposed load reductions
4.) Estimated amount of technical, financial and regulatory assistance needed
5.) A public information, education and participation component
6.) A reasonably expeditious schedule for implementation
7.) Interim measurable milestones for implementing the management measures
8.) Criteria to determine whether or not load reductions are being achieved
9.) A monitoring component to evaluate the effectiveness of implementation

The Hodunk-Messenger Chain of Lakes Watershed Management Plan was developed by the Branch County Conservation District (BCCD) under a contractual agreement with MDEQ. All components of the watershed planning process were completed by BCCD, with the exception of the following components that were sub-contracted out to the following organizations:

1.) A Natural Resource Inventory and Land Use Policy Analysis of Coldwater Township, completed by McKenna Associates, Inc in partnership with Wightman Petrie
2.) *A watershed monitoring component,* completed by ASTI Environmental
3.) *A Landscape Level Wetlands Functional Assessment*[1], completed by MDEQ-Land and Water Management Division

As a result of the watershed planning project and all research components associated with it, it has been most notably determined that the Hodunk-Messenger Watershed is currently experiencing sediment loading at a rate of 5,203 tons per year, nitrogen loading at 296,963.7 pounds per year, phosphorus loading at 52,264.5 pounds per year and *E. coli* levels in selected regions that grossly exceed 130 parts per 100ml (the maximum contamination level). These NPS pollutant levels have been determined to be excessive and detrimental to the health and stability of the watershed, as indicated by the threatened and impaired designated surface water uses apparent in the watershed (*Chapter 5*). This WMP outlines the action necessary for reducing annual sediment inputs by at least 1,443.28 tons, annual nitrogen inputs by at least 161,660.42 pounds, annual phosphorus inputs by at least 38,947.26 pounds and E. coli levels to fewer than 130 parts/100ml. This WMP also describes measures necessary for stabilizing watershed hydrology and sustaining it on a long-term basis.

[1] Although outsourced, the Wetland Functional Assessment was developed simultaneously and free of charge to the Hodunk-Messenger Watershed Planning Project by the MDEQ (not contracted)

TABLE OF CONTENTS

APPENDICES

TABLES, FIGURES and MAPS

Tables

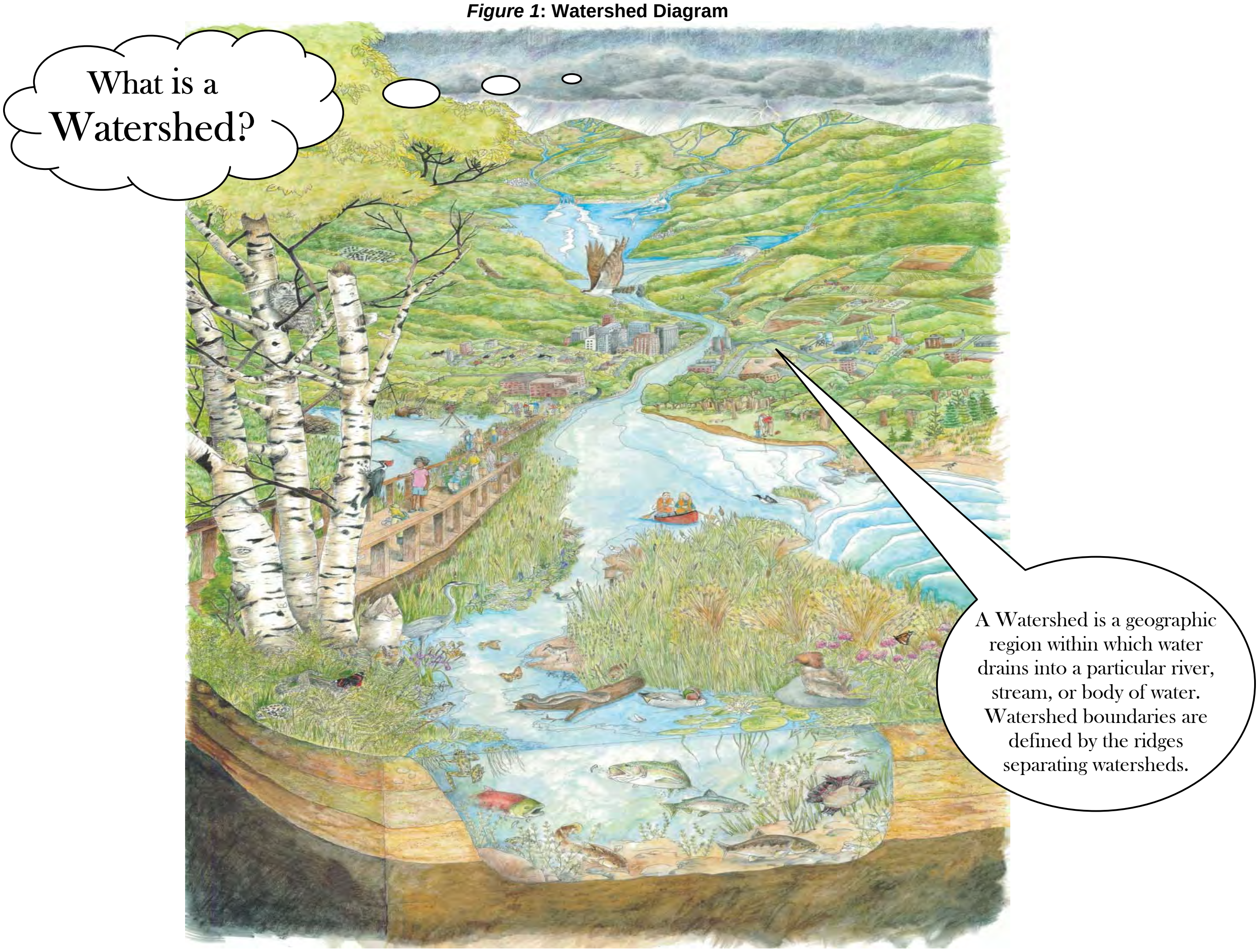
Figures

Maps

INTRODUCTION

A **watershed** is an area of land that drains to a common body of water. Watersheds may be identified at many different scales, depending on the size of the water body to which they drain. The Hodunk-Messenger Chain of Lakes Watershed is a 39,386.4-acre area of land that drains to the six mile long, interconnected Hodunk-Messenger Chain of Lakes. Within the Hodunk-Messenger Watershed there are three smaller drainage basins, or **sub-watershed**s. These three sub-watersheds correspond to the major streams or drains that they drain to: the Cold Creek Sub-watershed, the Miller Lake Drain Sub-watershed and the Sauk River Sub-watershed (*Map 1*). Each of the three sub-watershed hold slightly varying characteristics and land use types, and therefore each present unique problems and benefits to the overall health of the Hodunk-Messenger Watershed. The Coldwater River flows into the chain of lakes in the southern-most lake (South Lake) and flows out of the northern-most lake (Craig Lake) to the mouth of the watershed at Hodunk Dam in Hodunk. From Hodunk Dam, the Coldwater River then flows in a northeasterly direction to its confluence with the St. Joseph River. From here, the St. Joseph River ultimately flows into Lake Michigan.

***Figure 1*: Watershed Diagram**

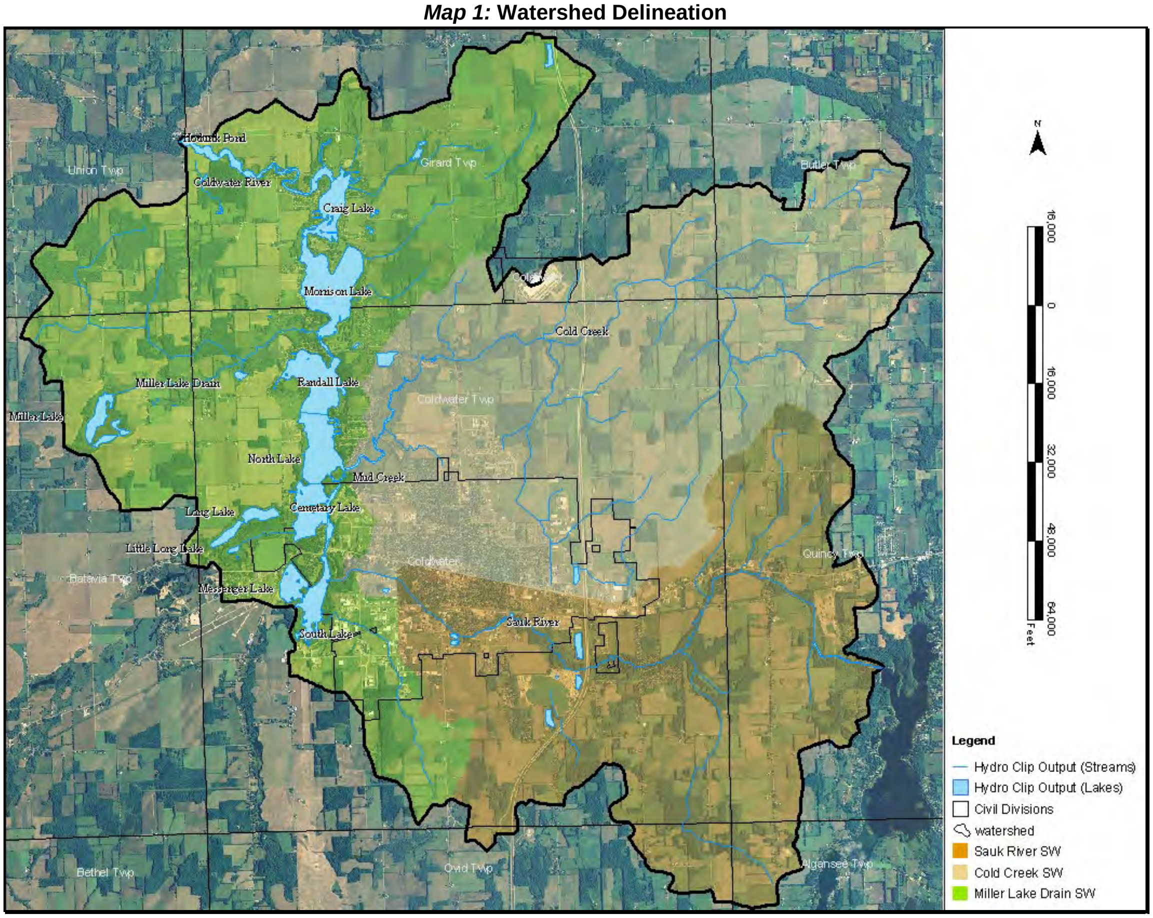


Source: WILD Education

The Hodunk-Messenger Chain of Lakes Watershed is an important watershed to protect because of its geographic location within the St. Joseph River Watershed. The Hodunk-Messenger Watershed is situated in the upper regions of the St. Joseph River Watershed, where watershed health and stability are most important. With a predominant agricultural land use, accompanied by the rapidly growing urban component of Coldwater, the Hodunk-Messenger Watershed is currently experiencing excess amounts of sediment and nutrient loads being delivered to the Hodunk-Messenger Chain of Lakes. These pollutants accelerate the aging process of the lakes, impair fish and aquatic life habitat and threaten navigation and human body contact recreation. Additionally, both MDEQ and the Branch-Hillsdale-St. Joseph Community Health Agency have identified contamination from pathogens taking place in Messenger Lake. Based on historic data and current watershed land uses, these same pollutants are considered to be threats to water quality throughout the watershed.

> The Hodunk-Messenger Chain of Lakes Watershed is an important watershed to protect because it's located in the upper portions of the St. Joseph River Watershed, where watershed health and stability are most important

***Map 1:* Watershed Delineation**



The pollutants impairing the water quality in the Hodunk-Messenger Watershed enter surface water bodies throughout the watershed from diffuse sources and cannot be tied to a single, easily identifiable source. Such pollution is considered **nonpoint source pollution**, since it does not originate from a stationary point (discharge pipes). Nonpoint source (NPS) pollution is caused when water from rainfall and snowmelt flows over land or through the ground picking up and transporting pollutants to a receiving body of water. Because point source pollution has been controlled and regulated by the U.S. Environmental Protection Agency (EPA) since 1972 through the National Pollutant Discharge Elimination System (NPDES) permit program, NPS pollution is now considered to be the leading source of pollution in the nation, as well as in Michigan.

The pollutants associated with the Hodunk-Messenger Watershed are not only degrading the water quality of the chain of lakes, they are also contributing to the impairments of the St. Joseph River. In 2008, a port at the mouth of the St. Joseph River along Lake Michigan had to be closed because water levels were too shallow to allow ship passage. A representative with the Army Corps of Engineers remarked, "…I've never seen the siltation take place so fast, so quickly, as it did here this spring… right now, it's by far the worst harbor in Michigan". The Corps estimated that the contractors would have to dig out around 180,000 cubic yards of sand and silt to get the river back to a suitable depth of 22 feet. This would require the removal of an estimated 16,000 truckloads of material, at an approximate cost of $3,145,500. As stated in the St. Joseph River Watershed Management Plan of 2005, sub-watersheds in the upper portion of the St. Joseph Watershed, such as the Hodunk-Messenger, are vital to manage for reduction of sediment loads and stabilization of hydrology in the St. Joseph River.

To facilitate the reduction of NPS pollutant contamination of waterways, the federal Clean Water Act (CWA) was amended in 1987 to include Section 319, which discussed and provided funding for the control of NPS pollution. Today, Section 319 funds are provided to state environmental protection agencies, such as MDEQ, for the control and reduction of NPS pollution, usually through watershed management. MDEQ awards these Section 319 grants annually to watershed organizations and local units of government for the development of watershed management plans and the implementation of best management practices (BMPs) for the reduction of NPS pollution.

In 2006, the Branch County Conservation District (BCCD) was awarded one such CWA Section 319 grant. The 319 grant provided the funding necessary to investigate and identify the full range and extent of NPS pollution in the Hodunk-Messenger Watershed, prescribe BMPs necessary for reducing these pollutants, and provide steps for achieving these reductions in the form of a WMP. The Hodunk-Messenger Chain of Lakes Watershed WMP is the result of the Hodunk-Messenger Chain of Lakes Watershed Planning Project provided by CWA Section 319 funds administered through the MDEQ.

This WMP was developed by conducting various watershed assessments, documenting current and future land use trends, using up-to-date watershed models to estimate pollutant loads and pollutant load reductions, collecting historic watershed data from past monitoring projects and feasibility studies and organizing an Advisory Council, Technical Subcommittee and Information and Education (I/E) Subcommittee. These watershed project groups consisted of resource professionals, local business owners, educators, elected officials, watershed stakeholders, and concerned members of the watershed community. These groups helped steer the direction of the project, guided planning efforts and provided project oversight so as to ensure that the Hodunk-Messenger Chain of Lakes WMP would be a document with reasonably achievable goals developed by a broad base of expertise.

Public participation was also a necessary and valuable component of the watershed planning process. For any natural resource project to succeed, it must be accepted and have ownership in the local community in addition to being based on sound science. Throughout the course of the watershed project, public meetings were held, concerns and desires expressed by residents were documented, social monitoring was conducted, project updates were administered to the public through press releases and bi-annual newsletters, multiple watershed presentations were delivered to local organizations and school groups in order to raise awareness and several volunteer projects were coordinated to help create a sense of watershed ownership.

The resulting Hodunk-Messenger Chain of Lakes WMP provides detailed descriptions of the watershed's natural characteristics, uses, cultural trends and factors currently causing water quality degradation as necessary background information. Information about potential pollutants and the sources and causes of these pollutants in the watershed have been compiled from various sources and are provided for public viewing throughout the middle portions of this document. Descriptions and results of the watershed assessments conducted during the course of the planning project are also summarized throughout the text and provided in full detail in the Appendix section. Subsequently, information from these supporting documents and assessment results has been evolved into recommendations for pollutant reduction and water quality enhancement in the latter portions of the document (Implementation Action Plan found in *Chapter 9*). Included in these recommendations are concise tasks, timelines, potential costs and partnering agencies, as well as estimated pollutant reductions expected to result from each task. The final portions of the WMP discuss assessing implementation efficiency and project sustainability through land use planning, funding and education. Appendices of the WMP consist of reference materials expected to aid stakeholders in implementing the recommended watershed management practices.

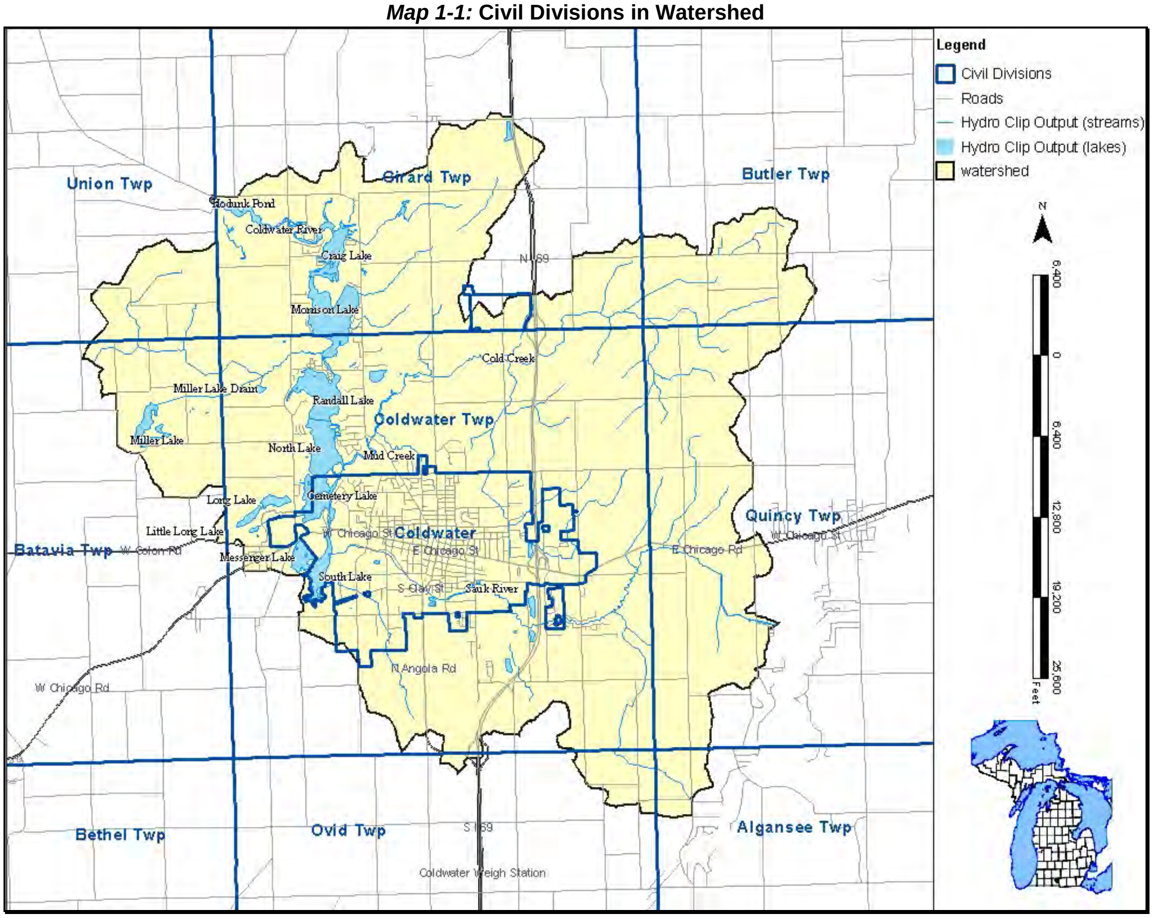
1. WATERSHED DESCRIPTION

1.1 Location, Boundary and Size

The Hodunk-Messenger Chain of Lakes Watershed is located in the south central region of Michigan's Lower Peninsula, 10 miles north of the Michigan-Indiana state border. It is a sub-watershed (lower portion) of the Coldwater River and a sub-watershed in the upper region of the St. Joseph River Watershed (Lake Michigan). The Hodunk-Messenger Watershed boundaries are defined by topographic divides or ridges where surface water runoff drains to either the Hodunk-Messenger Chain of Lakes or in other directions to Swan Creek, Hog Creek, the upper Coldwater River or to the Marble-Coldwater Chain of Lakes. The selection and **delineation** of hydrologic boundaries are determined solely upon science (direction of hydrologic flow) and are not influenced in any way by administrative or political boundaries. The particular watershed delineation that defines the land area that drains to the Hodunk-Messenger Chain of Lakes is identified with the Hydrologic Unit Code (HUC) 0405000101. This watershed delineation encompasses 61.5 square miles, or 39,386.4 acres.

The land area of the watershed lies entirely within Branch County, encompassing parts of Algansee, Batavia, Butler, Coldwater, Girard, Ovid, Quincy and Union Townships. By and large, Coldwater Township has the largest stake in the watershed, as it encompasses more watershed acreage than any other township in the watershed. The Hodunk-Messenger Watershed also contains the entire City of Coldwater, which is 8.28 square miles, or 5,298.92 acres in size.

Map 1-1: **Civil Divisions in Watershed**



There are three major tributary streams that feed into the chain of lakes which in turn create three major sub-watersheds within the Hodunk-Messenger. These tributary streams are the Miller Lake Drain which drains the entire western half of the watershed (Miller Lake Drain Sub-watershed), Cold Creek/Mud Creek which drains the northeast part of the watershed (Cold Creek Sub-watershed) and the Sauk River which flows from Branch County's southern chain of lakes and drains the southeast part of the watershed (Sauk River Sub-watershed). The Cold Creek Sub-watershed occupies 13,056 acres or 20.4 square miles, the Miller Lake Drain occupies 15,407.5 acres or 24.1 square miles and the Sauk River Sub-watershed occupies 10,898.5 acres or 17 square miles. The delineations and arrangements of the major sub-watersheds in the Hodunk-Messenger Chain of Lakes Watershed may be found in *Map-1* in the *Introduction* section.

1.2 Climate

Branch County is located in the Northern Temperate Climate Zone (between the Arctic Circle and the Tropic of Cancer). Compared to other states in the North and Midwest United States, Michigan typically experiences more moderate temperatures because of its situation between the Great Lakes. The average yearly air temperature in the Branch County area is 47° F and the growing season is approximately 150 days. Branch County receives an average of 35 inches of precipitation a year with an average of 0.603 inches of precipitation occurring during each event. This is somewhat higher than the state-wide yearly average, which is 32 ¼ inches. Not surprisingly, southern/southwest Michigan is often considered the "wettest" part of Michigan.

Historically, there are 127 rainy days per year in the watershed. Of the 35 inches of yearly precipitation that falls in the watershed, 63% of it will be cycled back into the atmosphere through the processes of evaporation and transpiration (*Table 1-1*). Surprisingly, only 3 inches (less than 9%) of the annual precipitation will infiltrate the soil and recharge groundwater supplies in the watershed. Conservative estimates show that the fate of the other 28.6% of precipitation in the watershed will be to run off directly to surface water.

***Table 1-1:* Branch County Water Budget**

Annual Rainfall	35 inches
Infiltrates	3 inches
Evaporation/transpiration	22 inches
Runs off	10 inches

Source: USDA-NRCS Climate Report

It should be noted that these water budget figures are cumulative and rates of infiltration and runoff will differ from location to location throughout the watershed. For example, forested areas support much higher infiltration rates than do urban areas. Likewise, urban areas will shed greater volumes of rainfall runoff than a forest would. *Table 1-2* documents the actual amounts of infiltration and runoff volumes that occur annually from each general land cover type in the watershed.

Table 1-2: **Calculated Infiltration and Runoff Volumes by Land Use**

	Urban	Cropland	Pastureland	Forest	TOTAL
Total Calculated Infiltration Volume (in millions of gallons per year):	88.9	1,740.7	412.8	464	2,706.5
Infiltration Volume PER ACRE (in gallons per year):	30,546.6	78,205.2	78,278.1	78,272.6	
Annual Runoff by Land Uses (in millions of gallons per year):	287.9	1,224.2	197.8	157.2	1,867.1
Annual Runoff PER ACRE (in gallons per year):	98,924.5	55,000.2	37,508.2	26,518.2	

Source: US EPA STEP-L ver. 4.0, based on the land cover acreages presented in Section 1-6

According to these models, cropland offers the greatest amounts of both infiltration *and* runoff in the watershed. However true, these calculations are reflective of the fact that cropland vastly dominates the land cover of the watershed. Cropland does in fact provide the greatest amounts of both infiltration *and* runoff volumes in the watershed, but acre for acre, urban land cover actually generates more of runoff volume than cropland. This summary of runoff volumes per land cover type directly correlates to the pollutant load contributions of each land cover type (presented in *Chapter 6*).

1.3 Watershed History

Over 100 lakes were formed in Branch County during or immediately after the last ice age. During the ice age, lobes of both the Erie and the Huron-Saginaw Glacier met in Branch County. The melting of the Huron-Saginaw Glacier created the Coldwater River and a large ice block left in the glacial drift of the Erie Glacier created the Hodunk-Messenger Chain.

Many of the earliest archaeological features found in Branch County were discovered around the two lake chains. The area around the Hodunk-Messenger Chain of Lakes was originally inhabited by the Potawatomi Indians. The inhabitation of the area around the Hodunk-Messenger chain (present day Coldwater) likely occurred because of the abundant water resources, rich soils and because it was an approximate halfway point between two major trading outposts: Chicago and Detroit. Highway US-12, which runs east and west through the middle of the Hodunk-Messenger Watershed, was once known as the "Sauk Trail". The old Sauk Trail was used as the primary travel corridor between Chicago and Detroit. Records maintained in the Holbrook Heritage Room of the Branch District Library indicate that there was a very large and uniquely misshapen tree along the Sauk Trail that natives would use as a landmark indicator of the halfway point between Chicago and Detroit when traveling. This unique tree stood in the area between Cemetery Lake and South Lake of the Hodunk-Messenger Chain, in what is present-day Oak Grove Cemetery.

Ever since the Potawatomi Indians occupied the territory, Branch County has been known as the "country of the cold water". In the Potawatomi language it was called "I-Yo-Pa-Wa" and in the Ottawa language, the area was referred to as "Chuck-Sew-Yah-Bish" (both meaning "cold water"). Not surprisingly, white settlers would later call the principle city of the area "Coldwater".

Early on, the lakes within the Hodunk-Messenger Watershed were found to contain substantial amounts of bog lime, otherwise known as marl. Early settlers to the region found that marl served as a substitute for building mortar, and was used to chink cabins. Making use of this natural resource, manufacturers began producing Portland Cement in the watershed as early as 1900. Marl was dredged from the bottoms of the lakes and shipped on barges to the manufacturing plants located along the southern portions of the chain of lakes. Dredging continued through the first half of the twentieth century into the late 1940's, resulting in Michigan's long-time status as the second largest producer of Portland Cement in the nation (behind New Jersey). Dredging locations and amounts are unknown from 1938 to 1947 though; likely as a result of WWII. In total, five million cubic yards of muck and marl were removed over the 47 years of industrial dredging. This amount is equivalent to lowering over half the lake chain 5-13 feet. In addition to the deepening of the lakes, channels were also created or widened in order to allow for the passage of barges between lakes. Because of sedimentation and rapid aquatic plant growth, many of these man-made channels have begun to fill in over time.

In 1967, the Hodunk-Messenger Lake Board was formed to address concerns for the lakes under Michigan Legislative Act 345 of 1966. Concerns included the rapid aging and filling-in of the lakes. The Lake Board immediately began setting up funds to hire an engineer to assess the problems of the chain of lakes. The engineering firm that was hired conducted a feasibility study for a lake improvement project. The feasibility study called for dredging in key locations throughout the chain of lakes in order to deepen lake levels, cool water temperatures and slow down biological activity. The project required $1,100,000 and was the first project conducted under Michigan Act 345. The spoils dredged from the lakes were stored in nearby low spots, held in by dikes. A dry well was dug for dry periods. The mouth of Coldwater River was re-routed to a more stable location with a harder shoreline. A legal lake level was also set and controlled by the Hodunk Dam and swampy areas around the lakes were filled in with sand to promote future development. As a result of the filling in of these swampy areas, the lakes have lost capacity to store excess water in times of flooding. Instead of being able to store rising flood waters in fringe wetlands along the lake chain, the lake level must now be actively manipulated through the use of dams so as to avoid home damage or severe shoreline erosion.

Early farming in the watershed predominately consisted of raising livestock. Then, in the 1930's, Polish immigrants moved to the area with knowledge of land drainage techniques and significantly shifted farming to the cultivation of crops. Today, agriculture in the watershed is dominated by cash crops; mainly corn, soybeans and wheat. Hay and pastureland occupy another 5,273.5 acres of agricultural land. While being an economic boon for the watershed community, this conversion to row cropping has also presented some environmental hazards such as increased soil erosion and unstable hydrology (*see Chapter 5 for a full analysis of watershed health*).

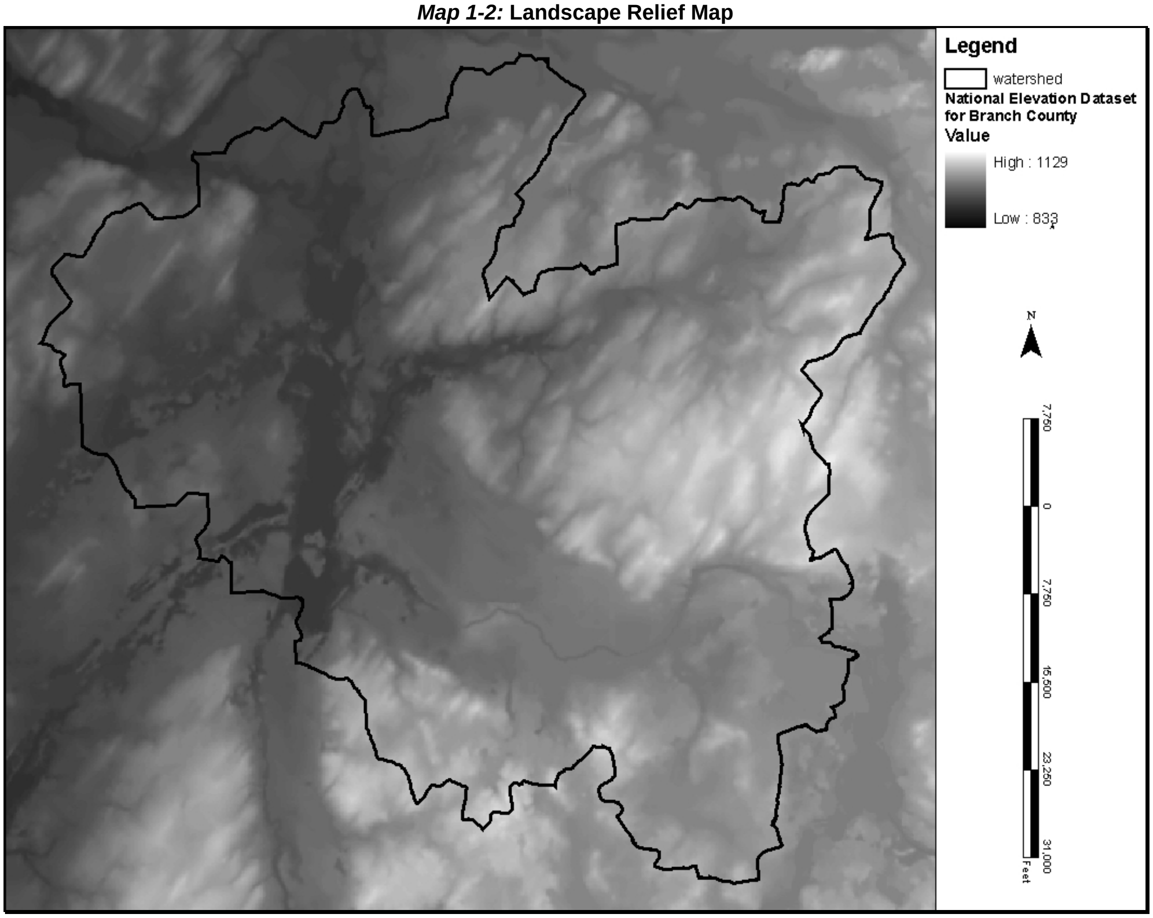
Also of historical significance is the "State Home", historically one of the largest employers in the watershed. A public facility has stood in the location of the State Home ever since 1874, when it was originally a public school for neglected children. This continued until 1935, when it was decided to include the mentally-ill and became known as the Coldwater State Home and Training School. At this point its occupancy increased to 1000 people. Expansion continued to increase until 1968, when it had 900 employees and 3000 patients. In 1980 the State Home was converted into two State of Michigan correctional facilities and became known as Florence Crane Women's Facility and Lakeland Correctional Facility. It was also around this time when the

State Home's waste water was routed into Coldwater's sanitary sewer system. Previously, it had been discharged into a 1st order tributary of Mud Creek (see *page 1-7* for an explanation of stream orders). The Coldwater Correctional Facilities currently house 1,660 prisoners and 207 employees. Today, the prison occupies the only tract of state or federally-owned land in the entire watershed. This 185.7 acre tract of land offers some of the most pristine, unfragmented and diverse wildlife habitat in the watershed. This state-owned property also contains some vital stretches of Mud Creek and its tributaries.

1.4 Topography

The Hodunk-Messenger Chain of Lakes Watershed is defined by topographic ridges that top out at 1,058 feet above mean sea level (AMSL). The Chain of lakes themselves are measured to be 928 AMSL (*Map 1-2*). The majority of the watershed is situated amongst a rolling relief of about 930-1030 AMSL. In general, the lowest areas in the watershed occur in the flood plain areas along the major streams and the highest areas occur at the watershed and sub-watershed divides.

Map 1-2: **Landscape Relief Map**

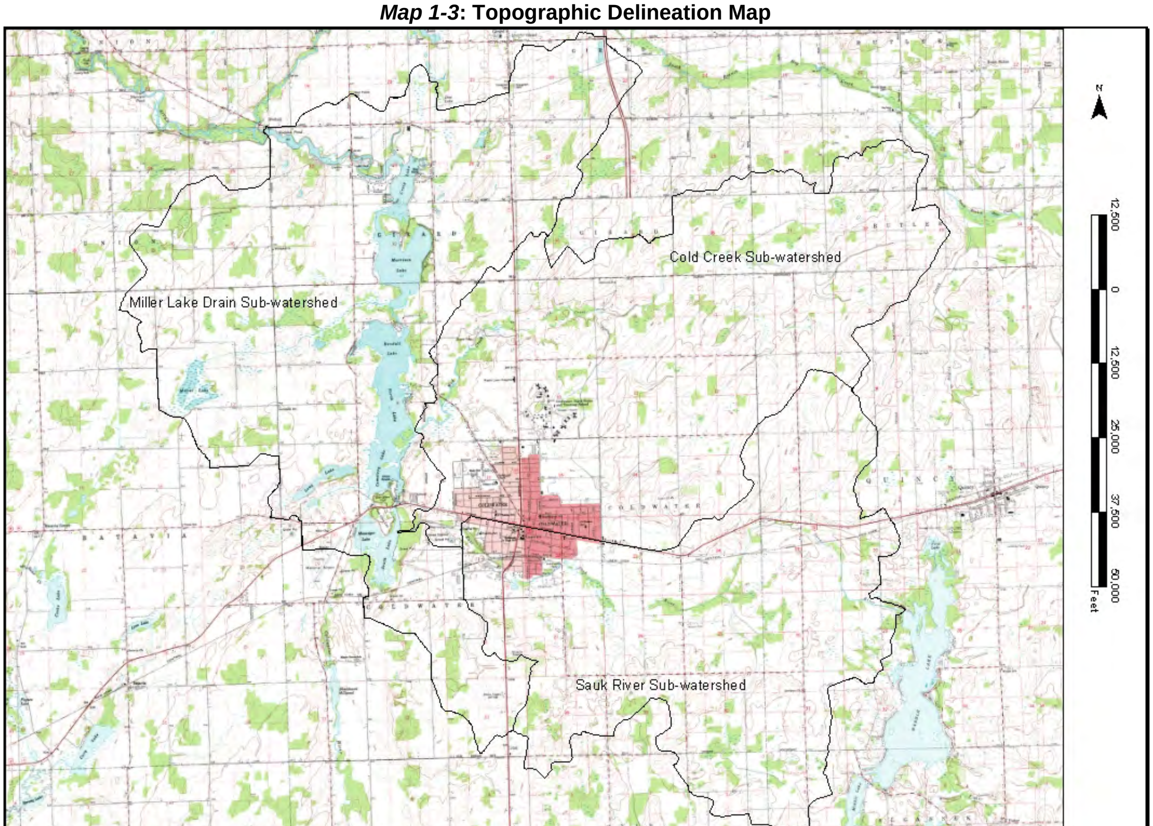


The topographic layout of the watershed generally trends downward towards the west and north (*Map 1-3*). Hence, this northwesterly slope of the land gives reason for the overall northwesterly flow of the watershed's **hydrology**. For instance, between the Marble-Coldwater Chain of Lakes and the Hodunk-Messenger Chain of Lakes, Sauk River drops by 63 feet (equivalent to a .002 ft/ft gradient).

The topography in the watershed consists of generally flat to gently sloping land and it's located in what's known as the Southern Michigan/Northern Indiana Glaciated Drift Plain. Hills in the watershed consist primarily of lateral moraines and drumlins, with one terminal moraine positioned just northeast of Coldwater. Some smaller terminal (or "end") moraines are also present south and east of the City. All of these small moraines and drumlins create a northwest trending topographic base for the watershed.

> **Common Glacial Formations Found within the Hodunk-Messenger Chain of Lakes Watershed:**
> **Lateral Moraines:** parallel ridges of debris deposited along the sides of a glacier.
> **Terminal Moraines** (or end moraines)**:** ridges of unconsolidated debris (soil and rock) deposited at the "snout" or end of a glacier. Glaciers tend to act like conveyor belts carrying debris from the top of the glacier to the bottom where it deposits it in end moraines.
> **Drumlins:** elongated whale-shaped hills formed by glacial action with the blunter end facing into the glacial movement. Drumlins are often found in drumlin fields of similarly shaped, sized and oriented hills.

***Map 1-3*: Topographic Delineation Map**



The three major sub-watershed delineations are based on higher elevation ridges that divide the flow of water.

1.5 Significant Natural Resources

As defined by the US Geological Service, natural resources can be define as stocks of anything naturally occurring that have a beneficial use for man including economic, nutritional, recreational, aesthetic, and other benefits. In terms of the Hodunk-Messenger Chain of Lakes Watershed, some specific natural resources such as fresh water and productive soils are found in abundance. These natural resources are important to understand not only because of their economic viability, but also because their exploitation can have a direct affect on the overall health and stability of the watershed. The natural resources specific to the Hodunk-Messenger Watershed will be discussed here in detail as individual natural features.

Natural features of the watershed such as surface water bodies, soils, vegetation and wetlands are extremely important for water storage, nutrient cycling, erosion control, and wildlife habitat. Unaltered tracts of natural resources help to purify and stabilize the flow of water through a watershed, especially when located in the upper regions of a watershed. The current state of the watershed can be in part characterized by the following natural resource descriptions.

Key natural resources found in the Hodunk-Messenger Watershed include abundant surface and groundwater resources, watershed soils that promote rapid drainage and tracts of indigenous vegetation that have remained since pre-settlement times. Wildlife is another natural feature found in the watershed worthy of consideration. Abundance and diversity of certain wildlife species tend to offer insight into the overall environmental quality of a given region. For more information about the major natural areas found within the watershed, refer to *Appendix K*, where these areas are described in great detail.

1.5.1 Water Resources

The Hodunk-Messenger chain of lakes is comprised of 7 inter-connected lakes and a portion of the Coldwater River between Craig Lake and Hodunk Dam. In total, the lake chain offers six miles of continuous watercourse, nearly one mile wide in some places. The unique **morphometry** (shape) of the lake chain includes many peninsulas and sharply bending channels. In total, the lake chain covers approximately 1,100 acres, averaging about 15 feet in depth. The only other lakes in the watershed are Miller Lake, Long Lake and Little Long Lake. All of these lakes are found in the Miller Lake Drain Sub-watershed and are all surrounded by significant wetlands complexes.

The Hodunk-Messenger lake chain is not significantly influenced by groundwater springs. Instead, the chain of lakes receives most of its water inputs from the Coldwater River. The river flows through the chain of lakes in a northerly direction from where it enters in South Lake, to the mouth of the watershed at Hodunk Dam in Hodunk. The Hodunk-Messenger Chain of Lakes is one of two lake chains along the Coldwater River in Branch County. The Hodunk-Messenger Chain of Lakes is the most northern lake chain and is sometimes referred to as the “North Chain”. The southern chain, stretching from Coldwater Lake to Marble Lake, is larger in size than the North Chain.

Surface water runoff also contributes significant amounts of volume to the chain of lakes. Water from precipitation that falls in the watershed runs downhill to one of three major drains or tributary streams. The three major watershed tributaries that contribute all of their water to the chain of lakes are: Cold Creek, Miller Lake Drain and Sauk River.

Cold Creek flows in a southwesterly direction, originating in the far northeast corner of the watershed where it shares a border with the Hog Creek Watershed. The Cold Creek Sub-watershed has many tributaries that flow north or south into the main stem of the creek. As it flows closer towards its confluence with the chain of lakes and is joined by many smaller tributaries. Because of the contributions of

Stream Order

Stream order is a numbering sequence which starts when two 1st-order, or headwater, streams join, forming a 2nd-order stream, and so on. Two 2nd-order streams converging form a 3rd-order. Streams of lower order joining a higher order stream do not change the order of the higher. Stream order provides a comparison of the size and potential power of streams.

smaller streams, Cold Creek eventually becomes a 3rd order stream (west of, or downstream of Marshall Street, otherwise known as "Old 27"). At this point, Cold Creek widens, deepens, becomes more navigable and becomes known as "Mud Creek".

As its name would suggest, Miller Lake Drain originates in Miller Lake on the west side of the watershed. Miller Lake Drain flows eastward through a series of wetlands and intermittent streams towards its ultimate confluence with the chain of lakes (in southern Morrison Lake). According to information provided by Michigan Natural Features Inventory (MNFI), Miller Lake is considered to be the only rare or imperiled wetland type in the watershed.

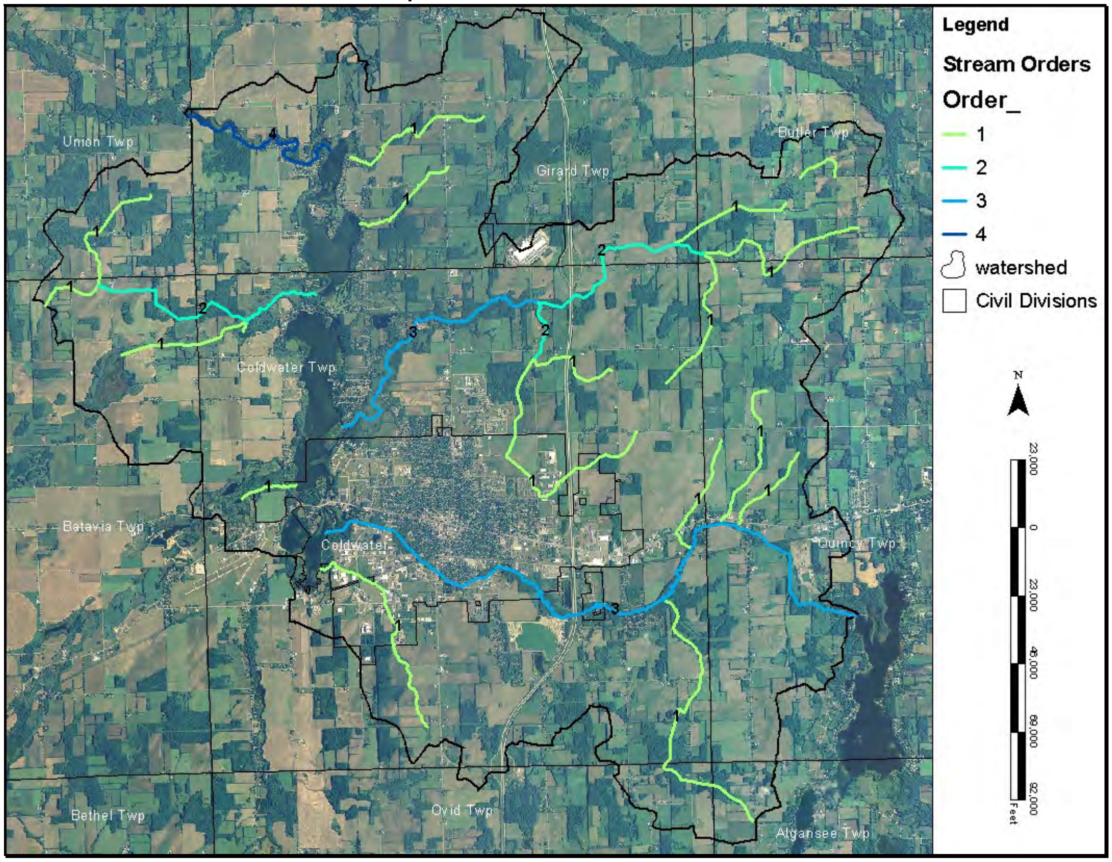
The Sauk River originates at the mouth of Marble Lake and is the northern outlet of the Coldwater-Marble Chain of Lakes (Southern Chain). The Sauk Rivers meanders westward through the City of Coldwater to its outlet into the southern portion of the lakes chain (South Lake). Sauk River has also been identified as a 3rd order stream. Along with numerous smaller streams and drainage ways, there's a total of 129.46 miles (683,579.68 feet) of waterfront in the watershed. Of the major tributaries, only the Sauk River and Mud Creek (the lower portion of Cold Creek) are navigable.

The abundant surface water resources in the watershed may arguably be the most valuable natural resource of the watershed because it is a constituent of living matter and a necessity for all plant life, aquatic life and wildlife to exist. The Hodunk-Messenger Watershed provides 1,361.4 acres of open surface water and 78.1 miles of stream systems.

Of these streams, only about 12.41 miles allow for human navigation. These navigable stream reaches are considered 3rd and 4th order streams and consist of the Sauk River, Mud Creek (downstream reaches of Cold Creek) and the Coldwater River between Craig Lake and Hodunk Dam. Stream order is a measure of the relative size of streams. Stream sizes range from the smallest, 1st-order, to the largest, the 12th-order (such as the Amazon River). When two smaller-order streams converge, they form one larger-order stream. In general, as stream order increases, streams gradually increase their width and depth. The amount of water they discharge also increases.

The largest stream in the Hodunk-Messenger Watershed is the 4th-order Coldwater River between Craig Lake and Hodunk-Dam. The majority of the streams (57.8%) found within the watershed are identified to be 1st-order streams. These small 1st order streams, also known as headwater streams, are found primarily in the upper regions of the watershed. 1st order streams serve an important role for the health of larger streams, rivers and lakes because they "nourish" downstream segments with essential supplies of water and food materials (insects, fish and organic matter). 1st order streams help control the flow of water to larger streams, thereby maintaining a consistent base flow of larger streams in times of drought, and reducing downstream scouring and flooding in times of heavy rainfall. 1st order streams with vegetated buffers can also help to reduce sediment and nutrient delivery to larger streams.

Map1-4: **Watershed Stream Orders**



The hydrology of the Hodunk-Messenger Watershed has been significantly altered from what had existed naturally. Historically, there were 20,525 acres of forests and 8,889 acres of wetlands in the watershed. These natural features helped to stabilize hydrology by storing rain water and snow melt in soils, water features and vegetation. Today, a growing urban area covers roughly 7% of the watershed with impervious surface, leading to greater amounts of stormwater that runs off the surface and is rapidly delivered to nearby waterbodies. Additionally, very few of the streams in the watershed have remained natural and unaltered. Today, nearly all streams have been significantly modified through straightening or **channelization** for agricultural use. Branch County tile records also indicate that many fields in the watershed have been tiled and drained.

Quick delivery to surface water bodies causes higher, more destructive peak flows (also known as **bankfull** discharge levels) to occur more frequently and results in greater overall fluctuation in stream flow volume. Severe fluctuation between high and low flow volumes devastates the habitat and movement patterns of fish and other aquatic life. This rapid flow fluctuation in streams is sometimes referred as a stream’s “flashiness”. In **flashy streams**, flows collect rapidly and peak flows occur very soon after a precipitation event, and then subside as rapidly as they collected. Peak flow (or bankfull discharge) stream flow volumes, also create greater amounts of “sheer stress” on stream banks.

Lake levels of the Hodunk-Messenger Chain of Lakes are controlled for the most part by the dam at the mouth of the watershed in Hodunk. Lake levels are also manipulated by the Black Hawk Dam on the Coldwater River (upstream of the Hodunk-Messenger lake chain) and the Marble Lake Dam on the Sauk River (at the Mouth of the Coldwater-Marble lake chain), even though these two dams are not within the watershed. While there are no other man-made dams within the watershed, many stream obstructions of woody debris have been observed. These stream obstructions, like man-made dams, can change stream flow patterns, create barriers to the migration of fish and other aquatic fauna, increase concentration of some toxic chemicals and create localized flooding.

Despite the name of the primary city being Coldwater, water features found within the Hodunk-Messenger Watershed exhibit conditions that support only warm water fish species. Cold water fish species are not found in the watershed because they require colder, more **oxygenated** water. Due to the shallow, slow moving waters found throughout the watershed, water temperatures increase to levels warm enough to provide optimal conditions for only warm water species, such as sunfish, pike, minnows, suckers and catfish. When water temperatures increase, dissolved oxygen (DO) is released from the water. On top of already low DO levels, the rapid biological turnover of aquatic plants currently taking place in the chain of lakes further robs the lakes and streams of DO and makes it nearly impossible for even cool water fish species such as walleye to exist in the watershed.

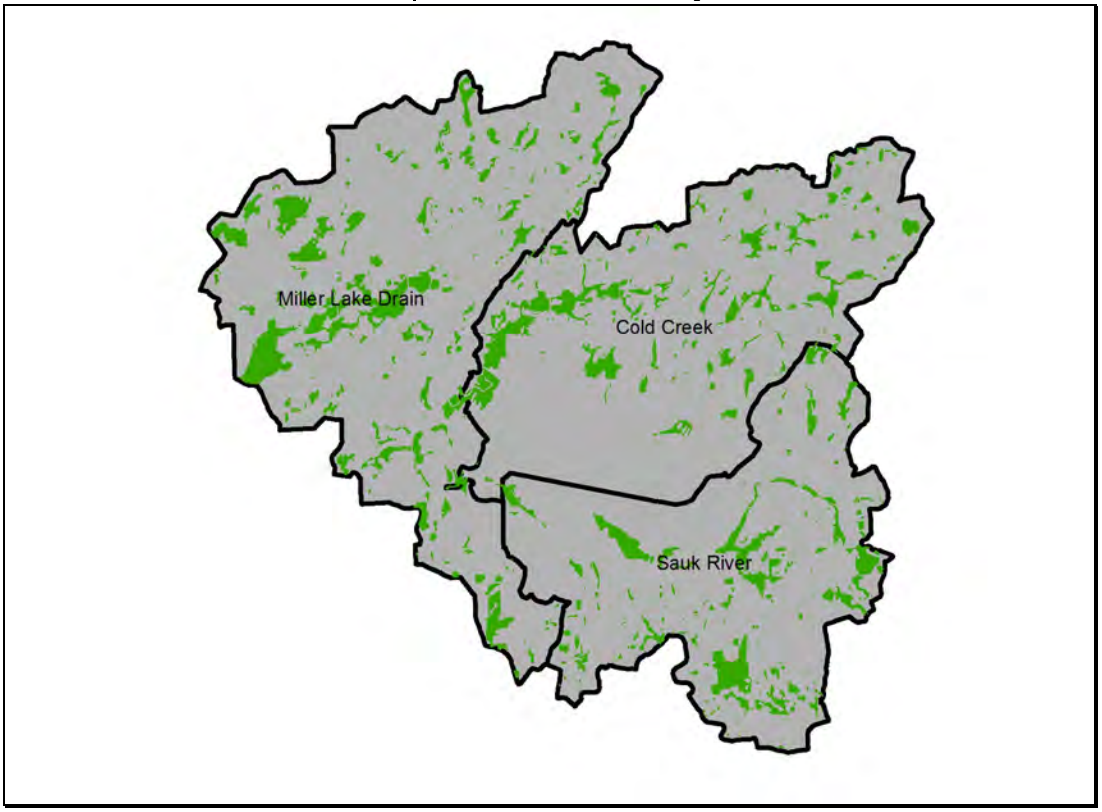
The 10 Most Common Warm Water Fish Species Found in the Hodunk-Messenger Chain of Lakes Watershed:

- Central Stoneroller	- Common Shiner
- Bluntnose Minnow	- Hornyhead Chub
- Creek Chub	- Johnny Darter
- Mottled Sculpin	- Northern Hog Sucker
- Bluegill	- Green Sunfish

Based on 2005 National Wetlands Inventory (NWI) data, the watershed currently contains 4,669 acres of wetlands. Of these wetlands, 2,995 acres are classified as forested wetlands, 1,019 are classified as emergent and 479 acres are classified as scrub shrub wetlands. Woody wetlands in the watershed are unique in the sense that they are dominated by broad leaved deciduous tree species. Results of an MDEQ Wetlands Functional Assessment (*Appendix J*) also indicate that there is one wetland complex considered to be rare or imperiled that still exists in the watershed. This rare or imperiled wetland was actually pinpointed to occur in and around Miller Lake, the headwaters of the Miller Lake Drain.

Most of the wetlands found in the watershed today are concentrated around the fringe of lakes and streams. The upper and lower portions of the Hodunk-Messenger Chain of Lakes have many wetland areas along their channels, as well as Mud Creek, Miller Lake Drain and the Sauk River. The areas around Messenger Lake, Long Lake, Mud Creek and the South end of North and Morrison Lakes make up the most extensive wetland complexes in the watershed. Additional smaller wetlands can be found scattered throughout the watershed.

***Map 1-5*: 2005 Wetland Coverage**



Source: MDEQ-LWMD Status and Trends Report (based on 2005 NWI data)

The Hodunk-Messenger Watershed also contains abundant supplies of groundwater. Groundwater replenishes streams and rivers, as well as provides fresh water for irrigation, industry and drinking water. Groundwater recharge areas in the watershed consist of the wetlands and surface waterbodies scattered throughout the watershed where groundwater levels are typically higher, as well as the areas where isolated soil types promote rapid infiltration (*Map 1-6*). Groundwater in the watershed is, on average, less than 25 feet below surface, with the level around the lakes reaching 3-5 feet closer to the surface (*Appendix F*). Northeast of Coldwater, groundwater is contained in a protected bedrock aquifer, while the remainder of the Watershed's groundwater resource resides in unprotected glacial drift. Available groundwater in the Hodunk-Messenger Watershed is pumped from large inter-connected aquifers of sandy glacial drift material, semi-confined by bedrock of Coldwater Shale. In fact, everyone in the watershed depends on groundwater as their sole source of usable drinking water. Coldwater's water supply is currently pumped from this aquifer by four municipal wells at a demand of 2.3 million gallons per day, or *mgd*, per well). As wells deplete an aquifer it must be replenished at an equal rate in order for the aquifer to remain a sustainable source of water for drinking and irrigation purposes. An equal recharge rate will prevent the negative ecological effects that are caused by draw-down of groundwater supplies. Currently, 35% of this groundwater is used for residential use while 65% is used for industrial and commercial purposes.

The importance of groundwater was stressed in the Natural Resource Inventories (NRI) of Butler and Coldwater Townships conducted during the watershed planning phase. As is the case with most areas of the watershed, most all of the groundwater recharge areas in Butler and Coldwater Townships were identified as the various wetlands and surface water bodies throughout the townships (with exception of a few selected upland soils). Protection of the land areas that recharge groundwater held the greatest importance in these NRIs.

While abundant, these groundwater supplies are highly susceptible to contamination from septic tanks, agricultural runoff, highway de-icing, landfills and pipe leaks. Groundwater recharge areas serve as a point-of-entry for nutrients and pollutants into the groundwater aquifer. One measure of local groundwater vulnerability is the level of pesticide and nitrate leaching potential of the soil types. In 2008, well water testing conducted through the Michigan Department of Agriculture (MDA) revealed that many water samples contained large amounts of nitrates. One of these well samples also was found to contain nitrite levels above the maximum contamination level (MCL). Based on soil analyses conducted during the watershed planning phase, it was determined that the majority of the watershed was well drained and soil types present in the watershed provided properties conducive for infiltration. These porous soils create a risk for nutrient and chemical leaching to groundwater resources.

In 2007, MDEQ recognized the Butler Township Speedway as a site responsible for groundwater contamination. Even though the Butler Speedway is just outside the watershed boundary, it still provides a good example of how important it is to be cognizant that surface water management practices implemented in the watershed should also support groundwater quality, and vise-versa. Aquifers that are connected underground, a condition that is pervasive throughout the Hodunk-Messenger watershed serve as an underground pathway for pollutants to travel between isolated and independent ecosystems. As identified through the MDEQ website, there have been six identified underground storage tanks (USTs) in the City of Coldwater suspected as leaking and therefore suspected of leaching potential chemical contaminants into the local groundwater supply.

1.5.2 Soils

The watershed is primarily composed of glacial outwash plains. Soils were left behind as the Huron-Saginaw and Erie Glaciers retreated from the watershed. The Huron-Saginaw Lobe carried mostly sandy-drift and the Erie Lobe carried mostly limey-drift. No substantial mineral deposits were left in the Hodunk-Messenger Watershed, but favorable soils for agricultural land were. The area of watershed in present day Girard Township was especially left with fertile prairie soil.

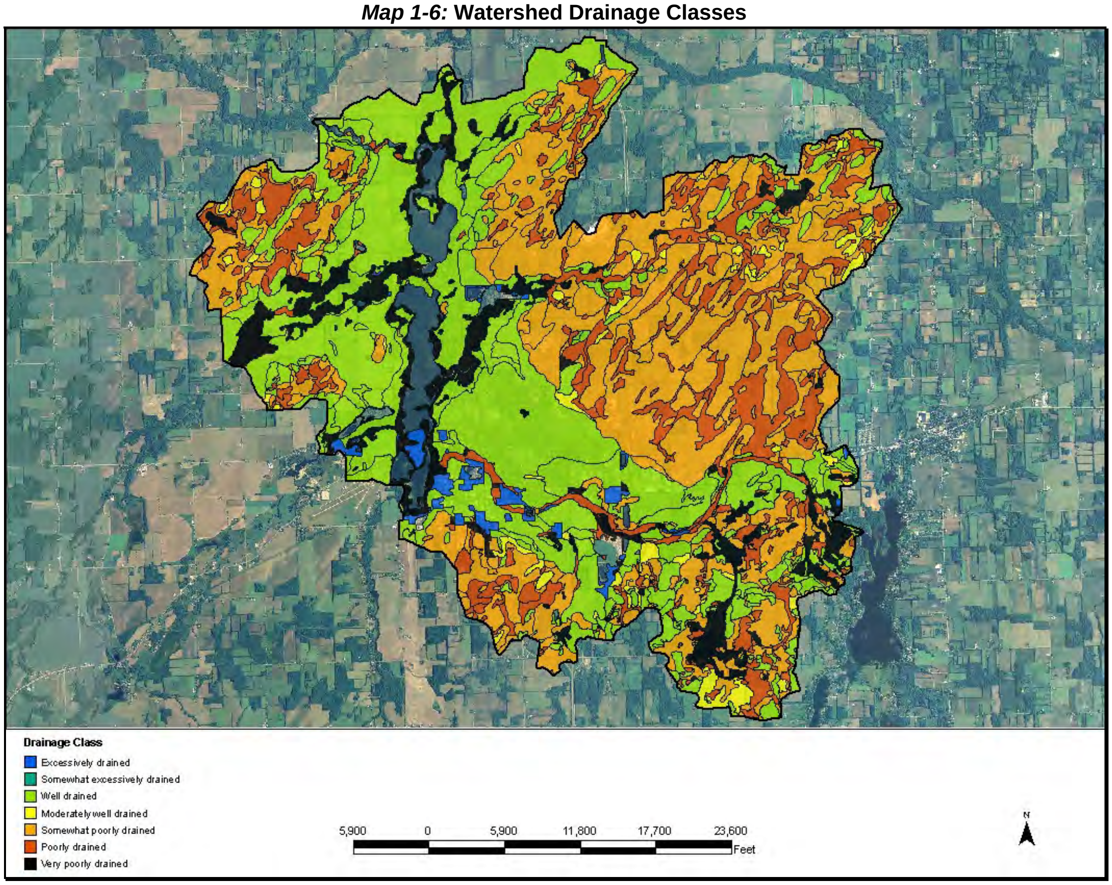
In general, soils in the watershed can be primarily classified as sandy loams in texture. The most abundant soil type found in the watershed is Locke fine sandy loam, followed by Fox sandy loam (*Appendix F*). All other soils scattered throughout the watershed are comprised of 35 other varying soil types. Soils of the watershed can more broadly be grouped into one of the following four **soil associations**:

1. Hatmaker-Lock-Barry Association – level to **undulating**, deep to very deep somewhat poorly drained to poorly drained, loamy soils on till plains and moraines; soils are underlain by local outcrops of Coldwater shale and silt stone, and water table is often within two feet of the surface providing prime farmland if drained.
2. Fox-Oshtemo-Ormas Association – nearly level to moderately steep, very deep and well drained, loamy and sandy soils on outwash plains and moraines; soils with less than four percent slope are prime farmland, and the City of Coldwater is built on these soils.
3. Fox-Houghton-Edwards Association – nearly level to moderately sloping, very deep and poorly drained, loamy soils on outwash plains and moraines and level, mucky soils in swamps, depressions, and drainage ways.
4. Matherton-Sebewa-Branch Association – level to gently sloping, very deep and moderately well drained to poorly drained, loamy and sandy soils on outwash plains and moraines.

As a result of glacial formation, lake bottoms in the watershed generally consist of 3-4 feet of muck (peat) and 10-15 ft. of marl, then gravel. Lower layers of soil throughout the watershed consist of sand and gravel laid down by glacial melt waters. These underlying beds of sand and gravel give most of the soils in the watershed a well drained characteristic.

In total, 83% of the soils types found in the watershed are classified as being "Hydrologic Group B" soils. Soils are grouped into hydrologic groups A-D based on their infiltration rates (Group A has the highest infiltration rate and Group D has the lowest infiltration rate, etc.). In terms of the Hodunk-Messenger Watershed, this means that when thoroughly wet; the predominant Group B soils have moderate infiltration. These Group B areas consist of deep, well drained soils that have moderately fine to moderately course texture. It should be noted, however, that only 63% of the Hydrologic Group B's occur naturally. Another 20% exhibit properties of Group B soils because they have been intentionally tiled and drained (*Appendix F*). The most well drained and excessively well drained soils in the watershed occur in the areas adjacent to the southern half of the chain of lakes and Sauk River, while the most poorly drained soils occur in the upper portions of the watershed. It is important to note that when soil infiltration decreases, the potential for surface runoff increases. By identifying the soil drainage classes of the watershed, *Map 1-6* can provide a good indication of the areas most susceptible to surface water runoff.

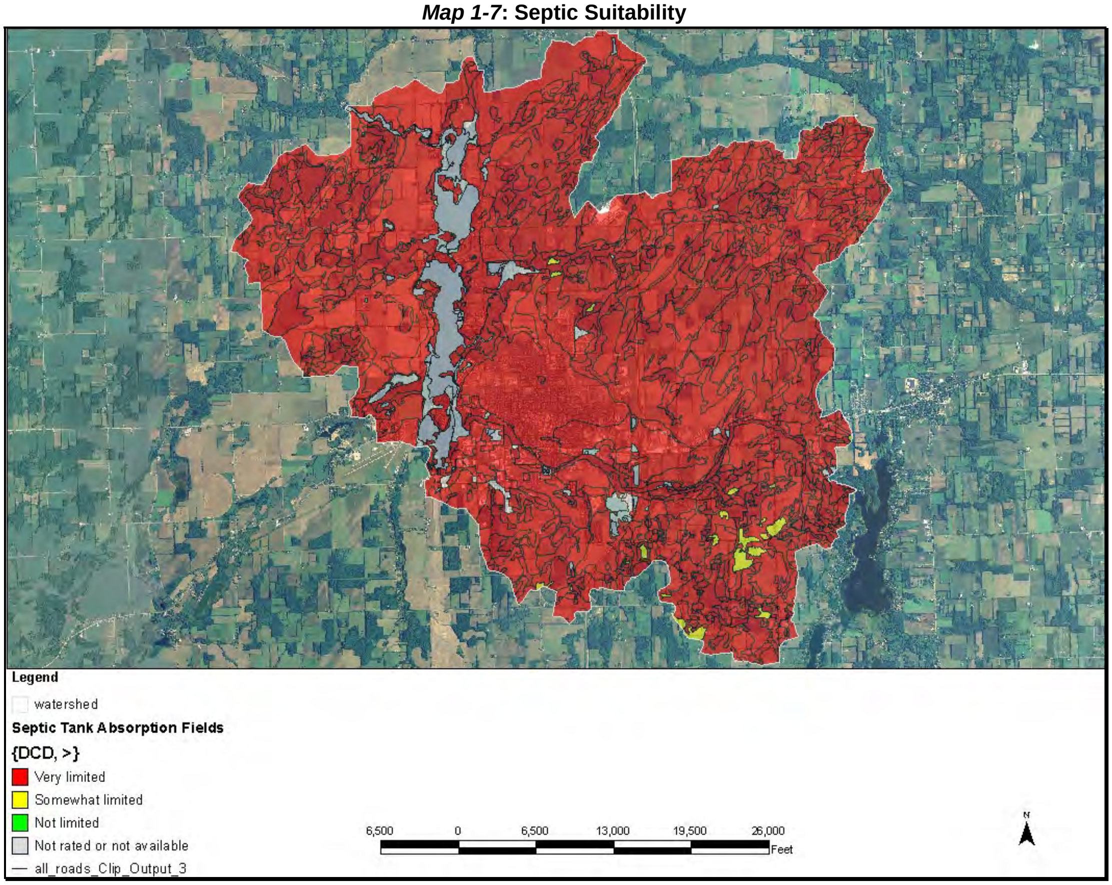
Map 1-6: **Watershed Drainage Classes**



As presented in *Map 1-7*, these same soil properties that provide a generally moderate water infiltration rate also present a risk to water quality through septic seepage. A soil analysis of the watershed conducted during the planning project (*Appendix F*) revealed that there are no soil types in the watershed that offer optimal septic field absorption properties- all show some limitations for septic absorption fields. In fact, 93.8% of the watershed contains soils that are *very* limited for septic absorption, and another 5.4% of the watershed contains soils that exhibit properties that are somewhat limited. Unfortunately, the areas that offer slightly better absorption do not correspond to the areas of development pressures.

If this finding wasn't disconcerting enough, there are also several areas within the watershed that have been identified by the Branch-Hillsdale-St. Joseph Community Health Agency as being areas of underperforming individual septic systems. The Community Health Agency based this assertion on the knowledge of undersized systems, unfavorable soil conditions and close proximity of dwelling units. These areas are geographically represented in *Map F-8* in *Appendix F* (report on the threat of groundwater seepage in the watershed) of this document.

***Map 1-7*: Septic Suitability**



Based on 2008 Branch-Hillsdale-St. Joseph Community Health Agency estimates, an average of 19% of the individual septic systems in the watershed fail in a given year. Unfortunately, due to the high water tables and seasonal flooding, the areas adjacent the chain of lakes are actually the most susceptible for septic inundation and failure. Based on US EPA Spreadsheet Tool for Estimating Pollutant Loads (STEP-L) program estimations, septic seepage is the greatest contributor of nutrient contamination in the watershed. *Table 1-3* details the full potential for NPS pollution to occur based on these septic performance figures provided by the Community Health Agency.

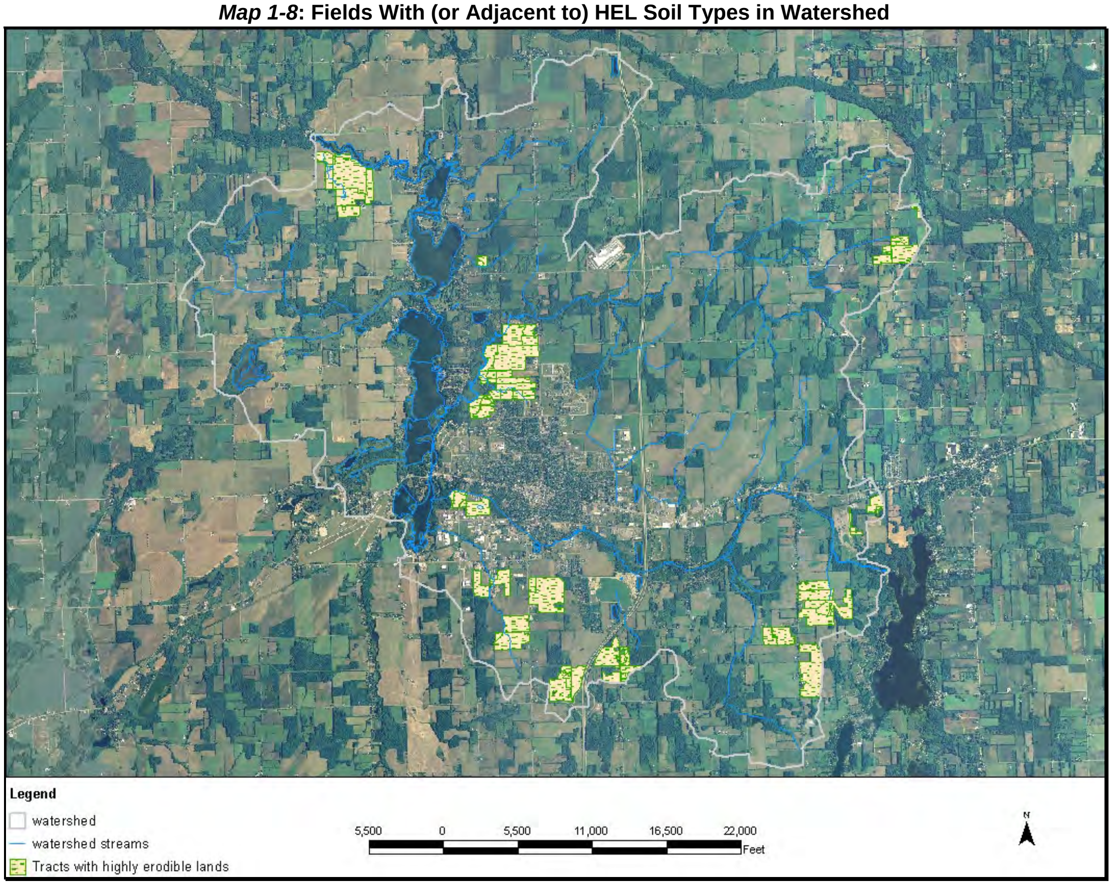
***Table 1-3:* Annual septic failure risks in watershed**

No. of Septic Systems	Population per Septic System	Septic Failure Rate, %	Failing Septic Systems	Population on Failing Septic	Failing Septic Flow, gal/day	Failing Septic Flow, l/hr
2395	2.43	19	455.05	1105.7715	77404.005	12208.585

Based on STEP-L model estimates

In addition to soil drainage properties, there have been 1,937 acres of land in the watershed identified by the USDA-NRCS to be highly erodible (*Appendix G*). The basis for identifying highly erodible land (HEL) is the erodibility index of a soil map unit. Soil units with a high erodibility index indicate that soil erosion is occurring at a rate causing long-term decline in productivity and are therefore identified as HEL. Even though the bulk of the HEL soils in the watershed are concentrated along the south side of Mud Creek, a total of 53 different farm fields were identified as either encompassing or bordering land with highly erodible soils (*Map 1-8*).

***Map 1-8*: Fields With (or Adjacent to) HEL Soil Types in Watershed**



1.5.3 Vegetation

The areas of natural vegetation existing in the watershed chiefly consist of either forested (5,928 acres) or wetland (4,493 acres) land cover types. Deciduous forests in the watershed are primarily comprised of Oak, Maple, Elm, Ash, Walnut, Hickory, Beech, Cottonwood and Aspen and nearly all are second growth. The most represented genus of trees in the watershed is White oak (White Oak, Burr Oak, Swamp White Oak and Chinquapin Oak). There are four types of hickories that can be found in the watershed: shagbark, pignut, bitternut and shell bark. At one time widespread, current populations of native Elm and Ash species have now been severely impacted and reduced by Dutch elm disease and the Emerald

Ash Borer. Scattered and isolated pockets of Basswood, Dogwood, Tamarack and Red Cedar also exist.

Historically, the watershed was covered by a mixture of deciduous and coniferous forest, oak savannas and scattered prairies but logging and agricultural cultivation in the 1800's has left only limited fragments of the original wooded areas, and no areas of oak savannah or prairie. Based on comparisons of USDA-NRCS Pre-settlement land cover data to 2001 USDA National land cover data, approximately 17,918 acres (or 75%) of forests in the watershed have been lost through these and other land clearing activities.

The remaining woodlots are primarily second growth areas and are generally located on poorly drained, mineral soils where crop cultivation is unproductive. The soil types which are most conducive for agricultural cultivation have the same soil characteristics that support the highest quality trees such as American basswood, Black cherry, Black walnut, Northern red oak, Sugar maple, White oak, Yellow birch and Yellow popular. The conversion of forest lands for agricultural uses in the watershed decreases the land area available for the trees that play such an important role in water filtration and soil stabilization.

Currently, there are 5,845 acres of deciduous forests, 77.5 acres of evergreen forest, 1,234 acres of swamp (woody wetlands) and 398 acres of emergent herbaceous wetland vegetation found in the wetland. Woody wetland species include a variety of willows, dogwoods, elders, swamp oaks, Nannyberry and other species from the *Viburnum* genus.

Emergent wetlands in the watershed have been known to include a diverse mix of species, including sedges, bulrushes, horsetails, foxtails and grasses. Unfortunately, development, agriculture, landscaping and invasive species introductions have resulted in the loss of diversity among the remaining vegetated areas in the watershed. Based on information provided by MNFI several plant species or communities in the watershed have been reduced to only very rare occurrences.

Rare Plants of the Hodunk-Messenger Watershed:

Leadplant	*Special Concern*
Virginia Snakeroot	*Threatened*
White or Prairie False Indigo	*Special Concern*
White Lady-Slipper	*Threatened*
High Prairie, Midwest Type	
Green Violet	*Special Concern*
Goldenseal	*Threatened*
Ginseng	*Threatened*
Globe Beak-rush	*Endangered*
Starry Campion	*Threatened*

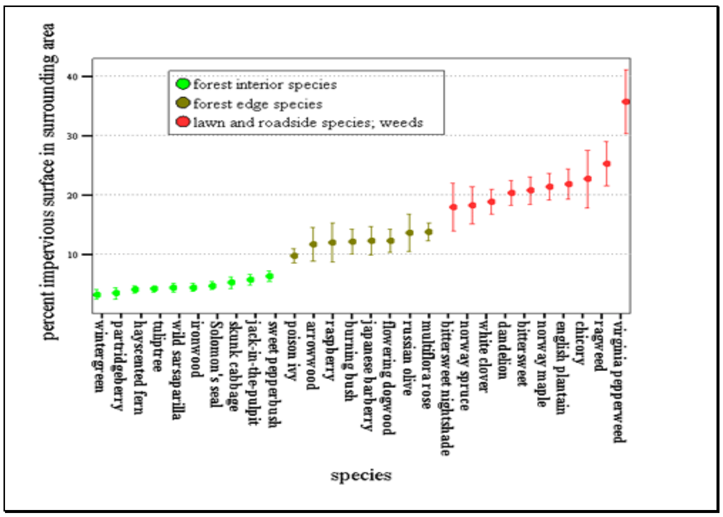
Scrub fields, meadows and other areas of early successional lands represent one of the most overlooked but ecologically important habitats in the watershed. Most of the rural character that residents in the watershed desire to protect is derived from the scattered early successional fields scattered throughout the watershed. Since many of these fields are more conducive for home site development than agriculture, special measures must be put in place to protect these areas.

Many invasive plant species have also been identified in the watershed during the course of the watershed planning project. Most detrimental to the Hodunk-Messenger Chain of Lakes are the invasive exotic species found in and along lakes and streams. Because of their adaptive and aggressive nature, species such as Purple loosestrife and giant *Phragmites* have been observed crowding out shorelines and out-competing the beneficial native flora that wildlife and aquatic life of the watershed depend on. The Hodunk-Messenger Lake Board also treats the lakes for the aquatic invasive species Eurasian milfoil and Curly-leaf pondweed. These submerged aquatic plant species are often seen as the "topped-out" mats of vegetation on the surface of the water in shallow areas of the lakes during the warm summer months. Due to the combination of nutrient loading and rapid growth rates, these species have significantly expanded their range and population in the chain of lakes in recent years.

Natural Resource Inventories (NRIs) conducted by Wightman Petrie in Butler Township and McKenna Associates Inc in Coldwater Township have also identified many exotic species that were prevalent in the ground cover of the townships. The extent to which these exotic species are affecting native species in the watershed is unknown. It was noted, however, that these species were especially predominant around disturbed areas. Not surprisingly, the amount of impervious surface in a watershed can serve as a shorthand measure not only of water quality, but vegetative quality as well (*Figure 1-1*).

Generally speaking, invasive and/or non-native plant species are mainly restricted to places having a high proportion of impervious surface. Likewise, plants associated with undisturbed forest interiors are restricted to areas with little impervious surface. Because of this, the areas of highest vegetative quality in the Hodunk-Messenger Watershed are found in the middle and upper portions of the watershed, away from the most densely developed areas.

Figure 1-1: **Effect of Impervious Surface on Plant Species**



Source: University of Connecticut Nonpoint Education for Municipal Officials (NEMO) Program

1.5.4 Natural areas

Several unfragmented natural areas have been identified in the Hodunk-Messenger Watershed. A natural area is a tract of land with native vegetation, undisturbed soils, unaltered hydrology, and is presumed to be unaltered from its original state. In total, there were 68 separate unfragmented natural areas (sometimes referred to as green spaces) over 20 acres identified in size in the watershed. These natural areas combine for a total of 5,480.6 acres of pristine vegetation and undisturbed soil (13.9% of watershed surface area). These areas are primarily located in areas unsuitable for farming such as steep slopes or wet low lands. The largest natural areas in the watershed are concentrated around lakes and streams. These areas provide such ecological services as soil stabilization, nutrient uptake, increased infiltration, water retention, pollutant filtration, temperature moderation, air purification, and wildlife habitat and migration corridors.

Currently, the State-owned land surrounding the Coldwater Correctional Facilities is the only publicly-owned tract of land in the watershed. At that, the 185.7 acres of forest on the state grounds only constitutes 3.4% of all natural lands in the watershed. The other 5,294.9 acres of the most ecologically important areas in the watershed are in private ownership. To retain the important ecological services offered by these natural areas, conservation easements and property conservation plans should be applied to privately-owned natural areas throughout the watershed in order to prevent land clearing and haphazard development. A conservation easement is a voluntary, legally binding agreement that limits certain types of uses or prevents development from taking place on a piece of property now and in the future, while protecting the property's ecological or open-space values. Currently, there are no conservation easements within the Hodunk-Messenger Watershed.

Natural Areas provide soil stabilization, nutrient uptake, increased infiltration, water retention, pollutant filtration, temperature moderation, air purification and wildlife habitat and travel corridors.

1.5.5 Wildlife

Temperate climate, diverse **ecosystem**s, abundant food sources (both natural and human-grown), close proximity to water sources and interconnected green space provide an array of habitat opportunities for wildlife in the watershed. The wetland communities found throughout the watershed offer the greatest abundance and diversity of wildlife species, and are especially important for amphibian and reptile breeding grounds. Some of the more common forms of wildlife found in the watershed include deer, mice, beaver, skunk, mink, woodchuck, rabbit, weasel, raccoon, mole, shrew, Gray and Red Fox, coyote, muskrat, vole, six different species of bat and six different species of squirrel. The most common large mammal found in the watershed is the White-tailed deer. Deer populations in the watershed have exploded in recent decades because they've adapted so well to the agricultural land use activities prevalent throughout the watershed. Deer thrive on "edge habitats" created by man, especially where croplands provide a reliable food source near the edge of forested or wetland areas. In many instances, the abundance of this grazing species can actually lead to the degradation of the vegetative quality in the watershed.

In addition to the **terrestrial** wildlife, there are also a large number of resident and migratory birds species that can be observed in the watershed. Mature woodlots, upland scrub fields and wetland ecosystems offer resident bird species permanent nesting and feeding sites. Major migratory flyways also bring in many transient bird species. The Hodunk-Messenger Watershed is unique in the sense that two of the five major migratory flyways of North America, the Mississippi Valley Flyway and the Atlantic Flyway, overlap in the Branch County area.

The large expanses of open water found in the watershed offer prime locations for many migratory waterfowl to converge on their fly through in spring and fall. Some of the more commonly occurring bird species in the watershed include owls, hawks, quail, pheasant, Wild turkey, Sora Rail, Killdeer, Woodcock, Mourning dove, Chimney Swift, Ruby-throated hummingbird, Flicker, Belted kingfisher, woodpeckers, Eastern Blue Jay, Robin, Crow, Black-capped Chickadee, Tufted tit-mouse, White breasted nuthatch, Brown creeper, House wren, Catbird, Brown thrasher, Blue bird, Cedar waxwing, Starling, English sparrow, Yellow throated, warblers, Mute swan, Canada goose, American bittern, Green and Blue herons, Sand Hill crane and over 15 different species of ducks.

In addition to the common wildlife species found within the Hodunk-Messenger Watershed, several other rare species have been documented as occurring, according to MNFI. When threatened and endangered species occur in a watershed, the importance of protecting undeveloped areas with indigenous vegetation is ever heightened. The same land use activities that threaten and impair surface water quality in the Hodunk-Messenger Watershed also reduce and degrade the necessary habitats of these species. There are several factors that affect the overall quality of a habitat, but two of the most important factors are size of undeveloped land and connectivity between these areas. For a complete listing of the highest priority natural areas in the watershed, see *Appendix K.*

Rare Species of the Hodunk-Messenger Watershed:

Blanchard's Cricket Frog	*Special Concern*
Slippershell Mussel	*Special Concern*
Henslow's Sparrow	*Threatened*
Grasshopper Sparrow	*Threatened*
Spotted Turtle	*Threatened*
Cisco or Lake Herring	*Threatened*
Creek Chubsucker	*Endangered*
Starhead Topminnow	*Special Concern*
Spotted Gar	*Special Concern*
River Redhorse	*Threatened*
Indiana Bat	*Endangered*
Copper belly Watersnake	*Endangered*
Pugnose Shiner	*Special Concern*
Tamarack Tree Cricket	*Special Concern*
Round Pigtoe	*Special Concern*
Prothonotary Warbler	*Special Concern*
King Rail	*Endangered*
E. Massasauga Rattlesnake	*Special Concern*
Regal Fritillary	*Endangered*
Dickcissel	*Special Concern*
Doug Stenelmis Riffle Beetle	*Special Concern*
Eastern Box Turtle	*Special Concern*

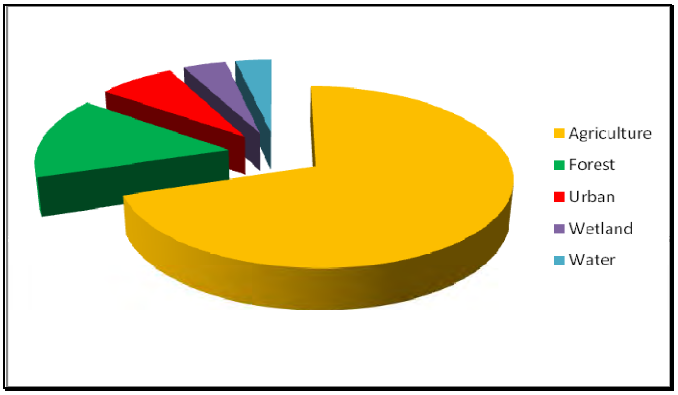
Social monitoring of the watershed community during the watershed project planning phase revealed that the number one priority activity in the watershed is viewing wildlife and nature. Unfortunately, anecdotal information collected from the Michigan Department of Natural Resources (MDNR) and MDEQ suggests that the sighting of wildlife in the watershed, with the exception of deer, has decreased over the past several decades, especially as farming operations and new developments abutting wetland areas have increased.

1.6 Land Use and Trends

Understanding the current land uses in the watershed is an important step towards understanding prevalent watershed conditions and the potential sources of pollutant sources. Alterations to the natural land cover can have magnified influences on the hydrologic and physical nature of a watershed. Moreover, watershed land use usually correlates to the activities that impact water quality. As a general rule of thumb, increased human activity generates more potential threats to water quality.

Land use in the Hodunk-Messenger Watershed is dominated by agriculture (69.94% of the watershed surface area, as represented in *Figure 1-2*). Of the 27,532 acres of agricultural land in the watershed, 13.4 % is used for hay and pastureland land, while another 56.53 % is utilized for row cropping. Traditionally, few specialty crops are usually grown within the watershed. The main row crops cultivated in the watershed are corn and soybeans.

Figure 1-2: **Watershed Land Use Breakdown**



Source: USDA NLCD

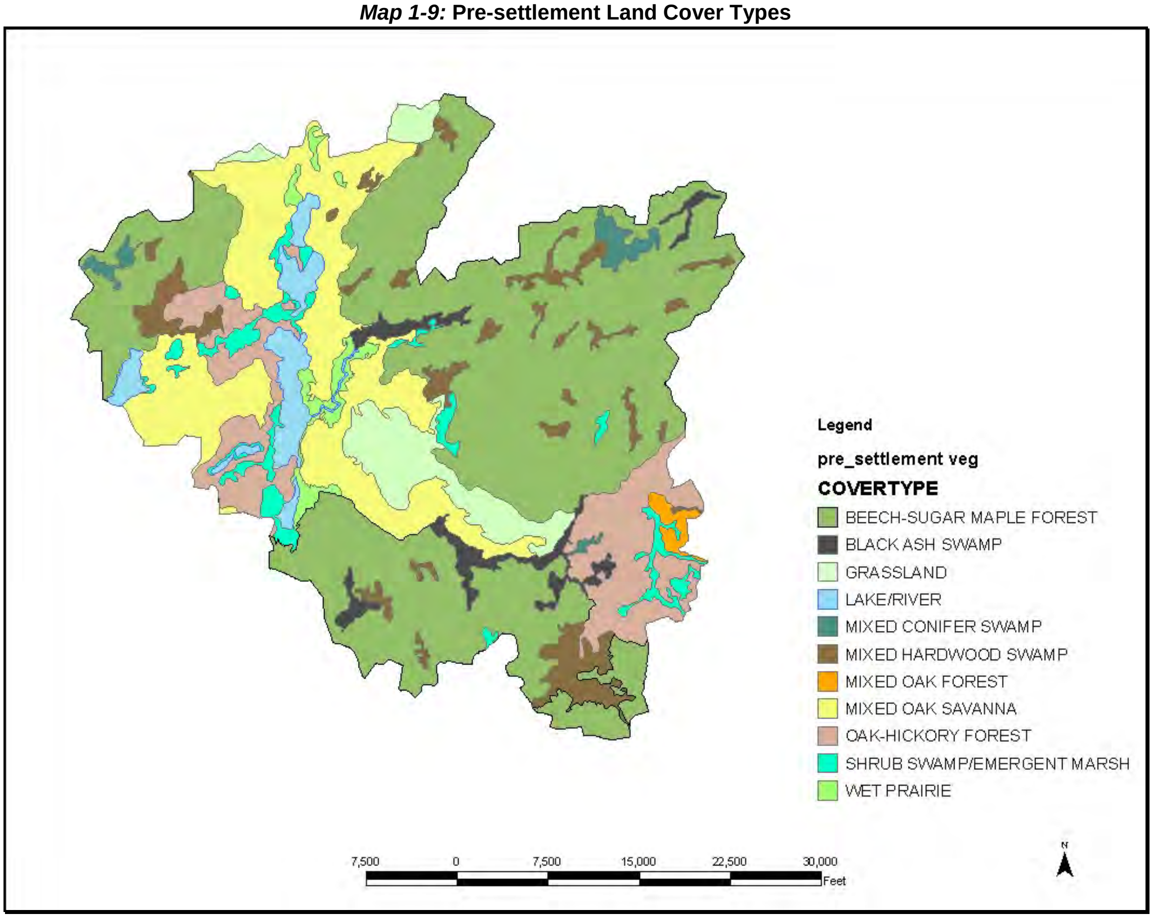
The large amount of agricultural land, coupled with another 5,298.9 acres of urban land cover, has contributed to a drastic decline of pre-settlement forests and wetlands (*Maps 1-9 and 1-15*). Historically, the landscape of the Hodunk-Messenger was comprised of 60.54% forest, 22.04% grassland and 14.14% wetlands. Today, 55% of pre-settlement wetlands in the watershed have been converted to other land uses and nearly all of the native grasslands have disappeared from the landscape altogether (*Appendix E*). The City of Coldwater occupies 7.39% of the land mass of the watershed but has the potential for additional outward growth. The following table gives a detailed breakdown of the land cover types present in the watershed both today and before European settlement:

Table 1-4: **Hodunk-Messenger Chain of Lakes Watershed Land Cover Acreage Report**

	NRCS-MI Pre-Settlement		NRCS-MI 2001 NLCD	
Class name	**Pre-settlement Acres**	**% of Watershed**	**2001 NLCD Acres**	**% of Watershed**
Row Crops	0	0%	22,258.1	56.5%
Deciduous Forest	23,846.1	60.5%	5,844.6	14.8%
Mixed Oak Savanna	6,660.8	16.9%	0	0%
Grassland	2,021.3	5.1%	0	0%
Pasture, Hay	0	0%	5,273.5	13.4%
Water	1,290.4	3.3%	1,361.4	3.5%
Low Intensity Residential	0	0%	1,357.2	3.4%
Woody Wetlands	3,690.7	9.4%	1,233.8	3.1%
Urban, Recreational Grasses	0	0%	795.1	2.0%
Commercial, Industrial, transportation	0	0%	574.1	1.5%
Emergent Herbaceous Wetlands	1,877.1	4.8%	398.0	1.0%
High Intensity Residential	0	0%	183.9	0.5%
Evergreen Forest	0	0%	77.5	0.2%
Mixed Forest	0	0%	5.9	0.0
TOTAL	**39,386.4**	**100%**	**39,362.9**	**100%**

**Values may vary slightly due to rounding. "0.0" indicates values of less than 1/10th. These values are based on NRCS-MI GIS layers and may vary slightly from NWI figures.*

Map 1-9: **Pre-settlement Land Cover Types**



1.6.1 Land Cover by Sub-watershed

Land cover types among the three sub-watersheds in the Hodunk-Messenger Watershed are generally similar in the fact that they are all dominated by row crop fields. There are, however, subtle differences found within in each of the sub-watersheds that correlate to unique sub-watershed characteristics. For instance, the Miller Lake Drain Sub-watershed contains the most forested land and has the most surface water area of any sub-watershed (*Map 1-11* and *Table 1-6*). The Sauk River Sub-watershed contains the largest amount of agricultural fields of any sub-basin in the watershed (*Map 1-12* and *Table 1-7*), and the Cold Creek Sub-watershed encompasses more urban area than any other sub-watershed (*Map 1-10* and *Table 1-5*). In order to better understand the different impairments occurring within each sub-watershed, detailed land cover analyses of each sub-basin were created.

Table 1-5: **Cold Creek Sub-watershed Land Cover Acreage Report:**

	NRCS-MI Pre-Settlement*		NRCS-MI 2001 NLCD*	
Class name	**Pre-settlement Acres**	**% of Watershed**	**2001 NLCD Acres**	**% of Watershed**
Row Crops	0	0%	7,412.7	56.8%
Deciduous Forest	8,801.2	67.4%	1,837.8	14.1%
Mixed Oak Savanna	1,263.6	9.7%	0	0%
Grassland	1,201.5	9.2%	0	0%
Pasture, Hay	0	0%	1,774.5	13.6%
Water	30.9	0.2%	25.3	0.2%
Low Intensity Residential	0	0%	776.9	6%
Woody Wetlands	1,343.5	10.3%	431.3	3.3%
Urban, Recreational Grasses	0	0%	390.9	3%
Commercial, Industrial, transportation	0	0%	185.7	1.4%
Emergent Herbaceous Wetlands	423.2	3.2%	104.6	0.8%
High Intensity Residential	0	0%	80.3	0.6%
Evergreen Forest	0	0%	36.0	0.3%
Mixed Forest	0	0%	0.2	0%
TOTAL	**13,063.9**	**100%**	**13,056.3 ac.**	**100%**

**Values may vary slightly due to rounding. "0.0" indicates values of less than 1/10th. These values are based on NRCS-MI GIS layers and may vary slightly from NWI figures.*

Map 1-10: **Land Use/Land Cover in Cold Creek Sub-Watershed**

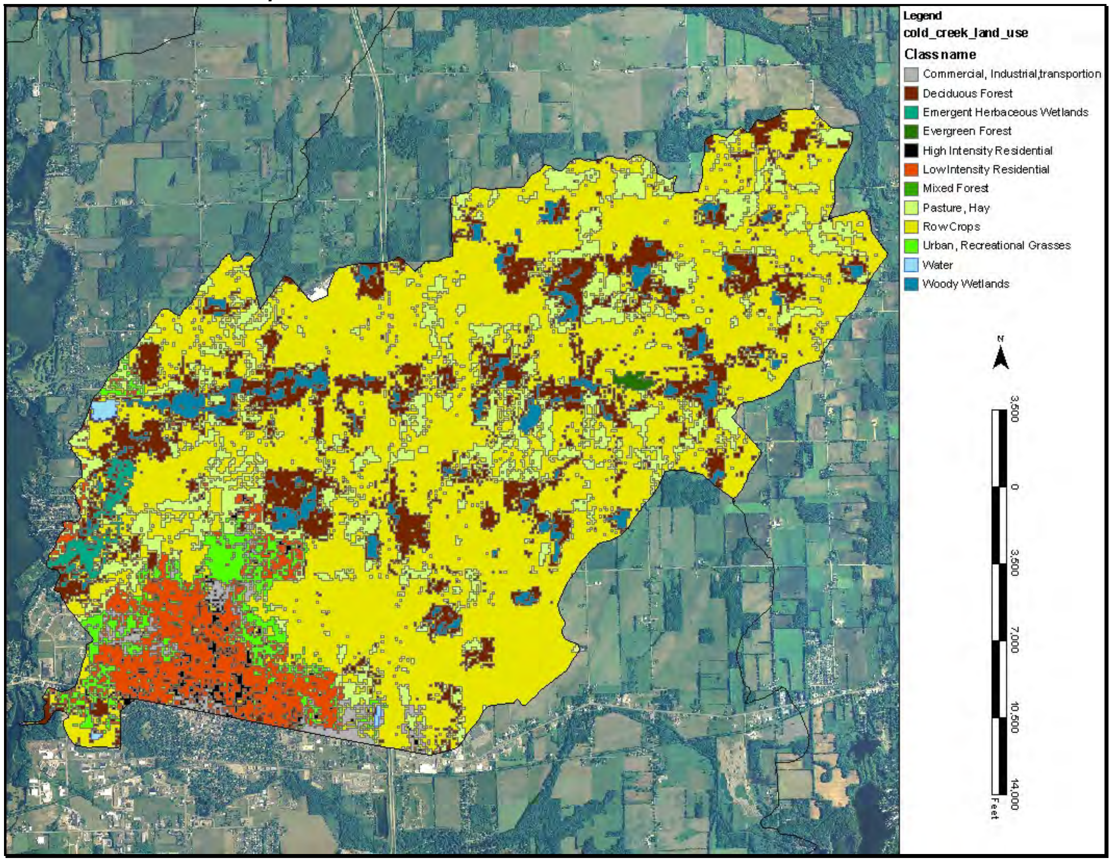


Table 1-6: **Miller Lake Drain Sub-watershed Land Cover Acreage Report:**

	NRCS-MI Pre-Settlement*		NRCS-MI 2001 NLCD*	
Class name	**Pre-settlement Acres**	**% of Watershed**	**2001 NLCD Acres**	**% of Watershed**
Row Crops	0	0%	8,487.7	55.1%
Deciduous Forest	7,128.1	46.2%	2,290.7	14.9%
Mixed Oak Savanna	4,690.7	30.4%	0	0%
Grassland	341.9	2.2%	0	0%
Pasture, Hay	0	0%	2,044.2	13.3%
Water	1,259.5	8.2%	1,265.8	8.2%
Low Intensity Residential	0	0%	208.2	1.4%
Woody Wetlands	890.5	5.8%	480.4	3.1%
Urban, Recreational Grasses	0	0%	182.9	1.2%
Commercial, Industrial, transportation	0	0%	115.5	0.7%
Emergent Herbaceous Wetlands	1,105.6	7.2%	287.8	1.9%
High Intensity Residential	0	0%	21	0.1%
Evergreen Forest	0	0%	20.5	0.1%
Mixed Forest	0	0%	2.8	0.0%
TOTAL	**15,416.3**	**100%**	**15,407.5 ac.**	**100%**

**Values may vary slightly due to rounding. "0.0" indicates values of less than 1/10th. These values are based on NRCS-MI GIS layers and may vary slightly from NWI figures.*

Map 1-11: **Land Use/ Land Cover in Miller Lake Drain Sub-Watershed**

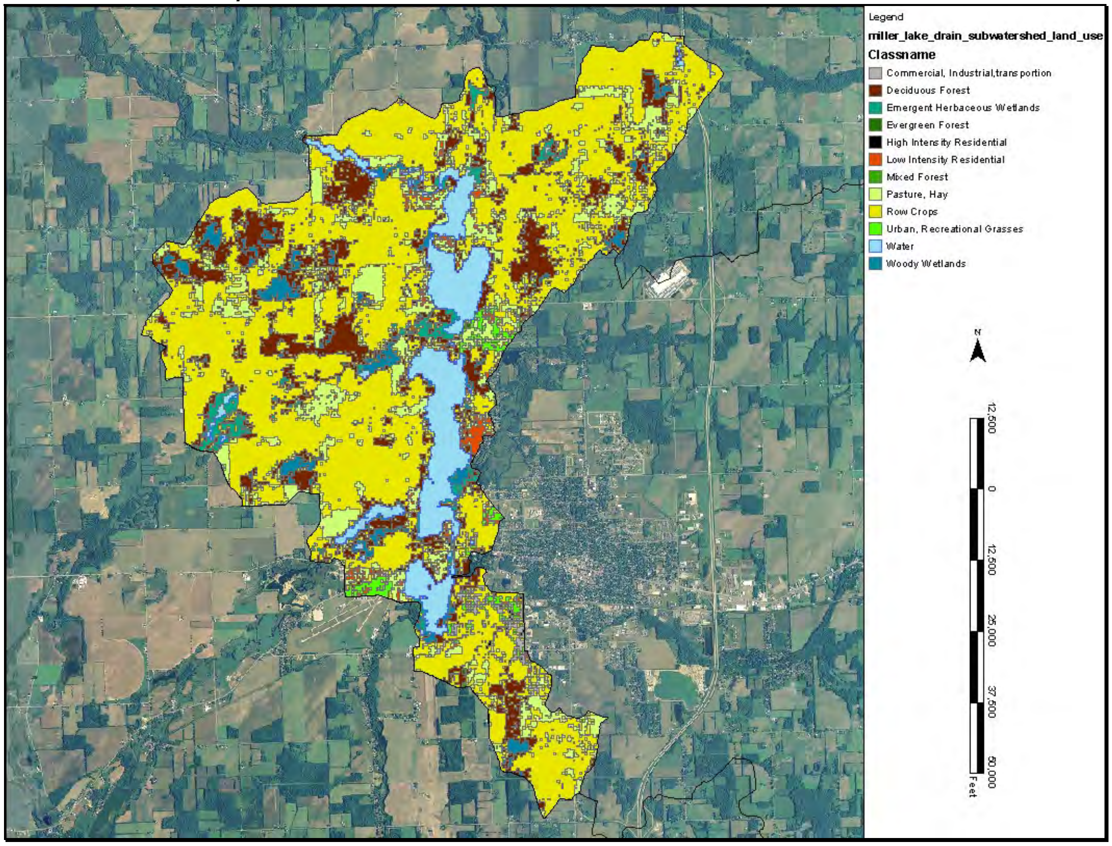
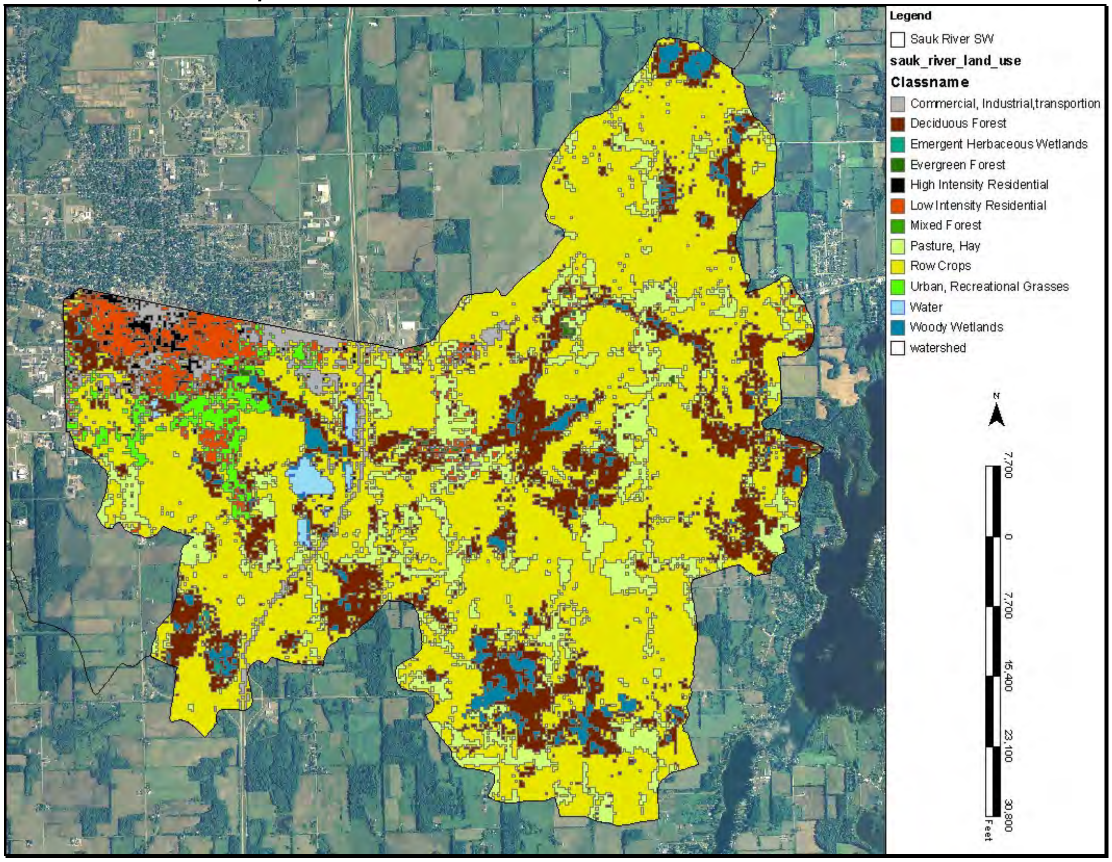


Table 1-7: **Sauk River Sub-watershed Land Cover Acreage Report:**

	NRCS-MI Pre-Settlement*		**NRCS-MI 2001 NLCD***	
Class name	**Pre-settlement Acres**	**% of Watershed**	**2001 NLCD Acres**	**% of Watershed**
Row Crops	0	0%	6,357.2	58.3%
Deciduous Forest	7,916.7	72.6%	1,716.1	15.7%
Mixed Oak Savanna	706.1	6.5%	0	0%
Grassland	477.9	4.4%	0	0%
Pasture, Hay	0	0%	1,454.7	13.3%
Water	0	0%	70.3	0.6%
Low Intensity Residential	0	0%	372.1	3.4%
Woody Wetlands	1,456.7	13.4%	322.1	3.0%
Urban, Recreational Grasses	0	0%	221.2	2.0%
Commercial, Industrial, transportation	0	0%	272.8	2.5%
Emergent Herbaceous Wetlands	348.3	3.2%	5.5	0.1%
High Intensity Residential	0	0%	82.5	0.8%
Evergreen Forest	0	0%	21	0.2%
Mixed Forest	0	0%	2.9	0.0%
TOTAL	**10,905.6**	**100%**	**10,898.5 ac.**	**100%**

**Values may vary slightly due to rounding. "0.0" indicates values of less than 1/10th. These values are based on NRCS-MI GIS layers and may vary slightly from NWI figures.*

Map 1-12: **Land Use/Land Cover Sauk River Sub-Watershed**



1.6.2 Recreational Uses

Because of the abundant surface water resources in the watershed, recreation and tourism have become major drivers of the local economy. The aesthetic vistas and recreational opportunities associated with lakes and rivers such as swimming, boating and fishing invites vacationers, hobbyists and seasonal residents to become active in the watershed in the months from April to October. Within the watershed, other outdoor recreational venues such as a Golf Course, driving range, recreation trails, dog walking park, five waterfront campgrounds, a public fishing pier, two MDNR public lake access sites and a public beach are also available. The chain of lakes, with its robust game fish populations, also plays host to a multitude of sport fishing tournaments throughout the year.

While these opportunities create benefits like a sense of watershed ownership and increased revenue for the local community, it also creates additional stressors on the health of the watershed and threatens the ecological balance of the lakes. Multiple lake access sites facilitate the introduction of invasive aquatic plants and invertebrates, while increased boat traffic creates erosive wave action and potential fuel leak threats. Public feedback compiled through social monitoring during the watershed planning project revealed that reduced litter along lakes and streams, extended recreational trails, improved lake and stream access, navigational river courses, improved navigation and scenic vistas are

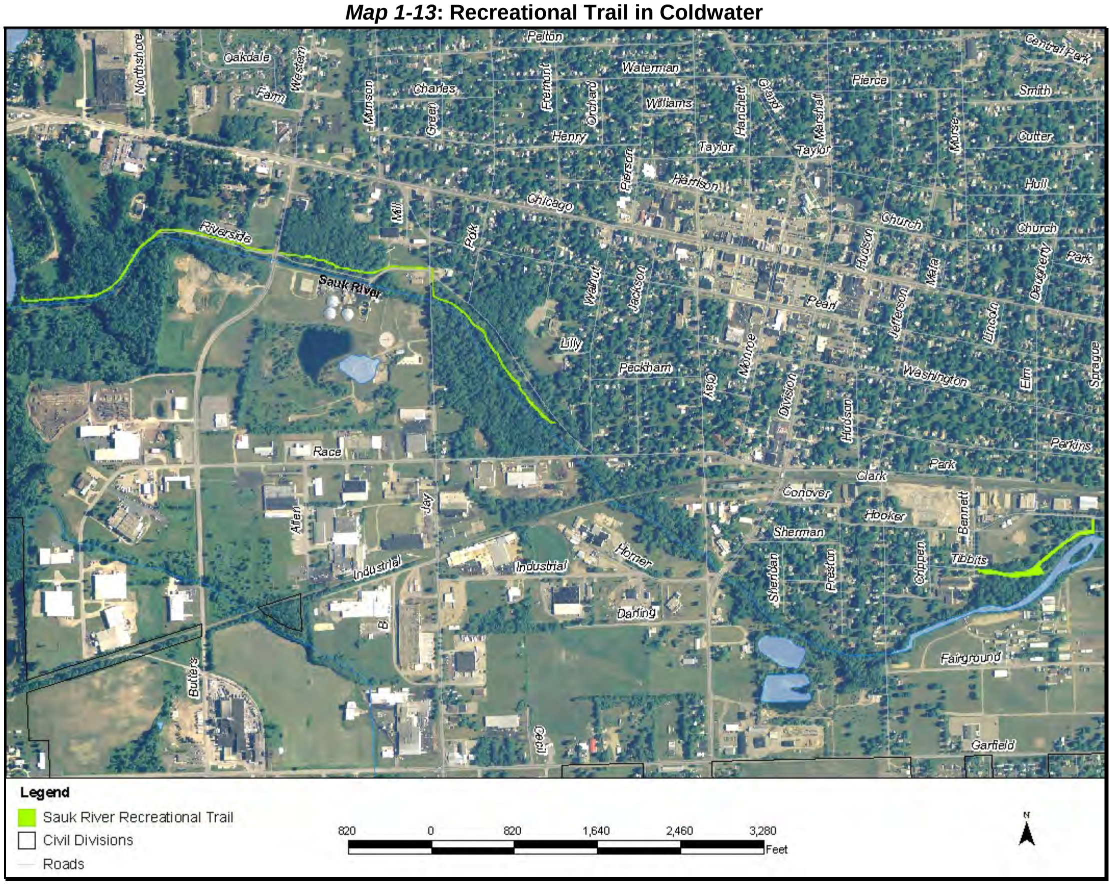
Common Sport Fish of the Hodunk-Messenger Chain of Lakes Watershed:

Bluegill
Green Sunfish
Pumpkinseed
Rock Bass
Smallmouth Bass
Largemouth Bass
White Crappie
Northern Pike
Yellow Perch
Brown Bullhead
Channel Catfish

among the top recreational priorities among the watershed community.

Beyond the MDNR public lake access sites, there are no state or federally owned lands publicly available for recreation in existence in the watershed. There are however, several parks in the City of Coldwater available for public recreation. Many of these areas are found on parcels adjacent to the Sauk River. Within these parks there is also an established linear trail that runs parallel to the Sauk River. Even though the trailway is fragmented into several areas of the city, there is a total of 8,043 (1.5 miles) linear feet of trail available for public use (*Map 1-13*). The forested land that surrounds these portions of linear trail way provide a corridor of green space within the city and acts as a beneficial buffer to the Sauk River. City officials have expressed an interest in extending and connecting these portions of trail way.

***Map 1-13*: Recreational Trail in Coldwater**



To underscore the prevalence and importance of scenic vistas in the watershed, it should be noted that the I-69 corridor, which passes through the center of the watershed in a north-south direction, has been recognized by the Michigan Department of Transportation (MDOT) as a recreational heritage route because of its scenic qualities. In 2002, a Scenic Corridor Management Plan was developed for the purpose of bolstering recreational opportunities along the I-69 corridor, as well as protecting and enhancing the scenic quality of the corridor as it passes through Branch and Calhoun Counties. Because of this heritage route designation, I-69 has been designated as the "Gateway to Michigan". Many of the goals and objectives associated with the I-69 Scenic Corridor Management Plan, such as open space preservation and wetland mitigation, fall in alignment with the goals and objectives of this WMP.

1.6.3 Agriculture

Due to the abundance of prime farmland soil types (as defined by the USDA); agriculture has overwhelmingly become the primary land use activity within the watershed. In the entire watershed, there are 21,197.4 acres (53.8%) that are considered prime farmland, 9,648.9 acres (24.5%) that would be prime if drained. 5,409.5 acres (13.7%) are farmlands of local importance and 3,130.5 acres (7.9%) of farmland are considered to be "not prime". This data provides reason for the predominately agricultural land use in the watershed. Of the 27,932.4 acres that constitute the farm fields of the watershed, 58.4% are prime, 29.2% are prime if drained, 10.9% are locally important and 1.6% are not prime.

Of the areas currently utilized for agriculture in the watershed, 5,273.5 acres (19.2% of the agricultural land) is in hay or pasture land and 22,258.1 acres (80.85%) are used for row crops. The soils in the watershed are proven to be conducive for producing cash crops, mainly corn and beans. Areas of row cropping present heightened risks for **sheet** and **rill erosion** to occur, especially when situated on slopes. Practices such as conservation tillage, runoff diversions and filter strips are actively being employed in some of these areas in the watershed in order to reduce runoff and exposure time of disturbed soils.

***Figure 1-3*: Row Cropping on Slope Near Stream in Watershed**

Very few farms in the watershed produce specialty crops, as in other parts of Branch County, and fewer yet require any significant irrigation. In contrast, extensive tiling has been required to facilitate expedient drainage throughout much of the watershed. Much of the wetland loss incurred within the watershed has also been contributed to the conversion of land to agriculture.

Compared to 19th and 20th century numbers, relatively few livestock operations remain in the watershed. Today, livestock in the watershed consists mainly of sheep, hogs and horses. Limited numbers of beef cow and poultry operations are also scattered throughout the watershed, along with a single dairy operation in the Cold Creek Sub-watershed. Although limited, the barnyards, feedlots and grazing pastures present in these livestock operations present a high risk potential for excessive nutrient leaching to surface waters if not properly managed. Threats are especially compounded in locations where livestock have unrestricted access to streams.

Collectively, not only does agriculture add economic stability to the watershed community, it also adds to the network of open space prevalent throughout the watershed. Open space is an important characteristic for the quality of life in the watershed by offering scenic vistas and serving as a buffer between development and natural landscapes. Agricultural lands, if properly managed, can also provide areas for stormwater infiltration and wildlife travel corridors. Through feedback collected from watershed stakeholders during the watershed planning process, a strong desire to preserve open space and rural character has become apparent in the watershed community. In fact, in 2007 Branch County adopted a farmland preservation ordinance into their comprehensive master plan for the desired purpose of permanently preserving farmland and open space.

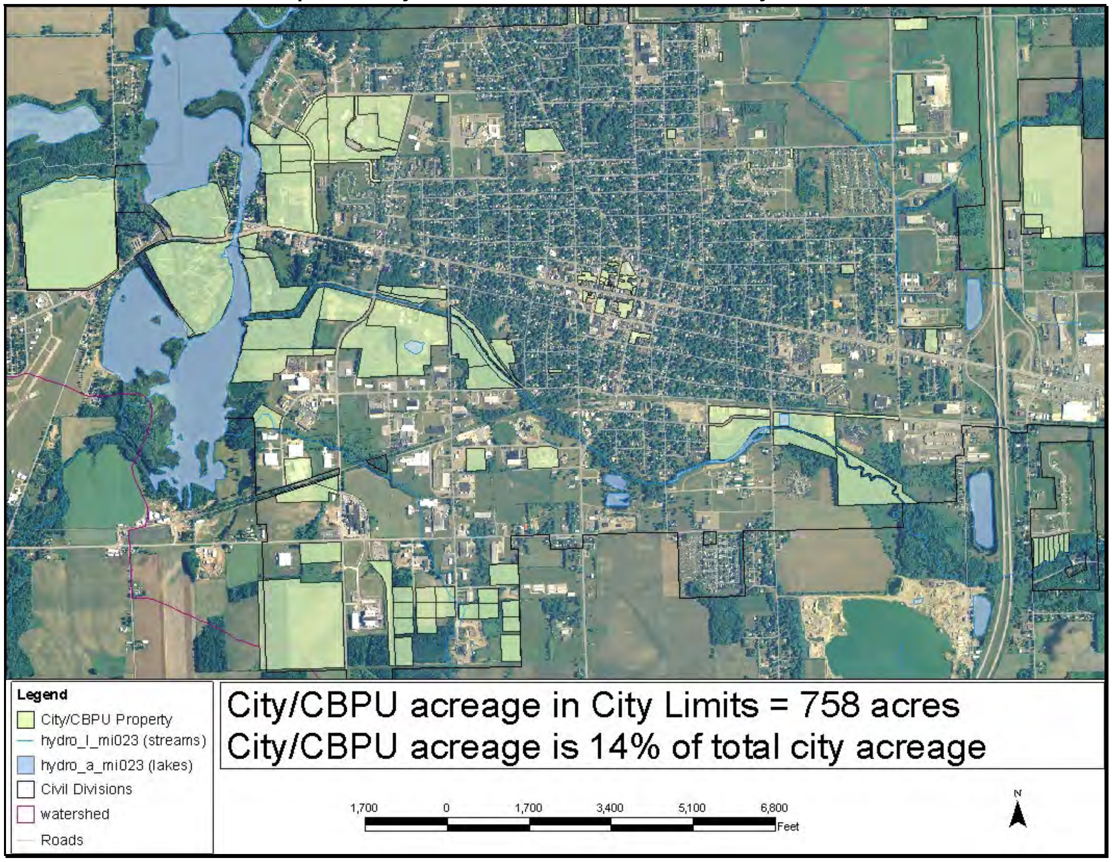
1.6.4 Urbanization trends

The City of Coldwater is located in the center of the Hodunk-Messenger Watershed and overlays parts of all three sub-watersheds. Coldwater contains two major transportation arteries in US-12 and I-69. US-12, also known as Chicago Street runs east and west through the City of Coldwater and bisects the watershed laterally. I-69 intersects US-12 and passes through the middle of the watershed running North and South. Industrial zones within the city are primarily concentrated south of US-12 in the Sauk River Sub-watershed, with the exception of some newer industrial developments along Michigan Avenue in the Cold Creek Sub-watershed.

The City of Coldwater currently owns approximately 758 acres of land within the city boundary (*Map 1-14*). One of these city-owned tracts is a 26-acre plot of land in the Miller Lake Drain along the eastern side of Cemetery Lake was once the site of an industrial plant, but has since been vacated and designated as a “Brownfield” site. A **Brownfield** is an area where expansion or redevelopment is complicated by the presence or potential presence of a hazardous substance, pollutant or contaminant. Today, this site has been removed of its developments and sits idle as open space. In regards to this and other City-owned properties, City of Coldwater representatives have remarked on their willingness to work with BCCD in implementing beneficial urban BMPs to help restore pre-development infiltration rates throughout the city.

The Miller Lake Drain is also host of the Branch County Municipal Airport and Oak Grove Cemetery, both of which are located on the west side of the chain of lakes along the western fringe of the City. Urbanization trends indicate that new development is primarily spreading to the east of I-69 along US-12. Through zoning, these new developments on the eastern fringe of the city are restricted to commercial and residential use only. As of June 26, 1995, all new and redevelopments within the City limits are required to treat **stormwater** on site, instead of conveying it directly into the municipal storm sewer system. As the 1995 City ordinance states: “stormwater shall be detained on site for controlled release. Special attention shall be given to proper site drainage such that the controlled release of storm waters will not adversely affect neighboring properties.”

***Map 1-14*: City Owned Land within Coldwater City Limits**



Currently, the Coldwater Board of Public Utilities supplies water and sanitary sewer services to all of Coldwater's industrial sites, commercial businesses and residences. According to a study completed by the City in January of 2008, the City water treatment facility and water supply will be adequate through 2028 if growth continues at historical rates. The City's sanitary sewer system currently treats an average of 2.2 million gallons of wastewater daily with an approximate surplus capacity of 640,000 gallons per day (GPD). This 640,000 GPD could allow service to an estimated 3,000 additional residents if Coldwater were to expand its municipal infrastructure to outlying developments.

However, with urban expansion comes the associated increase of impervious surface coverage in the watershed. In short, impervious surfaces cover soils that, before development, allowed stormwater to infiltrate. Impervious surfaces therefore affect both the quantity and quality of water resources in the watershed. Impervious surfaces include rooftops, transportation ways (roads, driveways and sidewalks) and parking lots. In recent years, research has shown that the amount of impervious surface in a watershed can be a reliable indicator of the impacts of development on water resources. Some of the specific threats that increased impervious surfaces presents for water quality in a watershed include increased stormwater runoff volume, habitat and open space loss, temperature modification of surface water, loss of infiltration and groundwater recharge, sedimentation from construction and excavation sites and chemical and nutrient loading from the **first flush** of stormwater runoff associated with precipitation falling on impervious surfaces.

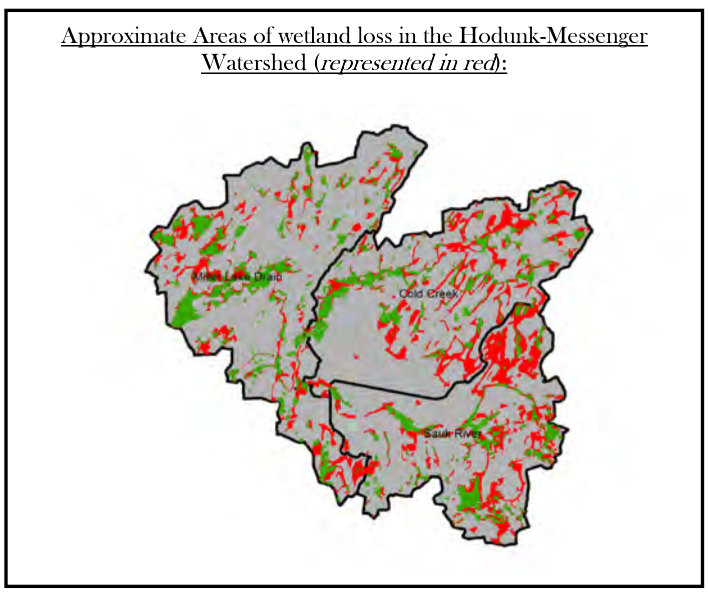
Increased impervious surface in a watershed results in more frequent flooding, higher peak flows and lower base flows in streams, and lower water table levels. Currently, the boundaries of the City of Coldwater encompass 5,298.92 acres, or 13.5%, of the watershed's land mass. Of these 5,298.92 acres, approximately 2,115.2 of them consist of some type of impervious surface. This amount of impervious surface coverage is equivalent to 5.4% of the watershed surface area.

According to a build out analysis featured in the St. Joseph River WMP (2005), urban developments could spread to another 7,907 acres in the years to come. This increase in development is estimated to result in a 23% increase in stormwater runoff, 12 ton/year increase in total suspended solids (TSS) and a 42.5 ton/year increase in total phosphorus. Additional build out analyses for Butler Township and Coldwater Township were generated through the NRIs and Land Use Planning Analyses created by Wightman Petrie and McKenna Associates (*Chapter 9, Appendix M*). These build out analyses indicate that Butler Township could grow to a population of 28,257-31,321 with 11,894-13,042 dwelling units (2,622% increase) while Coldwater Township could grow to a population of 55,939-84,052 with 21,592-31,244 dwellings units (1,519% increase).

1.6.5 Wetland Status and Trends

Wetlands play an important role in the watershed by providing floodwater storage, buffers which trap and prevent the entry of sediment and other pollutants into groundwater aquifers and open surface water bodies, and critical wildlife and aquatic life habitat. In 2008 a Wetlands Status and Trends report was generated for the Hodunk-Messenger Watershed by MDEQ Land and Water Management Division (LWMD), based on 2005 National Wetlands Inventory (NWI) data (*Appendix J*). This report documents the conditions of wetlands in the watershed in 2005 and analyzes the decline of watershed wetlands from pre-settlement to 2005. Results of the Wetlands Status and Trends Report show that the Hodunk-Messenger Chain of Lakes Watershed has lost approximately 4,480 acres of pre-settlement wetlands (*Map 1-15*). Based on 2005 NWI data, only 49% of the original watershed wetland acreage still exists.

***Map 1-15:* Wetland Loss**



Source: MDEQ-LWMD Status and Trends Report (based on 2005 NWI data)

Of the 49% of wetlands that remain in the watershed today, all were found to be severely fragmented. Before European settlement there were an estimated 411 separate wetland complexes, with an average size of 21 acres per complex. In 2005, there were 750 wetland areas with an average size of only 5.3 acres per wetland unit.

Of the three Hodunk-Messenger sub-watersheds, the Sauk River Sub-watershed has sustained the greatest amount of wetland loss over time. After losing 1,748 acres of wetlands, the Sauk River Sub-watershed only contains 39% of its original wetland acreage. Of the three sub-watersheds, the Miller Lake Drain Sub-watershed has retained the greatest amount of its pre-settlement wetlands, presently sustaining 63% of its original wetland acreage.

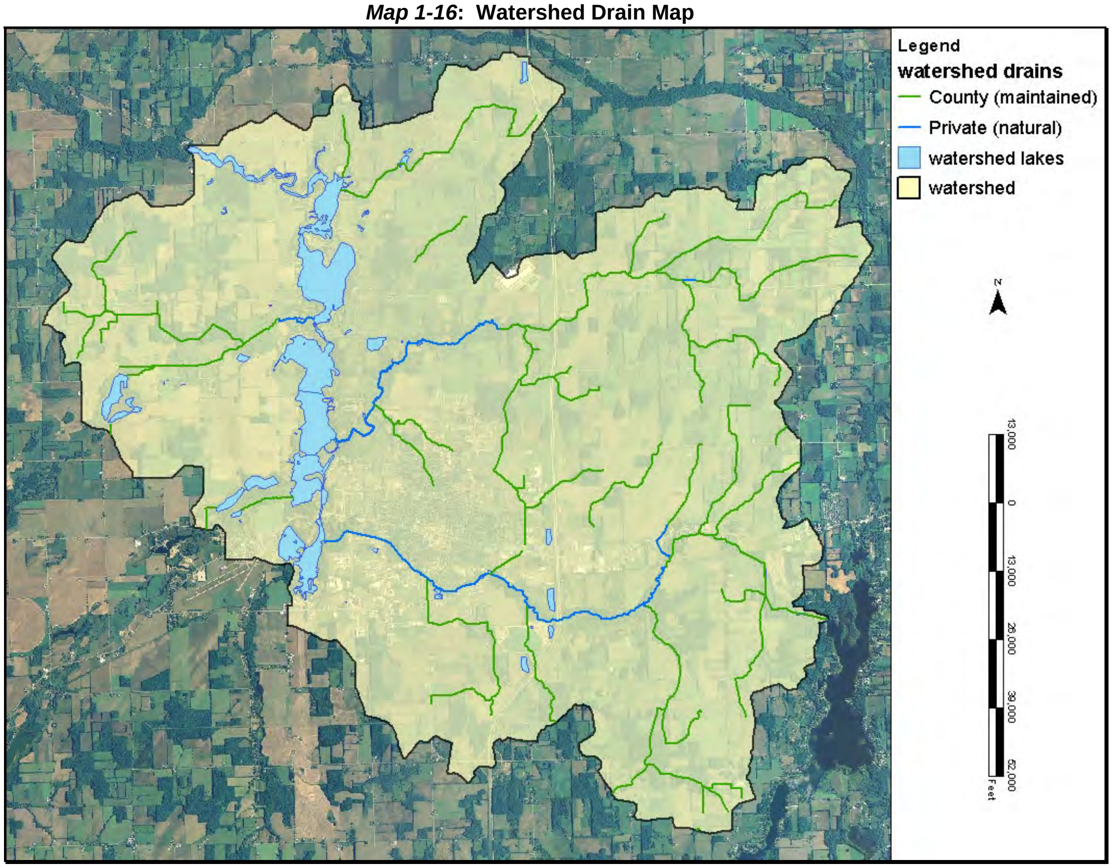
Wetlands provide flood protection, pollutant filtration and critical wildlife and aquatic life habitat.

In large part, wetland loss in the watershed can be attributed to the 27,531.6 acres of land that have been converted to agricultural cultivation, and to a smaller extent- residential and urban development. Wetland filling, drainage and fragmentation have led to reduced groundwater recharge, instability of watershed hydrology and loss of indigenous wildlife and aquatic life habitat. Wetland areas provide vital watershed functions, such as stream and shoreline stabilization, nutrient transformation, and floodwater retention (*Appendix J*).

1.6.6 Relevant Authorities

All portions of the Hodunk-Messenger Watershed are subject to the regulation, and privileged to the services of Branch County Government. The county government extends authority to such aspects as county road work, civil law, county parks, and perhaps most relevant to watershed management- county drain maintenance. *Map 1-16* illustrates the drainage ways of the watershed and identifies whether or not they are maintained by the County Drain Commission. In the Hodunk-Messenger Watershed, the majority of county owned and operated drains are located in the mid and upper regions of the watershed. Duties of the County Drain Commission include drain cleanouts, obstruction removal, culvert repair and replacement and general flow maintenance. The County is also responsible for administering a county-wide Soil Erosion and Sedimentation Control (SESC) program.

***Map 1-16*: Watershed Drain Map**



Source: USDA-NRCS GIS Department, based on Branch County Drain Maps (circa 1960's) and aerial "field truthing"

Beyond county control, there is also the political authority of eight different townships and one city (Coldwater) within the watershed. These individual municipalities are responsible for planning, zoning, building and setting ordinances within their respective boundaries. Therefore, there are nine separate areas of the watershed that fall subject to the planning and zoning authorities of nine separate municipalities; each area subject to the township (or City) it falls within. In this respect, Coldwater and the various townships play a vital role in the long-term land use of the watershed.

There are no federally-owned or protected lands within the watershed. On the state level, all point source pollutant discharges are subject to regulation through the MDEQ. There are two MDNR maintained public access sites on the Hodunk-Messenger Chain of Lakes. There are also 185.7 acres owned and regulated by the State of Michigan for the use of the Coldwater Correctional Facilities. This site is located in the Cold Creek Sub-watershed and is the only land in the entire watershed not owned by local authorities. However, even though they are situated on private lands, all surface water bodies and wetlands in the watershed are regulated by MDEQ. This regulation includes overall resource protection, monitoring of water quality and permitting for land alterations. On a local level, the Branch-Hillsdale-St. Joseph Community Health Agency is responsible for maintaining and overseeing environmental quality as it pertains to public health. The USDA also maintains regulatory authority in the watershed when it pertains to agricultural land under contract with the federal Farm Bill and land being converted from a natural state to agricultural use. All indigenous wildlife, fish and other aquatic life species are protected and regulated by the MDNR as a public resource, with the exception of migratory birds, which are regulated by US Fish and Wildlife Service. BCCD maintains no regulatory authority within the watershed and exists solely as a resource for technical assistance related to soil and water conservation.

1.7 Population and Demographics

There are an estimated 24,908 people living within the boundaries of the Hodunk-Messenger watershed. Over half of this population is concentrated within the City of Coldwater. With an estimated population of 12,697, Coldwater is the fastest growing urban area in south-central Michigan. Based on U.S. Census data, Branch County had the highest growth rate of any county on the Michigan side of the St. Joseph River Watershed (10.3%) between 1990 and 2000. Between 1980 and 2000, Branch County exhibited a 13.9% growth rate while the state of Michigan as a whole only exhibited a 7.3% growth.

Roughly 2.6% of the watershed community is reported as being foreign born. Persons of Hispanic origins comprise 3% of the watershed demographics. Black persons make up another 2.6%. People of American Indian descent are found in 0.5% of the population. Asian persons comprise 0.4% and persons classified as reporting some other race or multiple races comprise 3.1% of the watershed population. The other 93.4% of the watershed community is listed as white. The 2000 US Census data also reports that 23% of watershed residents are under 18 years old and 14% are over 65. While not recorded in Census data, public participation events conducted during the watershed planning project have also revealed a significant Amish component in the agricultural community of the watershed.

2. PROJECT BACKGROUND AND DEVELOPMENT

2.1 Project Background

In 1987, the federal government amended the 1972 Clean Water Act (CWA) to include Section 319. Section 319 recognized the need for greater federal leadership to help focus State and local nonpoint source pollution control efforts. Under Section 319, State, Territories, and Indian Tribes receive grant funds to support a wide variety of activities including technical assistance, financial assistance, education, training, technology transfer, demonstration projects, and monitoring to assess the success of specific nonpoint source implementation projects. State environmental protection departments such as MDEQ receive Section 319 funding, and then provide local governments and non-profit watershed organizations with grants to develop and implement comprehensive watershed management plans.

Immediately taking advantage of this funding opportunity, the BCCD began applying for a Section 319 grant to develop a WMP to address the concerns for the Hodunk Messenger Chain of Lakes Watershed. Multiple assessments and improvement projects had been conducted on this watershed throughout the years but nothing had proven effective in slowing the sedimentation and rapid algae and aquatic plant growth that kept occurring in the lakes. BCCD realized that resolving these problems meant developing a comprehensive strategy to reduce NPS pollutant inputs from the surrounding watershed. After several proposal applications in the 1990’s and early 2000’s, BCCD finally was approved for a Section 319 watershed planning grant in fiscal year 2006.

2.2 Project Development

The Clean Water Act (CWA) requires Michigan to prepare a biennial report on the quality of its water resources. This “Integrated Report” satisfies the listing requirements of Section 303(d) and the reporting requirements of Section 305(b) and 314 of the CWA.

Utilizing these recently acquired Section 319 grant funds, BCCD spent 2.3 years gathering surface water information and developing a plan to enhance and improve water quality in the Hodunk-Messenger Chain of Lakes Watershed. This was accomplished by investigating the sources and causes of pollutants impacting the water quality through “in-field” watershed inventories, digital land cover analyses, pollutant load modeling and the compiling of water quality data from various sources and past studies. A significant portion of staff time was also spent disseminating information and educational material and promoting community involvement for the purpose of generating watershed awareness. The final and most important allocation of project resources was also spent towards developing this comprehensive WMP and recommending measures to reduce pollutant loads and restore designated uses.

Water quality data for the Hodunk-Messenger Watershed was collected from a variety of sources, such MDEQ and MDNR biological surveys and reports, watershed pollutant estimation models, stakeholder feedback (*Appendix A*), lake association water quality monitoring data, environmental data from the USDA-NRCS and Branch-Hillsdale-St. Joseph Community Health Agency, as well as CWA Section 303(d) and 305(b) lists compiled in the MDEQ biennial Integrated Report on water quality.

The Hodunk-Messenger Chain of Lakes Watershed Planning Project was coordinated by Benjamin Wickerham (BCCD Watershed Project Coordinator), administered by Julia Kirkwood, MDEQ-Environmental Science and Services Division (ESSD) NPS Grants Program Administrator, assisted by Rick Pierson (BCCD Administrator, 2006-2007) and Kathy Worst (BCCD Administrator, 2007-present), and overseen by the BCCD Board of Directors.

Significant contributions of time and in-kind services were also supplied by a cadre of advisors, partnering agencies, resource professionals and local stakeholders. For a complete listing of planning project involvement, please refer to *Appendix N.*

In order to identify issues of concern among residents in the watershed, a series of public meetings and educational workshops were held throughout the watershed project. Both the public meetings and the educational workshops introduced the watershed project and provided residents with a forum to express their concerns or ask questions. The Watershed Coordinator also participated in several watershed management training programs throughout the course of the project.

2.2.1 Data Collection

A number of methods were adopted for obtaining the background data necessary for making sound watershed management recommendations for the improvement and enhancement of water quality in the Hodunk-Messenger Watershed. These methods included Geographic Information System (GIS) land cover analyses, aerial photo review, in-field watershed inventories, social monitoring, pollutant load estimation models and road stream crossing monitoring. Information was also gathered from other sources such as past watershed studies, regulatory water quality data and reports from other relevant agencies. All watershed assessment methods are included as *WMP Appendices C-K* and summarized in *Chapter 4*.

2.3 Public Participation

For any natural resources project to succeed, it must be accepted and have ownership in the local community, be based on sound science, and its plans must be reasonable, achievable, and developed with broad based expertise. To acquire this broad base of expertise, a Watershed Project Advisory Council was formed to provide guidance and lend oversight and direction to the project and the development of a WMP. The Watershed Project Advisory Council was comprised of local stakeholders, educators, City of Coldwater and consulting environmental engineers, resource professionals, representatives from the North Chain Lake Association, public officials and MDEQ advisors (*Appendix N*). All interested stakeholders were encouraged to become part of the Watershed Advisory Council and lend their voice to the planning project. In fact, early in 2007, a pre-program social survey was developed and administered to watershed residents for the purpose of assessing the community's level of watershed understanding and to collect feedback from the public about concerns and desires for the future use of the watershed.

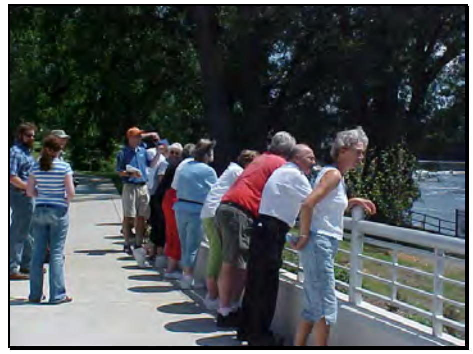
The Advisory Council aided the Watershed Project Coordinator by providing historic watershed data and land use planning assistance. The Watershed Project Advisory council also helped direct watershed programs and events and provided useful input into local desires and concerns. In addition to the Watershed Project Advisory Council, two smaller subcommittees of resource professionals from around the region were formed. A Technical Subcommittee was formed to oversee and review the development of this WMP and an Information and Education (I/E) Subcommittee for the overview and development of a watershed I/E Strategy (*Chapter 9*).

Two public meetings were also held during the planning project- one in the beginning and one toward the end. The first was held in early August of 2007, for the purpose of introducing the public to the problems of the watershed, the intention of the planning grant, and overall watershed planning process. At this meeting, the 96 watershed residents in attendance were encouraged to ask questions and provide feedback, become involved in volunteer projects, attend Watershed Advisory Council meetings and to sign up for bi-annual newsletters. Public comments from this meeting were recorded and later followed up on if they involved the location of potential sources of NPS pollution. A second public meeting was held in late May of 2009 for the purpose of presenting the results of the planning project, the WMP and the associated recommendations to the public. At this meeting, watershed residents (47 in attendance) were given an opportunity to ask questions, provide feedback or to receive draft copies of the WMP to review. A complete listing of the public and committee meetings conducted during the course of the planning project may be found in *Appendix N.*

2.3.1 Information and Education

In order to gain support for the watershed project, increase watershed understanding, raise public awareness of the NPS pollution affecting the Hodunk-Messenger Chain of Lakes and to encourage individuals to get involved with the watershed management process; a watershed I/E campaign was administered to the public throughout the duration of the planning project. Roughly 15% of the time and funds from the Section 319 planning grant went toward coordinating and providing various I/E events and materials for watershed residents. Components of this I/E program included:

- A pre-program social survey
- A public introduction meeting
- Annual watershed tours
- Several school group presentations on water quality per year
- Annual macro invertebrate sampling days with local schools
- Lake Association & Lake Board presentations
- BCCD Conservation Expo and Annual Meeting presentations
- A Rotary Club presentation
- A Garden Club presentation
- A shoreline management workshop
- An MSU-E Citizen Planner course: "Land use planning for water quality"
- Distributable watershed maps
- A project brochure
- Bi-annual watershed project newsletters
- A multi-faceted storm drain inlet labeling project
- Cost sharing for soil test kits
- A website to provide watershed project information
- A centrally located resource library (Branch District Library)
- A public wrap-up meeting



It is hoped that positive changes in watershed stewardship will occur as a result of these I/E efforts. The I/E program is also expected to smooth the transition from watershed planning to implementation. Raising awareness is likely to result in more landowners willing to implement measures to enhance water quality on their own properties. During the planning phase alone, there have been beneficial achievements for the improvement of water quality in the watershed. To date, about 400 storm drain inlets have been labeled with placards showing pre-cast messages warning citizens of the direct connection of the municipal storm sewer system to local waterways, nine additional watershed residents began testing their soil for nutrients, 11 local officials were trained in land use planning for water quality, 52 residents volunteered their time toward watershed project events like storm drain marking, subscriptions to the watershed project newsletter continually grew, stronger partnerships with lake associations and local entities developed and the Advisory Council responsible for overseeing the development of this WMP regularly expanded its participation base.

2.3.2 Outreach

Public outreach was instrumental in reaching individual watershed residents and getting them involved in watershed project events. Without aggressive I/E outreach efforts, the planning project would not have been nearly as successful in discovering the local concerns and desires for future watershed use. Things such as resident feedback and participation in public meetings, elected officials' participation in land use planning training, workshops with high levels of attendance, increased numbers of soil testing, establishment of lakeshore buffer plantings and storm drain marking efforts would have all been far less effective if not for the strong outreach component of the project.

Methods used to promote the watershed project and get people involved in the planning process included:

- Acquisition of a mailing list containing all address points within the watershed from the Branch County 911 Dispatch/GIS Department
- Acquisition of a Lake Association mailing list
- Mass mailings to advertise workshops
- A subscription based watershed newsletter, distributed bi-annually
- Radio Announcements
- Press releases in the local paper
- Distribution of NPS information, MDEQ informational booklets, helpful pollutant reduction guides and watershed project brochures at public events
- Promotional items (t-shirts, door hangers and reusable grocery bags)

The media outlets in Branch County have proven to be some of the most beneficial resources for proliferating watershed project information. Both the radio station and the newspaper have offered numerous opportunities to promote watershed project events at no cost. If not for these outlets, there would have not been as much support and ownership in protecting the watershed. This, in turn, would have led to less public feedback and participation, and therefore a less comprehensive watershed management plan

3. SURFACE WATER USES IN THE WATERSHED

3.1 Designated Uses

Surface water is defined as any and all water that is naturally open to the atmosphere, such as lakes, rivers, seas and reservoirs. Under section 303(d) of the Federal Clean Water Act, states, territories, and authorized tribes are required to develop lists of impaired surface waters. Impaired waters are waters that are too polluted or otherwise degraded to meet the surface water designated uses set by states, territories, or authorized tribes. Michigan's water quality standards were established and adopted through the passage of Public Act 451 (more commonly known as the Natural Resources and Environmental Protection Act) in 1994. Rule 323.1100 of Part 4 of Part 31 of PA 451 states that all surface water bodies in Michigan are required to support the following Designated Uses*.

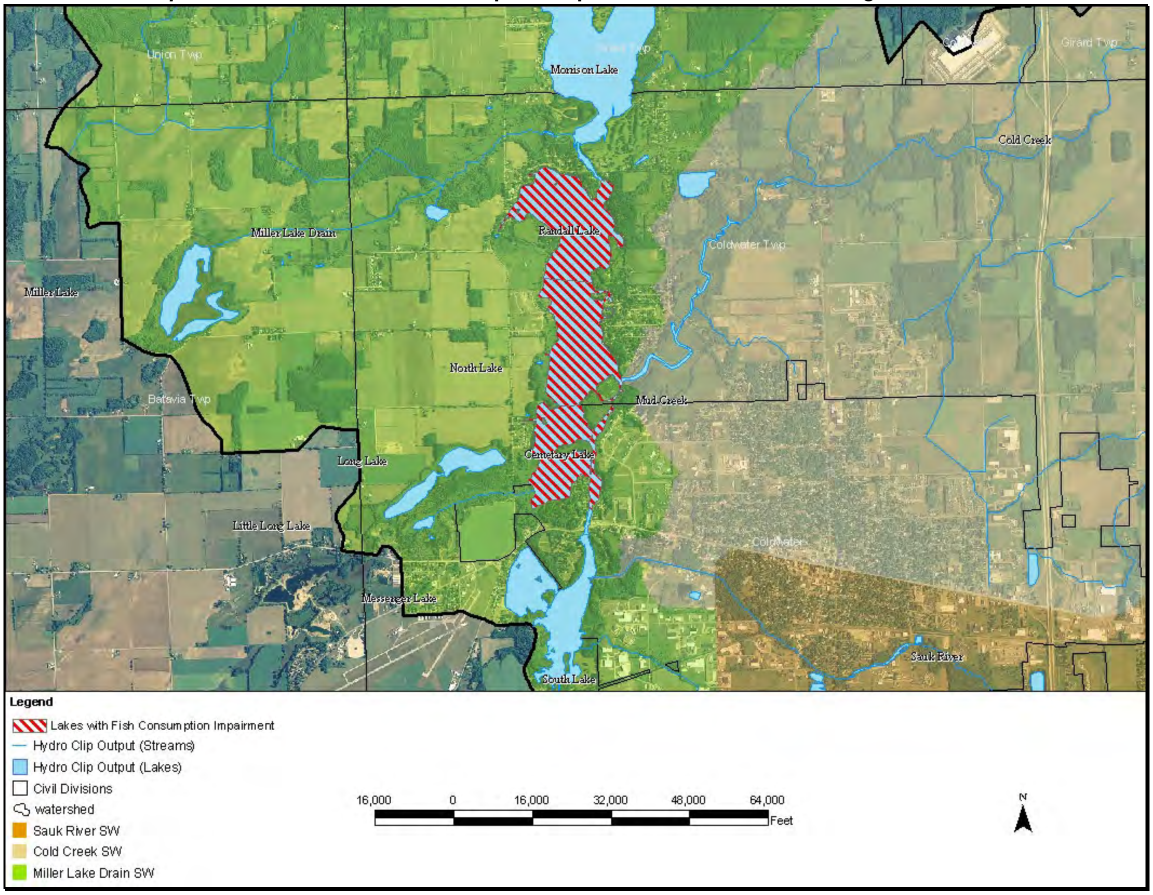
***Figure 3-1*: Designated Surface Water Uses**

1. Warm water fishery (supports reproduction of warm water fish species)
2. Other indigenous aquatic life/wildlife (supports reproduction of indigenous animals, plants and insects)
3. Partial body contact recreation (water quality standards are maintained for water skiing, canoeing and wading)
4. Total body contact recreation from May until October (water quality standards are maintained for swimming)
5. Navigation (waters are capable of being used for shipping, travel or other transport by private, military or commercial vessels)
6. Public Water Supply: Surface Intake Point (public drinking water source)
7. Industrial Water Supply (water utilized in industrial processes)
8. Agriculture (water supply for cropland irrigation and livestock watering)

** Certain water bodies are also protected as a coldwater fishery, but this designation does not apply to the Hodunk-Messenger Chain of Lakes Watershed*

In addition to these designated uses, the MDEQ also uses fish consumption advisories established by the Michigan Department of Community Health to evaluate whether a fish consumption designated use is met. Fish consumption is not currently supported in certain reaches of the Chain of Lakes (*Map 3-1*), due to accumulations of Mercury & PCBs found in samples of fish tissue. However, since PCBs & Mercury were not found to be NPS pollutants currently entering the lakes, they are not addressed for mitigation in this WMP.

***Map 3-1*: Waters with Fish Consumption Impairment in Hodunk-Messenger Watershed**



To meet the levels of water quality necessary for sustaining these eight designated uses defined in *Table 3-1*, the State of Michigan has defined certain water quality standards for certain pollutants. Specifically applicable to the Hodunk-Messenger Watershed are the water quality standards described in Rule 50, 53, 60 and 62 of PA 451:

- *Rule 60* of Part 4 of PA 451 limits phosphorus concentrations in point source discharges to 1 mg/l of total phosphorus as a monthly average. The rule states that other limits may be placed in permits when deemed necessary. The rule also requires that nutrients be limited as necessary to prevent excessive growth of aquatic plants, fungi or bacteria, which could impair designated uses of the surface water. Rapid aquatic plant and algae growth observed in the Hodunk-Messenger Chain of Lakes during the watershed planning project exceed this standard so far as to threaten aquatic life, navigation and contact recreation.
- *Rule 62* describes water quality standards that limit the concentration of bacteria in surface waters and surface water discharges of the state. Waters of the state which are protected for total body contact recreation must meet limits of 130 *Escherichia coli* (*E. coli*) per 100 ml water as a 30-day average and 300 *E. coli* per 100 ml water at any time. Waters that are protected for partial body contact recreation are limited to 1,000 *E. coli* per 100 ml water. Point source discharges containing treated or untreated human sewage shall not contain more than 200 fecal coliform bacteria per 100 ml water as a monthly average and 400 fecal coliform bacteria per 100 ml water as a 7-day average. For infectious organisms which are not addressed by Rule 62, MDEQ has the authority to set limits on a case-by-case basis to assure that designated uses are protected. The beach

water sampling data listed in *Appendix C* indicate that the water in Messenger Lake is far exceeding the suggested *E. coli* and fecal coliform limits get by this standard.

- *Rule 53* of Michigan's Water Quality Standards pertains to chemical contamination. Chemical contamination is assessed through a water body's hydrogen ion concentration, expressed as pH. While there are natural variations in pH, most pH variations in surface water are due to human influences. Fossil fuels and other human introduced chemicals that get deposited into surface water have a tendency to offset the neutral balance between hydrogen (H+) and hydroxyl (OH-) ions. This alteration of surface water pH is extremely detrimental to fish and other aquatic life that rely on a relatively neutral (+/- 7) pH level. Waters with pH levels below seven are considered "acidic" and those with pH levels above 7 are considered "basic" or "alkaline". For every unit change in pH, there is a ten-fold change in acidity or alkalinity. (For example, a pH of 6 is 10 times more acidic than a pH of 7). Rule 53 of Michigan's water quality standards states that pH shall be maintained within the range of 6.5 to 9.0 in all waters of the state. Since no pH data currently exists for the waters of the Hodunk-Messenger Chain of Lakes, it has been recommended that pH sampling is adopted into an implementation monitoring program.
- *Rule 50* sets standards for total suspended solids (TSS) by stating, "waters of the state shall not have any of the following unnatural physical properties in quantities which are or may become injurious to any designated use: turbidity, color, oil films, floating solids, foam, settleable solids, suspended solids, and deposits." This kind of rule, which does not establish a numeric level, is known as a "narrative standard." Most people consider water with a TSS concentration less than 20 mg/l to be clear. Water with TSS levels between 40 and 80 mg/l tends to appear cloudy, while water with concentrations over 150mg/l usually appears dirty. Although no TSS measurements were taken during the watershed planning project, however, many lakes and streams throughout the watershed were observed to exhibit one or several of the physical descriptions offered in Rule 50. These observations indicate that many water bodies in the watershed have TSS levels above the desired 20mg/l level and have designated uses that have become impaired or threatened.

If a water body exceeds one of Michigan's water quality standards and is no longer attaining one of the eight required designated uses, it is placed on MDEQ's 303(d) list (otherwise known as the non-attainment list) and is included in MDEQ's biennial Integrated Report until the designated use is restored to a functional level. This is usually accomplished by reducing the impairing pollutant(s) to a pre-determined Total Maximum Daily Load (TMDL) threshold. A TMDL is a calculation of the maximum amount of a pollutant that a water body can receive and still safely meet water quality standards.

TMDLs are set and enforced by the MDEQ and are usually developed on a case-by-case basis. Once a TMDL is in place for a water body, law requires that local authorities take measures to reduce and maintain pollutant levels within the parameters of the TMDL. In the case of Messenger Lake in the Hodunk-Messenger Chain of Lakes Watershed, pathogens (disease carrying bacteria) have been discovered in levels exceeding Michigan Water Quality Standards for total and partial body contact recreation. A TMDL for this pollutant is set to be established in 2017.

Six of Michigan's eight required surface water designated uses apply to the Hodunk-Messenger Chain of Lakes Watershed: warm water fishery, other aquatic life and wildlife, partial body contact recreation, total body contact recreation, navigation and agriculture. Of these six, the only use that is not impaired, threatened or in danger of becoming threatened in the watershed is the agricultural water supply. All other designated uses have become either impaired or threatened in some way. The community does not receive its public or industrial water supply from surface water and the watershed does not support a coldwater fishery. Therefore, these designated uses are not applicable to the Hodunk-Messenger Watershed.

As recently noted in MDEQ's Integrated Report of 2006 and 2008, Messenger Lake (located in the southern portion of the chain of lakes) does not meet the designated use of total body contact due to pathogen contamination. This impairment was actually first documented by MDEQ in the 2000 Integrated Report and it's been recognized that Messenger Lake does not support total or partial body contact recreation because of pathogens ever since. Fish consumption is also impaired in portions of the chain of lakes because of Mercury and PCB contamination discovered in fish tissue samples. However, since these pollutants stem from causes that can no longer be treated with watershed-exclusive BMPs, fish consumption will not be addressed as an impaired designated use in this WMP. Presently, mercury contamination is attributed to atmospheric deposition, while PCB contamination results from past industrial point sources in the watershed.

Watershed project field investigations have also revealed that the "other indigenous aquatic life and wildlife" designated use is being impaired in the Cold Creek Sub-watershed and threatened throughout the other two sub-watersheds even though this use is not currently recognized on the MDEQ Integrated Report as being impaired. Removal of riparian vegetation and fragmentation of natural areas has reduced viable wildlife travel corridors in the watershed. For this reason, a goal for establishing a green corridor throughout the watershed has been established as a recommended implementation action (*Chapter 8*).

> As stated in R323.1100 of Part 4 of Part 31 of PA 451, all surface water bodies must support reproduction of indigenous animals, plants, and insects. This qualification is known as the 'Other Indigenous Aquatic Life and Wildlife" designated use.

Indigenous aquatic life and wildlife habitat has also been degraded or destroyed through wetland conversion, urban sprawl and establishment of large tracts of **monoculture** crop fields. The most significant source of indigenous aquatic life and wildlife impairment is the watershed's highly modified hydrologic regime. Watershed inventories indicate that all 1st and 2nd order (headwater) streams in the Cold Creek Sub-watershed have become riddled with obstructions of sediment beds and woody debris. These obstructions are attributed to the rapid rate of stream bank erosion taking place in many of these stream reaches. Streambank erosion in the watershed is mostly caused by the frequent occurrence of stressful bankfull stream flow volumes, mainly attributed to rapid land drainage and lack of floodwater storage capacity in the upper watershed. These streams also exhibit base flows too low to provide proficient movement of aquatic life. Sensitive aquatic life has also been impaired by stream sedimentation and siltation that destroys, covers up and alters natural stream substrate that is important for fish spawning and macro invertebrate hatching.

The same watershed project field investigations have revealed that both the warm water fishery and navigation are currently being threatened throughout the watershed. Even though 2008 MDNR fish survey results show that the chain of lakes supports robust warm water fish populations, survey results throughout the years have shown a trending increase in rough fish species, indicating an increasingly eutrophic lake. This finding indicates that continual NPS pollutant loading in the Chain of Lakes (Miller Lake Drain Sub-watershed) is threatening the balance of the warm water fishery within the fragile lake ecosystem. Outside of the chain of lakes (Cold Creek & Sauk River sub-watersheds), the warm water fishery is being challenged even more greatly. Because of the sedimentation/siltation, extreme flow fluctuation, pollutant contamination and the loss of shade associated with riparian vegetation loss, the warm water fishery has been threatened to the extent that game fish are no longer known to exist in these upper watershed streams.

Rough fish species common in Michigan:
Black bullhead
Bowfin
Brown bullhead
Common carp
Longnose gar
Redhorse
White sucker
Yellow bullhead

(*Source: MDNR publications*)

For the same reasons, navigation is only permissible in limited reaches of the streams throughout the watershed. Anecdotally, watershed residents have expressed complaints (through watershed project social monitoring and various public events) about not being able to navigate certain channels within the chain of lakes. Places that have historically allowed boat passage have now become too shallow to navigate without dragging bottom or becoming stuck. Despite these concerns, navigation is not listed as being impaired because there are no areas in the watershed that are designated as navigational routes for private, military or commercial vessels.

***Table 3-1:* Designated Uses in the Hodunk-Messenger Chain of Lakes Watershed**
Key: I = Impaired; M = Met; NA = Not Applicable; T = Threatened

Designated Use	Cold Creek Sub-watershed	Miller Lake Drain Sub-watershed	Sauk River Sub-watershed
Warm water Fishery	T	T	T
Other indigenous aquatic life and wildlife	I*	T	T
Partial Body Contact Recreation	T	T	T
Total body contact recreation (between May 1 and Oct. 1)	T	I	T
Navigation	T	T	T
Public Water Supply	NA	NA	NA
Industrial Water Supply	NA	NA	NA
Agriculture	M	M	M
Fish Consumption[α]	T	I	T
Coldwater Fishery	NA	NA	NA

[*] Not recognized in MDEQ Integrated Report, but supported with findings of MDEQ project #2006-0127 watershed assessments
[α] Not addressed in this WMP due the irreconcilable nature of the Mercury and PCB pollutants

Since there are slight variances in the land uses and impairments associated with each of the three sub-watersheds within the Hodunk-Messenger Watershed, *Table 3-2* identifies the status of surface water designated uses as they apply to the water bodies in each of the three sub-watersheds. The table also lists all known and suspected pollutants from each sub-watershed, the pollutants causing an MDEQ non-attainment status and the projected TMDL establishment date for the pollutant responsible for the non-attainment status. Even though there are relatively few impairments reported for the many designated uses, there are an abundance of highly threatened designated uses within each sub-watershed.

Table 3-2: **Designated Uses by Sub-watershed**

	Non Attainment/ TMDL Status	Impaired	Threatened	Pollutants, *known (k) or suspected (s)*
Cold Creek Sub-watershed	-	Other indigenous aquatic life and wildlife in all CCSW Streams except Mud Creek	Total body contact recreation between May 1 & Oct. 1, partial body contact recreation, navigation, warm water fishery	Sediment (k), nutrients (k), Hydrologic flow (k), pesticide and herbicide chemicals (s), pathogens (s), oils, grease and metals (s)
Miller Lake Drain Sub-watershed	PCBS in Randall, North & Cemetery Lakes segment- TMDL in 2010* Mercury in Randall, North & Cemetery Lakes segment - TMDL in 2011* Pathogens in Messenger Lake - TMDL in 2017	Total body contact recreation (May 1- Oct 1) in Messenger Lake	Warm water fishery, other indigenous aquatic life and wildlife, navigation, partial body contact recreation	Sediment (k), nutrients (k), pathogens (k), PCBs (k), mercury (k), pesticide and herbicide chemicals (s), oils, grease and metals (s)
Sauk River Sub-watershed	-		Total body contact recreation between May 1 & Oct. 1, partial body contact recreation, navigation, warm water fishery, other indigenous aquatic life and wildlife	Sediment (k), nutrients (k), pesticide and herbicide chemicals (s), hydrologic flow (s), pathogens (s), oils, grease and metals (s)

*Pollutants will not be addressed as nonpoint source pollutants in this management plan

3.2 Desired Uses

In addition to state-regulated designated uses, a number of *desired* uses for the watershed have also been identified during the course of the planning project. The discovery of these desired uses is attributed to the public feedback obtained through public meetings and social monitoring (*Appendix A*) as well as from the characteristics and land use trends associated with the Hodunk-Messenger Watershed. Attainment of watershed desired uses has been made a priority along with attainment of designated uses in this WMP because they are either derived from the desires and concerns of actual watershed stakeholders, or are directly connected to reducing specific NPS pollutants.

Table 3-3: **Desired Uses for the Watershed**

Desired Use	Cold Creek Sub-watershed	Miller Lake Drain Sub-watershed	Sauk River Sub-watershed
Canoeing/Kayaking	X		X
Expand/extend recreational trail ways		X	X
Expanded municipal sewer services	X	X	
Improved accessibility to Sauk River			X
Improved navigation in channels		X	
Improved navigation in Sauk River			X
Lake accessibility		X	
Less debris/ refuse around water bodies†		X	X
Open space/ farm land preservation†	X	X	X
Public recreational land	X	X	X
Reduce/ deter nuisance species		X	
Reduction in algae/aquatic plant growth		X	
Reduction in invasive plant species	X	X	X
Source water protection			X
Wildlife and nature viewing	X	X	X

†These desired uses have also been listed as recommendations for achieving watershed management goals

4. WATERSHED ASSESSMENT

4.1 Assessing the Watershed

In the context of surface water, water quality is defined as the ability for a body of water to attain its designated uses. If a designated use is being threatened or impaired, it is most often the case of one or more NPS pollutants being delivered to a water body in excessive and detrimental amounts. To remedy a threatened or impaired designated use, the NPS pollutants at play must first be identified, along with the source and cause of the particular pollutant. Once these factors have been identified, an accurate estimate of the actual pollutant loads affecting the watershed must be attained. In the case of the Hodunk-Messenger Watershed, many of the lead NPS pollutants had been identified through regulatory monitoring conducted by MDEQ and the Branch-Hillsdale-St. Joseph Community Health Agency, past feasibility studies and the planning of the St. Joseph River WMP.

Despite this availability of rudimentary water quality data, a comprehensive watershed assessment had never been conducted for the Hodunk-Messenger Watershed. For this reason, a comprehensive watershed assessment had become necessary for the watershed planning process in order to establish an in-depth compilation of baseline data on the critical sites and current pollutant loads within the watershed. The data acquired through this comprehensive assessment is vital for prescribing appropriate BMPs and evaluating the success and efficiency of BMPs recommended for implementation.

The following methods were used during the Hodunk-Messenger Watershed Planning Project to uncover the full range of NPS pollutants, their sources, causes and the amounts in which they are being delivered to the watershed:

4.1.1 Bank Erosion Hazard Index

In watersheds like the Hodunk-Messenger that have extremely modified streams, drainage ways and riparian areas, a large amount of sediment can actually be generated in-stream through erosion. In order to assess the full extent of the stream bank erosion occurring in the Hodunk-Messenger Watershed, David Rosgen's Modified Bank Erosion Hazard Index (BEHI), a system for surveying streambanks for erosion "hot spots" was adopted and conducted during the months of August, September and October in 2007. During these months, every road stream crossing in the watershed was visited and inventoried.

To inventory a road stream crossing, an MDEQ Watershed Stream Crossing Data Sheet was completed in conjunction with a BEHI assessment form. A BEHI assessment rates the erosion hazard of a site based on four metrics: root depth, root density, bank angle and amount of surface protection. Once a site is measured for these four metrics, a score is applied to the site based on the severity of the erosion hazards found. The total score of a site correlates to a hazard ranking: very low, low, moderate, high or very high. This method of ranking provided good insight to the location of "hot spots" among road stream crossings.

The majority of the 77 road crossing sites visited were ranked as "low" (73%). Broken down by sub-watershed, there were 29 low-ranking sites in the Cold Creek Sub-watershed, 16 in the Sauk River Sub-watershed and 11 in Miller Lake Drain Sub-watershed. 18 sites scored "moderate", with half of them occurring in Cold Creek Sub-watershed, five in Miller Lake Drain Sub-watershed and four in the Sauk River Sub-watershed. There was also one site in the Cold Creek Sub-watershed and one in the Sauk River Sub-watershed that both scored "high". These two sites are considered to be the road stream crossings with the highest priority for receiving mitigation during the watershed implementation phase.

An exhaustive report on the findings from the watershed stream assessments may be found in *Appendix H* of this document.

4.1.2 Streambed Mobility Measurements

In an attempt to further classify the level of instability and impairment found in several watershed streams, four easily accessible sample sites were selected from upper portions of the watershed to undergo **tractive force** assessments and cross-channel modeling. Tractive force is a ratio of the potential particle size that would be mobile at a stream's bankfull discharge as compared to what size particle is actually present in the stream to be moved. By calculating tractive force, it was hoped that the amount of stress exerted by the water flowing in a stream channel on the stream bed (otherwise known as the "sheer stress" of stream flow) could be determined. Unfortunately, because of the excessive channel depths and widths associated with the agricultural ditch-like characteristics of the streams in the Hodunk-Messenger Watershed, the results were highly skewed and were not relied upon as a source of hydrologic interpretation (*Appendix I*).

However, in addition to assessing the tractive force present at each of these sites, cross-channel transect measurements also were also taken. These measurements consisted of taking elevation readings with a laser survey at every depth change along the stream bed from in a cross-channel transect. Elevation readings were taken from bank to bank across the entire stream channel (perpendicular to the direction of stream flow). The measurements were then entered into Mecklenburg's Spreadsheet Tools for River Evaluation, Assessment and Monitoring (STREAM) module to create relatively accurate cross-channel profiles of every stream assessment site. These plotted stream profiles serve as useful baseline (initial) cross-channel models for these sites. These models were established so that any future streambed movement or change will be noticed and documented during the course of future cross-channel measurements during implementation.

Because the cross-channel transect data will not provide any useful results until the changes in the channel profile are documented, it is recommended that these sites are continually monitored during the watershed project implementation phase. Moreover, watershed hydrology would be better understood if these cross-channel measurements were extended to additional stream reaches throughout the watershed. Cross-channel transect modeling would also help provide feedback on the affect of implementation activities on watershed streams.

4.1.3 Landscape Alteration Study

Riparian Vegetation Loss:

Riparian buffers in the watershed were assessed by evaluating the land cover near watershed streams (available through the USDA-NRCS 2001 National Land Cover Dataset, or NLCD). All stream segments that were already bordered by natural vegetation were omitted from this assessment. Once all stream segments lacking a vegetated buffer were identified, all urban land uses were also omitted. The reasoning for this was that urban land cover (impervious surface) would be highly unlikely of being reverted back to natural land cover. The stream segments remaining after these omissions represented the streams without 30 feet of riparian buffer bordered by agricultural fields. In total, there were 112,215.34 feet, or 21.25 miles, of streams in the watershed identified as bordering farm fields without any riparian buffer in place. By applying a hypothetical buffer with the NRCS-MI toolkit buffer tool, a minimum 30 feet of buffer on either of these stream segments would generate a potential watershed-wide total of 154.5 acres needing to be re-established with riparian vegetation.

GIS applications were also employed to the estimate acreage of current land use/land cover types in the watershed. Comparisons were again made to a pre-settlement vegetation layer and total amount of natural landscape that has been lost in the watershed was estimated (*Section 1.6* and *Appendix E*). To date, agriculture and urban development has displaced or destroyed approximately 18,000 acres of forest, 8,700 acres of grassland and 4,000 acres of wetlands in the watershed. This level of landscape alteration presents a severe threat to the level of water quality in the watershed because these natural areas help provide critical ecological services like water storage, pollutant filtration and soil stabilization.

Stream Meanders:

The three major watershed tributaries (Cold Creek, Miller Lake Drain and Sauk River) were individually analyzed for changes in stream **morphology** (*Appendix E)*. Specifically, the losses of stream meanders in these three streams were the object of the comparison. A highly meandering stream is often a stream of high water quality. The more meandering or **sinuous** a stream is, the longer it takes for the water flow to reach a receiving water body. With bends in the stream channel, pools and riffles are formed and the rate of fall in the stream is generally lower. The less rapid the fall of a stream is, the slower its flow over land. This slower flow gives sediment, suspended particles and other pollutants a chance to settle out of the water column.

Kept on file in the USDA-NRCS Coldwater Field Office annals are aerial photographs of Branch County from 1938. Since these documents were available for use during the watershed planning project, they were used as reference material in comparison to present day aerial imagery. The goal of comparing the 1938 imagery to present day imagery was to discover any major discernable changes to the watershed landscape, with a focus specifically on stream morphology.

To assess the amount of channelization that has taken place in each sub watershed over the years, the number of meanders (bends significant enough to switch a stream's directional trajectory) were counted in both time periods and compared. Results show that the Miller Lake Drain (for the limited stretches of stream between areas of wetlands) has lost an approximate 28% of its historic meanders. The comparison of the images of the Cold Creek showed that 37% of meanders have been lost through stream straightening and channelization. Results were not valid for Sauk River because the body of the River cannot be deciphered in the present day aerials due to an increase in riparian vegetation that obscured the view. Smaller order streams (1^{st} and 2^{nd} order) were not assessed in this comparison exercise.

4.1.4 Soils Analysis

The predominant soil types found within the watershed were analyzed for certain physical properties known to affect water quality, such as infiltration, erosion potential and septic field absorption ability. Analyses were conducted using GIS imaging and the NRCS-MI toolkit Soil Data Viewer tool. The majority of watershed soils (63.3% of the watershed) were found to be classified as hydrologic "Group B" soil types. Group B soils have a moderate infiltration rate when thoroughly wet. These chiefly consist of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission. Query results from a Soil Data Viewer analysis also show that 36.4% of the soils in the watershed are classified as well drained. These well drained soils are predominately located in the areas adjacent to waterbodies throughout the watershed. Another 34.2% of soils were found to be somewhat poorly drained. These areas are found in the middle and upper portions of the watershed. 8.1% of soils, mainly isolated to the wetland areas around the chain of lakes and major streams in the watershed, are classified as very poorly drained.

According to another Soil Data Viewer query, there are no soil types present in the watershed that offer sufficient septic tank absorption properties. All soil types within the watershed were found to show some amount of limitation for septic absorption fields. In fact, 93.8% of the watershed contains soils that are very limited for septic absorption, and 5.4% of the watershed contains soils that exhibit properties that are somewhat limited. An exhaustive report on the soil properties of the watershed is provided in *Appendix F* of this document.

4.1.5 Agricultural GIS Assessment

Utilizing GIS analysis capabilities, the mass of agricultural land cover in the Hodunk-Messenger Watershed was assessed for several quantifiable characteristics. These characteristics included: amount of established filter strips present in the watershed, classification of farmland (prime or not prime), and amounts and locations of highly erodible land (HEL). The findings from these assessments were used as the basis for recommending the majority of agricultural BMPs found in the Implementation Action Plan (*Table 9-1*) of this WMP. By using Geographic Information System (GIS) tools, acreage figures were derived from these assessments that are considered to be relatively accurate. Therefore, with the exception of determining the most high risk edge for polluted runoff on every farm field, the recommended agricultural conservation practices found in this WMP are also considered to be spatially and dimensionally accurate.

Using data provided by USDA-Farm Service Agency (FSA), a query was run to determine the amount and locations of filter strips established through the conservation reserve program (CRP). The reasoning behind this was to identify the amount of, or lack of, filter strips that exist on agricultural fields in the watershed. When vegetated field borders that act as natural filters are removed, increased wind erosion and prolonged sheet erosion is known to occur. By determining the amount of filter strips currently established in the watershed, an amount needing to be implemented would then be determined.

Based on the data collected, only a few Filter Strips (all in Miller Lake Drain Sub-watershed) were found to be in place within the watershed boundary. Based on this finding of surprisingly few field buffers, it is recommended that all other fields within the watershed have at least one field edge established with a filter strip (preferably on the side that's most downhill and vulnerable to erosion). The implementation of field buffers would help trap the sediment and other pollutants coming from each individual field, and reduce the amount of pollutant loads being delivered to nearby streams.

By applying a hypothetical field buffer (generated through the NRCS-MI toolkit buffer tool), it was found that if every field in the watershed were to establish a 30-foot wide buffer strip along the most "at-risk" field edge, a total of 1,097.1 watershed acres would be taken out of production and reverted to permanent vegetation for the purpose of surface water filtration. In most cases, the most "at-risk" field edge correlates to the most marginally productive area of a field for growing crops because of its situation on slopes and lands that are seasonally inundated by water.

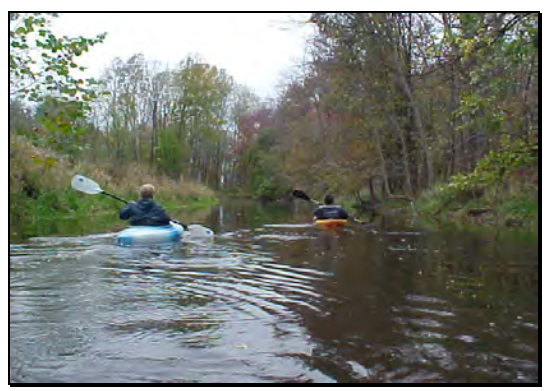
By utilizing NRCS-MI toolkit soil analysis tools to analyze the agricultural land in the Hodunk-Messenger Watershed GIS layer, it was determined that the majority of current watershed farmland is rated "prime" (as defined by the USDA). It was also determined that there were no areas determined to be *potentially* highly erodible in the watershed but there were 1,936.9 acres that *were* identified as highly erodible land (HEL). By sub-watershed, there were 215.7 acres rated HEL in the Cold Creek Sub-watershed, 116.9 acres rated HEL in the Miller Lake Drain Sub-watershed and 130.5 acres rated HEL in the Sauk River Sub-watershed (*Chapter 7*). All other areas in the watershed were rated to be "not highly erodible" or "not rated" (water/wetlands). A full report on these agricultural land use analysis methods is located in *Appendix G* of this document.

4.1.6 Field inspections

Once the basic information on watershed streams (*Sections 4.1.1* and *4.1.2)* and land use and trends (*Section 4.1.3 & 4.1.5*) were compiled, more in-depth field inspections were conducted to identify and verify site-specific critical areas responsible for contributing significant NPS pollutants loads. Field inspections were conducted in three ways:

1.) In-field site visits,
2.) Inspections of navigable water ways, and
3.) Stakeholder feedback.

Stakeholder feedback obtained through social monitoring, public meetings, advisory council meetings and notes taken by volunteer surveyors during stream crossing inventories provided descriptions and locations of sites with observable impairments. Such sites were followed up by the Watershed Project Coordinator with field inspections and, if necessary, photo documentation. Upon inspection, some stakeholder concerns were found to be unsupported (attributed to recent managerial improvements, landscape alterations or vagueness of reported concern). However, most concerns were in fact confirmed to some extent. Sites were evaluated in respect to the relevance of CWA Section 319 (i.e. all point source concerns such as waste water treatment facility effluence and other direct discharges were ruled out). Sites that did meet CWA Section 319 criteria were then prioritized based on severity. Small and/or temporary impairments such as lake-side litter or building construction projects were not listed as critical sites but were recorded to provide support for broader watershed objectives like lake cleanups or soil erosion control improvement. Sites of concern that were deemed significant or long term were photo-documented and prioritized as primary critical sites (*Chapter 7 and Appendix L*). In all, 27 individual specific sites in the watershed were listed as critical and in need of immediate mitigation.



Field inspection by water body navigation was conducted on all water bodies in the watershed that allowed for passage and navigation. Under these criteria, inspections were restricted to the Chain of Lakes, Sauk River and limited reaches of Cold Creek. In most cases, stream obstructions and shallow water levels prevented navigation of smaller order streams and drainage ways in the watershed. Observations were made on the waterfront of the chain of lakes and critical sites were identified. In general, observations were noted on hard shoreline armoring practices, soil erosion issues occurring at construction sites, loss of vegetated buffer and reduced channel navigation (*Appendix L*). On the navigable portions of Cold Creek and Sauk River, the same metrics that were used in the stream crossing BEHI inventory (bank angle, root depth, root density, and surface protection) were applied to the reaches of stream in between road crossings. This method helped to identify portions of stream bank that were at a high risk for erosion, in addition to the several segments of streams that were discovered to be severely impaired.

4.1.7 Beach water sampling

For the past six years, Messenger Lake has routinely been listed on the MDEQ 303(d)/305(b) Integrated Report list for not meeting the designated use of total body contact recreation between May 31 and October 1 because of a **pathogen** contamination at Memorial Beach. The source of the contamination in Messenger Lake was not an obvious one. Messenger Lake is one of the more undeveloped lakes in the entire chain (a campground and a few residences on the northern and western shores constitute the extent of development), and it's found well upstream of Coldwater's municipal waste water treatment facility outlet into the lake chain. The Branch-Hillsdale-St. Joseph Community Environmental Health Agency was therefore consulted on the matter of the Memorial Beach contamination. They were able to supply a short history of information about the pathogen loading taking place at the beach. The Health Agency provided beach water monitoring data from 2002 and 2004 showing that a distinct *E. coli* contamination was taking place. Detailed information from the summer of 2004 shows that ***E. coli*** levels spike in early-mid July and again in early August up to levels around 1-2,000 colonies per 100 ml of water. (Additional data should be collected to support long-term trends in *E. coli* levels in the beach water at Memorial Beach).

Since *E. coli* is only transmitted by warm-blooded animals, the local Community Health Agency has attributed the rise in *E. coli* (and **fecal coliform**s in general) during the summer months to the overabundant Canada goose population present in and along the chain of lakes. Geese prefer to inhabit the chain of lakes (and especially Memorial Park Beach) because of the lack of predation, the shallow waters, sparse shoreline vegetation and ease of access to waterfront lawns. According to literature compiled in *Appendix C*, geese have potential to contribute 69,400 fecal coliform organisms per day to the surface water of Messenger Lake through defecation. Research shows that an average of 13% of these fecal coliform organisms will be the *E. coli* bacteria. BMPs should be implemented at the Memorial Park site to reduce goose numbers, discourage geese from coming on land and better manage the amount of waste present in order to lower *E. coli* levels and restore the total body contact reaction designated use.

4.1.8 Groundwater Vulnerability Assessment

This Hodunk-Messenger Groundwater analysis compiled information pertaining to groundwater vulnerability through a two-step process. The first process utilized NRCS-MI GIS technology to analyze the soils and sub-surface geologic features of the watershed to determine where areas of groundwater recharge might be expected (*Section 4.1.4* and *Appendix F*). The second process was to simply gather relevant information from various sources about the causes of groundwater contamination currently known to exist in the watershed.

Watershed Soil Types were assessed in a number of different ways using USDA-NRCS GIS tools. As they pertain to groundwater, soil types were classified by their hydrologic group, drainage class and septic absorption properties. This was done by utilizing a number of NRCS-MI toolkit Soil Data Viewer applications. For example, by using Soil Data Viewer's "Soils Qualities and Features" analysis tool, a hydrologic group query was run on the soil types within the watershed. As a result of the query, soils in the watershed were assigned to one of four groups according to their rate of water infiltration. This same tool was used to analyze (natural) drainage classes within the watershed. As a result of this query, soils in the watershed were assigned to one of seven classes of natural soil drainage—excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained and very poorly drained. Using the Soil Data Viewer "Sanitary Facilities" analysis tools, a septic tank absorption field query was run on the soil types of the watershed. As a result of the query, watershed soils were assigned ratings based on soil properties that affect absorption of the effluent, construction and maintenance of the system, and public health such as saturated hydraulic conductivity (Ksat), depth to a water table, ponding, depth to bedrock or a cemented pan, flooding, stones and boulders. Only that part of the soil between depths of 24 and 60 inches were evaluated.

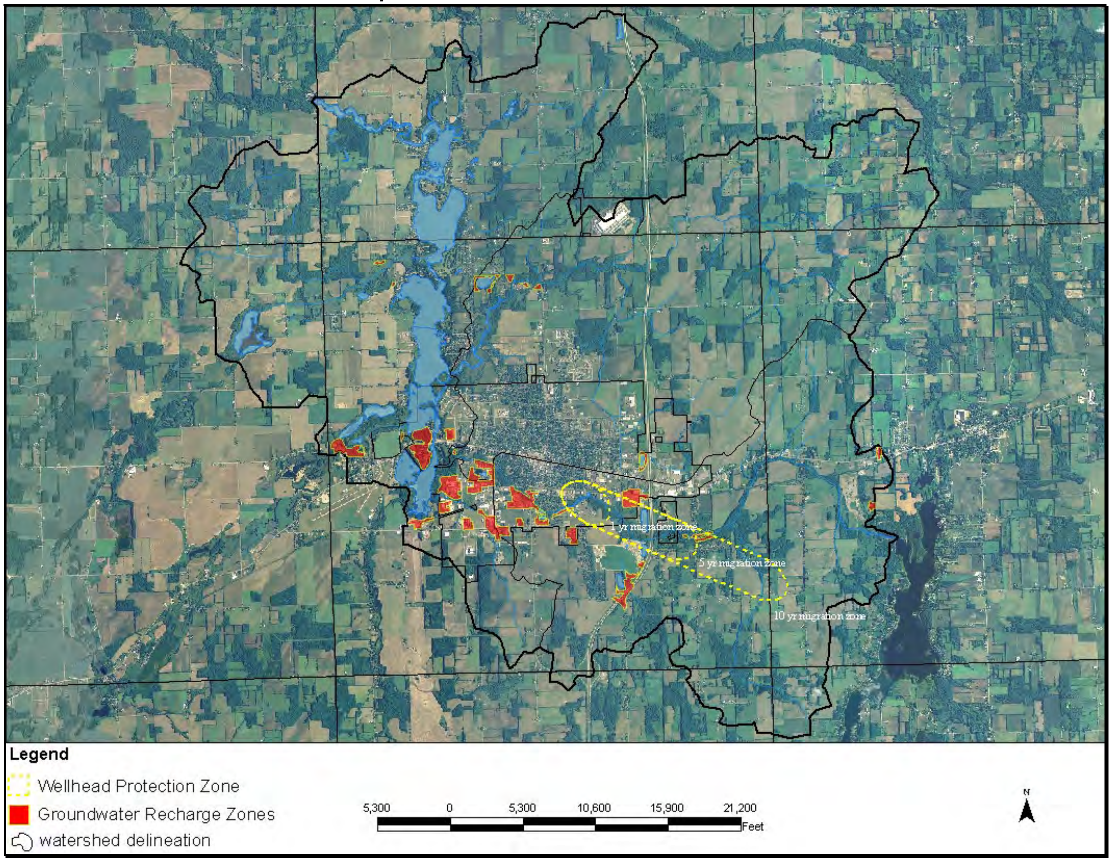
Once watershed soils were analyzed for their infiltration and absorption properties, a query of water table depths was run on the watershed. As a result of this query, the depth to the upper limits of the water table in the soils of the watershed was determined, based on observations of grayish colors (redoximorphic features) in the soil. In most cases, the areas with the highest water tables coincided with areas of greatest drainage and infiltration.

All of these soil characteristics were combined to isolate the areas that appeared to possess the greatest combination of properties for promoting ground and surface water interchange. These selected areas, which are considered the most likely places for groundwater recharge in the watershed, have been digitized and are represented in *Map 4-1*.

In addition to the scattered "groundwater recharge zones", the City of Coldwater has delineated a wellhead protection zone, based on the position of Coldwater's municipal wellfield. In 1995, the Coldwater Board of Public Utilities adopted a Wellhead Protection Plan (WHPP) that defined a protection zone around the city's municipal well field. The Wellhead Protection Program outlined in the WHPP (which includes an aquifer vulnerability study) has been approved by MDEQ and is currently being implemented by the city.

The municipal well field, located in Water Works Park, just north of the Branch County Fairgrounds, contains four large wells that each average 2.3 million gallons per day to supply all of Coldwater with potable water. The Coldwater WHPP provides delineations for a 1 year migration zone and 5 year migration zone. Both of these areas are in need of protection in order to prevent any groundwater contamination, based on the position and composition of the large aquifer that underlays Coldwater. *Map 4-1* displays the Wellhead Protection Zones in addition to the groundwater recharge zones found throughout the watershed. In acquiring this data from the Coldwater Board of Public Utilities, the City has expressed interest in working with BCCD to implement measures to permanently protect these areas.

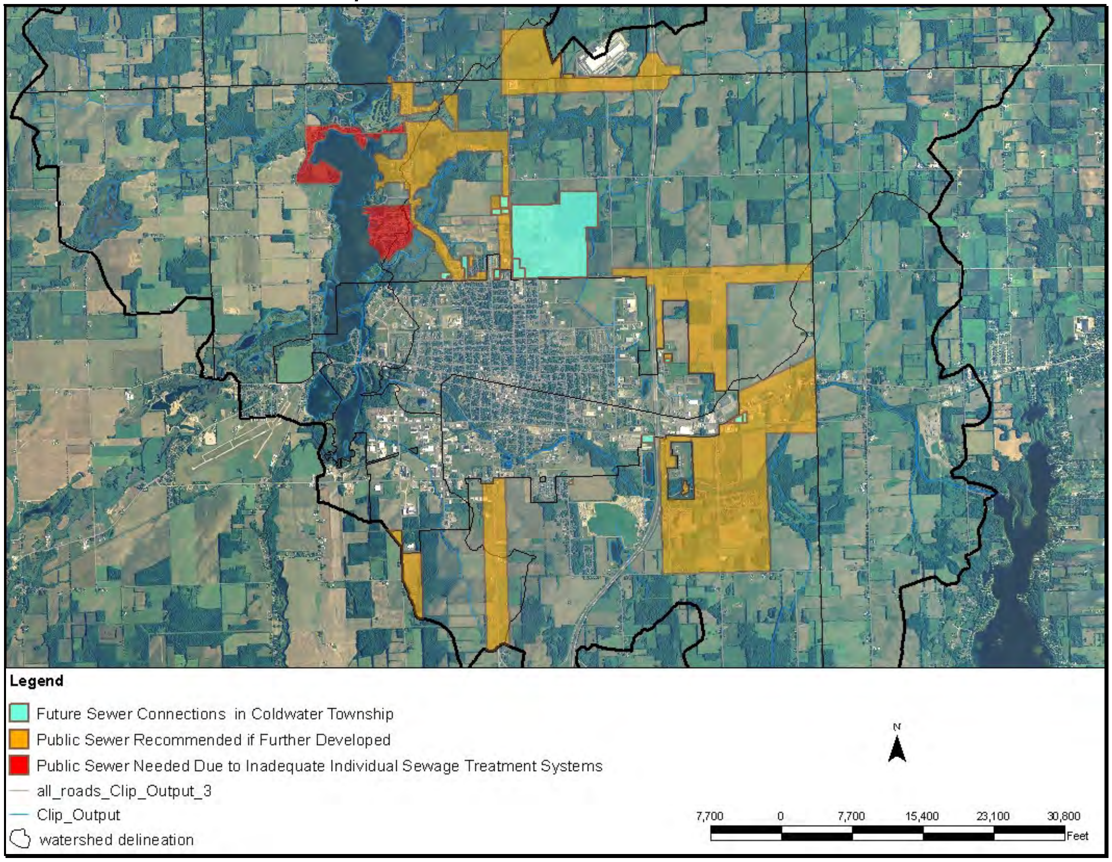
Map 4-1: **Groundwater Protection Zones**



A 1997 "windshield survey" conducted by the Branch-Hillsdale-St. Joseph Community Health Agency was also consulted during the watershed planning process to help corroborate these findings. The survey was conducted in Coldwater Township to assess the need for future expansion of the Coldwater sanitary sewer system. The survey used soils types, subsurface geological properties and proximity to other developments to help identify the areas that were in need of sewer establishment and the areas that would require a sewer connection if they were to be further developed. In addition to identifying the areas that would require public sewer hookup if further developed, the survey also helped to identify the areas of the watershed that are currently in need of retrofitted sanitary sewer infrastructure due to high rates of septic failure. The potential pollutant loads that are estimated to be occurring as a result of these "septic leaching zones" are found in *Table 1-3.*

Recently, the City of Coldwater has supplied GIS parcel data on the areas intended for the future expansion of municipal sewer infrastructure. Surprisingly, few of these areas correspond to the areas recommended by the Community Health Agency in 1997. *Map 4-2* illustrates the various areas recommended for sewer system expansion. The complete report on groundwater vulnerability in the watershed is presented in *Appendix F* of this document.

Map 4-2: **Sewer Needs in the Watershed**



4.1.9 Municipal Storm Sewer data collection

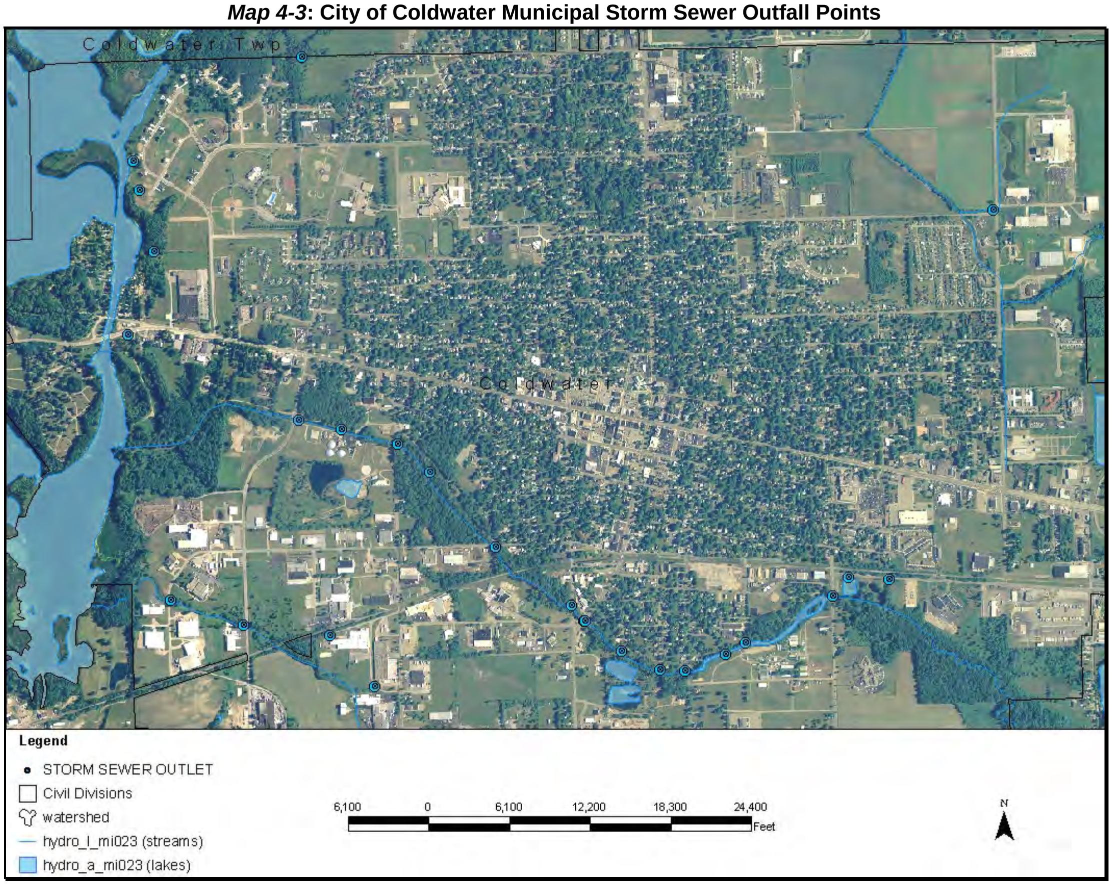
As a result of a watershed planning project storm drain inventory, it was discovered that 1,656 storm drains exist in Coldwater within the boundaries of Michigan Ave, State Rd, Garfield Rd and the chain of lakes. Although the City of Coldwater extends storm sewer hookups to every development within the city boundary, all new and re-developed establishments are required by a 1995 city ordinance to store and treat stormwater on-site before it is discharged to the city storm sewer. For this reason, the older part of the city west of Michigan Avenue was concentrated on for this inventory. This inventoried area was determined to be approximately 2,400 acres in size. Therefore it can be estimated that on average each storm drain inlet within the area west of Michigan Avenue would capture runoff from approximately 1.4 acres of urban land. In most cases, the majority of land cover within these 1.4 acres consists of impervious surface.

Inventories were conducted by traversing the city in vehicles and marking all storm drain inlets with hand-held global positioning system (GPS) units. These data points were then uploaded to GIS software, where they could be referenced, analyzed and utilized in mapping activities. During later stages of the watershed planning project, these storm drain inlet data points were used in maps provided to volunteers participating in the storm drain inlet marking project in the city. The goal of this project was to return to the storm drain inlets located in curbs along streets and adhere colorful placards with pre-cast messages warning the public of the direct connection to surface water to them.

The results of the storm drain inventory provide insight into a potentially significant source of NPS pollution. Studies have shown that up to 90% of the pollutants present on impervious surfaces get washed into storm drains during the “first flush” of a rainfall event. In

Coldwater, NPS pollutants such as sediment, nutrients, weed and feed chemicals, trace deposits heavy metals and petroleum based toxins get washed directly from impervious surfaces into one of the 1,656 storm drain inlets in the core area of the city, as identified by the storm drain inventory project. From here, suspended solids and water soluble pollutants are then conveyed directly to a discharge **outfall** point in a nearby surface water body. Contrary to popular belief, storm water entering the municipal storm sewer system in Coldwater undergoes no water quality treatment (beyond catch basins that serve in trapping large debris) and is instead piped directly to nearby surface waters. Information provided by the City of Coldwater states that stormwater is piped to 25 different outfalls situated along various nearby surface water bodies. Of these outfalls, 16 occur in the Sauk River, four in Cemetery Lake, one in County Drain #15 and four into an unnamed tributary of South Lake (*Map 4-3*).

***Map 4-3*: City of Coldwater Municipal Storm Sewer Outfall Points**



By referencing plan maps provided by the City Engineering Department, the directional flow of water entering the storm sewer was determined, as well where most storm drain outfalls lay. The analysis performed on the municipal storm sewer system is not intended to be an exhaustive analysis of NPS pollutant inputs to the storm sewer system. In fact, even though new developments are required to manage stormwater on site, there is currently no policy for standards or maintenance of privately owned retention or detention facilities in Coldwater. Significant monitoring activities should be applied to the entire Coldwater storm sewer system in the future to determine the full affect that it has on watershed water quality. Further analysis of this information can be found in *Appendix D* of this document.

4.1.10 Wetlands Assessments

In 2008 the national wetlands inventory (NWI) maps for Branch County were updated through a partnership between MDEQ and Ducks Unlimited. These wetlands maps, which previously had been based on 1978 aerial photography, were updated to reflect new imagery taken in 2005. With this new information available, MDEQ - Land and Water Management Division (LWMD) administered a Landscape Level Wetlands Functional Assessment (LLWFA) of the wetlands contained within the Hodunk-Messenger Watershed.

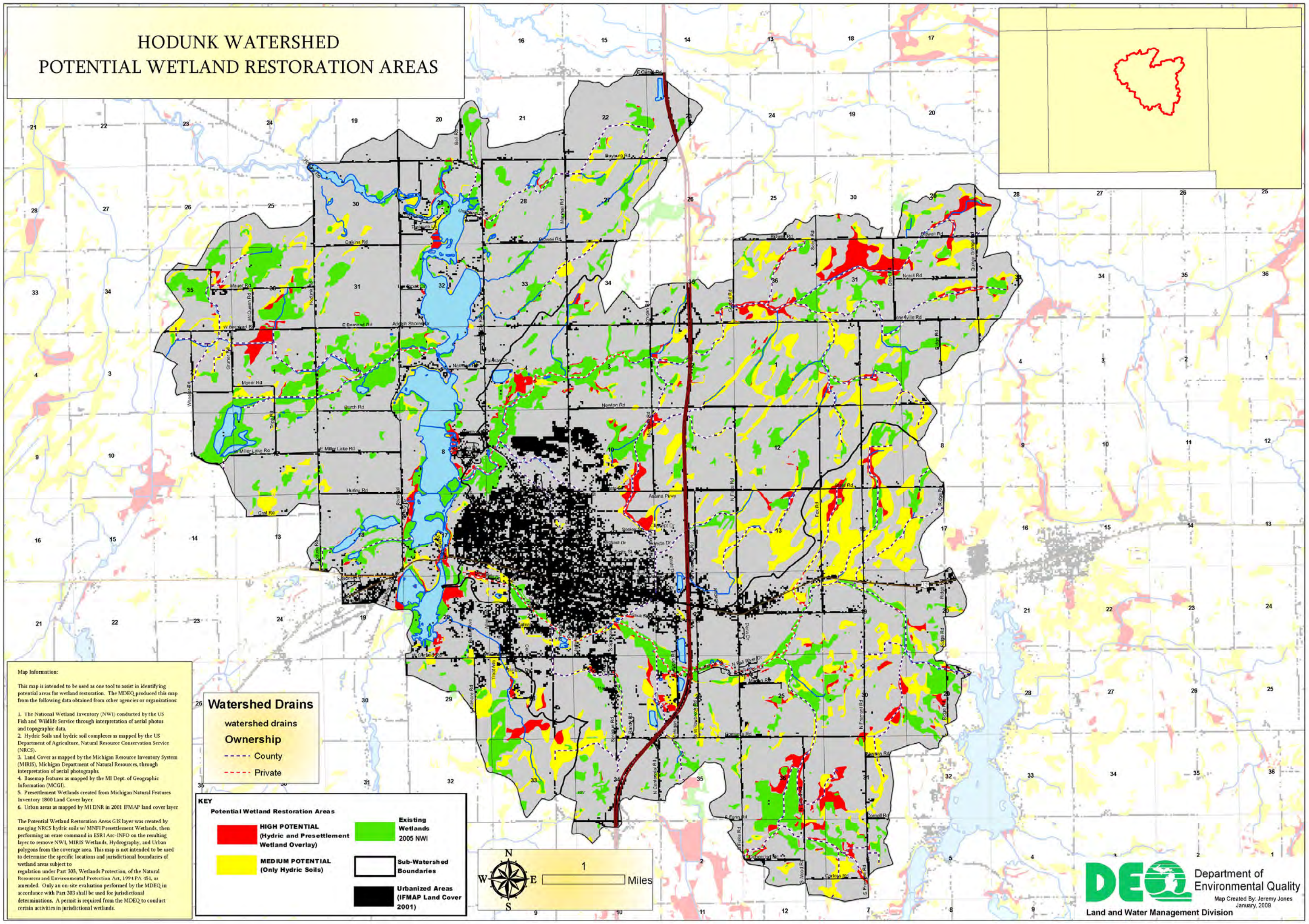
To decipher the status and trends of the wetlands in the watershed, MDEQ-LWMD compared the new 2005 NWI wetland acreages to the acreages of wetlands present in the watershed during pre-settlement times using GIS digital mapping tools. Results of the comparison showed the amount of wetlands lost and the exact spatial arrangement of these wetlands. The analysis went further to offer which of these lost wetland locations offer the greatest potential of being restored. Potential wetland restoration suitability was assigned to areas based on historic presence of wetlands and current hydric soil types overlapped. The Status and Trends Assessment was applied to each sub-watershed as well as to the overall watershed as a whole. A concise representation of the results from the Hodunk-Messenger Watershed Wetlands Status and Trends Assessment is represented in *Map 4-4*.

Building on the information generated from the wetlands status and trends analysis, MDEQ-LWMD Staff applied a comprehensive LLWFA to the Hodunk-Messenger Watershed using advanced GIS capabilities. This assessment generated information on the ability of wetlands (past and present) to perform certain ecological functions. These functions included flood water storage, stream flow maintenance, nutrient transformation, sediment retention, shoreline stabilization, presence of rare and imperiled wetlands and presence of a number of habitats for different key wetland wildlife species.

The process to identify which wetlands performed what functions at a high level of significance involved classifying each past and present wetland by its type and class. Known functions for each kind of wetland were then applied to each wetland, based on its type and class. Each function unit was then mapped separately onto several different maps. All wetland complexes that were not performing the given function to a high level of significance were eliminated. Essentially, the end result isolated the most important wetlands in the watershed based on their ability to perform a certain important ecological function (or functions) at a high level of significance.

To help steer future restoration and preservation efforts, the LLWFA was performed on both pre-settlement and 2005 wetlands (based on NWI information). In this way, a greater sense of value can now be applied to restoring wetlands that are known to have performed invaluable ecological services. Likewise, greater value can also be applied to permanently protecting the existing wetlands that offer the greatest amount of functions (benefits) for the watershed. A full report on the results of these wetland assessments may be found in *Appendix J* of this document.

***Map 4-4*: Potential Wetland Restoration Areas**



Source: MDEQ-LWMD Status and Trends Report (based on 2005 NWI data)

4.1.11 Priority Conservation Areas

Similar to wetlands, undisturbed vegetated terrestrial ecosystems (referred to as "natural areas") have also been proven to provide important ecological services for the maintenance of water quality. Such services include water retention, pollutant filtration and wildlife habitat. In an effort to identify and prioritize the natural areas providing the greatest amount of benefit to the watershed, a series of GIS land cover analyses were run on any unfragmented tract of land in the watershed over 20 acres and covered by natural land cover types (forests, prairies, etc.).

In the Hodunk-Messenger Watershed a total of 68 unfragmented natural areas were identified and prioritized through this process. The parameters for identifying priority conservation areas (PCAs) in this analysis were modeled after the work of John Paskus and Michigan Natural Features Inventory (MNFI). These parameters included total size, size of core area, length stream corridor, landscape connectivity, restorability of surrounding lands, vegetation quality and presence of rare species. Once a PCA was analyzed for a particular parameter it was applied a score based on the calculated results. Once an area was analyzed for all parameters, all of the parameters scores were added up. The total score for each PCA was then used for ranking priority. A higher PCA score indicated a more valuable natural area and therefore a higher priority to protect. Of the 68 PCAs over 20 acres in size, three were determined to be low priority, 38 medium, 23 high and three were found to be highest priority. A detailed explanation of the methods associated with the PCA analyses may be found in *Appendix K.*

4.1.12 Literature review

A key component in discovering the full range of NPS pollutants, sources and causes in the watershed was compiling information documented during other related studies of the past. As it turns out, concerns for the rapidly aging chain of lakes have spurred investigations into potential causes and probable remedies for decades. The oldest known study on the lakes was conducted by an engineering firm in the 1960's. This study proposed the potential feasibility of improving the quality of the lakes. The overriding recommendation contained in this study was to deepen the lakes in order to slow biological activity and to counteract the apparent rapid sedimentation taking place. Other studies with similar conclusions ensued in the 1970's and '80's. Even though the feasibility of recommended implementation activities in these studies may have changed over time, the background watershed information they present still holds true today.

Various other studies, more narrowed in scope, were also discovered to have come before the current planning phase of this watershed project. These studies, conducted by either state agencies or state-contracted agencies, contained more technical-natured data and were found to be of profound utility in forming reasonable conjectures about the current state of the watershed. Specifically, these studies include water quality data reports presented by the Michigan Cooperative Lakes Monitoring Program, fisheries studies conducted by the MDNR in the 1993 and 2008, water quality and biological assessment reports conducted by MDEQ, floodplain management studies developed by the USDA as well as urbanization trend information presented in the St. Joseph River Watershed Management Plan. All of these studies, in addition to other related resources, can be found in the technical reference section of *Chapter 10* of this plan.

5. WATER QUALITY SUMMARY

5.1 General Water Quality Statements

In this section, the overall health and condition of the watershed will be characterized by the quality of its surface water. The assertions regarding the state of the watershed's surface water resources have been drawn from the accumulated results of past and present watershed assessments, pollutant estimation models and current and future land use trends (*Chapter 4*). This water quality summary is meant to supplement the regulatory data that's available for isolated water bodies within the watershed in order to provide a comprehensive look at the current state of the entire watershed. Although specific problems have previously been identified, never before has this watershed been comprehensively evaluated at the landscape level. In short, this summary describes the cause-and-effect relationship that human activity has with the watershed, and provides reason for urgency in improving land and water stewardship practices.

This particular watershed is a sought after destination for recreation, tourism and vacationing. This recreational dynamic can be attributed to the watershed's ability to support a robust warm water fishery, the presence of six miles of continuous, navigable watercourse, the availability of scenic vistas, its location within close proximity to shopping, dining, and golfing and other recreational facilities, its abundance of seasonal cottages and vacation homes, and the presence of multiple public access sites, boat launches and campgrounds. While this may be an economic advantage for the local community, recreational pursuits have also been known to take a considerable toll on the environment.

Desire for lake living creates a high demand for residential development around the lakes. Often, this entails clearing riparian vegetation and filling low and wet areas along lake fringes. The result of this development is a decrease in a lake's ability to store floodwater during rain events. Replacing the built-in floodplains of natural **hydrophilic** vegetation and gradually sloping shorelines along a lake edge with abrupt edges of fill material and hard-armored retaining walls increases the likelihood of shoreline erosion because of the shoreline's lost ability to absorb wave action. Moreover, the close proximity of houses and higher water tables along the lakes create an increased risk of septic system leaching (*Appendix F*).

The Hodunk-Messenger Watershed is important to the citizens of Branch County because it provides water storage, nutrient cycling, pollutant filtration and recharges valuable groundwater supplies. The Hodunk-Messenger Chain of Lakes watershed also provides prime soils for agriculture (*Appendix G*). Crop cultivation in the watershed is primarily restricted to row crops, such as corn and beans, along with wheat to a lesser extent. During the planning phase a number of agricultural fields utilized for livestock forage have also been indentified. Livestock production in the watershed consists mainly of sheep, hogs and horses, and these operations are found scattered throughout the watershed, especially in the upper, or **headwater**, regions away from the city of Coldwater.

Although these agricultural components are a major economic staple in the watershed, they are also known to contribute significant amounts of NPS pollution to the waterways through processes such as soil erosion, rapid water drainage, insufficient animal waste storage, and mismanaged fertilizer and chemical application. Primary pollutants associated with these sources include sediment, nutrients, animal wastes (nutrients and pathogens) and **agrichemicals** (various pesticides and herbicides).   Soil erosion in particular is a primary concern associated with agriculture in the Hodunk-Messenger Watershed. Of all the sources of sediment in the watershed, agriculture by far contributes the greatest amounts of sediment loads. In fact, because of its predominance across the watershed landscape, cropland has been determined to contribute 51% of the total annual nitrogen input in the watershed, 70% of annual phosphorus loads and 78% of all annual sediment inputs (*Chapter 6, Table 6-14*). Not only does soil erosion cause sediment deposition in nearby lakes, streams and wetlands, but it also carries with it other pollutants like nutrients and pesticides that have become chemically-bonded to soil particles. In this way, soil erosion further robs the land of productivity.

Leading causes of soil erosion from agriculture in the watershed include row cropping and traditional tillage practices that expose bare soil for long periods of time. Heavy use of livestock in an area can also lead to localized increases in soil erosion. There is also concern for the increasing trend of fence row removal in the watershed. When fence rows and tree lines are cleared between agricultural fields, there are available less wind breaks and vegetated filter strips in place to reduce wind speeds and divert sheet flow runoff. Similarly, to maximize agricultural yields, there is often a tendency to remove riparian buffers and farm up to the edge of stream banks and wet areas. This practice is of concern because it allows for direct delivery of NPS pollutants to surface waters without undergoing any filtration. This practice has been observed in widespread abundance throughout the watershed. In addition to these conditions, USDA-NRCS determinations have also identified several areas within the watershed to be HEL (*Appendix G*). Nutrient, pathogen and chemical loading in the watershed is suspected as being contributed from insufficient waste storage, livestock access to streams and mismanaged application of manure, commercial fertilizer and other agrichemicals.

***Figure 5-1*: Ag. Drain During Period of Low Flow**

These agricultural activities are presently demonstrating the distinct consequence of directly impacting the navigation and natural hydrology of watershed streams. Through watershed planning project assessments, it has been determined that surface water bodies in the watershed are receiving excess amounts of sediment, nutrients and chemicals from agricultural practices based on observed stream **turbidity** and algae growth in streams adjacent to farm fields. Another unfortunate side-effect of large scale agricultural cultivation is that the habitats of aquatic species are also being directly impacted through the physical disturbances caused by equipment and livestock. Sediment loading in streams can damage the gills of fish and cover the spawning and feeding grounds of beneficial macro invertebrates.

The City of Coldwater is another factor that's been determined to be a major NPS pollutant contributor to the Chain of Lakes. Increased impervious surfaces from parking lots, rooftops and transportation ways creates increased polluted runoff since stormwater washes off and transports pollutants from these areas without an opportunity to infiltrate through the soil. Increased impervious surface also creates greater magnitudes of stormwater runoff for delivery to nearby streams, thereby increasing the frequency and volume of peak flows in streams after rainfall events. Coldwater is currently the fastest growing municipality in south central Michigan. According to a build out analysis conducted during the planning of the St. Joseph River Watershed Project, Branch County has the greatest potential for increased population and development growth out of any county on Michigan side of the St. Joseph River Basin.

Increased urban development and the associated impervious surface increase would only serve to increase the pollutant loads being delivered to the lakes. Fortunately, the City of Coldwater has adopted a comprehensive master plan that sets forth policies and guidelines that help guard against the dangers of haphazard development. The Coldwater Planning commission administers this master plan and designates pre-determined land uses for the long range development of the city. With this in mind, the biggest concern for the City of Coldwater becomes promoting pre-development infiltration rates in the existing urban areas and securing the funding necessary to appropriately retrofit components of the urban infrastructure with more water-quality development practices.

With increased urban growth and development comes the increase and outward sprawl of residential dwellings. At present, the most sought after area for residential development is located in the rural areas surrounding Coldwater as well as the lakeshore areas along the chain of lakes. Unfortunately, due to limiting soil types for septic absorption (*Appendix F*), high water tables and/or close proximity to wells or other septic drainage fields, these areas are unsuitable for individual septic systems to properly function. In fact, the Branch-Hillsdale-St. Joseph Community Health Agency currently estimates that 19% of all individual septic systems malfunction annually in the watershed. Many of these failing or underperforming septic systems occur around the chain of lakes themselves, where once seasonal cottages are being converted into year-round residences. In these instances, the septic systems are often sized too small and situated so closely together to properly serve year round homes. When septic systems do not function efficiently, they are apt to leach potentially hazardous amounts of nutrients and pathogens to surface and ground water resources. Based on the approximate 2,395 individual septic systems found in the watershed (based on Branch GIS Dept. estimates), there are 455.1 septic systems estimated to fail in the watershed in any given year. According to the EPA Spreadsheet Tool for Estimating Pollutant Loads (STEP-L) model estimations, these 455 septic systems contribute on average 1.62 lbs of nitrogen per hour and 0.63 lbs of phosphorus per hour to the watershed (*Table 1-3*). Given the findings of the GIS analyses and the information gathered from various environmental agencies, it can be concluded that groundwater resources in the Hodunk-Messenger Watershed are highly vulnerable and at-risk of contamination if proper management measures are not taken.

Based on an EPA watershed model, it is estimated that failing septic systems in the watershed contribute an average of **1.62 lbs of nitrogen and 0.63 lbs of phosphorus per hour** to the watershed

All of the various land use activities discovered to be taking place in the watershed cumulatively degrade water quality and contribute to an unbalanced watershed. The physical symptoms of degraded water quality are apparent in the chain of lakes themselves. The lakes, channels and contributing streams have become shallowed from sediment deposition and are choked with over-abundant aquatic plants and algal blooms. According to the 2005 Cooperative Lakes Monitoring Program (conducted locally by the North Chain Lake Association) Randall Lake had the 4^{th} highest amount of chlorophyll α (algae particles) of any of the lakes monitored in Michigan.

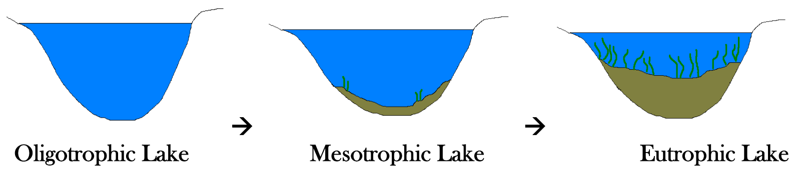
Water quality indicators such as this are signs of rapidly aging, or “dying”, lakes. The observable factors such as cloudy, turbid water, rapid and aggressive algae growth and shallow, silty lake beds present among the water bodies of the watershed would seem to intuitively indicate surface water impairments. However, as of yet MDEQ water quality data suggests that only Messenger Lake is impaired for total body contact. A 2007 MDNR fisheries study of the Hodunk-Messenger

Chain of Lakes supports these findings by reporting abundant and diverse populations of warm water fish species, and a healthy overall warm water fishery. Heavy lake use during summer months also indicates that the lakes still offer a level of navigation sufficient for most personal water crafts and the availability for most contact recreation activities. For these reasons, all designated uses besides total body contact recreation between May 31 and October 1 for the chain of lakes have been considered un-impaired by MDEQ. That being said, these same designated uses for the chain of lakes have been identified through the process of watershed planning as being highly threatened.

The NPS pollutant load inputs contributing to the threatened state of surface water in the watershed are thought to be significantly accelerating the life cycle of the lakes. This aging process, also known as **eutrophication**, is a natural process that involves the gradual filling in of a water body. Over a geologic timeline, sediment gets washed from the land and deposited into a water body. At the same time, other water bodies are carved out and formed in other places. Naturally, this process takes hundreds to thousands of years. However, because of the human-induced influences from surrounding land use activities, this process can accelerate at an alarming rate. Human-induced eutrophication, otherwise known as **anthropogenic** or cultural eutrophication, is a process that can cause significant changes to a lake in just decades, years, or in some cases, from season to season. In this process, silt and sediment cover the lake bed and nutrient inputs cause an explosion in plant and algae growth. As the lake becomes shallower, water temperatures raise slightly. Warmer temperatures, coupled with excess amounts of Nitrogen and Phosphorus, create prime conditions for plant life to grow. This advantage for plant growth is sometimes referred to as an increase in **biological productivity**. As the abundant amount of plant life in a eutrophying lake begins to die, huge amounts of dissolved oxygen in the water gets used up as the plants are decomposed by microbes, bacteria, detritivores and other decomposers. This decrease in available dissolved oxygen leads to higher fish (and other aquatic life) mortality. Without prevention or intervention, this process speeds up exponentially as the “dead” organic matter releases its nutrients back into the water column, sinks to the bottom and fills the lake bed.

MDEQ water quality sampling from the 1980’s indicates that in 1983, the Hodunk-Messenger Chain of Lakes was considered a eutrophic lake. MDEQ characterizes a lake’s overall level of water quality by its **trophic state**. Michigan lakes can generally be classified as one of three categories based on trophic state**-** **oligotrophic**, **mesotrophic**, and **eutrophic** (*Fig.5-2*). These categories reflect a lake's nutrient and clarity levels. Oligotrophic lakes are deep, clear, cold and highly oxygenated. Mesotrophic lakes have some accumulated organic matter and have slightly higher productivity. Mesotrophic lakes may support an occasional algal bloom and also lack dissolved oxygen in late summer, but they do support a very large and diverse fish population. Eutrophic lakes are shallow, warm, low in oxygen, high in nutrients and support a lot of biological activity. Eutrophic lakes do support a large fishery, but are susceptible to winter-kill offs and often contain an abundance of rough fish species.

Figure 5-2: **Trophic Conditions**



Unfortunately, continued pollutant loading for the past 29 years has only elevated the eutrophication process in the Hodunk-Messenger Chain of Lakes. Today, watershed residents complain of being unable to navigate motorized boats due to the sediment filled channels and topped-out mats of aquatic "weeds", as well as being unable to enjoy swimming and fishing due to the abundant algal blooms.

As one looks out across the adjacent landscape surrounding the lakes, with its myriad of land use activities, additional symptoms of a watershed in need of repair become apparent. Very little riparian buffer remains in the watershed, and surviving portions are small and fragmented (*Appendix E*). This lack of buffer allows polluted agricultural runoff to freely enter and contaminate nearby surface waters with sediment, nutrients, and agrichemicals. The majority of the land mass in the upper portions of the watershed has been converted from natural vegetation to agricultural fields. This conversion has resulted in the straightening (channelizing) of nearly all of the streams in the watershed, in addition to the tiling and draining of poorly drained fields. Today, 51% of the pre-settlement wetlands in the watershed have been lost to agriculture. Moreover, the LLWFA conducted in 2009 indicates that 73% of the wetlands known to provide significant floodwater storage in the watershed have been lost (*Appendix J*). With the loss of this historic storage capacity, rainfall runoff reaches streams much faster, and in greater quantities, than it would naturally. This results in increased frequency in bankfull discharge events in streams. Periods of bankfull discharge are when a stream bank is most stressed and when scouring and erosion occurs. Likewise, the normal base flows of streams are lower than would be normally, since tiling rapidly drains excess water from fields disallowing soil saturation and slower water delivery times to streams. This extreme variability of flow levels, also known as flashiness, generally indicates an unstable stream. Areas of severe stream bank erosion (scouring, undercutting and slumping) found throughout the Hodunk-Messenger Watershed indicate the presence of flashiness and a volatile hydrology that rapidly transports NPS pollution to the chain of lakes.

The level of the **water table** in the watershed also plays a factor in determines lake levels and base flows of streams. Depth to the water table also influences the hydrologic state of the remaining wetlands in the watershed. A low water table usually affects the base flow rate of streams and rivers. Low flow conditions reconfigure wetland areas and have negative impacts on the number and size of wetland plant and animal species populations. The varying depths to the water table in the watershed are represented in *Map F-6*.

The City of Coldwater has a similar effect on the flow levels of nearby water bodies. Increased impervious surfaces create larger quantities of stormwater that get delivered to the Sauk River and the chain of lakes. This is of great concern because Coldwater currently occupies 7% of the land mass in the watershed. Current watershed models show that once a watershed reaches 10% impervious land cover, the hydrology becomes so altered and unbalanced that the effects can never be fully reversed. Additional concerns regarding Coldwater's influence on the watershed stem from the fact that 100% stormwater falling on impervious surfaces runs off, taking with it up to 90% of the pollutants that have been deposited on that surface in the "first flush" of a rainfall event. In addition to the sediment, nutrients, pesticides and herbicides that get transported by stormwater runoff, oils, grease, other automotive liquids and trace heavy metals also have a tendency of accumulating on impervious surfaces and flushing to surface waters in urban areas. Currently, there are no filtration or separation devices in place to reduce NPS pollutants such as oils and fine particulate matter from entering the storm sewer system in the City of Coldwater. However, representatives from the City of Coldwater have stated that the City has begun looking for opportunities where Low-impact Development (LID) and green infrastructure techniques can be utilized as a way of keeping NPS pollutants out of the storm sewer system. Without a sufficient green infrastructure (contiguous natural areas) in place, hydrology of a watershed can be severely and sometime irreversibly impacted. The biodiversity of a watershed also decreases as natural areas are destroyed.

All of the aforementioned NPS pollutant contributions have had a chronic and negative effect on the water quality of the watershed, but none are currently having as great of an impact as pathogens. Starting in 2000, MDEQ monitoring revealed that Messenger Lake was not meeting the designated use of total body contact recreation between May 31 and October 1 because of pathogen contamination. Subsequent beach water sampling conducted by the Branch-Hillsdale-St. Joseph County Environmental Health Agency revealed that the pathogen in question was *E. coli* and that this contamination was likely attributed to the abundance of goose feces present along the public beach at Messenger Lake. Geese feces are high in nutrients and are notorious for being carriers of the *E. coli* bacteria (*Appendix C*). In fact, calculations made in *Appendix C* indicate that a single goose has the potential to contribute 9,022.1 E. coli organisms to surface water bodies per day. This finding, coupled with the tendency of geese to congregate in lake residents' lawns, has raised considerable concerns about the goose populations along the Hodunk-Messenger Chain of Lakes.

Both Canada goose and Mute swan numbers are known to abound in and around the chain of lakes. Some anecdotal reports from local stakeholders indicate that in 2007 and 2008, over 100 swans had been identified on Morrison Lake alone, with goose numbers estimated to be 2-3 times greater. The reason for this abundance of waterfowl (many migratory ducks frequent the chain of lakes as well) can be attributed to the overlaying migration flyways and vast expanses of water, manicured lawns and nearby crop fields for feeding. The pathogen contamination at Messenger Lake Beach has remained ever since the first discovery, and the most recent (2008) MDEQ Integrated Report indicates that Messenger Lake is still not attaining its full body contact recreation designated use.

5.2 Individual Water Quality Statements per Sub-watershed

Within the Hodunk-Messenger Watershed there are three major sub-watersheds. These sub-watersheds drain to the three main tributaries of the chain of lakes: Cold Creek (northeast), Miller Lake Drain (west) and the Sauk River. In other words, rainfall in the Hodunk-Messenger Watershed moves through either the Cold Creek Sub-watershed, the Miller Lake Drain Sub-watershed or the Sauk River Sub-watershed before entering the chain of lakes. With this in mind, watershed inventories were broken down by sub-watershed in order to more accurately characterize each area within Hodunk-Messenger Watershed by its individual strengths and weaknesses and develop a better conception of NPS pollutant origins. This sub-watershed analysis also helped to prioritize sub-watersheds on an impairment basis so that implementation activities are more efficiently applied throughout the watershed.

Before any field inventories were conducted, an aerial photography review and GIS land use analysis was conducted on each sub-watershed (*Appendix E*). These assessments indicated that the greatest loss of riparian vegetation and stream meanders took place the Cold Creek Sub-watershed. The Miller Lake Drain sub-watershed appeared to retain the greatest amount of riparian vegetation and had the least amount of stream channelization. The Sauk River sub-watershed showed loss of riparian vegetation and stream meanders somewhere in between the extent suffered by the other two sub-watersheds.

Several other watershed assessments (*Chapter 4*) were conducted to determine the priority of sub-watersheds within the overall watershed. For example, subsequent analyses proved that Cold Creek Sub-watershed presently contains the greatest amount of highly erodible land and impervious surface, while Miller Lake Drain Sub-watershed was proven to contain the greatest amount of pre-settlement wetlands and natural areas. In the majority of cases, Cold Creek Sub-watershed was rated as the most critical, Sauk River Sub-watershed a close next most critical, and Miller Lake Drain Sub-watershed was commonly found to be moderately to least critical. The results of these watershed analyses are represented in *Table 5-1*. Each sub-watershed parameter is listed separately as well as combined with other parameters for an overall sub-watershed prioritization.

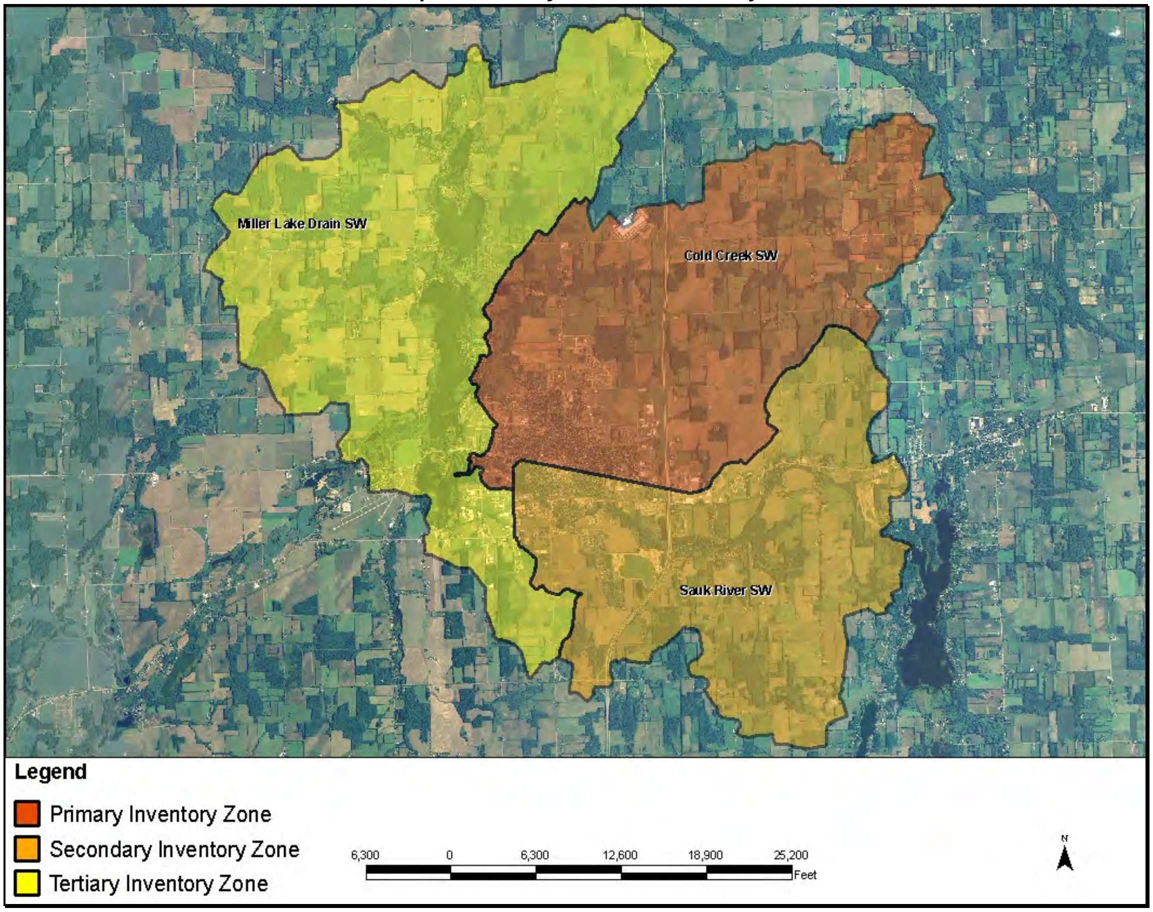
Table 5-1: **Sub-watershed rankings**

Sub-watershed Characteristic	Cold Creek SW	Miller Lake Drain SW	Sauk River SW
HEL (acres)	**215.7[1]**	116.9[3]	130.5[2]
Wetland Loss (acres)	1,611[2]	1,175[3]	**1,775[1]**
Wetland Loss (%)	57[2]	38[3]	**62[1]**
Buffer Loss (acres)	**149.7[1]**	145.6[2]	73.1[3]
Buffer Loss (%)	**55.7[1]**	32[3]	43.4[2]
Sinuosity Loss (% of meanders lost)	37%	28%	NA
Impaired Stream banks (feet)	**2,238.3[1]**	0[3]	1,765.1[2]
Moderate BEHI sites	**9[1]**	4[3]	5[2]
High BEHI sites	**1[1]**	0[2]	**1[1]**
Impervious Surface (acres)	**1,433.80[1]**	527.6[3]	948.6[2]
Impervious Surface (%)	**10.98[1]**	3.40[3]	8.70[2]
Agricultural Land (acres)	9,187.2[2]	**10,531.9[1]**	7,811.9[3]
Agricultural Land (%)	70.37[2]	68.36[3]	**71.68[1]**
Impaired Designated Uses	0[3]	**3[1]**	0[3]
Threatened Designated Uses	**6[1]**	3[2]	**6[1]**
Sediment Load (tons/yr)	**1,879.9[1]**	1,689.8[2]	1,348.4[3]
Nitrogen Load (lbs/yr)	**72,395.2[1]**	72,047.5[2]	57,095.4[3]
Phosphorus Load (lbs/yr)	15,542.6[2]	**15,789.7[1]**	12,388.2[3]
Total Score	**24**	40	35
Restoration Priority	High	Low	Moderate

**Figures in bold represent the highest value in a particular category*

With these parameters in mind, field inspections to discover site-specific sources of NPS pollution were structured around the results of this simplistic prioritization exercise. Field inspections were accordingly most concentrated in the Cold Creek sub-watershed, followed by the Sauk River Sub-watershed and least concentrated in the Miller Lake Drain sub-watershed (*Map 5-1*). The following water quality analyses for each sub-watershed are a result of these field inventories, a wetlands status and trends analysis, and current land use/ land cover information from each sub-watershed.

***Map 5-1*: Priority Areas for Inventory**



5.2.1 Cold Creek Sub-watershed

Based on comparisons of aerial photos from 1938 and 2005, the Cold Creek sub-watershed appears to have suffered the greatest loss of riparian vegetation. Field investigations support this claim and have revealed that a number of streams have crop fields actively farmed up to the edge of the stream banks. With little or no vegetated filter in place, eroded soil, feedlot leacheate, excess nutrients and agrichemicals run off directly into bordering streams. Along with the removal of riparian vegetation, the Cold Creek sub-watershed has undergone intensive tiling and stream channelization. Over time, the once-natural streams and wetlands in the Cold Creek Sub-watershed have been converted into a network of straight and deep agricultural ditches with steep gradients. Loss of stream meanders through channelization practices has caused stream flow in the Cold Creek Sub-watershed to have greater velocity and erosive force. Without natural meanders, impoundments, pools and riffles, sediment load in a stream does not receive a chance to settle out. Instead, streams in the Cold Creek Sub-watershed carry exceptionally large loads of sediment that get deposited downstream or are delivered to receiving waters.

Since much of the land mass in the Cold Creek Sub-watershed is tiled for agriculture (over 7,000 acres of row crops) water from precipitation gets delivered to nearby drainage ways much more quickly than it would normally. Land drainage through tiling does not permit soil saturation and slow groundwater movement to streams. This has caused an increase in peak flows, and has likewise reduced base flow levels. The extreme fluctuation between the peak flow and low flow and flashy nature of a stream makes streams in the Cold Creek Sub-watershed susceptible to flash flooding. Generally, the flashier a stream is, the more unstable it is. When a stream carries a flow at bankfull discharge level or has a flash flood, it has the greatest amount of erosive force (sheer stress) and therefore creates the highest amount of stress on the stream bank. This has been found to occur often in this particular sub-watershed, creating a number of impaired stream banks (undercut, slumping, scoured and rapidly widening), as well as a number of other predicted erosion hazard “hot spots”.

Besides stream channelization and land drainage, streams and drains in Cold Creek Sub-watershed are also stressed because they have little to no flood plain or fringe wetlands to spread out into in times of high water. According to 2005 NWI, Cold-Creek sub-watershed has lost 57% of its historic wetlands. Wetlands help to retain flood water, filter pollutants, settle out sediment, and take up excess nutrients.

The remaining wetlands and riparian buffers still existing in the Cold-Creek sub-watershed are primarily found in the lower regions of the sub-watershed. Downstream of Michigan Avenue, Cold Creek regains some of its meanders as it flows through large tracts of naturally occurring woody wetlands. Mud Creek replaces the name of Cold Creek downstream of Michigan Avenue and the confluence of the prison drain. At this point Cold Creek (Mud Creek) becomes a considerably wider and deeper 3rd order stream. It is at this point that navigation of the stream becomes possible. However, due to the creek’s upstream velocity and load, severe stream bank erosion still occurs. The erosive force has caused many severe logjams and stream obstructions to form throughout the length of the stream. These obstructions lead to localized flooding, stream scouring and flow redirection.

A number of unprotected livestock operations located directly adjacent to streams have also been identified in the Cold Creek Sub-watershed. These areas, scattered throughout the upper portion of the sub-watershed, present a direct threat to surface water because of the heavy use, water access and feeding areas for livestock of these operations are situated directly next to open surface water drainage ways with no vegetated buffer in place to filter polluted runoff. These areas are suspected to be delivering undesirable amounts of sediment, nutrients and pathogens to surface water due to streambank erosion, manure and feed runoff, and improperly stored waste material.

Cold Creek sub-watershed also contains the greatest amount of developed and urban area (Coldwater) of any of the sub-watersheds. Presently, 1,435.464 acres, or 11%, of the Cold Creek Sub-watershed is developed. This dynamic is cause for concern because current watershed models show that once a watershed reaches 10% impervious surface area that the impacts on the hydrology are detrimental and irreversible. For this reason there is a crucial need for restoring or creating detention wetlands and incorporating areas of **bioretention** and **bioinfiltration** within the City of Coldwater. Besides the effects on the local hydrology, the City of Coldwater contributes such NPS pollutants as oils, grease, metals, toxins from leaking underground storage tanks, sediments that are washed from construction sites and impervious surfaces, as well as pesticides, herbicides and excess nutrients from residential and commercial landscaping and lawn care.

In the Cold Creek sub-watershed, just north of Coldwater and along the eastern shores of the chain of lakes lies the only golf course in the Hodunk-Messenger Watershed; the 137 acre Golf Club of Coldwater (GCC). NPS pollutants (such as fertilizers, pesticides, herbicides) associated with a typical golf course, with its intensely maintained and manicured grounds, are even more of a concern in the case of the GCC because it abuts the chain of lakes and the entire grounds slope toward the lakes. Water quality is a concern around the GCC because there are few runoff diversions and little to no shoreline buffer. Shoreline erosion is also common around the GCC shoreline, due to woody vegetation removal and maintained turf grass up to the waters edge.

Near the GCC, residential dwellings and campgrounds are also creating a concern for water quality. In 1997 windshield survey of Coldwater Township conducted by the Branch-Hillsdale-St. Joseph Community Health Agency for the purpose of assessing the necessity of sanitary sewer needs in Coldwater Township (*Appendix F*). As a result, a number of areas in the Cold Creek Sub-watershed were identified as having septic concerns. According to the report, the residential areas along the eastern shores of the chain of lakes are too closely clustered to permit proper functioning septic systems, in addition to having unsuitable soils and seasonally high water tables (*Appendix F*). For these reasons, the individual septic systems along the lakes, as well as some areas around the City of Coldwater, are likely degrading water quality by leaching nutrients and pathogens into surface and ground water resources. This is of increasing concern as many of the seasonal residences along the lakes are being converted into year-round dwellings while many septic tanks are too undersized to facilitate this.

5.2.2 Miller Lake Drain Sub-watershed

The Miller Lake Drain is a series of inter-connected wetlands and intermittent streams that flow from Miller Lake east to the Chain of Lakes. This sub-watershed drains the entire western half of the Hodunk-Messenger Watershed and contains the actual chain of lakes themselves. However, as the name would suggest, other lakes besides the chain of lakes are contained within this sub-watershed. Both Miller Lake, Long Lake and Little Long Lake are located in the headwater regions of the southern half of this sub-watershed and all are fringed with wetlands. In fact, Miller Lake itself has been identified by MNFI to be the only rare and imperiled wetland in the entire watershed. Miller Lake Drain sub-watershed (MLDSW) is unique among Hodunk-Messenger sub-watersheds in the fact that it has retained a majority of its pre-settlement wetlands (68%) and has the least amount of riparian vegetation loss of all the sub-watersheds. Also by comparison of sub-watersheds, the Miller Lake Drain Sub-watershed has the greatest amount of forests (2,316 acres or 15% of the land cover) and the most blocks of large, unfragmented natural areas in the Hodunk-Messenger Watershed (*Appendix K*). For example, the only 4^{th}-order stream in the watershed (Coldwater River) is contained in the Miller Lake Drain Sub-watershed and between the outlet of the chain of lakes at Craig Lake and the Hodunk Dam at Hodunk Road, the Coldwater River maintains a natural, serpentine course with a sufficient riparian corridor surrounding it.

Coinciding with the relatively high level of natural area, the MLDSW has the lowest acreage of developed or urban land cover (529.09 acres or 3.43%) in the overall watershed. This is not, however, to suggest that this sub-watershed is without its problems. 2008 MDA groundwater sample testing (*Appendix F*) revealed that 2 well water samples within this sub-watershed contained nitrate levels above the MCL for human consumption. This finding suggests that agricultural fertilizer application is being severely mismanaged within this sub-watershed. Mismanaged fertilizer application puts surface water quality at risk, especially when no riparian buffer to filter runoff exists. Even though the Miller Lake Drain Sub-watershed retained high amounts of riparian buffer, there are still areas where no buffer exists at all. Likewise, because of agricultural land development, there are many areas of stream channelization that lack in-stream wetlands for pollution filtration. Of the three sub-watersheds, Miller Lake Drain Sub-watershed also contains the greatest overall acreage of farmland (10,535.84 acres). Corresponding to the large expanse of cultivated crop ground, the Miller Lake Drain Sub-watershed has been identified as the sub-watershed delivering the greatest amount of eroded soil and other agricultural-related pollutants to surface water resources.

Residential developments around the chain of lakes create similar concerns for unfiltered pollutant runoff entering the lakes. Because of the desirable recreational and **aesthetic** benefits associated with lake living, a large portion of the chain of lakes' original lakeshore vegetation and contiguous fringe wetlands have been destroyed in order to establish water front residential developments. In order to facilitate this development, many historic wetlands in the Miller Lake Drain Sub-watershed had to be filled. Today, the lakeshores of the chain of lakes have become unstable and susceptible to erosion in places not armored by artificial sea walls. Polluted runoff is also highly suspected along the lakeshore areas since the natural deep-rooted shoreline vegetation has been removed and replaced by high-maintenance lawns of turf grass. It should be noted, however, that these incidental additional pollutant inputs are not numerically represented in any tables in the WMP, nor were they factored into watershed pollutant models such as STEP-L because of their highly variable and un-confirmable nature.

MLDSW also faces water quality impairments created by an overabundance of Canada geese and Mute swans. Through their feeding habits and territorial nature, Mute swans have a large and disruptive impact on a lake's ecology and indigenous aquatic and wildlife species. Studies show (*Appendix C*) that *E. coli* levels in goose feces are known to be four times as great as in other waterfowl. MDEQ and Branch-Hillsdale-St. Joseph Community Health Agency has recognized high levels of *E. coli* contamination occurring at the public beach along Messenger Lake in the southern portion of the Miller Lake Drain Sub-watershed. After further investigation, the Health Agency attributed this contamination to an abundance of goose droppings. The abundance of these water fowl species is attributed to the large expanses of open, shallow water, the ease of access to lakefront lawns, overlapping migratory flyways in the Branch County area, and surrounding fields of crops and pastureland for feeding. Additional concerns of nutrient and pathogen input in the Miller Lake Drain Sub-watershed are caused by areas that the Community Health Agency has identified as having a high potential for septic failure. These areas are primarily concentrated along River Road along the western shores of the chain of lakes, and land around Randall Lake South of Narrows Road where residential developments are densely situated. A number of livestock operations in the northwest portion of this sub-watershed also give reason for concern of potential nutrient-ridden runoff.

5.2.3 Sauk River Sub-watershed

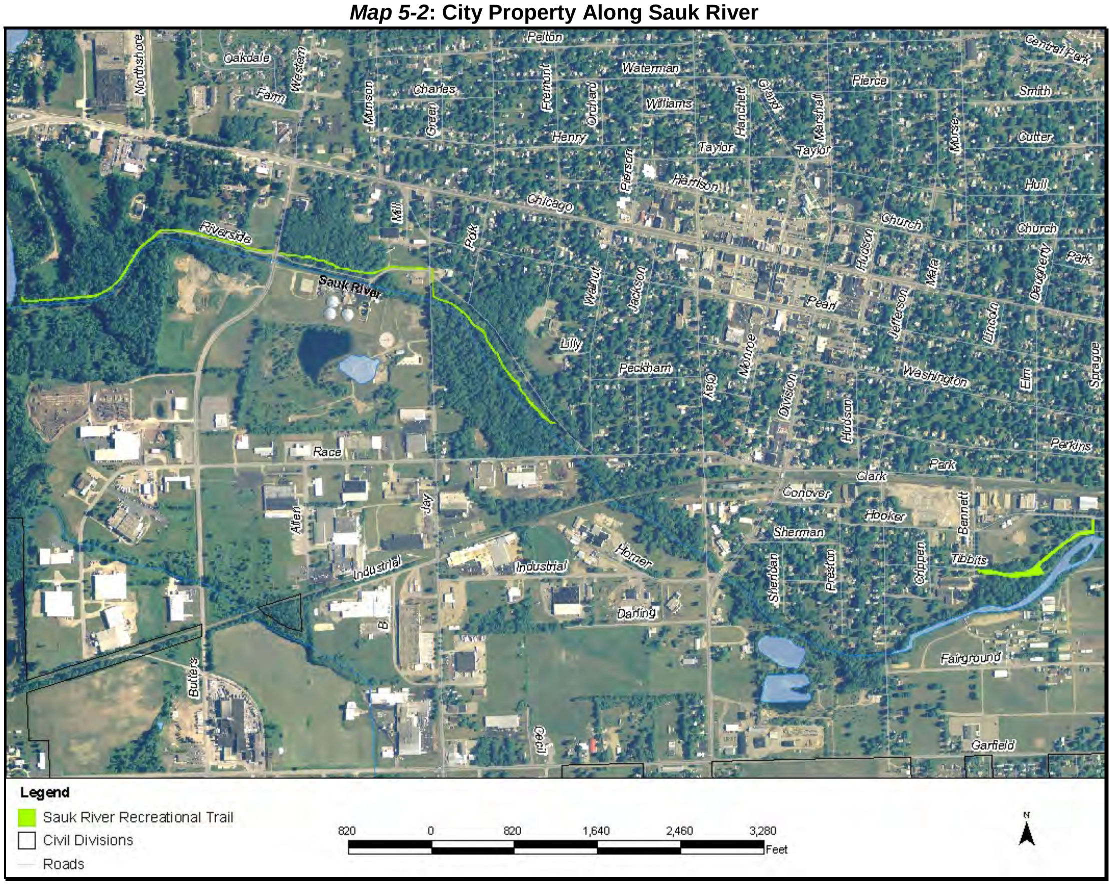
There are few smaller order streams that feed into and influence the Sauk River. For the most part, it is fed by Branch County's South Chain of Lakes (Marble Lake) and is a connective waterway between the two lake chains. The Sauk River flows west and slightly north from the mouth of Marble Lake to its outlet into South Lake. Sauk River is one of the largest streams in the Hodunk-Messenger Watershed (3^{rd} order) and in times of high water can be navigated from beginning to end.

The Sauk River watershed ranked as the second highest priority sub-watershed to inventory based on a review of aerial imagery and GIS land cover analyses. The Sauk River itself has sustained a considerable amount of vegetated buffer loss, but not quite as much as the Cold Creek Sub-watershed. In fact, the remaining segments of riparian buffer along the Sauk have actually matured and been allowed to grow up enough that they completely shelter the river and obstruct visual identification of the river in present-day aerial imagery. That being said, the Sauk River sub-watershed has also been shown to contribute significant amounts of pollutant loads to the chain of lakes.

The Sauk flows through the southern half of the City of Coldwater, where there are several segments where little to no buffer remains. In these areas with no significant buffer, the river becomes especially sensitive to influence of the adjacent urban land uses. These reaches reside predominantly between Jefferson and Race Streets. Fortunately, the majority of stream reaches upstream and downstream from these areas in the City are bordered by city-owned lands. These areas chiefly consist of public parks and municipal service facilities. Most of these areas maintain some level of vegetative cover in place of impervious surface near the river. Most of these city-owned properties are wooded and natural, and therefore offer substantial benefits to the river. However, there are also several areas that consist of manicured turf grass and lack any significant woody vegetation. In this way, these reaches of river still experience an unfavorable amount of surface water runoff, especially the reach of river that flows along side Waterworks Park and the Branch County Fairgrounds.

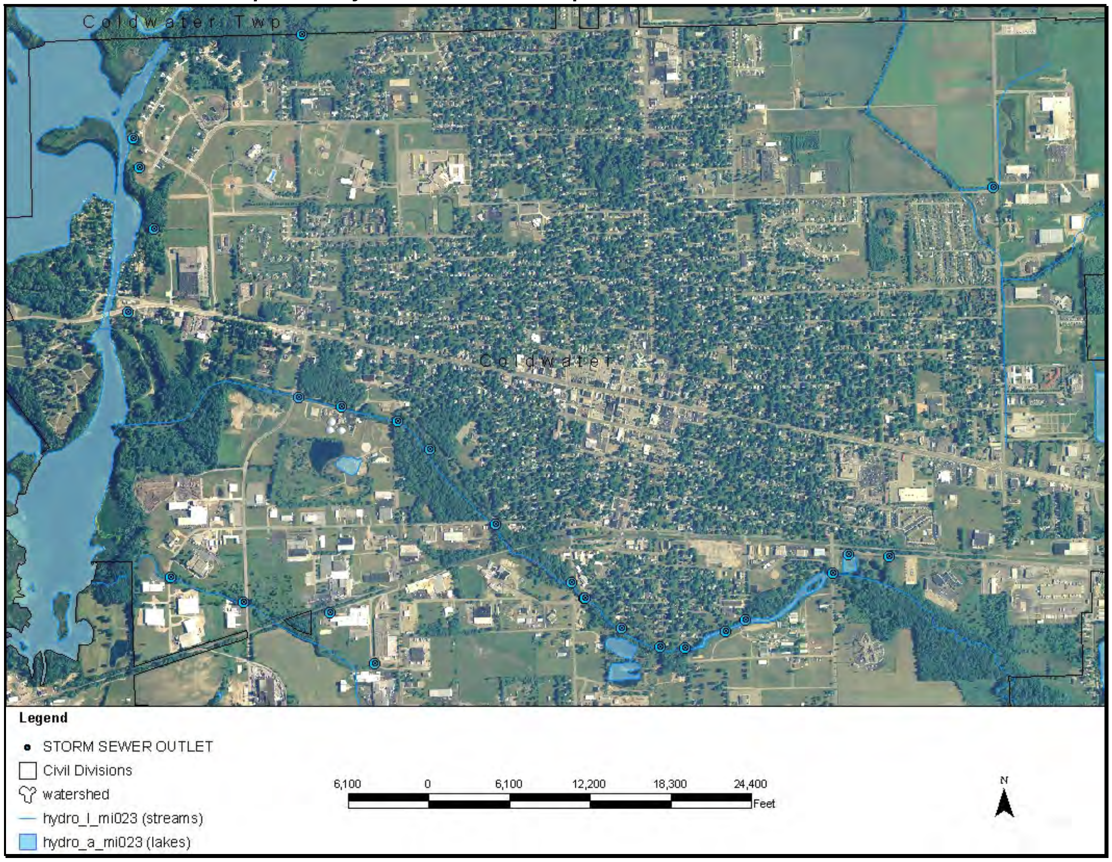
The distribution of city-owned and privately owned parcels along the Sauk River is represented in *Map 5-2*. As a benefit to the Sauk River Sub-watershed, the City is actively pursuing ways to acquire more riparian property and extend the parks system along the Sauk River.

***Map 5-2*: City Property Along Sauk River**



During rainfall events, the river picks up the city's stormwater runoff and carries it to the lakes via the municipal storm sewer system. Based on information provided by the City of Coldwater Engineering Department, 16 of Coldwater's 25 municipal storm sewer outlets discharge into the Sauk River (*Map 5-3*). The mouth of the Sauk River is also the site of the Coldwater's municipal waste water treatment plant outlet. The City's treated waste water effluence is discharged down to the outlet into South Lake through an underground pipe that is buried in the streambank along side Sauk River. Due to severe erosion problems, this waste water discharge pipe has become exposed as in need of immediate attention (Site *SR 8* in *Chapter 7 & Appendix L).* The City of Coldwater currently has plans to re-bury the discharge pipe and implement extensive streambank stabilization work along the Sauk to protect against reoccurrence of the erosion problems.

Map 5-3**: City of Coldwater Municipal Storm Sewer Outfall Points**



Over the years, residential and commercial areas have spread out from the city to upstream portions of the river. Sauk River itself has been left relatively unaltered, but its natural meanders and scenic qualities have caused a demand for riverfront developments. Outside of Coldwater and its myriad of pollutant inputs, rural land development constitutes a major threat to the health and proper functioning of the Sauk River. At present, development pressures in the river's floodplain and two insufficiently buffered gravel pits that border the river contribute significant sediment loads to the river during times of precipitation and high water.

Historically, the Sauk River Sub-watershed has suffered the greatest amount of wetland loss in the watershed. Based on 2005 NWI data, 1,748 acres of wetland (61% of the pre-existing wetlands) have been lost. Most of this wetland loss occurred in the upper reaches of the sub-watershed, away from the City of Coldwater where land use is predominately agricultural. Correspondingly, this sub-watershed has the greatest proportion of agricultural land (71.68%) and the least amount of water and wetland acreage (3.65%).

5.3 Need for Improvement

It has become apparent throughout the watershed planning process that the Hodunk-Messenger Chain of Lakes Watershed is a highly impacted watershed in need of mitigation for restoring and enhancing the current level of water quality and conservation for protecting the network of natural open space still benefitting the watershed. Based on the preceding summary of watershed problems along with the individual characteristics of each sub-watershed, a number of Best Management Practices (BMPs) and related watershed improvement activities have been recommended for the improvement of surface water resources in the Hodunk-Messenger Chain of Lakes Watershed. Based on the current state of the watershed, these recommended implementation activities have been generally geared toward reducing soil loss in agricultural areas, restoring beneficial vegetated buffers along lakes and streams, promoting stormwater infiltration over runoff and conveyance in the urban areas, and restoring and protecting wetlands in the headwaters regions to promote hydrologic stability.

Past improvement projects and annual aquatic weed control efforts have only temporarily alleviated the symptoms of an unhealthy chain of lakes. The real problems originate from the watershed and until management practices aimed at reducing NPS pollutant loads are put on the ground throughout the watershed, fully restored designated uses and enhanced water quality in the Hodunk Messenger Chain of Lakes is highly improbable. For a comprehensive listing of all recommended implementation activities, see the Implementation Action Plan in *Chapter 9* of this document.

6. POLLUTANTS

6.1 Pollutants of Concern

To date, NPS pollution remains the leading cause of problems degrading or threatening Michigan's surface water resources. These pollutants are transported from fields, parking lots, rooftops, lawns and land development sites into nearby water bodies by **precipitation** runoff (rain water & snow melt). According to the St. Joseph River Watershed Management Plan, the NPS pollutants of greatest concern in the St. Joseph River Watershed are *sediment, nutrients, habitat and natural systems loss, pathogens, pesticides, herbicides and other toxins, and hydrologic modification*. With this in mind, CWA Sec. 319 funds were utilized to investigate and discover the full range of these pollutants within the Hodunk-Messenger Chain of Lakes Watershed.

Based on public records, past studies and known land use activities, these and other pollutants have been proven or suspected to be entering the chain of lakes in quantities large enough to have a negative affect on the health of the watershed. The pollutants of greatest concern in the Hodunk-Messenger Watershed are listed below in *Table 6-1* in order of their priority (highest priority pollutants are having the greatest impact on the health of the watershed and/or are found in greater quantities).

Table 6-1: **Known and Suspected Pollutants, prioritized**

NPS Pollutant *known (k) or suspected (s)*	**Priority Ranking**
Sediment *(k)*	1
Nutrients (P & N) *(k)*	2
Pathogens *(k)*	3
Hydrologic Flow *(k)*	4
Pesticides/herbicides *(s)*	5
Oils, grease, metals *(s)*	6
Refuse/trash *(k)*	7
PCBs *(k)*[*]	n/a
Mercury *(k)**	n/a

By far, sediment was discovered to be the pollutant of greatest quantity in the watershed. According to *STEP-L* pollutant load estimates, 5,203 tons of sediment enters the Hodunk-Messenger Chain of Lakes from the surrounding 61.5 square mile watershed every year. This load estimate was based on soil properties, climate, impaired stream bank dimensions, land cover types and predominant land uses of the watershed. Sediment was listed as the pollutant of highest priority because it was found in large enough quantities to destroy aquatic habitats, disrupt natural hydrology and limit navigation. In areas where sediment loads are deposited, water bodies become shallower, causing water to redirect its flow and increase in temperature. Also important is the fact that secondary pollutants like nutrients and toxins become chemically bound to sediment particles and are transported to surface waters. With this in mind, nutrients were found to be the second highest pollutant of concern in the watershed.

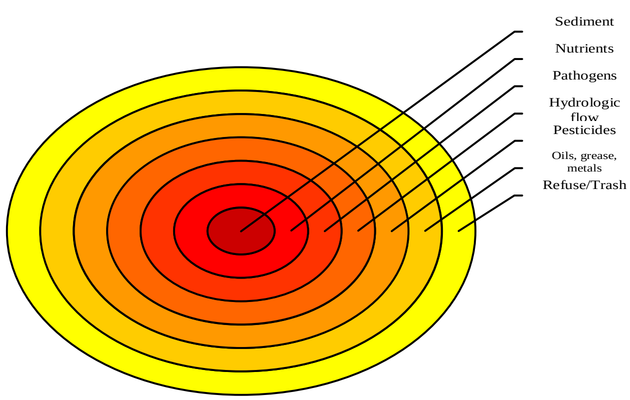
In nature, nitrogen and phosphorus are meant to be limiting factors in plant growth and are therefore found in very minute amounts. When excess amounts of these nutrients are deposited into the environment, whether it's intentionally applied for crop growth or unintentionally leached from sewage and organic wastes, negative results can occur. In surface water bodies, excessive nutrient loading tends to result in the accelerated growth of algae and aquatic plants. This, in turn, disrupts and impairs sensitive aquatic ecosystems. In fact, studies have proven that one input unit of phosphorus (lb., gram, etc.) typically results in a 500 unit output of algae and/or

1 pound of **Phosphorus** input into an aquatic system will yield **500** pounds of **algae** and **plant material**.

plant matter. Moreover, extreme amounts of nutrient contamination can cause human health concerns. In the Hodunk-Messenger Watershed, 296,963.7 lbs of nitrogen and 52,264.5 pounds of phosphorus are estimated to be entering surface water every year.

Pathogens are recognized as the third highest pollutant concern. While not known to be widespread, the MDEQ recognizes pathogens as the cause for the non-attainment of total body contact recreation within the Chain of Lakes. Pathogens can be defined as disease causing agents or infectious organisms such as bacteria, viruses, or fungi. Beach water sampling in 1995 (*Appendix C*) conducted by the Branch-Hillsdale-St. Joseph Community Health Agency revealed that the specific pathogen of concern is *E. coli*, a fecal coliform bacteria.

Figure 6-1: **Priority NPS Pollutants in the Watershed**



The Center of the target indicates the pollutant that possesses the greatest threat to the health of the watershed. Moving out from center, each successive ring indicates a lesser priority pollutant. The broader outer rings also help indicate the level of specificity of implementation efforts for that respective pollutant. The more far-reaching a circle is; the more general and educational in nature implementation efforts will be. The smaller the circle, the more site-specific implementation efforts will be.

Hydrologic flow was listed as a major pollutant in the Hodunk-Messenger Chain of Lakes due to the dramatic regional alterations of the natural hydrology, resulting from wetland conversion, agricultural drainage and urban sprawl. Even though there are no designated uses currently impaired by hydrologic flow, many are being threatened. Changes in flow can affect lake and stream levels, rates of water movement and water temperature. These changes result in flooding, stream bank erosion, sedimentation, excessive nutrient loading, and elevated toxin levels from faster delivery to surface water.

Pesticides and herbicides are NPS pollutants suspected of contributing to a decline in water quality, based on the intense agricultural land use present in the watershed. There is an estimated 21.25 miles of unprotected waterfront found within the watershed, therefore pesticide and herbicide contamination, to some extent, is expected. The level of this chemical contamination is yet to be determined. Besides agrichemical use, residential and commercial "weed and feed" landscaping and lawn care methods also play a role in contributing NPS pollution, further adding to the variability of pesticide and herbicide presence in the watershed. Although these chemicals are suspected to be present in the water resources of the watershed because of the common land use practices in the watershed, they are still only listed as a "suspected" pollutant in this WMP because no monitoring has been conducted to confirm their presence. Furthermore, 2008 well water testing turned up no sampling in Branch County containing Atrazine, a powerful but common agricultural herbicide.

Oils, grease and metals are additional pollutants highly suspected of being present in the large urbanized area of the watershed. Oils, grease and trace amounts of heavy metals (such as copper, lead and zinc) get deposited onto parking lots, roads, driveways and other impervious surfaces, where they then are washed into the municipal storm sewer system and piped directly to nearby surface water bodies. Within the Hodunk-Messenger Watershed, there are 7,907 acres of impervious surface that are currently contributing unconfirmed amounts of oil, grease and metal inputs to nearby surface water bodies.

Refuse (trash, litter, etc) represents the lowest NPS pollutant priority in this management plan. Although this has been discovered through social monitoring (*Appendix A*) as a point of concern for watershed residents, especially when it comes to refuse in the lake chain itself, it is thought to be too isolated and variable to require a high priority for action.

Polychlorinated biphenyls (PCBs) and Mercury are also listed as NPS pollutants found in the Hodunk-Messenger Chain of Lakes Watershed because they have been detected in fish tissue samples taken from the Chain of Lakes and are considered harmful to wildlife and human health. Nevertheless, these pollutants are not considered a priority in this WMP because they have previously been released into the environment as point sources and have since cycled and accumulated in the environment. Therefore, any significant reduction in their loads through the application of BMPs would if nothing else be costly, if not altogether unlikely. PCBs are leftover byproducts from industrial practices outlawed decades ago, but are residually found in many inland waterways today. In the Hodunk-Messenger Watershed, PCBs are linked to the Aluminum Plant that once operated in Coldwater. As for mercury, it is released into the atmosphere through the combustion of coal and is continually deposited into surfaces waters through the process of **atmospheric deposition**. Both of these pollutants are highly **bioaccumulative**. *Map 3-1* shows the areas in the lake chain identified by MDEQ as not attaining the fish consumption designated use due to these pollutants.

6.2 Pollutant Sources

Based on recent and historical watershed assessments (*Chapter 4*), currently available water quality and biological data and current land use activities, the following sources have been identified as, or are suspected of being the origins of the pollutants of concern in the Hodunk-Messenger Watershed. While this section offers only a snapshot of the sources of NPS pollution in the watershed, a more in-depth discussion of the sources and causes of NPS pollution in the watershed are discussed in greater detail as critical areas in *Chapter 7* and *Appendix L* of this document.

The known and suspected pollutant sources shown in *Table 6-2* have been listed in descending order of priority. Prioritization of these pollutant sources was made possible by the information gathered through the various watershed assessments (*Chapter 4*) conducted during the planning project. Ranking was based on how widespread or prolific a source was, and therefore how widespread the pollutant load contributions were.

Table 6-2: **Pollutant Sources**

Pollutant of Concern	**Source** *(known (k) or suspected (s))*
Sediment	1. Agricultural runoff *(k)* 2. Streambank Erosion *(k)* 3. Construction site/development runoff *(k)* 4. Gravel pit runoff *(k)* 5. Urban (impervious surfaces) runoff *(k)* 6. Road stream crossings *(k)* 7. Field stream crossings *(s)*
Nutrients (nitrates & phosphorus)	1. Septic Systems *(k)* 2. Ag. fertilizer use (manure & synthetic) *(s)* 3. Residential fertilizer use *(s)* 4. Animal waste *(k)* 5. Livestock feedlots *(k)* 6. Recreational (golf course) fertilizer use *(s)*
Pathogens	1. Goose feces *(k)* 2. Septic Systems *(s)* 3. Manure *(s)*
Hydrologic flow	1. Wetland Loss *(k)* 2. Agricultural Drainage *(k)* 3. Urban Storm Water *(k)*
Pesticides & Herbicides	1. Agrichemical use *(s)* 2. Residential/commercial lawn care*(s)*
Oils, grease & metals	1. Urban stormwater runoff *(s)* 2. Lake Access Sites *(k)*

Refuse/trash was not listed in this table because the sources are too scattered and variable. PCBs and Mercury are not listed because of the reasons described in *Section 6.1*. All of the sources denoted *(s)*, suspected, are listed because the current land cover and land use activities in the watershed indicate a high probability for their presence.

6.3 Causes of Pollutants

The following tables list the specific processes, or causes, of NPS pollutant load contribution in the watershed. Since a watershed operates over a broad landscape and many different land use activities, there may be multiple causes of one source of pollution, either natural or man-made, that collectively impact the level of NPS pollution. The tables for each pollutant of concern are listed in order of descending priority. However, the individual causes of each pollutant source are not listed in any type of priority or order since the amount of NPS pollution generated by each cause is generally unknown and unlikely to ascertain before a comprehensive implementation monitoring project is instituted.

***Table 6-3*: Causes of Sediment**

Sources *(known (k) or suspected (s))*	**Causes** *(known (k) or suspected (s))*
1. Stream bank Erosion *(k)*	1. Removal of riparian vegetation (k) 2. Flow fluctuation *(k)* 3. Stream obstructions *(k)* 4. Human access *(k)* 5. Drain cleanouts *(s)*
2. Agricultural runoff *(k)*	Soil erosion from traditional agricultural tillage practices *(s)*
3. Gravel pit runoff *(k)*	Gravel piled too closely to stream bank *(k)*
4. Construction site/development runoff *(k)*	Improper soil erosion and sedimentation control practices *(k)*
5. Urban Stormwater runoff *(k)*	1. Increased impervious surfaces from development *(k)* 2. Lack of stormwater management practices that treat stormwater for water quality (*k*)
6. Road stream crossing *(k)*	1. Eroding road stream crossings *(k)* 2. Undersized culverts *(k)*
7. Field stream crossings *(s)*	Erosion/spills/dumpings at crossings in agricultural fields *(s)*

***Table 6-4*: Causes of Nutrients**

Sources *(known (k) or suspected (s))*	**Causes** *(known (k) or suspected (s))*
1. Septic Systems *(k)*	1. Failing septics *(k)*
	2. Direct discharge of human waste from campgrounds *(s)*
2. Residential fertilizer use *(s)*	Mismanaged application *(s)*
3. Agricultural fertilizer use *(s)*	Mismanaged application *(s)*
4. Animal waste *(k)*	1. Improper manure storage *(k)*
	2. Mismanaged application *(s)*
	3. Unrestricted animal access to surface waters *(k)*
5. Livestock feedlots *(k)*	Uncontrolled feedlot runoff *(k)*
6. Golf Course fertilizer use (s)	Mismanaged application *(s)*

In addition to the individual sources and causes of nutrients listed in *Table 6-4*, there are also small proportions of nutrients that become chemically-bound to soil particles and are therefore delivered to surface water through the process of soil erosion and sedimentation. *Table 6-5* presents the additional amounts of nutrients that can be expected to result from sediment delivery to surface water in the Hodunk-Messenger Watershed.

***Table 6-5:* Nutrient Load from Sediment (tons/year)**

Watershed	N conc.%	P conc.%	N Load	P Load
Hodunk-Messenger Chain of Lakes	0.080	0.031	6.770	2.607

***Table 6-6*: Causes of Pathogens**

Sources *(known (k) or suspected (s))*	**Causes** *(known (k) or suspected (s))*
1. Goose feces *(k)*	Overpopulation *(k)*
2. Septic Systems *(s)*	1. Failing septics *(s)* 2. Direct discharge of human waste*(s)*
3. Animal waste *(s)*	1. Improper manure storage *(s)* 2. Mismanaged application *(s)* 3. Unrestricted animal access to surface water *(s)*

***Table 6-7*: Causes of the Modified Hydrologic Flow**

Sources *(known (k) or suspected (s))*	**Causes** *(known (k) or suspected (s))*
1. Wetland Loss *(k)*	1. Conversion to agriculture 2. Land Development 3. Fragmentation
2. Agricultural Drainage *(k)*	1. Wetland conversion (*k*) 2. Stream channelization (*k*) 3. Tiling *(k)*
3. Urban storm water *(k)*	1. Increased peak flow from increased impervious surfaces *(k)* 2. Lack of stormwater management practices that help minimize flow rate & volume (*k*)

***Table 6-8*: Causes of Pesticide & Herbicide Chemicals**

Sources *(known (k) or suspected (s))*	**Causes** *(known (k) or suspected (s))*
1. Agrichemical use *(s)*	1. Mismanaged application *(s)* 2. Lack of riparian buffer *(s)*
2. Residential/commercial lawn care *(s)*	1. Mismanaged application *(s)* 2. Lack of riparian buffer *(s)*

***Table 6-9*: Causes of Oil, Grease and Metal Contamination**

Sources *(known (k) or suspected (s))*	**Causes** *(known (k) or suspected (s))*
1. Urban Stormwater Runoff *(s)*	Increased Impervious Surfaces *(k)*
2. Lake Access Sites *(k)*	1. Impervious Surface *(k)* 2. Careless boating practices *(s)*

6.4 Pollutant Load Estimates

Estimating pollutant loads helps evaluate the relative magnitude of the sources. Estimating pollutant loads is a critical component to watershed management efforts because without having an understanding of the quantities in which pollutants are being delivered or knowing from where they are coming, agencies cannot effectively control them and protect the watershed. Since most of the available watershed monitoring data compiled during the watershed planning project was **qualitative** and not **quantitative** in nature, a watershed modeling technique was employed to estimate pollutant loads, predict future conditions and help to evaluate multiple management scenarios. Watershed models play an important role in linking sources of pollutants to receiving waterbodies as NPS loads.

Based upon the diverse land cover types, current land use activities, predominant agricultural uses, extent of impaired stream banks, climate and soil types found within the watershed, the US EPA's *STEP-L* pollutant load model was utilized to calculate pollutant load estimates for Nitrogen, Phosphorus and Sediment in the watershed. The STEP-L watershed modeling program uses simple algorithms to calculate surface runoff and nutrient and sediment loads from different land uses based upon the vague input data (characteristics) of a particular watershed. The STEP-L model was also used to estimate the pollutant load reductions that would result from implementing specific physical BMPs, including Low-Impact Development practices for urban areas.

The only factor not taken into account in these estimates is the potential for additional pollutant contributions from isolated critical sites throughout the watershed such as gravel pits, construction sites or leaking underground storage tanks. Therefore, the estimated pollutant load figures (shown in *Table 6-10*) should be considered to be the lowest possible estimate of NPS pollution currently occurring in the watershed annually.

Table 6-10: **Total Load Estimates***

Watershed	N Load (lbs/year)	P Load (lbs/year)	Sediment Load (tons/year)
Hodunk-Messenger Chain of Lakes	296,963.7	52,264.5	5,203.0

**Based on STEP-L model estimates*

When applied to the varying characteristics of each sub-watershed within the Hodunk-Messenger, the *STEP-L* model was also able provide reasonably accurate output data figures on the estimated pollutant loads generated within each sub-watershed. This information is not only helpful in prioritizing critical areas for implementation, but also for providing baseline data for evaluating the success of the BMPs implemented in any one of the of the three sub-watersheds.

Table 6-11: **Pollutant Loads by Sub-watershed*±**

	Cold Creek SW	Miller Lake Drain SW	Sauk River SW
Sediment Load (tons/yr)	1,879.9	1,689.8	1,348.4
Nitrogen Load (lbs/yr)	72,395.5	72,047.5	57,095.4
Phosphorus Load (lbs/yr)	16,023.2	15,789.7	12,544.8

**Based on STEP-L model estimates*

±Note: *the sum of the separate pollutant loads from the three sub-watersheds do not perfectly align with the pollutant loads from the entire watershed (Table 6-7). The slightly lower sum of pollutants found in Table 6-8 as compared to the watershed-wide totals in Table 6-7 may be attributed to computing errors in dividing the watershed wide land uses into the three sub-watersheds. Urban land cover and farm operations that overlapped sub-watershed boundaries in particular were difficult to allocate to the appropriate sub-watershed. In spite of these discrepancies, Table 6-8 is intended to be geared more toward a comparison and prioritization tool, as opposed to a comprehensive watershed model.*

When applied to the individual characteristics of the Hodunk-Messenger Watershed, the STEP-L pollutant load model further broke down the total annual amount of NPS pollution and was able to estimate the amount of NPS pollution being derived solely from the 2,910 acres of impervious surface in the watershed. The estimated pollutant load quantities of nitrogen, phosphorus and suspended sediments from urban land cover shown in *Table 6-12* are relatively small percentages of the total NPS pollutant loading that occurs in the watershed on an annual basis. This indicates that the majority of nitrogen, phosphorus and sediment inputs are accordingly being delivered from other parts of the watershed. However, this particular pollutant model fails to take into account the amount of chemicals, metals, petroleum based pollutants and other potentially toxic substances that are being delivered from impervious surfaces in to nearby surface waters.

Moreover, there has been no comprehensive stormwater flow monitoring conducted in Coldwater to assess the amount of stormwater runoff that is being discharged to nearby water bodies. Considering that there are very few locations within the urban area of Coldwater that experience infiltration at a pre-development rate, these numbers may prove to be even higher.

Table 6-12:* Pollutant Contributions by Land Cover Type

	N (lbs/yr)	P (lbs/yr)	TSS (t/yr)
Urban Pollutant Contributions	12,798.81	1,938.54	297.45
Non-urban pollutant Contributions	284,164.89	50,325.96	4,905.55

**Based on STEP-L model estimates*

Pollutant loads generated by septic seepage in the watershed were also isolated from total watershed pollutant inputs by the *STEP-L* program. Surprisingly, the amount of individual septic systems that fail on an annual basis commit significant amounts of NPS pollution to surface and groundwater resources, even at an hourly rate. These figures are based on a Branch-Hillsdale-St. Joseph Community Health Agency estimate that approximately 19% of all individual septic systems in the watershed fail on an annual basis. By comparison, as a source of NPS pollution, septic seepage actually commits greater amounts of nitrogen and phosphorus to the watershed annually than the entire urban area of Coldwater.

Table 6-13:* Estimated Pollutant Loads Contributed by Septic Seepage

N Load, lb/hr	P Load, lb/hr	BOD, lb/hr
1.615	0.633	6.594

**Based on STEP-L model estimates*

Table 6-14 shows the annual pollutant contributions in the Hodunk-Messenger Watershed from eight different watershed land cover types. According to these figures, it is apparent that cropland commits more NPS pollutant loads than any other source in the watershed. Forest land, on the other hand, commits the smallest quantities of pollution to the watershed.

Table 6-14*: Total Load by Land Uses

Sources	N Load (lb/yr)	P Load (lb/yr)	BOD Load (lb/yr)	Sediment Load (t/yr)
Urban	12798.81	1938.54	50149.12	297.45
Cropland	153489.28	36592.45	259693.44	4043.80
Pastureland	20811.04	1732.55	66943.45	173.11
Forest	851.84	420.55	2106.25	14.60
Feedlots	9810.04	1962.01	13080.05	0.00
Septic	14146.69	5540.79	57765.66	0.00
Streambanks	916.77	352.93	1833.52	674.10
Groundwater	84139.23	3724.68	0.00	0.00
Total	296963.70	52264.50	451571.50	5203.05

**Based on STEP-L model estimates*

As confirmed by field observations, the overall pollutant quantities shown in *Tables 6-10* and *6-14* are thought to be exceeding the Water Quality Standards set forth in R.100 of Part 4 of PA 451 (*Chapter 3*). Presence of certain water quality indicators such as turbidity and abundant aquatic plant and algae growth give reason to believe that these pollutant loads are greater than the levels needing to be maintained to support designated uses. Significant reductions in these estimated pollutants are required if the Hodunk-Messenger Chain of Lakes Watershed is to fully meet all of its designated uses.

7. PRIORITY AREAS

7.1 Priority Areas of the Watershed

Many of the goals and objectives for improving water quality defined in this WMP are designed to have a broad, watershed-wide impact. By positively affecting and enhancing individual watershed stewardship practices, it is projected that scattered sources of pollutant loads will be reduced throughout the watershed. However, the watershed inventories conducted throughout the planning process (*Chapter 4*) have revealed that several specific areas in the watershed are contributing, or have the potential to contribute, a majority of the NPS pollutant loads that are currently degrading water quality in the watershed. These areas are thought to be causing the largest and most concentrated amount of damage in the watershed and therefore hold priority for being the first areas to apply management measures. To gain maximum benefit of implementation efforts and obtain the greatest pollutant load reductions in the watershed, these areas tending to have the greatest influence on water quality have been isolated and targeted for immediate mitigation. By applying BMPs to these specific areas of priority, the quickest and greatest reduction of pollutant loads will be observed.

Conversely, there are other areas within the watershed that are thought to provide a *benefit* to the health and stability of the watershed. These areas have been prioritized as critical as well, under the premise that alteration or destruction of these areas will cause further degradation of water quality. By defining these priority conservation areas, protection and enhancement activities can then be targeted to the areas where the greatest long-term benefit to sustainable watershed health can be achieved.

In all, three types of critical areas have been prioritized in this plan: critical sites, priority conservation areas (PCAs) and potential restoration areas. Potential restoration areas are defined as the areas that, if reverted back to its natural state, could provide beneficial ecological services for the purpose of reducing NPS pollution and stabilizing watershed hydrology. These areas include, but are not limited to, sites of prior converted wetlands, riparian zones and reaches of impaired stream banks.

7.2 Priority Restoration Areas

To achieve the pollutant reductions that are needed throughout the watershed to improve water quality, strategically placed restoration and mitigation practices within the overall watershed will be key in maximizing the results of implementation efforts. In order to better direct these implementation activities, the three sub-watersheds of the Hodunk-Messenger Watershed were prioritized in terms of their potential water quality threats. The result of this prioritization provides insight to which sub-watershed in the Hodunk-Messenger has the greatest need for restoration. This prioritization is highly simplistic and is meant only to offer a general snap-shot into which sub-watershed may be having the greatest impact on water quality.

The prioritization of restoration areas is based on quantifying and ranking several potential contamination threats to surface water, such as amount of wetland loss, amount of impervious surface, amount of Highly Erodible Lands (HEL) and amount of riparian buffer loss in each sub-watershed. Each sub-watershed is then ranked in each of these individual categories based on the magnitude relative to the other sub-watersheds. Specifically, for any given category, a sub-watershed would be ranked as either 1st (highest), 2nd (next highest) or 3rd (lowest).

Characterizing a watershed by its sub-watersheds helps to identify the regions with the greatest need of restoring watershed functions to improve water quality and reduce peak flows. By ranking areas of the watershed in order of their relevance to water quality treatment, implementation activities such as wetland restoration, riparian buffer installation and streambank stabilization stabilization can first be directed toward the sub-watershed with the greatest need. *Table 7-1* details this comparison of sub-watersheds, based on some potential pollutant sources discovered through planning project assessments. *Note: Table 7-1* only represents an overall prioritization for the sub-watersheds of the Hodunk-Messenger Watershed. Different sub-watersheds will rank higher for certain aspects, but for a general rule of thumb, *Table 7-1* gives reason for an overall ranking.

Table 7-1: **Sub-watershed rankings**

Sub-watershed Characteristic	**Cold Creek SW**	**Miller Lake Drain SW**	**Sauk River SW**
HEL (acres)	**215.7^{1}**	116.9^{3}	130.5^{2}
Wetland Loss (acres)	1,611^{2}	1,175^{3}	**1,775^{1}**
Wetland Loss (%)	56^{2}	38^{3}	**62^{1}**
Buffer Loss (acres)	**149.7^{1}**	145.6^{2}	73.1^{3}
Buffer Loss (%)	**55.7^{1}**	32^{3}	43.4^{2}
Sinuosity Loss (% of meanders lost)	37%	28%	NA
Impaired Stream banks (feet)	**2,238.3^{1}**	0^{3}	1,765.1^{2}
Moderate BEHI sites	**9^{1}**	4^{3}	5^{2}
High BEHI sites	**1^{1}**	0^{2}	**1^{1}**
Impervious Surface (acres)	**1,433.80^{1}**	527.6^{3}	948.6^{2}
Impervious Surface (%)	**10.98^{1}**	3.40^{3}	8.70^{2}
Agricultural Land (acres)	9,187.2^{2}	**10,531.9^{1}**	7,811.9^{3}
Agricultural Land (%)	70.37^{2}	68.36^{3}	**71.68^{1}**
Impaired Designated Uses	0^{3}	**3^{1}**	0^{3}
Threatened Designated Uses	**6^{1}**	3^{2}	**6^{1}**
Sediment Load (tons/yr)	**1,879.9^{1}**	1,689.8^{2}	1,348.4^{3}
Nitrogen Load (lbs/yr)	**72,395.2^{1}**	72,047.5^{2}	57,095.4^{3}
Phosphorus Load (lbs/yr)	15,542.6^{2}	**15,789.7^{1}**	12,388.2^{3}
Total Score	**24**	40	35
Restoration Priority	High	Low	Moderate

**Figures in bold represent the highest value in a particular category*

When taking all of these factors into account, it would appear that Cold Creek Sub-watershed contains the greatest amount of potential pollutant sources. Although estimated pollutant load figures indicate that Miller Lake Drain Sub-watershed commits the greatest pollutant loads, it is thought that some of the individual sub-watershed characteristics have a large influence on the actual pollutant inputs from each sub-watershed. For example, characteristics such as existing riparian buffer or acres of highly erodible land per sub-watershed are not taken into account in the STEP-L model. Final priority was determined by the sum of category scores for each sub-watershed. A lower score represents a lower-quality sub-watershed and a higher score represents a higher quality sub-watershed. If funds and/or timing are limited for implementation, restoration efforts should first be applied to the Cold Creek Sub-watershed, followed by the Sauk River Sub-watershed and finally the Miller Lake Drain Sub-watershed. In this way, allocation of implementation project resources will provide the greatest possible benefit to the watershed.

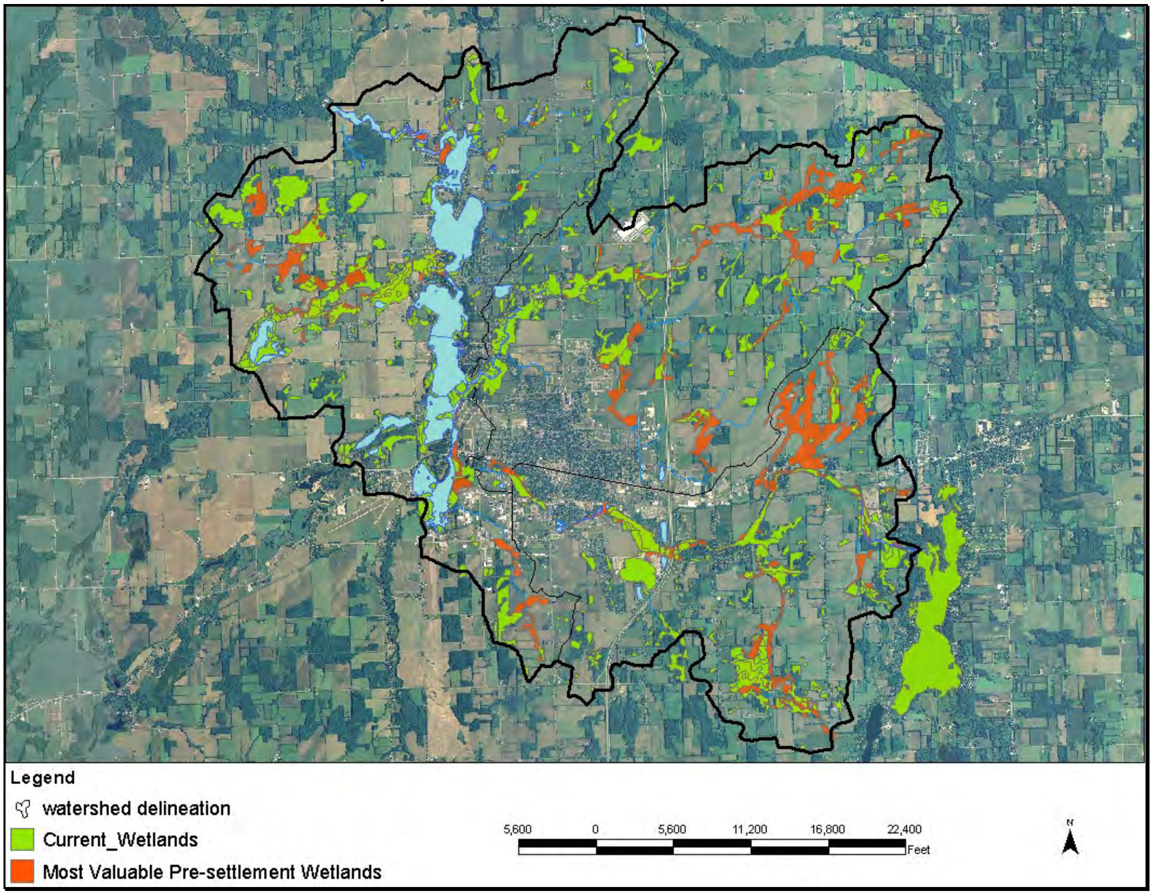
Within each sub-watershed there are several specific areas where restoration is needed to improve water quality. Specifically, these are areas of wetland loss where pre-settlement wetlands have been identified as performing certain ecological functions (*Appendix J*) and riparian areas without sufficient vegetated buffers in place (*Appendix E*). These areas require immediate restoration activities applied to restore their beneficial services to the landscape of the watershed. Restoring these areas would serve protecting surface water by filtering surface water runoff, retaining flood waters, stabilizing stream flow, neutralizing excess amounts of nutrients and providing diverse wildlife habitat. *Appendix J* contains a comprehensive look at the function lost wetlands historically provided to the watershed.

According to the watershed assessments described in *Appendices J*, there are currently 4,480 acres of potentially restorable wetlands (*Map 4-4*) and 154.4 acres of potentially restorable riparian buffer zones in the watershed (*Map 7-2*) that could be reestablished in the watershed. Patterning after MDEQ's long-term goal of 10% wetland restoration statewide, a long term goal for the Hodunk-Messenger Watershed would be to restore 448 acres of wetlands over the course of the next 20 years. A short term goal of 2% wetland restoration in the first 3 years of implementation would require 91 acres of wetlands be re-established between 2010 and 2013. Even though this might seem like a daunting goal, the advantage of watershed prioritization is that isolated restoration activities can be pinpointed at the most crucial areas in the watershed to gain optimal results.

In 2009, MDEQ-LWMD completed a LLWFA of the Hodunk-Messenger Watershed to help aid in prioritizing past and present wetlands. The functional assessment identified the functions that the lost wetlands in the watershed performed for the watershed. These functions included flood water storage, stream flow maintenance, nutrient transformation, sediment retention, shoreline stabilization and conservation of rare and imperiled wetlands. All past and present wetlands were rated for these several functions (results provided in *Appendix J*). By providing this information, stakeholders and natural resource conservation groups can now target the most "valuable" wetlands in the watershed to restore.

Since the Hodunk-Messenger Watershed suffers from such a lack of all six of the wetland functions represented in the Landscape Level Functional Assessment, it was thought beneficial to run a query to identify the wetlands predicted to perform multiple functions at a high level of significance. The wetlands that were identified through this query are predicted to be the most valuable and highest quality wetlands that have been lost in the watershed. These complexes (represented in *Map 7-1*) are the highest priority to restore among the 448 acres recommended for restoration in the watershed.

Map 7-1: **Most Valuable Wetlands to Restore**

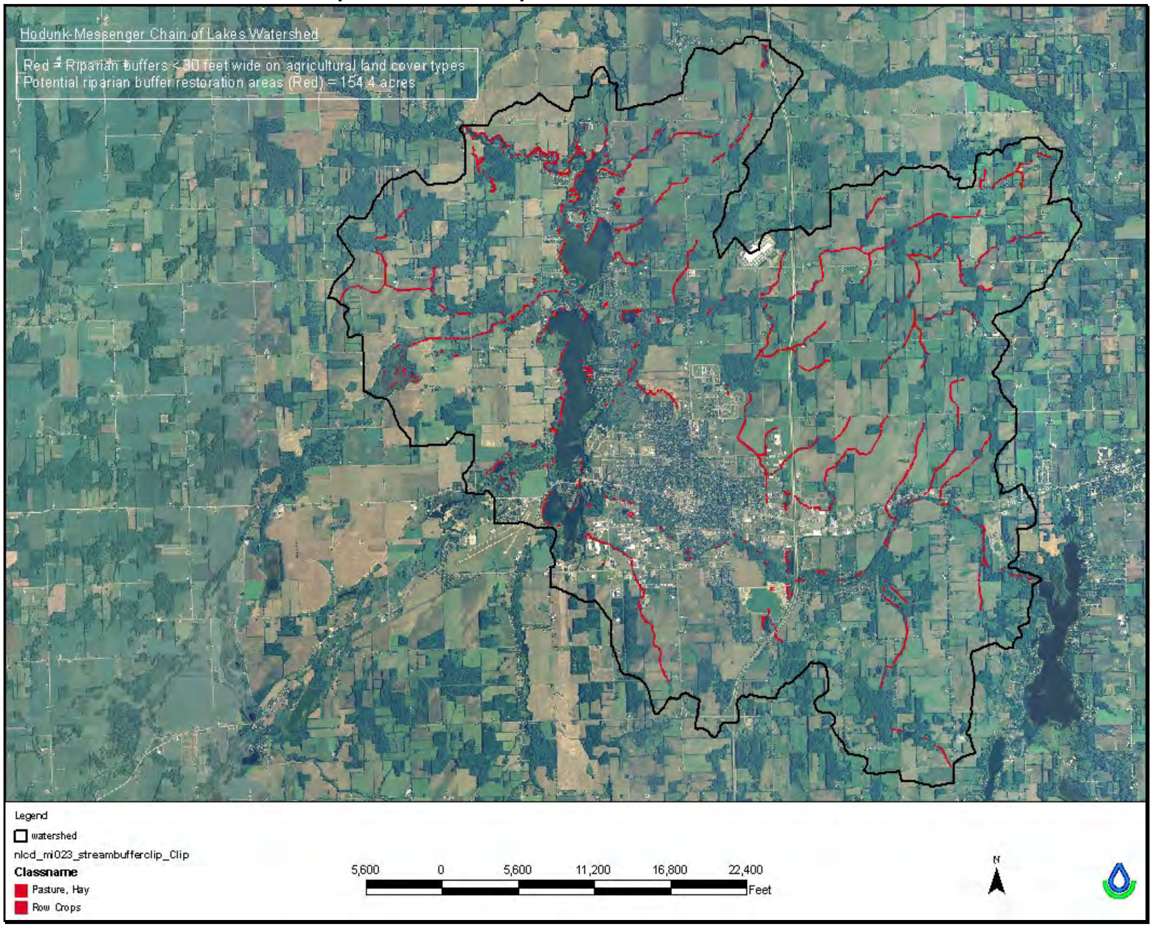


Plans for restoration also become more manageable when they are restructured on a sub-watershed basis (Implementation Action Plan *Goal 2: Objective 5*). Based on the sub-watershed prioritization shown in *Table 7-1,* restoration efforts should first be applied to Cold Creek Sub-watershed, followed by the Sauk River Sub-watershed and Miller Lake Drain Sub-watershed. The same strategy can be applied to restoring riparian vegetation in the watershed. The overall goal of restoring 154.4 acres of riparian buffer becomes more reasonable when targeted at the highest priority sites in the watershed over the course of many years. In this way, even if the desired acreage of restored ecosystems is not achieved, the most crucial areas for the support of water quality have been addressed.

Table 7-2: **Sub-watershed Restoration Tasks (In order of Priority)**

2010-2014	**2015-2030**
1. Restore 40.3 ac of wetlands in Cold Creek SW	1. Restore 161.1 ac wetlands in Cold Creek SW
2. Restore 32.5 ac of riparian buffer in Cold Creek SW	2. Restore 129.9 ac Cold Creek SW riparian buffer
3. Restore 44.4 ac of wetlands in Sauk River SW	3. Restore 177.5 wetlands ac in Sauk River SW
4. Restore 24.2 ac of riparian buffer in Sauk River SW	4. Restore 96.9 ac Sauk River SW riparian buffer
5. Restore 29.4 ac of wetlands in Miller Lake Drain SW	5. Restore 117.5 wetland ac in Miller Lk Drain SW
6. Restore 28.6 of riparian buffer in Miller Lake Drain SW	6. Restore 114.4 ac of riparian buffer in MLD SW

***Map 7-2*: Potential Riparian Buffer Restoration Areas**



The Implementation Action Plan found in *Chapter 9* of this document details the expected load reductions and other benefits expected to result from the restoration of these areas. For example, riparian buffers have specific pollutant reduction efficiencies that are expected to occur when they are implemented properly. Wetlands, on the other hand, can vary greatly in their pollutant reduction efficiencies depending on their type (shallow water pond vs. ephemeral marsh vs. flooded forest lowland, etc) and function (*Appendix J*). However, based on the information generated by the Landscape Level Functional Assessment, the *type* of pollutant reduction expected to result from restoration can now be predicted. Moreover, despite what type or class a wetland may be, wetlands always offer some level of hydrologic stabilization, especially when re-established in the upper portions of a watershed.

7.3 Critical Sites

Based on findings from the watershed assessments and field inspections detailed in the previous chapter, a number of sites in the watershed have been identified as pollutant sources that contribute excessive and detrimental amounts of NPS pollutants to the watershed. These sites require prompt mitigation efforts in order to significantly reduce pollutant loads as quickly and efficiently as possible. These sites have been identified as the watershed's "Primary Critical Sites" (*Map 7-3* and *Appendix L*).

However, this compilation of specific sites is not entirely exhaustive. These areas are by no means the only areas in need of improvement in the watershed, they just happen to be the areas of highest priority because they appear to be presenting the greatest impact on water quality in the watershed at the present time. *Map 7-3* identifies many of these sites separately and in detail, while maps found in *Appendix L* display critical areas that have a broader, more wide-spread reach throughout the watershed.

NOTE: The ordering of Primary Critical Sites in *Map 7-3* or in *Table 7-2* do not necessarily represent the order of priority.

Map 7-3: **Primary Critical Site Locations within the Watershed**

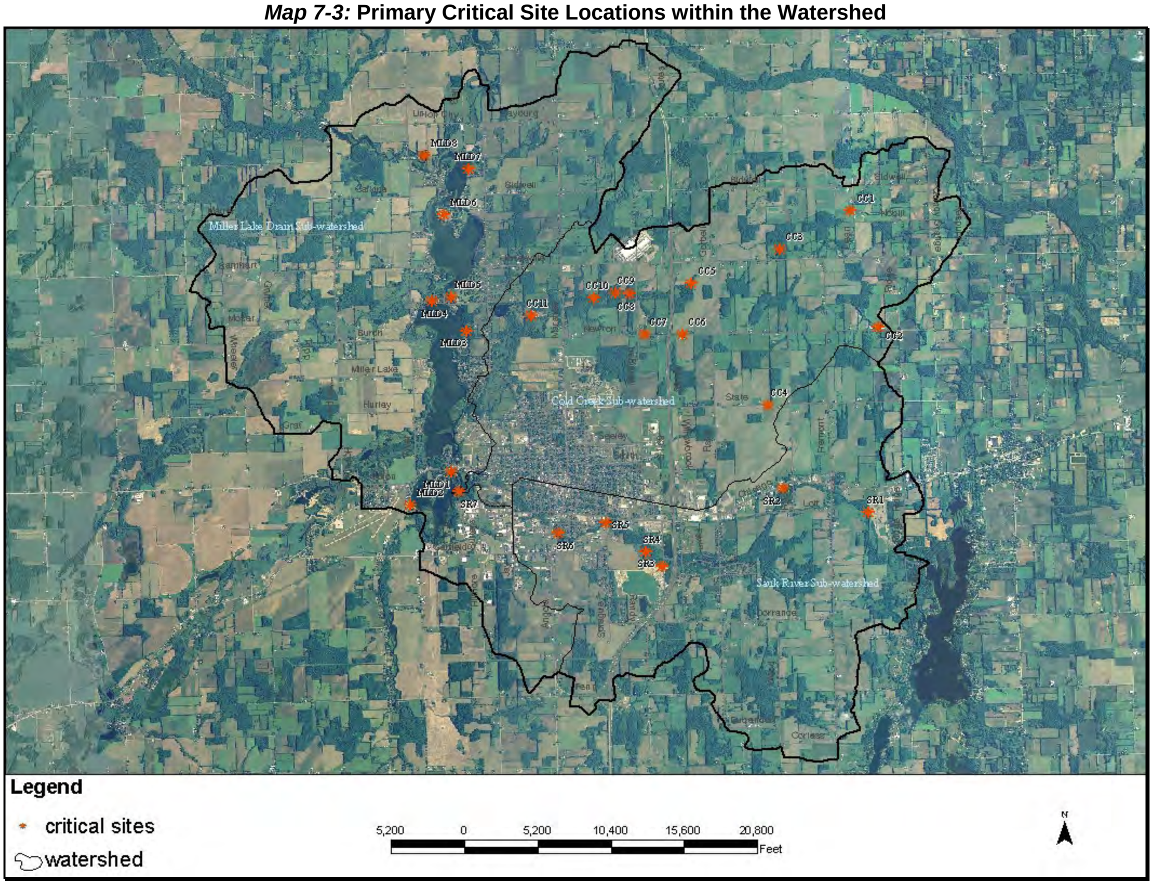


Table 7-3: **Critical Site Table**

Site#	Site Name/ Location	Pollutant Generated	Brief Description	Recommendations Cited in Table 9-1 (Goal: Objective: Task)	Full Profile Cited
CC 1	Dean Rd. Pasture (near Noblit Rd.)	P, N, Pathogens, Sediment	Very little to no buffer along creek in this pasture. Steep, channelized stream	G1:O3:T2; G2:O2:T2,3&4	Appendix L, pg. L-2
CC 2	Ridge Rd. Livestock Operation (Newton Rd.)	P, N, Pathogens, Sediment	Livestock confined to a very small area around an open stream with no buffer.	G1:O2:T2; G2:O2:T2,3&4	Appendix L, pg. L-2
CC 3	Cold Creek Impairment 1 (North of Jonesville Rd)	Sediment	Lack of upstream floodplain, undersized culvert+ log jams causing rapid widening	G1:O1:T3&7 G1:O3:T2	Appendix L, pg. L-3
CC 4	High BEHI Site (State Road)	Sediment	Bare surfaces and steep bank angles have attributed to "high" BEHI score.	G1:O1:T7; G2:O2:T2	Appendix L, pg. L-3
CC 5	Cold Creek Impairment 2 (Near I-69)	Sediment	Signs of rapid expansion through erosion include fallen & slumping trees.	G1:O1:T7 G1:O3:T2	Appendix L, pg. L-3

CC 6	Newton Road Livestock Operation (Near I-69)	P, N, Pathogens, Sediment	Livestock confined a small area directly adjacent to a stream without any buffer.	G1:O3:T2; G2:O2:T2,3&4	Appendix L, pg. L-4
CC 7	Newton Road Sand Dump (Near Michigan Ave.)	Sediment, Hydrology	A metal chute for disposing material is situated over a Cold Creek Tributary.	G1:O1:T1	Appendix L, pg. L-4
CC 8	Cold Creek Impairment 3 (West of Michigan Ave.)	Sediment	Trees are being eroded from stream edge, undercutting & slumping present.	G1:O1:T7 G1:O3:T3 G3:O3	Appendix L, pg. L-4
CC 9	Cold Creek Obstruction 1 (between Michigan & Marshall)	Sediment, Hydrology, Trash	Obstructions of woody debris accumulated, causes stream flow problems	G1:O3:T1&3 G3:O3	Appendix L, pg. L-5
CC 10	Cold Creek Obstruction 2 (between Michigan & Marshall)	Sediment, Hydrology, Trash	Obstructions of woody debris accumulated, causes stream flow problems	G1:O3:T1	Appendix L, pg. L-5
CC 11	Cold Creek Obstruction 3 (between Marshall & Union City)	Sediment, Hydrology, Trash	Obstructions of woody debris accumulated, causes stream flow problems	G1:O3:T1	Appendix L, pg. L-5
MLD 1	Rotary Park Lake Access (South Lake)	Refuse, Oils, grease & metals	Source of gas, oil, starting fluid & other harmful substances, + excessive trash.	G3:O6 G4:O2,3&4:T1	Appendix L, pg. L-5
MLD 2	Memorial Park Beach (Messenger Lake)	Pathogens, P, N, Sediment, Oils…	Pathogen contamination due to abundance of feces deposited by geese	G2:O1:T1&2 G3:5&6 G4:O2,3&4:T1	Appendix L, pg. L-5
MLD 3	Love's Lazy Lagoon Campground (Randall Lake)	Pathogens, P, N, Sediment	Potential human waste contamination, persistent litter and shoreline erosion.	G2:O3:T1 G3:O5&6 G4:O2	Appendix L, pg. L-5
MLD 4	MDNR Randall Lake Access Site (Narrows Road)	Refuse, Oils, grease & metals	Source of gas, oil, starting fluid & other harmful substances, + excessive trash.	G3:O6 G4:O2,3&4:T1	Appendix L, pg. L-5
MLD 5	Coldwater Golf Club (Union City & Narrows Roads)	Chemicals, N, P, Sediment	Eroding shoreline, buffer loss, potential source of pesticides and herbicides.	G1:O2&4 G2:O1:T1&2 G4:O2	Appendix L, pg. L-6
MLD 6	Waffle Farm Campground	Chemicals, N, P, Sed., Pathogens	Potential human waste contamination, persistent litter and shoreline erosion.	G1:O2&4 G2:O1:T1&2 G3:O5&6;G4:O2	Appendix L, pg. L-5
MLD 7	MDNR Craig Lake Access Site (Union City Road)	Refuse, Oils, grease & metals	Source of gas, oil, starting fluid & other harmful substances, + excessive trash.	G3:O6 G4:O2,3&4:T1	Appendix L, pg. L-5
MLD 8	Angel Cove Campground (River Road)	Pathogens, N, P, Sediment	Potential human waste contamination, persistent litter and shoreline erosion.	G2:O3:T1 G3:O5&6 G4:O2	Appendix L, pg. L-5
SR 1	Gravel Pit #1 (Sauk River off of US-12)	Sediment	Situated on land that slopes toward river, transports excessive sediment.	G1:O1:T2 G4:O1	Appendix L, pg. L-6
SR 2	Sauk River Floodplain Dumping Site (US-12, S.side)	Hydrology, Sediment	Experienced years of unpermitted clearing and dumping of ruble and fill.	G1:O1:T4 G1:O3:T2 G2:O2:T2	Appendix L, pg. L-6
SR 3	Gravel Pit #2 (Sauk River off of Michigan Ave.)	Sediment	Mined aggregate piles stacked too close to streambank, no buffer in place.	G1:O1:T2 G4:O1	Appendix L, pg. L-6
SR 4	Sauk River Obstruction 1 (West of Michigan Ave.)	Sediment, Hydrology, Trash	Fallen trees seldom removed from stream, accumulate trash, cause stress	G1:O3:T1 G4:O1	Appendix L, pg. L-7
SR 5	High BEHI Site 2 (Sprague Rd x-ing at Waterworks Park)	Sediment	Shallow-rooted turf grass to water edge, 90deg bank angle, 0 surface protection, heavy human use in park.	G1:O1:T5-7 G4:O1	Appendix L, pg. L-7
SR 6	Fairgrounds (Sauk River between Sprague & Jefferson)	Sediment, N, P, Pathogens	Little to no riparian buffer, river receives surface water runoff from fairgrounds, also a heavy human use area.	G1:O1:T5&6 G2:O2:T2 G4:O1	Appendix L, pg. L-7
SR 7	Sauk River Obstruction 2 (East of Old 27)	Sediment, Hydrology, Trash	Areas on river intentionally dammed with cut logs and broken concrete.	G1:O3:T1 G4:O1	Appendix L, pg. L-7
SR 8	Sauk River Impairment (Near Rotary Park)	Sediment	Bare, unprotected banks, local stream obstructions & evidence of heavy use.	G1:O1:T5-7 G3:O1:T2-4 G4:O1	Appendix L, pg. L-7

In addition to these priority site-specific sources of NPS pollution, there are also a number of more wide-spread critical *areas* identified throughout the watershed. These areas are suspected of contributing substantial amounts of NPS pollution to the watershed from broad sources over longer periods of time than the critical sites described in *Table 7-3*. For these reasons, these areas have been identified as “Secondary Critical Areas”.

These areas are considered to be NPS pollutant sources that affect the watershed on a landscape scale. Due to their expanse, these areas will require multiple BMPs and I/E efforts to shift managerial practices and individual stewardship practices. Detailed profiles of the following broad-range critical areas are found in *Appendix L* of this document:

Additional Critical Areas in need of immediate attention

- Coldwater’s Municipal Storm Sewer System
- Fields with Highly Erodible Land (HEL)
- Moderate BEHI sites
- Septic system leaching zones
- Lakefront Properties

7.4 Conservation Areas

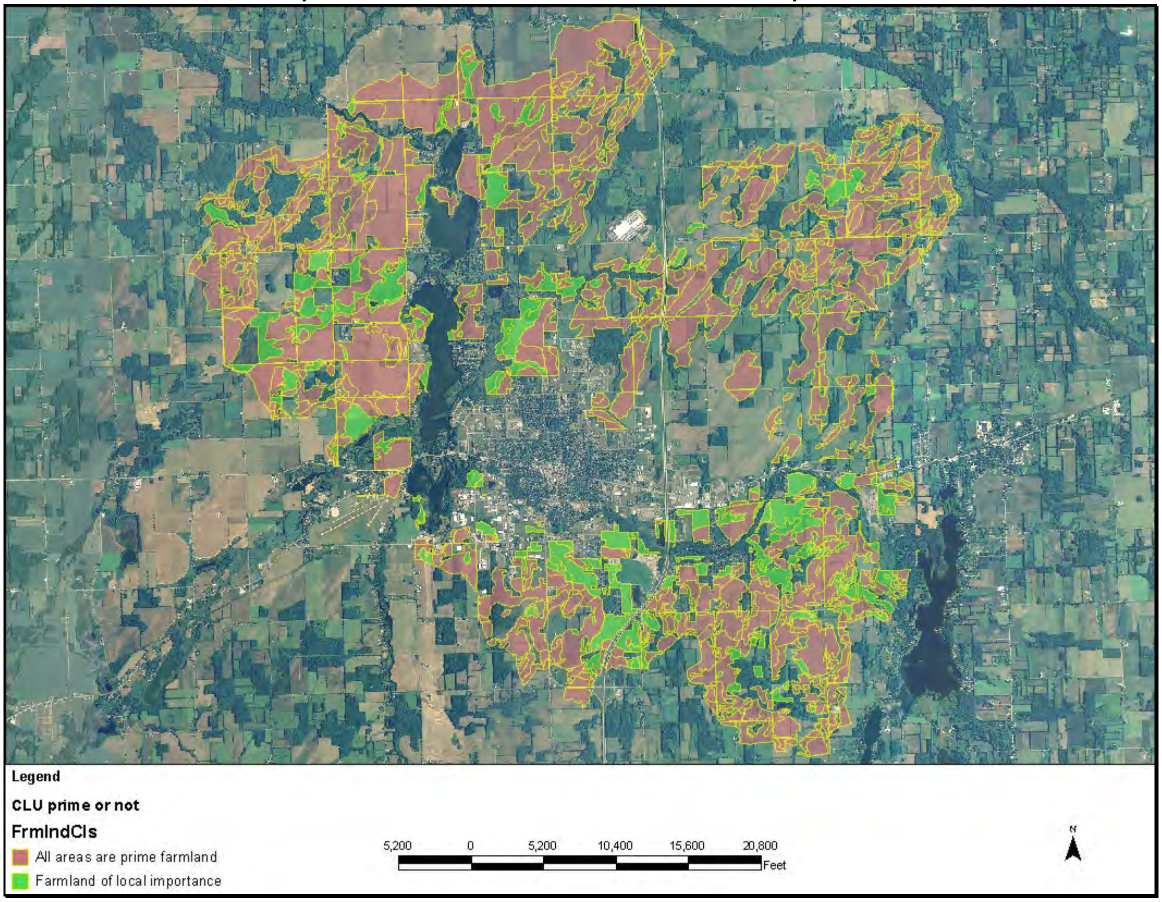
Undeveloped areas of natural vegetation and a natural hydrologic regime serve an important function in watersheds. These areas are an asset to a watershed because they provide a multitude of ecological services that become lost when land is cleared, developed or converted. Depending on whether a natural area is forest or wetland, these services can range from providing wildlife habitat and air purification, to recharging ground water supplies and filtrating pollutants. If the pristine natural areas that remain in the Hodunk-Messenger Watershed were to be destroyed, further degradation of water quality would ensue (*Chapter 5*). In order to attain and sustain all desired and designated uses in the watershed, the most important natural areas must be preserved.

Through a process developed by MNFI, all significant natural areas in the watershed have been evaluated for importance based on the ecological role they play in the watershed (*Appendix K*). Natural area characteristics that were evaluated in this process included such things as size, vegetative quality and connectivity. The resulting “Priority Conservation Areas” (PCAs) have been classified as being low, medium, high or highest priority. All high and highest priority PCAs are listed in *Appendix K* and represented in *Map K-1*. Even though it would be of great value to preserve all presently existing natural areas within the watershed, 36 particular sites have been identified as providing the greatest overall benefit for watershed health.

In addition to the PCAs, a number of sites within the City of Coldwater have been identified as good candidates for conservation. These areas include a wellhead protection zone, a linear trail system (and the land necessary for extending trail way segments), and an adjacent Brownfield site. It is thought that strategically placed open and **green space** in an urban setting would create a sense of watershed ownership among the community, promote stormwater infiltration, safeguard City groundwater supplies, enhance aesthetic value and provide a corridor for plant and animal movement.

Although not discussed in detail in this WMP, it is also recommended that measures are taken to preserve the highest quality farmlands in the watershed (*Map 7-4*). When properly managed, farmland can provide such benefits to the watershed as rainwater infiltration, wildlife migration corridors and protection against haphazard development. Branch County Government has recently adopted a farmland preservation ordinance, but since farmland in the watershed has not as of yet been prioritized in terms of importance, specific tracts for preservation are not here discussed.

***Map 7-4*: Prime Farmland and Farmland of Local Importance**



8. WATERSHED MANAGEMENT GOALS AND OBJECTIVES

8.1 Goals Summary

Several management goals have been defined f or restoring and/or enhancing water quality in the watershed. *Goals One* and *Two* are aimed at regaining the attainment of the two impaired designated uses in the watershed (discussed in *Chapter 3*), while *Goals Three* through *Five* are designed to achieve the desired uses defined by stakeholder input. Desired uses may or may not have a direct impact on water quality but do hold significant importance with the local watershed community, and are therefore important in guiding the long-term management of the watershed. Additionally, all five watershed goals reflect the need to implement measures to maintain and protect the designated uses in the watershed currently being threatened.

A summary of each goal is listed below, along with the specific objectives necessary for achieving them. Goal objectives are based on reducing the pollutants that affect water quality, their sources and their causes (identified through the watershed planning process and discussed in *Chapter 4*). Specific tasks, BMPs and timelines for implementing these goals may be found in the "Implementation Action Plan" provided in *Chapter 9*.

GOAL ONE: Restore and improve the warm water fishery and other indigenous wildlife and aquatic life habitat in the watershed.

In Michigan, all surface waters must meet the criteria of supporting a warm water fishery as well as supporting other indigenous wildlife and aquatic life. Even though the MDEQ has not recognized an outright impairment of these designated uses in the Hodunk-Messenger Watershed, watershed planning inventories indicate they are overwhelmingly threatened, and in some cases impaired. Development, agriculture and other land use activities that disturb the soil, clear natural vegetation and increase the amount of hard, impermeable surfaces in the watershed have led to a drastic reduction in the amount of viable habitat for indigenous fish, wildlife and other aquatic life and have also contributed to increased surface water pollution from nonpoint sources. In many instances, these pollutant levels prove toxic for many environmentally-sensitive indicator species (specifically macro invertebrates). Even in the cases where these species and their habitat have become threatened, sedimentation, excessive nutrient loads and drastically altered hydrologic flows have impeded animal movement, fragmented habitat, destroyed spawning areas and reduced biodiversity. It has become a major goal of the watershed management project to sustain and enhance these designated uses by implementing the following objectives:

Objective 1: Reduce sediment loading in the watershed enough that Michigan's narrative Water Quality Standard for sediment is achieved

Objective 2: Reduce nutrient loading in the watershed enough that Michigan's Water Quality Standard for nutrients is achieved

Objective 3: Reduce peak flows and work toward stabilizing the watershed's hydrologic regime

Objective 4: Reduce potential pesticide/ herbicide chemical inputs throughout the watershed

GOAL TWO: Restore recreational use of surface waters involving body contact by reducing the risk of pathogen inputs

The greatest priority in the Hodunk-Messenger Watershed is to eliminate the immediate human health risk of pathogen contamination at Memorial Park Beach on Messenger Lake, as well as to prevent it from occurring at other locations in the watershed. When a water body's contact recreation designated use (partial or total) becomes impaired, it means that the amount of a pollutant (or pollutants) found in the water has exceeded the allowable water quality standard, and human health has become at risk. In the case of Memorial Park beach, total body contact recreation has been impaired for the last nine years. Multiple water quality samples (*Appendix C*) have indicated that the *E. coli* bacteria, likely carried by goose feces, is the impairing pollutant in question. This problem is amplified by poor beach and shoreline management practices, rain water runoff that washes feces and leached contaminants into the water, and an over-abundant population of geese to deposit waste.

In addition to the goose feces-linked *E. coli* contamination, there is also an ever-present threat of other pathogen contamination to occur throughout the watershed through septic seepage. Unsuitable soils and individual septic systems in disrepair threaten to leach pathogens into surface and groundwater resources. Improperly stored livestock waste and manure fertilizer that is improperly applied to fields can also present a risk of pathogen contamination, as well as livestock access to streams. To help reduce the threat of these pathogen inputs, several watershed management objectives have been identified:

Objective 1: Reduce goose waste in and along chain of lakes
Objective 2: Reduce risk of human sewage contamination to surface waters
Objective 3: Reduce risk of manure contamination of surface water

GOAL THREE: Establish, expand and protect a green infrastructure in the watershed

Green infrastructure is an interconnected network of open spaces and natural areas, and may contain such man-made green infrastructure components as greenways, rain gardens/ bioretention swales, bike trails, walking paths, wetlands, parks, forest preserves, buffer strips and other native plant vegetation that naturally manages stormwater, reduces flooding risk and improves water quality. In most cases, green infrastructure usually costs less to install and maintain when compared to traditional forms of infrastructure. Green infrastructure projects promote and build the strength of communities by engaging all residents in the planning, planting and maintenance of installed green infrastructure practices. At the largest scale, the preservation and restoration of natural landscape features (such as forests, grasslands and wetlands) are critical components of a green (stormwater) infrastructure. On a smaller scale, green infrastructure practices include rain gardens, porous pavements, green roofs, infiltration planters, trees and tree boxes, and rainwater harvesting for non-potable uses such as toilet flushing and landscape irrigation.

Hodunk-Messenger Watershed stakeholders such as municipal officials, business owners, landowners and other local residents have expressed a desire to implement such green infrastructure measures for the purpose of promoting infiltration (the natural alternative to stormwater conveyance) to save costs on infrastructure maintenance, increase the abundance of wildlife and aesthetic vistas, sustain a strong agricultural and recreational economic backbone and to protect the rural character of the watershed. In addition to fulfilling these desired uses, an enhanced green infrastructure will also aid Goals One and Two in reducing pollutant loads by creating such ecological services as pollutant filtration, temperature moderation and soil stabilization. Several objectives have been identified for guiding implementation to obtain the goal of building a functional and lasting green infrastructure in the watershed:

Objective 1: Extend and connect current recreational trails in watershed
Objective 2: Preserve open space and prime farmland in the watershed
Objective 3: Protect most ecologically sensitive areas in watershed
Objective 4: Acquire undeveloped land for public use
Objective 5: Install continuous greenbelt around chain of lakes
Objective 6: Reduce populations of invasive species in watershed

GOAL FOUR: Establish and protect blue infrastructure in watershed

A **blue infrastructure**, similar to a green infrastructure, is an interconnected network of surface water systems. Watershed residents have expressed the desire for more opportunities to boat, canoe, kayak, fish and view nature (*Appendix A*). However, at present the streams in the watershed do not offer many recreational opportunities, as they suffer from low base flows, sediment deposition and abundant stream obstructions. Navigation is currently limited to portions of the Coldwater River (4th –order stream), Sauk River (3rd –order stream), Mud Creek/Cold Creek (3rd –order stream) and the chain of lakes themselves even though the channels between lakes are becoming more and more difficult to navigate due to sediment deposition and mats of topped-out aquatic **macrophytes** (large aquatic plants). The potential blue infrastructure recommended in *Table 9-1* would not only offer continuous navigation, but would also establish a posted navigational course with mileage markers and informational signs.

Even though the idea of maintaining a blue infrastructure came about as a desired recreational use for the watershed, it also provides important elements for supporting designated uses and overall watershed health. When properly managed, a blue infrastructure supports the designated uses of a warm water fishery, total and partial body contact recreation, navigation and other indigenous wildlife and aquatic life by offering a clean water source, uninhibited fish passage, spawning areas and travel corridors. The objectives associated with creating an interconnected and navigable blue infrastructure are:

Objective 1: Establish a posted navigational course in the Sauk River, Mud Creek/Cold Creek, Coldwater River and Hodunk-Messenger Chain of Lakes
Objective 2: Encourage environmentally responsible utilization of the chain of lakes
Objective 3: Reduce the amount of NPS pollution caused by public use of lake access sites
Objective 4: Reduce populations of invasive species associated with aquatic ecosystems in and around chain of lakes

GOAL FIVE: Protect groundwater resources in the watershed

Since there are so many areas conducive for groundwater recharge in the Hodunk-Messenger Watershed (*Appendix F*), protecting water quality not only addresses surface water, but groundwater as well. Currently, the City of Coldwater and countless rural dwellings in the watershed rely on groundwater as their sole source of potable water for everyday use. While many of the goals in this WMP aid in protecting the water quality of surface water, some additional measures are necessary to implement to ensure that groundwater is not contaminated from unseen sources. This goal may be achieved by simultaneously pursuing the following objective during the implementation phase:

Objective 1: Reduce risk of potential NPS pollutants from contaminating groundwater supplies

9. RECOMMENDATIONS FOR IMPLEMENTATION ACTIVITIES

9.1 Implementation Action Plan

The following Implementation Action Plan has been recommended by BCCD Staff and the Hodunk-Messenger Watershed Project Technical Subcommittee as an appropriate course of action for achieving the necessary pollutant load reductions to restore and enhance surface water quality in the Hodunk-Messenger Chain of Lakes Watershed. This concise plan recommends specific tasks, BMPs, potential lead agencies and the potential costs associated with re-attaining the impaired and threatened watershed designated uses and attaining the desired uses defined in *Chapter 3*. This action plan also provides estimations of the pollutant loads expected to be reduced as a result of implementing certain BMPs. Load reduction targets have been assigned according to the water quality standards discussed in *Chapter 3* and the aggressive timeline for implementing these practices has been recommended in accordance to achieving sufficient enough reductions to be in compliance with these standards as quickly as reasonably possible. Practices recommended to be implemented within the same year have been prioritized into high, medium or low categories in order to efficiently direct timing and funding resources. Likewise, multiple sites recommended for the same practice have been prioritized into high, medium or low categories. Both the Interim Milestone activities and the Sites listed for each Task have been labeled with either an "H" for high, "M" for medium and "L" for low priority.

All activities prioritized as "H" within a given year are intended to be addressed first, followed by "M" and finally "L" if time allows. These milestone prioritizations have been assigned based on the severity of the critical sites they are being implemented on, as well as the potential pollutant load reductions that can result from the implementation of the activity. Implementation activities recommended for the Hodunk-Messenger Watershed are to be directed primarily by the priority of the suggested Interim Milestones, and secondarily by the priority of the Site listed for each Task. In other words, resources should first be directed toward the high priority activities within a given year before the medium and low priority activities are addressed, and high priority activities should first be implemented on high priority sites, followed by medium and finally low priority sites. Once all sites are addressed for a given activity, focus can then be shifted toward the lower priority activities for that year.

The BMPs (or systems of BMPs) recommended in this plan have been designed to reduce and control NPS pollution and thus improve water quality in the watershed. These BMPs vary in nature from physical (structural), educational, institutional to managerial in nature. Of these, institutional, educational and managerial BMPs are predicted to have a distinct but unquantifiable correlation to pollution load reductions in the watershed. Only physical BMPs have known pollutant reduction efficiencies associated with their use. Based on these pollutant reduction efficiencies, relatively accurate reduction quantities have been predicted for all physical BMPs recommended in this plan. The physical BMPs recommended in this plan largely consist of soil erosion reduction practices for agricultural areas, stabilization practices for impaired streambanks, and low-impact stormwater management practices for urban areas. For any BMP that is not physical or structural in nature, significant influences on pollutant loads are expected to occur, but actual reduction quantities derived from these practices will not be determined until future monitoring data is collected.

Above all other BMP types, I/E practices will require the greatest allocation of time and resources during the implementation phase. It is thought that I/E activities will not only create a positive shift of individual watershed stewardship behaviors within the community, but they will also serve to generate support and acceptance of all other recommended BMPs. If applied in a timely manner that corresponds to the implementation of other BMPs, I/E implementation could quite possibly prove to be the most effective BMP of all recommended. To this end, a separate "Watershed I/E Strategy" has been developed to describe the myriad of I/E activities recommended for implementation. This I/E Strategy is listed separately in Section 9.3, but is frequently referenced throughout the *Table 9-1* Implementation Action Plan as "*I/E Strategy*". This Watershed I/E Strategy contains specific costs, target audiences and potential timelines for implementation. Because they are included in the *Table 9-6* I/E Strategy, there are no milestones or projected start dates for any I/E related tasks listed in *Table 9-1*. Detailed descriptions of all other recommended BMPs and definitions of any acronyms referenced in this table may be found in the glossary of BMPs and the Glossary of Acronyms at the end of the WMP. For the sake of brevity implementation sites listed in this *Implementation Action Plan* have routinely been shortened or described by their "site ID code". For reference, full descriptions of these sites may be found in *Chapter 7, Sections 7.2 – 7.5* or in *Appendix L*.

Table 9-1: **Implementation Action Plan**

GOAL ONE: Improve warm water fishery and other indigenous aquatic life and wildlife by reducing sediment, nutrient and pesticide/herbicide inputs, and reducing peak flows											
Objective	**Pollutant**	**Source**	**Cause**	**Task**	**Site and priority (Low, Med. or High)**	**BMPs**	**Estimated Load Reductions/ Benefits**	**Cost**	**Potential Lead Organization (& Partners)**	**Interim Milestone Activities and Priority of Activity (Low=L, Medium=M, High=H)**	**Projected Start Date**
Objective 1: Reduce sediment loading in the watershed	Sediment (nutrients; hydrology; oils, grease, and trace metal inputs are also affected)	Cultivated fields	Soil erosion through runoff	**1.** Reduce soil erosion from agricultural fields	HEL fields in CCSW-**H**; HEL fields in MLDSW-**H** (*Map F-5*)-**H**; row crop fields in CCSW-**H**; row crop fields in SRSW-**M**; row crop fields in MLDSW-**L**	Filter strips (NRCS practice #393), conservation tillage (NRCS practice #329) and *I/E Strategy*, plus critical area plantings (NRCS practice # 342), GWWs (NRCS practice #412), diversions (NRCS practice, #362), and GSS (NRCS practice #410) when necessary.	13,170.4 lb/yr reduction of N; 2,963.8 lb/yr reduction of P; 404 ton/yr reduction of sediment expected if tillage is reduced on HEL fields and all actively farmed fields implement one field-edge filter strip	$562,935.03 for filter strips ($13.58/ac) and $68,759.95 for conservation tillage ($35.50/ac); also $6,550/gss; $0.92/sq. ft of critical area planting; $5,201/ac of grassed waterway and $7/ft of diversion	BCCD + (USDA-NRCS, MGSP, Potawatomi R,C&D, MDEQ, Drain Commissioner, County Road Commission, Twps, Landowners)	Short Term (0-5years) Secure funding & establish a cost-share incentives program for implementing conservation tillage in 2010 - **H** Implement 109.6 acres of filter strips on critical field borders by 2012 - **H** Implement 274 acres of filter strips on critical field borders by 2013 - **H** Implement conservation tillage on 193.7 acres of agricultural fields with HEL by 2014 - **H** Implement conservation tillage on 484.2 acres of agricultural fields with HEL by 2014 - **H** Long Term (6-20years) Implement 548.1 acres of filter strips on critical field borders by 2020 - **H** Implement 1,096.1 acres of filter strips on critical field borders by 2030 - **H** Implement conservation tillage on 968.5 acres of agricultural fields with HEL by 2020 - **H** Implement conservation tillage on 1,936.9 acres of agricultural fields with HEL by 2030 - **H** Install GWWs, diversions, GSSs and critical area plantings where necessary - **L**	 2010 2010 2010 2010 2010 2010 2010 2010 2010 2013

GOAL ONE (*continued*): Improve warm water fishery and other indigenous aquatic life and wildlife by reducing sediment, nutrient and pesticide/herbicide inputs, and reducing peak flows											
Objective	**Pollutant**	**Source**	**Cause**	**Task**	**Site and priority (Low, Med. or High)**	**BMPs**	**Estimated Load Reductions/ Benefits**	**Cost**	**Potential Lead Organization (& Partners)**	**Interim Milestone Activities and Priority of Activity (Low=L, Medium=M, High=H)**	**Projected Start Date**
Objective 1: Reduce sediment loading in the watershed	Sediment (nutrients; hydrology; oils, grease, and trace metal inputs are also affected)	Active gravel pits	Aggregate piles located too close to stream	**2.** Set back aggregate piles away from riparian areas	SR1 & SR3 (*Map 7-1*)-both **H**	Buffer zones, sediment barriers/silt fence, site visits, SESC program, *I/E Strategy*	Approximately 3.8 tons of sediment, 6.08 lbs of N and 2.36 lbs of P reduced from Sauk River	$935.68 to vegetate buffer zones, $750 for silt fence ($1.50/linear ft)	County Drain Office + (BCCD, Quarry Owners, County Road Commission, Branch County Board of Commissioners)	Short Term Relocate aggregate piles located within 30 feet of streambank in 2010 - **H** Install sediment barriers/silt fence around aggregate piles in gravel pits by 2011 - **H** Maintain sediment barriers/silt fence & encourage establishment of permanent set back or buffer zones - **M** Establish set back or buffer zones along river by 2012 - **M** Long Term Revegetate buffer zones by 2020 - **M** Monitor and maintain buffers as necessary - **L**	 2010 2010 2011 2011 2012 2012
		Field stream crossings and dredging spoils	Erosion/spills/dumping at field stream crossings and inefficient drain cleanouts & maintenance	**3.** Reduce soil erosion occurring from field stream x-ings & drain cleanouts	Field stream xings in CCSW-**M**; Field stream xings in SRSW-**L**; Field Stream xings in MLDSW-**L**	SESC Program, Dredged Material Management	Reduction of potential silt/sediment contamination	$4,000 in staffing costs	County Drain Office + (BCCD, MDEQ, USDA-NRCS, County Planning Commission, City of Coldwater, Twps, County Road Commission)	Short Term (0-5years) Inventory all 1st and 2nd order streams in watershed to document status of field crossings in 2011 - **L** Provide information on problem field stream crossings to County Drain Office in 2011-2012 - **L** Work w/ Drain Office & land owners to reduce/eliminate sediment loading from field stream x-ings in 2013 - **L**	 2011 2011 2012
		Impaired streambanks	Stream obstructions	**4.** Reduce localized streambank erosion from isolated stream obstructions	CC9-11, SR4, SR7 (*Map 7-1*)-all **H**	Woody debris removal, volunteer stream cleanups and Streambank Stabilization if necessary (NRCS practice #580)	Reduction of streambank scouring and therefore of sediment loads, also a reduction of flooding	$3,000 in staffing cost for debris removal, $11,324 for volunteer cleanup ($596/yr at $7.45/volunteer hour) , also $220/ft of streambank stabilization if needed	BCCD + (Branch County Parks Department, County Drain Office, volunteers, MDEQ, Potawatomi R,C&D, Landowners)	Short Term Remove debris obstructions/log jams from streams using woody debris removal methods (http://www.therouge.org/Programs/PI/RiverRestorationPrograms.htm) by 2011 - **M** Long Term (6-20years) Annually coordinate volunteer stream cleanup - **L** Maintain clear navigational path in river - **L**	 2010 2012 2012
		Development/ construction sites	Improperly managed land development; removal of riparian vegetation	**5.** Restore Sauk River Floodplain at US-12 site and prevent unwanted sediment deposition in the future	SR2 (*Map 7-1*)-**H** and construction/ development sites in & adjacent to the City **- M**	Dumping restriction, floodplain mitigation and floodplain easement, *I/E Strategy*	348.5 ton removal of sediment from floodplain and increased in floodwater retention	Mitigation cost N/A (at expense of land owner), easement cost dependant on land appraisal	MDEQ + (Landowner, County Drain Office, Coldwater Township, County Road Commission, BCCD, SWMLC, USDA-NRCS, local contractors)	Short Term Assist MDEQ-LWMD in pursuing restoration of floodplain in 2010-2014 - **H** Administer I/E Strategy to land development target audience - **L** Long Term Administer I/E Strategy to land development target audience - **L** Work with land owner to adopt a floodplain conservation easement in 2015-2020 - **M**	 2010 2011 2011 2012
		Impaired streambanks and road & field stream crossings	Human access of streams, removal of riparian vegetation	**6.** Stabilize human access sites and restrict human access on critical areas for streambank erosion	SR5-6 and SR8 (*Map 7-1*)-both **M**	Revegetate slopes with critical area plantings (NRCS practice #342) and heavy use area protection (NRCS practice #561), stream access improvement (installation of steps or walkway), signage	500 lbs of sediment/ year reduction and the additional prevention of future streambank degradation	$5,000/ access site improvement, $920 for critical area plantings ($0.92/sq.ft.), $1,350 for heavy use area protection ($1.35/sq.ft.), $100 ($50/sign)	County Parks Department + (BCCD, MDNR, County Drain Office, Potawatomi R,C&D, City of Coldwater, local advocacy groups, local civic groups)	Short Term Define areas of potential human access improvement - **L** Identify possible sponsors for signs - **L** Coordinate site selection of access site improvements with City of Coldwater staff so that projects correlate with the City's Capitol Improvement Plan - **L** Identify project partners and funding sources - **L** Hire local contractor to design/install a potential access walkway/stairway by 2014 - **L** Long Term Revegetate and stabilized critical areas by 2015 - **L** Post informational/cautionary signs in 2015 - **L**	 2011 2011 2012 2012 2013 2014 2012

GOAL ONE (*continued*): Improve warm water fishery and other indigenous aquatic life and wildlife by reducing sediment, nutrient and pesticide/herbicide inputs, and reducing peak flows											
Objective	**Pollutant**	**Source**	**Cause**	**Task**	**Site and priority (Low, Med. or High)**	**BMPs**	**Estimated Load Reductions/ Benefits**	**Cost**	**Potential Lead Organization (& Partners)**	**Interim Milestone Activities and Priority of Activity (Low=L, Medium=M, High=H)**	**Projected Start Date**
Objective 1: Reduce sediment loading in the watershed	Sediment (nutrients; hydrology; oils, grease, and trace metal inputs are also affected)	Impaired streambanks and road & field stream crossings	Eroding road stream crossings; undersized culverts; human access of streams, removal of riparian vegetation; stream obstructions; loss of historic wetlands; drain cleanouts & maintenance	**7.** Restore and protect impaired streambanks and road crossings most at risk for bank erosion	CC3-5, CC8, SR5 and SR8 (*Map 7-1*)-all **H**; potential wetland restoration sites with greatest ability to perform the function of stream stabilization (*Appendix J*)-**H**	Streambank stabilization (NRCS practice # 580), bioengineering, culvert replacement, Wetland restoration/creation (NRCS practices #657 & 658, respectively)	640 ton/yr reduction of sediment, 0.5 lb/yr reduction of N, 0.2 lb/yr reduction of P	$880,748 for streambank stabilization ($220/ft.), $75,000 for culvert replacement ($25,000/ culvert); plus $1,294/ac of wetland restoration or $1,200/ac of wetland creation	County Drain Office + (BCCD, County Parks Department, City of Coldwater, MUCC, EPA, MDNR, R,C&D, MDEQ, USDA-NRCS, Twps, County Drain Commissioner, USDA-NRCS)	Short Term Seek stakeholder buy-in for stream improvement projects - **M** Stabilize 1,000.9 ft. of impaired streambank reaches in Cold Creek by 2012 - **H** Replace problem culverts near impaired streambanks as necessary (3 minimum) in 2012 - **H** Restore pre-settlement wetland complex known for streambank stabilization in upper Cold Creek Sub-watershed by 2012 - **H** Stabilize CC4 and SR 5 road stream x-ings by 2013 - **M** Stabilize 2,001.7 total ft. of impaired streambank reaches in Cold Creek by 2015 - **H** Long Term Stabilize 4,003.4 total ft. of impaired streambank reaches in Cold Creek and Sauk River by 2020 - **H** Stabilize moderate BEHI crossings by 2020 - **L** Continue to monitor and stabilize road stream crossings when necessary - **L**	 2010 2011 2011 2010 2012 2011 2013 2013 2020
		Urban stormwater	Pollutant deposition on impervious surfaces	**8.** Prevent sediment & other NPS pollutants from reaching storm drain inlets	City of Coldwater-**H**	Identification of urban NPS pollution "hot spots", street sweeping/vacuuming of problem areas, illicit discharge monitoring	719.98 lb reduction in sediment, 0.9 lb reduction of P as well as a reduction in trace NPS pollutant inputs from impervious surface runoff	$65,135 for monitoring system, $15,000 for hiring consultant to delineate stormsheds, $700 in staff time to revise sweeping routine	City of Coldwater + (BCCD, CBPU)	Short Term Hire engineering firm to delineate stormsheds for Coldwater's municipal storm sewer system - **M** Establish discharge monitoring system and illicit discharge follow-up program by 2011 - **L** Prioritize stormsheds based on discharge monitoring results by 2012 - **M** Revise Coldwater's street cleaning routine (sweep and vacuum) to target high risk areas by 2013 - **M** Long Term Routinely sweep streets that have a high risk of pollutant deposition - **M** Continue to monitor pollutant levels in storm sewer discharges during periods of dry weather - **L**	 2010 2010 2011 2012 2011 2011
Objective 2: Reduce nutrient loading in the watershed	Nutrients (also pathogens)	Seepage from individual septic systems	Failing/ underperforming individual septic systems	**1.** Reduce annual septic failure rate by half	Septic leaching zones (Map E-7)-**H**	*I/E Strategy*	Reduction of 7,072.65lbs of N/year and 2624.58 lbs of P per year if numbers of failing septic systems were reduced by 50%	$2,750 in I/E costs (see *Table 9-6*)	Community Health Agency + (BCCD, MSU-E, Twps, MGSP, MDEQ, Co. Planning Comm., Planning Consultants, North Chain Lake Association)	Short Term Implement I/E tasks associated with the residential target audience (*see Table 9-6*)	 2010
		Residential & commercial course fertilizer use	Mismanaged fertilizer application	**2.** Improve residential/commercial fertilizer application rates, timing and distance from surface water	Lakefront properties in MLDSW-**H** and City of Coldwater-**M**	*I/E Strategy*, soil testing, lakeshore greenbelt, City Phosphorus Ordinance	26.6 ton/yr reduction in sediment, 1,076.2 lb/yr reduction of nitrogen, 269.9 lb/yr reduction of phosphorus, also reduction in potential chemical, oil, grease & metal contamination and reduced waterfowl access to shoreline	$4,500 for soil testing ($9/soil test), $16,500 for greenbelts ($330/ac), $6,000 for hiring planning consultant for phosphorus ordinance	BCCD + (MGSP, MSU-E, North Chain Lake Association, Commercial Fertilizer Dealers, County Drain Office)	Short Term (0-5years) Acquire source of funding for cost sharing soil testing and establishment of greenbelts in 2010 - **M** Administer 50 soil tests (at lower rate) by 2011 - **M** Establish a greenbelt demonstration site along lake chain in 2012 - **M** Have administered 125 soil tests (at lower rate) by 2013 - **M** Implement 12.5 acres of greenbelt along the lake chain by 2013 - **H** Work with City to develop a Phosphorus Ordinance in 2012 - **M** Long Term (6-20years) Have administered 250 soil tests (at lower rate) by 2020 - **M** Implement 25 acres of greenbelt along the lake chain by 2020 - **H** Have administered 500 soil tests (at lower rate) by 2030 - **M** Implement 50 acres of greenbelt along the lake chain by 2030 - **H**	 2010 2010 2011 2010 2011 2012 2010 2011 2010 2011

GOAL ONE (*continued*): Improve warm water fishery and other indigenous aquatic life and wildlife by reducing sediment, nutrient and pesticide/herbicide inputs, and reducing peak flows											
Objective	**Pollutant**	**Source**	**Cause**	**Task**	**Site and priority (Low, Med. or High)**	**BMPs**	**Estimated Load Reductions/ Benefits**	**Cost**	**Potential Lead Organization (& Partners)**	**Interim Milestone Activities and Priority of Activity (Low=L, Medium=M, High=H)**	**Projected Start Date**
Objective 2: Reduce nutrient loading in the watershed	Nutrients (also pathogens)	Golf course (and other recreational grasses) fertilizer use	Mismanaged fertilizer application	**3.** Improve recreation (specifically golf course) fertilizer application rates, timing and distance from surface water	MLD5-6 (Map 7-1)-both **H**	*I/E Strategy*, soil testing, filter strips (NRCS practice #393), lakeshore greenbelt, vegetated swales (wet and/or grassed)	Reduction of approximately 49.4 lbs of phosphorus, 179.87 lbs of nitrogen and 5.7 tons of sediment per year	$5,135.80 for filter strips (513.58/ac), $214.5 for nutrient management ($21.45/ac), $6,000 for vegetated swales ($1,200/ac)	BCCD + (Golf Club of Coldwater, MGSP, MSU-E, North Chain Lake Association, Commercial Fertilizer Dealers, County Drain Office, USDA-NRCS)	Short Term (0-5years)	
										Work w/ GCC to develop a nutrient management plan by 2011 - **H**	2010
										Implement 1 acre filter strips on critical area on GCC landscape by 2012 - **M**	2010
										Implement 0.5 acre of vegetated swale in critical area of GCC landscape by 2012 - **M**	2010
										Establish 100 feet of greenbelt along GCC shoreline in 2012 - **H**	2011
										Implement 2.5 acres filter strips on critical area of GCC landscape by 2012 - **M**	2010
										Implement 1.25 acre of vegetated swale in critical area of GCC landscape by 2012 - **M**	2010
										Implement 200 acres of greenbelt along GCC shoreline by 2013 - **H**	2011
										Long Term (6-20years)	
										Implement 5 acres filter strips on critical area on GCC landscape by 2012 - **M**	2010
										Implement 2.5 acre of vegetated swale in critical area of GCC landscape by 2012 - **M**	2010
										Establish 400 feet of greenbelt along GCC shoreline in 2012 - **H**	2011
										Implement 10 acres filter strips on critical area of GCC landscape by 2012 - **M**	2010
										Implement 5 acre of vegetated swale in critical area of GCC landscape by 2012 - **M**	2010
										Implement greenbelt along entire GCC shoreline by 2030 - **H**	2011
		Agricultural fertilizer use (commercial & manure)	Mismanaged fertilizer application	**4.** Improve agricultural fertilizer application rates, timing and distance from surface water (*see also Goal 1: Objective 1: Task 1*)	Crop fields bordering water bodies in CCSW-**H**; crop fields bordering water bodies in SRSW-**M**; crop fields in MLDSW-**L**	*I/E Strategy*, soil testing, PSNT testing, filter strips (NRCS practice #393), riparian forest buffers (NRCS practice #391), Nutrient Management (NRCS practice #590)	Reduction of approximately 28,449.4 of phosphorus, 112,439.3 lbs of nitrogen and 171.4 tons of sediment per year	$562.935.03 for filter strips (513.58/ac), $6,300 for soil testing ($9/soil test & $15/PNST test), $364,650 for nutrient management ($21.45/ac), $144,468.99 for riparian forest buffers ($935.68/ac)	BCCD + (USDA-NRCS, MGSP, MSU-E, Commercial Fertilizer Dealers, County Drain Office)	Short Term (0-5years)	
										Develop a nutrient management plan for 11 watershed farms with land adjacent to a water body by 2011 (4 in MLDSW, 4 in CCSW and 3 in SR SW) - **M**	2010
										Implement 109.6 acres filter strips on critical field borders by 2012 - **H**	2010
										Implement 15.4 acres of riparian forest buffer along agricultural fields streams by 2012 - **H**	2010
										Administer 25 soil tests and 25 PSNT tests (at lower rate) by 2011 - **M**	2010
										Implement 274 acres filter strips on critical field borders by 2013 - **H**	2010
										Implement 38.6 acres of riparian forest buffer along agricultural fields streams by 2013 - **H**	2010
										Administer 50 soil tests and 50 PSNT tests (at lower rate) by 2011 - **M**	2010
										Develop a nutrient management plan for 22 total watershed farms with land adjacent to a water body by 2013 (9 in MLDSW, 7 in CCSW and 6 in SR SW) - **M**	2010
										Long Term (6-20years)	
										Develop a nutrient management plan for 54 total watershed farms with land adjacent to a water body by 2020 (21 in MLDSW, 18 in CCSW and 14 in SR SW) - **M**	2010
										Implement 548.1 acres filter strips on critical field borders by 2020 - **H**	2010
										Implement 77.2 acres of riparian forest buffer along agricultural fields streams by 2020 - **H**	2010
										Administer 100 soil tests and 100 PSNT tests (at lower rate) by 2011 - **M**	2010
										Develop a nutrient management plan for 217 total watershed farms with land adjacent to a water body by 2030 (87 in MLDSW, 74 in CCSW and 56 in SR SW) - **M**	2010
										Implement 1,096.1 acres filter strips on critical field borders by 2030 - **H**	2010
										Implement 154.4 acres of riparian forest buffer along agricultural fields streams by 2030 - **H**	2010
										Administer 200 soil tests and 200 PSNT tests (at lower rate) by 2011 - **M**	2010
		Residential, agricultural and golf course fertilizer use	Mismanaged fertilizer application	**5.** Restore wetlands known to historically provide nutrient transformation at a high level of significance	Wetland restoration sites with ability to provide nutrient transformation (*Map I-8*)-**M**	Wetland restoration/creation (NRCS practices #657 & 658, respectively)	Significant reduction in N and P expected, but actual load reductions dependent upon size and location of wetland restoration	$103,520-96,000 for wetland restoration ($1,294/ac restoration or $1,200/ac of creation)	USDA-NRCS + (MDEQ, County Drain Office, BCCD, OSU, USFWS, MDNR LIP Program, USDA-FSA CRP, MUCC, USDA-NRCS WRP, USFWS)	Short Term	
										Restore 40 acres of wetlands known to historically perform nutrient transformation to a high degree of significance - **H**	2010
										Long Term	
										Restore 80 acres of wetlands known to historically perform nutrient transformation to a high degree of significance - **H**	2010

GOAL ONE (*continued*): Improve warm water fishery and other indigenous aquatic life and wildlife by reducing sediment, nutrient and pesticide/herbicide inputs, and reducing peak flows

Objective	Pollutant	Source	Cause	Task	Site and priority (Low, Med. or High)	BMPs	Estimated Load Reductions/ Benefits	Cost	Potential Lead Organization (& Partners)	Interim Milestone Activities and Priority of Activity (Low=L, Medium=M, High=H)	Projected Start Date
Objective 3: Reduce peak flows	Hydrologic Flow (also affects sediment, nutrients, pesticide & herbicide chemicals, oils, grease and trace metal inputs)	Agricultural drainage, urban stormwater	Stream channelization, tiling, wetland conversion/ loss, increased impervious surfaces	**1.** Assess the impact of man-made drainage on the watershed hydrology	City of Coldwater-**H**; entire watershed-**M**	Hydro Geomorphic Assessment	Development of a useful planning tool	$18,000 for hydro geomorphic assessment	City of Coldwater + (Branch County Parks Department, volunteers, MDEQ, Potawatomi R,C&D, Landowners, BCCD, County Drain Office)	Short Term Hire environmental monitoring firm or work w/ USGS to conduct hydro geomorphic assessment by 2011 - **M** Distribute information derived from hydro geomorphic assessment to all municipal planning commissions by 2012 - **M** Long Term Continue to monitor watershed hydrology (flow, volume) - **L**	 2010 2012 2013
		Agricultural drainage, urban stormwater	Stream channelization, tiling, wetland conversion/ loss, increased impervious surfaces	**2.** Increase number of water retention areas in upper watershed	Wetland restoration areas along Cold Creek w/ greatest overall functional value (*Map 7-1*)-**H**; Wetland restoration areas along Sauk River w/ greatest overall functional value (*Map 7-1*)-**M**; Wetland restoration areas along Miller Lk Drain w/ greatest overall functional value (*Map 7-1*)-**L**; Cold Creek between Michigan Ave & I-69-**M**	Wetland restoration/creation (NRCS practices #657 & 658, respectively), Two-stage ditch	Reduction of 762.8 lbs/year N, 355.4 lbs/year P, 79.45 tons/year sediment and significant reduction in frequency of bankfull discharges	$646,800-697,466 for wetland restoration ($1,294/ac restoration or $1,200/ac of creation), $4,000 for 2-stage ditch establishment ($20/linear ft. of 2-stage ditch)	USDA-NRCS + (MDEQ, County Drain Office, BCCD, OSU, USFWS, MDNR LIP Program, USDA-FSA CRP, MUCC, USDA-NRCS WRP, USFWS)	Short Term (0-5years) Seek buy-in from landowners w/ property in potential wetland restoration areas based on wetlands map - **M** Restore 40.3 acres of lost wetlands with highest functional value in Cold Creek Sub-watershed by 2011 - **H** Restore 44.4 acres of lost wetlands with highest functional value in Sauk River Sub-watershed by 2012 - **H** Restore 29.4 acres of lost wetlands w/ highest functional value in Miller Lk Drain Sub-watershed by 2013 - **H** Install 200 feet of 2-stage ditch in Cold Creek by 2014 - **M** Long Term (6-20years) Monitor & observe efficiency of 2-stage ditch - **L** Restore 80.6 acres of lost wetlands with highest functional value in Cold Creek Sub-watershed by 2020 - **H** Restore 88.8 acres of lost wetlands with highest functional value in Sauk River Sub-watershed by 2020 - **H** Restore 58.8 acres of lost wetlands w/ highest functional value in Miller Lk Drain Sub-watershed by 2020 - **H** Restore 161.1 acres of lost wetlands with highest functional value in Cold Creek Sub-watershed by 2030 - **H** Restore 177.5 acres of lost wetlands with highest functional value in Sauk River Sub-watershed by 2030 - **H** Restore 117.5 acres of lost wetlands w/ highest functional value in Miller Lk Drain Sub-watershed by 2030 - **H**	 2010 2010 2011 2012 2010 2014 2010 2011 2012 2010 2011 2012
		Agricultural drainage, urban stormwater	Stream channelization, tiling, wetland conversion/ loss, increased impervious surfaces	**3.** Protect remaining natural areas and wetlands in watershed	Properties containing the Highest priority PCAs throughout watershed (*Map K-1 & Branch County Plat Map*)-**M**	*I/E Strategy*, Conservation easements, WRP, CRP, USFWS wetlands program	Prevention of additional 7 tons of sediment, 140 lbs of nitrogen and 16 lbs of phosphorus per year	Cost of easement dependant on land appraisal	SWMLC + (BCCD, MDEQ, Potawatomi R,C&D, County Planning Commission, Twp Planning Commissions, MDA, USDA-NRCS PRPP & WRP, MDNR)	Short Term Preserve 3 highest PCAs with conservation easement, USFWS wetlands program, WRP or CRP by 2012 - **M** Preserve next 3 highest PCAs w/ conservation easement, USFWS wetland program, WRP or CRP by 2013 - **M** Long Term Recruit landowners & preserve 28 additional high-ranking PCAs w/ conservation easements, USFWS wetlands program, WRP or CRP by 2020 - **M** Recruit landowners and preserve as many of the remaining 40 PCAs in the watershed as possible by using conservation easements, USFWS wetlands program, WRP or CRP by 2030 - **L**	 2011 2011 2014 2014

GOAL ONE (*continued*): Improve warm water fishery and other indigenous aquatic life and wildlife by reducing sediment, nutrient and pesticide/herbicide inputs, and reducing peak flows											
Objective	**Pollutant**	**Source**	**Cause**	**Task**	**Site and priority (Low, Med. or High)**	**BMPs**	**Estimated Load Reductions/ Benefits**	**Cost**	**Potential Lead Organization (& Partners)**	**Interim Milestone Activities and Priority of Activity (Low=L, Medium=M, High=H)**	**Projected Start Date**
Objective 3: Reduce peak flows	Hydrologic Flow (also affects sediment, nutrients, pesticide & herbicide chemicals, oils, grease and trace metal inputs)	Urban stormwater	Increased impervious surfaces	**4.** Increase stormwater infiltration in urban area	City of Coldwater-**H**	Vegetated swales (wet and grassed), Wetland Detention/ Extended wetland detention, Porous pavement, Rain gardens (bio-retention areas), Recessed parking lot landscape islands, *I/E Strategy*, Flow monitoring, LID ordinance, Stormwater Ordinance	1,558.9 lbs/yr reduction of N; 367.08 lbs/yr reduction of P; 40.74 tons/yr reduction of sediment and significant decrease in first flush volume	$1,956 for vegetated swales ($1,200/ac), $168,350 for wetland or extended wetland detention ($2,500/ac wetland detention), $12,533,518 for porous pavement ($3/sq. ft.), $6,222,110.4 for rain garden bioinfiltration ($4/sq. ft.), $4,978,036.8 for landscape islands ($4/sq. ft.), $1,200-$1,500 for planning consultant; $2,159.88 for flow monitoring	City of Coldwater + (BCCD, Coldwater DDA, CWP, Potawatomi R,C&D, Wal-Mart, CBPU, MDEQ, County Drain Office, other Private/Corporate Sponsors, Branch County Board of Commissioners, local advocacy groups, planning consultants)	<u>Short Term (0-5years)</u>	
										Work w/ City Planning Commission & consultants to incorporate incentives into master plan so that LID practices are encouraged in new and re-developments in 2010 - **H**	2010
										Establish flow monitoring of Coldwater storm sewer system by 2011 - **H**	2010
										Assist City develop & adopt stormwater "standard operation and maintenance" ordinance that strengthens current & on-site stormwater treatment practices by 2011 - **H**	2010
										Install 0.41 ac of vegetated swales at institutional sites in city where no LID practices are present in 2011 - **H**	2011
										Install 7.14 acres of recessed landscape islands on city-owned commercial parking lots where no LID practices are present in 2012 - **H**	2012
										Install 23.98 acres of porous pavement on city-owned commercial and/or industrial impervious surfaces where no LID practices are present in 2012 - **H**	2012
										Install 16.84 acres of wetland detention or extended wetland detention areas on city-owned industrial areas of city where no LID practices are present in 2012 - **H**	2012
										Install 8.93 acres of rain gardens in residential areas throughout city where no LID practices are present in 2012 - **H**	2012
										<u>Long Term (6-20years)</u>	
										Install 0.82 ac of vegetated swales at institutional sites in city where no LID practices are present in 2020 - **H**	2012
										Install 14.29 acres of recessed landscape islands on city-owned commercial parking lots where no LID practices are present in 2020 - **H**	2012
										Install 47.96 acres of porous pavement on city-owned commercial and/or industrial impervious surfaces where no LID practices are present in 2020 - **H**	2012
										Install 33.67 acres of wetland detention or extended wetland detention areas on city-owned industrial areas of city where no LID practices are present in 2020 - **H**	2012
										Install 17.86 acres of raingarden in residential areas throughout city where no LID practices are present in 2020 - **H**	2012
										Install 1.63 ac of vegetated swales at institutional sites in city where no LID practices are present in 2030 - **H**	2012
										Install 28.57 acres of recessed landscape islands on city-owned commercial parking lots where no LID practices are present in 2030 - **H**	2012
										Install 95.91 acres of porous pavement on city-owned commercial and/or industrial impervious surfaces where no LID practices are present in 2030 - **H**	2012
										Install 67.34 ac of wetland detention or extended wetland detention areas on city-owned industrial areas of city where no LID practices are present in 2030 - **H**	2012
										Install 35.71 acres of rain gardens in residential areas throughout city where no LID practices are present in 2030 - **H**	2012

GOAL ONE (*continued*): Improve warm water fishery and other indigenous aquatic life and wildlife by reducing sediment, nutrient and pesticide/herbicide inputs, and reducing peak flows

Objective	Pollutant	Source	Cause	Task	Site and priority (Low, Med. or High)	BMPs	Estimated Load Reductions/ Benefits	Cost	Potential Lead Organization (& Partners)	Interim Milestone Activities and Priority of Activity (Low=L, Medium=M, High=H)	Projected Start Date
Objective 4: Reduce pesticide/ herbicide chemical inputs	Pesticides & herbicides (sediment and nutrients are also affected)	Residential, recreational and agricultural use	Mismanaged application	Improve agricultural, residential & recreational pesticide/ herbicide chemical application rates, timing and distance from surface water (*see also Goal 1: Objective 1: Task 1*)	MLD5-6 (*Map 7-1*)-**H**; lakefront properties-**H**; City of Coldwater-**M**; crop fields in CCSW-**H**; crop fields in SRSW-**M**; crop fields in MLDSW-**L**	Agrichemical containment facilities or *ACFs* (NRCS practice #702), Pest Management (NRCS practice #595), handling pads,/*IE Strategy*, Filter strips (NRCS practice # 393)	Reduction in potential pesticide & herbicide chemical contamination	$312,000 for ACFs ($24,000/ACF), $510,000 for pest management ($30/ac), $562,935.03 for filter strips (513.58/ac)	MGSP + (USDA-NRCS, BCCD, MSU-E, Agrichemical Industries, Commercial Fertilizer Dealers, North Chain Lake Association, County Drain Office)	Short Term (0-5years) Develop a pest management plan for 11 watershed farms with land adjacent to a water body by 2011 (4 in MLDSW, 4 in CCSW and 3 in SR SW) - **M** Implement 109.6 acres of filter strips on critical field borders by 2012 - **H** Install ACF or handling pad on 2 farms over 1,000 acres in the watershed by 2012 - **M** Develop a pest management plan for 22 total watershed farms with land adjacent to a water body by 2013 (9 in MLDSW, 7 in CCSW and 6 in SR SW) - **M** Implement 274 acres of filter strips on critical field borders by 2013 - **H** Install ACF or handling pad on 4 farms over 1,000 acres in the watershed 2013 - **M** Long Term (6-20years) Develop a pest management plan for 54 total watershed farms with land adjacent to a water body for by 2020 (21 in MLDSW, 18 in CCSW and 14 in SR SW) - **M** Implement 548.1 acres of filter strips on critical field borders by 2020 - **H** Install ACF or handling pad on 6 farms over 1,000 acres in the watershed by 2020 - **M** Develop a pest management plan for 217 total watershed farms with land adjacent to a water body for by 2030 (87 in MLDSW, 74 in CCSW and 56 in SR SW) - **M** Implement 1,096.1 acres of filter strips on critical field borders by 2030 - **H** Install ACF or handling pad on 13 farms over 1,000 acres in the watershed 2030 - **M**	 2010 2010 2011 2010 2010 2011 2010 2010 2011 2010 2010 2011

GOAL TWO: Restore recreational use involving body contact by reducing the risk of pathogen inputs

Objective	Pollutant	Source	Cause	Task	Site and priority (Low, Med. or High)	BMPs	Estimated Load Reductions/ Benefits	Cost	Potential Lead Organization (& Partners)	Interim Milestone Activities and Priority of Activity (Low=L, Medium=M, High=H)	Projected Start Date
Objective 1: Reduce goose waste along chain of lakes	Pathogens and Nutrients	Goose feces	Over population of geese on the chain of lakes and ease of access to public areas & residential shorelines	**1.** Reduce Canada goose population in watershed	MLD2 (*Map 7-1*)-**H**; other lakefront properties-**M**	Roundup/ translocation, MDNR Hunting Access Program and egg oiling/nest destruction if necessary	Potential reduction of 9,022.1 E. coli colonies per goose, per day (overall E.coli reductions dependent on number of geese excluded)	$10,200 in staffing costs ($2,040/year), $1,430.40 in volunteer labor ($7.45/volunteer hour) or costs for contractor if volunteers are not available	North Chain Lake Association + (MDNR, County Parks Department, Hodunk-Messenger Lake Board, BCCD, USFWS, BACC, FFA, MUCC, Private Contractor, Potawatomi R,C&D)	Short Term (0-5years) Lake association goose roundup application to MDNR in 2010 - **L** Initial goose population inventory in 2010 - **L** Identify and enroll watershed landowners in MDNR HAP program by 2012 - **M** Conduct goose roundup/translocation in 2012 - **M** Conduct egg oiling and nest destruction in 2012 and 2013 if necessary - **L** Long Term (6-20years) Conduct goose population inventories annually - **L** Promote MDNR HAP program annually - **L**	 2010 2010 2011 2012 2012 2010 2011
		Goose feces	Over population of geese on the chain of lakes and ease of access to public areas & residential shorelines	**2.** Improve goose waste management practices at public areas on Chain of Lakes (*see also Goal 1: Objective 2: Task 2*)	MLD2 (Map 7-1)-**H**; other lakefront properties-**M**	Greenbelts, exclusion fence (NRCS #382), artificial deterrents, goose waste management, signage	Potential reduction of 9,022.1 *E. coli* colonies per goose, per day (overall *E.coli* reductions dependent on number of geese excluded)	$16,500 for greenbelts (330/ac), $860 for exclusion fencing ($1.72/ sq. ft. of fence), $100 for signage ($50/sign)	County Parks Department + (MDNR, BCCD, Hodunk-Messenger Lake Board, North Chain Lake Association, USFWS, BACC, FFA, MUCC, Private Contractor, Potawatomi R,C&D)	Short Term Secure funding and establish a cost-share incentives program for installing greenbelts in 2010 - **H** Install greenbelt along Memorial Park shoreline where beach and docks are not present in 2011 - **H** Develop goose waste mgmt plan w/ practices for proper treatment of waste & waterfowl exclusion in 2011 -**H** Install a simple exclusion fence at Memorial Park Beach in 2011 - **H** Implement 12.5 acres of greenbelt along the lake chain by 2013 - **H** Install signs to inform public of health risks, benefits of greenbelts & discourage goose feeding in 2013 - **M** Long Term Implement 25 acres of greenbelt along the lake chain by 2020 - **H** Implement 50 acres of greenbelt along the lake chain by 2030 - **H** Maintain, repair and make additions to Memorial Beach greenbelt as needed - **M**	 2010 2011 2011 2011 2011 2012 2011 2011 2013

GOAL TWO (*continued*): Restore recreational use involving body contact by reducing the risk of pathogen inputs											
Objective	**Pollutant**	**Source**	**Cause**	**Task**	**Site and priority (Low, Med. or High)**	**BMPs**	**Estimated Load Reductions/ Benefits**	**Cost**	**Potential Lead Organization (& Partners)**	**Interim Milestone Activities and Priority of Activity (Low=L, Medium=M, High=H)**	**Projected Start Date**
Objective 2: Reduce risk of manure contamination of surface water	Pathogens and Nutrients	Livestock manure	Mismanaged application	**1.** Improve manure application rates, timing and distance from surface water (*see also Goal 1: Objective 2: Task 2*)	Crops fields in CCSW-**H**; crop fields in SRSW-**M**; crop fields in MLDSW-**L**	Nutrient Management Plans (NRCS practice #590), soil testing, pre-sidedressed nitrogen (PSNT) testing, MAEAP	112,439.3 lbs of N and 28,449.4 lbs of P/year reduction when 16,972.2 acres are managed	$364,650 for nutrient management ($21.45/ac), $24,000 for soil testing ($9/soil test & $15/PSNT test),	BCCD + (USDA-NRCS, MGSP, MSU-E, Livestock Associations, MDEQ, MUCC, Riparian Landowners, Livestock Producers)	Short Term (0-5years)	
										Develop a nutrient management plan for 11 watershed farms with land adjacent to a water body by 2011 (4 in MLDSW, 4 in CCSW and 3 in SR SW) - **M**	2010
										Develop a nutrient management plan for 22 total watershed farms with land adjacent to a water body by 2013 (9 in MLDSW, 7 in CCSW and 6 in SR SW) - **M**	2010
										Long Term (6-20years)	
										Develop a nutrient management plan for 54 total watershed farms with land adjacent to a water body by 2020 (21 in MLDSW, 18 in CCSW and 14 in SR SW) - **M**	2010
										Develop a nutrient management plan for 217 total watershed farms with land adjacent to a water body by 2030 (87 in MLDSW, 74 in CCSW and 56 in SR SW) - **M**	2010
		Livestock manure	Unrestricted livestock access to streams	**2.** Install buffers in agricultural riparian areas (*see also Goal 1: Objective 1: Task 1 and Goal 1: Objective 2: Task 2*)	Potential riparian buffer restoration areas throughout watershed (*Map J-1*)-**H**	Filter strips (NRCS practice #393), riparian forest buffers (NRCS practice #391)	Reduction of 1,614.3 lbs of N, 404.8 lbs of P and 40 tons of sediment per year when 1,096 acre of filter strips and 341.2 acres of riparian forest buffer are implemented	$562,935.03 for filter strips (513.58/ac), $144,468.99 for riparian buffers ($935.68/ac)	USDA-NRCS + (BCCD, County Drain Office, Landowners, Branch County Road Commission)	Short Term	
										Implement 109.6 acres filter strips on critical field borders by 2012 - **H**	2010
										Implement 15.4 acres of riparian forest buffer along agricultural fields streams by 2012 - **H**	2010
										Implement 274 acres filter strips on critical field borders by 2013 - **H**	2010
										Implement 38.6 acres of riparian forest buffer along agricultural fields streams by 2013 - **H**	2010
										Long Term	
										Implement 548.1 acres filter strips on critical field borders by 2020 - **H**	2010
										Implement 77.2 acres of riparian forest buffer along agricultural fields streams by 2020 - **H**	2010
										Implement 1,096.1 acres filter strips on critical field borders by 2030 - **H**	2010
										Implement 154.4 acres of riparian forest buffer along agricultural fields streams by 2030 - **H**	2010
		Livestock manure	Improper manure storage	**3.** Reduce runoff from feedlot areas and ensure sufficient waste storage at livestock operations in watershed	CC1-2 & CC6-both **H**; other livestock pastures in CCSW-**M**; other livestock pastures in SRSW-**M**; other livestock pastures in MLDSW-**M**	Comprehensive Nutrient Management Plan (NRCS practice #100), prescribed grazing (NRCS practice #528), waste storage facilities (NRCS practice #313)	112,439.3 lb/yr reduction of N and 28,449.4 lb/yr reduction of P when prescribed grazing and nutrient management is applied to all 5,278.7 acres of pastureland in the watershed	$15,836.4 for prescribed grazing ($12/ac), $364,650 for nutrient management ($21.45/ac), $2.65/cu ft. of waste storage facility	USDA-NRCS + (BCCD, MGSP, MDEQ, Livestock Producers, Riparian Landowners, MUCC, Livestock Associations)	Short Term	
										Apply prescribed grazing to CC1, CC2 and CC6 in 2010 - **H**	2010
										Develop nutrient management plans for CC1, CC2 and CC6 for livestock systems in 2010 - **H**	2010
										Install animal waste storage facilities at CC1, CC2 and CC6 by 2011 - **H**	2010
										Apply prescribed grazing to 527.9 acres of additional pasture land in watershed in 2011 - **M**	2011
										Develop nutrient management plans for 12 additional livestock operations in watershed for livestock systems in 2011 - **M**	2011
										Apply prescribed grazing to 1,319.7 acres of additional pasture land in watershed in 2012 - **M**	2011
										Develop nutrient management plans for 30 total livestock operations in watershed for livestock systems in 2012 - **M**	2011
										Long Term	
										Apply prescribed grazing to 2,639.4 acres of additional pasture land in watershed by 2020 - **M**	2011
										Develop nutrient management plans for 59 total livestock operations in watershed for livestock systems - **M**	2011
										Apply prescribed grazing to 5,278.7 acres of additional pasture land in watershed by 2030 - **M**	2011
										Develop nutrient management plans for 118 total livestock operations in watershed for livestock systems by 2030 - **M**	2011
										Install additional animal waste storage facilities at feedlots located near streams as necessary - **M**	2013

GOAL TWO (*continued*): Restore recreational use involving body contact by reducing the risk of pathogen inputs

Objective	Pollutant	Source	Cause	Task	Site and priority (Low, Med. or High)	BMPs	Estimated Load Reductions/ Benefits	Cost	Potential Lead Organization (& Partners)	Interim Milestone Activities and Priority of Activity (Low=L, Medium=M, High=H)	Projected Start Date
Objective 2: Reduce risk of manure contamination of surface water	Pathogens and Nutrients	Livestock manure	Mismanaged application, improper manure storage and unrestricted livestock access to streams	**4.** Restrict livestock access to streams (*see also Goal 2: Objective 2: Task 3*)	CC1-2 & CC6-both **H**; other livestock pastures in CCSW-**M**; other livestock pastures in SRSW-**M**; other livestock pastures in MLDSW-**M**	Streambank stabilization (NRCS practice #580), exclusion fencing (NRCS practice # 382), watering devices (NRCS practice #614)	162.1 lb/yr reduction of N, 13.7 lb/yr reduction of P, 1.6 ton/yr reduction of sediment and potential reduction in pathogen loads	$880,748 for streambank stabilization ($220/ft.), $1.72/ sq. ft. of exclusion fence and $177.5-2,460/watering device if needed	BCCD + (USDA-NRCS, MGSP, MDEQ, County Drain Office, County Road Commission, Livestock Associations, MUCC, Riparian Landowners, Livestock Producers)	Short Term (0-5years) Implement system of livestock stream access BMPs at CC1, CC2 and CC6 in 2011 - **H** Conduct survey of 1st & 2nd order streams to discover additional sites of livestock stream access in 2011 -**M** Implement system of livestock stream access BMPs at other sites (as identified) in 2012 - **L** Long Term (6-20years) Implement system of livestock stream access BMPs at other sites of priority (as identified) in 2020 - **L**	 2011 2011 2012 2012
Objective 3: Reduce risk of human sewage contamination to surface waters	Pathogens and Nutrients	Human waste	Insufficient sewage storage @ camp-grounds & campers discharging holding tanks to surface water	**1.** Improve campground sewage management	MLD 2, 3, 6 & 8 (*Map 7-1*)-all **M**	*I/E Strategy*, updated sewage maintenance practices	Reduction in potential pathogen and nutrient contamination	$2,000 in staffing costs to work w/ campgrounds	Branch-Hillsdale-St. Joseph Community Health Agency + (BCCD, County Parks Dept., MDNR, North Chain Lake Assoc., MGSP, MDEQ)	Short Term Work with campgrounds within watershed to update their sewage maintenance practices in 2011 - **M** Post educational signs throughout campgrounds in 2013 - **L**	 2011 2012
		Human waste	Leaching individual septic systems	**2.** Reduce number of individual septic systems failing per year	Septic leaching zones (*Map E-7*)-**H**	*I/E Strategy*, Septic management point-of-sale ordinance	Reduction in potential pathogen and nutrient contamination	$9,000-$7,200 ($1,200-1,500/TWP) for work with planning consultant	Community Health Agency + (BCCD, MSU-E, Twps, MGSP, MDEQ, Co. Planning Comm., Planning Consultants, North Chain Lake Association)	Short Term Coordinate the development point-of-sale septic ordinance with local municipalities by 2012 - **H**	 2011

GOAL THREE: Establish, expand and protect a green infrastructure in the watershed

Objective	Pollutant	Source	Cause	Task	Site and priority (Low, Med. or High)	BMPs	Estimated Load Reductions/ Benefits	Cost	Potential Lead Organization (& Partners)	Interim Milestone Activities and Priority of Activity (Low=L, Medium=M, High=H)	Projected Start Date
Objective 1: Extend and connect current recreational trails in watershed	All NPS pollutants identified in the watershed are all affected to some extent	Lack of connected green space in watershed	Urban Sprawl	**1.** Form watershed oversight group	City of Coldwater-**L**	Watershed Advisory Council and EPA "Adopt Your Watershed"	Access to additional grants, planned parks development, implementation oversight	$700 in staffing & meetings, $298 in volunteer time ($7.45/ volunteer hour)	BCCD + (City of Coldwater, County Parks Board, MDOT, MDNR)	Short Term (0-5years) Organize partners and establish Watershed Advisory Council and register as a EPA "Adopt Your Watershed Group" in 2010 - **L** Incorporate watershed goals with Park Board's plan of work by 2011 - **L** Apply for supplementary grant funding for park & tree projects - **L** Hold quarterly Watershed Group oversight meetings - **L**	 2010 2010 2012 2010
		Lack of connected green space in watershed	Development (land clearing/ conversion)	**2.** Connect fragmented segments of walking path presently in existence	Coldwater Linear Trail-**M**, other potential trail sites in City of Coldwater-**L**	Non-Motorized Transportation Grants, Michigan Natural Resources Trust Fund, conservation easements	Creates watershed ownership, fulfills desired watershed use, expands recreation and tourism	$1,490 in volunteer time (7.45/volunteer hour), $800,000 for biking/hiking trails ($200,000 per linear mile)	City of Coldwater + (BCCD, County Parks Department, MDOT, MDNR, Smart Group, Trail way Associations, County Commissioners, CBPU, Potawatomi R,C&D, SWMLC)	Short Term Coordinate partners to identify priority corridor areas (or critical breaks in corridor) in 2011 - **L** Apply for grants/secure funding to connect corridor segments - **L** Physically connect trails with pedestrian walkways & path clearing by 2014 - **M**	 2011 2011 2012
		Lack of connected green space in watershed	Development (land clearing/ conversion)	**3.** Establish buffer to surround trail ways	Coldwater Linear Trail-**M**	Vegetated buffer, land acquisition (donations, purchases, easements)	Creation of wildlife corridors	$935.68/ac vegetated buffer, $1,200-$2,000/ ac of easement	Parks Dept + (BCCD, SWMLC, MDNR, local non-profits, MUCC, landowners, other advocacy groups)	Long Term (6-20years) Work to persevere all undeveloped land surrounding walking trails with conservation easements by 2020 - **H**	 2015
		Lack of connected green space in watershed	Development (land clearing/ conversion)	**4.** Manage trail corridor for wildlife	Coldwater Linear Trail-**M**	Forest wildlife mgmt, open land wildlife mgmt, Army Corps ecosystem restoration & mgmt	Creation of wildlife habitat (forest, wetland, open lands)	$1,320 in staffing costs, $2,384 in volunteer labor (7.45/volunteer hour), $935.68/ac of buffer plant material	County Parks Department + (BCCD, USFWS, USDA-NRCS, MDNR LIP Program, Potawatomi R,C&D)	Short Term Revegetate buffers as necessary by 2013 - **M** Long Term Manage plant species for wildlife habitat - **L**	 2012 2013
Objective 2: Preserve prime farmland in the watershed	Sediment, nutrients, pathogens, pesticides/ herbicides, hydrologic flow, oils, grease, & metals (all affected to some extent)	Threat of further loss of open space	Development pressures	Assist farms with development of farmland conservation plan and expand local planning to enroll selected farms in the farmland preservation program	Prime farmland throughout watershed (*Map F-2*)-**M**	Farmland conservation plans, PDR, Open Space Preservation, Farmland Development Rights Agreements (Public Act 116), conservation easements, WRP, USFWS wetlands programs, local Open Space Easements and Designated Open Space Agreements	Prevention of further watershed degradation	$12,000 for hiring planning consultants ($1,200-1,500 per twp), $1,500-3,000 per acre of farmland PDR	County Planning Commission + (BCCD, MSU-E, Townships, County Planning Commission, SWMPC, Branch County Ag. Preservation Board, USDA-NRCS, MDA, Branch County Board of Commissioners, USDA-NRCS PRPP)	Short Term (0-5years) Hire planning consultant to assist twps w/ developing & adopting open space preservation/ PDR programs-**L** Work w/ MSU-E, County Planning Comm. & Ag. Board to prioritize farmland & open space in 2011 - **L** Use farmland preservation program to purchase development rights of a high priority farm in 2012 - **M** Long Term (6-20years) Offer technical assistance to farm operators developing conservation plans - **M** Seek additional land owners to enroll in farmland and open space preservation programs - **L** Preserve and purchase development rights of additional priority farmlands in watershed by 2030 - **L**	 2010 2011 2012 2011 2013 2013

GOAL THREE (*continued*): Establish, expand and protect a green infrastructure in the watershed											
Objective	**Pollutant**	**Source**	**Cause**	**Task**	**Site and priority (Low, Med. or High)**	**BMPs**	**Estimated Load Reductions/ Benefits**	**Cost**	**Potential Lead Organization (& Partners)**	**Interim Milestone Activities and Priority of Activity (Low=L, Medium=M, High=H)**	**Projected Start Date**
Objective 3: Protect most ecologically sensitive areas in watershed	Sediment, nutrients, pathogens, pesticides/ herbicides, hydrologic flow, oils, grease, & metals (all affected to some extent)	Polluted surface runoff from converted natural areas	Reduction in watershed's ecological services (altered, converted and developed natural areas and features)	**1.** Conduct Land Use Policy analysis of municipalities in watershed	City of Coldwater-**H**; Quincy & Girard Twps-**M**; Algansee, Batavia, Ovid & Union Twps-**L**	Natural Resource Inventories (NRIs), Land Use Policy Analyses, Greenprint Plans and model ordinances	Prevention of further watershed degradation and potential reduction in pollutant loads if stricter land use ordinances are adopted	$126,000 for planning consultants ($18,000 per twp)	City & Twp Planning Commissions + (BCCD, MSU-E, planning consultants)	Short Term Conduct Land Use Policy Analysis for City of Coldwater by 2011- (**H**) Conduct Land Use Policy Analysis for Girard & Quincy Twps by 2013 - (**M**) Long Term Conduct Land Use Policy Analysis for remaining Twps in watershed by 2020 - (**L**)	2010 2011 2015
		Polluted surface runoff from converted natural areas	Reduction in watershed's ecological services (altered, converted and developed natural areas and features)	**2.** Protect ecologically sensitive areas from haphazard development by increasing number of conservation easements within watershed	Highest PCAs (*Map J-1*)-**H**; High PCAs (*Map J-1*)-**M**	Conservation easements, *I/E Strategy*, CRP, WRP, US FWS Wetlands Program	Prevention of further watershed degradation, linkage of green infrastructure	$1,200-$2,000/ac of easement	SWMLC + (BCCD, County Planning Commission, Townships, USDA-NRCS, USFWS, County Parks Department, Potawatomi R,C&D, MDA, USDA-NRCS WRP & PRPP)	Short Term Preserve 3 highest PCAs with conservation easements, USFWS wetlands program, WRP or CRP by 2011 - **H** Preserve the 3 next highest PCAs with easements, USFWS wetlands program, WRP or CRP by 2012 - **H** Long Term Recruit landowners & preserve 28 additional high-ranking PCAs w/ conservation easements, USFWS wetlands program, WRP or CRP by 2020 - **M** Recruit landowners and preserve as many of the remaining 40 PCAs in the watershed as possible by using conservation easements, USFWS wetlands program, WRP or CRP by 2030 - **L**	2010 2010 2010 2010
Objective 4: Acquire undeveloped land for public use	n/a	n/a	n/a	Develop tools to identify, acquire and permanently protect land for public use	Site dependant upon availability	Conservation easements, land grants, MDNR Natural Resource Trust Fund Grants	Creates watershed ownership, fulfills desired watershed use	Cost dependant on land appraisal	BCCD + (MDNR, County Parks Department, MDOT, County Planning Commission, twps, USDA-NRCS WRP & PRPP, Potawatomi R,C&D, MDA)	Short Term ID land suitable for permitting public recreation & seek buy-in from stakeholders/landowners in 2013 - **L** Coordinate grant-writing team, pursue grants for acquiring land, advertise for land donations - **L** Long Term Acquire land for public use through grants or donations by 2020 - **L** Preserve any acquired public land with conservation easements by 2030 - **L**	2013 2013 2014 2015
Objective 5: Install continuous greenbelt around chain of lakes	Sediment, nutrients, pathogens, pesticides/ herbicides, oils, grease & metals	Waterfront properties	Removal of riparian vegetation	Develop program to help waterfront residents install native greenbelts along their lake shore (*see also Goal 1: Objective 2: Task 2)*	Lakefront Properties-**H**	Greenbelts, shoreline stabilization/ bioengineering, *I/E Strategy*	26.6 ton/yr reduction in sediment, 1,076.2 lb/yr reduction of nitrogen, 269.9 lb/yr reduction of phosphorus, also reduction in potential chemical, oil, grease & metal contamination and reduced waterfowl access to shoreline	$16,500 for greenbelts ($330/ac), $440,374 for shoreline stabilization ($110/ft.),	North Chain Lake Association + (BCCD, MGSP, NRCS, USFWS, Potawatomi R,C&D, Conservation non-profits, MUCC,)	Short Term Secure funding and establish a cost-share incentives program for installing greenbelts in 2010 - **H** Establish a greenbelt demonstration site along lake chain by 2011 - **M** Install 12.5 acres of continuous greenbelt along lake chain by 2012 - **H** Long Term Provide guidance and technical assistance on lakescaping to watershed residents - **M** Install 25 acres of continuous greenbelt along lake chain by 2020 - **H** Install 50 acres of continuous greenbelt along lake chain by 2030 - **H**	2010 2010 2011 2011 2011 2011
Objective 6: Reduce #'s of invasive species in watershed	Loss of biodiversity	Invasive species	Human introduction	Develop & provide tools to watershed residents to ID & manage invasive species	Chain of Lakes-**M**; lakefront properties-**L**	*I/E Strategy*, demonstration plots/gardens	Reduced invasive species and increased biodiversity	$1,000 for demonstration plot	North Chain Lake Assoc. + (BCCD, MSU-E, MDNR, Garden Clubs, JFNew, MDEQ, Businesses, Clean Water Action, SWMLC)	Short Term Provide guidance on invasive species management - **L** Create a demonstration plot that showcases bio-retention and plants native to the region by - **M**	2011 2011

GOAL FOUR: Establish and protect blue infrastructure in watershed											
Objective	**Pollutant**	**Source**	**Cause**	**Task**	**Site and priority (Low, Med. or High)**	**BMPs**	**Estimated Load Reductions/ Benefits**	**Cost**	**Potential Lead Organization (& Partners)**	**Interim Milestone Activities and Priority of Activity (Low=L, Medium=M, High=H)**	**Projected Start Date**
Objective 1: Establish a posted navigational course in the Sauk River and North Chain of Lakes	n/a (*desired use*)	n/a (*desired use*)	n/a (*desired use*)	Post informational signs and mileage markers along course of navigational waterways (*see also Goal 1: Objective 1: Task 4*)	Sauk River-**M**; Chain of Lakes-**L**	Woody debris removal, volunteer stream cleanups, signage, *I/E Strategy*	Promotion of watershed protection, fulfill desired use	$3,000 in staffing cost for debris removal, $11,324 for volunteer cleanup ($596/yr at $7.45/volunteer hour), $500 for signage ($50/sign)	Tourism Bureau + (BCCD, County Parks Department, County Drain Office, volunteers, Rotary Club and other Service Organizations, Stream Team, North Chain Lake Association)	Short Term Remove woody debris obstructions/log jams from streams using woody debris removal methods (http://www.therouge.org/Programs/PI/RiverRestorationPrograms.htm) by 2011 -**M** Post informational & navigational & mileage marker signs throughout Sauk River and Chain of Lakes by 2012-**M** Long Term Annually coordinate volunteer stream cleanup - **L** Maintain clear navigational path in river - **L**	2010 2011 2012 2011

GOAL FOUR (*continued*): Establish and protect blue infrastructure in watershed

Objective	Pollutant	Source	Cause	Task	Site and priority (Low, Med. or High)	BMPs	Estimated Load Reductions/ Benefits	Cost	Potential Lead Organization (& Partners)	Interim Milestone Activities and Priority of Activity (Low=L, Medium=M, High=H)	Projected Start Date
Objective 2: Encourage utilization of chain of lakes	n/a (desired use)	n/a (desired use)	n/a (desired use)	Develop a Chain of Lakes brochure	MLD1-8 and Chain of Lakes (*Map 7-1*)-all **L**	*I/E Strategy*, sign maintenance	Raise awareness of opportunities to utilize Chain of Lakes, create watershed ownership	$1,320 in staffing costs	Tourism Bureau + (BCCD, MDNR, Branch County Parks Dept., North Chain Lake Association, Chamber of Commerce)	Long Term Maintain/repair Lake Access and County Park signs - **L**	 2013
Objective 3: Reduce NPS pollution caused by public use of access sites	Oils, grease, metals, litter/refuse, sediment	Lake access sites	Irresponsible boating practices	Provide waste/recycling receptacles at landings	MLD1-2, MLD4, MLD7 and Chain of Lakes (*Map 7-1*)-all **L**	*I/E Strategy*, recycling & waste receptacles	Reduction of refuse and liquid wastes at lake access sites	$200 for signage ($50/sign), $2,120 for recycling & waste bins, ($265/bin/yr), $1,780 for waste service ($89/yr)	North Chain Lake Assoc + (BCCD, MDNR, County Parks Department, MSU-E, Potawatomi R,C&D, Republic Waste Services, Hodunk-Messenger Lake Board)	Short Term (0-5years) Provide trash & recycling receptacles as needed at landings along Chain of Lakes by 2012 - **L** Post information signs/notices about NPS and how to reduce waste at landings by 2013 - **L**	 2011 2012
Objective 4: Reduce populations of invasive species in and around chain of lakes	Loss of biodiversity, (nutrients and pathogens are also affected)	Invasive species	Human introduction	**1.** Raise awareness of invasive aquatic plant transport via boating	MLD1-2, MLD4, MLD7 and Chain of Lakes (*Map 7-1*)-All **M**	*I/E Strategy*	Reduced invasive species and increased biodiversity	$200 for signage ($50/sign)	North Chain Lake Assoc + (BCCD, MDNR, MSU-E, MDEQ, Private Businesses, Clean Water Action, County Parks Dept, Coldwater, Twps, Hodunk-Messenger Chain Lake Board)	Short Term Post signs about invasive species & the transport of exotic species via boating at landings along Chain of Lakes in 2013 - **M**	 2012
		Invasive species	Human introduction	**2.** Reduce Mute swan population along Chain of Lakes	Chain of Lakes-**M**	Swan roundup/ translocation, egg oiling	Reduction in Mute swan numbers (reduction in potential pathogen & nutrient loads expected, but currently no empirical data exists on pollutant content of swan waste to formulate predicted loads), also increased aquatic biodiversity	$10,200 in staffing costs and $1,430.40 in volunteer labor ($7.45/volunteer hour)	North Chain Lake Association + (BCCD, MDNR, MUCC, Private Contractors)	Short Term Lake association swan roundup application to MDNR in 2011 - **L** Initial Mute swan population inventory in 2011 - **L** Conduct swan roundup/translocation in 2012 - **M** Conduct egg oiling and nest destruction if necessary in 2012 - **L** Long Term (6-20years) Conduct annual swan population inventories - **L**	 2010 2011 2012 2012 2011

GOAL FIVE: Protect groundwater resources in the watershed

Objective	Pollutant	Source	Cause	Task	Site and priority (Low, Med. or High)	BMPs	Estimated Load Reductions/ Benefits	Cost	Potential Lead Organizations (& Partners)	Interim Milestone Activities and Priority of Activity (Low=L, Medium=M, High=H)	Projected Start Date
Objective 1: Reduce risk of potential NPS pollutants from contaminating groundwater supplies	Pesticides/ herbicides, nutrients, pathogens, gasoline and other chemicals & toxins	Underground Storage tanks	Leaking tanks	**1.** Fix, replace and/or remove leaking underground storage tanks (USTs)	City of Coldwater/ Leaking UST sites (*Map E-8*)-**H**	*I/E Strategy*, monitoring, storage tank replacement	Reduction in chemical inputs to groundwater	$480,000-600,000 for UST closure or repair ($80,000-$100,000/ UST)	City of Coldwater + (BCCD, Branch-Hillsdale-St. Joseph County Environmental Health Agency, MDEQ, MDA, Coldwater DDA)	Short Term Facilitate the closing of 4 leaking underground storage tanks (USTs) in the watershed by 2011 - **H** Long Term Facilitate the closing of 6 total leaking USTs in the watershed by 2020 - **H** Continue to monitor information on underground storage tanks in Coldwater - **M**	 2010 2010 2016
		Residential, recreational and agricultural chemical treatments	Mismanaged chemical applications in groundwater recharge zones	**2.** Permanently protect land in Coldwater's Wellhead Protection Zone	Coldwater Wellhead Projection Zone (*Map E-9*)-**H**	Conservation Easements	Permanent source water protection for Coldwater	Cost dependant on land appraisal	SWMLC + (City of Coldwater, Coldwater Township, BCCD, Branch County Board of Commissioners, Coldwater Wellhead Protection Committee)	Short Term Hire land use planning consultant to work with City and Twps - **H** Preserve parcels closest to municipal well field by 2012 - **M** Long Term Preserve parcels in 1 year migration zone by 2020 - **M** Preserve parcels in 5 year migration zone and any feasible parcel adjacent to protection zone by 2030 - **L**	 2010 2011 2011 2011
		Household hazardous waste materials	Improper disposal	**3.** Facilitate proper disposal of hazardous waste materials	Waterworks Park (site irrelevant)	Annual hazardous waste collection day	Reduction in hazardous waste contamination	$200,000 for waste collection day ($20,000/yr)	CBPU + (BCCD, City of Coldwater, Twps, MGSP)	Long Term Annually advertise for and sponsor an annual hazardous waste collection day, provided free to residents - **H**	 2010

GOAL FIVE (*continued*): Protect groundwater resources in the watershed											
Objective	**Pollutant**	**Source**	**Cause**	**Task**	**Site and priority (Low, Med. or High)**	**BMPs**	**Estimated Load Reductions/ Benefits**	**Cost**	**Potential Lead Organizations (& Partners)**	**Interim Milestone Activities and Priority of Activity (Low=L, Medium=M, High=H)**	**Projected Start Date**
Objective 1: Reduce risk of potential NPS pollutants from contaminating groundwater supplies	Pesticides/ herbicides, nutrients, pathogens, gasoline and other chemicals & toxins	Residential, recreational and agricultural chemical treatments	Mismanaged chemical applications in groundwater recharge zones	**4.** Improve fertilizer, pesticide and herbicide application rates and timing around groundwater recharge areas	Groundwater recharge areas (*Map E-6*)-**H**	Crop*A*Syst, Integrated Pest Management (NRCS practice #593), nutrient management plans (NRCS practice #590); soil testing, PSNT testing, *I/E Strategy*	Reduction in potential pesticide & herbicide contamination of groundwater	$9,652.5 for nutrient management ($21.45/sq.ft.), $24,000 for soil testing ($9/soil test & $15/test), $36,000 for pest management ($80/ac)	MGSP + (MSU-E, USDA-NRCS, commercial fertilizer, pesticide and herbicide dealers, MDA)	Short Term Apply nutrient management to 10% of fields (45 acres) in groundwater recharge areas in 2010 - **M** Apply pest management to 10% of fields (45 acres) in groundwater recharge areas in 2010 - **M** Apply nutrient management to 25% of fields (112.5 acres) in groundwater recharge areas by 2012 - **M** Apply pest management to 25% of fields (112.5 acres) in groundwater recharge areas by 2012 - **M** Long Term Apply nutrient management to 50% of fields (225 acres) in groundwater recharge areas in 2020 - **M** Apply pest management to 50% of fields (225 acres) in groundwater recharge areas in 2020 - **M** Apply nutrient management to 100% of fields (450 acres) in groundwater recharge areas by 2030 - **M** Apply pest management to 100% of fields (450 acres) in groundwater recharge areas by 2030 - **M**	 2010 2010 2010 2010 2010 2010 2010 2010

9.2 Load Reduction Targets

Based on the predictions of comprehensive watershed pollutant load models (*Chapter 4*), the strategically-placed application of physical BMPs are expected to yield certain potential pollutant load reductions. These pollutant load reduction estimates are summarized in *Table 9-2*. By implementing the recommended BMPs, it is estimated that total suspended solid (TSS) loading would be reduced by 27.7%. This reduction is expected to significantly reduce the undesirable and unnatural surface water properties such as turbidity, color, suspended solids and sediment deposits that are present in the watershed. Implementation activities are also expected to produce a 54.4% reduction in nitrogen loads and a 74.5% reduction in phosphorus loads. These reductions are expected to significantly restrict the excessive growth of aquatic plants, fungi, bacteria and algae. By implementing measures to restrict and reduce Canada geese use of Memorial Park and other public recreational areas in the watershed, it is also expected that *E. coli* levels in the Hodunk-Messenger Chain of Lakes will be brought back under a 130/100ml H_20 concentration. Since the average *E. coli* concentration from the 2004 Beach Water Sampling data (found in Appendix C) was approximately 186/100ml of water, it is thought that the recommended goose waste reduction practices at least reduce Messenger Lake *E. coli* concentrations by 60 colonies/100ml (*Table 9-2*). This will be achieved by removing or excluding as many geese as possible from public areas, since estimates show that each goose has the potential to deposit as much as 9,022.1 *E. coli* organisms per day (*Appendix C*).

Although no empirical calculations for the reduction in chemical loads has been determined, it is also predicted that these implementation measures will produce a significant reduction in the amount of pesticides, herbicides, oils and other toxins entering surface water through surface water runoff. It should be noted that these figures are considered to be minimum expectations for NPS pollutant load removal because they are based exclusively on the implementation of site-specific physical BMPs. The pollutant load removal predictions presented in this plan do not take into account the pollutant reductions that may result from changes in managerial practices and individual stewardship behaviors.

Table 9-2: **Potential Reductions Sought to be Achieved through Individual BMPS**

BMP	**Pollutant Reductions (per Year)**			
	TSS (tons)	N (lbs)	P (lbs)	Pathogens (E. coli #'s)
Conservation Tillage (1,936.9 ac)	273.00	7,830.60	1,616.50	
Filter Strip (1,096.1ac)	132.80	5,393.20	1,360.80	
Goose waste reduction (Memorial Park Beach)	-0-	*No data*	*No data*	~60/100ml reduction in average summertime *E.coli* levels
LID/ Bioretention Areas (35.71 ac)	-0-	44.57	15.27	
LID/ Vegetated Swales (1.63 ac)	1.66	19.62	9.10	
LID/ Recessed Landscape Islands (28.57 ac)	2.99	88.54	11.52	
LID/ Porous Pavement (95.91 ac)	11.63	490.77	53.14	
Nutrient Management (27,531.6 ac)	0.00	112,439.30	28,449.40	
Greenbelt (21 ac)	29.30	1,183.50	296.90	
Riparian Forest Buffer (341.2 ac)	40.00	1,614.30	404.80	
Stream bank Stabilization (4003.4 ft)	640.40	0.51	0.20	
Waste Management of all livestock operations	-0-	24,053.70	3,133.10	
Street Sweeping (problem areas)	2.57	0.00	6.43	
LID/Wetland/Extended Wet Detention (67.34)	7.85	150.08	36.05	
Wetland restoration (456.1 ac)	79.45	762.80	355.40	
System of Gravel Pit BMPs	3.80	6.08	2.37	
Floodplain fill site mitigation	216.07	348.50	557.60	
Septic failure reduction (50%)	-0-	7,072.00	2,624.58	
Livestock Stream Fencing/exclusion	7.30	162.10	13.70	
Human access site stabilization/improvement	0.16	0.25	0.40	
TOTAL	1,443.28	161,660.42	38,947.26	60/100ml

By achieving these load reductions, it is expected that the threatened warm water fishery in the watershed will be improved. All surface water bodies are also expected to regain the necessary properties needed to support indigenous wildlife and aquatic life and recreational use once these reductions are achieved. In addition to the re-attainment of designated uses, recommended implementation activities are also expected to generate the added benefits of an expanded green infrastructure in the watershed, the establishment and protection of a blue infrastructure, and the protection of groundwater resources.

After installation of the recommended BMPs, not only will NPS pollution be reduced, but it will also be brought into more of an equilibrium with the various sources of NPS pollution throughout the watershed. For instance, *Figures 9-1* through *9-6* represent the pollutant loads expected before and after BMPs. After BMPs, there should be a shift from extreme sources to more diverse, balanced sources with reduced contributions. After implementation, these sources will become more manageable because the rate and quantity of their pollutant loading will be reduced to a level more in line with natural processes.

Figure 9-1: Sediment Load Sources BEFORE BMPs

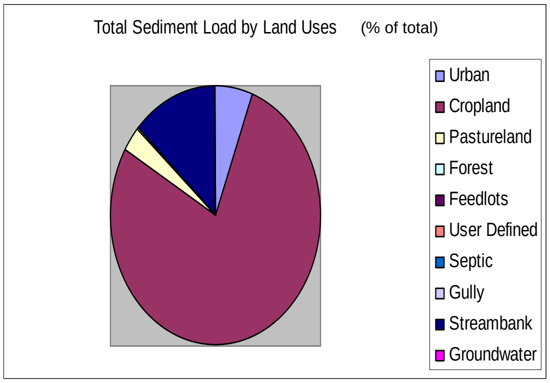
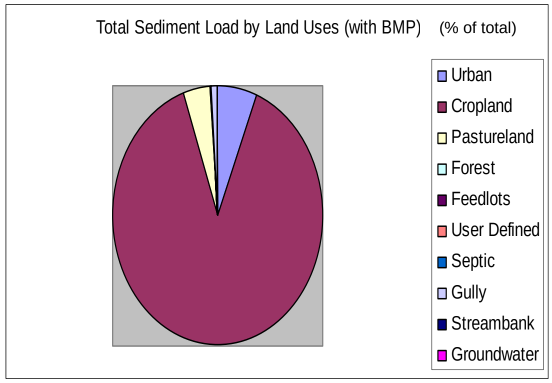


Figure 9-2: Sediment Load Sources AFTER BMPs



Note that in *Figure 9-2* nearly all of the sediment load contributions from impaired streambanks have been eliminated due to the potential implementation of streambank stabilization BMPs. This reduction gives the appearance that sediment load contributions from cropland will increase. However, this is not the case. The actual load quantities from cropland will be reduced, even though cropland will remain the leading contributor of sediment loads in the watershed.

Figure 9-3: Nitrogen Load Sources BEFORE BMPs

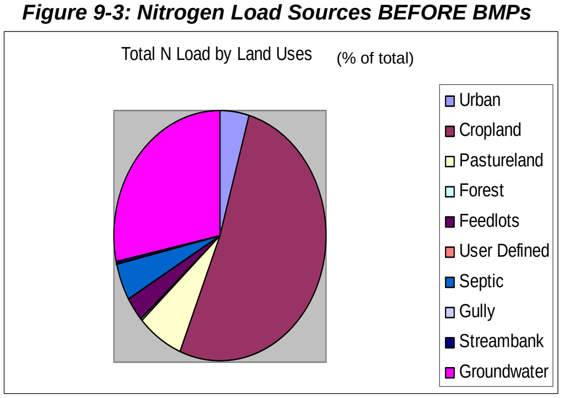


Figure 9-4: Nitrogen Load Sources AFTER BMPs

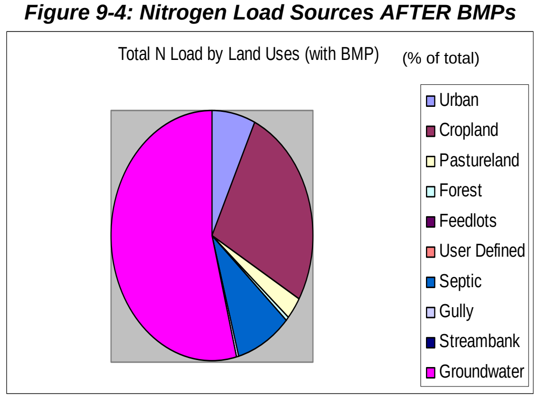


Figure 9-5: Phosphorus Load Sources BEFORE BMPs

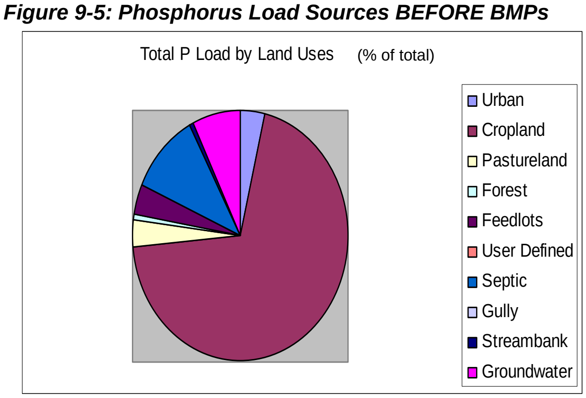
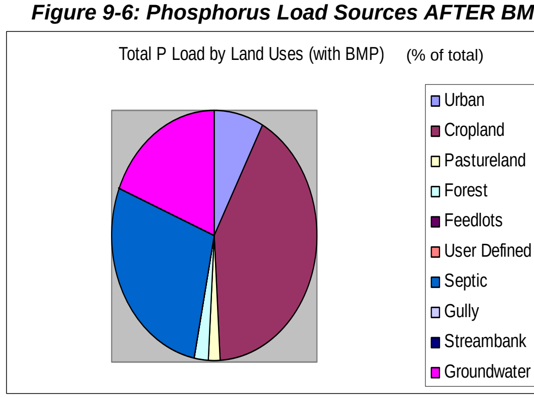


Figure 9-6: Phosphorus Load Sources AFTER BMPs



Since urban pollutant inputs are often overlooked in such an agricultural watershed, the necessity of LID BMP implementation within the urban area of Coldwater was reinforced by calculating the potential pollutant load reductions through the use of pollutant load models. The figures represented in *Table 9-3* help show the magnitude and substantial impact that management of impervious surfaces can have on a watershed. *Table 9-3* represents how much of a factor urban stormwater runoff can be in the total yearly pollutant load accumulation in the watershed, and also how strategically placed LID practices can produce such a substantial impact on the overall load reductions.

Table 9-3: **Urban Pollutants upon Implementation of Recommended BMPs**

	Pollutant Load (lbs/year)		
	N	P	TSS
Current Load Amounts	12,798.81	1,938.54	594,893.41
Estimated Load Reduction	1,831.58	382.08	90,149.53
Loads After BMPs	10,967.23	1,556.46	504,743.88

9.3 Pollutant Load Prevention

In addition to the pollutant reductions estimated to occur through corrective measures, there are a number of recommended activities aimed at the *prevention* of potential future NPS pollutant loading. These recommended activities are considered conservation or preservation measures, rather than mitigation. By applying conservation easements to the highest priority natural and open space areas identified in the watershed, significant pollutant increases in the watershed can be averted. *Table 9-4* represents the hypothetical pollutant loads that could be controlled through conservation, as estimated by the Illinois EPA "Conservation Easement Load Reduction Worksheet". These estimates are based on the application of conservation easements on all 68 priority conservation areas in the watershed (*Appendix K*), the properties within the Coldwater Wellhead Protection Zone, and the Coldwater Brownfield site. The conservation easement worksheet estimates the potential pollutant inputs that would be generated if these lands were developed (left column) and then, from that amount, estimates the amount of pollutants that could be saved if conservation easements were applied to these areas first (right column).

Table 9-4: **Pollutants Controlled with Conservation Easement**

Pollutant	Load Generated by Development of Land w/o Easement (lbs/yr)	Pollutants Controlled with Easement (lbs/yr)
Biological Oxygen Demand (BOD)	2,542	280
Chemical Oxygen Demand (COD)	93,403	8,571
Total Suspended Solids (TSS)	127,103	13,993
LEAD	34	4
COPPER	13	1
ZINC	182	12
Total Dissolved Solids (TDS)	1,532,466	169,488
Total Nitrogen (TN)	1,271	140
Total Kjeldahl Nitrogen (TKN)	2,796	308
Dissolved Phosphorus (DP)	182	12
Total Phosphorus (TP)	751	16
CADMIUM	1	0

9.4 Land Use Planning

Long-term land use planning is an integral part of watershed management. In the Hodunk-Messenger Watershed, several vital wetlands, natural areas and streams have been identified during the planning project. Because of the natural ecological functions they provide, these areas are important to protect. These areas help maintain watershed health by providing floodwater storage, nutrient uptake, soil stabilization and groundwater recharge. However, without applying a long-term land use strategy to the watershed, all of the recommended implementation activities might be for naught. For example, if haphazard development were to occur in critical natural areas throughout the watershed after BMP implementation, any positive effects they had created would be negated. With this in mind, a substantial portion of the implementation activities recommended for the Hodunk-Messenger Watershed have been devoted to the promotion of sustainable land use planning.

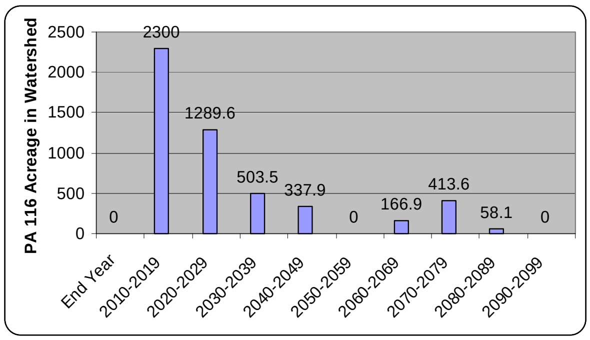
Land use planning, from a water quality perspective includes setting ordinances and establishing appropriate zoning to protect surface water and critical ecosystems, avoid degradation of water quality, permanently protect open space and natural areas and provide incentives for LID and Smart Growth practices. LID practices treat stormwater by promoting infiltration rather than conveyance. LID stormwater treatment practices help to protect surface waters from the critical first flush of a rainfall event. Various case studies have shown that up to 90% of all pollutants left on impervious surfaces are washed off and delivered to surface waters during first flush. Smart Growth practices on the other hand, encourage urban redevelopment rather than outward sprawling urban development.

> Smart growth is an urban planning and transportation theory that concentrates growth in the center of a city to avoid urban sprawl.
>
> Smart growth advocates compact, walkable, bicycle-friendly land use.
>
> Some goals associated with smart growth are to equitably distribute the costs and benefits of development; preserve and enhance natural and cultural resources and promote public health. For more information on the advantages of smart growth planning, visit www.smartgrowth.org.

To help facilitate the adoption of sustainable land use policies in the future, two Land Use Policy Analyses were conducted for two townships within the watershed during the planning project. An NRI and an analysis of Coldwater Township's land use policies were performed under funding from the Hodunk-Messenger 319 funds by McKenna Associates, Inc. A similar analysis of Butler Township was undertaken and funded through the Hog Creek Watershed Implementation Project. The Butler Township analysis, though conducted in 2007, was administered by the Hog Creek Watershed Project because the northeast half of Butler Township drains to the Hog Creek. However, the information presented in Butler Township analysis was found to be very applicable to the Hodunk-Messenger Watershed Project because so much of Butler Township falls within the Hodunk-Messenger Watershed.

The first step of developing a Land Use Policy Analysis is to conduct a thorough Natural Resource Inventory (NRI) of the subject area. An NRI serves to document surface water bodies, vegetative quality, soil productivity, wetland and riparian areas, environmentally sensitive or threatened ecosystems and other significant natural features essential for the environmental and economic prosperity of the subject area. This information is valuable to watershed planning because it identifies areas of ecological importance within a particular civil division.

Figure 9-7: **Ending dates of PA116 terms in watershed**



Data Source: Michigan Department of Agriculture

The next step of a Land Use Policy Analysis is to thoroughly review all existing land use ordinances, policies and plans applicable to the subject area. In the third step, the land use planning consultant then makes policy recommendations to better facilitate the protection of water quality, based on the findings of the NRI and the current policy analysis. All of these results are presented in a fourth and final step: a Township "Greenprint Plan". A greenprint plan takes into account all of the contributing factors and presents them in a comprehensive "strategy for growth that emphasizes land conservation to ensure quality of life, clean air and water, recreation and economic health."[2]

The results of these analyses were expected to provide a dual benefit for watershed management efforts in the future. First and foremost, these analyses provided Butler and Coldwater Township with sound recommendations of land use policies to adopt in the future in order to protect and enhance water quality in each Township. A secondary goal was that the analyses performed in these two Townships would serve as poignant examples for other municipalities in the future. For the implementation of this WMP to be most effective, active participation in land use planning from every municipality in the watershed is highly recommended. An excerpt of the Coldwater Township NRI and Land Use Policy Analysis may be found in *Appendix M* of this document.

Application of conservation **easement**s are another part of land use planning highly recommended for the extended health of the Hodunk-Messenger Watershed. Conservation easements are legally binding agreements that permanently limit certain types of uses or prevent development from taking place on a piece of land. Currently, there are no conservation easements in place in the watershed. This is critically important because there have been 68 priority conservation areas identified within the watershed that currently aid in sustaining the water quality. Loss of any of these areas would likely result in further degradation of water quality. The areas in the Hodunk-Messenger Watershed most critical for protecting are described in *Section 7.4* and *Appendix K.*

Like conservation easements, there are also no publicly available recreational lands and no permanently preserved farmland within the watershed (the State owned prison grounds are not available for public use). Both land use opportunities have been expressed as highly desirable by the watershed community. Implementation activities to aid the watershed community in acquiring these lands would not only satisfy a desired use, but would aid in protecting the longevity of watershed health. Public recreational lands established as nature preserves, recreational trails or game areas would provide benefits in the way of wildlife habitat, rainwater retention and infiltration. Likewise, permanently preserved farmland would offer benefits like infiltration and exclusion of urban sprawl.

Although there has not been permanently protected farmland established in the watershed, there are a number of tracts that have been temporarily preserved through Michigan's Farmland Preservation Act: *PA 116*. It is important to make the distinction that these lands are only temporarily preserved, however. In fact, of the 5,194.4 acres of farmland currently preserved under PA 116 in the watershed, 2,476.8 acres (or, 48%) will have their contracts expire within the next decade (*Appendix G* and *Figure 9-7*). In the coming years, as the PA 116 terms on these tracts expire, a large portion of farmland in the watershed may become susceptible for development if appropriate land use planning measures are not taken.

As part of the implementation Action Plan, it is recommended that a thorough analysis and prioritization of all farmland in the watershed is completed (*Goal 3: Objective 2*). With the information that would be obtained from this prioritization, local municipalities would be better able to steer their farmland purchase of development rights (PDR) activities toward the highest

[2] Definition used by *The Trust for Public Lands*

quality farms. As it stands in the recently adopted county "farmland preservation ordinance", only USDA rated "prime farmland" can be eligible for PDR. A map of the prime farmland locations in the watershed was developed during the preceding watershed planning phase and is included in *Appendix G* and of this document. This map of prime farmland indicates where farmland and open space preservation activities would be concentrated.

9.5 Information and Education Strategy

For watershed implementation efforts to succeed, they have to be promoted, understood, accepted, and have ownership in the entire community. For the sake of effectively delivering this information to the watershed community, a Hodunk-Messenger Chain of Lakes Watershed Information and Education (I/E) Strategy has been developed. To facilitate this, an I/E subcommittee of the Advisory Council was formed (*Appendix N*) to oversee the development of an I/E Implementation Strategy. As a result, the following action plan (*Table 9-5)* was produced to guide the implementation of a 3-year long watershed-wide NPS I/E Strategy.

The overall goal of this I/E Strategy is to establish and promote educational programs that will support and encourage the acceptance of implementation tasks. A secondary goal of the I/E Strategy is to create positive changes in both individual and societal watershed stewardship. This I/E strategy is meant to be administered in conjunction with other tasks from the management plan to help ensure the success of the recommended implementation practices. In general, the watershed I/E plan involves:

1.) Increasing the community's understanding of watershed related issues through targeted educational campaigns,

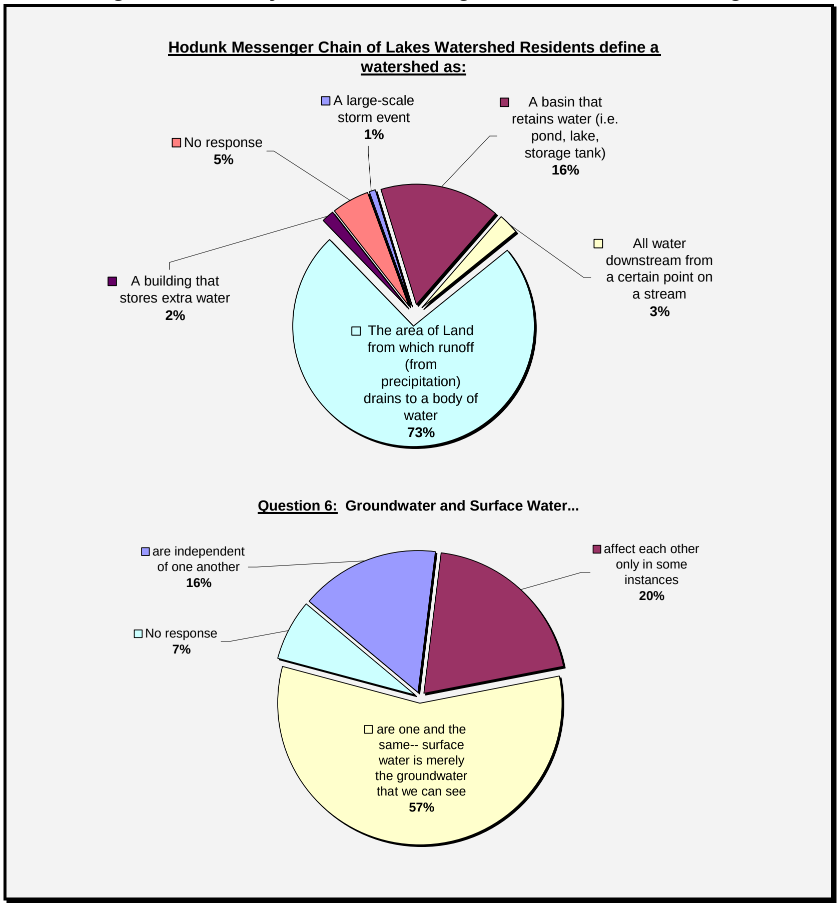
2.) Introducing watershed stakeholders to the WMP/ raising public awareness of the extent of NPS threats in the watershed,

3.) Increasing landowner buy-in for certain management practices,

4.) Encouraging as much public involvement in events to protect water quality as possible.

Development of the I/E strategy was based on reducing the specific NPS pollutants (identified in *Chapter 6*), as well as incorporating information about the local community obtained through public feedback. There were several opportunities to obtain public input during the planning phase. There have been four North Chain of Lakes Association meetings that have taken place, in addition to a public meeting held in August of 2007 where 96 watershed residents attended to express their concerns about the watershed. More community information still was collected from social survey (*Appendix A*) that was administered in 2007 to the residents and businesses within the Hodunk-Messenger Chain of Lakes Watershed. This social survey helped to determine the level of watershed awareness in the community and to assess the individual knowledge base of current water quality impairments. Survey results proved that, unlike many communities, residents in the Hodunk-Messenger Chain of Lakes Watershed seem to possess a high level of understanding on many watershed related concepts (*Fig.9-8*). For example, the overwhelming number of correct responses to survey *Question 2* indicates that people in the community have a good understanding of what a watershed is.

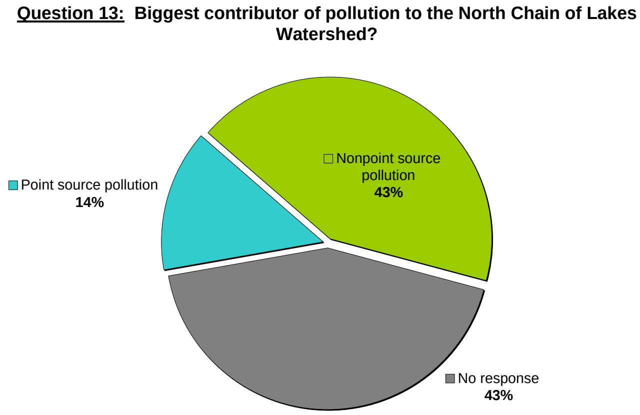
Figure 9-8: **Survey Results Indicating Watershed Understanding**



Given the high level of watershed knowledge apparent throughout the watershed community, not a lot of broad, general-knowledge watershed education will need to be administered to the public in the implementation phase. Instead, much of the I/E strategy will focus on more detailed, issue-specific watershed education. During the implementation phase, education and outreach will be used as a tool to help reduce NPS pollution and raise awareness of specific impairments.

Question 13 of the social survey asked survey recipients to choose which was the larger contributor of pollution, point source or nonpoint source? Even though (according to the US EPA) NPS pollution is the leading cause of degraded water quality in surface water bodies nation-wide, only 43% of Hodunk-Messenger respondents indicated this (*Fig. 9-9*). By raising public awareness of NPS threats and making them a central theme of the I/E strategy, it is hoped that any social monitoring administered during or after implementation will reveal an increase in this understanding.

Figure 9-9: **Responses to Question 13 of the Social Survey**



A number of the tasks associated with the I/E Strategy are meant to be applied to the entire watershed community for the purpose of raising the baseline level of watershed knowledge and understanding. However, to further maximize the effectiveness of I/E efforts and thoroughly address all water quality impairments in the watershed, watershed residents have been grouped into several target audiences. Based on these groupings, several different approaches to I/E have been developed according to the needs and characteristics of each group. While some I/E efforts will be applied universally to the entire watershed community (baseline watershed knowledge), it is thought that targeting specific groups with specific messages will encourage more participation and "buy-in" for specific projects such as greenbelt implementation for lakeshore residents or conservation tillage practices for agricultural producers.

The target audiences identified as having the greatest impact on water quality (good or bad) in the Hodunk-Messenger Watershed are: *residential homeowners, riparian landowners, the agricultural industry, businesses and industries, the recreation and tourism industry, construction (contractors, developers and excavator) and students and educators.* In the first 2-3 years of implementation, considerable time and effort is intended to be put toward building awareness of watershed and NPS related issues in addition to familiarizing the various groups of watershed stakeholders to the WMP, the findings of the watershed planning project and the associated implementation activities recommended for watershed improvement.

Residential Homeowners

Household residences in the watershed are considered to have the broadest reach of any target audience and therefore present a great potential for contributing NPS pollution in the watershed. Causes of the NPS contamination associated with residential areas include, but are not limited to: *increased runoff from areas of turf and impervious surfaces, improper hazardous waste disposal, mismanaged application of fertilizers, pesticides and herbicides and pollutant leaching from individual septic systems*. The specific pollutants associated with residential areas are:

- Sediment
- Nutrients
- Hydrologic flow
- Pathogens
- Pesticides and herbicides
- Oils, grease & metals

By offering I/E resources to residents on topics such as water quality-friendly lawn care practices, stormwater treatment techniques and proper septic system maintenance, it is hoped that a reduction in these pollutants may be achieved. Residential homeowner I/E is especially important because it will be the only method used to reduce NPS pollution from individual septic systems. Based on the 1997 assessment of Coldwater Township (*Appendix F*) conducted by the Branch-Hillsdale-St. Joseph Community Health Agency, several areas adjacent to the chain of lakes and around the City of Coldwater were found to be unsuitable for the individual septic systems in place there due to high water tables, close proximity of lots/dwellings and unsuitable soil types. Currently, the Health Agency estimates that about 19% of all septic systems in the watershed fail every year. Results from the social survey show that septic system risk awareness is low. *Question 14* suggests residents feel that agricultural, residential and urban runoff are the leading sources of NPS pollution; not septic seepage. Since pollutant leaching from faulty septics only received about 14% of the responses, raising public awareness on this issue is critical. In *Question 18,* 70% of the homeowners with individual septic systems say they clean their septic system every year or every 2-5 years, leaving 30% that clean it less regularly than recommended. Furthermore, 98% percent of residents with individual septic systems replied that they were unaware of the location of their septic drainage field. Based on this information, implementing a Residential I/E campaign will encourage individual septic maintenance and improvement and will therefore aid in achieving *Goals 1, 2, 3* and *5* of the Implementation Action Plan.

Riparian Landowners

Waterfront residents and property owners are often considered the "last line of defense" against polluted runoff entering a lake or river. Likewise, waterfront property owners also possess the greatest potential to degrade water quality given their close proximity to surface water. Because of the land clearing, development and draining necessary to live in a riparian area, coupled with the desire for unhindered views and ample lake access, there is often little to no vegetated buffer or fringe wetlands left in these areas. Riparian buffers and fringe wetlands serve in filtering pollutants, slowing and reducing peak flows from runoff and stabilizing soil loss. In most cases, runoff from developed and residential riparian areas will transport such pollutants as:

- Sediment
- Nutrients
- Pesticides and herbicides

These pollutants are washed from waterfront properties into surface water bodies without ever undergoing any treatment. For these reasons, riparian landowners are a critical audience to target. The main objective in the Riparian Landowner I/E strategy is to re-establish native vegetation along lakeshores and streambanks. Since there are no readily available government cost-share programs for residents and small lot owners along lakes for installing conservation practices, much of the attention in promoting vegetated buffers will go toward the North Chain Lake Association and individual property owners along the chain of lakes. The ultimate goal of this effort will be to encourage the reestablishment a continuous vegetated buffer, or "greenbelt" along the entire length of the chain of lakes. A continuous greenbelt will not only serve to slow the rate of runoff from adjacent lakeshore properties through infiltration and plant uptake. It will also filter pollutants, transform nutrients, reduce erosion and create lost wildlife habitat and travel corridors. The latter benefits are especially important to watershed residents based on *Question 3* of the social survey, where "viewing wildlife and nature" was rated as the top priority watershed activity. Targeting this audience with a tailored I/E campaign will also help in achieving *Goals 1, 2, 3* and *5* of the Implementation Action Plan.

Agriculture Industry

Since land use in the watershed is predominantly agricultural, it's of the utmost importance that information on farming conservation practices gets delivered to the agriculture industry sector so that soil loss and polluted runoff is minimized. By promoting practices that will help keep the soil on the land in the upper parts of the watershed, the Agriculture Industry I/E plan will aid in the reduction of the following NPS pollutants:

- Sediment
- Nutrients
- Hydrologic Flow
- Agrichemicals (various pesticides and herbicides)

Interestingly, *Question 14* from the social survey shows that farmers overwhelmingly regard agricultural runoff as the largest problem in the watershed; whereas the survey as a whole shows a standard deviation for that question and suggests that overall, residents feel that agricultural runoff, residential runoff *and* urban runoff are the leading NPS sources. This finding is important to consider, as it would suggest that farmers are aware of their impact on the watershed and that they may be willing to implement measures to reduce that impact.

It is also important to include septic maintenance in this targeted I/E strategy because of the farmers that responded to the social survey, only 59% of them say they maintain their septic tanks regularly, whereas overall, 70% of watershed residents are servicing their systems regularly. The hope is that, through the Agricultural Industry I/E Plan, these agricultural producers could be steered toward adopting improved management practices and becoming involved in environmentally-beneficial cost-share programs. By doing so, *Goals 1, 2, 3* and *5* of the Implementation Action Plan will be served.

Business and Industry

According to the 2000 census, Coldwater is the fastest growing urban area of all urban areas on the Michigan side of the St. Joseph River Watershed. Given this trend, it is imperative that urban BMPs are adopted and that public awareness of watershed health is raised so that further degradation of water quality may be avoided. Fortunately the City of Coldwater has expressed a willingness to work with BCCD in developing educational workshops, demonstration sites and activities for residents, businesses, and City staff that raise awareness of watershed health. Goal One of the Implementation Action Plan sets forth recommendations for implementing Low Impact Development (LID) stormwater practices in the City of Coldwater in order to increase infiltration rates, stabilize the local hydrology and reduce such NPS pollutants as:

- Sediment
- Nutrients
- Pesticides and Herbicides
- Oils, grease, metals

It should be noted, however, that the pollutant reductions associated with implementing these LID practices (*Table 9-1*) are based strictly on the establishment of these practices on city-owned only. The City of Coldwater owns several substantial tracts of land within the city boundaries (758 acres in all), and has expressed an interest in working with BCCD to implement LID practices in these areas. Even though this situation will be extremely beneficial for the watershed implementation project, the majority of the land within Coldwater's boundaries is privately owned (76%) and will therefore not receive any LID BMPS unless the buy-in of private businesses and industries is gained. This may be one of the most vital I/E audiences because the success of implementing LID stormwater practices in Coldwater will be directly related to the acceptance of local business and industries. The Business and Industry I/E tasks in the I/E Strategy (*Table 9-5*), along with an LID demonstration site implemented by the City, will help facilitate this acceptance. If additional LID stormwater practices are applied to the privately-owned impervious surfaces of businesses and industries throughout the City, pollutant load reductions will actually exceed the minimum load reduction estimates provided in this WMP.

Recreation and Tourism

Due to its size, location, ease-of-access, abundant fish populations, navigability and other recreational attractions, the Hodunk-Messenger Chain of Lakes watershed gains a lot of seasonal and transient use. This can be both good and bad for the health of the watershed. It is good in the sense that communities in the watershed gain economically and consequently may invest back into protecting those natural attractions which bring visitors in, but can also be detrimental if non-residents pollute the watershed.

The Recreation and Tourism I/E Plan consists of both raising the watershed awareness of non-residents and promoting watershed stewardship at resident recreational attractions. Efforts directed at resident recreational attractions will involve reducing pollutant inputs from the golf course, campgrounds and lake access sites. By doing so, this I/E campaign will effectively increase the chances of achieving all recommended implementation goals. The pollutant inputs most commonly associated with the Recreation and Tourism target audience include:

- Sediment
- Nutrients
- Hydrologic flow
- Pathogens
- Pesticides and herbicides

Construction (development, excavators and contractors)

To strengthen the Soil Erosion and Sedimentation Control (SESC) Program in Branch County, a series of educational workshops and trainings are recommended for all contractors doing any development, drain maintenance or other excavation work in the watershed. Oftentimes excavation and land development results in soil disturbance and soil loss through erosion, alterations to the natural hydrology, and improperly stored spoil material. The Soil Erosion and Sedimentation Control I/E Plan is expected to significantly reduce:

- Sediment loading
- Nutrients (transported by sediment)
- Impacts on the natural hydrology

By doing so, this facet of the I/E Strategy will effectively serve *Goal 1* of the recommended Implementation Action Plan.

Students and educators

The final audience, the local school system, is targeted not to reduce any specific pollutant, but to prevent the future degradation of watershed as well as gain watershed project volunteers. Not only will students be the subject of this I/E Plan; educators will as well. By working with teachers, school boards and local outdoor education committees, the BCCD will help to integrate watershed, NPS pollution and water-quality concepts into school curriculum, thereby increasing watershed understanding among young watershed residents. By developing educational programs for school groups, large numbers of students may be reached at one time. The hope is that this awareness will carry over into students' adult life, resulting in a positive change in watershed stewardship behaviors. Specifically, this will directly serve *Goal 3* and *4* of the Implementation Action Plan and hopefully be able to indirectly support the sustainability of all other goals.

***Table 9-5:* I/E Strategy**

Audience	Pollutant Targeted	I/E Message	Delivery Mechanism	Tasks	Responsible Party	Projected Start Date	Priority (Low, Med., High)	Costs	Evaluation Criteria
Entire Watershed Community	Sediment, nutrients, pathogens, hydrologic flow, pesticides & herbicides, oils, grease & metals, and refuse	"Nonpoint source pollution is the greatest threat to water quality"	Local media	**1.** Develop watershed-related educational announcement(s) to be played on Coldwater radio and/or television stations (28public service announcements (PSAs)/month)	Q-1 Video Networking & WTVB AM 1590	2012	L	$24,000 ($4,800/yr x 5 yrs)	Deliver 336 PSAs/yr, expand mailing & volunteer list
				2. Submit Bi-annual advertising that promotes watershed health in local newspaper	BCCD	2010	M	$1,200 ($400/yr x 3 yrs)	Submit 4 ads/year
			Newsletter	Develop and distribute an informational newsletter bi-annually	BCCD	2010	M	$8,400 ($2,800/yr x 3 yrs)	Distribute 2/year
			Website	Provide information about NPS pollution control on Conservation District website	BCCD/Creative Web Design	2010	M	$4,500 ($1,500/yr x 3 yrs)	Increase site traffic
			Workshops	**1.** Hold a SWMLC workshop on land conservation & green infrastructure	SWMLC	2010	M	$750	Well-attended workshop
				2. Hold a second SWMLC landowner workshop on the benefits of conservation easements	SWMLC	2011	M	$750	Increase conservation easements in wtrshd
		"Water quality-friendly lawn care", "Septic maintenance" and "On-site stormwater treatment"	Watershed Stewardship Program	**1.** Develop a set of guidelines for watershed residents to follow in order to reduce the amount of NPS pollution leaving their property. This program will provide criteria a resident must achieve in order to be recognized as a "Watershed Steward"	BCCD	2010	H	$2,000 in Staffing Costs, $2,000 in material	Increase number of individuals participating
				2. Develop a long-term plan for sustaining the Watershed Stewardship Program	BCCD	2010	M	$264 in Staffing Costs	Sustainability plan
				3. Establish and/or identify sources of funding for cost sharing the installation of residential BMPs recommended in the Watershed Stewardship Program.	BCCD	2010	H	$2,000 in Staffing Costs	Acquire funding source
		"Watershed Awareness"	Social Survey	Administer a social survey to assess changes in the level of watershed awareness and knowledge of NPS-related topics	MSU-E	2014	L	$12,000 (for survey development and analysis)	Increase number of correct responses

Residential (home-owners)	Sediment, nutrients, pathogens, hydrologic flow, pesticides/herbicides	"Water quality-friendly lawn care" and "Septic maintenance" "On-site stormwater treatment"	Watershed Stewardship Program	Develop & distribute Residential I/E packet including informational resources on water quality-friendly lawn care, septic maintenance on stormwater management	BCCD	2010	H	$2,000 ($10/packet x 200 packets)	Increase number of participants
			Workshops	Hold a workshop that discusses regular septic maintenance and the problems that faulty septic systems can have in a watershed	Community Health Agency	2011	H	$750	Decrease number of septics failing per yr

Riparian Landowners	Sediment, nutrients, pathogens, hydrologic flow, pesticides & herbicides and refuse	"Riparian land management (the importance of riparian buffers)" and "Water quality-friendly lawn care"	Greenbelt Initiative Program	Develop & distribute Riparian Landowner I/E packet that includes informational resources on creating greenbelts, bioengineering, native plants & water quality-friendly lawn care	BCCD	2010	H	$2,000 ($10/packet x 200 packets)	Increase acreage of greenbelts implemented
			Watershed Tour	Organize an annual watershed tour that will include site visits to well managed riparian areas, include invasive species management demonstration and lake ecology discussion	BCCD	2012	L	$1,500	Well-attended tour
		"Understanding lake ecology"	Workshops, Lake Association Meetings	**2.** Deliver informational presentations/ project updates at Lake Association meetings	BCCD	2010	L	$198 in staffing costs	2 meetings/year

Agriculture Industry	Sediment, nutrients, pathogens, hydrologic flow and agrichemicals	"Advantages of, and opportunities for, agricultural conservation practices" "Impacts of agrichemical use on water quality" "Importance of fertilizer application rates and timing"	NRCS Annual Summer Agricultural Field Day	(Annually) present the advantages of, and opportunities for, agricultural conservation practices at an annual field day targeted at agricultural industry, offer presentations on the impacts of agrichemical use, and offer demonstrations on proper fertilizer spreading methods. Host event on a farm implementing conservation practices and hold demonstrations and/or a tour.	USDA-NRCS	2010	M	$2,250 ($750/yr x 3 yrs)	Increase acreage of conservation tillage and filter strips implemented
		"Impacts of agrichemical use on water quality" "Proper chemical storage"	Groundwater Stewardship Program	Recruit and refer landowners to the GSP and the local Groundwater Technician when possible	MGSP	2010	L	$800 in staffing costs	Increase in nutrient mgmt plans and conservation farms

Audience	Pollutant Targeted	I/E Message	Delivery Mechanism	Tasks	Responsible Party	Projected Start Date	Priority (Low,Med.,High)	Costs	Evaluation Criteria
Business and Industry	Sediment, nutrients, pathogens, hydrologic flow, pesticides & herbicides, oils, grease & metals, and refuse	"Advantages of LID stormwater management techniques"	Watershed Stewardship Program	Develop & distribute a Business & Industry I/E packet that includes informational resources on LID stormwater management techniques	BCCD	2010	H	$500 ($10/packet x 50 packets)	Increase number of participants
			Workshop	Hold a workshop to educate the watershed community on the advantages of and opportunities for LID practices	SWMPC	2010	M	$750	Increase in LID practices implemented
			Watershed Tour	Hold a watershed tour that showcases LID demonstration sites	BCCD	2012	M	$750	Increase in LID practices implemented
		"Avoiding surface water contamination via storm drains"	Storm drain labeling	Label storm drain inlets annually in Coldwater with markers that educate the public about the connectedness of storm sewers to surface waters	City of Coldwater	2010	M	$3,000 ($1,000/yr x 3 yrs)	200 storm drain markers applied/year
			Feature activities in local media	Develop and submit a follow-up press release for every storm drain awareness activity	BCCD	2010	L	$300 ($100/yr x 3 yrs)	Submit 2/year
		"The leadership role businesses can play in protecting the watershed"	Workshop	Hold one workshop targeted at business leaders to discuss how businesses can play a leadership role in protecting the watershed	SWMPC	2011	M	$750	Increase in LID practices implemented
Recreation and Tourism	Nutrients, pathogens, oils, grease & metals, and refuse	"Clean boating practices"	Promotional Items	**1.** Develop & distribute promotional items addressing clean boating practices at fishing tournaments and other lake events	BCCD	2011	L	$1,500 ($1 x 1,500 items)	Distribute 100/year
		"Clean camping practices"	Campground signage	Post signs throughout campgrounds on proper waste & sewage disposal methods	Local Campgrounds	2012	M	$200 ($50/sign)	Post 4 signs minimum
		"Awareness of spreading aquatic invasive species"	Informational signs at lake access points	Provide informative signs at lake access points that describe the danger of spreading aquatic invasives and the proper way to safely transport watercrafts between lakes	BCCD	2012	M	$200 ($50/sign)	Post 4 signs minimum
		"Help us protect the beauty you enjoy when you are our guests"	Promotional Items	**1.** Develop promotional items that remind visitors of the efforts to protect and improve the watershed and distribute to campgrounds, tourism bureau other information kiosks, and at festivals and other events within the watershed	Tourism Bureau	2011	L	$1,500 ($1 x 1,500 items)	Expand mailing and volunteer list
		"Goose population control"	Media release	Promote utilization of HAP land	BCCD	2011	L	$123 ($41/press release)	Decrease goose pop.
			Waste Management Information	Develop and distribute useful guides and informational resources to parks, campgrounds and lake associations	Community Health Department	2012	M	$200 ($2 x 100 items)	Lower fecal coliform levels in surface water
Contractors, excavators, developers, etc.	Sediment, nutrients, hydrologic flow	"Minimizing soil disturbance and erosion" and "Understanding the requirements of the Soil Erosion & Sedimentation Control (SESC) Program"	Trainings	Hold 2 SESC trainings targeted at area developers and excavators regarding permitting, dredged material mgmt. and techniques to reduce soil disturbance and erosion on construction sites, land clearing sites, drain cleanout sites, etc.	BCCD	2010	H	$1,500 ($750/wrkshp x 2)	Train minimum of 10 local contractors
			Informational brochure or fact sheet	Develop and distribute informational brochure or fact sheet detailing the SESC Program in Branch County	BCCD	2010	H	$500 ($1/brochure x 500 brochures)	Increased compliance with SESC program
Area K-12 Students and Educators	*Prevention of all*	"The impact of NPS pollution on water quality"	Presentations to school groups	Schedule dates and line up speakers for presenting watershed related topics to local school groups	MSU-E	2010	M	$2,400 in staffing costs	3 school presentations/year
		"Incorporate watershed concepts into curriculum of local K-12 schools"	Outdoor Education Committee	Participate in local schools' outdoor education committees	Local School Districts	2010	L	$396 in staffing costs	Attend min. of 2 meetings/year
			Educational field trips	Coordinate site visits within the watershed for area school groups	Local Schools	2011	M	$2,400 in staffing costs	1 school site visit/year
		"Connect Watershed Project activities and school activities"	Volunteer water quality monitoring/ MiCorps	Enroll in MiCorps program and train student groups to routinely sample macro invertebrates from sites within the watershed in order to monitor water quality	MiCorps	2010	H	$750 in staffing costs	Train 3 student volunteers annually
			Feature activities in local media	Develop and submit a follow-up press release for every activity conducted in cooperation with the schools	BCCD	2010	L	$600 ($200/yr x 3 yrs)	Submit 2/year

10. PROJECT SUSTAINABILITY

10.1 Watershed Ownership

A management plan is only as effective its implementation.

For any natural resource management implementation project to succeed, it must not only be based on sound science, but also must be accepted and have ownership in the local community. If not taken into action by local stakeholders, implementation timelines will not likely be carried out, BMPs are not likely to be applied, stewardship behaviors will not change and pollutant load reductions will never occur. For these reasons, gaining support through public outreach and participation will be a substantial facet of the watershed implementation phase. Public ownership of the watershed project will be facilitated through the in-depth I/E strategy presented in *Table 9-5* in *Chapter 9*, as well as by the formation of a watershed oversight group early on in the project.

In general, the watershed implementation project is to be executed with a multi-jurisdictional approach through the encouraged participation of multiple agencies, buy-in of local property owners and the on-the-ground support of volunteers. *Table 10-1* recommends a projected structure of partner roles and responsibilities during implementation.

Table 10-1: **Implementation Roles**

Project Coordination	Lead Agencies of Implementation	Supporting Groups	On-the-Ground Work	Project Oversight
Branch County Conservation District	County Drain Commission, North Chain Lake Association; Hodunk-Messenger Lake Board; Branch-Hillsdale-St. Joseph Community Health Agency; USDA-NRCS; City of Coldwater; Branch County Conservation District	Branch County Road Commission, MDNR; MGSP; MDOT; Potawatomi R,C&D; Southwest MI Land Conservancy; planning consultants; MSU-E; US FWS; Audubon Society; Pheasants Forever; MDEQ; Local Clubs, advocacy groups and service organizations	Property Owners (stakeholders); ag. producers; local contractors; individual businesses and industries; CBPU; Townships; local planning commissions, BACC Students; Garden Club/Master Gardeners and other volunteers	Watershed Advisory Council; BCCD Board of Directors

Once the WMP has been accepted, adopted and applied, measures must be taken to ensure that any positive outcomes (such as reduced pollutant loads or attained designated uses) derived from implementation activities are sustained over time. This sustainability of improved water quality requires long-term management efforts (implementation years 5-20) from the groups listed in *Table 10-1*. For these groups, sustaining watershed goals and objectives over time can be accomplished by utilizing several key components including continual I/E (*Chapter 9*), maintenance of existing BMP systems, continued watershed group meetings, continued water quality monitoring and project evaluation (*Chapter 11*), implementation of land use recommendations and continued landscape restoration and conservation efforts (*Chapter 9*).

10.2 Possible Funding Sources

Perhaps the most important factor of all when it comes to implementing beneficial land management measures is finding a sustainable funding source. Based on the recommendations of this WMP, complete fulfillment of every single implementation activity would cost approximately $28,424,144 over the course of the next 20 years. While this cost figure may appear overwhelming and unattainable, it should be noted that these implementation costs are projected to be the highest possible amounts that might be incurred in the next two decades if no other watershed protection or improvement activities take place. Moreover, these implementation activities are designed to be shared by all partnering agencies and stakeholders. USDA-NRCS will be a particularly vital source of cost share. If all of the agricultural BMPs recommended in this plan are funneled through cost-share programs such as the Environmental Quality Incentives Program (EQUIP) and Wetlands Reserve Program (WRP), it is estimated that as much as 10% of the implementation costs could be provided for through 2008 "Farm Bill" funds. More manageable still is the per year cost needed for implementation, as compared to the overall cost of 20 combined years of implementation. *Table 10-2* demonstrates the potential breakdown of costs needed for the implementation of 100% of the recommendations found in this WMP.

Table 10-2: **Project Costs**

	Cost per Year	**Total Short-term Cost**	**Total Long-term Cost (includes short term costs)**	**% of Total Cost**
NRCS Cost Share	$149,977.83	$749,889.15	$2,999,556.70	10.55%
All Other Lead Agencies	$1,270,311.60	$6,351,558.00	$25,406,232.00	89.38%
Volunteers	$917.84	$4,589.20	$18,356.80	0.06%
Total Cost	**$1,421,207.20**	**$7,106,036.00**	**$28,424,144.00**	**100%**

The extremely high costs that have been estimated for implementing all of the practices recommended in this plan stem from the fact that they include both corrective and preventative measures. Although the overall cost for implementing only corrective measures would initially be lower, the long-term costs to the watershed community would increase. By preventing further water quality degradation, it is expected that funds spent on pollution prevention will vastly reduce the funds needed for additional and ongoing implementation of corrective measures in the future. Given the myriad of corrective measures recommended in this WMP, *Table 10-2* seems to add legitimacy to the need for NPS pollution prevention over mitigation. The current state of the Hodunk-Messenger Watershed goes to show that it is much more cost effective to prevent water quality impairments, rather than repair them once they have already occurred. For ways to help defray the future costs of water quality maintenance, refer to *Section 9.4* and *Goal 3* of the Implementation Action Plan.

The target pollutant load reductions listed in this plan are based on the premise that 100% of the recommended BMPs will be achieved during the implementation phase. Since reality does not always correlate with ideals, it goes without saying that the actual pollutant load reductions achieved during the watershed implementation phase will be directly dependant upon the amount and extent of BMPs actually implemented. To help ensure that the maximum amount of watershed goals are achieved to their fullest extent, several potential funding sources have been compiled and are provided here for use when seeking watershed project funding (listed in alphabetical order only):

- Branch County Community Foundation Grants
- Clean Michigan Initiative (CMI) State Revolving Fund
- Clean Water Act – Section 319 Grants
- Clean Water Act – Section 604(b) Grants
- Clean Water Act – Source Water Protection Grants
- Coastal Nonpoint Pollution Control Program. Authority: Section 6217 CZARA of the Coastal Zone Management Act. Program administered jointly with NOAA

- Dredged Material Management Program. Authority: Section 102 of the Marine Protection, Research and Sanctuaries Act and section 404 of the CWA
- EPA Office of Water's Catalog of Federal Funding Sources for Watershed Protection
- EPA Region 5 Grants and Financial Information
- EPA Region 5 Great Lakes Grants and Financial Information
- Great Lakes Commission Grants (various)
- Michigan Department of Natural Resources Trust Funds
- Michigan Department of Transportation Non-Motorized Transportation Enhancement Grants
- Michigan Groundwater Stewardship Program
- MiCorps Volunteer Stream Monitoring Grants
- National Estuary Program (NEP). Authority: Section 320 of the CWA, Estuaries and Clean Waters Act of 2000
- Nonpoint Source (NPS) Program Authority: Section 319 (h) of the CWA
- Source Water Assessment and Protection Program (SWAP). Authority: Section 1453 of the Safe Drinking Water Act
- Targeted Watersheds Grants Program
- USDA Conservation Reserve Program, Environmental Quality Incentives Program, Wetlands Reserve Program and Wildlife Habitat Improvement Programs. Authority: 2008 Farm Bill
- US Fish and Wildlife Service Partners Program
- Wal-Mart Community Enhancement Grants

10.3 Sources of Technical Assistance

Since many of the implementation recommendations are contingent upon individual stakeholder adoption and application, it is necessary to supply the users of this WMP with additional sources of technical assistance for watershed management and the associated stewardship practices.

Some technical assistance resources available for agricultural BMPs include:

- *MAEAP Farm*A*Syst, Crop*A*Syst and Livestock*A*Syst programs*
- *USDA-NRCS MI Electronic Field Office Technical Guide, available at www.efotg.usda.gov*

Some technical assistance resources available for conservation easements include:

- *Southwest Michigan Land Conservancy (SWMLC) – www.swmlc.org/*
- *The Nature Conservancy – www.nature.org*

Some technical assistance resources available for gravel pit BMPs include:

- CODWR. General Guidelines for Substitute Water Supply Plans for Sand and Gravel Pits Submitted to the State Engineer, pursuant to SB 89-120 & SB 93-260. Colorado Division of Water Resources - http://water.state.co.us/surfacewater/pits.asp
- Massachusetts Nonpoint Source Pollution Management - Sand and Gravel Operation Guidelines

- User's Manual to Best Management Practices for Gravel Pits and the Protection of Surface Water Quality in Alaska, by Ecology & Environment, Inc.
- USDA. 2000. Vegetating New Hampshire Sand and Gravel Pits. PM-NH-21. Natural Resource Conservation Service.

Some technical assistance resources available for groundwater protection include:

- *DEQ Drinking Water & Radiological Protection Division – 517/335-9218 or www.deq.state.mi.us/dwr/*
- *EPA drinking water protection sites*
- *Coldwater Wellhead Protection Plan*

Some technical assistance resources available for hazardous waste disposal include:

- *Coldwater Board of Public Utilities – 517/278-9276*
- *DEQ Waste Management Division – 517/7373-2730 or www.deq.state.mi.us/wmd*
- *Michigan Groundwater Stewardship Program (available at any Conservation District Field Office)*

Some technical assistance resources available for invasive species management include:

- Michigan Department of Environmental Quality – *Aquatic Nuisance Species Handbook for Government Officials, July 1999; Michigan's Aquatic Nuisance Species State Management Plan Update: Prevention and Control in Michigan Waters*, Oct 2002; *Integrated Pest Management for Nuisance Exotics in Michigan Inland Lakes*, June 2000
- Michigan Natural Features Inventory (MNFI) – *web4.msue.msu.edu/mnfi/*

Some technical assistance resources available for lake ecology include:

- *DNR Fisheries Division – 517/373-1280 or www.dnr.state.mi.us/www/fish/index.html*
- *MSU-E Water Quality Area of Expertise Team – 517/353-9222 or www.msue.msu.edu/waterqual*

Some technical assistance resources available for lakescaping include:

- *"Lakescaping for Water Quality and Wildlife"* – Minnesota DNR Publications
- Michigan Groundwater Stewardship Program – *Lake*A*Syst*

Some technical assistance resources available for land use planning include:

- *Center for Remote Sensing and Geographic Information Sciences – 308 Manly Miles Building/1405 S. Harrison Rd./East Lansing, MI 48823; 517/353-7195 or www.crs.msu.edu/*
- *City of Coldwater Comprehensive Master Plan*
- *Federal Emergency Management Agency (FEMA) – 877/336-2627 (FEMAMAP) or www.fema.gov/nfip/fmapinfo.htm*
- *Michigan Dept. of Management and Budget, Michigan Information Center – 517/373-7910 or www.state.mi.us/dmb/mic/*
- *Southwest Michigan Planning Commission (SWMPC) -*
- *US Census Bureau – www.census.gov/*

Some technical assistance resources available for lawn care include:

- MSU-E “Keep Your Lawn Green and Your Water Clean” brochure - http://www.kbs.msu.edu/extension/lakescaping/publications/Lawn%20Green%20Water%20Clean.pdf
- www.stormwatercenter.net – Pollution Prevention Fact Sheet: Landscaping and Lawn Care

Some technical assistance resources available for low-impact development include:

- EPA Factsheets and Reports – http://www.epa.gov/nps/lid/#fact
- Low Impact Development Manual for Michigan – SEMCOG, 2008

Some technical assistance resources available for sedimentation and soil erosion control:

- MDEQ Soil Erosion and Sediment Control resource page – http://www.michigan.gov/deq/0,1607,7-135-3311_4113---,00.html
- Regional Sediment Management (RSM) Program

Some technical assistance resources available for septic maintenance include:

- Branch-Hillsdale-St. Joseph Community Health Agency – 570 N. Marshall Rd/Coldwater, MI 49036 or 517/279-9561
- A Homeowner’s Guide to Septic Systems (EPA-832-B-02-005) – US EPA Office of Water

Some technical assistance resources available for smart growth include:

- www.smartgrowth.org
- US EPA Smart Growth page – http://www.epa.gov/dced/

Some technical assistance resources available for stream monitoring include:

- Michigan Clean Water Corps – http://www.micorps.net/
- A Strategic Environmental Quality Monitoring Program for Michigan’s Surface Waters – MDEQ, January 1997

Some technical assistance resources available for wetland construction/restoration include:

- USDA-NRCS Electronic Field Office Technical Guide (EFOTG) - www.nrcs.usda.gov/technical/**eFOTG**
- Wetland Restoration factsheet (file # EPA 843-F-01-002e) – US EPA Office of Water, September 2001

Some technical assistance resources available for wildlife management include:

- DNR Wildlife Division – 517/373-1263 or www.dnr.state.mi.us/wildlife/default.htm
- Wildlife Management Institute – *http://www.wildlifemanagementinstitute.org/*

10.4 Supporting Documents

A number of other documents that support the cause for improving water quality in the Hodunk-Messenger Chain of lakes have been developed over the years. Through watershed planning efforts, these documents have been discovered and are here recommended for reference and use in conjunction with the implementation of this WMP. These documents of similar purpose consist of past studies and recommendations for the improvement of the Hodunk-Messenger Chain of Lakes, along with other management plans from the region that support the vested interests of the watershed community. Many of these plans and documents were found to represent similar goals and objectives; some of which overlapped with the goals and objectives of this plan. Among other places, these documents are all available for public viewing at the BCCD field office:

- *Branch County Master Plan*
- *Coldwater Wellhead Protection Plan*
- *Cooperative Lakes Monitoring Program Annual Summary Report, 2002-2008*
- *Feasibility Study for the Restoration of Messenger-Hodunk Chain of Lakes, Snell Engineers, Inc, 1969*
- *Flood Plain Management Study of Cold Creek, 1991*
- *I-69 Recreational Heritage Route Management Plan*
- *Natural Resource Inventory and Land Use Policy Analysis of Butler Township, 2007*
- *Natural Resource Inventory and Land Use Policy Analysis of Coldwater Township, 2009*
- *Sauk/Coldwater Rivers Watershed Management Plan, 1996*
- *US-12 Historic Heritage Route Management Plan*

11. EVALUATION

11.1 Project Evaluation

A system for project evaluation is necessary for evaluating progress and successfulness of implementing the recommended watershed Implementation Action Plan (*Chapter 9*). It is hoped that evaluation guidelines will provide a way to measure the completeness and effectiveness of a watershed implementation project as a whole, while water quality monitoring efforts will help to evaluate successes and report the effects that individual BMPs are having on local water bodies. For project evaluation, a suite of reporting and review methods have been proposed. To assess future trends in water quality, however, BCCD sub-contracted ASTI Environmental during the watershed planning phase to develop of a comprehensive watershed monitoring component. This monitoring component provides guidelines for monitoring techniques, sampling methods, timelines and frequency of the sampling needed to monitor trends in water quality during implementation. The methods recommended for monitoring have been based on the characteristics of the Hodunk-Messenger Watershed and its current sources of NPS pollution. This monitoring program (included as *Appendix B*) is thought to provide a comprehensive framework for tracking changes in water quality throughout future implementation efforts. Plainly stated, project evaluation will assess the level of success in implementing practices, while water quality monitoring will assess the level of success in reducing pollutant loads.

There are a number of evaluation methods useful for judging the success of a potential watershed implementation project. For instance, changes in watershed awareness and knowledge base should be evaluated through “before-and-after” social monitoring techniques during implementation. The planning project social survey described in *Appendix A* can be used as an applicable source of baseline data for assessing the watershed community’s general level of watershed-related knowledge. Subsequent surveys or other social monitoring techniques can be administered during and after the implementation phase to assess if any shifts in awareness or knowledge have taken place. Changes in the numbers of crop producers or individual watershed residents that employ soil testing methods can also be evaluated through before-and-after social monitoring techniques. For a potential watershed awareness social survey, success will be determined by an increase in correct responses. For the soil testing surveys, success will be determined by an increase in number of producers soil testing. Static rates or decreases in watershed knowledge or soil test numbers will be considered unsuccessful. An increase in the number of volunteers participating in watershed project events will also be considered a success in the realm of project involvement. In these ways, I/E activities will be evaluated.

Another method of evaluation is to periodically review this very document and update it for relevancy as needed. Since watersheds are a very dynamic place with many influencing factors, it may be necessary from time to time to evaluate and revise this WMP to ensure it best reflects the needs of the watershed and watershed community. If significant changes in the watershed occur or if new or better data becomes available, timely revision of the WMP is expected. However, if no revisions or amendments to the WMP are prompted by new information acquisition, it is recommended that a mandatory WMP review is conducted by an oversight group at a minimum of once every five years, regardless of circumstances.

Perhaps the most basic, but at the same time most important method for evaluating watershed project implementation is to actually document implementation progress and/or rate the level of its completion. This proposed evaluation method is based on whether or not the “interim milestones” of the tasks recommended in *Table 9-1* are being achieved. It is expected that at least 90% of the completion milestones associated with any given task should be achieved in order to consider implementation of that task successful.

Once all tasks are successfully completed, it is predicted that the desirable and necessary pollutant load reductions will be achieved. As predicted by the US EPA *STEP-L* model, carrying out these tasks will result in at least a 42.6% reduction in nitrogen, 55.1% reduction in phosphorus and a 23.3% reduction in total suspended solids (sediment). Attainment of these goals will be assessed though a combination of revised pollutant load modeling such as STEP-L and the Revised Universal Soil Loss Equation (RUSLE2) with adjusted land use activity input data and actual BMP pollutant reduction data. Analytical water quality monitoring data will also be used to evaluate whether or not pollutant loads are being reduced as a result of better land use decisions and individual behaviors. Results of these activities will be the basis for evaluating whether or not the proposed load reduction goals are actually being met.

By achieving these reductions, Michigan's Water Quality Standards, and therefore all surface water designated uses, will again be achieved within the watershed. Specifically, these pollutant load reductions are predicted to result in safer *E. coli* levels in Messenger Lake (<130mg/L of H_20), reduced turbidity in lakes and streams, reduced sediment deposition and a slowing of aquatic plant and algae growth in the chain of lakes. These general water quality benchmarks will be determined through water sampling for *E. coli* levels along with qualitative field observations for turbidity, sediment deposition and aquatic plant and algae growth. Analytical monitoring (*Appendix B*) and long-term data collection will help determine the trends toward achieving, or not achieving these benchmarks.

When achieved, these benchmarks will denote the success of the tasks under *Goals One and Two* and will most likely signal the re-attainment of the impaired designated uses in the watershed. However, final determination of designated use attainment will be made by MDEQ during their biennial surface water quality assessments. Since they are primarily based on watershed desired uses, success of *Goals Three* and *Four* will only be determined by the achievement of the completion milestones outlined in *Table 9-1*.

Implementation of this management plan is also designed to produce a more stable hydrologic regime in the watershed by reducing peak flows. This hydrologic stabilization will result in slower stream velocities and increased chances for pollutants to settle out and infiltrate into the soil. Therefore, hydrologic stabilization will help restrict of the amount of sediment, nutrient, chemical and other toxin loads being contributed to surface waters. Though numerical ideals are not designated to these outcomes, the water quality monitoring program that is to be carried out during implementation will reveal whether these pollutants are increasing or decreasing as a result of implementation activities. For evaluation purposes, the tasks under *Goals One and Five* of the Implementation Action Plan will be considered successful if peak flows and chemical levels are reduced, and will be considered unsuccessful if peak flows and chemical inputs increase or remain unchanged. *Note: in addition to water quality parameters, the monitoring component (Appendix B) also contains recommendations for flow monitoring.*

Not including the procedures detailed in the monitoring component found in *Appendix B*, *Table 11-1* summarizes all of the above evaluation methods recommended for use during implementation:

***Table 11-1*: Evaluation Structure**

Year	Frequency	Evaluation Task	Responsible Party	Oversight	Expected Outcome
2010	Quarterly	Volunteer and mailing list	BCCD Administrator	Watershed Advisory Council	Constant increase in number of individuals signed up for mailing list as well as constant growth in volunteer numbers.
2010	Quarterly	Report project progress	Project Coordinator	BCCD Board of Directors	Timely completion of recommended implementation tasks.
2010	Once	Soil Test Pre Survey	MSU-E	BCCD	Baseline data of number of producers using soil tests.
2011	Yearly	Monitoring Reports	Private Monitoring Firm, Branch Careers Center	BCCD	Long-term watershed data, declining trend in NPS pollutant loads.
2014	Once	Soil Test Post Survey	MSU-E	BCCD	Increase in number of producers using soil tests.
2014	Every 5 years or as otherwise necessary	WMP review	Watershed Advisory Council	Project Coordinator	Necessary amendments, addition of better information, focus tailored to current NPS threats, continuation and extension of relevance.
2014	Once	"Post-I/E" Social Survey	MSU-E	Watershed Advisory Council	Survey responses that indicate an increase in watershed knowledge and awareness of NPS related issues in the Hodunk-Messenger Watershed.

In general and narrative terms, the success of the implementation project will be known when the following criteria are achieved:

- Predicted pollutant load reductions (*Chapter 6*) are achieved or exceeded (to be determined through monitoring activities and pollutant load modeling).
- All Michigan Water Quality Standards are met in all surface water bodies in the watershed.
- All designated uses are supported by all surface water bodies in the watershed.
- Water Quality is so improved in Messenger Lake that it is de-listed from the MDEQ Integrated Report before a TMDL has to be written (2017).
- Public awareness and knowledge base of watershed related topics such as NPS pollution is increased.

Estimating pollutant load reductions is yet another way to evaluate the successfulness of implementation. By comparing actual pollutant load reductions achieved through implementation to the load reductions predicted in the WMP, a rough measure of success may be gleaned.

11.2 Monitoring

To empirically assess the effectiveness of any and all watershed management activities implemented as a result of this WMP, a framework for water quality monitoring has been established. Development of the monitoring component to be included in this WMP was sub-contracted to the environmental services group ASTI Environmental. ASTI Environmental worked closely with BCCD during the latter stages of the planning project to incorporate the known water quality conditions of the watershed into a comprehensive monitoring program. Recommendations for sampling parameters were based largely on the pollutants of priority, as identified in this WMP. These parameters are described in detail in *Appendix B* of this document, but are also summarized at a glance in *Table 11-2*:

***Table 11-2*: Water Quality Parameters to Monitor**

	Sample Collection & Lab Analysis	**Field Measurements**
Stream Water Quality Parameters	Benthic Macroinvertebrates, suspended sediment, total phosphorus, *E. coli* bacteria, soluble reactive phosphorus, nitrite + nitrate nitrogen and ammonia nitrogen	Temperature, dissolved oxygen, velocity, specific conductance, pH
Lake Water Quality Parameters	Total phosphorus, soluble reactive phosphorus, nitrite + nitrate nitrogen and ammonia nitrogen	Secchi Disk transparency, temperature, dissolved oxygen, specific conductance, pH
Beach Water Quality Parameters	*E. coli* bacteria	(null)

The core monitoring program consists of macro invertebrate sampling at 10 priority stream sites and bacteriological monitoring at Memorial Park beach. Sites for sampling were chosen according to their proximity to known sources of NPS pollution, their accessibility and their suitability to sample from (water depth). Sites were split into groups of primary and secondary priority. Primary sites were selected to acquire a baseline characterization of the quality of the Coldwater and Sauk Rivers as they enter the chain of lakes from other sub-watersheds upstream to characterize tributary stream systems as they discharge to the chain of lakes and to provide on-going monitoring to known public health concerns. Depending of funding and volunteer availability, monitoring can be expanded to include basic chemistry sampling and the addition of secondary sites. For the most part, secondary sites are recommended for isolating tributary drainages. If feasible, administering a monitoring program that included all recommended sites would provide more accurate results and would uncover a fuller characterization of water quality in the watershed.

Another beneficial monitoring activity not listed in the monitoring component developed by ASTI is "source tracking" the *E.coli* contamination in Messenger Lake. Although it is highly suspected that *E.coli* found in goose feces is to blame for the high pathogen levels in the Messenger Lake beach water, this theory has never been field truthed by tracing the source of this specific contamination. Using advanced DNA testing methods, it is now possible for *E.coli* samples to be analyzed to determine the host animal of a given *E.coli* strain. That being said, an optional but useful first step to monitoring in the Hodunk-Messenger Watershed would be to track the source of an *E.coli* sample from Messenger Lake. This task would be useful in proving or disproving the assumption of the goose waste contamination in Messenger Lake. If this monitoring activity were administered first, appropriate changes could still be made to the implementation action plan and timeline if needed. Unfortunately, the cost of this monitoring activity is significant– $450 for each sample analyzed– and it has not been factored into the project costs listed in *Chapter 9* because of its expensive and optional nature. If sufficient funding were available, however, it is recommended that this source tracking be one of the first monitoring activities administered.

The water quality data collected under the guidance of the monitoring component in *Appendix B* will offer useful feedback on any changes that may occur in watershed surface water as a result of implemented BMPs, and is therefore an invaluable tool for evaluation. The information generated from this monitoring program will also help track long term trends water quality. This compilation of data will serve as a useful tool for education as well as an essential reference for future land use decision making.

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GLOSSARY of ACRONYMS

ACF………………………………………………..	Agrichemical Containment Facility
AMSL…………………………………………...	Above Mean Sea Level
BCCD…………………………………………...	Branch County Conservation District
BEHI…………………………………………….	Bank Erosion Hazard Index
BMP……………………………………………..	Best Management Practice
CMI…………………………………...………	Clean Michigan Initiative
CNMP…………………………………………...	Comprehensive Nutrient Management Plan
CRP……………………………………………..	Conservation Reserve Act
CWA…………………………………………….	Clean Water Act
DO…………………………………...……….	Dissolved Oxygen
FSA……………………………………………..	Farm Service Agency
GCC…………………………………………….	Golf Club of Coldwater
GIS…………………………………...………	Geographic Information System
GPD……………………………...………..	Gallons per Day
GPS……………………………………………..	Global Positioning System
HEL…………………………………………….	Highly Erodible Lands
HUC…………………………………………….	Hydrologic Unit Code
LID……………………………………………...	Low-Impact Development
LLWFA…………………………………………	Landscape Level Wetlands Functional Assessment
MCL…………………………………………….	Maximum Contamination Level
MDA……………………………………………	Michigan Department of Agriculture
MDEQ…………………………………………..	Michigan Department of Environmental Quality
MDNR…………………………………………..	Michigan Department of Natural Resources
MGD…………………………………………….	Million Gallons per Day
MGSP…………………………………………...	Michigan Groundwater Stewardship Program
MNFI……………………………………………	Michigan Natural Features Inventory
NLCD…………………………………………...	National Land Cover Dataset
NRCS……………………………………………	Natural Resources Conservation Service
NRI……………………………………………...	Natural Resource Inventory
NMP…………………………………………….	Nutrient Management Plan
NWI……………………………………………..	National Wetlands Inventory
PA……………………………………………….	Public Act
PCA……………………………………………..	Priority Conservation Area
QAPP…………………………………………...	Quality Assurance Project Plan
RUSLE2………………………………………..	Revised Universal Soil Loss Equation
SESC……………………………………………	Soil Erosion and Sedimentation Control
STEP-L………………………………………….	Spreadsheet Tool for Estimating Pollutant Load
TMDL…………………………………………...	Total Daily Maximum Load
TSS…………………………………………….…..	Total Suspended Solid
US EPA…………………………………………	United States Environmental Protection Agency
USDA…………………………………………...	United States Department of Agriculture
US FWS…………………………………………	United States Fish & Wildlife Service

WMP……………………………………..…….. Watershed Management Plan

Glossary of Terms

Aesthetic – a characteristic referring to beauty or the appreciation of beauty

Agrichemical – a chemical, such as a hormone, fungicide, or insecticide that improves the production of crops

Anthropogenic – caused by humans

Atmospheric Deposition – a phenomenon in which pollutants are transported long distances in the atmosphere and redeposited on the earth or in large bodies of water

Bacteria – single-celled microorganisms which can exist either as independent (free-living) organisms or as parasites (dependent upon another organism for life)

Bankfull Discharge – a flow condition where stream flow completely fills the stream channel up to the top of the bank. In undisturbed watersheds, this discharge condition controls the shape and form of natural channels and only occurs once every one to two years

Best Management Practice – methods or techniques found to be the most effective at controlling pollutant loads

Bioaccumulative – the accumulation of a substance, such as a toxic chemical, in the tissue of a living organism

Bioinfiltration – the process of capturing stormwater runoff with shallow, landscaped depressions used to promote absorption and infiltration

Biological Productivity – the amount of organic matter which is accumulated during a given period of time, particularly in aquatic systems

Bioretention – a process of managing stormwater runoff, using the chemical, biological and physical properties afforded by a natural community of plants, microbes and soil. Bioretention provides two important functions: flood control and water quality improvement through the removal of pollutants and nutrients associated with runoff

Blue infrastructure – an interconnected network of navigable surface water bodies that conserve ecosystem functions and provide associated benefits to human populations

Brownfield – abandoned industrial or commercial properties whose re-use is restricted by environmental contaminations

Channelization – reducing the length of a stream channel by substituting straight cuts for winding meanders. Channelization involves some loss of capacity in the channel as a whole, and in the case of a large river with a considerable flow it is very difficult to maintain a straight channel due to the tendency of the current to erode the banks and form again a sinuous channel

Delineation – drawing of an outline or boundary of an area, or a depiction

***E. coli* –** a genera of fecal coliform (bacteria) that originates in feces. *Escherichia coli, or E. coli,* is normally found in the gastrointestinal tract of warm-blooded animals only. *E. coli* can exist as numerous strains, some of which are responsible for diarrheal diseases

Easement – a legal agreement between a property owner and a qualified conservation organization or agency in which the owner voluntarily agrees to restrict the type and amount of development that may take place on his or her property

Ecosystem – an ecological community together with its environment, functioning as a unit

Eutrophic – a lake or pond having waters rich in mineral and organic nutrients that promote a proliferation of plant life, especially algae

Eutrophication – The process in which a lake, pond, or stream becomes eutrophic, typically as a result of nutrient rich runoff entering the water body from the surrounding land. The increased growth of plants and algae that accompanies eutrophication depletes the dissolved oxygen content of the water and often causes a die-off of other organisms

Fecal coliform – rod-shaped bacteria found in the intestinal tracts of mammals

First Flush – the initial surface runoff from a rainstorm. During the first flush, surface runoff entering storm drains in areas with high proportions of impervious surfaces is typically more concentrated with pollutants than compared to the remainder of the storm.

Flashy Stream – A stream in which flows collect rapidly from the surrounding land and flood peaks occur soon after the rain (hence "flash floods"). The flows in such streams also subside as rapidly as they collect.

Green infrastructure – interconnected network of natural lands, landscapes and other open spaces that conserve ecosystem functions and provide associated benefits to human populations

Green space – a plot of undeveloped land separating or surrounding areas of residential or industrial use

Headwater – the water source of a stream (usually used in plural)

Hydrophilic – having an affinity for water. Simply put: "water loving"

Hydrology – the properties, distribution, and effects of water on the earth's surface

Macrophyte – commonly used to describe an aquatic plant large enough to see with the naked eye

Mesotrophic – describes water of a lake or pond that has moderate biological productivity. Mesotrophic lakes are midway in nutrient levels between the eutrophic and oligotrophic lakes

Monoculture – the cultivation of a single crop

Morphology – the study of the form, structure and shape of organisms or geologic features without consideration of function

Morphometry – the form, structure and shape of organisms or geologic features without consideration of function

Nonpoint Source Pollution – pollution discharged over a wide land area, not from one specific location. These are forms of diffuse pollution caused by sediment, nutrients, organic and toxic substances originating from land-use activities, which are carried to lakes and streams by surface runoff. Non-point source pollution is contamination that occurs when rainwater, snowmelt, or irrigation washes off plowed fields, city streets, or suburban backyards. As this runoff moves across the land surface, it picks up soil particles and pollutants, such as nutrients and pesticides.

Oligotrophic – Lakes or ponds that lack plant nutrients and have a large amount of dissolved oxygen throughout. These lakes are typically deeper and colder than eutrophic or mesotrophic lakes

Outfall – The place where a sewer, drain, or stream discharges

Oxygenated – water enriched with dissolved oxygen

Pathogen – An agent that causes disease, especially a living microorganism such as bacteria or fungus

Precipitation – Any form of water, such as rain, snow, sleet, or hail, that falls to the earth's surface

Qualitative – based on the quality or character of something, as opposed to its size or quantity

Quantitative – involving the measurement of quantity or amount

Rill Erosion – removal of soil by running water with formation of shallow channels. This type of erosion is common on agricultural land and unvegetated ground

Riparian – the land adjacent to a surface water body; shorelines or banks of natural water courses, commonly

Sheet Erosion – erosion by sheets of running water, rather than by streams

Sinuous – characterized by many curves or turns; winding

Soil Associations – soils and nonsoil areas that occur in a repeatable pattern on the landscape; otherwise known to be an aggregate of different soil types within a given map unit

Stormwater – an abnormal amount of surface water due to a heavy rain or snowstorm

Sub-watershed – individual and unique drainage basins within a larger watershed or river basin

Terrestrial – of or relating to land as distinct from air or water, living on or in or growing from land, or more specifically; a plant that grows on the land or an animal that inhabits the surface of the earth

Tractive Force – a ratio between the ability of stream flow to mobilize stream bed particles of a certain size compared to the actual available particle size in a given stream, otherwise referred to as a measure of the erosive force of a stream's flow

Trophic State – a widely accepted method of classifying lakes. Trophic State generally refers to the nutrient status, amount of biological production that occurs in the water, and morphological characteristics of the lake basin itself. Lakes are divided into three trophic categories: oligotrophic, mesotrophic, and eutrophic

Turbidity – having sediment or foreign particles stirred up or suspended, resulting in muddy water

Undulating – having a wavy outline or appearance

Watershed – an area of land draining into a common river, river system, or other body of water. Watersheds are separated by ridges of high land dividing two areas that are drained by different river systems

Water Table – the level below which the ground is completely saturated with water

Glossary of Best Management Practices

***A**grichemical Containment Facility* – An impermeable barrier and containment placed or constructed on the ground where agricultural storage, loading, mixing, and clean-up occur.

Artificial goose deterrents – Artificial goose deterrents are man-made objects or barriers produced as a non-lethal method for discouraging goose habitation. Artificial deterrents can be grouped into two main categories: scare devices or strategies and physical deterrents. Scare devices or strategies, by design, are intended to frighten or chase birds away from an area whereas physical barriers are intended to prevent birds from gaining access to an area.

***B**ioengineering* – Increasing the strength and structure of the soil with a combination of biological and mechanical elements.

Buffer zones – A legally defined parameter of vegetated area, including trees, shrubs and herbaceous vegetation, which exists or is established to protect a surface water system.

***C**onservation Easement* – A conservation easement is a restriction placed on a piece of property to protect its associated resources. The easement is either voluntarily donated or sold by the landowner and constitutes a legally binding agreement that limits certain types of uses or prevents development from taking place on the land in perpetuity while the land remains in private hands. Conservation easements protect land for future generations while allowing owners to retain many private property rights and to live on and use their land, at the same time potentially providing them with tax benefits.

Conservation Reserve Program (CRP) – Provides technical and financial assistance to farmers and ranchers to address soil, water, and related natural resource concerns on their lands in an environmentally beneficial and cost-effective manner. CRP reduces soil erosion, protects the Nation's ability to produce food and fiber, reduces sedimentation in streams and lakes, improves water quality, establishes wildlife habitat, and enhances forest and wetland resources. It encourages farmers to convert highly erodible cropland or other environmentally sensitive acreage to vegetative cover, such as tame or native grasses, wildlife plantings, trees, filter strips, or riparian buffers. Farmers receive an annual rental payment for the term of the multi-year contract. Cost sharing is provided to establish the vegetative cover practices.

Conservation Tillage – Reduced tillage refers to any system that is less intensive and aggressive than conventional tillage. The number of operations is decreased compared to conventional tillage, or a tillage implement that requires less energy per unit area is used to replace an implement typically used in conventional tillage system. The term is sometimes used to imply conservation tillage; however, for a system to be considered a conservation tillage system, 30 percent of the soil surface must be covered with residue after planting.

***D**emonstration plot* – A plot of land that is cultivated and planted to demonstrate different methods of gardening, crop farming or vegetation management. A demonstration plot may also be created to demonstrate different plant materials (or different varieties of the same plants). In terms of watershed management, a demonstration plot would be established to showcase soil and water conservation practices as well as plants native to the eco-region.

Designated Open Space Agreement – An ordinance that protects open space from future development and environmental damage by restricting the area from any future building and against the removal of soil, trees, and other natural features, except as is consistent with conservation, recreation, or agricultural uses or uses accessory to permitted uses. A Designated Open Space Agreement may also provide that residents have access to the open space at all times or may dictate whether open space is for the benefit of residents only, or may be open to residents of the given municipality.

***E**gg oiling* – A widely-used method of reducing goose brood numbers. Eggs that are young enough to addle humanely are coated with corn oil that keeps air from passing through the shell so the embryo cannot develop.

EPA Adopt Your Watershed – A national catalog of organizations involved in local watershed protection available at www.epa.gov/adopt.

Exclusion Fence – Fencing is used to restrict livestock access to stream banks because animal traffic erodes stream banks, increases sediment load, and contributes animal waste in and near the stream, impairing water quality.

Extended Wetland Detention – An extended wet detention basin is a detention basin designed to increase the length of time that storm water is retained. This type of basin is typically configured in sections with a shallow forebay and a deeper permanent pool of water. The permanent pool of water provides a storage volume for pollutants to settle out. During large storm events, storm water temporarily fills the additional storage volume and is slowly released over a number of hours, reducing peak flow rates. Detention basins are often heavily vegetated so the vegetation can filter pollutants.

F*arm Conservation Plan* – A Farm Conservation Plan consists of a comprehensive inventory and assessment of natural resources, agricultural lands and management practices. A Farm Conservation Plan is a strategy for implementing BMPs and guides the improvement of land management practices and the implementation of projects for specific properties. Each Plan is like a blueprint for sustainability for a farm because it addresses the features and conditions of the particular property.

Farmland and Open Space Preservation Program – Established under the *Development Rights Agreements Public Act 116* and administered by the Michigan Department of Agriculture, this program is designed to preserve farmland and open space through agreements that restrict development, and provide tax incentives for program participation.

Filter Strip – A filter strip is a strip or area of vegetation for removing sediment, organic matter, and other pollutants from runoff and wastewater before they reach water bodies or water sources, including wells.

Forest Wildlife Management – A suite of NRCS practices that deal with managing forested areas for forest health, wood and/or fiber, water, recreation, aesthetics, wildlife habitat, and plant biodiversity.

G*rade reduction* – To reduce slope or inclination, specifically in the case of watershed management, as it pertains to a shoulder of a road at a road stream crossing.

Grade Stabilization Structures – A grade stabilization structure is designed to reduce channel grade (steepness) in natural or constructed watercourses to prevent erosion of a channel that results from excessive grade in the channel bed. This practice allows the designer to adjust the channel grade to fit soil conditions.

Grassed Swale – Grass swales are elongated depressions in the land surface that are at least seasonally wet, usually heavily vegetated, and normally without flowing water. Swales direct storm water flows into primary drainage channels and allow some of the storm water to infiltrate into the ground surface. Swales are vegetated with erosion resistant, and flood tolerant grasses. Sometimes check dams are strategically placed in swales to moderate flow, and an engineered soil mixture might underlie swales.

Grassed Waterways – A grassed waterway is a natural or constructed channel that is shaped or graded and planted with suitable vegetation for the stable conveyance of runoff without causing erosion of the channel.

Greenbelt – A contiguous riparian buffer of native plants along a lakeshore (www.huronpines.org).

H*andling Pad* – An impervious surface to provide an environmentally safe area for the handling of on-farm agrichemicals.

H*uman Access Site* – A reinforced or stabilized site along a lake or river that allows for safe human access to and from the river or lake without causing major disturbances to the local environment.

Hydro Geomorphic Assessment – A method of classifying the physical state of a wetland or riparian site by broad hydrological processes and concurrent geomorphological patterns.

I*/E* – Short for Information and Education, this facet of watershed management uses the proliferation of information to increase the baseline knowledge of factors that affect water quality within a watershed community. The BMP of education is thought to have significant influence on individual and societal behaviors and therefore is predicted to have positive changes on managerial practices for watershed health.

Illicit Discharge Monitoring – Monitoring municipal separate storm sewer effluence in order to detect any discharge that is not composed entirely of storm water, except for discharges allowed under an NPDES permit or waters used for firefighting operations.

***M**ichigan 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.

MDNR HAP – The Michigan Department of Natural Resources Hunting Access Program. This program where MDNR leases private lands throughout southern Michigan for public hunting.

***N**est destruction* – Properly timed nest destruction of nuisance bird species (e.g. Canada geese, Mute swans). Research studies show that nest destruction encourages many affected adult geese to migrate out of urban areas. The Department of Natural Resources oversees a Canada goose nest destruction program, which is designed to decrease human-goose conflicts in eligible metropolitan sites in southern Michigan. The nest destruction program allows for goose nest destruction under a special permit issued by the DNR.

Non-motorized Transportation Grants – grant funding for improvements to non-motorized paths, promotion of bike mobility and beautification of streetscapes.

Nutrient Management – Managing the amount, source, placement, form, and timing of the application of nutrients and soil amendments.

***O**pen Land Wildlife Management* **–** A suite of NRCS practices that help restore open land wildlife habitat.

Open Space Easement – A restriction placed on a parcel of land in a predominantly open and undeveloped condition that is suitable for any of the following: natural areas; wildlife and native plant habitat; important wetlands or watershed lands; stream corridors; passive, low-impact activities; little or no land disturbance; and/or trails for non-motorized activities. The easement is either voluntarily donated or sold by the landowner and constitutes a legally binding agreement that limits certain types of uses or prevents development from taking place on the land in perpetuity while the land remains in private hands.

Open Space Preservation **–** Open space preservation supports smart growth goals by bolstering local economies, preserving critical environmental areas, improving our community's quality of life, and guiding new growth into existing communities.

***P**DR* **–** Purchase of Development Rights (PDR) is a voluntary program, where a land trust or some other agency usually linked to local government, makes an offer to a landowner to buy the development rights on a farm or other parcel of land. Once an agreement is made, a permanent deed restriction is placed on the property which restricts the type of activities that may take place on the land in perpetuity. In this way, a legally binding guarantee is achieved to ensure that the parcel will remain agricultural or as open space forever.

Pest Management **–** Utilizing environmentally-sensitive prevention, avoidance, monitoring, and suppression strategies to manage weeds, insects, diseases, animals, and other organisms (including invasive and non-invasive species) that directly or indirectly cause damage or annoyance.

Phosphorus Ordinance – A municipal regulation that prohibits or restricts the amount of manufactured phosphorus fertilizer to be used or sold within the municipality boundary.

Porous Pavement – An alternative to conventional asphalt, porous pavements uses a variety of porous media, often supported by a structural matrix, concrete grid, or modular pavement. The media allow water to percolate though the pavement to a sub base for gradual infiltration into the underlying soil.

Prescribed Grazing – Prescribed grazing is the controlled harvest of vegetation with grazing or browsing animals, managed with the intent to maintain or improve water quality and quantity. For example, on grazed forest, native pasture, or rangeland, grazing is limited so that the grazing animals will consume no more than 50 percent (by weight) of the annual growth of high or medium preferred grazing species.

***R**ain garden* – A rain garden is a planted depression that is designed to absorb rainwater runoff from impervious urban areas like roofs, driveways, walkways or compacted lawn areas.

Recessed Parking Lot Landscape Islands – A low-impact development practice that integrates the absorption of parking lot runoff into landscape islands. Commonly known as "bioretention" areas, these landscaped islands treat stormwater using a combination of microbial soil process, infiltration, evaporation, and appropriate plantings. Instead of the typical landscape islands that are set higher than paved grade (and which often require supplemental irrigation), these "biofiltration" or wetland landscape islands are recessed, and the pavement is graded so that surface flow is into, rather than away from, these areas ("Multi-Functional Landscaping: Putting Your Parking Lot Design Requirements to Work for Water Quality".

Recycling – To extract useful materials from garbage or waste.

Revegetation – To cause (eroded land, for example) to bear a new cover of vegetation.

Riparian Forest Buffer – An area of predominantly trees and/or shrubs located adjacent to and up-gradient from watercourses or water bodies.

***S**ediment barriers* – A barrier erected to intercept and detain small amounts of sediment from disturbed areas of limited extent in order to prevent sediment from leaving a construction site

Septic Management Point-of-Sale Ordinance – A regulation that requires the inspection and evaluation of septic systems and/or wells before any residential home property is transferred (Ingham County Sanitary Code, Chapter VII, Regulation # 06109, SECTION 701).

Septic Management Workshop – A workshop aimed at offering instruction, information and education on the problems that septic tanks can have in a watershed as well as the importance of regular maintenance.

Sewage maintenance – A suite of practices that help maintain proper function and prolong the life of individual septic systems. These practices involve elements of water conservation, careful landscaping and septic tank pumping. In the case of campgrounds and other public recreational facilities with closed sewage systems, a more frequent and stringent maintenance routine may be appropriately adopted.

Shoreline Stabilization – a suite of erosion control practices implemented on a lake shoreline to stabilize and prevent future shoreline erosion. Shoreline stabilization may involve structural (shoreline armoring, terracing, erosion control blankets, etc.) or vegetative (bioengineering) methods. Vegetation can either be planted or allowed to colonize naturally. *See "bioengineering" and "stream bank stabilization" definitions.*

Silt Fence – A temporary sediment barrier made of woven, synthetic filtration fabric supported by either wood or steel posts.

Site visit – A visit in an official capacity to examine a site to determine its level of surface water contamination potential.

Sign maintenance – Installation, repair or replacement of Watershed Project I/E signs. This may also involve some brush/vegetation clearing to a limited extent.

Signage – The design and use of signs and symbols for the purpose of proliferating Watershed Project I/E.

Soil Erosion and Sedimentation Control trainings/workshops – Training offered to local land excavators, developers and contractors on the MDEQ's Soil Erosion and Sedimentation Control Program. This program regulates the pollution of Michigan waters by improper construction site management practices. Trainings offered will include current regulations, special provisions and best management practices.

Soil testing – A method of measuring the pH of and the nutrients in the soil.

Stormwater flow monitoring – A system of measuring and recording the rate of flow, pressure, or discharge of a fluid in a municipal storm sewer system.

Stormwater Ordinance – A municipal regulation that ensures stormwater BMP designs facilitate easy maintenance and that regular maintenance activities are completed.

Stream cleanup – A stream cleanup involves volunteers walking or paddling stream channels, collecting trash and recording any relevant information (resource concerns, trash quantities, etc).

Stream bank Stabilization – Stream channel stabilization means stabilizing the channel of a stream with suitable structures to prevent erosion or siltation of the channel. A channel is considered stable if, the channel bottom remains essentially at the same elevation over long periods of time. Stream channel stabilization methods include modifying the channel capacity, channel armoring (riprap lining), providing channel crossings for livestock, and seeding (vegetating or planting the channel to prevent erosion). Stream bank protection helps to prevent stream bank erosion. Stream bank protection methods are essentially the same as stream channel stabilization methods. They include modifying the channel capacity, channel armoring (riprap lining), providing channel crossings for livestock, and seeding (vegetating or planting the channel to prevent erosion).

Street Sweeping – Weekly street sweeping of problematic areas or "pollution hot spots" is performed to remove contaminants, sediment, and debris from roadways before they have a chance to wash away in storm water runoff.

***T**ranslocation* – A change in location. In terms of this WMP, translocation refers to moving of Canada geese to a predetermined location by MDNR. Translocation takes place after geese are collected via a MDNR approved goose roundup.

Tree Advisory Board – A Tree Advisory Board coordinates with other government agencies, non -profit groups, and the public concerning tree related activities and issues. This Board is also responsible for applying for grants for reforestation and management purposes as they relate to goals and objectives of local Parks and Recreation plans.

Two-stage Ditch – An alternative stream channel designed developed by observing natural processes that form stable streams and rivers. The design incorporates a floodplain zone, called benches, into the ditch by removing the ditch banks roughly 2-3 feet about the bottom for a width of about 10 feet on each side. This allows the water to have more area to spread out on and decreases the velocity - or energy - of the water. The flow of that water is a function of the velocity and area of the water. And since flow can be considered as the amount of water moving through the ditch, the design has actually increased the amount of water that the ditch can process by constructing the benches, or floodplain area. This not only improves the water quality, but also improves the biological conditions of the ditches where this is located.

***U**S Army Corp of Engineers Ecosystem Restoration and Management* – A suite of programs offered by the Army Corp that provide responsive, tactical and state of the art restoration technologies for water resource development activities. These programs include the Ecosystem Management and Restoration Research Program, the Wetlands Regulatory Assistance Program and the Wetlands Restoration Program. Ecosystem Restoration and Management is targeted toward ecosystems of particular concern to the Corps, namely: streams, riparian corridors, wetlands, and special aquatic sites.

USFWS Small Wetlands Program – Created in 1958 with an amendment to the 1934 Migratory Bird Hunting Stamp Act *(commonly referred to as the Duck Stamp Act)* the Small Wetlands Program administered by the US Fish & Wildlife Service utilizes funds from the sale of Federal Duck Stamps to permanently protect waterfowl production areas.

***W**aste Management* – Waste management systems comprise a variety of best management practices (BMPs) or combination of BMPs used at concentrated animal feeding operations (CAFOs) and farms to manage animal waste and related animal by-products. These systems include engineered facilities and management practices for the efficient collection, proper storage, necessary treatment, transportation, and distribution of waste. The BMPs are designed to reduce the discharge of nitrogen, phosphorus, pathogens, organic matter, heavy metals (such as zinc, copper, and occasionally arsenic, which are present in many animal rations), and odors. Example facilities and management methods are holding ponds, waste treatment ponds, composting, and manure management and land application.

Waste receptacle **–** A container where waste products can be discarded or held for further use.

Waste Storage Facility – A waste storage facility is an impoundment made by constructing an embankment or excavating a pit or dugout, or by fabricating a structure.

Watering Device **–** A device (tank, trough, or other watertight container) for providing animal access to water.

Wet Swale **–** A broad, open channel capable of temporarily storing water (approximately 24 hrs). Similar to a dry swale, wet swales use vegetation to treat stormwater runoff through the settling of suspended solids, microbial breakdown of nutrients and adsorption. Unlike the dry swale, a wet swale does not have an underlying filtering bed. Wet swales can serve as part of a stormwater drainage system can replace curbs, gutters and storm sewer systems (Minnesota Small Site BMP Manual, 3, Metropolitan Council & Barr Engineering Co).

Wetland Creation – A wetland created on a site which historically was not a wetland or is a wetland but the site will be converted to a wetland with a different hydrology, vegetation type, or function than naturally occurred on the site.

Wetland Detention – Wetland detention uses a detention basin planted with wetland vegetation. The wetland vegetation improves the quality of storm water released from the basin more effectively than dry detention and typical wet detention because the wetland vegetation reduces nutrients like nitrate nitrogen and phosphorus by as much as 90 percent, and settling and mechanical filtration by wetland plants also reduce suspended solids and turbidity.

Wetland Restoration – A rehabilitation of a degraded wetland or the reestablishment of a wetland so that soils, hydrology, vegetative community, and habitat are close approximation of the original natural condition that existed prior to modification to the extent practicable.

Woody Debris Removal – The process of determining whether to move, remove or add woody debris in a river and how best to do that work. The Clean and Open Method of Woody Debris Management has been specifically developed to give guidance on how to manage logjams, preserving the benefits they provide while minimizing the problems they can create (Woody Debris Management 101, Riparian Corridor Management Technical Advisory Committee, 4-20-2004).

WRP – A voluntary program offering landowners incentives to protect, restore, and enhance wetlands on their property. The USDA-NRCS provides technical and financial support to help landowners with their wetland restoration efforts. The NRCS goal is to achieve the greatest wetland functions and values, along with optimum wildlife habitat, on every acre enrolled in the program. This program offers landowners an opportunity to establish long-term conservation and wildlife practices and protection.

Appendix A

Social Monitoring of the Watershed Community
Final Report

1. Background

As a way of gaining public feedback on water quality concerns, watershed awareness and desired watershed uses for the Hodunk-Messenger watershed, a social monitoring exercise was conducted on a sample group of watershed residents during the early stages of the Hodunk-Messenger Chain of Lakes Watershed Planning Project. The selected method of social monitoring in this case was survey, or questionnaire, administered through the mail. The survey method was deemed appropriate for assessing the current level of awareness and knowledge amongst the general watershed population in regards to nonpoint source (NPS) pollution and basic fundamentals of a watershed. As a result, the survey also offered an opportunity for individuals to provide written feedback on their current priority uses and priority concerns for the watershed.

2. Description of Analysis

The overall goals that were expected to be achieved through the social survey project are:

1.) Obtain current attitudes toward the level water quality present in the watershed today, and
2.) Establish a baseline characterization of the community's NPS pollution awareness and watershed knowledge.

To achieve these goals, a 21-question survey was developed. Questions varied in format (multiple choice, short answer, true/false), but were all phrased in ways that would elicit clear and conclusive answers on the following issues:

- public knowledge of watershed fundamentals, the hydrologic cycle and basic NPS concepts
- priority activities and priority land uses in the watershed
- changes in the quality of outdoor recreation within the watershed
- level of concern for water quality
- public perception of whom is responsible for natural resource protection
- public awareness and level of concern for invasive species within the watershed
- a demographic breakdown of the number of farm owners that responded to the survey
- individual waste water system awareness

With guidance and oversight from MDEQ Water Bureau and MDEQ Environmental Science and Services Division, Branch County Conservation District (BCCD) was the primary party responsible for the development and administration of the social survey.

3. Methodology

According to 2000 census data, approximately 24,908 people live within the delineated Hodunk-Messenger Watershed boundary. In order to acquire sufficient enough information to accurately represent the entire watershed community, sample size for the survey was based upon a 5% confidence interval (CI). A sample size of 378 was needed in order to achieve this desired 5% CI (or margin of error) with a 95% confidence level (indicates that the sample group would accurately represent any sample size of the watershed population 95% of time).

To ensure enough surveys were returned for analysis, the sample size was multiplied by 4 to allot for an assumed 25% return rate. A mailing list of all address points within the watershed boundary was generated by the Branch County GIS Department. A database of 6,189 address points was created in this process (averages 4 people per address). The 1,512 surveys that would be necessary for a 5% CI were then selected at random from the master list of 6,189 households and businesses. Random and unbiased selection of addresses was achieved by selecting every fourth address from an alphabetical list of names.

A questionnaire was then developed, printed and uniformly stuffed into personally addressed envelopes with an included watershed map and letter explaining the purpose of the survey. The questionnaire consisted of 21 questions that inquired into the public's knowledge of NPS pollution, watershed fundamentals, priority watershed activities and current watershed concerns. The social survey was administered through the mail and required return correspondence. Return envelopes with appropriate postage were included in the mailing for this purpose. All surveys were mailed en mass on the same day in order to ensure a uniform time allotment for watershed residents to complete the survey. Likewise, all survey recipients were required to return the completed surveys to the BCCD Office by the same date (roughly 5 weeks after the initial mailing).

To insure uniformity and control the quality of data collected, a Quality Assurance Project Plan (QAPP) was developed by the Watershed Project Coordinator and approved by MDEQ prior to the development of the survey. Prior to distribution, the questionnaire underwent reviews by MDEQ, USDA-Natural Resources Conservation Service (NRCS) and BCCD staff. The purpose of this was to ensure the survey was unbiased, clear and objective. There was no sub-sample population that was surveyed prior to the mass-mailing.

Once returned, questionnaire responses were tallied and compiled by the Watershed Project Coordinator into both Excel and Access format databases for record keeping and analysis. These results were later subject to further observation and statistical analysis by the Watershed Project Advisory Council as well as by the MDEQ NPS program. Any relevant correlations between questionnaire results are listed in the "conclusions" section.

4. Results

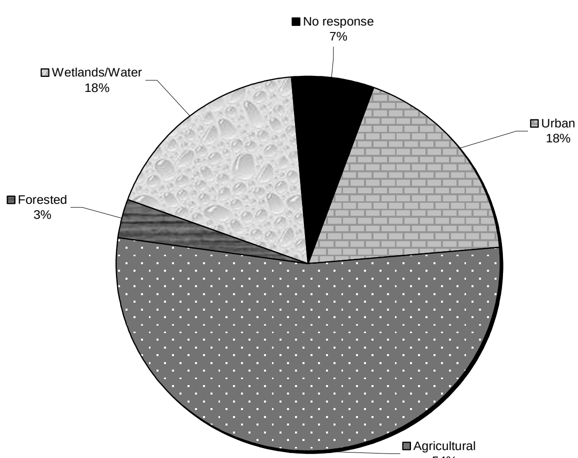
Out of the 1,512 surveys administered, 237 ended up being returned (15.6%). Of these 237, three of them were returned unanswered with comments explaining why the respondent declined to participate in the survey. Only two unopened envelopes were returned for having incorrect addresses. Based on the number of responses, the results of this survey are thought to be significant enough to justify creating a long-term Information/Education Strategy based on the findings.

Survey response data for every question in the survey has been compiled in to both tabular and graphical representations below:

QUESTION 1:

The land area in the North Chain of Lakes Watershed is predominately:	Urban	Agricultural	Forested	Wetlands/Water	No response
	46	137	8	46	18

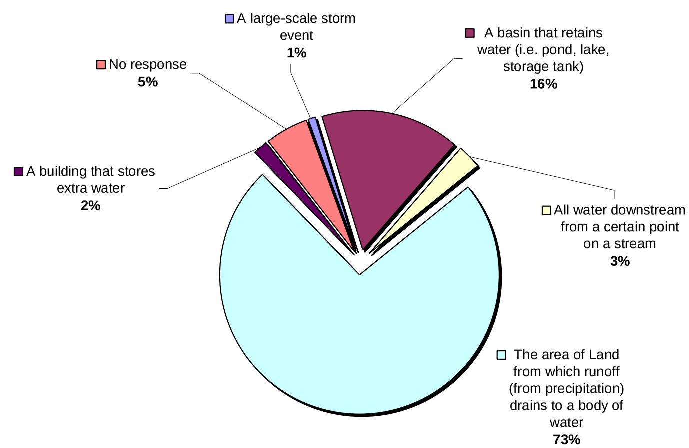
Question 1: **The land area in the North Chain of Lakes is predominately:**



QUESTION 2:

A watershed can best be defined as:	A large-scale storm event	A basin that retains water (i.e. pond, lake, storage tank)	All water downstream from a certain point on a stream	The area of Land from which runoff (from precipitation) drains to a body of water	A building that stores extra water	No response
	2	39	7	178	4	12

Question 2: **A watershed can best be defined as:**

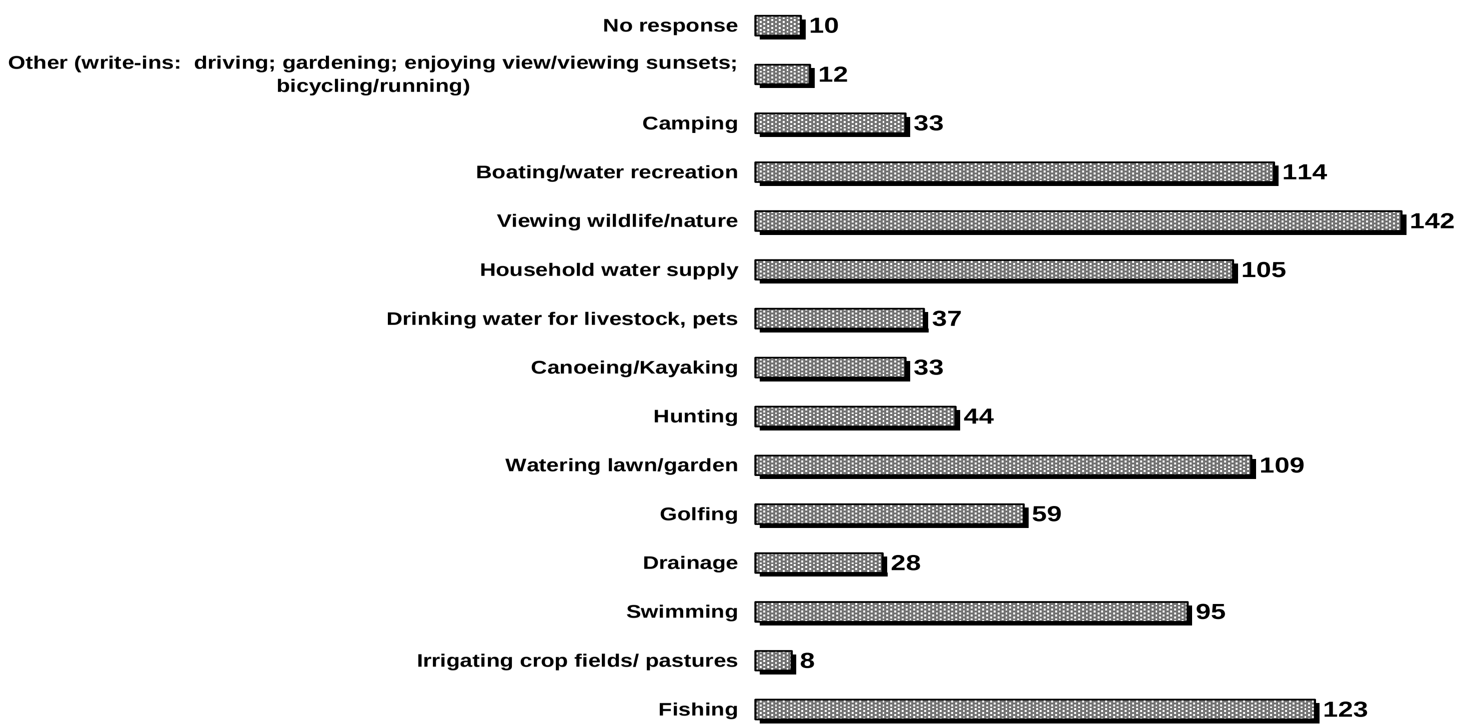


QUESTION 3:

From the list of activities below, please select all activities within the North Chain of Lakes Watershed that you engage in.	Fishing	Irrigating crop fields/ pastures	Swimming	Drainage	Golfing	Watering lawn/garden	Hunting	Canoeing/Kayaking
	123	8	95	28	59	109	44	33

Drinking water for livestock, pets	Household water supply	Viewing wildlife/ nature	Boating/ water recreation	Camping	Other (write-ins: driving; gardening; enjoying view/viewing sunsets; bicycling/running)	No response
37	105	142	114	33	12	10

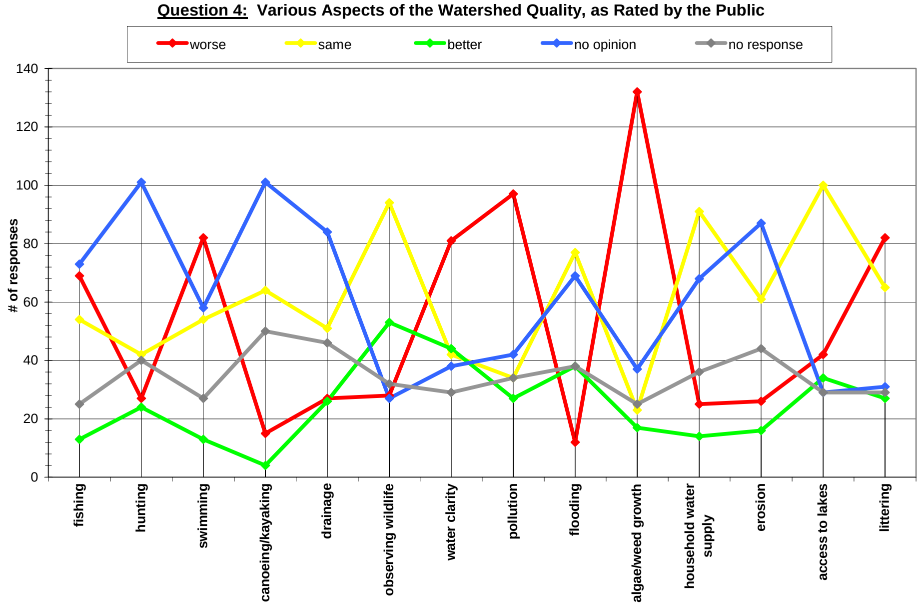
Question 3: Priority Activities within the Watershed



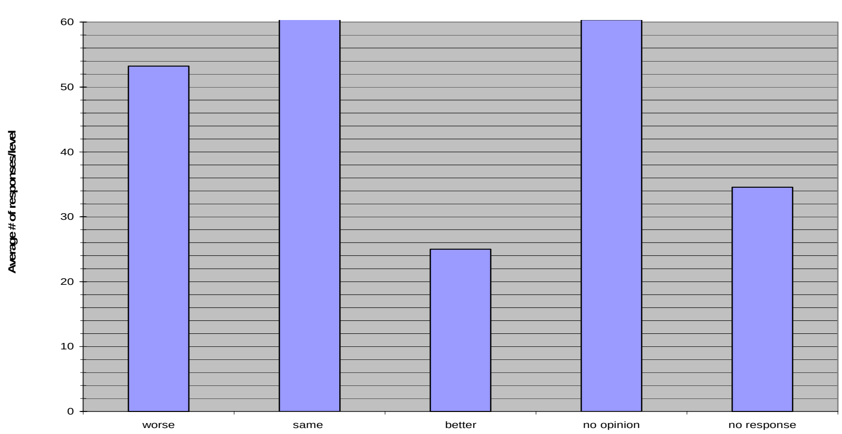
QUESTION 4:

	worse	same	better	no opinion	no response
fishing	69	54	13	73	25
hunting	27	42	24	101	40
swimming	82	54	13	58	27
canoeing/kayaking	15	64	4	101	50
drainage	27	51	26	84	46
observing wildlife	28	94	53	27	32
water clarity	81	42	44	38	29
pollution	97	34	27	42	34
flooding	12	77	38	69	38
algae/weed growth	132	23	17	37	25
household water supply	25	91	14	68	36
erosion	26	61	16	87	44
access to lakes	42	100	34	29	29
littering	82	65	27	31	29

Question 4: Various Aspects of the Watershed Quality, as Rated by the Public



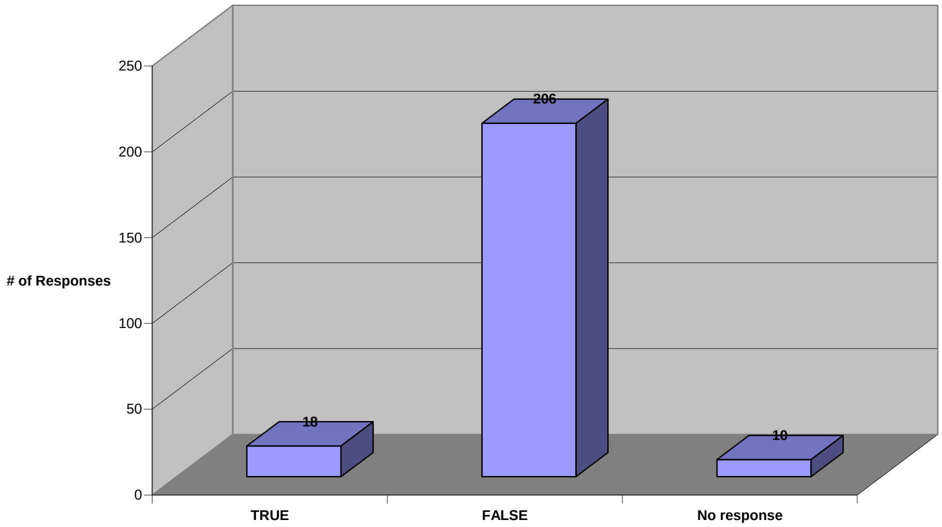
Overall Trend in Watershed Quality



QUESTION 5:

Fresh water is an unlimited natural resource	TRUE	FALSE	No response
	18	206	10

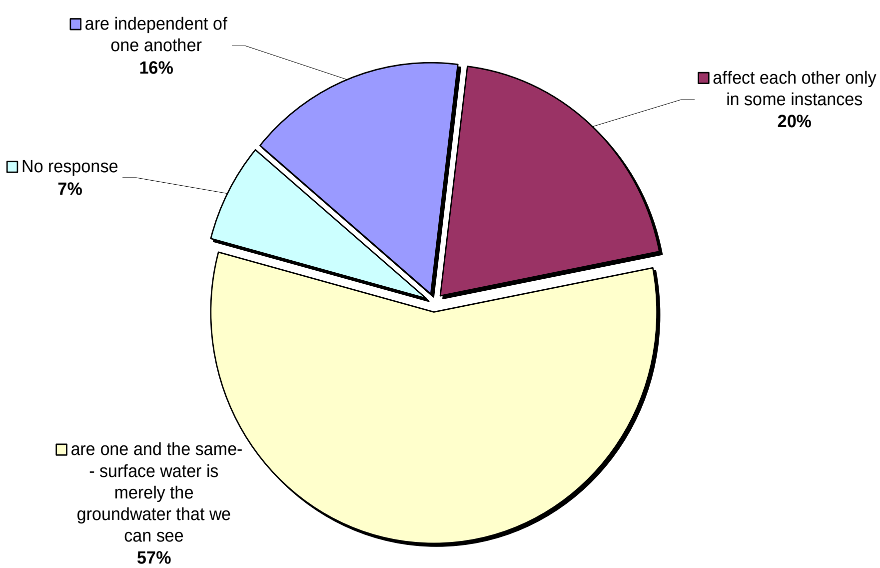
Question 5: **Fresh Water is an Unlimited Resource?**



QUESTION 6:

Ground water and surface water...	are independent of one another	affect each other only in some instances	are one and the same-- surface water is merely the groundwater that we can see	No response
	38	48	137	17

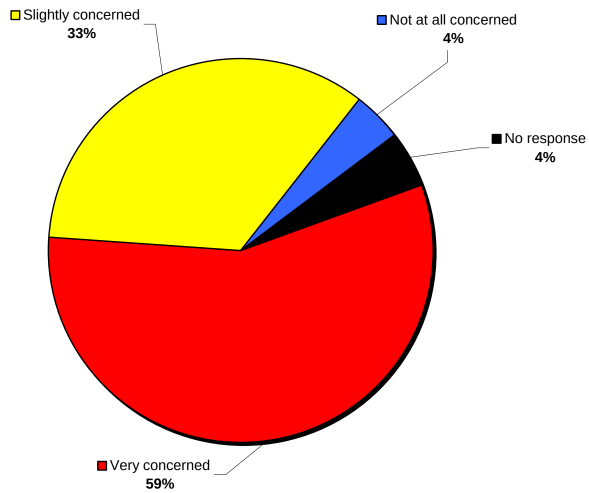
Question 6: **Groundwater and Surface Water...**



QUESTION 7:

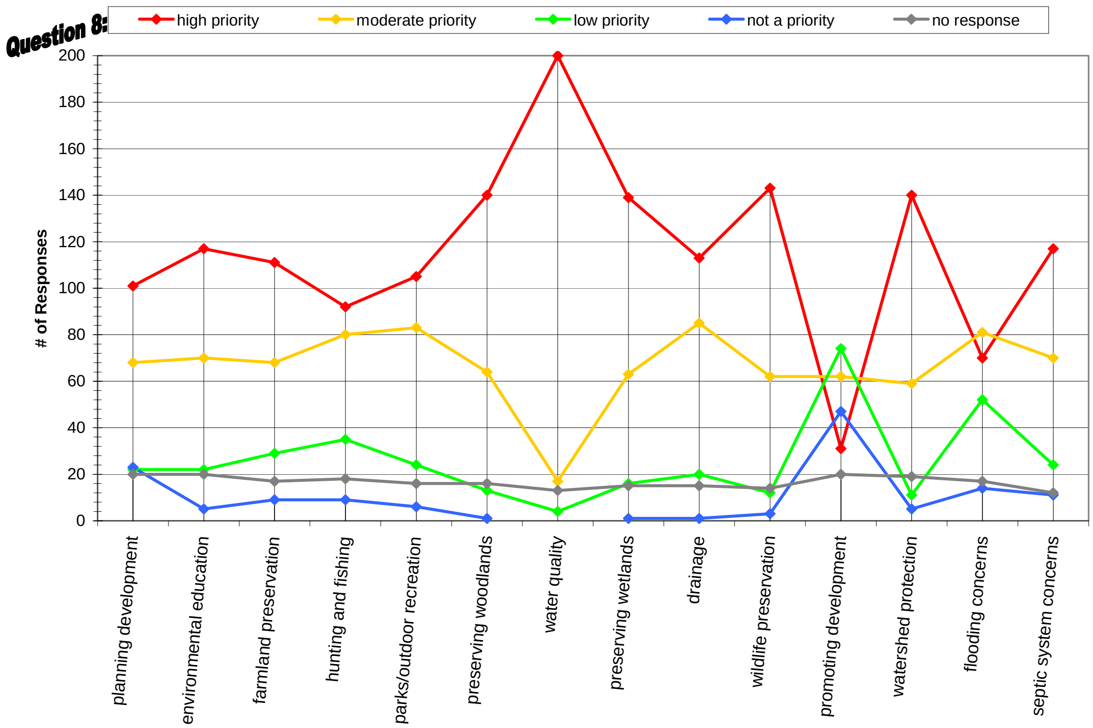
Level of concern for the water quality of the North Chain of Lakes and its tributaries:	Very concerned	Slightly concerned	Not at all concerned	No response
	132	80	10	11

Question 7: Rate Your Level of Concern for the Water Quality in the North Chain of Lakes and its Tributaries



QUESTION 8:

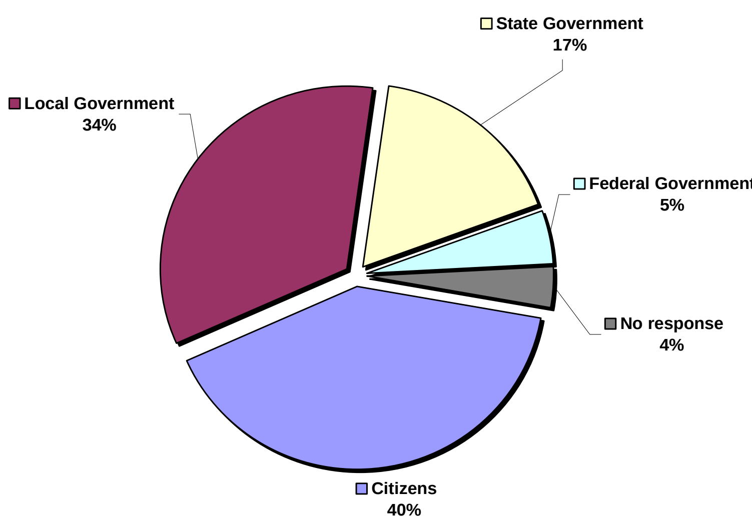
	high priority	moderate priority	low priority	not a priority	no response
planning development	101	68	22	23	20
environmental education	117	70	22	5	20
farmland preservation	111	68	29	9	17
hunting and fishing	92	80	35	9	18
parks/outdoor recreation	105	83	24	6	16
preserving woodlands	140	64	13	1	16
water quality	200	17	4		13
preserving wetlands	139	63	16	1	15
drainage	113	85	20	1	15
wildlife preservation	143	62	12	3	14
promoting development	31	62	74	47	20
watershed protection	140	59	11	5	19
flooding concerns	70	81	52	14	17
septic system concerns	117	70	24	11	12



QUESTION 9:

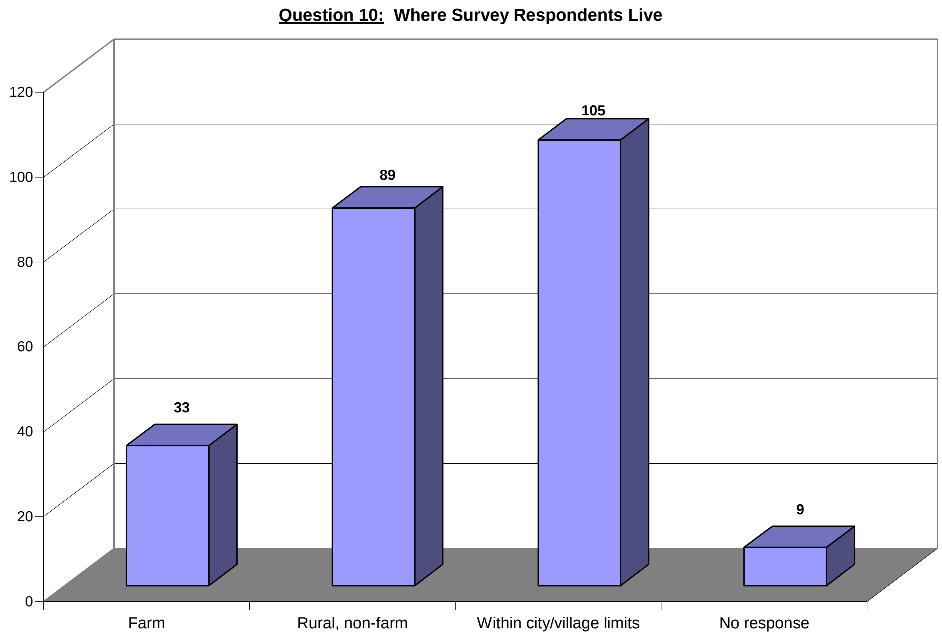
Who is primarily responsible for protecting the water quality in the North Chain of Lakes Watershed?	Citizens	Local Government	State Government	Federal Government	No response
	126	105	53	15	11

Question 9: Who's Primarily Responsible for Protecting the Water Quality in the Watershed?



QUESTION 10:

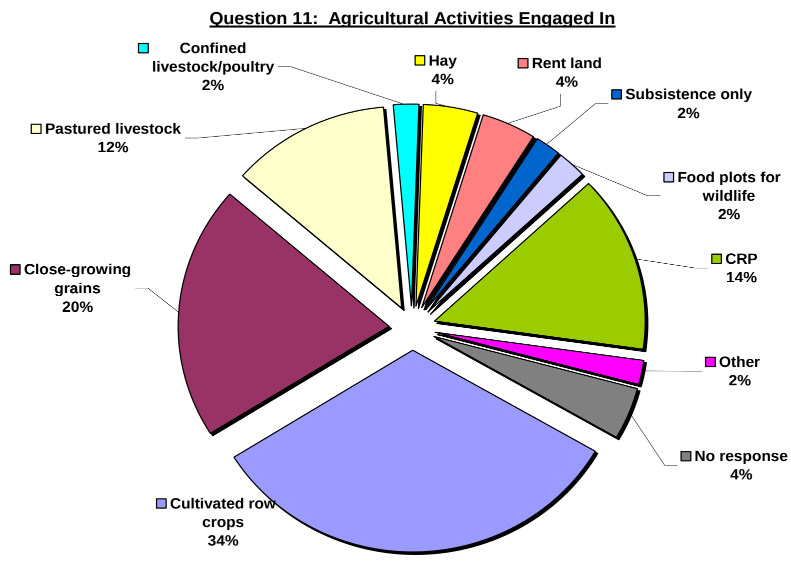
Where do you live?	Farm	Rural, non-farm	Within city/village limits	No response
	33	89	105	9



QUESTION 11:

What type of agricultural activities do you engage in?	Cultivated row crops	Close-growing grains	Pastured livestock	Confined livestock/poultry	Hay	Rent land
	16	10	6	1	2	2

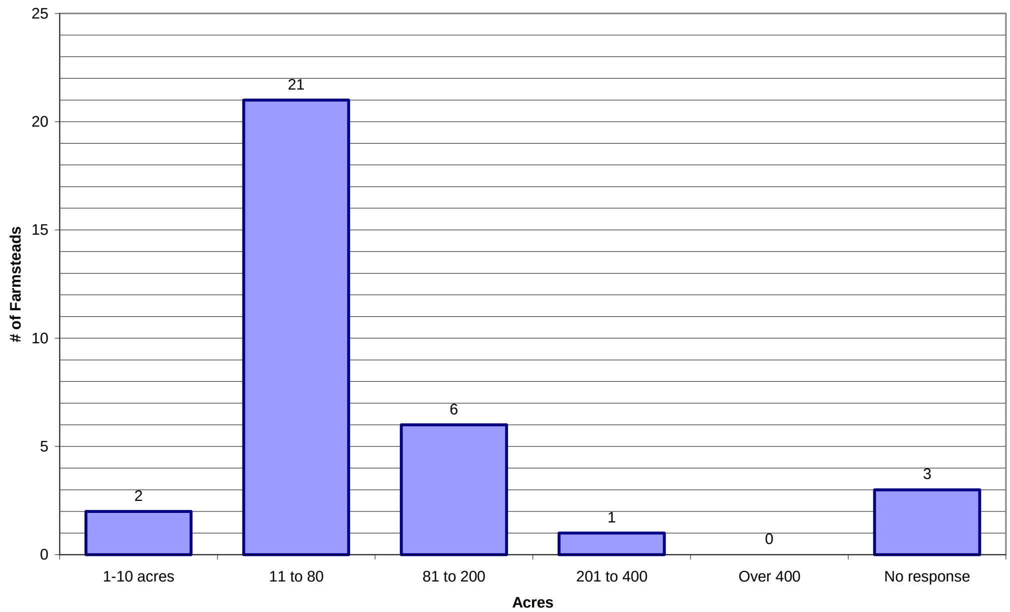
Subsistence only	Food plots for wildlife	CRP	Other	No response
1	1	7	1	2



QUESTION 12:

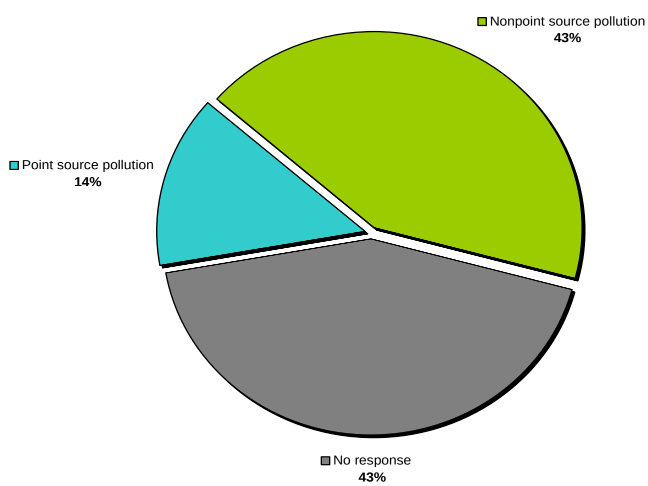
How many acres is your farmstead?	1-10 acres	11 to 80	81 to 200	201 to 400	Over 400	No response
	2	21	6	1	0	3

Question 12: Size of the Farms that Responded



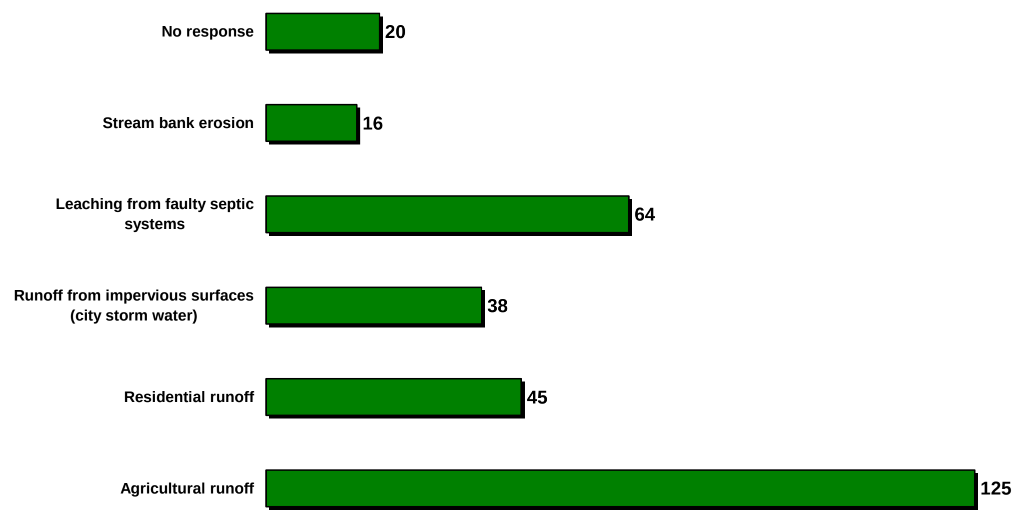
QUESTION 13: **What is the bigger contributor of pollution to the North Chain of Lakes Watershed?**	Point source pollution	Nonpoint source pollution	No response
	33	101	101

Question 13: Biggest contributor of pollution to the North Chain of Lakes Watershed?



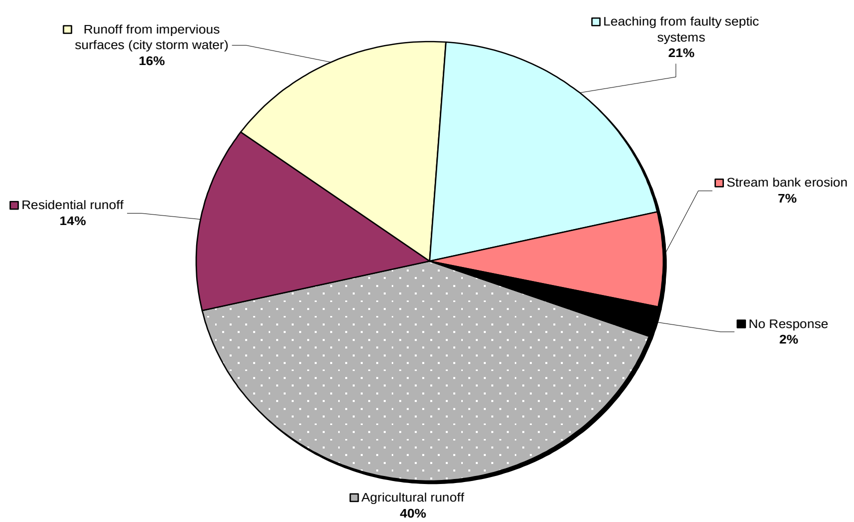
QUESTION 14: **What would you consider the leading source of nonpoint source pollution in the watershed?**	Agricultural runoff	Residential runoff	Runoff from impervious surfaces (city	Leaching from faulty septic	Stream bank erosion	No response
	125	45	38	64	16	20

Question 14: **Leading Source of Nonpoint Source Pollution in the Watershed**



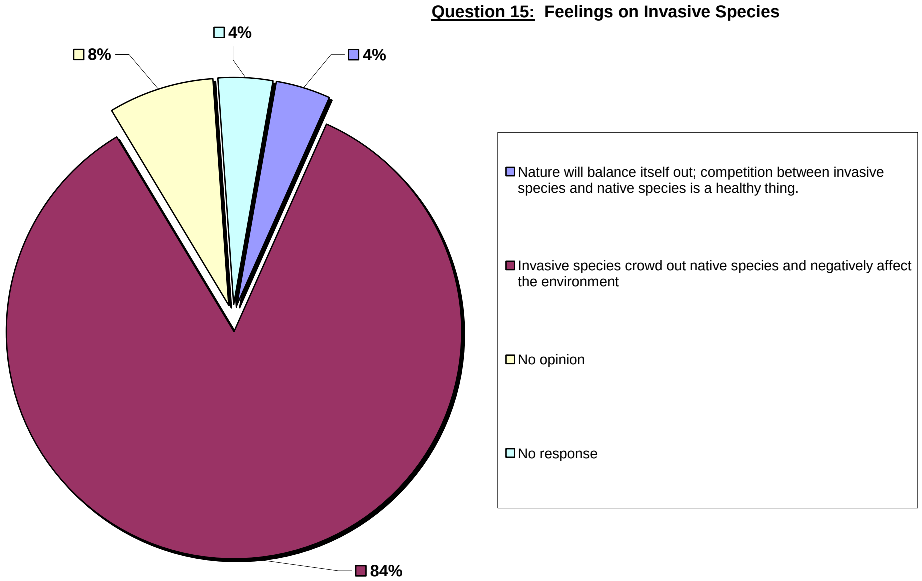
Farmers' opinions of biggest nonpoint source polluter	Agricultural runoff	Residential runoff	Runoff from impervious surfaces (city storm water)	Leaching from faulty septic systems	Stream bank erosion	No Response
	18	6	7	9	3	1

Farmers' Opinions of Biggest Nonpoint Source Pollution



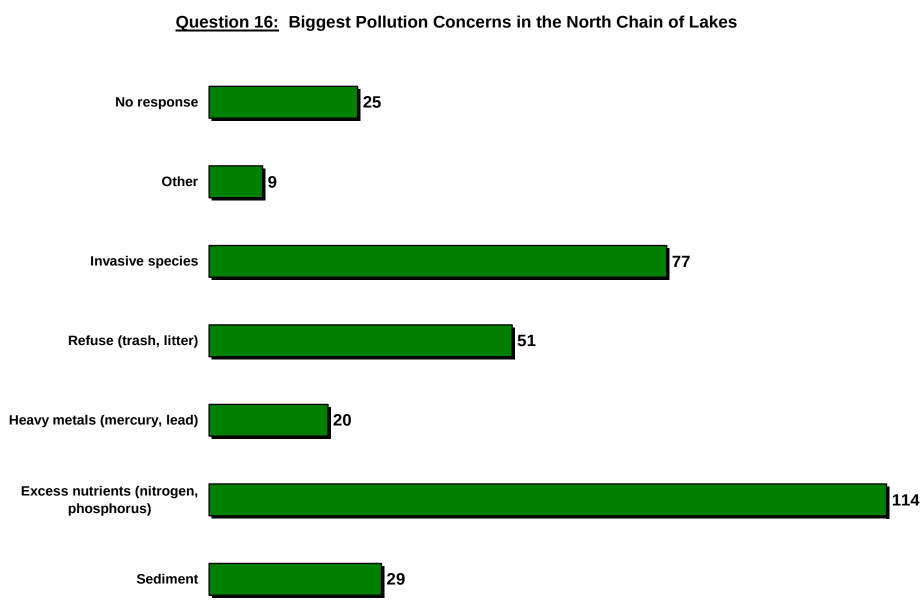
QUESTION 15:

Your thoughts on invasive species?	Nature will balance itself out; competition between invasive species and native species is a healthy thing.	Invasive species crowd out native species and negatively affect the environment	No opinion	No response
	9	199	18	9



QUESTION 16:

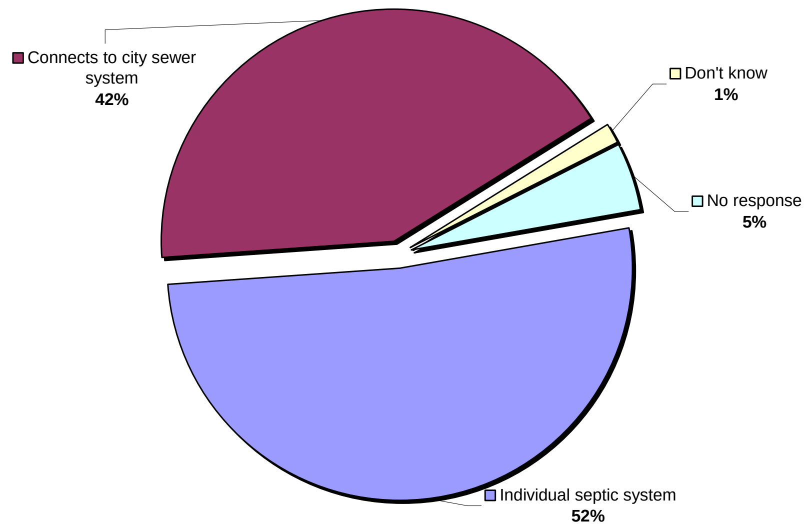
Which is the bigger pollution concern in regards to the North Chain of Lakes?	Sediment	Excess nutrients (nitrogen, phosphorus)	Heavy metals (mercury, lead)	Refuse (trash, litter)	Invasive species	Other	No response
	29	114	20	51	77	9	25



QUESTION 17:

Where does your home waste water go?	Individual septic system	Connects to city sewer system	Don't know	No response
	121	99	3	11

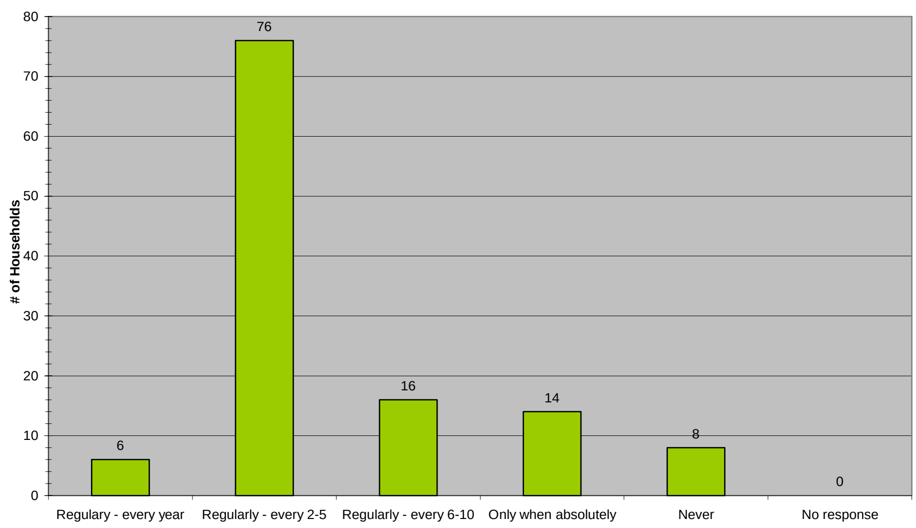
Question 17: Waste Water Systems of People Surveyed



QUESTION 18:

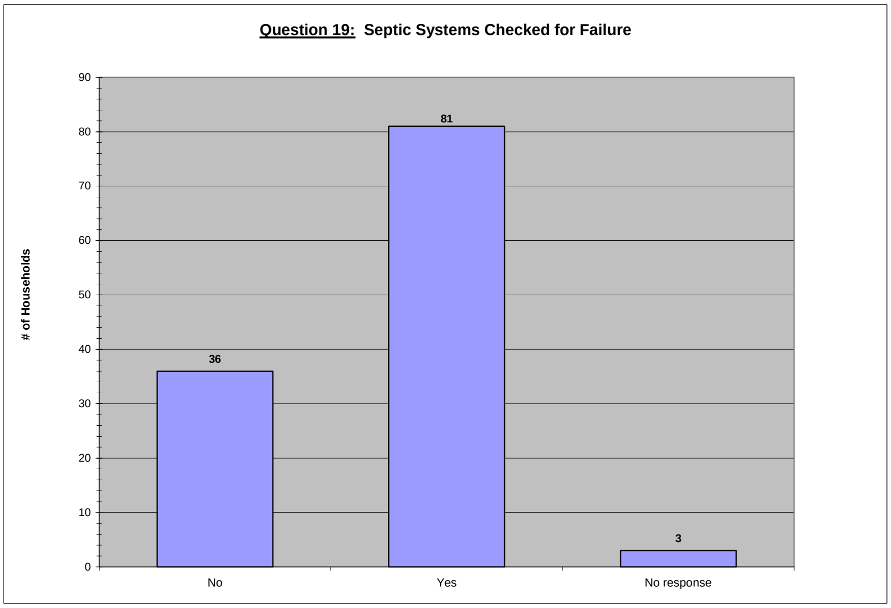
How often do you have your septic system pumped/maintained?	Regularly - every year	Regularly - every 2-5 years	Regularly - every 6-10 years	Only when absolutely necessary	Never	No response
	6	76	16	14	8	0

Question 18: Frequency of Septic Systems getting pumped/maintained



QUESTION 19:

Have you ever had your system checked to see if it's failing?	No	Yes	No response
	36	81	3



QUESTION 20:

Are you aware of the location of your septic storage tank?	Yes	No	No response
	118	2	0

QUESTION 21:

Additional Concerns Written in by Survey Respondents

- Mowing to edge of waterline/lack of vegetative borders/buffers (x 4)
- Excess fertilizer from Coldwater Golf Club
- Swan & Goose overpopulation
- Deer overpopulation
- Human overpopulation (x 3)
- Low water levels (x 2)
- Gas/oil leaks from watercraft (x 3)
- Boaters littering on lakes
- Introduction of invasives by boat (x 2)
- Loosing Zebra Mussels
- Waterfowl waste (x 4)
- In need of sewer system for lakes (x 6)
- Issues related to accelerated eutrophication (i.e. weeds/sediment filling in the lakes) (x 7)
- Lake of information about the Watershed Project
- Fires
- Negative effects of power boat/jet ski traffic/overuse (x 7)
- Excessive number of campgrounds
- (Negative effect of) Bass tournaments (x 2)
- CAFOs (Concentrated Animal Feeding Operations)
- Chemical weed treatment of Lakes (x 4)
- Pet waste
- Drainage tube on Paradise Island
- Inadequate public access to Lakes (x 3)
- Campers' waste
- Too many people harvesting weeds
- Not enough people harvesting weeds
- Swimmers' Itch
- In need of new/better research/plan for Lakes (x 3)
- Dead fish w/ sores, fish virus (x 2)
- Ag. Chemicals/antibiotics
- "Green water" in canals
- Need to dredge Lakes (x 4)
- Quality resources for future generations

- Groundwater contamination through over-fertilization near well-head
- Storing contaminants outside
- Rust in water
- Muddy Mud Creek
- Out of state pollution being brought in (x 2)
- Noise pollution
- Debris in yards
- Loss of native species
- Loosing fishing line/hooks on weeds
- Stench created from harvested weeds
- Irrigation depleting water supply
- Purity of groundwater supply
- Dredge Sauk River
- Open up Damn to Sauk River
- Shoreline weeds

6. Conclusions

Based on the results of the social survey, several correlations in responses have been observed. The following conclusions have been made about public perceptions and the level of watershed knowledge in the Hodunk-Messenger Chain of Lakes Watershed:

Question 4 provided a glimpse into the public's perception of overall watershed quality. By taking the average number of responses to each watershed aspect for each quality rank, an overall trend in watershed quality (Section 5, page A-5) was observed. Through this method it was determined that overall watershed residents have either no opinion on watershed quality or think that it has historically remained the same. The third highest response was that watershed quality had gotten worse over the years. The lowest scoring opinion was that it has gotten better.

Question 13 of the survey asked residents what they perceived to be the biggest contributor of pollution: point source or nonpoint source. 43% of survey recipients did not provide an answer to this question. This may be an indication that many people do not know what point or nonpoint source pollution is. It will be important for the Information/Education (I/E) Strategy to incorporate this finding, making sure that some effort is taken to explain what NPS pollution is, (and that it is the nation's largest water quality problem).

Question 14 showed an interesting result when it came to the responses of farmers. Farmers overwhelmingly say that agricultural runoff is the largest problem in the watershed; whereas the survey as a whole has a standard deviation[3] for that question. This correlation may suggest that farmers are fully aware of the impact they are having on the watershed and may be willing to adopt better management practices.

In general, residents feel that agricultural, residential and urban stormwater rainwater runoffs are the leading source of NPS pollution; with contaminant leaching from individual septic systems only receiving 14% of the responses. When coupled with *Question 18*, where 30% of individual septic system owners say that they clean it less regularly than recommend, this low level of awareness provides reason for making septic owners a target audience for I/E implementation activities. This is especially true for the farming community. For farmers that responded, only 59% say they clean their septic tanks regularly. Based on these findings, increasing the baseline understanding of the impacts of failing septics may go a long way in remedying some NPS pollution in some critical areas. A key component of the I/E strategy will be to develop a two-step education program that first discusses the problems that septic tanks can have in a watershed, and then follows up with the importance of regular maintenance.

Overall, people in the Hodunk-Messenger Watershed community seem to be unique in the sense that they clearly understand what a watershed is (based upon the overwhelming number of correct responses to *Question 2*). Based on this finding, an implementation I/E strategy will not need much time spent on general watershed education (except in the case of grade school students) and will instead focus on individual watershed stewardship, specific watershed impairments and the impact of NPS pollution.

[3] MDEQ NPS Program

Appendix B

Hodunk-Messenger Chain of Lakes Watershed

Water Quality Monitoring Plan

Branch County Conservation District

May 22, 2009

ASTI Environmental

Hodunk-Messenger Chain of Lakes Watershed
Water Quality Monitoring Plan
Branch County, Michigan

May 22, 2009

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This report has been completed as part of the North Chain of Lakes Watershed Project through the Branch County Conservation District. This initiative is designed to reduce erosion and nutrient enrichment, educate the public about water quality issues, and promote sustainable land use in target areas of the Hodunk-Messenger Chain of Lakes Watershed. For more information, visit www.branchcd.org.

TABLE OF CONTENTS

1.0 Introduction

In 2006, the Branch County Conservation District (BCCD) was awarded a Clean Water Act Section 319 planning grant to develop a Watershed Management Plan (WMP) for the Hodunk-Messenger Chain of Lakes in south central Michigan. The BCCD has developed a draft WMP, which contains more than 140 individual actions for implementation. As one element of continued watershed planning, the BCCD has decided that a long-term water quality monitoring program is needed to track progress toward water quality improvement goals over time and to provide educational opportunities for watershed residents. ASTI Environmental (ASTI) was contracted by the BCCD to develop a monitoring strategy.

ASTI developed the watershed monitoring plan recommendations contained within this report based upon discussions and a site investigation with the BCCD Watershed Coordinator, review of the draft WMP, Review of Michigan Department of Environmental Quality (MDEQ) water quality reports, and geographic information system (GIS) land use and land cover data for the watershed.

2.0 Recommendations

2.1 Sampling Locations

ASTI's recommendations for a network of sampling locations and parameters are summarized in Table 1. In accordance with discussions with BCCD staff, the monitoring plan was developed to provide a range of options for the number of locations and parameters sampled. Sampling locations are divided into primary and secondary sites (the 4^{th} and 5^{th} columns from the left, respectively, in Table 1).

The proposed sampling network ranges from 11 to 30 (or more) sampling locations. Sample locations were selected to provide ease of access from road crossings and, where possible, to coincide with sites for which other water quality or habitat data are available.

2.11 Core Program

ASTI recommends volunteer benthic macro-invertebrate collection at the 10 primary stream sites, coupled with bacteriological monitoring at Memorial Beach (11 sites total), as the core watershed monitoring program. The BCCD may choose to expand the sampling program from this basic core by adding sampling locations, by expanding the list of parameters sampled at each site, or a combination of both.

The core program of assessing macroinvertebrate populations, which integrate the effects of habitat and chronic water quality conditions, may be augmented by recording additional information regarding the physical conditions in the streams, such as temperature, pH, conductivity, and flow velocity and discharge. Water chemistry parameters may also be added.

2.12 Primary Sampling Locations

The sampling network of 10 primary stream sites (noted by a red check mark, Column 4, Table 1) is designed to (1) characterize the quality of the Coldwater and Sauk Rivers as they enter the

Hodunk-Messenger Chain of Lakes Watershed from other subwatersheds upstream and (2) to characterize tributary stream systems as they discharge to the chain of lakes. Memorial Beach on Messenger Lake, which has previously exhibited *Escherichia coli* (*E. coli*) bacteria concentrations in excess of state water quality standards, is also included as a primary sampling site; providing on-going monitoring of a known public health concern.

With the addition of basic water chemistry sampling the primary monitoring network may be expanded to 14 sites to provide a means of characterizing the quality of the lakes themselves. This additional monitoring may be conducted on either connecting channels between the lakes or by in-lake sampling and analysis (blue check marks, Column 4).

2.13 Secondary Sampling Locations

The number of sites monitored may be expanded as the program becomes more widely known and the cadre of volunteers grows. Secondary sampling locations have been selected, in part, to isolate tributary drainages. If downstream water quality is poor, these sampling stations may provide a means of systematically breaking the subbasins into smaller drainages to further isolate and identify pollution sources. In some cases, secondary sampling locations were selected to differentiate between dominant land use or land cover to measure their influence on the streams.

2.2 Sampling Parameters

Like the network of sampling locations, the list of sampling parameters may also be expanded based upon the sampling resources available, the desired level of effort, and the information desired.

2.21 Sampling Parameter Priorities

The recommended sequence of water chemistry parameters is noted in columns 12 through 25 of Table 1. Symbols of 1, 2, or 3 dots are used to indicate 1st, 2nd, and 3rd priority parameters, respectively. The prioritization is based upon a combination of the pollutant prioritization in the WMP as well as an assessment of which parameters provide the most new information while attempting to contain program analytical costs.

For example, both nitrogen and phosphorus are important nutrients in lakes. In freshwater lakes in this part of the country, phosphorus tends to be the limiting nutrient. Therefore sampling and analysis of phosphorus is a higher priority than various forms of nitrogen if the chief concern is plant and algae growth. Likewise, although ortho- (or soluble reactive) phosphorus is the form most readily used by aquatic plants, it is generally found at very low concentrations and sampling results can only really be evaluated if total phosphorus concentrations are also known. Indexes are available to characterize lake quality based upon Secchi disk transparency, total phosphorus concentrations, or chlorophyll *a* concentrations.

Each of the parameters noted above provides different information, but each allows a watershed manager to characterize lake quality. So, if choices have to be made based upon limited resources, the recommended order of parameters for the example here would be Secchi disk transparency measurements, followed by chemical analysis for total phosphorus, followed by ortho-phosphorus, followed by various forms of nitrogen. Which forms of nitrogen to analyze would be informed by the particular question of interest beyond plant and algae growth (e.g., toxicity to aquatic organisms, drinking water and human health, etc.).

3.0 Sampling Locations

Note: Local conditions such as access, safety, depth, backwater conditions, etc. may require some sites to be relocated. If sites do need to be replaced, the general rationale described below for the selection of each site may be used to identify alternative sampling stations nearby.

3.1 Miller Lake Drain Subwatershed

Recommended sampling locations throughout the watershed are listed in Table 1. Stream sampling locations within the Coldwater River and Miller Lake Drain Subwatershed, and sampling sites located on connecting channels between lakes within the chain of lakes, are shown in Map 1. Recommended lake sampling locations are pictured in Map 2.

Sampling Station ML1

Station 1 within the Miller Lake Drain Subwatershed (ML1) is located on the Coldwater River, south of the Hodunk-Messenger Chain of Lakes, at Garfield Road. Although outside the watershed boundary, this site is located at the nearest road crossing upstream of the point where the Coldwater River enters both the Hodunk-Messenger Chain of Lakes Watershed and South Lake and therefore is designated as a primary sampling location.

The MDEQ has water chemistry data for this site from 1980 and assessed habitat and macroinvertebrate assemblage quality here in 2000. This is one of the few sites within the immediate area with existing macroinvertebrate data, and therefore is important for comparing with volunteer data for quality assurance purposes.

Sampling Station ML2

Station ML2 is located on an unnamed tributary to South Lake, at Jay Street. Site ML3, located closer to South Lake captures the composite picture of this tributary system. Sampling at ML2 could help differentiate the effects of agricultural land uses upstream of ML2 from the commercial/industrial land use between ML2 and ML3. It is designated as a secondary sampling location.

Sampling Station ML3

Station ML3 is located at Race Street, on the same unnamed tributary as Station ML2. Station ML3 is located near the downstream end of this tributary system and, therefore, serves to characterize water quality inputs from this drainage to South Lake. It is designated as a primary sampling location.

Sampling Station ML4

Station ML4 is located on an unnamed tributary to Cemetery Lake at River Road. It is intended to characterize water quality inputs from this small tributary system to Cemetery Lake. However, because this tributary drainage is small and exhibits a largely intact forested riparian corridor, it is anticipated to exert little negative impact to Cemetery Lake. Station ML4 is therefore designated as a secondary sampling location.

Sampling Stations ML5 and ML6

Stations ML5 and ML6 are both located at Hodunk Road on the south and north branches, respectively, of the Miller Lake Drain. These sites can serve to differentiate the relative contributions of upstream land uses and drainages of the two branches and are designated as secondary sampling locations.

Sampling Station ML7

Station ML7 is located on the Miller Lake Drain at River Road. It serves to characterize the Miller Lake Drain Subwatershed and inputs from that tributary system to the south end of Messenger Lake. It is designated as a primary sampling location.

Sampling Stations ML8, ML9, and ML10

Stations ML8, ML9, and ML10 are all located along Union City Road where they capture small, unbranched tributaries to Morrison and Craig Lakes. Stations ML8 and ML9 drain to Morrison Lake. ML9, draining a larger area, is designated a primary sampling station whereas ML8 is designated as secondary. Station ML10, capturing the tributary drainage to Craig Lake is designated as a primary sampling site.

Sampling Station ML11

Station ML11 is the downstream-most recommended sampling location; located on the Coldwater River, at Hodunk Road, as it exits the Hodunk-Messenger Chain of Lakes Watershed. It is designated as a primary sampling location.

Sampling Stations LC1, LC2, and LC3

Stations (lake channel = LC) LC1, LC2, and LC3 represent sites on connecting channels between lakes within the Hodunk-Messenger Chain of Lakes. Water chemistry has been previously monitored at all three of these sites by the MDEQ. Station LC1 is located at Old US-12 between South and Cemetery Lakes, station LC2 is located at Narrows Road between Randall and Morrison Lakes, and station LC3 is located at River Road between Craig Lake and Hodunk Pond.

Adding these sampling stations to the primary sampling network is recommended when and if water chemistry parameters are added to the sampling program. Although somewhat riverine in nature, their location between the lakes will strongly influence the macroinvertebrate communities found at these locations and, as such, it is anticipated that the macroinvertebrate assemblages found at these sites will not be strictly comparable to those from stream sampling stations. Because of additional concerns about water depths and access, and whether these sites may be safely waded, it is recommended that these sites be sampled from shore or bridges. Their locations between the lakes enable these sites to characterize water quality inputs and outputs from the various lakes and to provide information about how the lakes may act as sinks for various water quality parameters.

Stations LC1, LC2, and LC3 are recommended, initially, over sampling stations within the lakes themselves simply because of the relative ease of sampling from shore or bridges. Sampling within the lakes requires additional equipment and therefore increases sampling costs. However, lake sampling does provide additional information about the quality of individual lakes and how the lakes assimilate the nutrient loads they receive from upstream tributaries or their immediate shoreline drainage areas. Sampling stations within the lakes themselves would allow the BCCD to determine how, or whether, individual lakes may stratify seasonally, whether lower layers are seasonally anoxic and may, therefore, release phosphorus from bottom sediments, etc.

Lake sampling stations are shown in Map 2. Like the stream sampling locations, they are designated as either primary or secondary sampling locations. This prioritization is based upon their location relative to incoming tributary systems and how they may therefore provide information regarding how the lake assimilates those inputs.

Three of the lake stations (i.e., those in South, North, and Morrison Lakes – Table 1, Column 4) are listed as primary sampling stations. Although sampling may be conducted at both lake stations and connecting channel locations, sampling at the primary lake stations (LS1, LS3, and LS5) could substitute for sampling at the connecting channels, should either minimizing costs or managing a sampling program with few volunteers be paramount.

Sampling Stations LS1 - LS6

Stations LS1 through LS6 are located in the deep basins of South, Cemetery, North, Randall, Morrison, and Craig Lakes, respectively. All of these stations, except Station LS2 on Cemetery Lake, have one or more years of existing MDEQ data for comparison over time. Secchi disk and phosphorus concentration data, collected by volunteers through the Michigan Cooperative Lakes Monitoring Program, are also available for Randall Lake for the years 2002 through 2005, 2007, and 2008.

Beach monitoring station 1 (BM1), located at Memorial Beach on Messenger Lake, is also shown in Map 2. Station BM1 is identified as a primary sampling location. Sampling here requires different methods, frequency, and parameters than sampling at the other lake stations because fecal material from waterfowl is suspected to be the dominant source of elevated bacteria at Memorial Beach. Sampling at BM1 is intended to track compliance with Michigan Water Quality Standards for total body contact and to monitor the efficacy of best management practices implemented to reduce or manage the goose and swan populations in this area.

3.2 Cold Creek Subwatershed

Stream sampling locations within the Cold Creek Subwatershed are shown in Map 3.

Sampling Station CC1

Station 1 within the Cold Creek Subwatershed (CC1) is located on Cold Creek at Union City Road, north of the City of Coldwater. It is intended to characterize surface water inputs to the chain of lakes from the entire Cold Creek Subbasin and/or characterize the downstream end of this tributary system. Water chemistry data, collected by the MDEQ in 1980, are available for this location. Station CC1 is designated as a primary sampling location.

Sampling Station CC3

Station CC3 is the other primary sampling station within the Cold Creek Subwatershed. It is located at Jonesville Road a short distance east (upstream) of Interstate-69. Sampling conducted at Stations CC1 and CC3 allow comparison of water quality between areas with differing amounts of riparian forest cover. Although both sites drain areas that are primarily agricultural, the area upstream of CC3 exhibits less forest cover within the riparian corridor than the area between Stations CC3 and CC1.

Sampling Stations CC2, CC4, and CC5

Stations CC2, CC4, and CC5 are recommended as secondary sampling locations within the Cold Creek Subwatershed. Station CC2, at Newton Road, allows characterization of water quality from a southern branch of Cold Creek, while Stations CC4 and CC5, both along Jonesville Road, allow characterization of two headwater areas on the northern, or main, branch of Cold Creek.

3.3 Sauk River Subwatershed

Stream sampling locations within the Sauk River Subwatershed are shown in Map 4.

Sampling Station SR1

Station 1 within the Sauk River Subwatershed (SR1) is located on the Sauk River at Jay Street within the City of Coldwater. It is the downstream-most road crossing before the Sauk River enters South Lake, it includes drainage from a portion of the City of Coldwater, and it is the site of a former U.S. Geological Survey (USGS) stream flow gage. All of these factors argue for including this location as a part of the core sampling network of primary sites.

However, Station SR1 is designated here as a secondary sampling station. Station SR3, at Willowbrook Road (described below), has 2 years of MDEQ macroinvertebrate data and for this reason is recommended over SR1 as a primary sampling location in the Sauk River Subwatershed.

Most volunteer-based macroinvertebrate monitoring programs in Michigan follow a model wherein a team of volunteers is assigned 2 sites to visit in a single day. The core stream sampling network recommended as a starting point for the BCCD includes 10 stream sites (sampling at Memorial Beach would follow a different schedule and procedures). Following the pattern that other Michigan river groups have adopted, 5 teams of volunteers could monitor the 10 recommended sites in a day. Assuming that 20 individuals (volunteers plus BCCD staff) is a reasonable number of volunteers for a brand new program, the 10 stations could be assessed with 5 teams of 4 people.

If it is determined that at least one team is willing to sample 3 stations in a day, if more volunteer teams are available to add another stream and/or connecting channel station to the sampling network, or if nutrient or other inputs to the lake chain are emphasized, then Station SR1 could/should be added to the list of primary sampling locations.

Sampling Station SR2

Station SR2 is located on the Sauk River at Sprague Road. This sampling location allows differentiation between areas that are primarily agricultural (upstream) and downstream areas that include the southern end of the City (monitored at SR1). It is designated as a secondary sampling location to be added as the monitoring program grows.

Sampling Station SR3

Station SR3 is located on the Sauk River at South Willowbrook Road. The MDEQ assessed both fish and macroinvertebrate assemblages here in 1995, and assessed macroinvertebrates again in 2000. It is the only known location within the Hodunk-Messenger Chain of Lakes Watershed with these data available for comparison to future monitoring results.

Comparison of the 1995 and 2000 macroinvertebrate data noted a decline from an "Excellent" rating in 1995 to an "Acceptable" rating in 2000, with the apparent loss of 1 stonefly, 2 mayfly, and 5 caddisfly families in this period. Two sampling events are insufficient to demonstrate a trend, but the recorded decline in quality at this site indicates that this sampling station warrants long-term monitoring. The invertebrate fauna makes it a good site for showing watershed residents what constitutes a high quality stream and the 1995 data provide a benchmark for restoring impacted sites within the watershed. As such, this site is a primary sampling location.

Sampling Stations SR4, SR5, and SR6

Stations SR4, SR5, and SR6 are located in the upper end of the Sauk River Subwatershed. They are located at Lott, Dorrance, and Wood Roads, respectively, with Stations SR4 and SR6 on the northern branch of the Sauk River and Station SR5 on the southern branch. Comparative sampling at Station SR4 and SR6 would help identify the influence of 3 small tributary streams coming in from the north between the 2 stations. These sites are identified as secondary sampling locations.

Sampling Station SR7

Station SR7 is located at Ridge Road and serves to characterize water quality in the Sauk River where it enters the Hodunk-Messenger (North) Chain of Lakes Watershed from Marble Lake in the South Chain of Lakes Watershed. Due to this position in the watershed, Station SR7 is recommended as a primary sampling site.

3.4 Summary

Map 5 presents all primary and secondary sampling locations within the 3 subwatersheds. The proposed sampling sites have been recommended primarily based upon their locations on the various tributary systems, access, and in some cases based upon existing data and/or watershed land use and land cover. They do not specifically capture all of the trouble spots previously identified by the BCCD.

As resources allow, the BCCD may wish to add other sampling stations beyond those described. Particularly, it may be beneficial to monitor areas adjacent to individual sites of known or suspected erosion or contamination. In these cases monitoring may be conducted upstream and downstream of the location to confirm suspected conditions or sampling may be done immediately downstream of a site for a period before a corrective action is taken and again, in the same location, following a corrective action.

4.0 Water Quality Parameters

The following parameters are recommended to assess and monitor water quality in the Hodunk-Messenger Chain of Lakes watershed. Although the list of possible constituents is long, the relatively short list presented here is intended to provide the most important information while keeping analytical costs low. Water quality parameters for which samples are collected in the field for later analysis and those that may be measured in the field with a meter(s) are each listed in order of suggested importance and reflect the priority ranking of nonpoint source pollutants within the Hodunk-Messenger Chain of Lakes Watershed Management Plan.

<u>Stream Water Chemistry & Physical Parameters</u>

Sample Collection & Laboratory Analysis

1.) Benthic Macroinvertebrates
2.) Suspended sediment (SSC or TSS)
3.) Total phosphorus (TP)
4.) *Escherichia coli* (*E. coli*) bacteria
5.) Soluble reactive phosphorus (SRP)
6.) Nitrite + Nitrate nitrogen (NO_2+NO_3 - N)
7.) Ammonia nitrogen (NH_3-N)

Field Measurements

8.) Temperature
9.) Dissolved Oxygen (DO)
10.) Velocity
11.) Specific Conductance (Conductivity)
12.) pH

<u>Lake Water Chemistry & Physical Parameters</u>

Sample Collection & Laboratory Analysis

13.) Total phosphorus (TP)
14.) Soluble reactive phosphorus (SRP)
15.) Nitrite + Nitrate nitrogen (NO_2+NO_3 - N)
16.) Ammonia nitrogen (NH_3-N)

Field Measurements

17.) Secchi Disk transparency
18.) Temperature
19.) Dissolved Oxygen (DO)
20.) Specific Conductance (Conductivity)
21.) pH

<u>Beach Monitoring (Memorial Beach)</u>

Sample Collection & Laboratory Analysis

22.) *Escherichia coli* (*E. coli*) bacteria

Water quality varies seasonally and in response to precipitation and overland runoff. Water quality constituents are also influenced by watershed location (e.g., proximity to riparian wetlands, etc.), changes in stream flow, air temperature, and plant and bacteria growth. Due to the seasonal hydrologic and climatological patterns of low flow, minimum dilution, and high temperatures, summer and early fall are typically the critical period for evaluating the worst-case impact of pollutant loads on water quality. Analysis of U.S. Geological Survey stream flow data for the Coldwater River near Hodunk (USGS Gage 04096600) and the Sauk River at Jay Street in the City of Coldwater (USGS Gage 04096500) confirm that August through early October generally exhibit the lowest monthly average stream flows for the year.

4.1 Benthic Macroinvertebrate Monitoring

The core, recommended water quality monitoring program for the Hodunk-Messenger Chain of Lakes Watershed is a volunteer benthic macroinvertebrate monitoring program, with associated habitat assessments. Additional physical and chemical parameter sampling can be added, as human and financial resources allow, to provide additional information and to further assist in the interpretation of the macroinvertebrate data.

Different species of benthic macroinvertebrates (bottom-dwelling aquatic insects, mollusks, and crustaceans) have varying habitat requirements and tolerance of ecological degradation. The diversity and composition of these biological communities, therefore, tend to integrate the cumulative effects of chemical, physical, and biological conditions within a lake or stream over time.[i,ii,iii,iv] As such, the biological assessment of these communities is used as a measure of overall stream integrity, combining the cumulative effects of water and sediment chemistry and habitat quality and availability.

In Michigan, the MDEQ assesses the quality of stream and river habitat and biota using Procedure 51.[v,vi] Procedure 51 is a multi-metric assessment and scoring system that combines measures of overall community diversity, evenness, and the preponderance of groups known to be either particularly tolerant or intolerant of poor water or habitat quality. Sites are scored relative to reference (least-impacted) stream sites within the same ecoregion, as described by Omernik and Gallant.[vii]

Conducting assessments of in-stream habitat and benthic invertebrate communities following Procedure 51 protocols is relatively inexpensive and easy to do, yet they yield a number of insights into the quality of local river systems. It also serves as a valuable means of providing education about the watershed and involving watershed residents in the study and care of the river system.

Collection methods require modest training and a number of Michigan watershed groups train volunteers to conduct assessments using methods similar to the MDEQ. The Michigan Clean Water Corps has been established by the MDEQ and the Great Lakes Commission to provide training for local program coordinators, volunteer training resources, and a central data repository for Michigan rivers.

Although macroinvertebrate monitoring is listed along with parameters requiring collection and laboratory analysis, it differs from water chemistry analysis in that samples are not generally sent to a laboratory for analysis. Typically, watershed groups organize days in which teams of volunteers visit sampling sites, describe the in-stream and riparian habitat observed, and collect macroinvertebrates to later identify on a separate date. During the separate "Bug Identification" event, volunteers sort collected invertebrates into like groups, count them, and may conduct some identification using taxonomic keys. Procedure 51 and the MiCorps program require taxonomic identification to the family level for most invertebrate groups. BCCD staff, or other experts supporting the program, would need to provide oversight of the identification process and would likely need to conduct some data verification to ensure quality assurance and quality control (QAQC) for the program.

4.2 In-Field Physical Parameter Monitoring

A macroinvertebrate monitoring program may be conducted without the additional use of other sampling or monitoring, but several basic water quality measurements may be added at relatively low cost. These include several parameters than can be recorded in the field with the use of hand-held meters, specifically: temperature, dissolved oxygen, pH, and conductivity. These may be measured using multi-parameter meters that serve as data-loggers to record and store the data from multiple sites, or using separate meters for individual parameters.

Stream velocity is also measured in the field with the use of a current meter. Velocity measurements coupled with measurements of stream depth and width are combined to calculate stream discharge. Additional information about each of these parameters is provided below:

4.21 Temperature

Temperature is easily recorded and is one of the most important water quality variables. It affects the amount of dissolved oxygen (DO) that can be held in solution, the rates of various chemical transformations, and the metabolic rate and reproductive activities of aquatic organisms. Water generally holds less oxygen in solution with increased temperature, and higher temperatures increase metabolic activity in fish and invertebrates. This, in turn, increases their demand for DO. Fish and other aquatic organisms can therefore suffer metabolic stress at high temperatures.

Water temperature varies according to season, elevation, geographic location, and climate, and is influenced by stream flow, the amount of shade provided by riparian vegetation, and the relative contributions of groundwater, surface water runoff, and/or effluent.

4.22 Dissolved Oxygen (DO)

Oxygen dissolved in water is necessary for life of both aquatic plants and animals. The amount of oxygen that can be held dissolved in water is generally temperature dependent, although saturation in excess of oxygen's equilibrium solubility (>100%) from photosynthesis or extreme turbulence is possible. Oxygen solubility increases with decreasing temperature (colder water generally holds more oxygen than warm water).

Besides temperature, the amount of DO in water is also dependent upon processes that consume, produce, and/or entrain oxygen. Oxygen is consumed through both plant and animal respiration and decomposition and oxygen is added to the system from the atmosphere, by photosynthesis, and turbulence.

Plants produce oxygen during the daylight hours through photosynthesis. During the night, plants and bacteria continue to use oxygen for respiration while no photosynthesis is occurring. Thus, DO levels decrease at night, and are generally lowest just before dawn.

Rule 64 of the Michigan Water Quality Standards (Part 4 of Act 451)[viii] states that surface waters protected for warm water fish and aquatic life must contain a minimum of 5.0 mg/L DO. Prolonged exposure to low DO levels (less than 5 mg/L) may not directly kill organisms, but can increase their susceptibility to environmental stresses. Exposure to less than 30% saturation (less than 2 mg/L) for periods of one to four days may kill aquatic organisms unable to move to areas exhibiting higher concentrations.[ix]

4.23 Conductivity

Conductivity (specific conductance) is a measure of water's ability to conduct an electrical current and, as such, is an indirect measurement of the presence of inorganic dissolved solids such as carbonate, bicarbonate, chloride, nitrate, sulfate, and phosphate anions (ions that carry a negative charge) or sodium, magnesium, potassium, calcium, iron, and aluminum cations (ions that carry a positive charge). Conductivity is affected by temperature: the warmer the water, the higher the conductivity. Because it is related to temperature, measurements of conductivity are generally standardized as conductivity at twenty-five degrees Celsius (25^{o} C).

Conductivity in streams and rivers is affected primarily by the geology of the watershed. Streams that run through areas with granite bedrock tend to have lower conductivity because granite is composed of more inert materials that do not ionize (dissolve into ionic components) when washed into the water. Streams that run through areas with clay soils tend to have higher conductivity because of the presence of ionizing materials. Groundwater inflows can have the same effects depending on the bedrock they flow through.

Conductivity of rivers in the United States generally ranges from 50 to 1,500 µS/cm. Studies of inland fresh waters indicate that streams supporting good mixed fisheries have a range between 150 and 500 µS/cm. Conductivity values outside the 150 to 500 µS/cm range (or outside of the normal background values of local waters) may indicate inputs from urban storm water or wastewater and may be unsuitable for certain species of fish or macroinvertebrates. Studies conducted by the Huron River Watershed Council have found that conductivity values greater than 800 µS/cm were correlated with impaired macroinvertebrate communities and imperviousness values greater than 8%.[x]

4.24 Hydrogen Ion Concentration (pH)

The pH of water is a measurement of the concentration of hydrogen (H+) ions, on a scale ranging from 0 to 14. A pH of 7 is considered "neutral", indicating equal concentrations of H^+ and OH^- ions. Liquids or substances with pH measurements below 7 are considered acidic. Those with pH measurements above 7 are considered basic or alkaline. Every unit change in pH, indicates a ten-fold change in acidity or alkalinity. Natural waters generally exhibit pH values between 6.5 and 8.5 and Michigan's water quality standards require that surface waters be between 6 and 9 pH. pH varies naturally in relation to temperature and photosynthesis.

4.25 Secchi Disk Transparency

Should the BCCD decide to include lake sampling as part of a long-term monitoring program, measuring water clarity using a Secchi disk is a low cost method for recording changes in water clarity over time. Water clarity is assumed to be a product of the amount of zoo- and phytoplankton and suspended solids within the water column and, therefore, is also a product of the amount of nutrients (particularly phosphorus) and chlorophyll *a* within the lake, all of which can be used to characterize the trophic status of a lake and assess trends.

4.26 Stream Velocity

Water quality measurements are generally recorded as concentrations; the amount of a particular substance in a unit volume of water (e.g., mg/L). Concentrations allow one to determine if water quality standards are being met, but do not always provide sufficient information to determine the impact one water body may have on another or to compare one stream to another to determine priorities for action. For example, if concentrations of total suspended solids (TSS) in the Sauk River and Coldwater Creek are the same, but the volume of water entering the chain of lakes, over time, from the Sauk River is twice that of Cold Creek, then the Sauk River delivers twice the load of sediments to the lakes and may therefore be a higher priority for addressing the source(s) of that sediment.

Comparative measurements of stream discharge (the volume of water passing a point in a given unit of time) are therefore useful to determine the total volume (load) of a given substance within the lake or stream. Measurements of stream discharge under different conditions (wet-weather vs. dry) are also valuable for determining how stable stream flows are and for designing stream bank stabilization measures.

In-stream current velocities are generally measured with either a Price Type AA or a mini (pygmy) velocity meter (depending upon anticipated velocities and the appropriate ranges for the meter type) attached to a top setting wading-rod, following the midsection method of the U. S. Geological Survey (USGS).[xi] Measurements of stream width and depth, taken at the time velocities are measured, are used to determine the stream's cross-sectional area. The stream discharge (Q) is the product of velocity (V) and cross-sectional area (A): Q=VA.

Historic land uses and dredging of streams in the watershed have altered the hydrology and increased the erosion and instability of stream channels. Analysis at four sites in the Sauk River and Cold Creek drainages found that all 4 were unstable or highly unstable.

Measuring stream velocities is an essential component of characterizing how streams react to precipitation in the watershed as well as determining pollutant loads. The BCCD has requested that the monitoring program include analysis of both watershed hydrology and changes in the shape and elevations of the stream channels (geomorphology) caused by erosion.

Such a study could be done by staff, contractors or volunteers, but requires that date be collected over a range of dry and wet-weather conditions. Included in the cost estimates for this program are values for contractual training services to initiate a volunteer program and an estimate of costs if this component was conducted by an outside contractor (Table 4). A hydro-geomorphic study would include collecting stream velocity and channel cross-section measurements at each of the 10 primary stations, installation of staff gages at each site, development of stage-discharge relationships for each cross-section, the installation and surveying of permanent monuments at each sampling site to allow future monitoring of changes in stream geometry, and assessment of the current channel stability.

4.3 Parameters Requiring Laboratory Analysis

4.31 Suspended Sediment

The principal physical function of a stream or river system is the upstream to downstream transport of water and sediment. However, sediment inputs in excess of equilibrium conditions can lead to increased in-stream erosion, deposition of fine sediments, changes in stream morphology, and impacts to fish and invertebrates. Deposition of finer-grained sediment, such as silts, clays, or sand, can fill the pore spaces between, or even bury, gravels and other coarse substrates, and fill pool habitat. Stream habitat is therefore simplified or made homogenous, resulting in the loss of aquatic species that require a variety of habitats or coarse substrates for colonization.

High sediment loads also degrade water quality. In-stream erosion is accelerated, adding more sediment to the system. Streams can either erode the channel bottom (down-cutting or degradation) or the stream banks. Stream banks are generally made of softer material than the stream bottom, so a stream carrying excess water or excess sediment generally erodes laterally, resulting in a wide, shallow channel. Water is more readily heated in a shallow channel and the widening of the channel further exacerbates this effect as stream-side vegetation has less cooling influence over a wide channel. Turbid water is also warmed more easily. Warm water is able to hold less dissolved oxygen. Additionally, soil particles bind with and carry pollutants, like phosphorus, which can lead to nutrient enrichment and increased growth of algae and other plants. Plants as well as the sediments themselves can, in turn, further reduce dissolved oxygen levels.

Sediment is transported within a stream either along the bottom (bed-load) or mixed in the water column. The latter component is more readily sampled and is measured as either total suspended solids (TSS) or, more recently, as suspended sediment concentration (SSC).

In a review of the scientific literature, the European Inland Fisheries Advisory Commission (EIFAC)[xii] documented impacts on fishes' reproductive success, growth, behavior, and health – even mortality – attributed to high levels of suspended sediment. Although cold water fishes appear to be more sensitive to suspended sediment than warm water fishes, both cold and warm water fish are known to avoid areas of high turbidity and fish have been shown to reduce feeding in highly turbid waters due to reduced visibility and ability to find prey. Reduced feeding, in turn, reduces growth. High TSS concentrations have been shown to increase fishes' susceptibility to disease and toxicants, to abrade gill and other tissue, and in some cases to cause acute mortality, particularly in young fish.

Michigan does not have a numerical standard for either TSS or SSC, but the MDEQ now references the following EIFAC criteria in their regulatory directives:

- Continuous TSS concentrations <25 mg/L were found not harmful to fish,
- Concentrations 25 - 80 mg/L result in reduced fish yields and macroinvertebrate densities,
- Good fisheries were unlikely at concentrations between 80 and 400 mg/L,
- Concentrations greater than 400 mg/L resulted in poor fish populations.

In developing Total Maximum Daily Load (TMDL) allocations for rivers elsewhere in southern Michigan, the MDEQ has established a goal of mean wet-weather TSS concentrations less than or equal to the 80 mg/L threshold cited above.

4.32 Phosphorus

Phosphorus and nitrogen are essential nutrients for plant growth. In Michigan waters, phosphorus is generally considered the limiting nutrient. This means that, because it is generally less available than other nutrients (relative to plant needs), the amount of available phosphorus generally determines the rate and amount of plant growth. Excessive phosphorus in aquatic systems can lead to excessive growth of algae and other aquatic plants, which can in turn deplete the available dissolved oxygen in the water. High nutrient concentrations and the resulting growth of nuisance plant levels can also inhibit recreation and enjoyment of lakes and streams. As such, phosphorus is a key water quality concern.

Phosphorus binds to soil particles, and is thereby delivered to streams and lakes with eroded soil. Phosphorus is also a chief component of lawn, garden, and agricultural fertilizers, detergents, fuels, and animal wastes. Phosphorus from these sources is carried in storm water runoff, and also enters rivers and lakes from failing septic tanks and from wastewater treatment plants.

Ortho-phosphate (Ortho-P or Soluble Reactive Phosphorus [SRP]) is measured as a separate component of total phosphorus (TP), because it is the form generally available for plant growth.

Various indices are available for characterizing the productivity of lakes based upon measured phosphorus or chlorophyll *a* concentrations, or Secchi disk transparencies. For streams, the U.S. EPA has developed a network of sampling stations in each ecoregion that provide a surrogate measure of unimpacted (reference) conditions. From this database of ambient water quality, the EPA has determined that streams like Cold Creek and the Sauk and Coldwater Rivers, within the Southern Michigan – Northern Indiana Till Plain ecoregion, should exhibit TP and SRP concentrations less than or equal to 0.031 and 0.017 mg/L, respectively.[xiii] The U.S. EPA and the MDEQ consider TP concentrations higher than 0.05 mg/L to have the potential to cause eutrophic conditions (e.g., nuisance algae and plant growth, widely fluctuating DO concentrations, etc.) in lakes, ponds, and reservoirs. Thus, these agencies recommend that total phosphorus not exceed 0.05 mg/L in streams or rivers at the point where they enter a lake or reservoir. The U.S. EPA and the MDEQ further recommend that TP concentrations not exceed 0.1 mg/L in streams and rivers that do not discharge directly into lakes or reservoirs.[xiv,xv]

4.33 Nitrogen

Nitrogen is generally more available than phosphorus. Although nitrogen is abundant naturally in the environment, it is also introduced through sewage and fertilizers. Excess nitrogen can result in excessive aquatic plant growth, providing plant growth is not limited by concentrations of another nutrient (e.g., phosphorus) or trace constituent.

Nitrogen is found in a variety of forms. Those generally measured in water quality studies include ammonia, nitrate and nitrite, and organic nitrogen. Total Kjeldahl nitrogen is an analytical measure of ammonia plus organic nitrogen.

The sum of nitrate+nitrate (NO_2+NO_3) is a measure of total oxidized nitrogen. Nitrate dissolves readily in water, is stable over a wide range of environmental conditions, and is easily transported in groundwater and streams. Nitrite is an intermediate form and is quickly converted to nitrate by bacteria. Nitrite concentrations are hence generally very low or non-detectable.

4.34 Ammonia

Ammonia, a form of nitrogen, occurs naturally in groundwater and surface waters, is the preferred form of nitrogen for aquatic plant uptake and growth, and is the least stable form of nitrogen in water. It is easily transformed to nitrate in oxygenated waters or to nitrogen gas in water low in oxygen. Ammonia takes the forms of the ammonium ion (NH_4^+) and dissolved un-ionized ammonia gas (NH_3). Total ammonia nitrogen (NH_3-N) is the sum of these two forms. The ammonium ion is considered nontoxic and generally comprises most of total ammonia. NH_3 is much more toxic to aquatic organisms than the ammonium ion (NH_4^+).[xvi] The relative balance of these two forms is dependent upon both pH and temperature. Increases in pH push the balance toward aqueous NH_3. At pH < 8.75, NH_4^+ predominates. The two forms are in approximately equal proportions at a pH of 9.24, and aqueous NH_3 predominates at pH >9.75. Michigan's Rule 57 Aquatic Maximum Value for un-ionized ammonia (NH_3) in warm water systems is 0.210 mg/L and the Final Chronic Value is 0.053 mg/L.

4.35 Bacteria (Pathogens)

Bacteria are simple, single-celled organisms that can reproduce rapidly by binary fission. While over 60 genera of bacteria are naturally present in waters of the U.S., certain types of bacteria can increase as a result of human use of a watershed and may indicate sources of water pollution.[xvii]

Most bacteria are harmless; however, some have the potential to cause illness or disease in humans. These are referred to as *pathogens*. Examples of waterborne diseases caused by bacteria include cholera, dysentery, shigellosis and typhoid fever. Minor gastro-intestinal discomfort is probably the most common ailment associated with water-borne bacteria; however, pathogens that cause only minor discomfort to some may cause serious illness or even death in other individuals, particularly the young and elderly or those with compromised immune systems.[xviii,xix]

Of particular interest or concern is a sub-group called coliform bacteria, typically found in the digestive systems of warm-blooded animals. Coliform bacteria include total coliforms, fecal coliforms, and the group *Escherichia coli* (*E. coli*). Each of these indicates the presence of fecal waste in surface waters.[xx] The fecal-coliform bacteria group was formerly the preferred indicator for potential water quality concerns; however, recent advances in the use and analysis of indicator bacteria have shown that *E. coli* are more reliable for predicting the presence of disease-causing organisms.[xxi]

Rule 62 of the Michigan Water Quality Standards (Part 4 of Act 451)[xxii] limits the concentration of microorganisms in surface waters of the state. Waters of the state which are protected for total body contact recreation must meet limits of 130 *E. coli* per 100 milliliters (mL) of water as a 30-day average and 300 *E. coli* per 100 mL of water at any time. The limit for waters of the state which are protected for partial body contact recreation is 1000 *E. coli* per 100 ml water during any one sampling event.

Bacteria from human sources can enter waters through either point or nonpoint sources of contamination. Point sources are those that are readily identifiable and typically discharge water through a system of pipes (e.g., an industrial or wastewater discharge). Point source discharges can also include "illicit" connections to storm drainage systems, wherein wastewater that would normally require treatment prior to discharge is instead routed through storm drains without treatment. Nonpoint sources are diffuse, with contamination entering waters through overland runoff or seepage through the soil. Fecal coliform and *E. coli* concentrations in urban storm water frequently exceed water quality standards by a factor of 35 to 75.[xxiii] Failed septic systems in residential or rural areas can contribute bacteria to surface water and groundwater. Other sources include combined sewer overflows, sanitary sewer overflows, dumping of wastewater, and animal wastes from livestock, pets, wildlife and waterfowl. Domestic dogs and cats were found to be the primary source of fecal coliforms in urban watersheds near Puget Sound in Washington State.[xxiv]

5.0 Sampling Frequency and Schedule

5.1 Benthic Macroinvertebrate Monitoring

Most volunteer programs monitoring benthic macroinvertebrates in Michigan sample in the early spring (~late April) and late summer-early fall (~late September) and MiCorps guidance materials state that this is the ideal sampling schedule to allow a more complete picture of the total stream community. However, the MDEQ monitors invertebrate assemblages once during the summer field season.

Either sampling schedule is legitimate and acceptable. The BCCD may choose the time(s) to conduct sampling within the Hodunk-Messenger Chain of Lakes Watershed based upon available human and financial resources, the desired number of public involvement activities per year, and the dataset against which the BCCD wishes to compare their data.

In a program with a spring and fall sampling schedule, spring data would generally be compared only to other spring data, and fall data would be compared against other fall collections. Both summer collection data and data from a September collection could reasonably be compared to MDEQ data.

Sampling methods employed by MiCorps are essentially the same as those of the MDEQ's Procedure 51, Qualitative Biological and Habitat Survey Protocols for Wadable Streams and Rivers. Sampling methods should therefore not limit data comparisons.

5.2 Diurnal Variation - Streams

Temperature, dissolved oxygen, and pH all exhibit diurnal variation based, in part, upon relationships with one another, and, in part, due to patterns of weather, runoff, photosynthesis, and plant and bacterial respiration. In general, they increase during the daylight hours and decrease during the night, exhibiting their lowest values just before dawn.

If dissolved oxygen (DO) fails to meet water quality standards or is periodically limiting within a stream system, measuring DO during the daytime when volunteer monitoring generally occurs may not reveal any problems. Stream DO should be measured during the early morning hours prior to sunrise. If DO sags are suspected, single measurements at this time of night may be sufficient to document the problem. Measurements taken at 4 to 6 hour increments over a 24 to 48-hour period will generally reveal whether problems of low DO exist under normal circumstances.

A study of this duration, even at multiple sites within the same watershed, may be conducted by 2 to 3 individuals with a hand-held meter. Studies of longer duration may be necessary to detect periodic DO sags associated with stormwater runoff or pollution events and may best be conducted with in-situ meters and data loggers.

5.3 Seasonal and Wet-Weather Variation - Streams

Most, if not all, physical and chemical parameters will change due to seasonal patterns of weather and precipitation. Measurements of stream discharge, temperature, dissolved oxygen, pH, specific conductance, bacteria, and nutrients should be collected during, or immediately following, both dry- and wet-weather events.

Dry weather events are defined as having less than 0.1 inches of rain within the preceding 72 hours. Wet weather events are defined as having more than 0.1 inches of rain within the preceding 72 hours. A value of 0.1-inches of rain is commonly considered the minimum amount of rain that results in overland runoff. The preferred design of a sampling program for any of these parameters should include measurements and/or samples collected in a variety of stream flow and weather conditions.

For stream discharge, 6 stream flow measurements, coupled with water surface height gage readings and taken under as wide a range of conditions as possible, is generally considered the minimum necessary to establish a stage-discharge relationship for a specific stream channel cross-section. Thereafter, gage readings can be used to estimate stream discharge from that location's stage-discharge curve.

As noted previously, late July through September will generally exhibit the lowest stream flows and the highest air and water temperatures, and therefore represent an important period for monitoring temperature, DO, and stream flow. Nutrients are likely to be highest in the early spring, following agricultural fertilizer applications, but before plants have grown enough to fully capture these constituents. March to June is generally the period of highest runoff and stream discharge. In more urban settings, phosphorus and other nutrients may be elevated following any runoff, regardless of season. Both sediment and bacteria, from either rural or urban settings, are also likely to be elevated following stormwater runoff events.

5.4 Seasonal Variation - Lakes

During the summer, many lakes stratify into different layers that, due to differences in water temperature and density, do not mix. As a result, DO concentrations in the lower layer (hypolimnion) may be used up and the hypolimnion may become anoxic (lacking-oxygen). Anoxic conditions in the hypolimnion limit the area of habitat available to fish and other aquatic organisms, and also may result in the release of phosphorus from the bottom sediments.

During the spring and fall, when temperature differences between the surface and deeper parts of the lake are decreased, wind across the lake surface can overcome the stratification and effectively mix the water throughout the water column. This is referred to as spring or fall turnover, and results in a period when temperature, DO, and chemical constituents may be mixed and generally equal throughout the lake.

Lake sampling is generally designed to exploit these seasonal differences. Temperature and DO meter readings, taken during spring and fall can indicate when the lake is fully mixed. Chemical samples taken at a single depth during this time can then be used to represent concentrations throughout the water column and be used to calculate whole-lake totals for these constituents. DO meter readings in mid-summer are used to determine if the hypolimnion does go anoxic and, if so, for what duration.

Recommended sampling schedules for a program consisting of macroinvertebrate monitoring only, and for a macroinvertebrate monitoring program with additional chemistry sampling are provided in Table 2.

6.0 Sampling & Analytical Methods

Detailed descriptions of sampling, laboratory, or data analysis methods are not included in this document. Standards laboratory analytical methods, required sample volumes, bottle types and preservatives, and acceptable hold-times, however, are presented in Table 3.

The BCCD has applied for grant funding from MiCorps to develop a water quality monitoring Quality Assurance Program Plan (QAPP), and sampling methods will be described in greater detail within that document. In general, stream and lake water samples, for chemical analysis, will be collected as grab samples following standard accepted methods used by the MDEQ, the

U.S. EPA, and/or the USGS. Likewise stream flow measurements will be conducted following USGS methodologies.

Stream samples should be collected at mid-stream, where possible, and at mid-depth within the water column. Care should be taken to avoid sampling the surface film. Lake samples can be taken at discrete depths using a Van Dorn or similar bottle.

Macroinvertebrate samples are to be composited from a 300-foot (~100-meter) stretch of river, making sure that all available habitats are represented.

A list of recommended sampling equipment and a list of references for sampling methods are provided in Appendix A.

7.0 Estimated Costs

Estimated costs for water quality monitoring within the Hodunk-Messenger Chain of Lakes Subwatershed are presented in Table 4. Unit costs for laboratory analysis and for field or laboratory equipment to support a volunteer monitoring program are presented separate from staffing costs for various elements. Total estimated costs are presented for a variety of program scenarios. These include a range of options from sampling only macroinvertebrates at the 10 primary sampling stations to a program including macroinvertebrate, water chemistry, and bacteriological sampling, and hydro-geomorphic analysis at 27 stream and connecting channel stations and within individual lakes.

Estimated contractual costs have been included as requested by the BCCD. They include one year of training and oversight assistance in the macroinvertebrate collection and identification and contractual services for a hydro-geomorphic assessment of the watershed. Footnotes for Table 4 describe assumptions used in developing the cost estimates and, in some cases, note factors that may alter program costs.

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Tables

Table 1. Sampling Locations and Parameters

					Site Location						Sample Collection & Lab Analysis								Field Measurements						MDEQ Sampling Results Available				
Station ID	Map #	Site Type	Primary Sampling Stations	Secondary Sampling Stations	Waterbody	Location	Township	Section	Latitude	Longitude	Macroinvertebrates	Suspended Sediment	Total Phosphorus	*E. coli* Bacteria	Ortho-Phosphorus (SRP)	Chlorophyll a	Nitrite + Nitrate	Ammonia Nitrogen	Secchi Disk	Dissolved Oxygen	Temperature	Hydrogen Ion Conc. (pH)	Specific Conductance	Velocity & Discharge (Q)	Water Chemistry	Macroinvertebrates	Fish	Habitat	Stream Flow (Q)
ML1	1	Stream	√		Coldwater River	Garfield Road	Coldwater	19	41.927226	-85.046949	.	:	:	:	...		...	...		.	.	:	:	:	1980	2000		2000	2000 estimate
ML2	1	Stream		√	Un-named Tributary 1	Jay Street	Coldwater	28	41.923571	-85.014878	.	:	:	:	...		...	...		.	.	:	:	:					
ML3	1	Stream	√		Un-named Tributary 2	Race Street	Coldwater	20	41.933500	-85.027914	.	:	:	:	...		...	...		.	.	:	:	:					
ML4	1	Stream		√	Un-named Tributary 2	River Road	Coldwater	18	41.947963	-85.039941	.	:	:	:	...		...	...		.	.	:	:	:					
ML5	1	Stream		√	S.B. Miller Lake Drain	Hodunk Road	Batavia	1	41.973283	-85.059807	.	:	:	:	...		...	...		.	.	:	:	:					
ML6	1	Stream		√	N.B. Miller Lake Drain	Hodunk Road	Batavia	1	41.978005	-85.059992	.	:	:	:	...		...	...		.	.	:	:	:					
ML7	1	Stream	√		Miller Lake Drain	River Road	Coldwater	5	41.981589	-85.040180	.	:	:	:	...		...	...		.	.	:	:	:					
ML8	1	Stream		√	Un-named Tributary 3	Union City Road	Girard	33	41.988730	-85.020050	.	:	:	:	...		...	...		.	.	:	:	:					
ML9	1	Stream	√		Un-named Tributary 4	Union City Road	Girard	33	41.993646	-85.020228	.	:	:	:	...		...	...		.	.	:	:	:					
ML10	1	Stream	√		Un-named Tributary 5	Union City Road	Girard	28	42.004629	-85.020308	.	:	:	:	...		...	...		.	.	:	:	:					
ML11	1	Stream	√		Coldwater River	Hodunk Road	Girard	30	42.013889	-85.060249	.	:	:	:	...		...	...		.	.	:	:	:					
LC1	1	Lake Channel	√		Coldwater River	Old US-12	Coldwater	17	41.945281	-85.031116		...	:	...	...		...	...		.	.	:	:	?	1980				
LC2	1	Lake Channel	√		Coldwater River	Narrows Road	Coldwater	5	41.978059	-85.029170		...	:	...	...		...	...		.	.	:	:	?	1980				
LC3	1	Lake Channel	√		Coldwater River	River Road	Girard	29	42.010142	-85.040282		...	:	...	...		...	...		.	.	:	:	?	1980				
CC1	3	Stream	√		Cold Creek	Union City Road	Coldwater	9	41.963892	-85.018616	.	:	:	:	...		...	...		.	.	:	:	:	1980				2000 estimate
CC2	3	Stream		√	Cold Creek	Newton Road	Coldwater	15	41.970882	-84.979363	.	:	:	:	...		...	...		.	.	:	:	:					
CC3	3	Stream	√		Cold Creek	Jonesville Road	Girard	35	41.985573	-84.964460	.	:	:	:	...		...	...		.	.	:	:	:					
CC4	3	Stream		√	Cold Creek	Jonesville Road	Quincy	6	41.985579	-84.938672	.	:	:	:	...		...	...		.	.	:	:	:					
CC5	3	Stream		√	Cold Creek	Jonesville Road	Quincy	7	41.985631	-84.926743	.	:	:	:	...		...	...		.	.	:	:	:					
SR1	4	Stream		√	Sauk River	Jay Street	Coldwater	21	41.939727	-85.015281	.	:	:	:	...		...	...		.	.	:	:	:	1980, '79				USGS 1937-'62
SR2	4	Stream		√	Sauk River	Sprague Road	Coldwater	22	41.932942	-84.990645	.	:	:	:	...		...	...		.	.	:	:	:					
SR3	4	Stream	√		Sauk River	S. Willowbrook Road	Coldwater	26	41.924470	-84.970900	.	:	:	:	...		...	...		.	.	:	:	:		2000, 1995	1995	2000, 1995	2000, 1995 est.
SR4	4	Stream		√	Sauk River	Lott Road	Coldwater	24	41.934442	-84.945965	.	:	:	:	...		...	...		.	.	:	:	:					
SR5	4	Stream		√	Sauk River	Dorrance Road	Coldwater	36	41.912543	-84.943886	.	:	:	:	...		...	...		.	.	:	:	:					
SR6	4	Stream		√	Sauk River	Fremont Road	Quincy	20	41.938505	-84.931829	.	:	:	:	...		...	...		.	.	:	:	:					
SR7	4	Stream	√		Sauk River	Ridge Road	Quincy	29	41.924123	-84.912708	.	:	:	:	...		...	...		.	.	:	:	:					
LS1	2	Lake	√		South Lake	NW Basin	Coldwater	20	41.937781	-85.035004			:		:	...			.	.	.	:	:		2005, '83, '80, '79				
BM1	2	Beach	√		Messenger Lake	Memorial Beach	Coldwater	20	41.937520	-85.041350				.											2004				
LS2	2	Lake		√	Cemetery Lake	Central Basin	Coldwater	17	41.953255	-85.035491			:		:	...			.	.	.	:	:						
LS3	2	Lake	√		North Lake	Central Basin	Coldwater	17	41.960559	-85.030004			:		:	...			.	.	.	:	:		1985, '83, '80, '79				
LS4	2	Lake		√	Randall Lake	North Central Basin	Coldwater	5	41.975763	-85.033720			:		:	...			.	.	.	:	:		2008, '07, '02-'05, [illegible]				
LS5	2	Lake	√		Morrison Lake	Central Basin	Girard	32	41.988059	-85.028338			:		:	...			.	.	.	:	:		1988, '79				
LS6	2	Lake		√	Craig Lake	North Central Basin	Girard	29	42.004170	-85.027781			:		:	...			.	.	.	:	:		1988, '80, '79				

. 1st priority monitoring parameter
: 2nd priority monitoring parameter
... 3rd priority monitoring parameter
√ monitoring of lakes may be substituted for/by monitoring of connecting channels between the lakes
? If the connecting channel sites can be waded safely, then velocity and discharge may be measured at the lake connecting channel stations using the same techniques and equipment as stream sites.

Table 2. Recommended Annual Sampling Schedules

Sampling Parameter	Stream and Connecting Channel Sampling Stations												Lake and Beach Sampling Stations											
	1st Quarter			2nd Quarter			3rd Quarter			4th Quarter			1st Quarter			2nd Quarter			3rd Quarter			4th Quarter		
	January	February	March	April	May	June	July	August	September	October	November	December	January	February	March	April	May	June	July	August	September	October	November	December
Macroinvertebrates[1]																								
Suspended Sediment[2]																								
Total Phosphorus[3]																								
E. coli Bacteria[4]																								
Ortho-Phosphorus (SRP)[3]																								
Chlorophyll a[5]																	x	x	x	x				
Nitrite + Nitrate[3]																								
Ammonia Nitrogen[3]																								
Secchi Disk[6]																								
Dissolved Oxygen[3]																								
Temperature[3]																								
Hydrogen Ion Conc. (pH)[3]																								
Specific Conductance[3]																								
Velocity & Discharge (Q)[7]																								

[1] Volunteer benthic macroinvertebrate collections are generally conducted in early spring and fall. Ideally, sampling is conducted at all sites during a single day, but may be spread over ~ 2 weeks without sacrificing data quality.
Alternatively, sampling could be conducted during a single summer event to correspond with MDEQ sampling conducted every 5 years. An additional event to collect winter-emerging stoneflies may be conducted in late January or early February.

[2] Sampling and analysis for total suspended solids or suspended sediment should generally be conducted during or immediately following rain and/or snowmelt runoff events to determine if wet-weather concentrations exceed 80 mg/L.
Sampling in August-September should provide dry-weather data for comparison to wet-weather data.

[3] Sampling for most stream water chemistry parameters should include both dry-weather and wet-weather events. A recommended sampling schedule would include 2-4 sampling events (1-2 wet-weather and 1-2 dry-weather events) per quarter.
Stream sampling need only include a single sample taken in mid-channel at mid-depth. Additional monitoring of possible dissolved oxygen sags related to diurnal patterns and/or runoff may be conducted separately during the summer months.
Lake monitoring would include samples taken at multiple discrete depths throughout the water column. Lake sampling is scheduled based upon lake turnover and stratification and need not be tied to individual dry- or wet-weather events.

[4] Stream sampling for *E. coli* may be desired to identify problem areas and sources. Stream sampling for bacteria would follow the same schedule as other water chemistry parameters.
Sampling for *E. coli* at Memorial Beach would be conducted between the Memorial and Labor Day holidays. Sampling could be done weekly or, more intensively, on a schedule of 5 events in each 30 days.

[5] The schedule shown for chlorophyll *a* sampling in lakes is patterned after the MiCorps/ Michigan Cooperative Lakes Monitoring Program schedule for Branch County in 2009.
Chlorophyll a is sampled 5 times during the season on the 15th of May, June, July, and August and within the period of September 24-28.

[6] Lake monitoring with measurements of Secchi disk transparency; meter readings for dissolved oxygen and temperature (minimum) and pH and conductivity (if desired); and water chemistry is generally conducted during one spring and one summer event.
Sampling times include the spring turnover, when the lake is fully mixed, and a late-summer sampling event to determine if summer stratification occurs, and if so, to characterize the lake when fully stratified.
The sampling times shown correspond to the MiCorps/Michigan Cooperative Lakes Monitoring Program 2009 schedule for Branch County. Spring monitoring is to be conducted within the period April 9-13 and late-summer sampling is to be conducted within the dates of September 24-28.

[7] Stream velocity measurements to calculate discharge should be conducted at each stream site a minimum of 6 times to establish a stage-discharge relationship.
If those 6 measurements capture the full range of high and low flows then staff gage readings can be used to estimate discharge for subsequent dates/events.

Table 3. Analytical Methods and Sampling Requirements

Parameter	Detection Limit (mg/L)	Method Reference	Bottle Type	Sample Volume	Preservative	Hold Time
Benthic Macroinvertebrates	----				95% ethyl alcohol	
Total Suspended Solids	10 [1]	EPA 160.2	Polyethylene	250 mL[1]	None	28 days
Phosphorus, Total	0.01	EPA 365.2	Polyethylene		$H2_SO_4$, pH<2	28 days
Escherichia Coli (*E. coli*) Bacteria	1 cfu/100 mL	SM-9223	Plastic		Sodium thiosulfate	8 hrs field/ 24 hrs lab
Phosphorus, Soluble-Reactive	0.01	EPA 365.2	Polyethylene		None	48 hrs [2]
Chlorophyll *a*			Polyethylene	100	None	NA
Nitrogen, Nitrite + Nitrate (NO_2 + NO_3)	0.05	EPA 353.2/300.0	Polyethylene		None	48 hrs
Nitrogen, Ammonia	0.01	SM 4500/350.1	Polyethylene		$H2_SO_4$, pH<2	28 days
Secchi Disk Transparency	----	---	---	---	---	---
Dissolved Oxygen	----	---	---	---	---	---
Temperature	----	---	---	---	---	---
pH (Hydrogen Ion Concentration)	----	---	---	---	---	---
Specific Conductance	----	---	---	---	---	---
Stream Velocity & Discharge	----	---	---	---	---	---

[1] A lower detection limit (1 mg/L) is possible, if necessary, provided adequate sample volume (1 L) and discussion with lab prior to analysis.

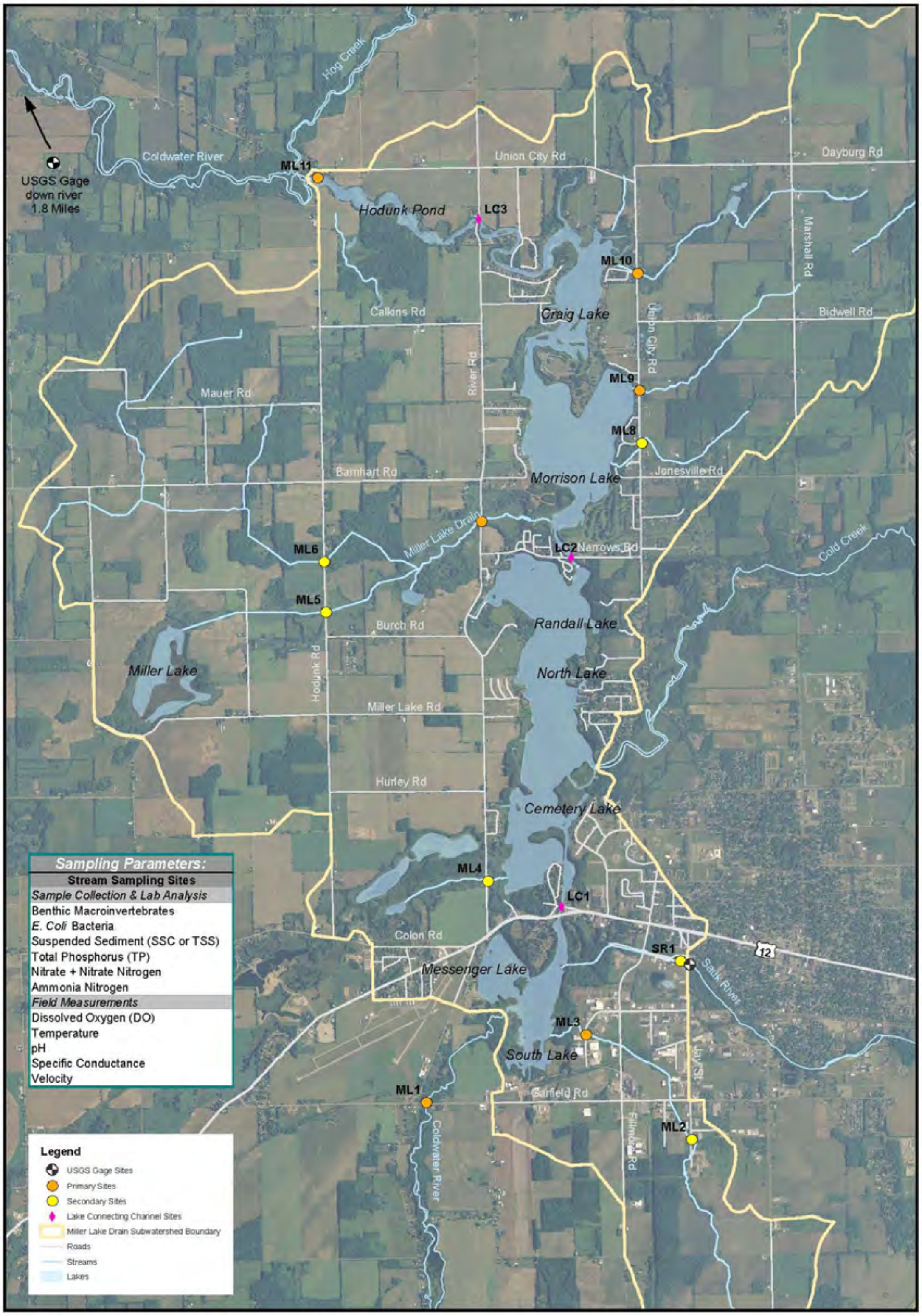
[2] Note that samples should be filtered in the field or delivered to the lab within 4 hours and filtered in the laboratory.

Table 4. Estimated Program Costs

Parameter	Number of Sampling Locations [1]	Number of Sampling Events (per year)	Lab & Equipment Costs: Unit Lab Costs	Lab & Equipment Costs: Unit Equipment Costs	Staffing Costs: Contractual/ Training Costs [2]	Staffing Costs: BCCD Staffing Costs [3]	Estimated Equipment & Analytical Costs: Primary Sampling Locations (10): Macros [4]	Estimated Equipment & Analytical Costs: All Stream Locations (24): Macros	Estimated Equipment & Analytical Costs: Primary Sampling Locations (10): Macros, Meters & Hydro-Geo	Estimated Equipment & Analytical Costs: All Stream Locations (24): Macros, Meters & Hydro-Geo	Estimated Equipment & Analytical Costs: All Primary Stream & Connecting Channel Locations: Macros & Geo (10), Meters, & Analytical (13)	Estimated Equipment & Analytical Costs: All Stream & Connecting Channel Locations: Macros (24) & Geo (10), Meters, & Analytical (27)	Estimated Equipment & Analytical Costs: Bacteria Sampling Memorial Beach	Estimated Equipment & Analytical Costs: Lake Sampling: Additional Costs per Lake	Total Estimated Costs: Primary Sampling Locations (10): Macros	Total Estimated Costs: All Stream Locations (24): Macros	Total Estimated Costs: Primary Sampling Locations (10): Macros + Meters	Total Estimated Costs: All Stream Locations (24): Macros + Meters	Total Estimated Costs: All Primary Stream & Connecting Channel Locations: Macros & Geo (10), Meters, & Analytical (13)	Total Estimated Costs: All Stream & Connecting Channel Locations: Macros (24) & Geo (10), Meters, & Analytical (27)	Total Estimated Costs: Bacteria Sampling Memorial Beach	Total Estimated Costs: Lake Sampling: Assumes 6 Lakes
Benthic Macroinvertebrates	10-24	2		$600 - $1,000 [5]	$9,856	$9,900	$3,000 - $7,000 [1]	$7,200 - $11,200 [1]	$3,000 - $7,000 [1]	$7,200 - $11,200 [1]	$3,000 - $7,000 [1]	$7,200 - $11,200 [1]			$22,756 - $26,756	$26,956 - $30,956	$22,756 - $26,756	$26,956 - $30,956	$22,756 - $26,756	$26,956 - $30,956		
Total Suspended Solids	10-27	2-8	$20			$9,900					$600 [6]	$1,200 [6]		$100 [7]					$600 [6]	$1,200 [6]		$600
Phosphorus, Total	10-27	2-8	$35	$200 [8]							$1,050 [6]	$2,100 [6]		$175 [7]					$1,050 [6]	$2,100 [3]		$1,250
Escherichia Coli (*E. coli*) Bacteria	3	18 [9]	$50								$1,500 [6]	$3,000 [6]	$3,600						$1,500 [6]	$3,000 [6]	$3,600	
Phosphorus, Soluble-Reactive	10-27	2-8	$50 [10]	$200 [11]							$1,500 [6]	$3,000 [6]		$250 [7]					$1,500 [6]	$3,000 [6]		$1,700
Chlorophyll *a*	10-27	5	$50								$1,500 [6]	$3,000 [6]		$300 [11]					$1,500 [6]	$3,000 [6]		$1,800
Nitrogen, Nitrite + Nitrate (NO_2 + NO_3)	10-27	2-8	$40								$1,200 [6]	$2,400 [6]		$200 [7]					$1,200 [6]	$2,400 [6]		$1,200
Nitrogen, Ammonia	10-27	2-8	$30								$900 [6]	$1,800 [6]		$150 [7]					$900 [6]	$1,800 [6]		$900
Secchi Disk Transparency	10-27	$19		$26 [13]																		$26
Dissolved Oxygen	10-27	2-8		$3,295 [14]					$3,295	$3,295	$3,295	$3,295					$3,295	$3,295	$3,295	$3,295		
Temperature	10-27	2-8																				
pH (Hydrogen Ion Concentration)	10-27	2-8																				
Specific Conductance	10-27	2-8																				
Stream Velocity & Discharge	10-27	8		$3,024 [15]	$1,050- $16,950				$3,024	$3,024	$3,024	$3,024					$4,074 - $16,950	$4,074 - $16,950	$4,074 - $16,950	$4,074 - $16,950		
Totals					**$10,906 - $26,806**	**$19,800**	**$3,000 - $7,000**	**$7,200 - $11,200**	**$9,319 - $13,319**	**$13,519 - $17,519**	**$17,569 - $21,569**	**$30,019 - $34,019**	**$3,600**	**$1,175**	**$22,756 - $26,756**	**$26,956 - $30,956**	**$30,125 - $47,001**	**$34,325 - $51,201**	**$38,375 - $55,251**	**$50,825 - $67,701**	**$3,600**	**$7,476**

1 Sampling locations noted in this column include primary and secondary stream sites and the connecting channels between the lakes. Lake sampling stations are noted separately elsewhere.
2 As requested, ASTI has included an estimate of costs to provide training, invertebrate identification, quality assurance, and a summary report for the first year of volunteer monitoring activities.
At the bottom of the column are ASTI's costs for measuring stream flow and conducting a hydro-geomorphic study of the stream channel at the 10 primary sampling sites. Costs presented represent a day-long training session for staff and volunteers or a year-long study conducted by ASTI or other contractor.
3 Costs represent BCCD staff time at $16.50 per hour. 600 hours are included to oversee a volunteer monitoring program for benthic invertebrates. An additional 600 hours per year are included if stream and lake chemistry monitoring are added to the program.
4 Numbers in parentheses indicate the number of sampling locations.
5 Two unit costs are presented, representing the costs of field equipment for each sampling team and the cost of field equipment plus microscopes. The values presented assume that a single sampling team will monitor 2 sites, utilizing the same equipment for each.
Field equipment includes 2-pairs of waders, 2 D-shape nets, 2 white plastic sorting trays, 100 whirly-paks, forceps and 95% ethyl alcohol per team. Some supplies will need periodic replacement or replenishment.
Purchase costs for a single stero microscope and added lighting range from approximately $150 to more than $1,000. The value presented here represents $400 per unit, and assumes the purchase of 10 microscopes, lights, and watch glasses or petri dishes.
It may be possible to borrow laboratory space and stereo microscopes from local schools/colleges, in which case project costs would only need include the purchase of field equipment.
6 Analytical costs include dedicated samples and duplicate samples. Duplicate samples for quality assurance are included at a rate of 1 duplicate per 10 sites/samples, or part thereof.
These costs assume 1 dry-weather and 1 wet-weather sampling event per year (assumed a minimum if stream chemistry is to be monitored). Multiply by 4 or 8 for the recommended schedule of 2-4 total events per quarter (Table 2).
7 Analytical costs for lake sampling assume laboratory analysis of 1 surface sample for the spring turnover event, and 3 samples (from near the surface, the center of the water column, and near the bottom) for the summer sampling event. Costs for a duplicate sample (at one depth) are also included.
8 Cost for a Van Dorn bottle or similar sampling apparatus; required for lake sampling to sample at discrete depths.
9 Assumes 5 sampling events (at 3 stations) per 30 day period, Memorial Day to Labor Day. This is the recommended sampling schedule for monitoring of public beaches by health agencies.
Less frequent sampling could be used to monitor BMP efficacy. Different water quality standards apply for discrete sampling events vs the geometric mean of 5 events per 30-day period.
10 Samples should be either filtered in the field or delivered to the lab within 4 hours for laboratory filtration. Analytical price presented assumes sample filtration in the field. Filtration conducted at the laboratory is available for an additional fee of $30 per sample.
11 Estimated cost for a hand pump operated filtration system for field filtration.
12 Price reflects 5 samples per lake, per year, for chlorophyll *a* following methods used in the Michigan Cooperative Lakes Monitoring Program.
13 Price is for an inexpensive, weighted, plastic Secchi disk with 20 m of unmarked line.
14 Price is for a Yellow Springs Incorporated (YSI) multi-parameter meter (Model 556) with data-logging capabilities. Price includes probes for temperature, dissolved oxygen, pH, and specific conductance, and a 20 m cable for use in lakes.
Note that a single meter may be used to record measurements at all sites. A combination of 1-2 parameter, non-recording meters may be less expensive.
15 Approximate cost for a USGS Type AA current meter, a 4-foot top-setting wading road, digital readout unit, and 300-foor fiberglass measuring tape. Use of headphones and a stop watch may replace the digital readout for a cost savings of approximately $860.
Note that a single current meter, rod, and readout combination may be used to record measurements at all sites. A mini or "pygmy" current meter (instead of Type AA) may be needed for small streams with low velocities.
The cost of a Type AA current meter = $745 (included in cost presented in table); Mini current meter = $545 (not included above). An additional cost of $80 per site is included for staff gages. The cost of staff gages and use of ASTI's velocity meter are included in the contractual costs.

Figures



Hodunk-Messenger Chain of Lakes
Water Quality Monitoring Plan

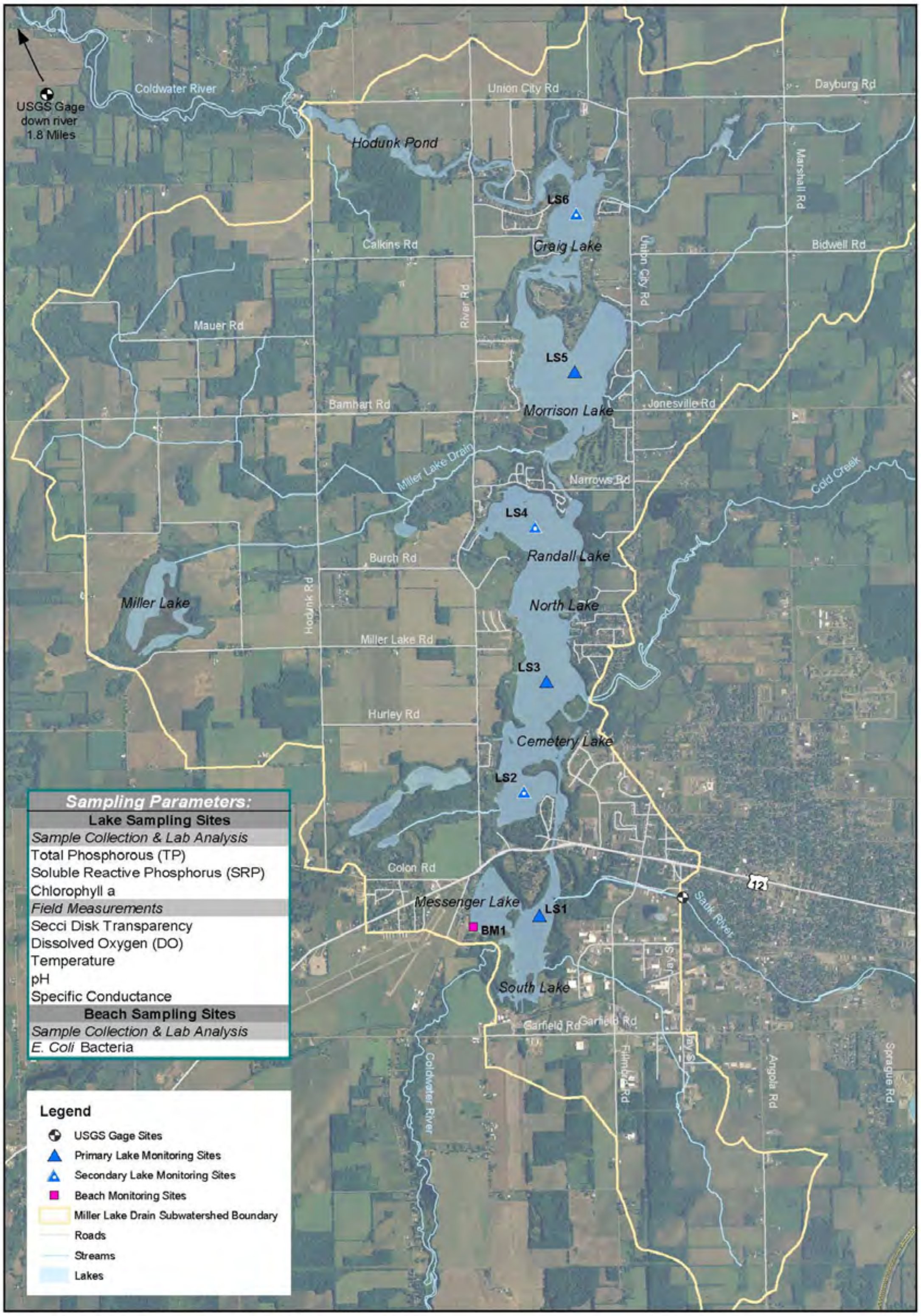
Branch County, MI

3,000 0 3,000 Feet

ASTI Environmental

Created for: Branch County Conservation District
Created by: AGS, March 6, 2009, ASTI Project 6947

Map 1 - Miller Lake Drain Sub-Watershed
Stream Monitoring Sites



Hodunk-Messenger Chain of Lakes
Water Quality Monitoring Plan

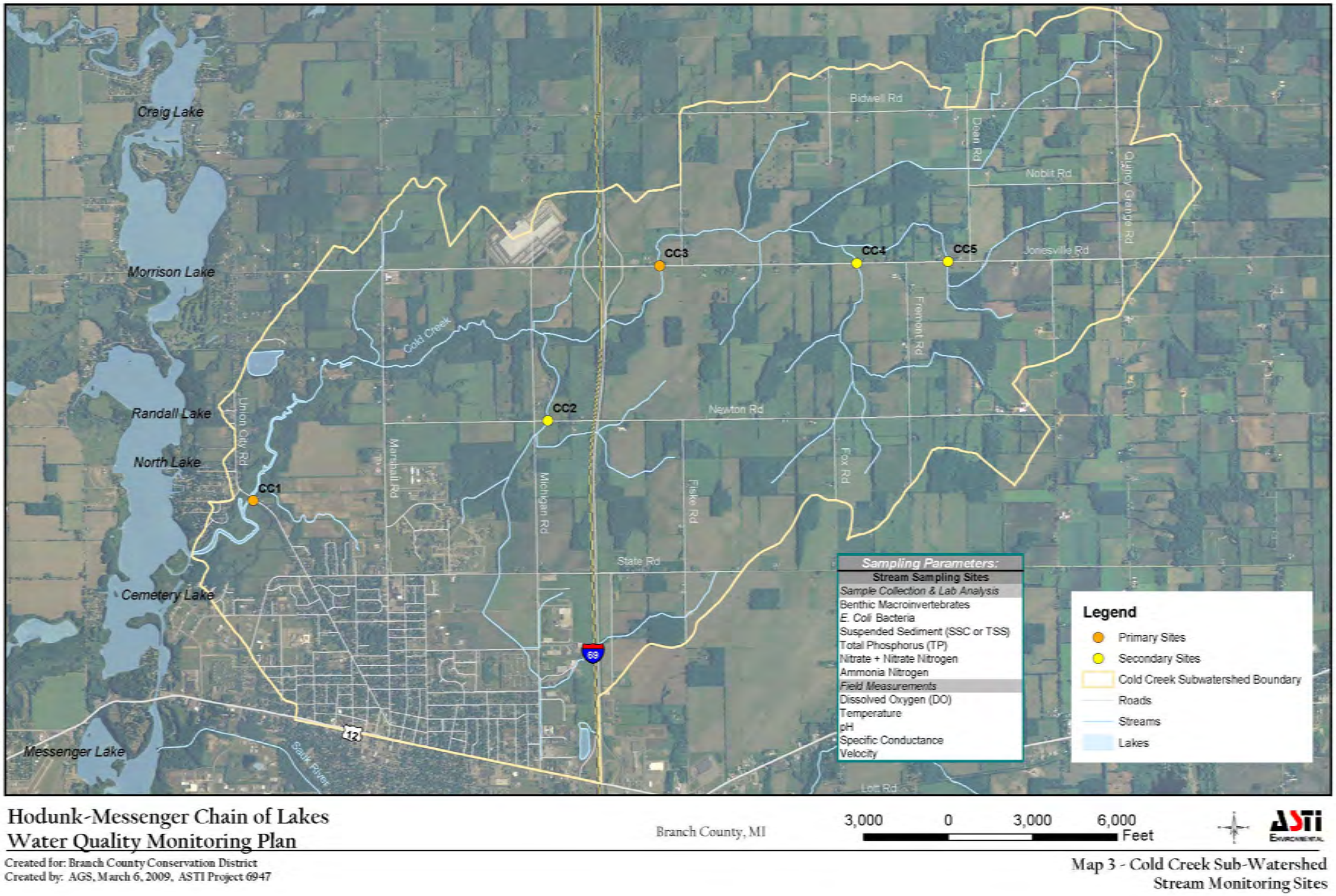
Branch County, MI

3,000 0 3,000 Feet

ASTI Environmental

Created for: Branch County Conservation District
Created by: AGS, March 6, 2009, ASTI Project 6947

Map 2 - Miller Lake Drain Sub-Watershed
Lake Monitoring Sites


Craig Lake
Morrison Lake
Randall Lake
North Lake
Cemetery Lake
Messenger Lake
Sauk River
Cold Creek
Union City Rd
Marshall Rd
Michigan Rd
Fiske Rd
Fox Rd
Fremont Rd
Dean Rd
Quincy Grange Rd
Bidwell Rd
Noblit Rd
Jonesville Rd
Newton Rd
State Rd
Lott Rd
CC1
CC2
CC3
CC4
CC5
69
12
Sampling Parameters:
Stream Sampling Sites
Sample Collection & Lab Analysis
Benthic Macroinvertebrates
E. Coli Bacteria
Suspended Sediment (SSC or TSS)
Total Phosphorus (TP)
Nitrate + Nitrate Nitrogen
Ammonia Nitrogen
Field Measurements
Dissolved Oxygen (DO)
Temperature
pH
Specific Conductance
Velocity
Legend
Primary Sites
Secondary Sites
Cold Creek Subwatershed Boundary
Roads
Streams
Lakes
Hodunk-Messenger Chain of Lakes
Water Quality Monitoring Plan
Created for: Branch County Conservation District
Created by: AGS, March 6, 2009, ASTI Project 6947
Branch County, MI
3,000 0 3,000 6,000 Feet
ASTI Environmental
Map 3 - Cold Creek Sub-Watershed
Stream Monitoring Sites

Hodunk-Messenger Chain of Lakes
Water Quality Monitoring Plan

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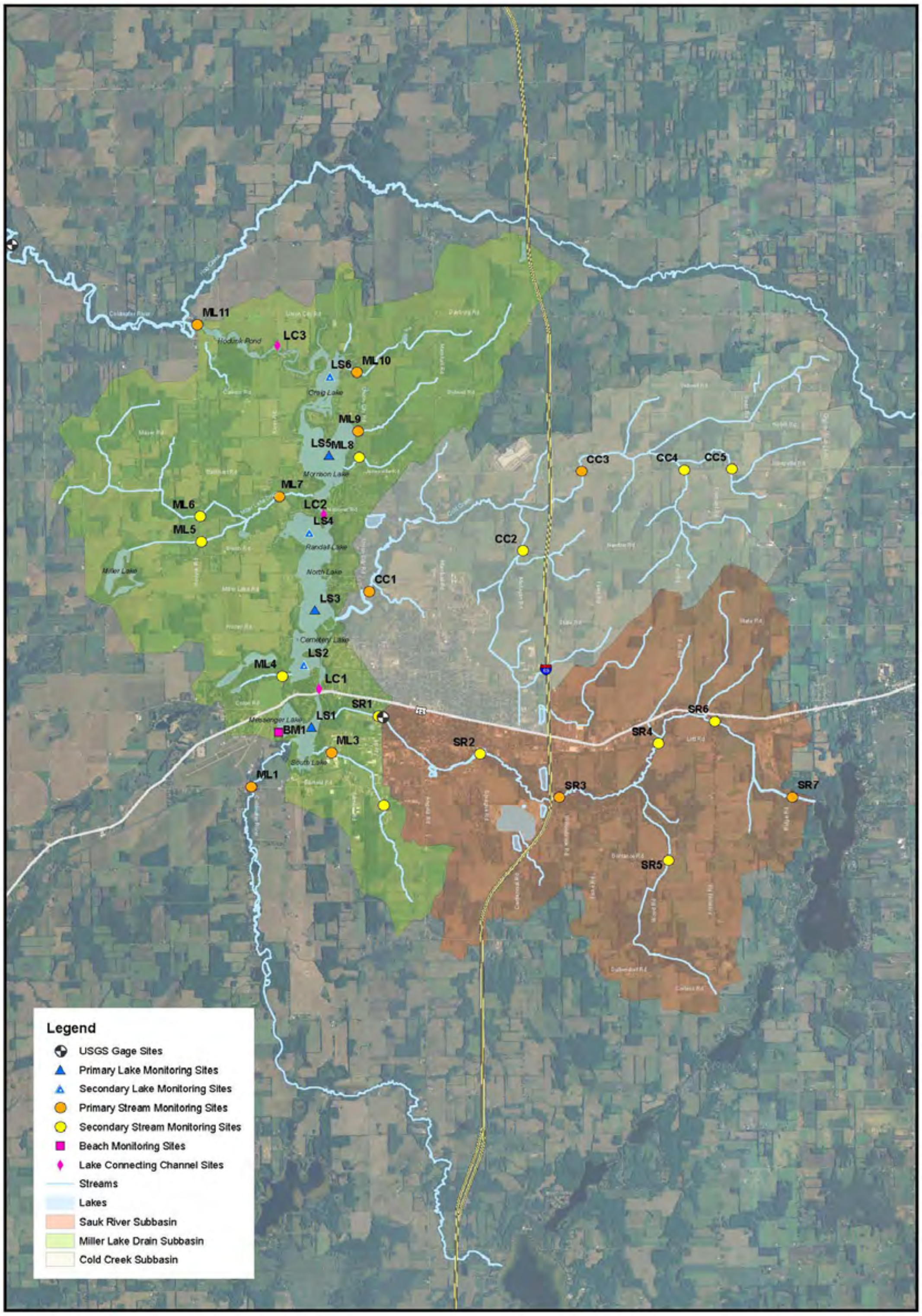
Branch County, MI

ASTI Environmental

Map 4 - Sauk River Sub-Watershed
Stream Monitoring Sites



Hodunk-Messenger Chain of Lakes
Watershed Water Quality Monitoring Plan

Branch County, MI

6,000 0 6,000 Feet

ASTI Environmental

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Created by: AGS, March 6, 2009, ASTI Project 6947

Map 5 - Hodunk-Messenger Chain of Lakes Watershed
All Sampling Sites

Appendix A
Suggested Sampling Equipment and Method References

Appendix A: Sampling Equipment & Methods References

Macroinvertebrate Sampling Equipment

- 500-micron, D-frame kick/sampling nets
- White plastic sorting trays
- Forceps
- 70 or 95% ethyl alcohol (ethanol)
- Sampling jars and lids
- Jar labels
- Stereo dissecting microscope

Flow/Velocity Measuring Equipment

- Type AA and/or Mini (Pygmy) current meter
- Headphones
- Scientific Instruments Model 9000 Digimeter or other digital readout
- 4 or 6-Foot Top-setting wading rod
- Stopwatch
- Measuring tape (100' nylon – open reel)
- Tent stakes (2 – for securing measuring tape)

Lake Monitoring Equipment

- Boat and anchor
- Secchi disk and measured line
- Composite sampler and measured line
- Multiparameter (DO, Temperature, pH, Conductivity) meter with 20 m cable
- Calibration solutions
- Filtration system
- Sample bottles with labels and preservative (as appropriate)
- Sharpie™ permanent markers
- Cooler and ice pack(s)
- Van Dorn bottle (or similar apparatus for sampling at discrete depths) with measured line and weighted messenger

Stream Chemistry Monitoring Equipment

- Multiparameter meter
- Calibration solutions
- Filtration system
- Sample bottles with labels and preservative (as appropriate)
- Cooler and ice pack(s)
- Mosquito dipper or other grab sampler

General Sampling Equipment

- Chest waders
- Polarized sunglasses and/or safety glasses
- Latex/Nitrile gloves
- Project-specific sampling data forms
- Waterproof field notebook
- Sharpie™ permanent markers
- Copies of monitoring procedures
- Digital camera
- Alconox phosphorus-free soap for equipment decontamination

- Distilled or de-ionized water

Safety Equipment

- Orange traffic vests (as appropriate)
- Traffic cones (as appropriate)
- Magnetic-mount Flashing Lightbar (as appropriate)
- High beam flashlight(s)
- Rain gear
- Cell phone
- PFD/life jacket
- First aid kit

Useful Methods References

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

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MiCorps. 2009. Cooperative Lakes Monitoring Program Dissolved Oxygen and Temperature Monitoring Procedures (YSI Model 95D). http://www.micorps.net/documents/DO&TempPROC_YSI-95D-09.pdf

MiCorps. 2009. Cooperative Lakes Monitoring Program Phosphorus Monitoring Procedures. http://www.micorps.net/documents/PhosphorusPROC-09.pdf

MiCorps. 2009. Cooperative Lakes Monitoring Program Secchi Disk Transparency Monitoring Procedures. http://www.micorps.net/documents/SecchiPROC-09.pdf

U.S. EPA. 1997. Volunteer Stream Monitoring: A Methods Manual. U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA 847-B-97-003, November 1997. http://www.epa.gov/volunteer/stream/stream.pdf

Appendix C

Messenger Lake Report

Background

In 2002, Messenger Lake, which is located in the southern reaches of the Hodunk-Messenger Chain of Lakes in Branch County, was recognized on MDEQ's 303(d)/305(b) Integrated Report for not attaining the surface water designated use of total body contact recreation between May 31 and October 1. This non-attainment status was attributed to the high level of pathogens found in water samples taken from Memorial Park Beach on Messenger Lake. This nonpoint source (NPS) pollutant has remained through 2008, when Messenger Lake was again listed on the 2008 Integrated Report for the same reasons.

In order to reduce the amount of pathogens to healthy levels and restore the contact recreation designated use in Messenger Lake, a Clean Water Act Section 319 Watershed Planning Grant was awarded to Branch Conservation District in 2006 to discover the sources and causes of this pollutant. Additionally, a total maximum daily load (TMDL) parameter is set to be established in 2017. Since Messenger Lake exhibits the only State recognized impaired designated use in the Hodunk-Messenger Lake Watershed, priority has been given to restoring the water quality of this site. In order to better understand the extent of pathogen pollution and its sources and causes, the local health department in Branch County was consulted during the 319 Watershed Planning Project and the following data was obtained.

Summary of Beach Water Sampling Data

The Branch-Hillsdale-St. Joseph Community Health Agency reports that water quality samples were taken from Memorial Park Beach in the summer of 2002. These water samples were analyzed for fecal coliform content. The results of these samples are listed below:

Table C-1: **2002 Memorial Park Beach Water sampling data**

Date	Site	Results (per 100 ml water)
7/24/2002	West swimming beach	3,300 fecal coliform organisms
8/22/2002	All 3 docks at Memorial Park	<10 *E. coli*

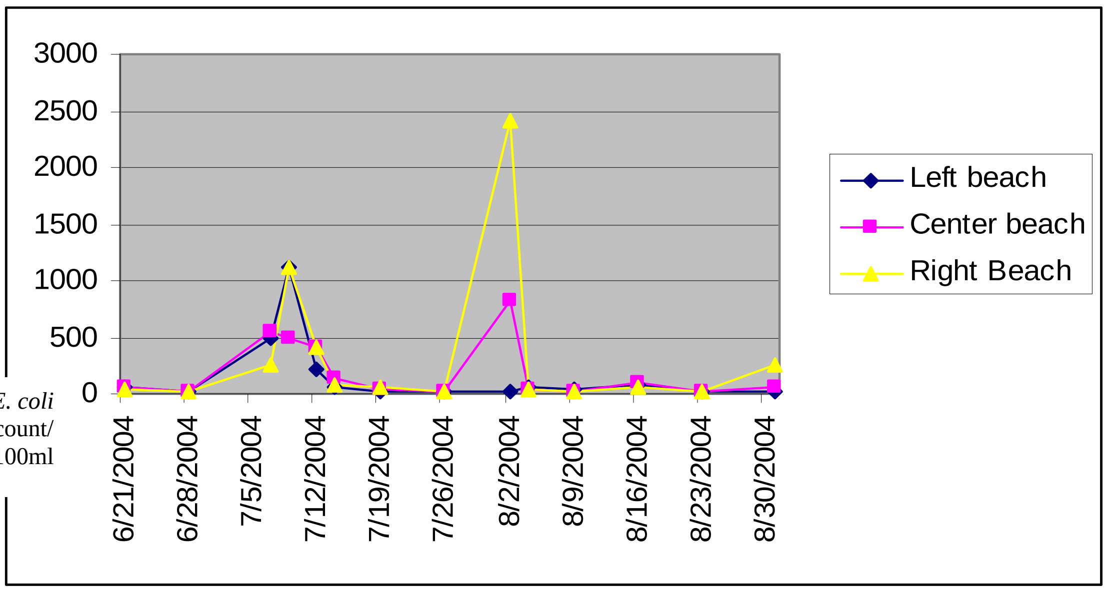
The Community Health Agency also supplied data from a beach water monitoring program that was conducted at Memorial Park Beach in 2004. Unlike 2002, the 2004 monitoring program was more specific in that it was analyzed for the E. coli bacterium. Beach water sampling in 2004 was made possible through an MDEQ Beach Water Sampling Grant. The results of the 2004 beach water monitoring program are compiled in the following table and graph. It is important to note that the water quality standards for Michigan (set forth in Part 4 of the Natural Resources Act of 1994) define the maximum *E. coli* level for allowing safe total body contact is set at a threshold of 130 *E. coli* count/100 ml of water.

Table C-2: **2004 Memorial Park Beach Water sampling data**

	E. coli per 100 ml of Water			
Date	**Left beach**	**Center beach**	**Right Beach**	**Comments**
5/24/2004	8	7	15	
6/1/2004	6	4	7	
6/7/2004	10	84	3	
6/14/2004	77	46	N/A	
6/21/2004	55	52	35	
6/28/2004	19	24	22	
7/7/2004	488	548	248	
7/9/2004	1120	488	1120	Turbid & green
7/12/2004	219	411	411	Turbid & green

7/14/2004	61	131	88	Turbid & green
7/19/2004	25	34	67	
7/26/2004	12	15	15	Turbid & green
8/2/2004	27	816	2419	Turbid & green
8/4/2004	53	37	41	Turbid & green water. Drizzling
8/9/2004	36	10	22	Turbid & light brown
8/16/2004	71	93	50	
8/23/2004	15	17	23	
8/31/2004	28	57	248	Smells fishy
Average *E. coli* Level	129.44	159.67	268.56	

Figure C-1: **2004 Memorial Park Beach Water sampling results graph**



Discussion and Conclusions

The *E. coli* bacterium only comes from 2 sources: human waste or other warm-blooded animal waste. Since Messenger Lake and the connected South Lake are the upstream-most lakes in the Hodunk-Messenger Chain of Lakes with little development found along their shorelines, the possibility of septic leaching contributing to *E. coli* levels is unlikely. Moreover, Coldwater's municipal waste water treatment facility effluence enters the chain of lakes downstream of Messenger Lake and therefore has no chance of flowing upward to the Memorial Park beach waters. Given these facts, the cause of this *E. coli* pollution at the Memorial Park beach has been predicted by the Community Health Agency to most likely be limited to one of two sources (or, a combination of both): animal waste at the beach or human waste contamination stemming from the public campground found at Memorial Park along the shores of Messenger Lake.

Although there have been unconfirmed complaints of sewage dumpage directly into the surface water at the Memorial Park Campground, the Community Health Agency indicates that the source of *E. coli* contamination is most likely goose feces deposited from the over-abundant population of Canada geese that commonly inhabit the shoreline of Messenger Lake. In addition, the Health Agency indicates that improper beach management practices (raking feces from the shore to the water) have exacerbated the problems during past periods of water quality monitoring.

Memorial Park and Memorial Park Beach offer prime goose habitat with its shallow waters, absence of tall shoreline vegetation, ease of access, and availability of turf grass for grazing. During the summer months, hundreds of geese congregate in and around Memorial Park, leaving an estimated average of 0.1 lbs (45.36 g) of waste per goose per day[2]. With an estimated 1,530 colonies of fecal coliforms in each gram of goose excrement[1], it can be derived that every goose at Memorial Park has the potential of depositing 69,400.8 colonies of fecal coliform at Memorial Beach every day. The percentage of fecal coliform colonies that are *E. coli* colonies can be highly variable (0-97.4%[4]). A widely recognized "rule-of-thumb" has not been established for *E. coli* content in for waterfowl waste, although one study conducted by USDA-APHIS[8] suggests that *E.coli* content in goose feces averages about 13% of the total fecal coliform organisms during the warm summer months when nonmigratory geese dominate the local waters. Using this calculation, it can be estimated that every "resident" goose around Messenger Lake has the potential to deposit 9,022.1 *E.coli* organisms per day. For the purpose of estimating potential loads in the Hodunk-Messenger Chain of Lakes Watershed, the 13% E.coli content ratio was utilized. Although this figure may not be exactly appropriate for all times of the year, it can at least be concluded that the amount of *E. coli* colonies increase as overall fecal coliform colonies, and therefore the overall number of geese, increase.

In addition to pathogens, goose waste also presents a real threat for phosphorus (P) contamination. One study shows that geese have the potential of generating 2.2 times more grams of P in a day than dabbling ducks, and 2.6 times more grams of P than diving ducks[3]. Another study[5] shows that geese can contribute three times more grams of P per day than mallards, 4.5 times more than other duck species, and 3.6 times more grams of P than other water birds (cranes, herons, egrets, etc). When one also takes into account the greater abundance of Canada geese over other species of waterfowl on the Hodunk-Messenger Chain of Lakes, the threat of degraded water quality is compounded.

While the Community Health Agency has not indicated that Mute swans are a possible source of *E. coli* contamination at the beach, they are certainly being taken into consideration for management. Concerned citizens on Morrison Lake (also Hodunk-Messenger Lake Chain) in 2007 and 2008 have consecutively observed over 100 individual Mute Swans on Morrison Lake in one day. Mute swans are known to generate more waste than Canada geese but there is currently no data available on the nutrient/ bacteria content of their waste, nor are there any recorded observances of their presence on Memorial Lake.

Not only do the results of the Community Health Agency reflect a severe *E. coli* contamination of the beach waters at Memorial Park beach in 2004, they also indicate that *E. coli* levels tend to spike in early-mid July and again in early August. Results also indicate that *E. coli* levels are highest in the "right beach" area. Further investigations should be conducted at Memorial Park to determine the specific cause of the *E. coli* elevation in the "right beach" area. Although more data is needed to be conclusive, one might also assume that more pathogen loading takes place around the beach areas than does around the dock areas, based on a comparison of the 2002 to 2004 data.

References

[1] Seasonal Enumeration of Fecal Coliform Bacteria from the Feces of Ring-Billed Gulls (*Larus delawarensis*) and Canada Geese (*Branta canadensis*), K. A. ALDERISIO* AND N. DELUCA, *New York City Department of Environmental Protection, Bureau of Water Supply, Quality, and Protection, Division of Water Quality Control, Valhalla, New York 10595*, Received 27 April 1999/Accepted 1 October 1999

[2] Lake Merritt Canada Goose Management Study, July 2007, *Jones & Stokes*

[3] Scherer, N., H. Gibbons, K. Stoops, and M. Muller. 1995. Phosphorus loading of an urban lake by bird droppings. *Lake and Reservoir Management* 11(4):317-327.

[4] Comparison of Total Fecal Coliform Bacteria and E. *coli* in Pond vs. Lake Waters by: Amy Bieniek & Stacy Koprowski, 11/30/00

[5] Manny, B.A., W.C. Johnson and R.G. Wetzel. 1994. Nutrient Additions by Waterfowl to Lakes and Reservoirs: Predicting Their Effects on Productivity and Water Quality. *Hydrobiologia* 279/280:121-132.

[6] 2004 Beach Water Sampling data, Branch-Hillsdale-St. Joseph Community Environmental Health Agency, 2008.

[7] 2002 Beach Water Sampling data, Branch-Hillsdale-St. Joseph Community Environmental Health Agency, 2008.

[8] *Avian Diseases: Carriage of Bacterial Pathogens by Canada Geese and Blackbirds*, USDA-Animal and Plant Health Inspection Service, 2004

Appendix D

Summary of Volunteer Storm Sewer drain Inlet Marking in Coldwater, 2008

Background

According to City of Coldwater public works officials, the municipal storm sewer in Coldwater currently covers 100% of the city, with future plans for expansion to the area north and northeast of the City as it develops. The City also states in a 1998 city ordinance that new and re-developments established in Coldwater are in some way required to treat stormwater on-site. In most cases, this involves some form of stormwater retention and a controlled, delayed release to the existing municipal storm sewer system at a release rate of which the downstream system can transport. If soils on a new development site prohibit infiltration, then a detention basin is allowed. However, most developments located between Michigan Avenue, State Road, Garfield Road and the chain of lakes pre-date the city ordinance requiring on-site stormwater treatment (1998). Therefore, stormwater falling on the impervious surface in these areas runs directly into the existing storm sewer system infrastructure. This stormwater runoff is then conveyed directly to one of several discharge points along either the Sauk River or to an interconnected series of wetlands that fringe Mud Creek and the eastern side of the North Lake.

Contrary to popular belief, the stormwater entering the municipal storm sewer system does not undergo treatment at a waste water treatment facility. Instead, stormwater that becomes contaminated with nonpoint source (NPS) pollution as it runs over land gets washed into storm drain inlets and is carried directly to nearby surface water bodies. One of the missions of the Hodunk-Messenger Chain of Lakes Watershed Planning Project was to conduct a preliminary inventory of Coldwater's storm sewer system in order to roughly quantify the amount of potential contamination sites within the Hodunk-Messenger Chain of Lakes Watershed's urban area. Inventories were concentrated to the area of the city west of Michigan Avenue, east of the Chain of Lakes, north of Garfield Road and of State Road because of the predominance of older establishments with no on-site water storage. It was presumed that this core area of the city was most responsible for the greatest amount of direct runoff to the storm sewer system, since the overwhelming majority of establishments in this area pre-date the city's on-site stormwater treatment ordinance.

Once the inventory was completed, a follow-up volunteer storm drain marking project was organized for the purposes of raising stormwater awareness and building a sense of watershed ownership amongst the local community. At the time of inventory, no storm sewer system GIS data or storm sewer system monitoring data had been collected by the city of Coldwater.

Description of Project

As earlier stated, this storm drain project was a two-phase effort. The first phase consisted of data collection, while the second phase consisted of building public awareness of the data.

Data Collection

The first watershed project task involving the City's storm sewer system was to canvas the city in vehicles and mark every storm drain inlet with handheld Global Positioning System (GPS) receivers. This marking effort allowed for permanent documentation of storm drain locations, helped identify and record NPS pollution hotspots and accurately quantified the number of drain inlets in the city.

Storm drain Inlet Marking

The second watershed project task associated with the Coldwater's stormwater system project was to organize a volunteer drain inlet marking project. The goal of this task was to raise awareness of stormwater's influence on surface water quality by having volunteers adhere colorful placards with pre-cast messages warning the public of the connection to surface water to the tops of curb-side storm drain inlets.

Methodology

Data Collection

In March of 2008, several resource professionals from the South-central Michigan area gathered in Coldwater for the purpose of collecting waypoints (GPS data points) for every storm drain inlet in Coldwater. These volunteers split up into four groups of two, each pair with their own vehicle. Each group took a separate area of Coldwater; corresponding to one of the four city wards. One USDA backpack GPS unit and one City map was sent with each group.

Drain inlet waypoints were taken, or “marked”, as the vehicle slowly rolled over or near the storm drains. Even though they were unsuitable for adhering markers, grates and manhole covers were marked as waypoints along with the curb inlets. These inlets were not distinguished or recorded separately from curb-side inlets.

Generally, satellite reception throughout the day kept the GPS units accurate to within 18 feet. Once the information was collected with the portable GPS units, it was later uploaded into geographic information system (GIS) programs for future reference and mapping purposes.

Storm drain Inlet Marking

In May of 2008 and again in October of 2008, several dozen students and other community volunteers gathered in Coldwater to attach circular, vinyl markers to the storm drain inlets throughout the city. Volunteers split up into small groups of 4-6 and dispersed into different areas of the City. Groups were equipped with maps of storm drain inlet locations, storm drain markers, industrial adhesive, rubber mallets, rubber gloves, whisk brooms and educational door hangers. Groups would apply adhesive to the back of markers and then proceed to tamp them down by hammer onto a level, clean surface on the top of a curb-side storm drain inlet.

While some individuals participated in actually sealing the markers down, others would distribute educational door hangers to the nearby households. The educational door hangers explained the marking project as well as provided useful tips on reducing NPS pollution. Once a location was completed, the site was marked on a map so as to preserve a tally of marked storm drains.

Discussion

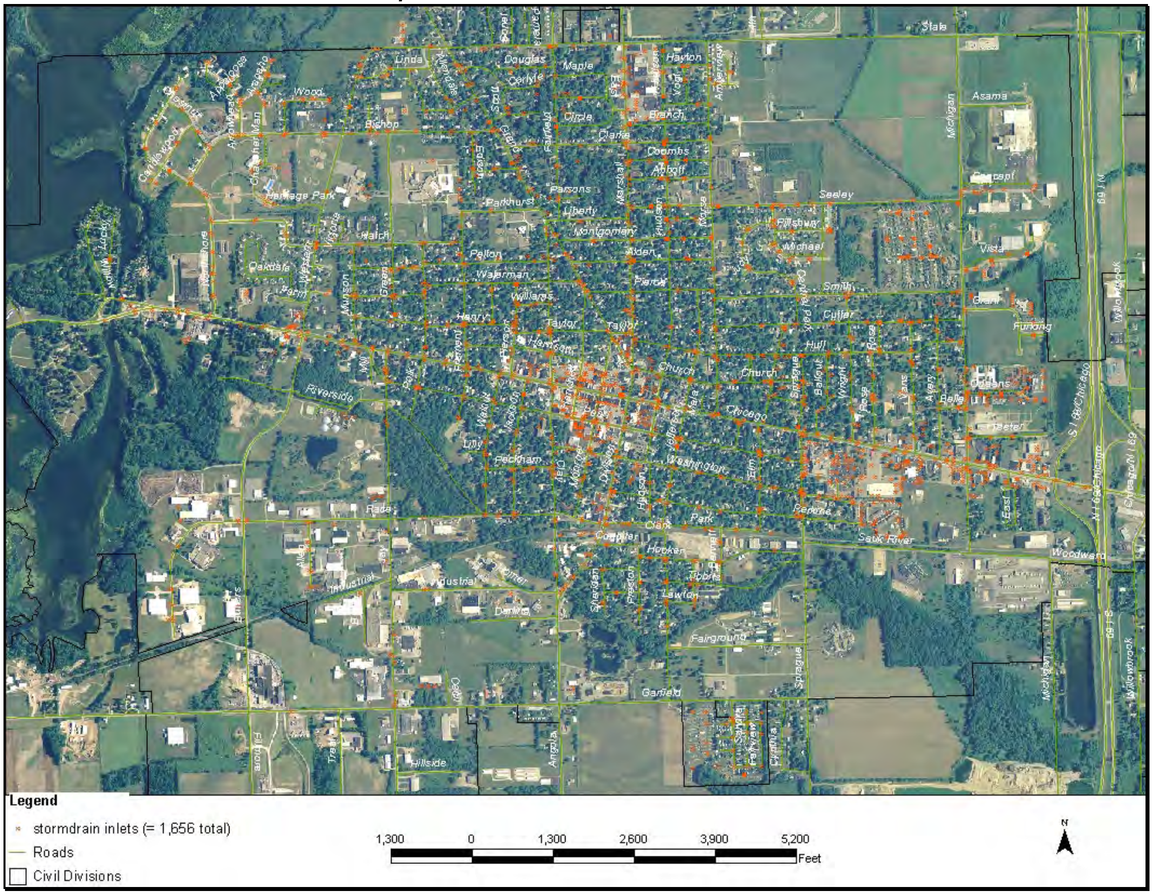
Many storm drain inlets were obscured from view by overgrown turf/sod, leaf piles, garbage, and other debris. In many cases, identification of hidden drain inlets was only made possible by the presence of a corresponding inlet on the opposite side of the street. *Map D-1* may be hard to observe, but many street-side drain inlets were found opposite of each other.

An unexpected outcome of the storm drain marking project was vandalism. Although widely accepted, this stewardship project was short lived among several blocks due to removal of the placards. Anecdotally, the City of Coldwater is now looking into installing pre-labeled, molded storm drain inlets when doing road construction work.

Results/Conclusion

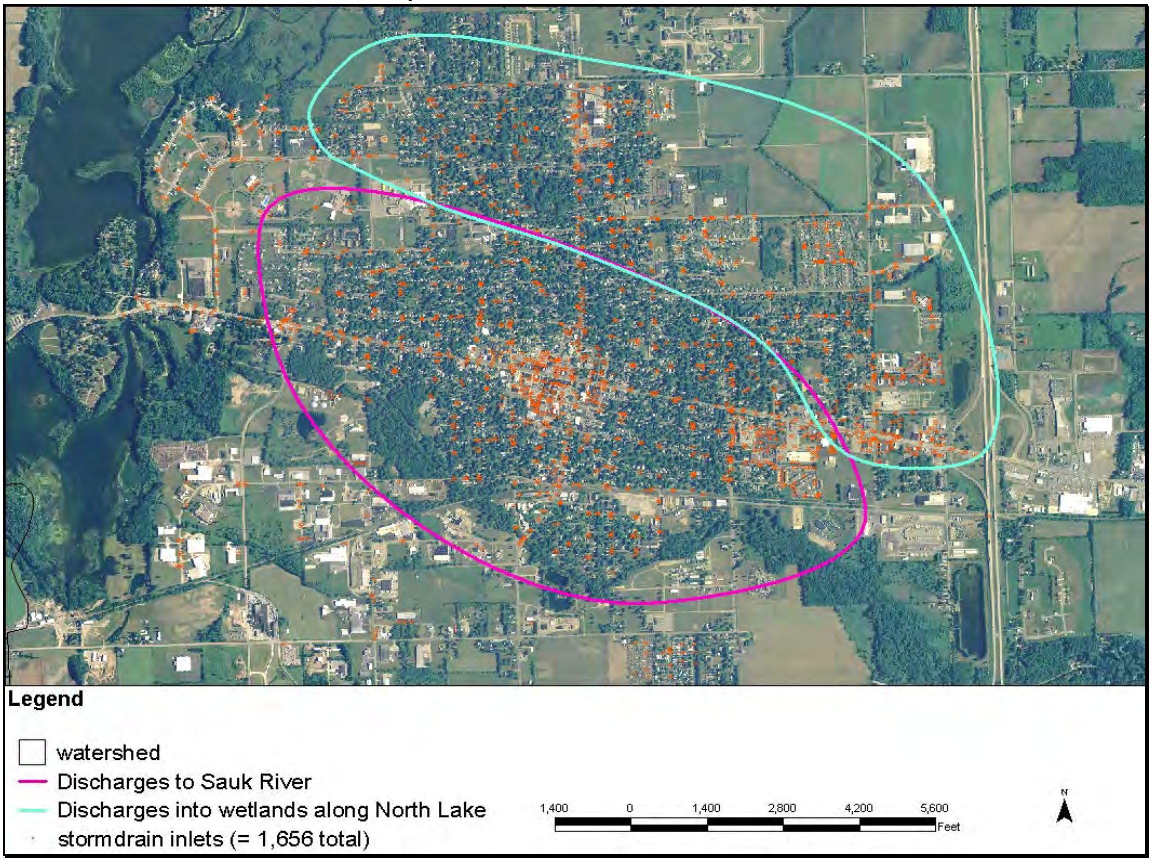
In total, 1,656 storm drains (*Map D-1*) were identified and marked within the boundaries of Michigan Ave, State Rd, Garfield Rd and the chain of lakes. Since this area is roughly 2,400 acres in size, it could be concluded that, on average, each storm drain inlet captures runoff from approximately 1.4 acres of urban land cover. When compared to City of Coldwater storm sewer infrastructure designs, it can also be concluded that roughly 1503.9 acres are drained to the Sauk River, while 607 acres are drained toward the chain of lakes (*Map D-2*).

Map D-1: **Storm drain inlets in Coldwater**



These estimates were derived from storm sewer infrastructure maps (not featured in this report) provided to the Conservation District from the City of Coldwater Engineering Department. Although dated, these maps provided the greatest amount of insight to the direction of flow of Coldwater's stormwater runoff. *Note:* this map is only intended to be a rough approximation of Coldwater's storm sewer infrastructure, based blueprint interpretations.

Map D-2: **Stormwater fate in Coldwater**



As a result of the two volunteer storm drain marking days, nearly 400 storm drain markers were applied throughout the city. To amplify the informational and educational success of the markings, over 800 informational door hangers were also distributed throughout the neighborhoods where marking took place. Several press releases and radio spots were also administered in conjunction with the volunteer marking days.

Appendix E

Landscape Alteration Study of Hodunk-Messenger Chain of Lakes Watershed in Branch County, Michigan

Background

Due to the predominate agricultural land use in the Hodunk-Messenger Chain of Lakes Watershed, it was deemed appropriate that an in depth landscape alterations study was to be conducted. The purpose of the analysis was to quantify the amount of disruption the natural landscape has undergone since European settlement. When land is cleared and developed, many valuable ecological services are lost. Such services include soil stabilization, water storage, nutrient uptake, wind breaks, wildlife habitat, shade (cooler water temperatures), recharge of groundwater supplies and pollutant filtration. To varying degrees, these losses are often permanent. Experience has proven that as land development increases in a watershed, so does the amount of nonpoint source (NPS) pollutant loads. The goal of this study was to obtain a reasonable estimate of the extent of land alteration that has taken place so that the current sources of pollutants could be better understood. The quantifiable amounts of landscape alteration derived in this study will also serve as baseline data for future land development or restoration efforts to be measured against.

Description of Analysis

Three watershed attributes were analyzed in this study: riparian buffer loss, land development and stream channelization. These factors were analyzed on a sub-watershed basis and used to rank sub-watersheds by priority. Priority was determined by the greatest amounts of riparian buffer loss, urban growth, and amounts of stream meander loss. The data generated in this study is also intended to serve as supplemental background information to the wetlands status and trends study conducted by MDEQ LWMD in 2008.

Methodology

Riparian Buffer Loss

Riparian buffer loss, for the purposes of this study, was defined as any riparian area (land bordering surface water) that has not retained a desirable 30 feet of permanent vegetation (not a crop seasonal). The advantages of pristine, natural vegetation areas are considerable, but for purpose of filtering polluted runoff, any 30 foot stand of vegetation that borders a water body from development or agriculture will suffice. For this reason, natural vegetation was not a factor in tabulating square feet of riparian buffer. The riparian buffer analysis was conducted by using geographic information system (GIS) land cover/land use resource and analysis tools. All metadata utilized was established and provided by USDA-NRCS MI.

Steps for Riparian Buffer Loss Analysis:

1. By using the ArcGIS 9.0 program, the Hydrologic Unit Code (HUC) number 000405000108 watershed delineation (Hodunk-Messenger Chain of Lakes Watershed) and the hydrology layer for Branch County (hydro_l_mi023.shp) were imported from “f:\geodata\” and overlaid.
2. The hydrology layer for the county was then clipped by the watershed boundary. The resulting hydrology layer clip output contained all streams found within the watershed; 208,355.06 feet (39.46 miles) in all.
3. A 30-foot buffer layer was then generated for the watershed hydrology layer clip output. This consisted of 30 feet outward on either side of a stream. Any overlaps between buffer boundaries caused by meanders or oxbows in a stream were dissolved.
4. The resulting buffer layer was overlaid onto the USDA’s 2001 National Land Cover Dataset (NCLD).
5. The NCLD layer was filtered so that only developed or cultivated land covers were visible (e.g. agriculture, urban, residential and recreational land).

6. Square footage of overlapping area between the remaining modified land covers and the hypothetical buffer layer was then calculated. This calculation represents the total amount of lost riparian buffer in the Hodunk-Messenger Watershed.

7. All urban land cover types were then removed from the watershed layer. These areas represent developed areas that have a low probability of being reverted back to vegetative buffers.

8. The remaining land cover types (row crops, pastureland and recreational areas) represented areas that have a higher chance of having riparian buffers implemented on them. The area where the 30-foot buffer overlapped these remaining polygons was then calculated. (*Note: a USDA-FSA query was run for all CRP established Riparian Bird Buffers in Branch County, but none were found to be located within the boundary of the Hodunk-Messenger Watershed).*

Human Land Use Activity/Landscape Alteration Analysis

By calculating acreage of agricultural, urban, residential and recreational land cover types found within the watershed, the amount of "natural area" in the watershed is determined.

Steps of Human Land Use Activity/Landscape Alteration Analysis

1. By using the ArcGIS 9.0 program, the USDA-NRCS HUC 000405000108 watershed delineation shapefile (c:\documents\unzipped\watershed\extended_watershed.shp) and pre-settlement National Land Cover Dataset (NLCD) for Branch County (f:\geodata\presettlement_ncld_023mi.lyr) were imported to northchain_watershed.mxd ArcGIS project.

2. The watershed delineation shapefile was used to clip the pre-settlement nlcd dataset.

3. A summary was then run on the acreage of land cover types in the resulting pre-settlement land cover clip output.

4. The same process (Steps 1-3) was then run for Branch County's 2001 NLCD layer. The acreage summaries of the tow land cover layers were then compared.

5. Shapefiles of the three sub-watersheds in the Hodunk-Messenger Watershed were then imported (c:\documents\unzipped\watershed\CCSW.shp, MLDSW.shp and SRSW.shp) and applied to both the pre-settlement and present-day land cover datasets. The same clipping and land cover type summarizing processes (steps 1-3) were then run for each sub-watershed. Acreage summaries were again run for each land cover layer for each sub-watershed.

Stream Meander Analysis

In light of having no pre-settlement hydrologic layer available for Branch County, aerial images were instead utilized for determining areas of major stream alterations in the Hodunk-Messenger Watershed. Aerial photographs of Branch County from 1938 are kept on file in the annals USDA-NRCS Coldwater field office. Since these documents were on hand during the Hodunk-Messenger Watershed Planning Project, they were utilized as a baseline reference for assessing stream meander loss. The goal of comparing the 1938 imagery to present day imagery was to discover any major discernable changes to the three major waterbodies in each of the three sub-watersheds: Cold Creek, Miller Lake Drain and Sauk River. Although a more comprehensive approach to documenting stream straightening would have been to compare present day stream meanders to pre-settlement stream meanders, the images from 1938 were the most valid historic information known to be available at the time of the assessment. There is no photo documentation of the watershed prior to 1938 and all available GIS hydrology data is based on relatively current stream morphologies.

Steps for Stream Meander Analysis:

1. All 1938 aerial photographs that were involved in the depiction of the land area of the Hodunk-Messenger Watershed were sorted out from the entire compilation of 1938 Branch County aerials. The required photographs were: 1938 Branch County aerial # 2-33, 2-34, 2-35, 2-37, 2-39, 2-41, 2-57, 2-59, 2-61, 2-63, 2-65, 2-67, 4-80, 4-82, 4-84, 5-7, 5-9, 5-11, 5-13, 5-15, 5-31, 5-33, 5-35, 5-37, 5-39 and 5-41.

2. The photographs were then arranged in geographic and spatial relationship to one other so that the entire watershed was represented in unity.

3. The number of significant bends in Cold Creek, Miller Lake Drain, and Sauk River were then counted. Significant bends, for the purpose of this analysis, were classified as stream bends that changed the direction of stream flow over 45%. *Note:* all bend angles were based on estimations. However, significant bends were only counted if they appeared to be a corner vertex in a stream meander.
4. Due to time constraints, only the three most major tributaries of the Hodunk-Messenger Chain of Lakes Watershed had their significant bends tallied.
5. While working with the 1938 imagery, general observations of the watershed landscape were also recorded if they appeared to have significance or relevance.
6. The same process of stream bend counting was then performed on 2006 NAIP imagery of the watershed. Numbers of significant bends in 1938 and 2006 were then compared.

Discussion

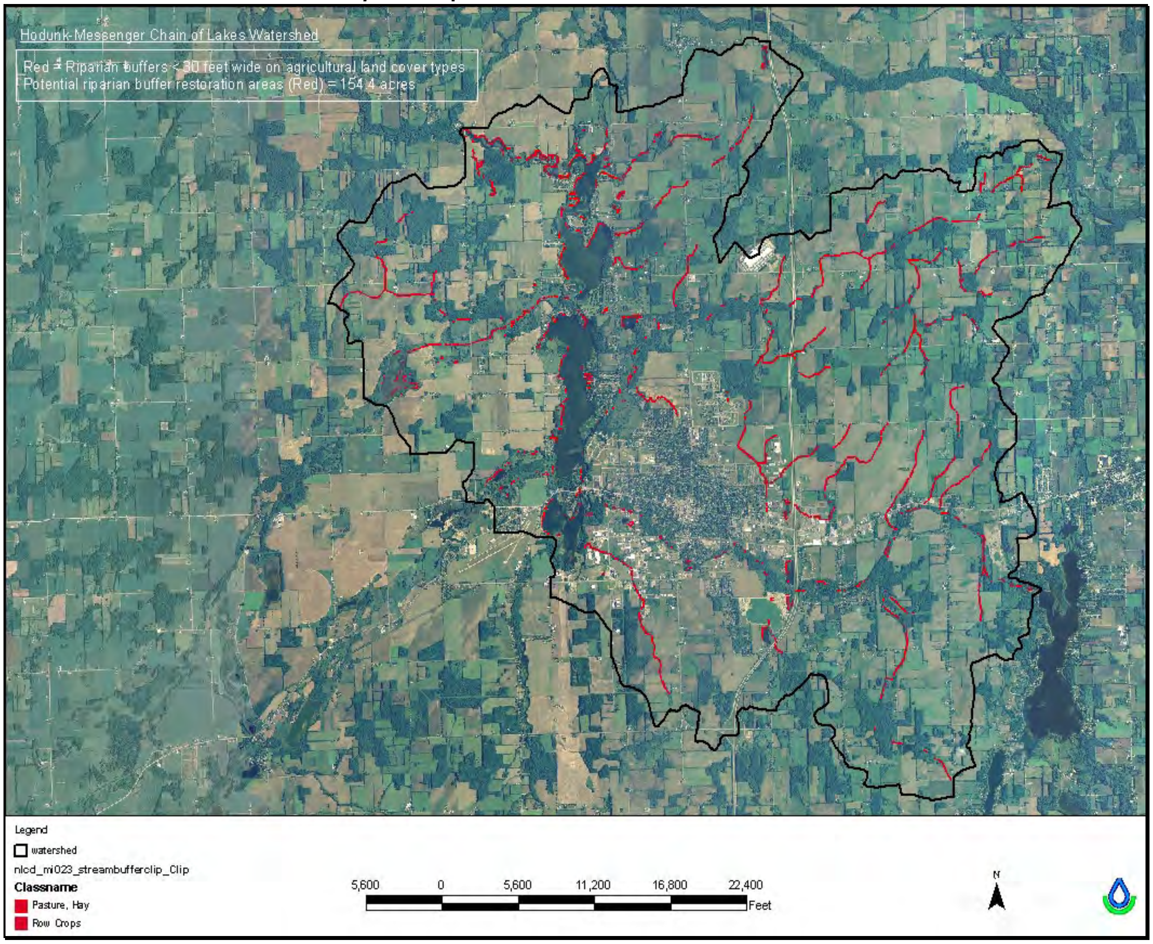
The aerial photos from 1938 proved to be a good resource for developing a rapid characterization of watershed land use activities; especially when contrasted with present day imagery. These pictures were not, however, equipped with any type of directional indicator, scale, road or section names so more accurate measurements and calculations were not viable to pursue. Instead, all information gathered from these photos is based entirely on observation.

One such non-quantifiable observation was the amount of forested tracts that have disappeared since 1938. Forested natural areas have most notably appeared to remain intact and undisturbed since 1938 within the Miller Lake Drain Sub-watershed. Many large vegetated tracts were observed to be reduced and removed from the Sauk River Sub-watershed, but the riparian buffer around the river itself actually appears to have expanded since 1938. The greatest loss of forested areas appears to have occurred in the Cold Creek watershed. The most noticeable losses occurred around the edges of fields.

Results

Results of the riparian buffer analysis show that there are 208,355.06 linear feet, or 39.46 miles, of stream in the watershed. The red areas represent riparian zones (30-feet on either side of stream) that have been cleared of their natural vegetation and are now in direct contact with agricultural field edges. In total, there are 112,215.34 feet, or 21.25 miles, of stream that border farm fields and have no riparian buffer. If a minimum of 30 feet on either of the stream is established with a recommended riparian buffer, it would generate a watershed-wide total of 154.5 acres needing to be established. All buffer loss areas that were bordered by impervious surfaces have already been removed from this map because it was determined to be unlikely to reestablish a set-back distance in these areas.

***Map E-1:* Riparian Buffer Loss in the Watershed**



Tables E-1 – E-5 show the results of the GIS land use analyses. Overall, the onset of agriculture and urban development in the watershed has caused a severe displacement of most other beneficial (natural) land cover types. Presently, agriculture and urban development accounts for a combined 77% of land cover in the watershed. The most severely impacted land cover type as a result of these land use activities was determined to be forests, grasslands and wetlands. Over the last 2 centuries, over 75% of the pre-settlement forest land in the watershed has been cleared. 100% of the historic grasslands in the watershed have also been lost. NCLD data analysis also showed that 70.70% of pre-settlement wetlands have been lost, but this information will not be used or referenced in the Hodunk-Messenger Watershed Management Plan because a more comprehensive watershed status and trends report been prepared by MDEQ-Land and Water Management Division (LMWD) using 2005 National Wetland Inventory (NWI) maps.

***Table E-1:* Overall Watershed Landscape Alteration**

	Pre-settlement LU/LC (acres)	2001 LU/LC (acres)	% Change
Grasslands	8,680.76	0	-100%
Forest	23,844.53	5,928	-75.18%
Agriculture	0	27,531.6	∞
Wetlands	5,569.24	1,631.8	-70.70%
Water	1,291.87	1,361.4	5.38%
Urban	0	2,910.3	∞

Table E-2: Pre-settlement Land Use/Land Cover by Sub-watershed

	Cold Creek SW (acres)	Miller Lake Drain SW (acres)	Sauk River SW (acres)
Grassland	2,465.1	5,032.6	1,184
Forest	8,801.2	7,128.1	7916.7
Agriculture	0	0	0
Wetlands	1,766.7	1,996.1	1,805
Water	30.9	1,259.5	0
Urban	0	0	0

Table E-3: 2001 Land Use/Land Cover by Sub-watershed

	Cold Creek SW (acres)	Miller Lake Drain SW (acres)	Sauk River SW (acres)
Grassland	0	0	0
Forest	1,874	2,314	1,740
Agriculture	9,187.2	10,531.9	7811.9
Wetlands	535.9	768.2	327.6
Water	25.3	1,265.8	70.3
Urban	1,433.8	527.6	948.6

Table E-4: % Change by Sub-watershed

	Cold Creek SW	Miller Lake Drain SW	Sauk River SW
Grassland	-100%	-100%	-100%
Forest	-78.71%	-67.54%	-78.02%
Agriculture	∞	∞	∞
Wetlands	-69.67%	-61.52%	-81.85%
Water	-18.12%	0.50%	70.30%
Urban	∞	∞	∞

Table E-5: Significant Stream Beds

	Cold Creek	Miller Lake Drain	Sauk River
1938	88	25	124
2006	55	18	n/a*
% lost	**37%**	**28%**	n/a*

**increase in tree cover interfered with view to river*

The review of the 1938 aerial photos supported these findings. Even though agriculture and the City of Coldwater were already well established by 1938, there were many more patches of natural areas scattered throughout the watershed than are found today. The most noticeable difference in the 1938 imagery was the checkerboard appearance created by the abundance of smaller farm and field sizes. The aerials from 1938 show a considerably greater quantity of fields located within the same geographic area as the fewer large, expansive fields today. This expansion of farm tract sizes has attributed to an even greater loss of forests, grasslands and wetlands. Many of the vegetated field borders, fence rows and patches of scattered trees observed in the 1928 photos were not visible in the 2006 imagery.

The aerial photo review also provided an opportunity to contrast stream meanders over a 70 year interval. 33 fewer "significant stream bends" were observed in Cold Creek in 2006, as compared to 1938. There were 7 less bends observed in the Miller Lake Drain in 2006 but it should be noted that recent imagery shows that a large portion of the fringe wetlands along the Miller Lake Drain have been drained or "dried up" as agriculture has significantly encroached on the waterway. Sauk River was observed to have 124 significant bends from South Chain of Lakes to North Chain of Lakes in 1938, but an increase in riparian tree cover in 2006 has caused a secluded channel view, making it very difficult to observe the stream bed in many stretches. For this reason, the analysis of stream meander loss in Sauk River was thrown out.

Conclusions

Based on the results on these analyses, it can be concluded that the Miller Lake Drain Sub-watershed appears to exhibit the most characteristics of stability and intactness and therefore may be described as the *least* critical sub-watershed.   It is less obvious to discern the priority between the Cold Creek and Sauk River Sub-watershed. Neither have any real great advantage, but both have their fair share of stressors. Based on these findings, supplemental watershed inventories will be most concentrated in to these two sub-watersheds. Whether or not one is more impaired than the other will be discovered through supplemental inventories.

Appendix F

Groundwater Vulnerability Report

Background

The City of Coldwater derives 100% of its potable water supply from groundwater reserves held in glacial drift material. Since Coldwater lies entirely within the Hodunk-Messenger Chain of Lakes Watershed, it is reasoned that any land use activity (or shift in land use activities as a result of watershed management) that affects surface water quality in the watershed may have the potential to affect Coldwater's usable groundwater supply. Likewise, any activity that contaminates groundwater also has the potential to affect surface water quality.

Through Hodunk-Messenger Chain of Lakes Watershed Planning project assessments, a thorough compilation of surface water pollutants have been identified and quantified. Additionally, Michigan Department of Agriculture (MDA) well-water screenings from 2008 revealed some baseline data of groundwater contamination in the watershed. Specifically in 2008, 5 well-water samples were found to contain nitrate levels and 1 containing nitrite levels above the maximum contamination level (MCL)[3]. With this information in mind, the biggest groundwater concerns yet to be determined are:

1.) What's the level of interconnectedness between groundwater and surface water in the watershed (how vulnerable are groundwater supplies in the watershed), and

2.) Are there any additional potential pollutant sources in the watershed that could affect groundwater (not previously identified by watershed inventories)?

This report summarizes the measures taken to uncover the full extent of these issues concerning groundwater in the Hodunk-Messenger Watershed. The analysis methods used to assess groundwater vulnerability were all carried out using geographic information system (GIS) tools. Aspects analyzed included soil types, soil hydrology groups, soil drainage classes, water table depth and septic field absorption. The findings derived from these queries will be taken into consideration when making recommendations in the Hodunk-Messenger Chain of Lakes Watershed Management Plan.

Description of Analysis

This Hodunk-Messenger Groundwater analysis compiled information pertaining to groundwater vulnerability through a two step process. The first process utilized NRCS-MI GIS technology to analyze the soils and sub-surface geologic features of the watershed to determine where areas of groundwater recharge might be expected. The second process was simply to gather relevant information (from various sources) about the sources of groundwater contamination currently found in the watershed. The methodology of the latter method is not described here, but a summary of the findings can be found in the results, conclusion and reference sections of this report.

Methodology of GIS Analyses

Watershed Soil Types

1.) The Branch County soils layer (F:\FOTG\Section_II\soil_d_mi023.mdb) was added to a Branch County GIS template

2.) The hydrologic unit code (HUC) number 04050001010-watershed delineation shapefile (Hodunk-Messenger Chain of Lakes Watershed) (c:\documents\benjamin.wickerham\unzipped\watershed\extended_boundary.shp) was then added to the existing soils map

3.) The soils layer was then clipped using the watershed layer

4.) The resulting output layer (c:\documents\benjamin.wickerham\unzipped\cut_boundaries\soils_output.shp) represented all soils types found within the watershed[3]. This soils map was utilized in all the following soil analyses.

Soil Hydrologic Groups

1.) The NRCS-MI Soil Data Viewer tool was opened and the watershed soil layer (described above) was set as a source layer for the Soil Data Viewer to analyze
2.) Using the Soil Data Viewer "Soils Qualities and Features" analysis tools, a soil hydrologic group query was run on the soils types within the HUC 04050001010- watershed
3.) As a result of the query, soils in the watershed were assigned to one of four hydrologic groups according to their rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms[3]
4.) The resulting output layer was then added to the watershed soils map.

Soil Drainage Classes

1.) Using the Soil Data Viewer "Soils Qualities and Features" analysis tools, a (natural) soil drainage class query was run on the soil types within the HUC 04050001010- watershed.
2.) As a result of the query, soils in the watershed were assigned to one of seven classes of natural soil drainage - excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained, and very poorly drained[3]
3.) The resulting output layer was overlaid on the watershed soils map.

Water Table Depth

1.) Using the Soil Data Viewer "Water Features" analysis tools, a depth to water table query was run on the 04050001010- watershed layer.
2.) As a result of the query, the depth to the upper limits of the water table in the soils of the watershed was determined, based on observations of grayish colors (redoximorphic features) in the soil[3]
3.) The resulting output layer was then overlaid onto the watershed soils map.

Septic Tank Absorption Class

1.) Using the Soil Data Viewer "Sanitary Facilities" analysis tools, a septic tank absorption field query was run on the soil types within the 04050001010- watershed
2.) As a result of the query, watershed soils were assigned ratings based on soil properties known to affect absorption of the effluent, construction and maintenance of the system, and public health. These properties included such things as saturated hydraulic conductivity (Ksat), depth to a water table, ponding, depth to bedrock or a cemented pan, flooding, stones and boulders. Only that part of the soil between depths of 24 and 60 inches is evaluated[3]
3.) The resulting output layer was overlaid onto the watershed soils map.

Groundwater Recharge Zones

1.) The Soil Hydrologic and Drainage Class layers generated in previous analyses were imported to a 04050001010-watershed map
2.) These layers were overlaid one another and the top layer was made 50% transparent so that both layers were visible
3.) All soil groups that were less than excessively well drained were removed from the soil drainage class layer. Likewise, all soil hydrologic groups that were not rated Group A (highest infiltration when wet) were removed from the soil hydrologic group layer. The remaining polygons from each layer were thought to represent the areas within the watershed with the greatest ability to serve as a natural conduit to groundwater
4.) The areas where these two soil layers intersect were then identified and digitized into a new layer. The reasoning for this was that the overlapping areas would likely indicate a heightened likelihood of rapid groundwater recharge
5.) The two original soil layers were then removed to reveal the newly isolated polygons thought to represent the most likely areas of groundwater recharge in the watershed.

Discussion

Even though there was no way of knowing the full extent of all sources of groundwater pollution in the watershed (such as abandoned wells, bulk storage of agricultural chemicals, automotive service garages, laundries/dry cleaners, transportation terminals, medical labs/hospitals, mining/excavation or improper disposal of hazardous wastes), these analyses do point out areas within the watershed that are considered to be likely pathways of groundwater contamination based on soil properties and surface/groundwater interconnectedness.

Another important variable not factored into this report on groundwater vulnerability is the effect that impervious surface has on groundwater recharge. All of the soil data queries run on the watershed soil types are based on historic sub-surface soils and their properties. Therefore, these results do not take into account the modification of hydrology caused by increased impervious surfaces or increases or losses of vegetative cover.

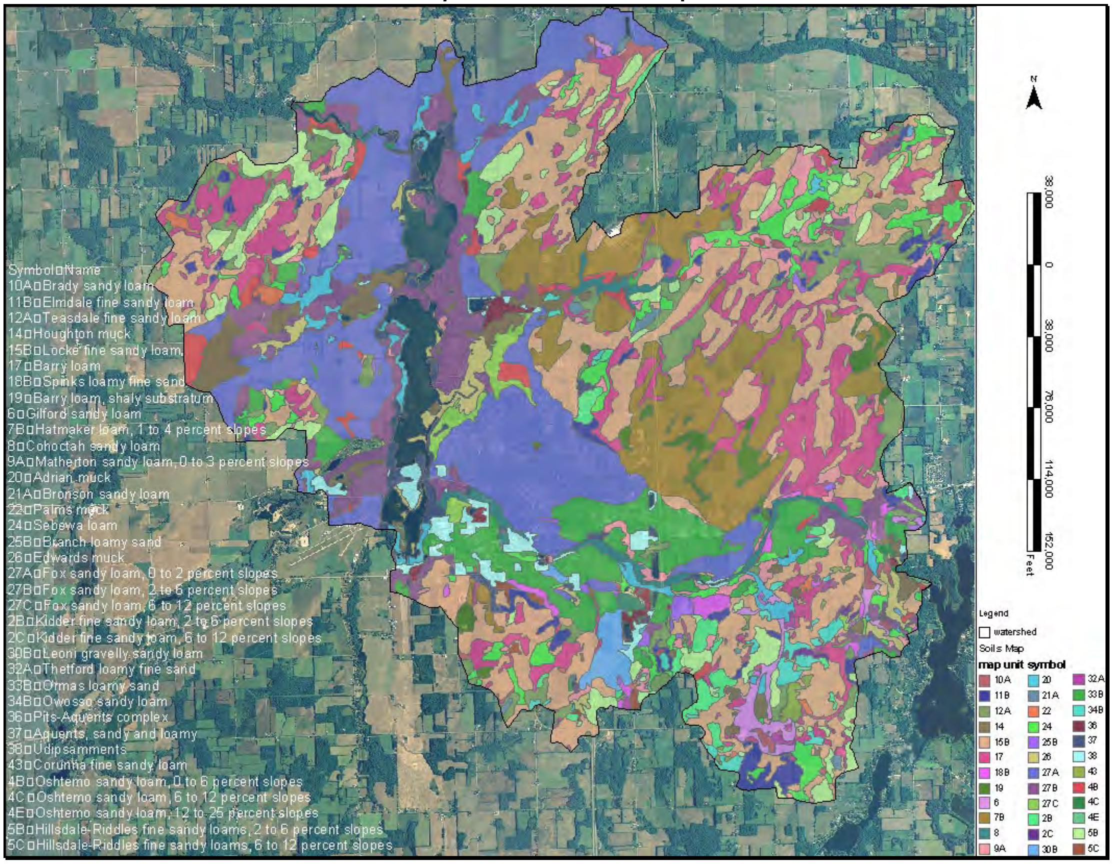
Results

The results of the soil data generated from the GIS analyses are represented in *Map F-1 – F-6*, along with summaries of the findings as they relate to groundwater recharge in the watershed. Also summarized below are some additional findings on potential groundwater contamination sources in the watershed. Potential groundwater contamination data was collected from several different sources: 2008 MDA Ag. Expo Well Water Screening Data, the EPA.gov/WATERS website, a 1995 Branch-Hillsdale-St. Joseph Community Health Agency windshield survey report and the Coldwater Wellhead Protection Plan.

Watershed Soil Types –

A majority of the soils types found within the watershed are of sandy-loam associations. Loams make up the second highest association in quantity and distribution. Several other isolated pockets of varying soil types exist throughout the upper regions of the watershed. Generally speaking, all soils of the Hodunk-Messenger Watershed can be described as glacial outwash.

***Map F-1:* General Soils Map**



Soil Hydrologic Groups –

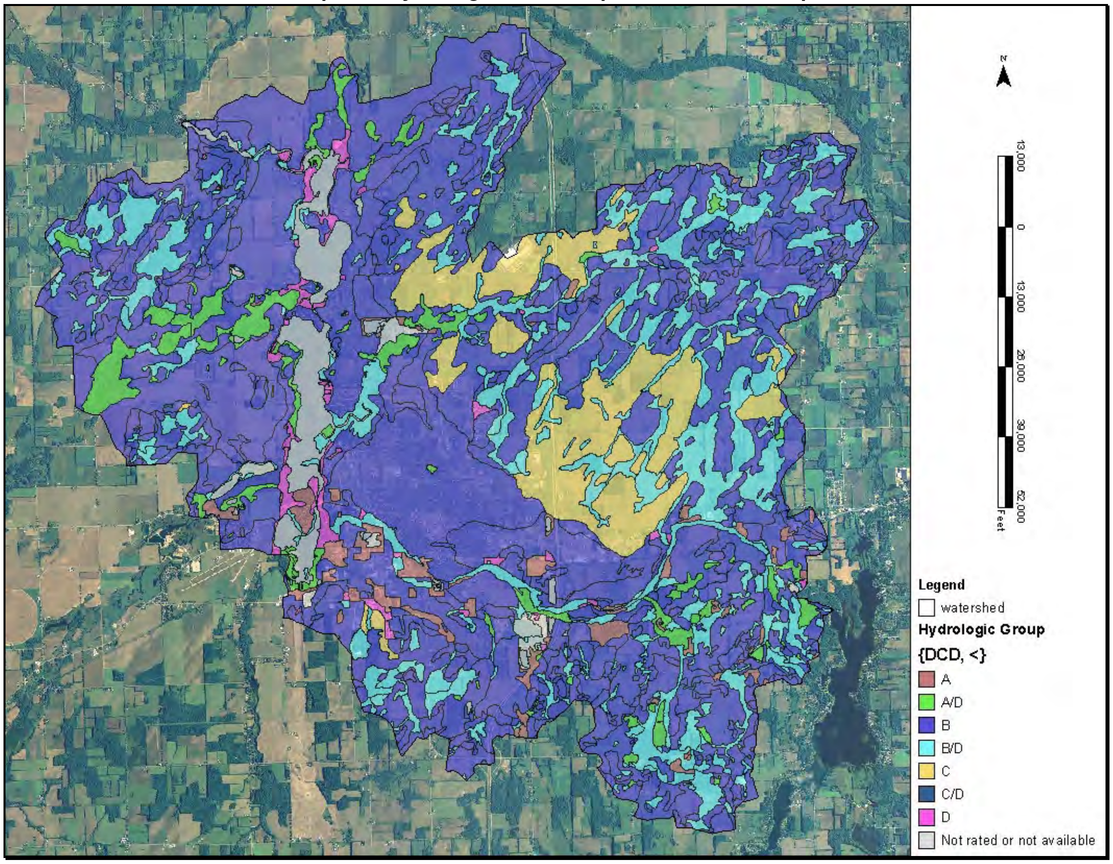
Hydrologic Group B soils make up 63.6% of the soils in the watershed. Group B soils have a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

The next most widespread hydrologic group found in the watershed is Group B\D (19.8%). When a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter represents drained areas and the second represents undrained areas. Only soils that are rated D in their natural condition can be assigned to dual classes. Group D soils have a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

The third most widespread hydrologic group found in the watershed is Group C. Group C soils have a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission. Various other hydrologic groups make up only a very small portion of the watershed (>9%)[3].

Of specific interest, there are several Group A polygons located along the Sauk River (*Map F-2*). These areas of rapid infiltration are thought to correspond with the areas of greatest groundwater recharge.

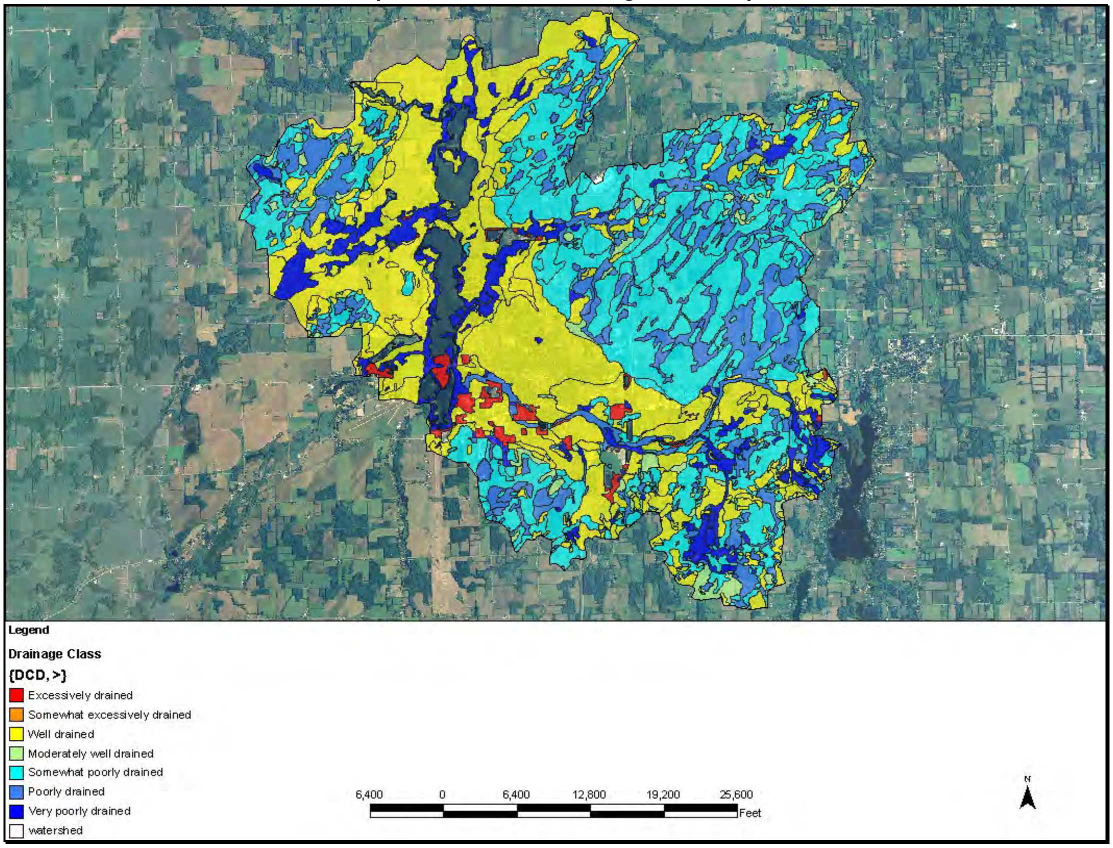
Map F-2: **Hydrologic Soil Groups in Watershed Map**



Soil Drainage Classes –

Soil data viewer query results show that 36.4% of the soils in the watershed are classified as well drained. These well drained soils are predominately located in areas adjacent to water bodies in the watershed. Another 34.2% of soils were found to be somewhat poorly drained. These areas are found in the middle and upper portions of the watershed. These somewhat poorly drained areas surround another 17.5% of soils that are poorly drained. 8.1% of soils, mainly isolated along the chain of lakes and the three major tributaries of the watershed, are classified as very poorly drained. Other pockets of moderately well drained and excessively drained soils are found throughout the watershed, but only in small amounts[3]. The polygons denoting the excessively drained soils are considered to be the areas of greatest groundwater.

Map F-4: **Watershed Drainage Class Map**

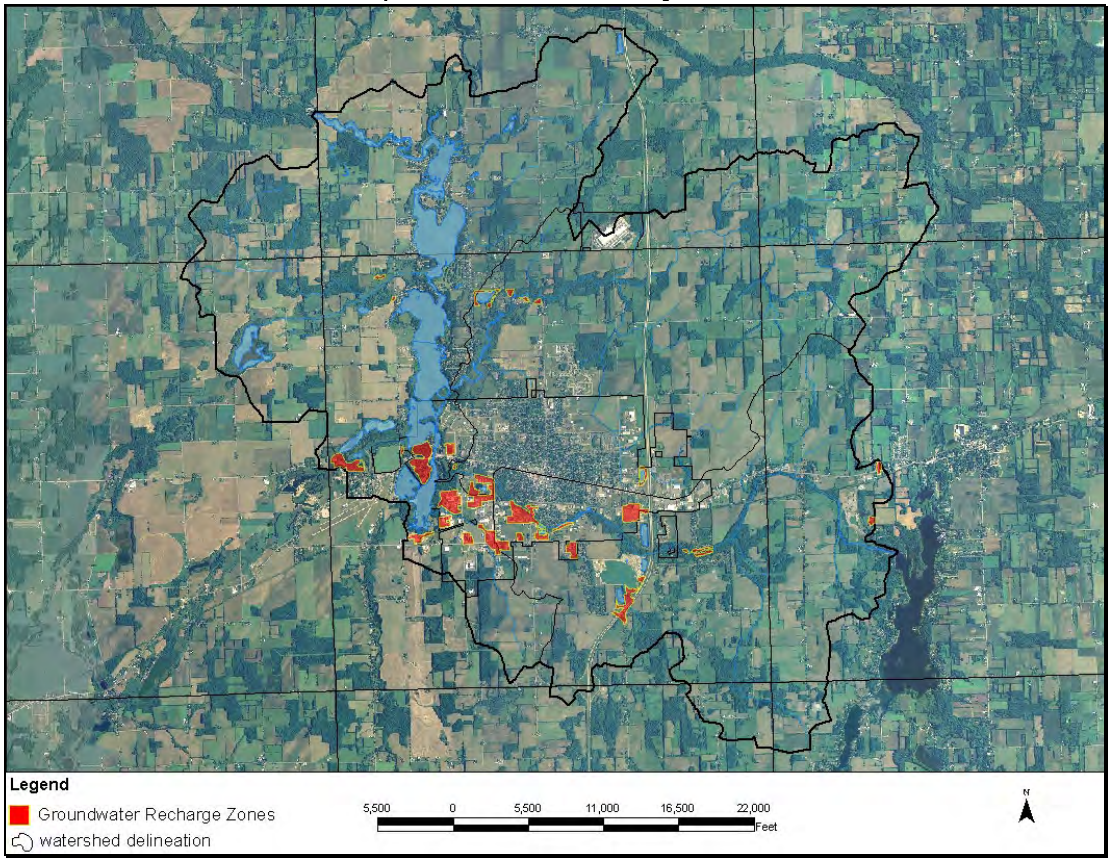


Likely Groundwater Recharge Zones –

The resulting outputs of the Soil Hydrologic Group and Soil Drainage Class analyses revealed a correlation between the locations of excessively drained soils and hydrologic Group A soils (highest infiltration when wet) within the watershed. These isolated areas of rapid infiltration provide the most likely conduit for groundwater recharge in the watershed. *Map F-5* isolates the areas where the Excessively Drained Soils polygons overlapped the Soil Hydrologic Group A polygons. For the most part, these two groupings of soil property classes aligned almost completely. (Water depths were not taken into account for this analysis for the fact that if soils did not offer sufficient infiltration, water depth would not be a factor and water would tend to run of the surface, no matter how deep or shallow the water table lay).

.

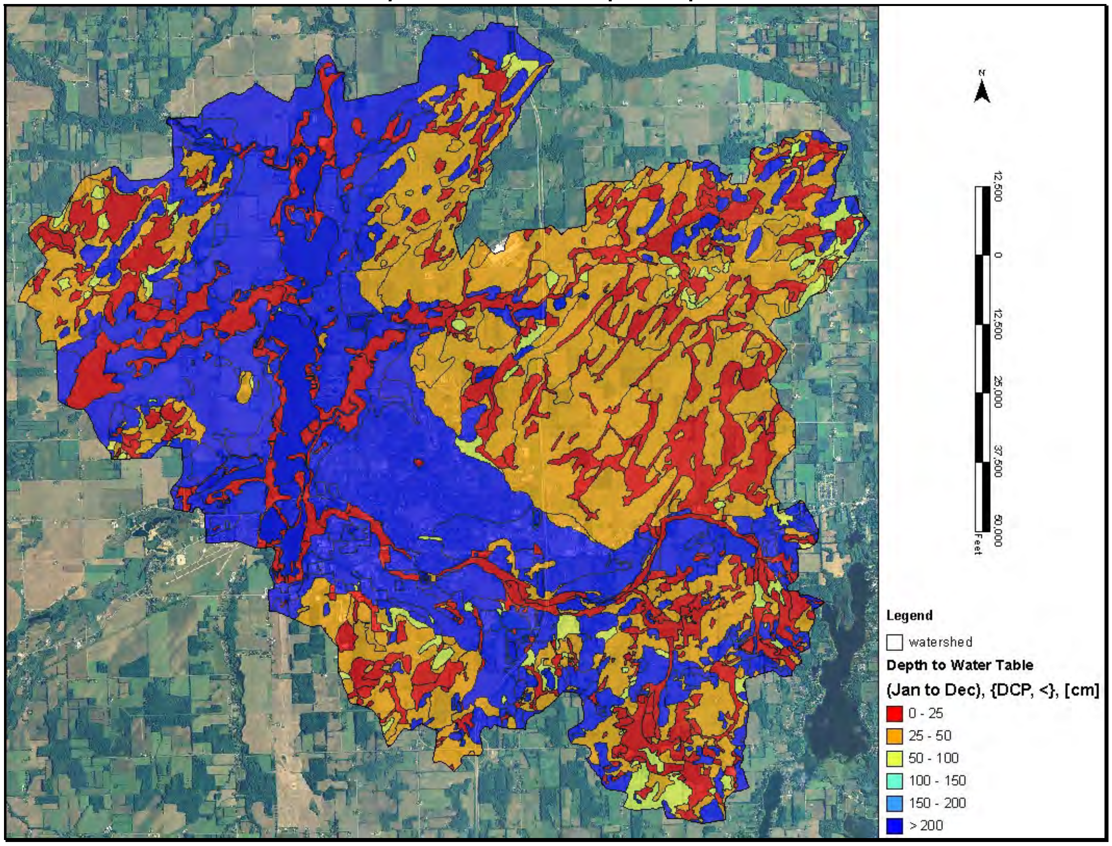
Map F-5: Groundwater Recharge Zones



Water Table Depth –

The greatest water table depths in the watershed are found in the 16,451 acres that surround the chain of lakes and the Sauk River. This area is underlain with a "Coldwater Shale" bedrock that trends northwest from the Marble-Coldwater Chain of Lakes[2]. These areas have a depth to water table of over 200 feet and take up roughly 42% of the area in the watershed. The next most common depth to water table is 25-50 feet down. These areas can be found in the upper regions of the watershed (roughly 33% of the watershed). 22% of the watershed has been identified as having a relatively high water table (0-25 feet below grade). These areas are scattered throughout the watershed, especially around the chain of lakes and its tributaries[3]. When compared to aerial and land cover imagery, these areas with the 0-25 foot water table depth correspond to many of the wetland complexes found in the watershed.

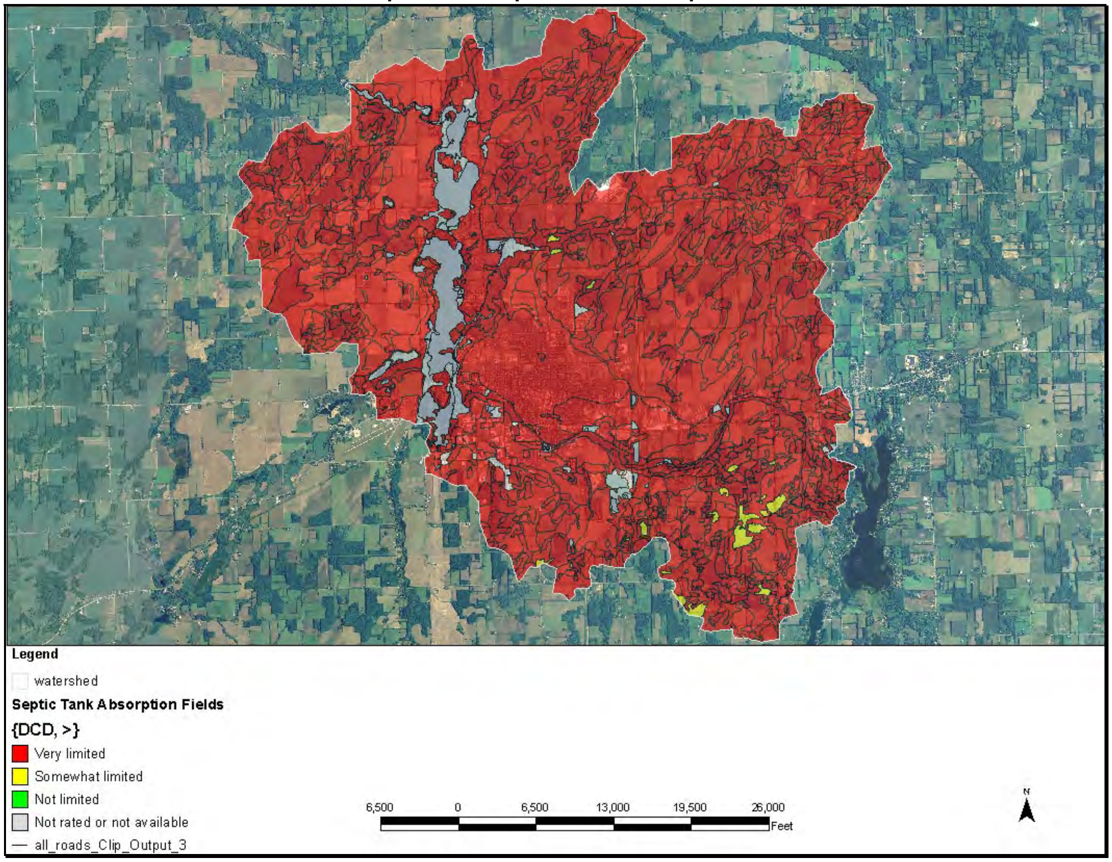
***Map F-6:* Water Table Depths Map**



Septic Tank Absorption –

According to the Soil Data Viewer query results, there are no soil types in the watershed that offer optimal septic tank absorption properties. All soil types in the watershed show limitations for septic absorption fields. In fact, 93.8% of the watershed contains soils that are very limited for septic absorption, and only 5.4% of the watershed contains soils that exhibit properties that are somewhat limited[3].

***Map F-7:* Absorption Classes Map**



Current Septic High-Risk Areas, Identified by the Community Health Agency –

According to a 1997 windshield survey of public sewer and/or water needs for Coldwater Township conducted by the Branch-Hillsdale-St. Joseph Community Health Agency, there are multiple areas in the watershed in need of public sewer infrastructure in order to address environmental needs. Specifically:

> "The present River Road lots are too small for the septic systems necessary for year around occupancy. Present septic systems are poorly isolated from water wells, the lake, or channel making replacement of failed septic systems nearly impossible without a variance from isolation and construction requirements. Sewer is most critical to these congested resort areas…"
>
> "…Old lots [along Narrows Rd.] that have sat idle for years are being eyed with new enthusiasm. However, the older existing properties are typical of old lake side resorts; small lots, septic systems too close to the water, and congested development. Sewer service would protect the lake and on-site well water supplies..."
>
> "…Most all of the [Ebyview/North Lake] areas are low land developments within the North Lake flood plain, and on very small lots built initially for seasonal use only. Septic systems are seasonally saturated and can produce seepage to the ground water or into the lake itself. Isolation of septic systems from surface water or well water supplies is far from adequate. Replacement septic systems can be difficult at best and frequently impossible to install, due to the small lots and closeness to a lake or channel. Water wells are generally shallow drive points which provide little or no protection from poorly isolated, undersized, seasonally saturated septic systems. As cottages are being remodeled or replaced by year around homes, their simple little seasonal septic systems are no longer adequate for the increased water usage. Public sewer is a necessity in these areas to protect the surface water, individual well water supplies, and allow for continued property improvements."

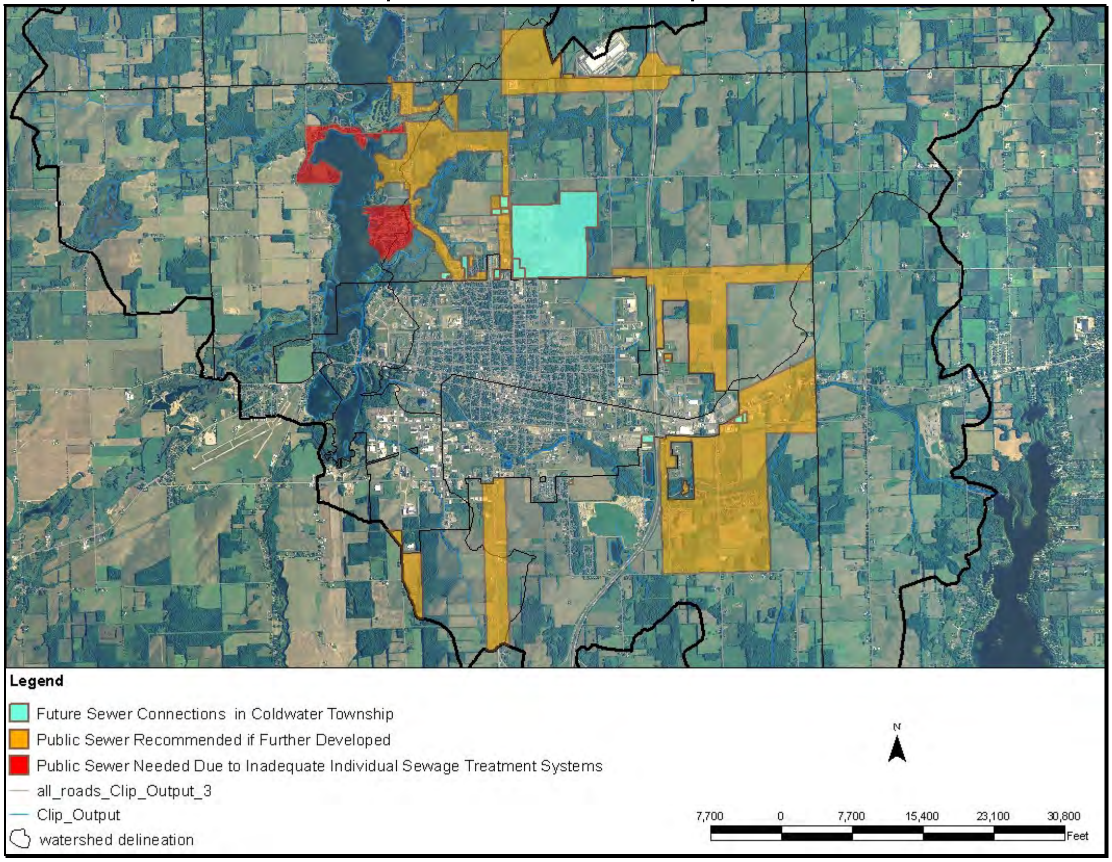
According to Community Health Agency estimates, approximately 19 % the individual septic systems located in the Hodunk-Messenger Watershed are expected to fail on an annual basis. Based on the recommendations of the Community Health Agency, the majority of these failing systems are predicted to occur in the areas referred to in the windshield survey report. Besides the areas of septic underperformance identified here because of poor soil conditions and spatial issues, it is unsure how many additional systems are underperforming or in need of maintenance throughout the watershed.

In addition to the critical areas already suspected of contaminating groundwater, there are also a number of other areas identified in the windshield survey report that are suspected of posing a threat to groundwater supplies in the future. These areas are where land use trends indicate further development might be taking place, but, according to the report, do not exhibit soil properties or water table levels that are conducive for individual septic systems. It was suggested in the report that if development were to expand into these areas, they would require an expansion of public sewer systems.

Several isolated parcels within the City of Coldwater have also been identified by the City to still be operating on an individual septic system. A city ordinance adopted in 1984 states that any septic system that fails within 150 feet the City's existing municipal sanitary sewer infrastructure is required to hook up to the sanitary system. The fact that these 26 separate systems still exist indicates that, at least for the time being, they continue to operate properly.

Map F-8 portrays the areas of concerns discussed in the Community Health Agency's windshield survey. Areas shown in red represent places with an existing need for public sewer hook-ups due the current groundwater contamination threats caused by individual septic systems, including the isolated areas within the city limits operating on individual septic systems. Areas shown in green represent places that would require public sewer services if development were to expand further into those areas. This map also plots the areas where the City has intentions of extending the sanitary sewer system to (red hash marks). An interesting finding represented in *Map F-8* is that the areas slated for sewer expansion do not correspond necessarily to the areas recommended by the Community Health Agency 1997 windshield survey report. *NOTE:* Parcel data on the locations of the 26 separate individual septic systems within the City and the areas for sewer expansion shapefiles were supplied by the City of Coldwater GIS Department.

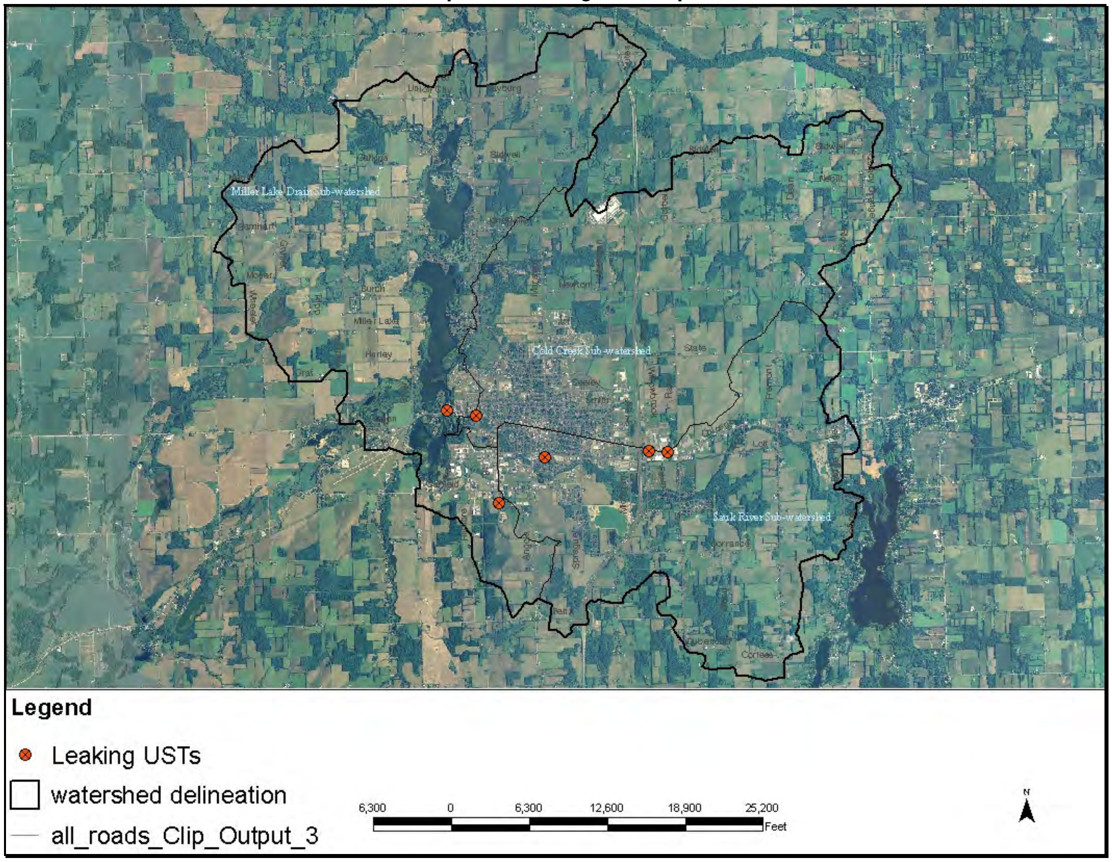
Map F-8: **Public Sewer Needs Map**



Underground Storage Tank –

According to information obtained from the Michigan DEQ's *Storage Tank Information Database,* there are currently 71 sites in the Hodunk-Messenger Watershed with underground storage tanks (UST); many with multiple tanks per site. Among these 71 sites, 39 tanks have been identified as having had a leak since their installation. Of these 39 tanks, 32 have of them have been closed or replaced. Based on this UST information compiled on the MDEQ website (which is based on forms provided to the MDEQ by the owners of USTs), there are seven tanks still suspected of leaking in the watershed. These seven tanks are located at six sites (two USTs at facility ID #17021) and are identified in Map E-8, below.

Map F-9: **Leaking UST Map**

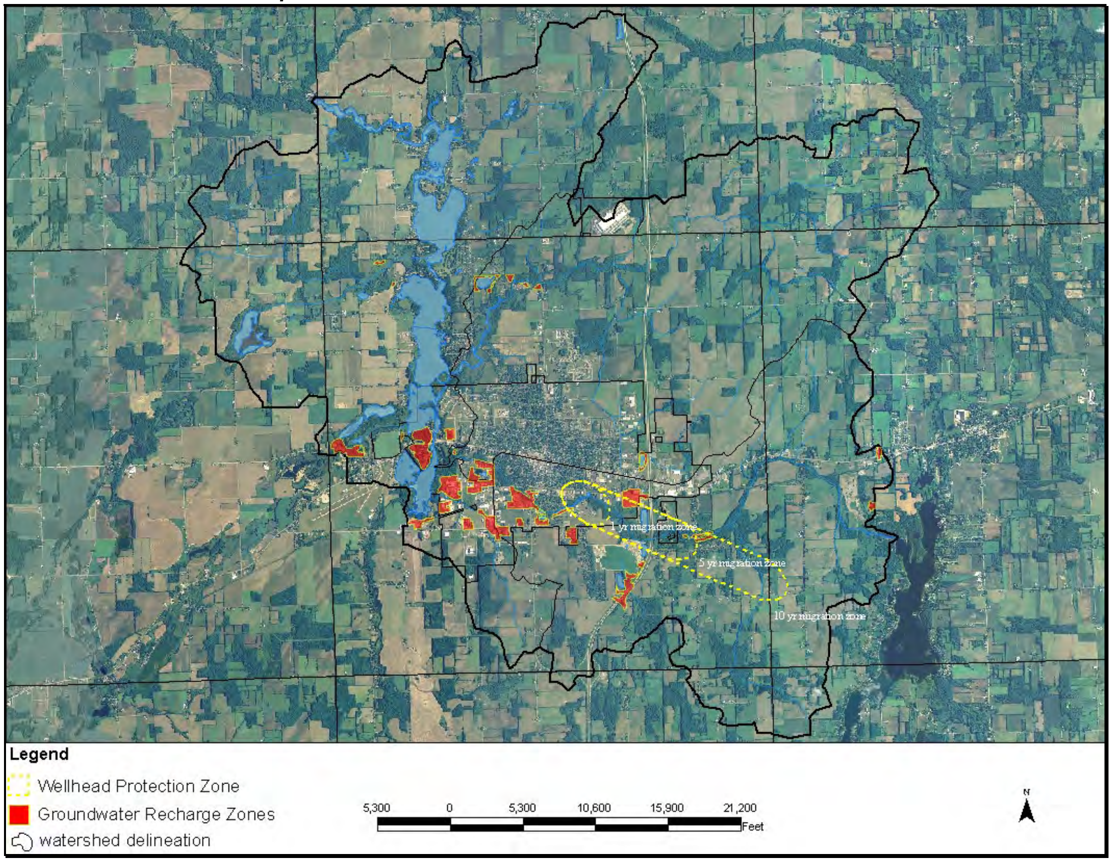


Coldwater's Well Field –

In 1995, the Coldwater Board of Public Utilities adopted a Wellhead Protection Plan (WHPP) that defined a protection zone around the city's municipal well field. The well field, located in Water Works Park, just north of the Branch County Fairgrounds, contains four large wells that each average 2.3 million gallons per day to supply all of Coldwater with potable water. Since the Coldwater Well field is the source of Coldwater's water supply, a protection zone was delineated for the city wellhead area. The Coldwater Wellhead Protection Plan also provides delineations for a 1 year migration zone and 5 year migration zone- both in need of protection in order to prevent any groundwater contamination, based on the position and composition of the large aquifer that underlays Coldwater. *Map F-9* displays the Wellhead Protection Zones in relation to the watershed.

In addition to wellhead protection, soil analyses have revealed that there are several other locations in the watershed that promote rapid groundwater recharge (*Page F-7*). These groundwater "recharge zones" are included in *Map E-9* to provide a comprehensive look at the areas in the watershed requiring groundwater protection efforts in the implementation phase.

Map F-10: **Groundwater Protection Zones in Watershed**



Conclusions

Given the findings of the GIS analyses and the information gathered from various environmental agencies, it can be concluded that groundwater resources in the Hodunk-Messenger Watershed are highly vulnerable and at-risk of contamination if proper management measures are not taken. The soil types found in the watershed offer properties that prove to be conducive for drainage and infiltration if left bare. This drainage factor allows for relatively quick delivery to surface water bodies such as wetlands, where groundwater is known to intermingle. There are also many pockets of shallow bedrock and water table levels near the surface scattered throughout the watershed.

These same properties do not allow for sufficient septic absorption into the soil anywhere in the watershed. Figure 4 shows that there are no locations within the watershed that are free from septic absorption field limitations. This finding presents the risk that underground pollutants could easily leach and contaminate individual well-water drinking supplies. This also is true of underground storage tanks. Several leaking USTs have been identified in the watershed, but more threats could exist if small pinhole leaks develop and are not detected.

Based on these watershed characteristics, proper management measures should be taken during watershed management implementation that protect groundwater resources. For example, proper agrichemical application methods should be put in place during critical times when soils are bare or heavy rains are frequent. Sanitary sewer infrastructure should be put in place before further development occurs and individual septic systems should be relocated, removed or retrofitted to improve performance. Based on known pollutant sources such as the leaking USTs, it should also be recommended that immediate UST removal occur to enhance groundwater quality. In addition, the areas identified to have of greatest groundwater recharge ability within the watershed will be important to reference when pursuing future protection or land use planning decisions

References

1.) *MI Dept. of Agriculture 2008 Ag Expo Domestic Well Screening Summary Results; MDA Pesticide and Environment Lab, July 15 - 17, 2008, available at http://www.msue.msu.edu/objects/content_revision/download.cfm/revision_id.504754/workspace_id.-30/2008%20Ag%20Expo%20Results.pdf/*
2.) *CBPU Wellhead Protection Program, April 25, 1995*
3.) *NRCS-MI Soil Data Viewer*
4.) *Branch-Hillsdale-St. Joseph Community Health Agency Windshield Survey, 1995*
5.) *http://www.deq.state.mi.us/sid-web/*

Appendix G

GIS Analysis of Agricultural Land in Hodunk-Messenger Chain of Lakes Watershed

Background

In the Hodunk-Messenger Chain of Lakes Watershed there are over 27,000 acres of land that are used for agricultural purposes. While providing economic stability to the region, agriculture also presents inherit risks to local water quality if proper conservation practices are not utilized. Through past investigations and observances it has been established that agriculture can present such problems as soil erosion, nutrient loading to surface and groundwater and modification of the local hydrologic regime. In order to assess the quantity of nonpoint source (NPS) pollutants and extent of impact stemming from agriculture in the Hodunk-Messenger Watershed, a series of Geographic Information System (GIS) analyses were run.

Description of Analyses

The agricultural land mass in the Hodunk-Messenger Watershed was assessed for several quantifiable characteristics: amount of protected riparian buffer (through CRP), amount of protected farmland (PA 116), areas of highly erodible land (HEL) and several other erosion factors, and classification of farmland (prime or not prime). An analysis of the soils in the watershed was run to determine which areas were prime for farming, which would be prime if drained, which were of local importance and which were not prime at all (prime farmland designations have been predefined by USDA-NRCS). This analysis was important for gaining information to help steer future land use decisions by determining which agricultural areas are a priority for preserving. An HEL query was run to identify the areas currently being farmed that have been determined (USDA-NRCS definition) to be highly erodible. These areas are most crucial to implementing conservation practices on in order to help keep the soil on the land and out of the waterways. To this end, three additional erosion analyses were run in order to discover additional erosion hot spots in the watershed. Based on soil properties, the susceptibility of soil to erode from water runoff and from wind were determined individually, as well as combined in what's combined in what's known as a soil's "T Factor".

Methodology

Riparian Buffers

1.) The hydrologic layer for branch county ("f:\geodata\hydro_l_mi023") was added to a basic aerial map of the hydrologic unit code (HUC) number 04050001010-watershed (Hodunk-Messenger Chain of Lakes Watershed)
2.) A 30-foot buffer was then drawn along each side of every stream (combined to be 60-foot wide polygon)
3.) The general land cover types for the watershed were imported using the National Land Cover Dataset (NLCD_mi023)
4.) The stream buffer layer was then used to clip out the land cover layer. The resulting output layer ("c:\documents\unzipped\cut_boundaries\streamBuffer_clip_output") contained only the land cover within a 30-foot radius to the streams
5.) A query was then run to locate all "set back" areas in the watershed (filter strip practice or riparian bird buffer practice) that had been established under CRP. This information was made available through a request to USDA-FSA
6.) A comparison was then made to see if there were any protected filter strips or riparian bird buffers within the buffer polygon.

P.A. 116 Preserved Farmland

1.) Data of all the farmland/open space preserved through Michigan Public Act 116 in Branch County was requested of the Michigan Department of Agriculture (MDA).
2.) Once received (in spreadsheet format), all preserved tracts that occurred within the watershed were isolated using the legal description provided for each parcel.
3.) Once these tracts were isolated, they were each digitized onto a GIS watershed map, following the legal descriptions provided in the MDA Branch County data.

   Steps for Digitizing PA 116 Field Boundaries:

   a.) A new data layer was created in the watershed ArcGIS watershed template (c:\documents\unzipped\watershed\PA_116).
   b.) Using the 04050001010- watershed CLU layer created a previous analysis, selected CLU tract boundaries were traced if they corresponded to the legal description given in the MDA PA 116 information and a new polygon was created in the PA 116 layer
   c.) If a legal description did not seem to exactly match an existing CLU tract, 2005 NAIP Imagery was then used to aid in identifying and defining the PA 116 polygon (field) boundaries
   d.) Whenever a new PA 116 polygon was digitized, it was attributed with the appropriate contract number and the end year of the contract term
   e.) Since field boundaries seldom adhere to watershed boundaries, many PA 116 polygons that were created overlapped on the outside of the watershed. Therefore, when all PA 116 fields that occurred in the watershed were mapped, the PA 116 layer was clipped with the HUC 04050001010- watershed boundary
   f.) The resulting clip output layer (c:\documents\unzipped\cut_boundaries\PA116_in_watershed) represented the exact acreage of preserved farmland within the watershed.

Field edge filter strips

1.) The delineation of the HUC 04050001010-watershed shapefile was overlaid onto the USDA-FSA Common Land Unit (CLU) layer for Branch County. CLUs represent all established agricultural fields in the county
2.) The CLU layer was then clipped with the watershed delineation. The cumulative acreage of all remaining tracts was then summarized
3.) The watershed CLU acreage was then converted to square footage
4.) The square footage was then divided by the total number of tracts remaining within the watershed so as to determine the average square footage per tract
5.) Once the average area was determined, the square root was taken in order to estimate the average length (in linear feet) per side of an average field (CLU tract) in the watershed
6.) Once this average field edge length was determined, it was then multiplied by the total number of tracts in the watershed. The reasoning behind this was that a filter strip should be implemented on *at least* one edge of every farm field in the watershed- preferably the most vulnerable (in terms of contributing to water pollution) edge of the field
7.) This linear footage of watershed field edges was then multiplied by 30 (represents a recommended minimum filter strip width of 30 feet)
8.) The resulting square footage represents a recommended amount of field edge filter strips to be implemented in the watershed.

Farmland Classification

1.) The Branch County soils layer (f:\FOTG\Section_II\soil_d_mi023.mdb) was added to a Branch County GIS template
2.) The hydrologic unit code (HUC) number 04050001010-watershed delineation shapefile (Hodunk-Messenger Chain of Lakes Watershed)

(c:\documents\benjamin.wickerham\unzipped\watershed\extended_boundary.shp) was then added to the existing soils map

3.) The soils layer was then clipped using the watershed layer
4.) The resulting output layer (c:\documents\benjamin.wickerham\unzipped\cut_boundaries\soils_output.shp) represented all soils types found within the watershed[3]
5.) Using the USDA-NRCS-MI Toolkit "Soil Data Viewer", a farmland classification query was run on all watershed soil types (utilizing the SSURGO data) to determine which areas were prime for farming and which were not; based on the USDA pre-defined classifications
6.) With this data two maps were created: one isolating only farmland classified as "prime" and one isolating farmland classified as "not prime".

HEL Ratings

1.) Again using the watershed soils map, an HEL rating analysis was run using the USDA-NRCS-MI Toolkit "soil layers" tool. The resulting layer classified all areas as either highly erodible, not highly erodible or not rated
2.) All non-HEL soil ratings were then removed in order to isolate only the highly erodible critical areas.

K Factor

1.) The NRCS-MI Soil Data Viewer tool was opened and the watershed soil layer (described above) was set as a source layer for the Soil Data Viewer to analyze
2.) Using the Soil Data Viewer "Soils Qualities and Features" analysis tools, a soil hydrologic group query was run on the soils types within the HUC 04050001010-watershed
3.) As a result of the query, soils in the watershed were assigned a value according to their susceptibility to sheet and rill erosion, based on soil structure, saturated hydraulic conductivity and percent of silt, sand and organic material
4.) The resulting output layer was then added to the watershed soils map.

Wind Erosion Index

1.) The NRCS-MI Soil Data Viewer tool was opened and the watershed soil layer (described above) was set as a source layer for the Soil Data Viewer to analyze
2.) Using the Soil Data Viewer "Soils Qualities and Features" analysis tools, a soil hydrologic group query was run on the soils types within the HUC 04050001010-watershed
3.) As a result of the query, soils in the watershed were assigned a value according to their susceptibility to wind erosion, based on texture of the soil surface layer
4.) The resulting output layer was then added to the watershed soils map.

T Factor

1.) The NRCS-MI Soil Data Viewer tool was opened and the watershed soil layer (described above) was set as a source layer for the Soil Data Viewer to analyze
2.) Using the Soil Data Viewer "Soils Qualities and Features" analysis tools, a soil hydrologic group query was run on the soils types within the HUC 04050001010-watershed
3.) As a result of the query, soils in the watershed were assigned a value according to their susceptibility to all types of erosion, based on a broad range of soil properties
4.) The resulting output layer was then added to the watershed soils map.

Discussion

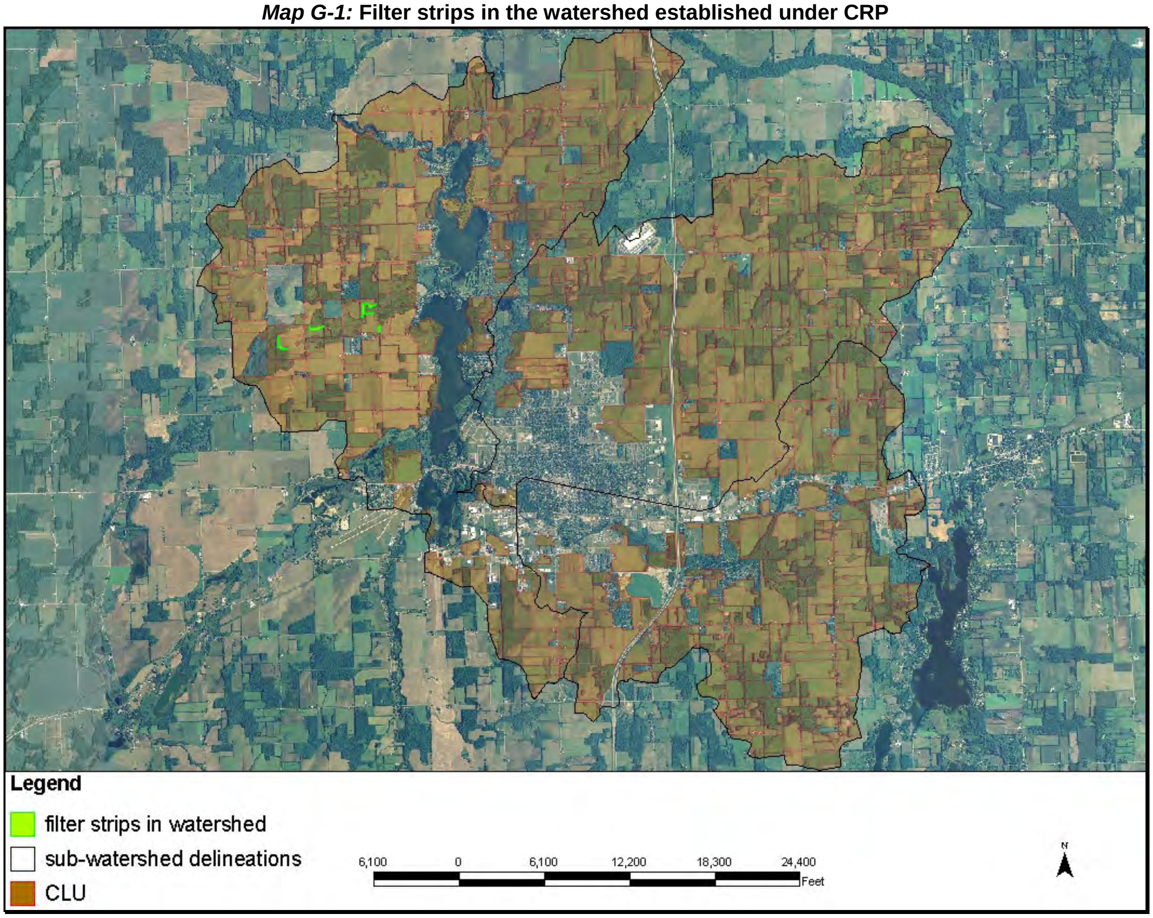
These analyses were conducted to determine critical areas in the agricultural land use areas of the watershed that may be in need of improvement for the sake of protecting water quality. In the interest of time, these GIS analyses were run in lieu of field inspections. In most cases, these methods produced relatively accurate and reliable results that can be used for calculating pollutant loads. The results also established baseline information for measuring the success of implementation activities against. For the most part, agricultural BMP recommendations in the Watershed Management Plan have been based upon the measurements collected from these analyses.

Results from the individual GIS analyses are portrayed in *Maps G-1 – G-9.*

Results

There were no NRCS Riparian Bird Buffers found within the HUC 04050001010-watershed delineation and very few Filter Strips (all in Miller Lake Drain Sub-watershed). Based on this finding, it is recommended that all fields within the watershed have at least one field edge be established with a filter strip (preferably on the most vulnerable, downhill, side) in order to trap the sediments and other pollutants coming from each individual field before reaching a surface water body. Based on the field edge analysis, if every field established a 30-foot wide buffer strip along the most at-risk field edge, a total of 1,097.1 acres would be taken out of farming.

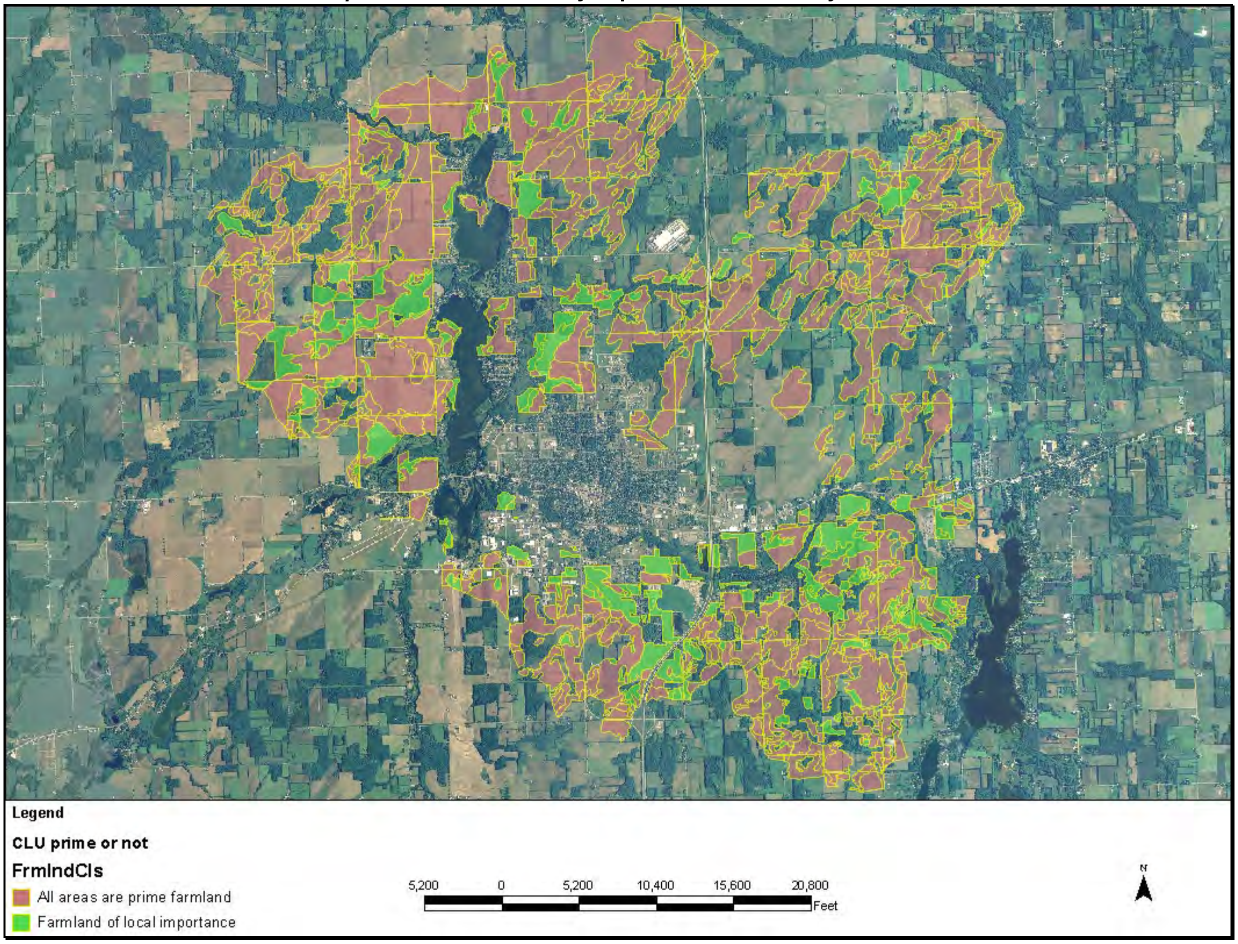
Map G-1: **Filter strips in the watershed established under CRP**



Results from the farmland classification query show that in the entire watershed, there are 21,197.4 acres (53.8%) that are considered prime farmland, 9,648.9 acres (24.5%) that would be prime if drained, 5,409.5 acres (13.7%) are farmlands of local importance and 3,130.5 acres (7.9%) are not prime at all. This data gives reason to the predominately agricultural land use in the watershed. Of the 27,932.4 acres that constitute the farm fields of the watershed, 58.4% are prime, 29.2% are prime if drained, 10.9% are locally important and 1.6% are not prime.

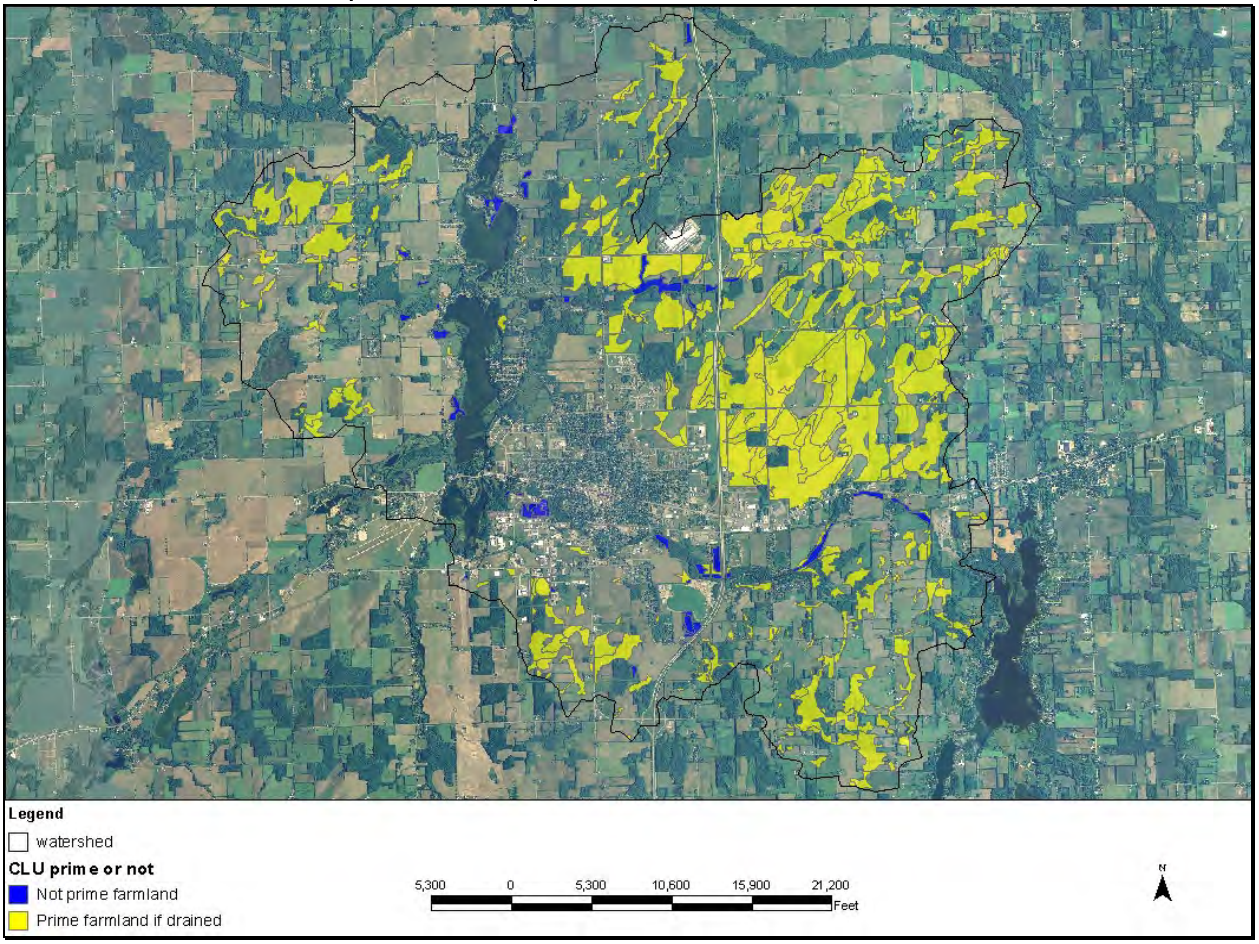
Map G-2 represents the 30,846.3 acres of land that are prime or locally important farmland. If any farmland/open land in the watershed were to be permanently preserved; these areas would be of the top priority.

Map G-2: **Prime and locally important farmland only**



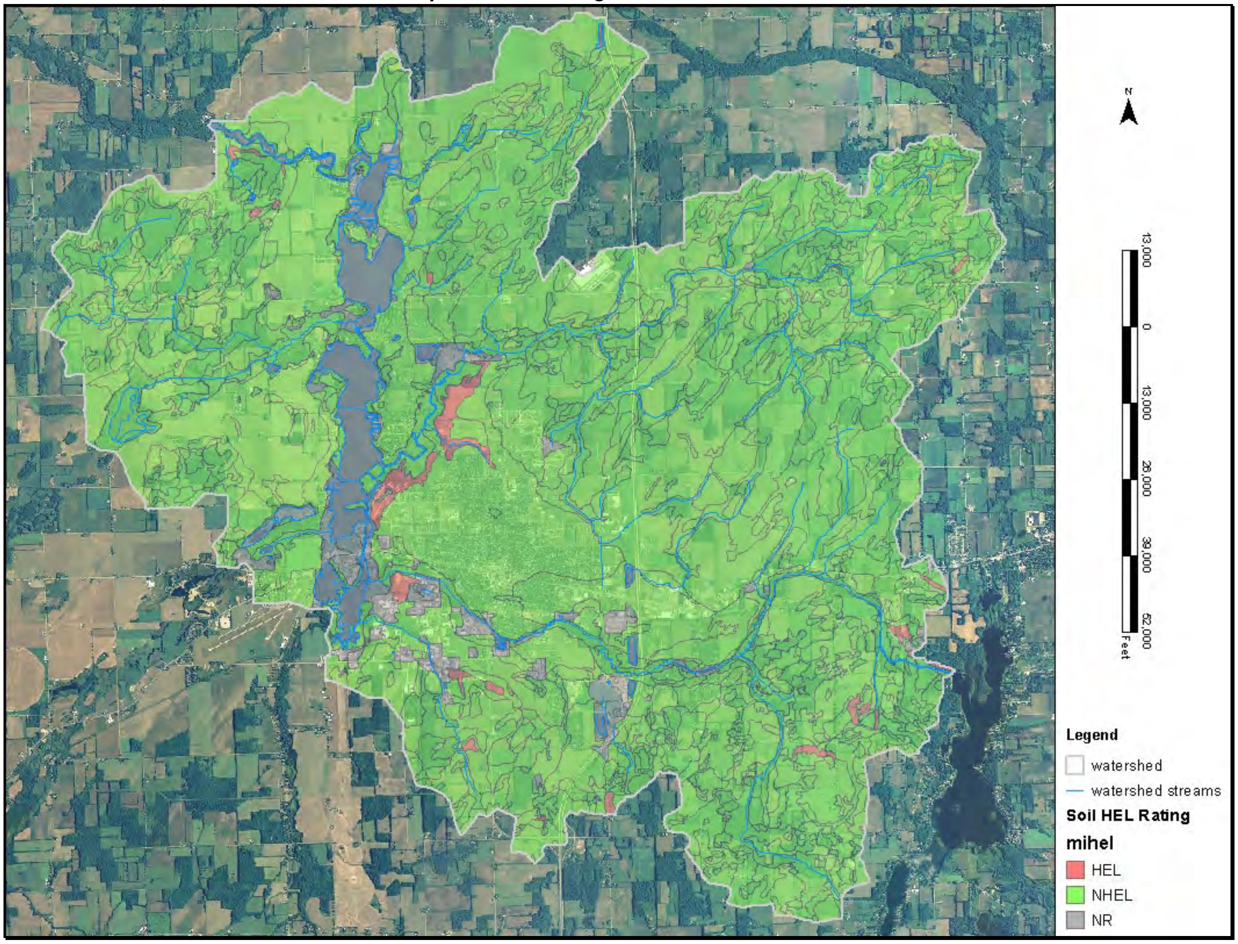
Map G-3 represents the 12,779.4 acres of land that are not prime or would need to be drained in order to become prime within the watershed. Since these areas are not the most conducive for agriculture, any future land use alterations or development in the watershed could be directed toward these areas so that no prime areas are lost, and thereby having a lesser impact on the local economy.

Map G-3: **Areas "not prime" farmland in watershed**



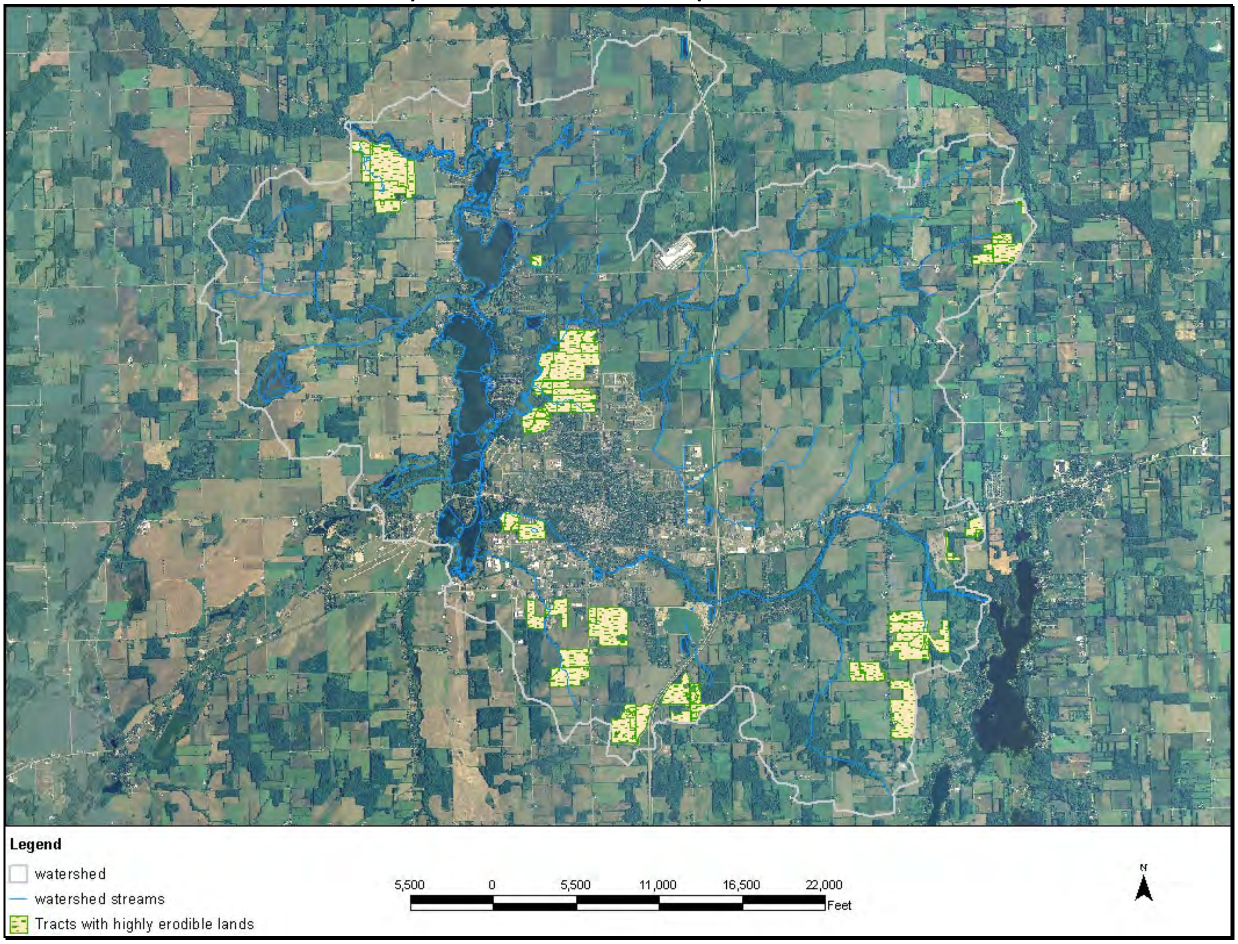
Based on the soil layer analysis, there were no areas that were determined to be potentially highly erodible in the watershed, but there were 1,936.9 acres that were highly erodible. All other areas were found to be either not highly erodible or not rated (water/wetlands). By sub-watershed, there were 215.7 acres rated HEL in the Cold Creek Sub-watershed, 130.5 acres rated HEL in the Sauk River Sub-watershed, and 116.9 acres rated HEL in the Miller Lake Drain Sub-watershed.

Map G-4: **HEL ratings in watershed**



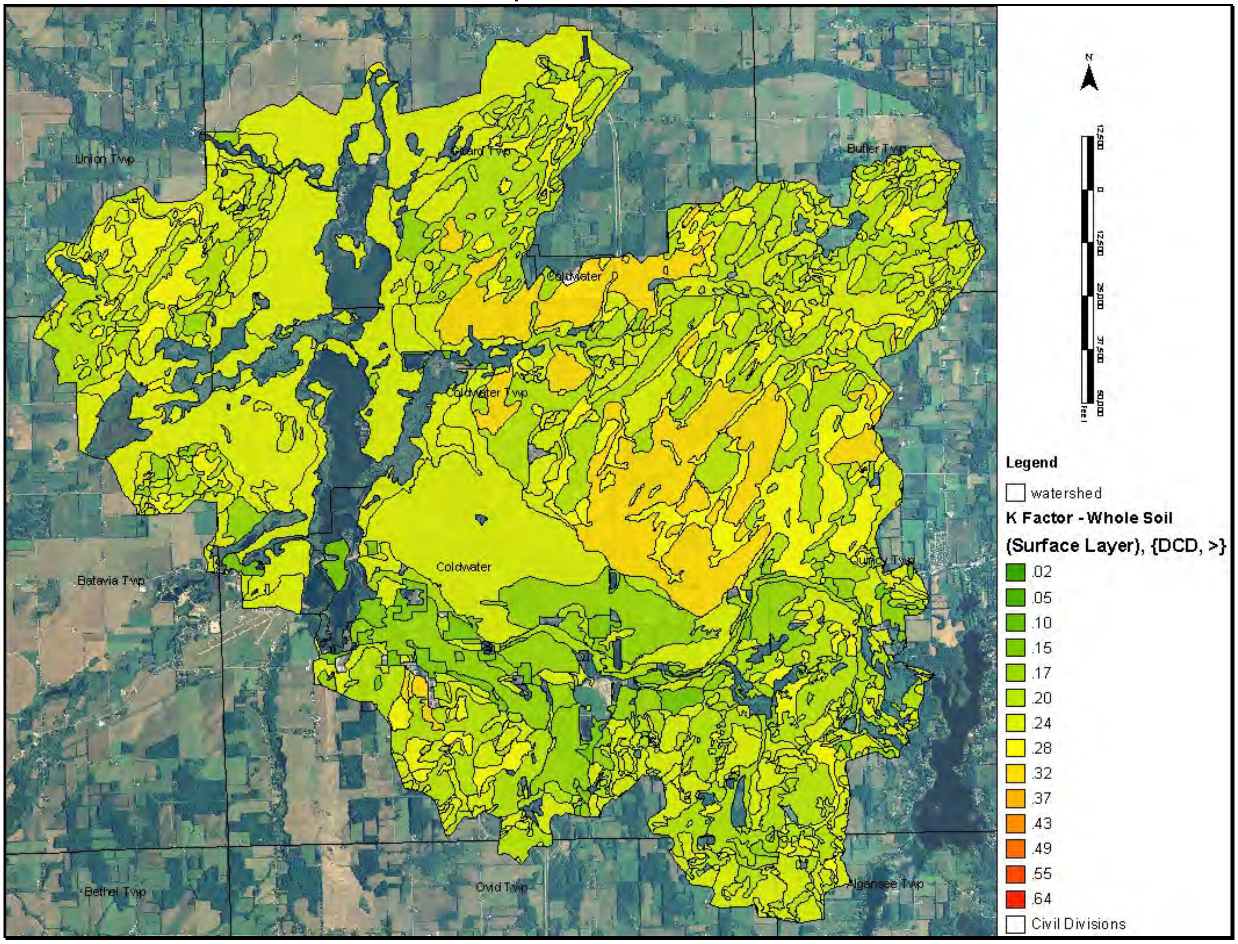
The fields (CLUs) shown in *Map G-5* were singled-out for implementing conservation tillage and developing conservation plans on because they had, at least in part, areas rated HEL within or along them. Even if only a small portion of a field was rated HEL, the whole tract was included for the purposes of this analysis.

Map G-5: **Farm fields with HEL present**



Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. The estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and saturated hydraulic conductivity (Ksat). Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water. As depicted in *Map G-6*, the soil types with the greatest K Factor value are found to be contained in the middle portion of the Cold Creek Sub-watershed.

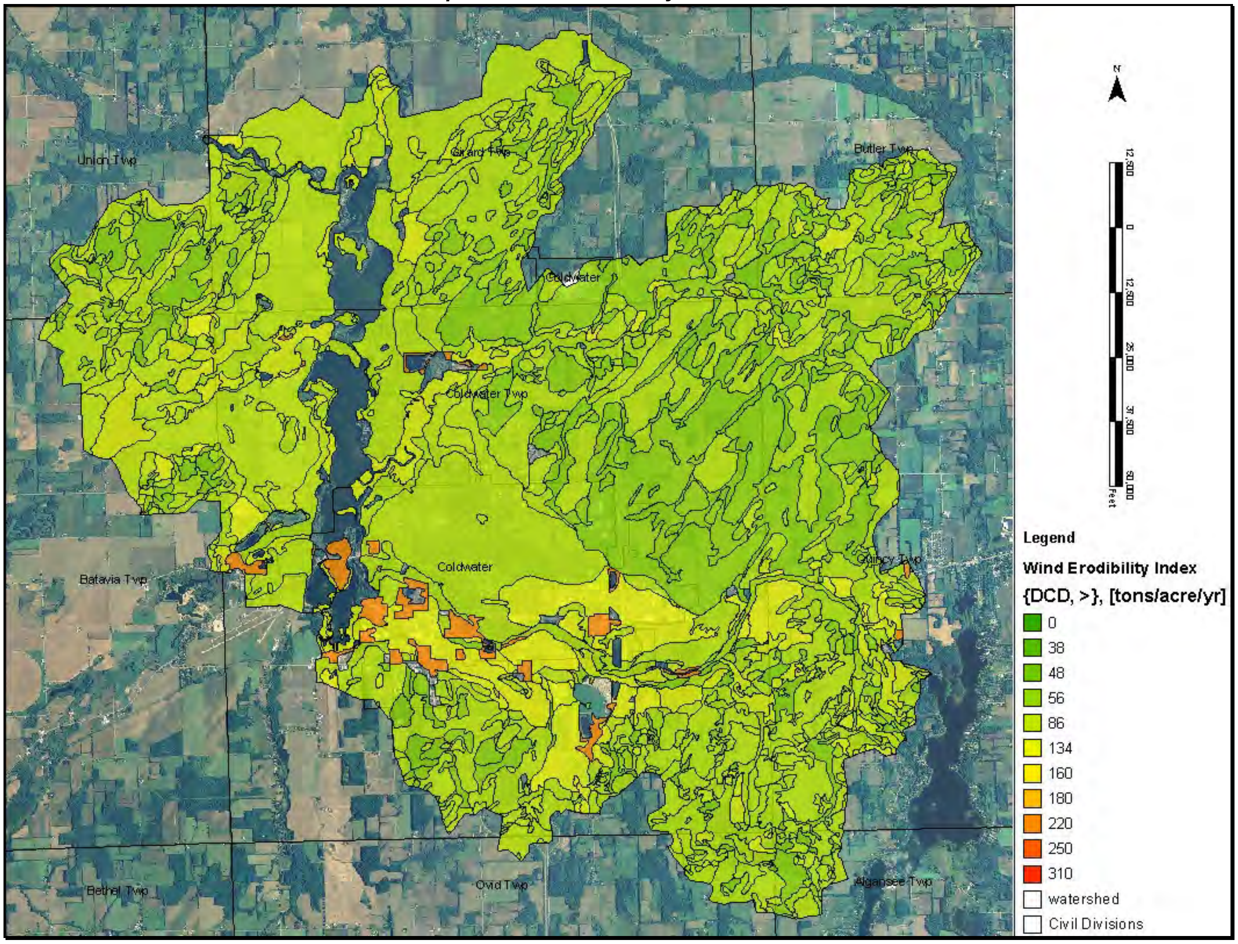
Map G-6: K Factor



The wind erodibility index is a numerical value indicating the susceptibility of soil to wind erosion, or the tons per acre per year that can be expected to be lost to wind erosion. There is a close correlation between wind erosion and the texture of the surface layer, the size and durability of surface clods, rock fragments, organic matter, and a calcareous reaction. Soil moisture and frozen soil layers also influence wind erosion.

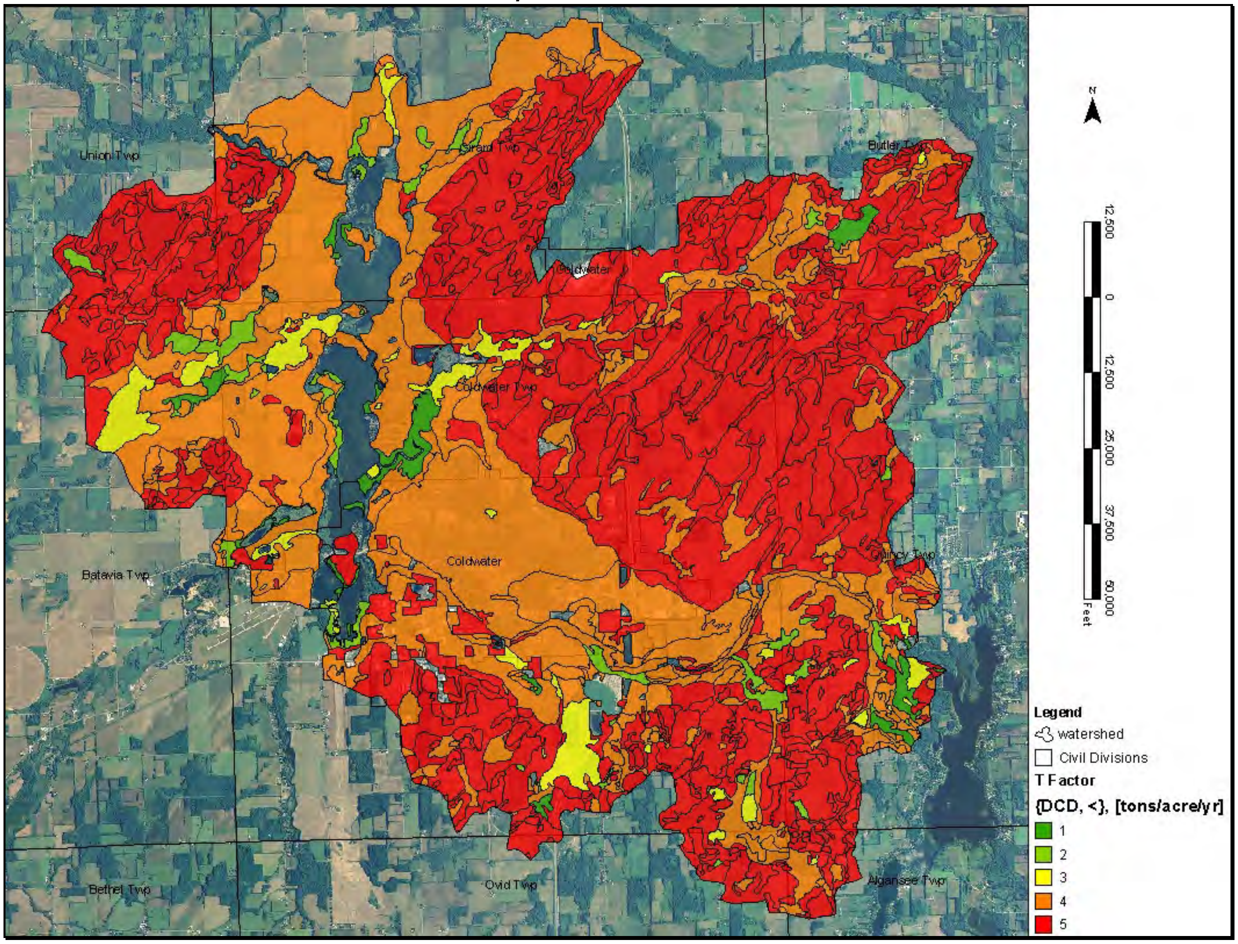
Based on the wind erodibility index assessment conducted on the Hodunk-Messenger Watershed, it was found that there were several areas in the southern half of the watershed, especially along the Sauk River that had high wind erodibility indexes. These results indicate that these isolated areas typically loose more soil through wind erosion than other places in the watershed.

***Map G-7:* Wind Erodibility Index**



The T factor is an estimate of the maximum average annual rate of soil erosion by wind and/or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year. According the T factor analysis of the Hodunk-Messenger Watershed, the greatest losses of top soil occur in the upper regions of the watershed. *Map G-8* dramatically portrays the areas in which the amplified rates of soil loss are taking place. This result leads to the conclusion that the greatest amounts of sediment loading take place in the upper portion of each and every sub-watershed. For this reason, the need for implementing soil conservation measures becomes increasingly imperative in the upper portions of the watershed.

***Map G-8:* T Factor**



Public Act 116 allows for the temporary preservation of farm lands/open lands in Michigan. *Map G-9* was developed as another land use planning tool because PA 116, even though not permanent, can be used to legally restrict development and therefore preserve open space in the watershed. This is a benefit to water quality because it restricts the amount of impervious surface that can be added in the watershed, and therefore protects infiltration and groundwater recharge. Since PA 116 preserved farmland is a constantly changing thing, this map should be used in conjunction with the prime farmland analysis so as to preserve the highest priority farmlands first and most frequently. As represented in *Figure G-1*, there will be a continuous decline in preserved farmland in the watershed over the next several decades, with the greatest losses occurring in the next decade.

Map G-9: **PA 116 land in the watershed**

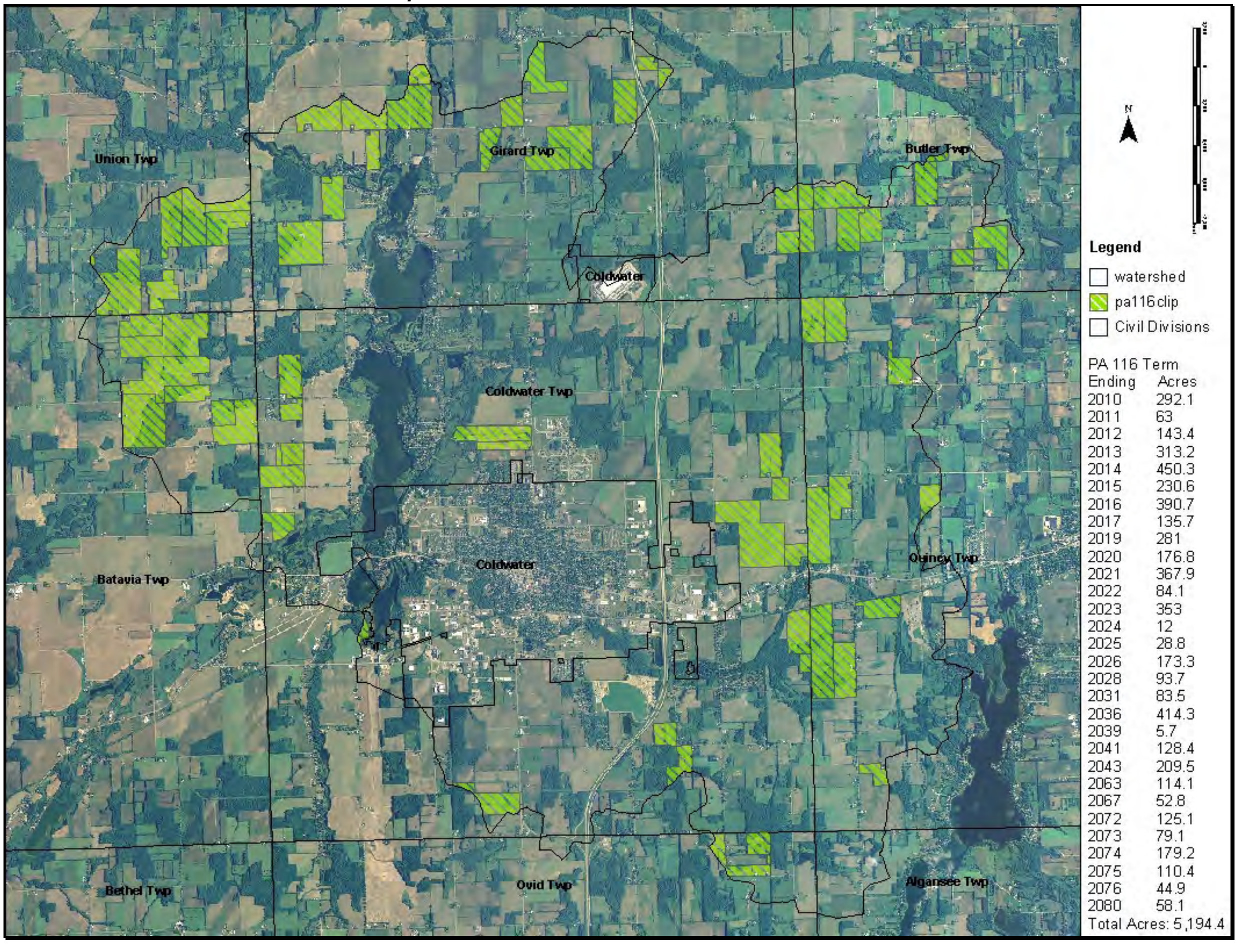
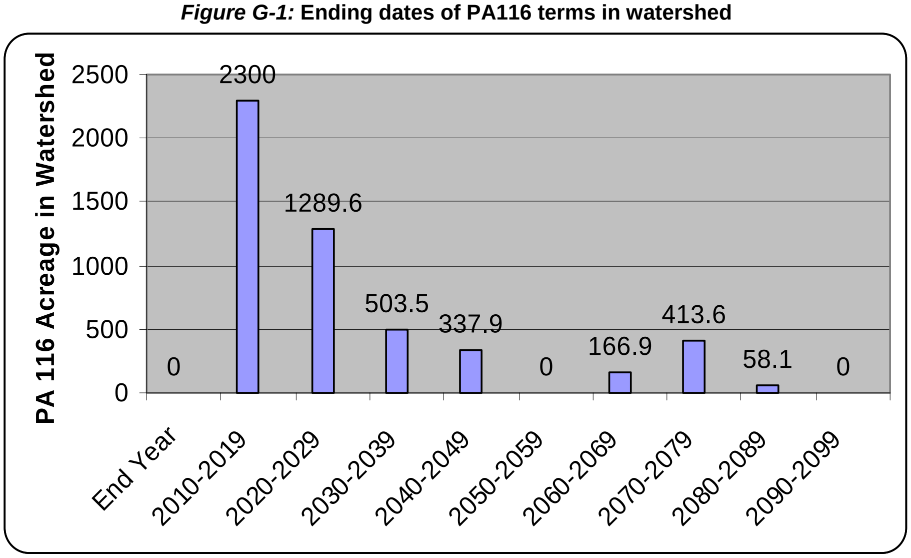


Figure G-1: **Ending dates of PA116 terms in watershed**



Appendix H

Hodunk-Messenger Chain of Lakes Watershed Streambank Erosion Inventory Report

Background

The Hodunk-Messenger Watershed is known to be a predominantly agricultural watershed. Because of this, watershed streams have undergone significant alterations through the years, such as channelization or straightening, removal of riparian vegetation and wetland drainage and conversion. When these practices take place, it is common for stream bank erosion to occur.

Depending on the severity and extent of erosion occurring, these impaired streambanks can often be a leading contributor of sediment loads to a receiving body of water. Given the agricultural characteristics of the Hodunk-Messenger Chain of Lakes Watershed (51% loss of wetlands and a channelization of streams) it is suspected that there may be significant stream bank erosion occurring throughout the watershed. In order to assess streambank erosion to a fuller extent, a system of monitoring erosion “hot spots” was adopted and a MDEQ approved Quality Assurance Project Plan (QAPP) was developed for the assurance of good results when administering this monitoring system.

Description of Analysis

For ease of access and efficient use of time, road stream crossings were selected as monitoring points for watershed streams. To assess the potential of stream bank erosion at road stream crossings in the Hodunk-Messenger Chain of Lakes Watershed, a Stream Crossing Watershed Survey Procedure, developed by MDEQ in 2002, was used in conjunction with a modified version of David Rosgen’s Bank Erosion Hazard Index (BEHI).

The stream crossing survey helped to characterize each road stream crossing while the BEHI procedure helped to quantify the potential for stream bank erosion at a given site. The Stream Crossing Watershed Survey method requires gathering such data from road-stream crossings as weather, substrate composition, stream dimensions, morphology, physical appearance, cover and adjacent land use. This broad range of data works well to help classify a stream crossing. The MDEQ Stream Crossing Survey form also helped to record potential pollutant sources. Rosgen’s modified BEHI requires data takers to assess the stream banks at road stream crossings based on four metrics: the ratio of root depth to bank height, root density, bank angle and percent of surface protection.

Using Rosgen’s method, a score is then applied to each measurement. The four metric scores are then added and based on the sum of the four scores, a stream crossing is ranked into one of six categories: very low, low, moderate, high, very high and extreme bank erosion hazard. These analysis methods go hand and hand with one another because they both are intended to be conducted at road stream crossings and can be done simultaneously. However, since each method acquires slightly different types of information, both were deemed necessary for the acquisition of data in the Hodunk-Messenger Watershed.

This two-step approach to road stream crossing monitoring was chosen for two reasons. For one, surveying road stream crossings is a relatively quick and easy way to assess the stability of streams throughout the watershed. While road stream crossings may not absolutely and accurately represent all stream reaches between road crossings, they at least provide snapshots of some erosion “hot spots” for future investigation. Secondly, road stream crossings themselves can be known to be a significant cause of sedimentation. Erosion and sediment occurs at road stream crossings when road approaches are not properly graded or vegetated, stream bank surfaces near the crossings are not sufficiently protected, if crossings or culverts are undersized or if precautionary erosion control methods are not utilized during construction projects.

The modified BEHI method proved to be a useful tool for quickly assessing potential erosion hot spots along reaches of streams while in-field as well. However, of all streams in the watershed, only the main body of Cold Creek and the Sauk River allowed for extended navigation by canoe, kayak or wading. Thus, these two actually fully assessed were the only two analyzed for stream bank erosion.

Methodology

Sites for conducting the road stream crossing inventories were selected from the 42 road stream crossings in the watershed equipped with culverts 36 inches in diameter or larger. The watershed-wide query of culverts ≥ 36 inches in diameter was generated by the Branch County Road Commission. These culverts were attributed with a numerical naming convention previously established by the Road Commission. To ease confusion, these identifying numbers were reused for the purposes of the watershed inventories. The selection of culverts used for the watershed inventory ranged sporadically from #12 to #2059 in no particular order.

Added to the large culvert sites were road stream crossings in the watershed that were designed as bridges. By referencing county drain maps of each township (c. 1960), 32 of these bridge/overpass sites were identified. All bridge/overpass sites that were added to the inventory selection were also given numerical identities, starting at #2060, since 2059 was the last road commission ID given, and increased sequentially. An additional six sites were happened upon by chance while inventorying other sites. Even though these six "bonus" sites were not originally identified as having a culvert three ft. or greater in size, at the time of inventory, there seemed to be enough water flow at the site to justify evaluation. In all, 80 road stream crossing sites within the watershed were visited to inventory.

To help accomplish the task of inventorying the 74 identified sites (later 80), seven volunteers were recruited and trained in surveying (in addition to the Watershed Project Coordinator). These seven volunteers consisted of Mary Ellen Newton, Branch Conservation District Vise-Chairperson; Mike Hard, Branch County Drain Commissioner; Trent Arver, Branch County Road Commission and six student volunteers from the Branch Area Careers Center. In order to insure uniformity among the data collected, designated surveyors were required to be trained by an MDEQ representative. Once trained, surveyors were evenly distributed sites to inventory.

At a given crossing site a surveyor was required to complete both a "Watershed Survey Data Sheet" for the Stream Crossing Watershed Survey portion and a "Modified BEHI Field Form" for the BEHI portion. Filling out the two-page Watershed Survey Data Sheet consisted of providing a variety of site characteristics based on observations. Any statistical observations made were based on estimations. For this reason, surveyors were encouraged to approach the stream and get as close as possible to make observations when ever possible. The Watershed Survey Data Sheets also required filling out a detailed description of the site so that site relocation and survey duplication could be possible. This description information consisted of water body name, site #, county, township and latitude and longitude if provided by the Road Commission.

The Watershed Survey Data Sheet is divided into both upstream and downstream observations for each question. Due to the necessity of analyzing both sides of a stream, the Modified BEHI Field Form is divided into four sections. These four sections are upstream left, upstream right, downstream left, and downstream right. For each section of stream bank, ten measurements were made: percentage of root density; degree of bank angle; and average percentage of surface protection. No tools or measuring devices were used in estimating the four metrics (hence the necessity for training and consistency among surveyors). Once an estimated measurement was made, a pre-determined score was applied to each of the 4 metrics (scores ranged from 1.45 to 10, with 1.45 being the least hazardous and ten being the most). Once every metric for every portion of stream bank at site was measured and assigned a score, a total score was added together and the site as a whole was assigned a BEHI category. This BEHI category, based on the total score of a site, ranged from very low hazard to very high and extreme hazard. However, it should be noted that surveyors did not complete the BEHI calculations in the field. A surveyor's responsibility ended at making estimated measurements. Once all measurements were completed on both survey data forms, they were returned to the watershed project manager within ten days. Once received, the Watershed Project Coordinator scored all BEHI sites and entered the data into a modified Microsoft Access database template created by Matthew Meersman for the Paw Paw River Watershed Project. Sites with a "high" BEHI score, along with any questionable sites that were suggested by volunteer surveyors, were revisited by the Watershed Project Coordinator for either photo documentation or re-evaluation. The road stream crossing survey period lasted from August-October, 2007.

Once a thorough inventory of all road stream crossings was conducted, navigable streams were revisited to obtain more in depth streambank erosion inventory into. Extended reaches of these streams were examined for the same characteristics as the road crossings were – especially for BEHI metrics. Since there were literally miles of stream to classify, assessments were applied more broadly over extended reaches of streams that exhibited similar characteristics. Specifically, a new BEHI score was not applied to a stream reach unless noticeably different stream bank characteristics were observed to extend 100 feet in length or more. In this way, limited and small-scale impairments were avoided in favor of generally defining the erosion hazard of broader reaches of streams.

By using the same ranking system as the road stream crossing BEHIs, impaired stream banks will be identified as stream reaches receiving a "High" BEHI score. These areas will be targeted for future mitigation, while stream reaches receiving "Moderate" scores will warrant routine check ups. All stream reaches classified were logged using GPS for future reference and mapping purposes.

Discussion

These inventory methods proved to be a great way to characterize road stream crossings in the watershed. In addition to identifying erosion hot spots, the inventories also helped to identify sites with visible refuse and discarded debris, stream obstructions/log jams and possible sources of additional nonpoint source (NPS) pollution from the adjacent land uses. All in all, trained volunteer data takers proved to be a reliable and efficient source of labor. However, variability in measurements between data takers did cause a few sites to be revisited. The multitude of volunteers also allowed for a greater distribution of survey work load.

In total, 80 road stream crossing sites were evaluated. Unfortunately, during the time period that these inventories were conducted (August-October 2007), water levels in streams were very low. At some sites, volunteers indicated that there was no water present at all (*Figure H-1*). In some extreme cases, it appeared that water had not flowed at the site for a very long period of time. Even though there were still culverts present at the sites, if there was no indication of water conveyance were thrown out. In all, three sites considered "not applicable" and were thrown out for this reason. Thus, the remaining database consisted of 77 crossing sites in the watershed.

***Figure H-1*: Watershed Drain with no Water**

Because of low flow and/or overgrown vegetation, several other stream crossing sites were difficult to locate and sometimes evaluate. On the other hand, low water conditions made observations of in stream erosion easier to identify at most sites. Low flow periods also helped to identify areas that were affected by other NPS pollutant inputs from surrounding land use activities. These discoveries were made by observing occurrences of oil sheens, bacterial slimes and foam in stagnant or slow moving water.
Due to time constraints and available stream access, only limited reaches of streams were classified during the course of these assessments. It would be beneficial in the future to expand assessment efforts to additional reaches of streams positioned between road crossings throughout the Hodunk-Messenger Watershed. These efforts may lead to a discovery of additional stream impairments and sources of NPS pollution. Furthermore, Cold Creek was not surveyed in its entirety due to low flow and/or extreme stream obstructions.

Results

Table H-1 displays the results of the road stream crossing BEHI survey in the Hodunk-Messenger Watershed. Of the 77 sites compiled in the table, only one was found to be ranked in the "very low" category. The very low site was found on Dayburg Road in the Miller Lake Drain Sub-watershed. The majority of sites (56 in all) were ranked as "low". These low sites were allocated to the three sub-watersheds as follows: 29 sites in Cold Creek Sub-watershed, 16 sites in the Sauk River Sub-watershed and 11 sites in Miller Lake Drain Sub-watershed.

18 road stream crossing sites were classified as "moderate", with half of them occurring in Cold Creek Sub-watershed, five in the Miller Lake Drain Sub-watershed and four in the Sauk River Sub-watershed. There was also one site in the Cold Creek Sub-watershed and one in the Sauk River Sub-watershed that were scored as "high" for stream bank erosion.

Table H-1: **BEHI Score Result Table**

InvtryID	WtrBdyNm	LocDesc	SiteBEHIscr	SiteBEHI	ObsEros
Cold Creek Sub-watershed					
883		Jonesville Road	6.175	Low	No
2060		Willowbrook Rd. (I-69)	6.55	Low	No
863		Newton Road	7.05	Low	No
84	Burton Drain	Fox Road (north)	7.3	Low	No
746		N Fremont Road	7.3	Low	Yes
945	County Drain #33	Bidwell Road	7.3	Low	No
947	County Drain #33	Bidwell Road	7.3	Low	No
2076	n/a	Union City Road (north)	7.3	Low	No
2067	County #15	Seeley Road	7.425	Low	No
79		Newton Road	7.55	Low	No
889	County Drain #33	Dean Road	7.8	Low	No
2100	County Drain #33	Bidwell & Dean Rd	8.05	Low	No
2106	n/a	Jonesville Road (fox/sobie)	8.3	Low	No
884		Jonesville Road	8.55	Low	No
2063		Fiske Road (north)	8.675	Low	No
72	Mud Creek	Newton Road	9.05	Low	Yes
1013		Jonesville Road	9.3	Low	No
2065	County Drain #15	Michigan/State (south)	9.3	Low	No
748	Cold Creek	N. Fremont Road	9.55	Low	No
781		State Road	9.55	Low	Yes
2074	Mud Creek	Union City Road (south)	9.675	Low	No
2070	County #33 (Mud Creek)	Michigan Rd (Mud Creek)	9.925	Low	No
780	Burton Drain	State Road	10.6875	Low	No
2066	County #15, Branch #1	Michigan/State (north)	10.825	Low	Yes
2103	County #15	Newton Road (E. of Michigan)	10.925	Low	Yes
57	County Drain #15	State Road	11.05	Low	Yes
2084	Sauk River	Butters Road	11.05	Low	Yes
2085	Sauk River	Waste Water Treatment Plant	11.05	Low	No
2068	County Drain #15	Michigan Rd. (by Newton)	11.8	Low	Yes
2073	n/a	Marshall Road (south)	12.425	Moderate	Yes
2069	Branch # 2	Newton East	12.675	Moderate	No
1011		Jonesville Road	12.9625	Moderate	No
2064		Willowbrook Rd (north)	13.175	Moderate	Yes

2062		Fiske Road (south)	13.55	Moderate	No
2072	County #33 (Cold Creek)	Gorbell Road	13.5625	Moderate	No
2071	County #33 (Cold Creek)	Jonesville Road	17.4625	Moderate	Yes
1016		Jonesville Road	17.825	Moderate	No
865	Cold Creek	Ridge Road	19.375	Moderate	No
59		State Road	23.3	High	No

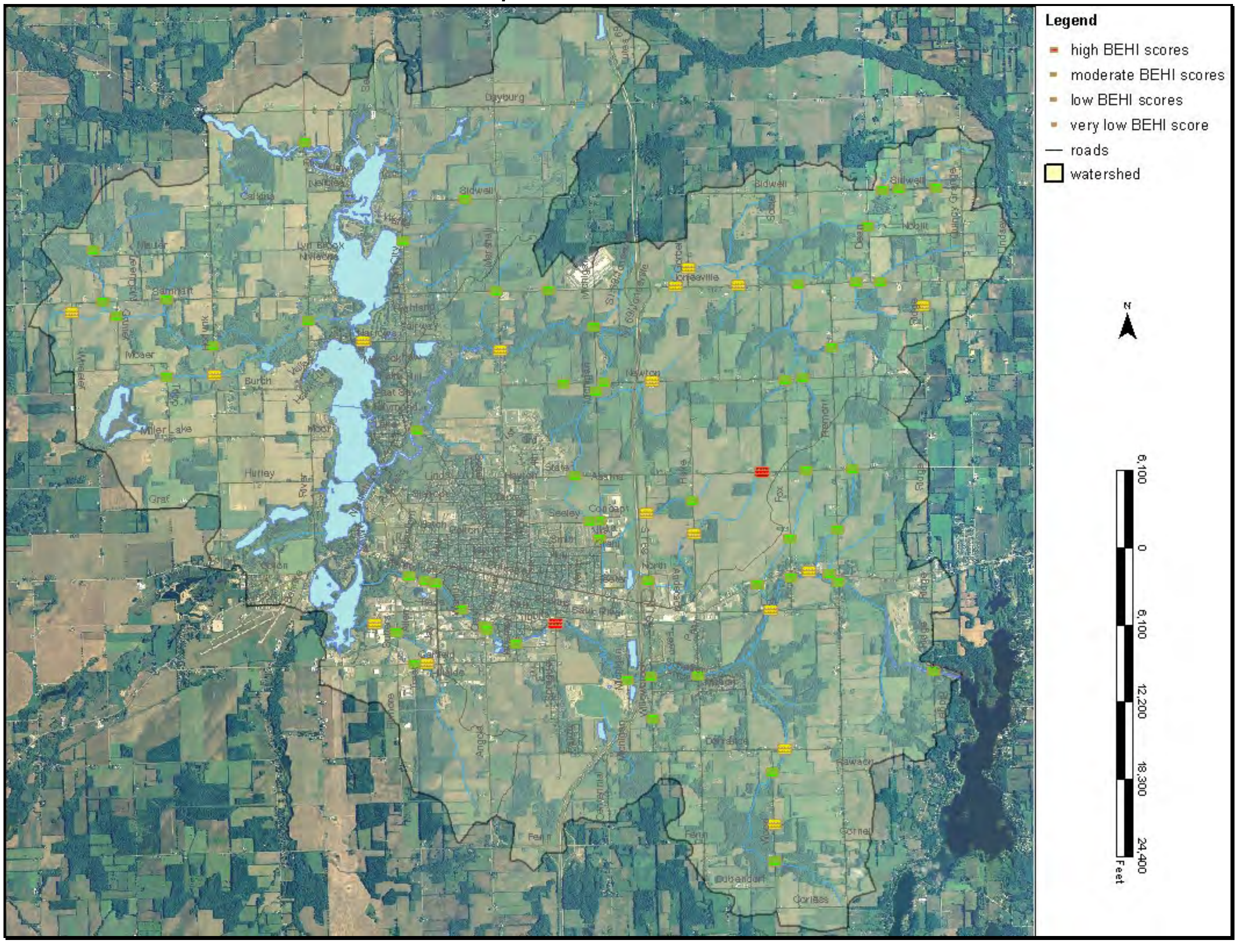
<u>Sauk River Sub-watershed</u>

786	County Drain #22 (Sauk Rv)	Ridge Road	6.175	Low	No
65	n/a	Willowbrook Rd (by Dorrance)	6.55	Low	No
2093	Burton Drain	US 12	6.925	Low	No
2091	Sauk River	Fiske Road (Sauk River X-ing)	7.675	Low	Yes
2097	County # 40	Woods Road (south)	8.425	Low	No
2086	Sauk River	Jay Street	8.8	Low	No
69	Sauk River	Gravel Pit	9.175	Low	No
2107	Quincy # 37	US 12 (east)	9.3	Low	No
2095	Sauk River	Fremont Road (near US 12)	10.05	Low	Yes
2088	Sauk River	Old 27	10.175	Low	No
2087	Sauk River	Walnut Street	10.3	Low	No
2101	Sauk River	Clay Street	10.925	Low	No
2096	County # 40	Woods road (north)	11.3	Low	No
2102	Sauk River	Willowbrook Road (Sauk Rv)	11.425	Low	No
2089	Sauk River	Jefferson St. (by fairgrounds)	11.55	Low	No
2094	County #22 ext (Sauk Riv)	Fox Road (south)	11.55	Low	Yes
12	County Drain #40	Dorrance Road	12.8	Moderate	No
2108	n/a	US 12 (mid)	12.8	Moderate	Yes
2092	Sauk River	Lot Road	16.55	Moderate	Yes
164	Quincy Drain #9	S. Wood Road	16.8	Moderate	Yes
2090	Sauk River	Sprague Rd (Waterworks Park)	19.875	High	Yes

<u>Miller Lake Drain Sub-watershed</u>

1071		Dayburg Road	5.8	Very Low	No
34		Garfield Road	7.05	Low	No
2077	n/a	Bidwell Road (west)	7.3	Low	No
2079	Coldwater River	River Road	8.3	Low	No
1162	County Drain #3	W. Barnhart Road	8.3	Low	No
2105	n/a	Butters Road (south)	8.675	Low	No
43	Miller Lake Drain	River Road	8.6875	Low	No
1160		W. Barnhart Road	8.8	Low	No
2082	Joint # 3	Tripp Road	9.3	Low	No
130		Hodunk Road	9.55	Low	No
2081	Joint # 3	Gruner Road	9.675	Low	No
2059		Mauer Road	11.8	Low	No
2080	Joint # 19	Wheeler Road	12.925	Moderate	Yes
32	n/a	Garfield Road (east)	13.05	Moderate	No
2099	Coldwater River (narrows)	Narrows Road	13.8125	Moderate	No
129	Miller Lake Drain	Hodunk Road	14.8375	Moderate	Yes
2104	n/a	Race Street (west)	15.6875	Moderate	Yes

***Map H-1:* BEHI Sites**



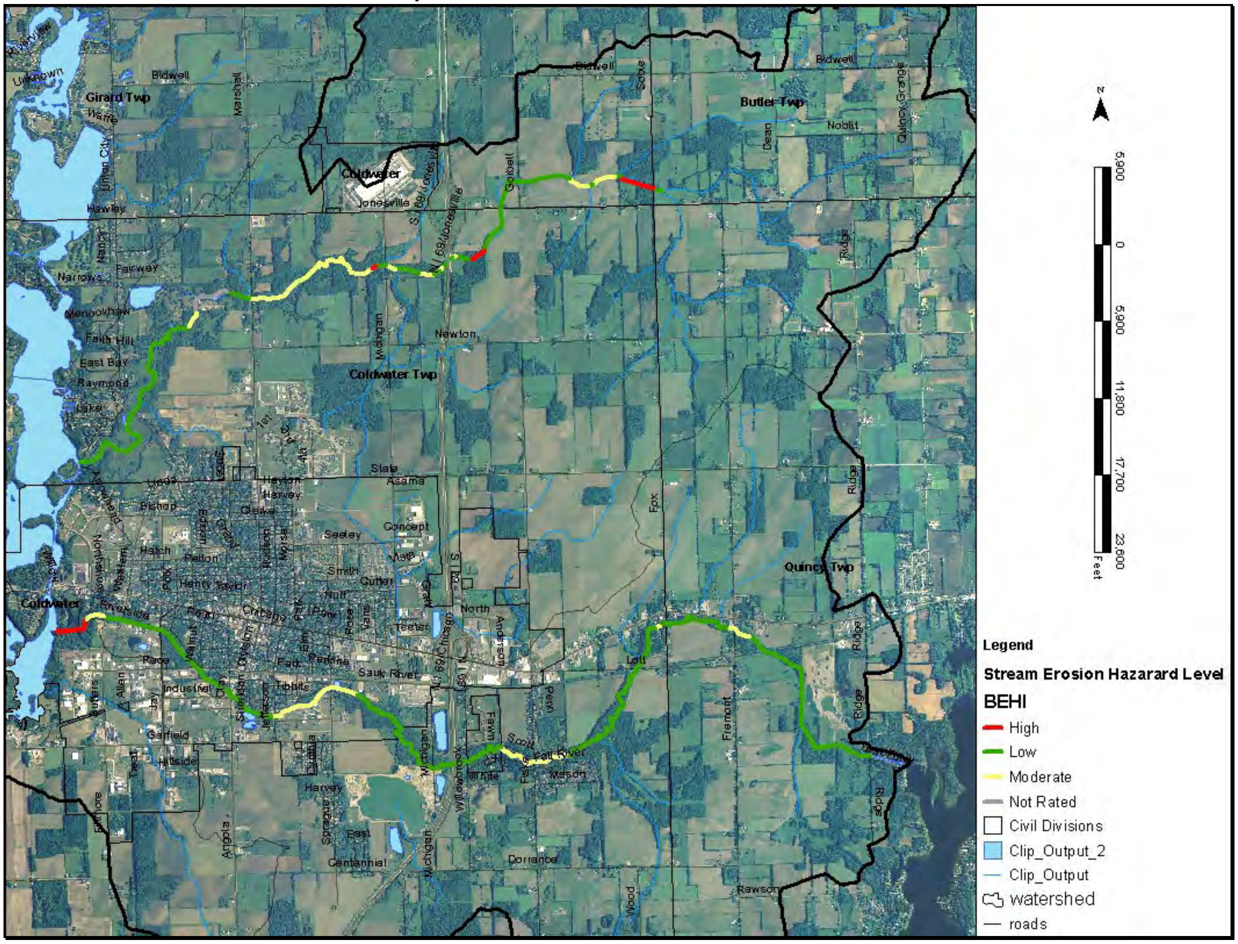
NOTE: Stream Crossing Watershed Survey data is not included in this report because it does not so much provide measurements or conclusive results on pollutant loading as it does characterize road stream crossings through observation. However, information collected in the Stream Crossing Watershed Survey will be entered into the US EPA's STORET database, since no stream crossing information currently exists in the Hodunk-Messenger Chain of Lakes Watershed. STORET, short for STOrage and RETrieval, is a database of water quality, biological, and physical data used by state environmental agencies, universities and private citizens.

Of the navigable portions of Cold Creek and Sauk River inventoried, no reaches were found to exhibit "very low" BEHI site characteristics for any extended distance (over 100 ft. continuously). Instead, every stream reach navigated was classified as either "high", "moderate" or "low". A breakdown of linear footage for each of these classifications is shown in *Table H-2*, while *Map H-1* depicts the spatial relationship of these classified reaches.

***Table H-2:* Stream bank Erosion Hazard of Portions of Cold Creek and Sauk River (in linear feet)**

	Low	Moderate	High	Not Rated
Cold Creek	19,401.9	9,721.65	2,238.3	1,739.7
Sauk River	37,754.8	8,691	1,765.1	

Map H-2: Stream Reach Classification



Conclusions

The inventories conducted at road stream crossings throughout the watershed have identified impaired road stream crossings and stream banks with a high potential of erosion in the future. These inventories have also provided enough information to establish a baseline characterization of stream banks within the watershed against for which BMP effectiveness can be evaluated against in the future. However, since very few road stream crossings were found to be of "high" erosion potential, it may be concluded that stream crossings are not the only (and perhaps not even the leading) source of soil erosion in the watershed streams. On the whole, most road stream crossings were found to be low or moderate. With this in mind, further investigation of stream reaches upstream and downstream of road crossings may be appropriate for a more comprehensive discovery of streambank impairments.

Sites receiving a low or very low score are considered satisfactory and will not require recommendations to be made for implementation. Digital photography will be utilized on sites with a moderate score and mitigation on moderate sites will be applied on a per-site basis. Recommendations for implementation will not likely be made on moderate sites unless an obvious physical impairment is observed. Mitigation will, however, be recommended for the two sites that received a high score. If time permits, further assessment methods would be warranted on the sites that received a high or moderate score. This would help to better characterize the impairments at each site and aid in recommending specific implementation activities to remedy the problems.

All stream reaches falling between road crossings that received a "High" score are to be considered impaired. Of the 33,101.6 feet of Cold Creek assessed, 2,238.3 feet, or 6.8% was found to be impaired. Of the 48,210.8 feet of Sauk River assessed, 1,765.06 feet or 3.7% was found to be impaired. It may be concluded that both of these streams have areas where stream bank erosion is occurring more rapidly than others, and that these areas are contributing significant amounts of sediment to the watershed through rapid stream bank erosion.

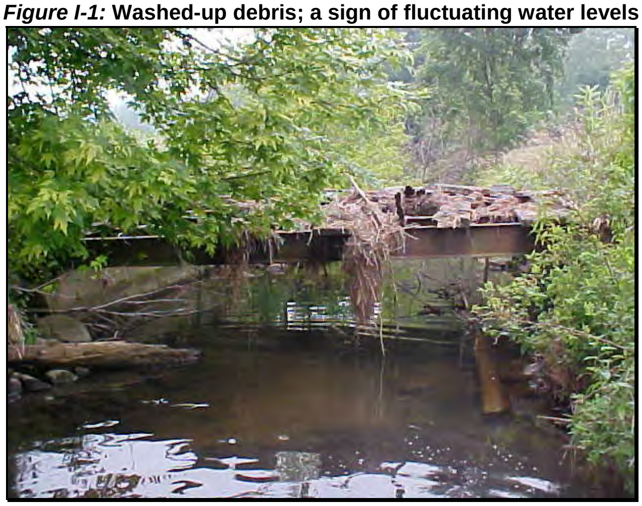
Appendix I

Streambed Mobility Trends of Selected Stream Reaches in the Hodunk-Messenger Chain of Lakes Watershed

Background

Because of the Hodunk-Messenger Watershed's long history of agricultural land use in the Hodunk-Messenger Chain of Lakes Watershed (currently employed on roughly 70% of the watershed's land mass), a majority of streams within the watershed have been straightened or channelized and a majority of wetland areas have been drained for land cultivation. These alterations to the natural hydrology ultimately results in flashier (more volatile, fluctuating) stream flow. Flashy streams have lower than normal base flows, increased peak flows and less recovery time between the two periods. In addition, flashy streams reach the bankfull stage- the most erosive and stressful water level- more often. Evidence of this flashiness has been discovered in the Hodunk-Messenger Watershed through watershed project inventories conducted during the Hodunk-Messenger Watershed Planning Project. For example, *Figure I-1* shows debris deposited on a bridge after a flash flood event, illustrating the fluctuation between flow levels in the stream.

Figure I-1: **Washed-up debris; a sign of fluctuating water levels**



Alterations to the natural hydrologic regime of the watershed such as wetland conversion, tiling and stream channelization are believed to be having a severe impact on stream channel stability among watershed streams. "Stream channel stability refers to the capacity of a stream channel to transport its water and sediment inputs without changing its dimensions (width, depth, slope, etc.). The gradual movement of stream bank and stream bed dimensions is a naturally occurring phenomenon. The difference between a stable stream and an unstable stream is the rate of this bank and bed movement."[4] Several sites within the Hodunk-Messenger Watershed indicate that stream channels are shifting at an unhealthy rate through a process of degradation (erosion) and aggradation (deposition). This stream channel instability is characteristic of channelized streams trying to recover some of their natural sinuosity.

[4] MDEQ *Stream Stability Assessment Guidelines for NPS Grant Applicants,* Draft #2-4/15/08, (pg. 1)

Figure I-2: **Eroding Bank in Flashy Stream**

Quantifying the level of stream stability in a watershed is important for recommending the most suitable best management practices (BMP) for correcting sediment loading and hydrologic flow problems. To facilitate this, cross-channel trend assessments were conducted on selected reaches of streams in the watershed.

Description of Analysis

Using laser-level survey equipment, cross-channel depth measurements were taken at several stream segments thought to be highly unstable in the watershed. These measurements established a cross-section profile of the streams at that particular point. In years to come, if the same method of cross-section analysis is applied to the same exact sites, the magnitude and rate of stream bed movement will become apparent.

Tractive force measurements were also carried out at the cross section analysis sites. Tractive force measurements are a way of predicting the stability of a stream system by calculating the ratio that lays between the shear stress of a stream and the size of streambed particles available to be moved. Unfortunately, calculations soon revealed that applying tractive force to channelized agricultural ditches was futile. Historically, tractive force has only been intended to be applied to natural streams and the measurements taken in the Hodunk-Messenger Watershed served to “field proof” this assertion. The excessively deepened ditches that are frequently encountered in many upper watershed waterways generated results that indicate wildly unstable streams. In reality though, the excessive width of these ditches keeps water depths so low that under normal flow conditions, they possess no real power.

Methodology

Sites for cross-channel measurements in the Hodunk-Messenger Watershed were initially selected from road stream crossing sites in the watershed that scored a “high” or “moderate” score in the Bank Erosion Hazard Index (BEHI) inventory previously conducted on all road stream crossing sites in the watershed (*Map I-1*). Site visits were then conducted to determine which of these sites were easily accessible and wade-able from road crossings. Since tractive force measurements were also attempted at the sites of cross-channel modeling, the final parameter for site selection was the presence of a straight reach of stream at least 100 feet in length with a clear line of site for utilizing surveying equipment.

Once a site of appropriate characteristics was selected, the location was marked with a GPS for future reference and mapping purposes. In the end, four sites were selected for analysis. Of these sites, 3 were located in the main branch of Cold Creek and one was in the Sauk River.

A tripod laser survey unit was then mounted and leveled. The laser survey unit was used to mark depths of a cross-channel transect within the given reach of stream. This was done by marking depths (Foresight points) across the channel, working from left bank to right bank and marking the depth at every change in elevation. A measuring tape was stretched from left bank to right bank and at every depth change, the distance from the left bank was recorded.

From these cross-channel depths, the bankfull depth in feet (D_{BF}) was recorded. Since the stream segments analyzed were so overly-modified, it was often difficult to determine the bankfull depth. In the cases where it was difficult to qualitatively observe the position of the bankfull height, channel depth from the top of the bank to the thalweg (lowest point in channel bed) was used as a substitute for D_{BF}.

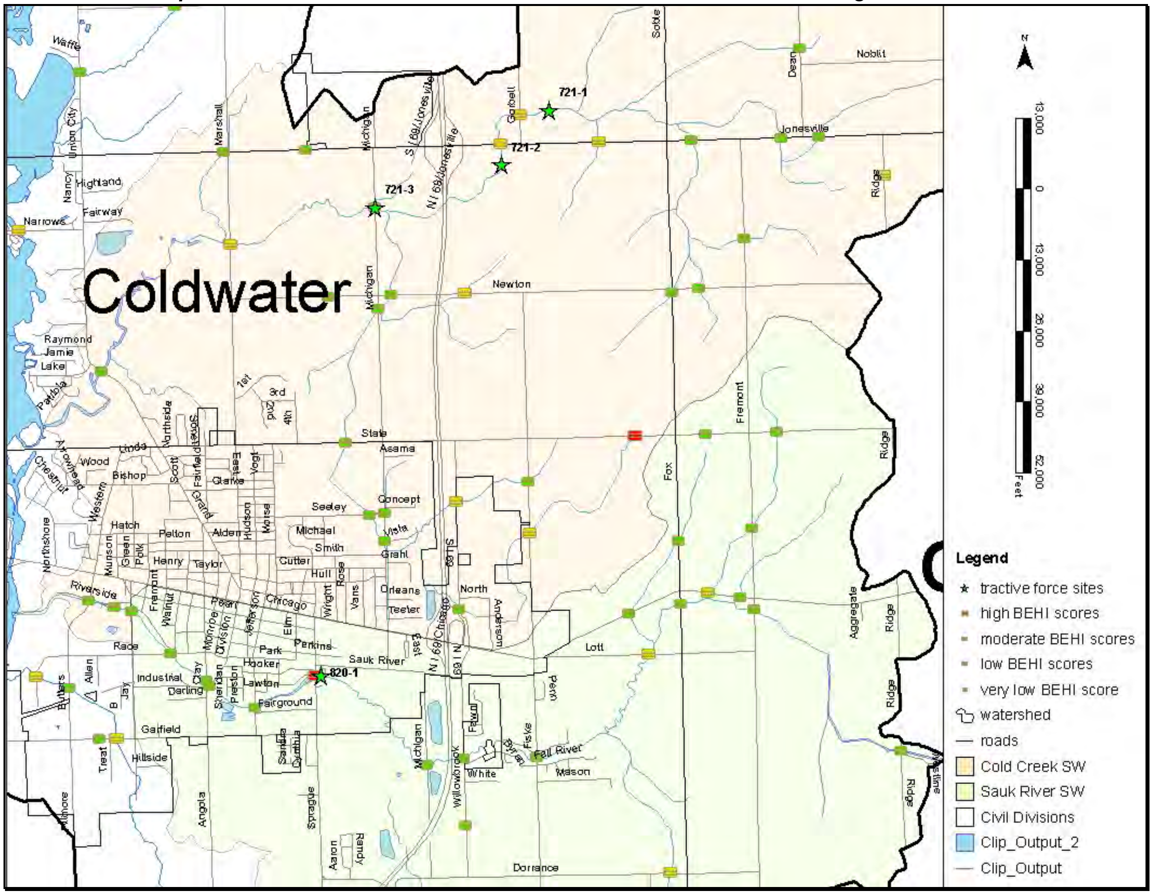
Once the cross-channel measurements were collected, the measurements necessary for the tractive force assessments were also taken. This was done by taking an elevation reading at an upstream foresight (FS) point where a riffle was present (or the shallowest point available). Another FS elevation was then marked and recorded at another riffle (or shallow point) at least a hundred feet downstream from the established upstream FS point. The exact distance between the two points was then measured. The difference of elevation between the two FS points was calculated and, using the distance between the two points, the slope (S) of the stream segment was calculated.

Once "S" and "D_{BF}" were determined and recorded on a field data form, a *calculated* tractive force measurement was then able to be determined. This was calculated by using the tractive force equation: $T = D_{BF} \times S$, where "T" represents the particle size (in centimeters) that is mobile at bankfull discharges. This particle size, "T" represents the calculated incipient particle diameter; later referred to as "IPD_c".

With the necessary information for calculating the IPD_c obtained, a pebble count was conducted. If the stream substrate was observed to be of a homogenous granule size, the same particle diameter size was applied to the entire reach. If the stream substrate was a mixture of varying granule sizes, at least a 100 particle samples were chosen at random from the entire length of the stream reach starting at the upstream FS point working downstream to the downstream FS. Granule diameters were recorded for all samples taken. The 84^{th} percentile diameter (D_{84}) was then calculated from the cumulative pebble count of each stream reach by entering the data into the tractive force calculation spreadsheet, developed by Joe Rathbun, MDEQ-WB Monitoring Specialist. Studies indicate that the D_{84} represents the maximum particle size mobile at bankfull discharges. The particle size corresponding to the D84 is known as the measured incipient particle diameter, or IPD_m.

Assumed stream stability for a given stream reach was then determined by taking the ratio of IPDc/IPDm. This figure was automatically calculated when entered into the tractive force spreadsheet developed by MDEQ Monitoring Coordinator Joseph Rathbun. Cross-Channel transect data was also entered into the STREAM (Spreadsheet Tools for River Evaluation, Assessment and Monitoring) module developed by Dan Mecklenburg, Ohio Department of Natural Resources.

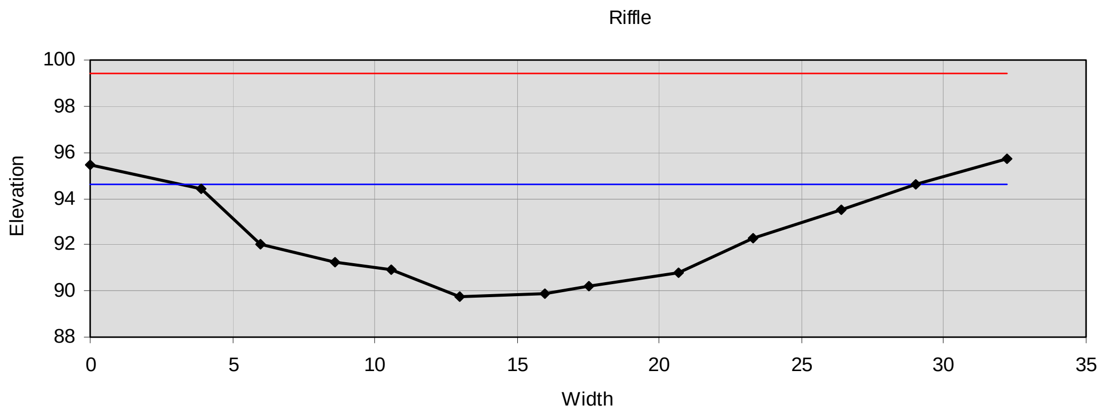
Map I-1: **Tractive Force stream measurement sites in Hodunk-Messenger Watershed**



Discussion

It proved to be very difficult to identify bankfull dimensions at the four sites surveyed in the Hodunk-Messenger Watershed. In fact, calculating the BF depth by measuring channel depth from the top of the bank to the thalweg actually proved to be unreliable because the streams were so deep and incised. Instead, BF depth had to be visually interpolated from the Mecklenburg STREAM module by plotting the Cross-Channel Transect dimensions and observing the most likely place for the BF level to occur. For example, the blue line in *Figure I-3* appears to be the most likely bankfull height for this particular stream cross section, indicating that the maximum depth at bankfull stage would be 4.8 feet.

Figure I-3: **Cross-Channel Transect Example**



More sites might have been measured and analyzed for stability if not for time constraints. The sites that were analyzed were selected based on a combination of their priority and ease of access. No sites were surveyed in the Miller Lake Drain sub-watershed of the Hodunk-Messenger Watershed because only very low, low and moderate priority BEHI sites were identified in it. Limited access to suitable reaches of streams was also an issue in the Miller Lake Drain Sub-watershed.

The Cold Creek Sub-watershed had the greatest amount of moderate and high priority BEHI sites and impaired streambanks so stability analyses were concentrated on suitable reaches within this sub-watershed. Even though there were very few impaired streambanks, the Sauk-River sub-watershed had the second-highest amount of priority BEHI sites, so measurements were also conducted on a segment in the middle of the Sauk River near a high priority road stream crossing.

In the end, the results from the tractive force measurements and calculations were so skewed that they were thrown out and not taken into consideration as a reliable source of information in this watershed. In retrospect, more emphasis should have been place on the cross-channel transect measurements. To better track the stability of watershed streams, it is recommended that the cross-channel modeling is expanded during a watershed implementation project. Including more transect locations would help accrue more baseline information about the rate of streambed movement in various watershed streams.

Results

The cross-channel profiles for all four sites surveyed are represented below graphically. *Table I-1* also shows the tractive force measurements for each of the four stream reaches surveyed during this project. The measured D_{84} was derived from a modified version of Mecklenburg's STREAM module. The ratio in the last column (highlighted in yellow) is what the interpretation of stream stability is based on. Under normal circumstances, a IPDc/IPDm ratio ≤ 1 indicates a stable stream and a ratio >1 indicates and unstable stream.

Table I-1: **Hodunk-Messenger Results from "TractiveForceCalcs.xls"**

Location	Reach Length (Ft)	Upstream Foresight (Ft)	Downstream Foresight (Ft)	Slope (Ft/Ft)	Maximum Bankfull Depth (Ft)	Maximum Bankfull Depth (mm)	Calculated IPD (IPDc; cm)	Measured D84 (IPDm; mm)	Measured D84 (IPDm; cm)	Ratio IPDc/IPDm
721-1 (Cold Creek 1)	221	9.46	9.49	0.0001	4.8	1463	0.2	0.45	0.045	4.4
721-2 (Cold Creek 2)	195	11.27	11.81	0.0028	4.6	1402	3.9	1.2	0.12	32.4
721-3 (Cold Creek 3)	192	13.09	13.12	0.0002	4.3	1311	0.2	1.1	0.11	1.9
820-1 (Sauk River)	100	5.42	5.44	0.0002	3.4	1036	0.2	0.9	0.09	2.3

Conclusion

The cross-channel transect data acquired during this stream assessment project does not offer any conclusive evidence for determining the state of hydrologic stability among watershed streams. The data collected only represents a baseline of profiles for which future cross-channel measurements can be compared against. Stream bed movement can now be documented at these four sites by taking future cross-channel transect measurements and comparing them to these newly established channel models. When time and personnel allows, it is recommended that additional sites are surveyed and established as cross-channel transects so that streambed movement can start to be tracked in a greater number of stream reaches in the watershed.

No conclusions are drawn from the tractive force measurements either, save for the conclusion that tractive force is, in fact, not an appropriate measure of stream stability in agricultural ditches.

Appendix J

LANDSCAPE LEVEL WETLAND FUNCTIONAL ASSESSMENT REPORT COMPLETED BY MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY – LAND AND WATER MANAGEMENT DIVISION

Wetlands Status and Trends Report

Pre-settlement to 2005

Created By:

DEQ Department of Environmental Quality
Land and Water Management Division

DATA LIMITATIONS AND DISCLAIMER

National Wetlands Inventory (NWI)

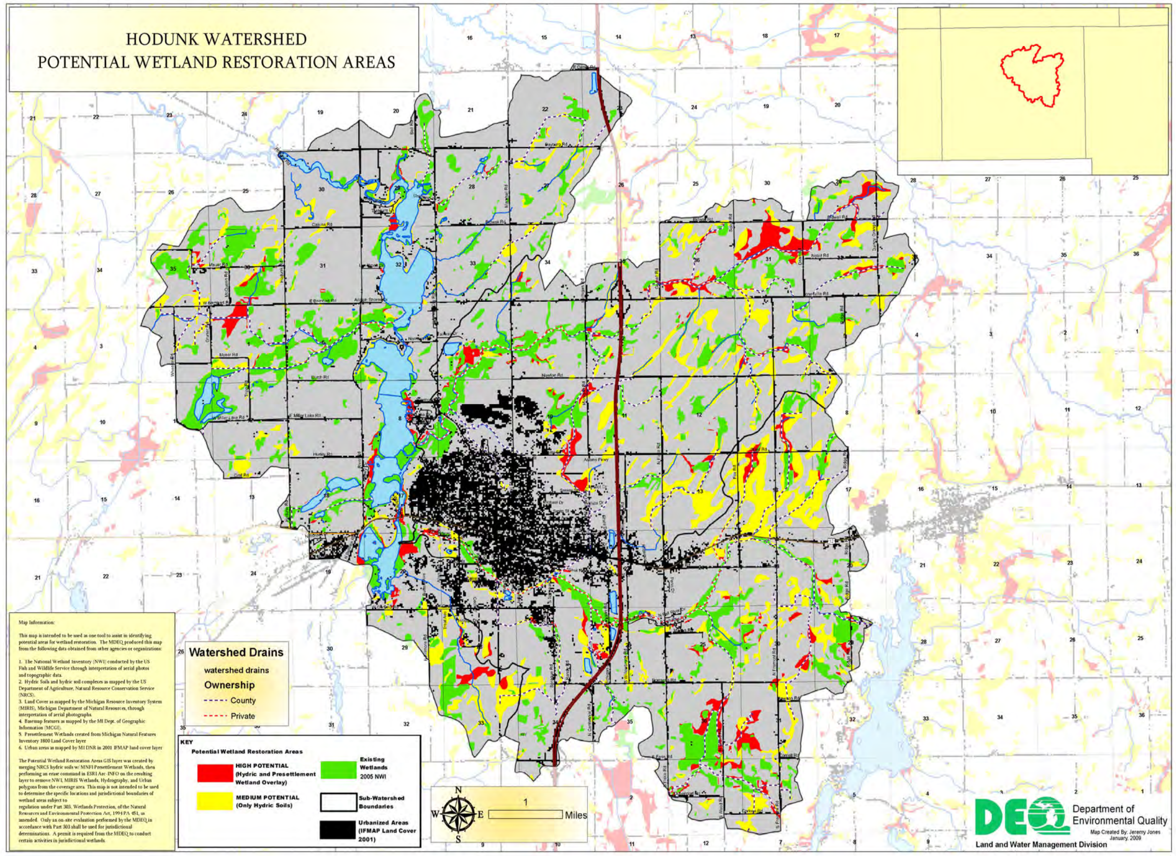
- Wetland boundaries determined from Aerial Imagery
- Last updated in 1978
- Obvious limitations to Aerial Photo Interpretation:
  - Errors of Omission (forested and drier-end wetlands)
  - Errors of Commission (misinterpretation of aerials)

The 2005 NWI data was used in this analysis to report status and trends, as this is currently the best data source available. However, this data may not accurately reflect current conditions on the ground.

THE MDEQ-Land and Water Mgmt Division has begun a joint project with Ducks Unlimited, Inc. to update the 1978 NWI using 1998 aerial imagery and 2005 aerial imagery. The project is on going, and this data will be used for all future Wetland Status and Trends analysis.

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

HODUNK -MESSENGER CHAIN OF LAKES WATERSHED



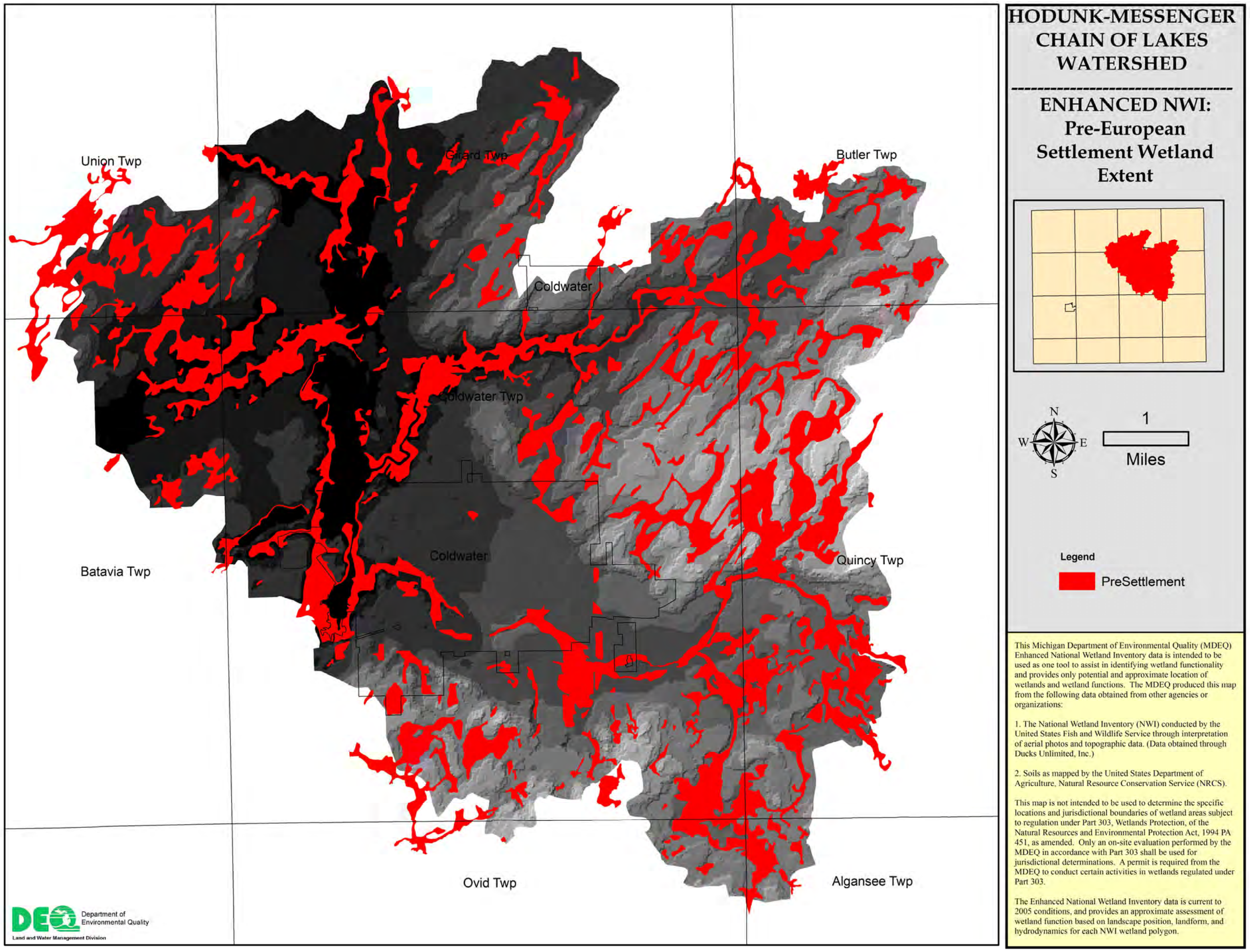
HODUNK -MESSENGER CHAIN OF LAKES WATERSHED WETLAND RESOURCES STATUS AND TRENDS

Pre-settlement Wetland conditions	2005 Wetland Condition***
8,812 Acres of Wetlands	4,353 Acres of Wetlands
411 Polygons	821 Polygons
Average Size – 21 Acres	Average Size – 5.3 Acres

49% of original wetland acreage remains

51% loss of total wetland resource

HODUNK-MESSENGER CHAIN OF LAKES WATERSHED: PRESETTLEMENT WETLANDS



This Michigan Department of Environmental Quality (MDEQ) Enhanced National Wetland Inventory data is intended to be used as one tool to assist in identifying wetland functionality and provides only potential and approximate location of wetlands and wetland functions. The MDEQ produced this map from the following data obtained from other agencies or organizations:

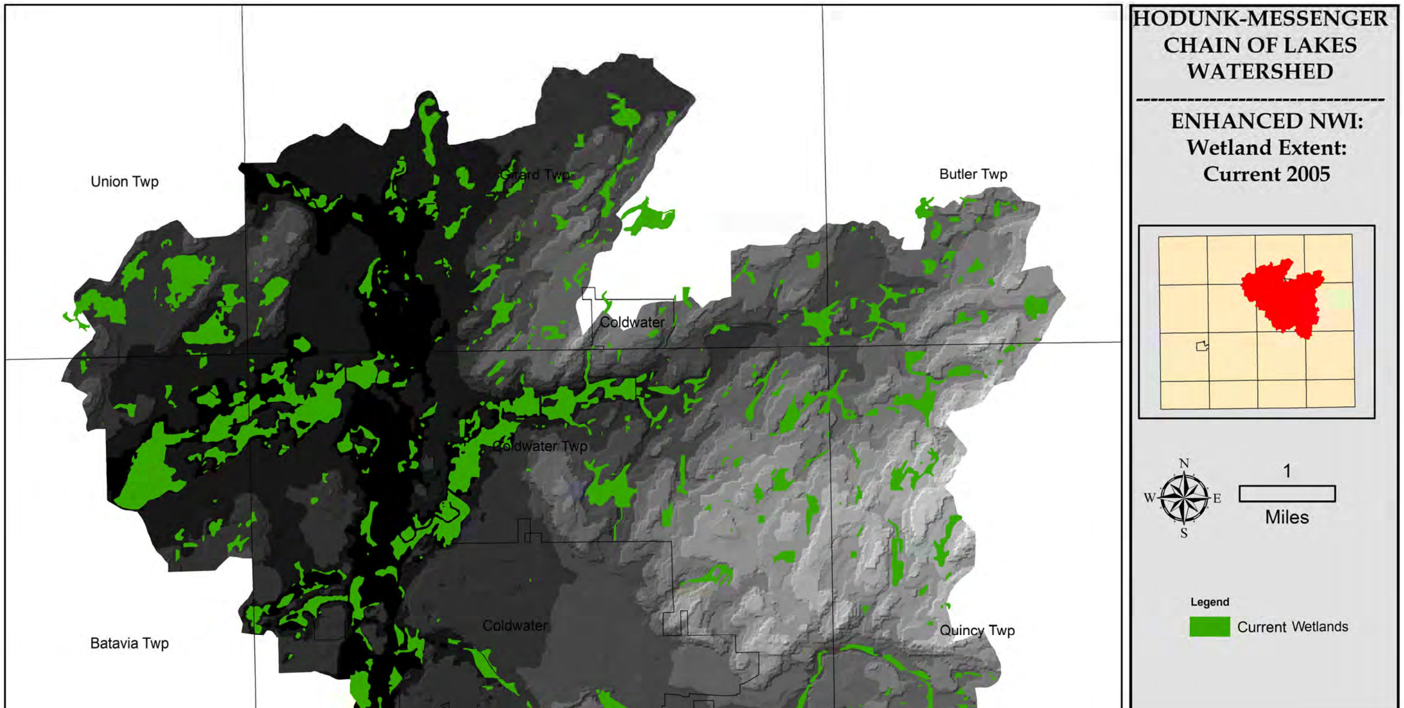
1. The National Wetland Inventory (NWI) conducted by the United States Fish and Wildlife Service through interpretation of aerial photos and topographic data. (Data obtained through Ducks Unlimited, Inc.)

2. Soils as mapped by the United States Department of Agriculture, Natural Resource Conservation Service (NRCS).

This map is not intended to be used to determine the specific locations and jurisdictional boundaries of wetland areas subject to regulation under Part 303, Wetlands Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. Only an on-site evaluation performed by the MDEQ in accordance with Part 303 shall be used for jurisdictional determinations. A permit is required from the MDEQ to conduct certain activities in wetlands regulated under Part 303.

The Enhanced National Wetland Inventory data is current to 2005 conditions, and provides an approximate assessment of wetland function based on landscape position, landform, and hydrodynamics for each NWI wetland polygon.

HODUNK-MESSENGER CHAIN OF LAKES WATERSHED: 2005 WETLANDS



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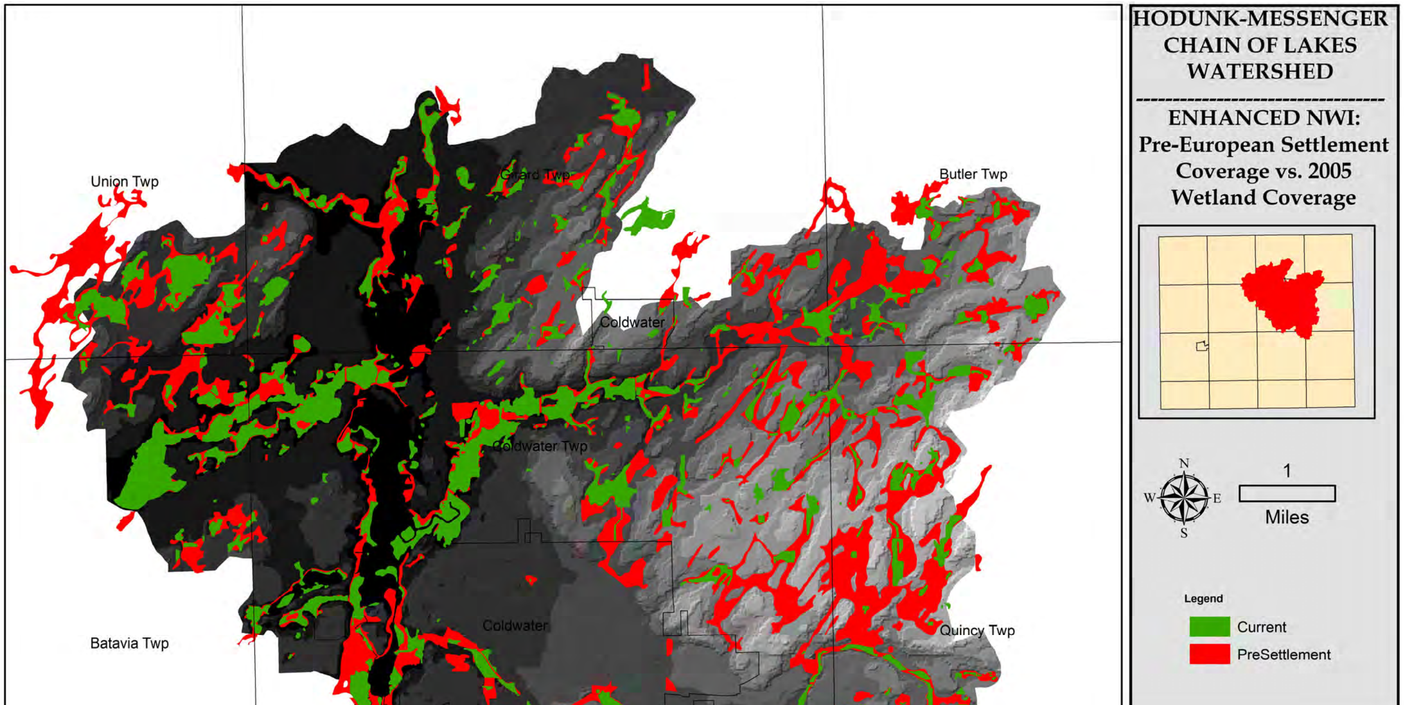
HODUNK-MESSENGER WATERSHED: APPROXIMATE AREAS OF WETLAND LOSS



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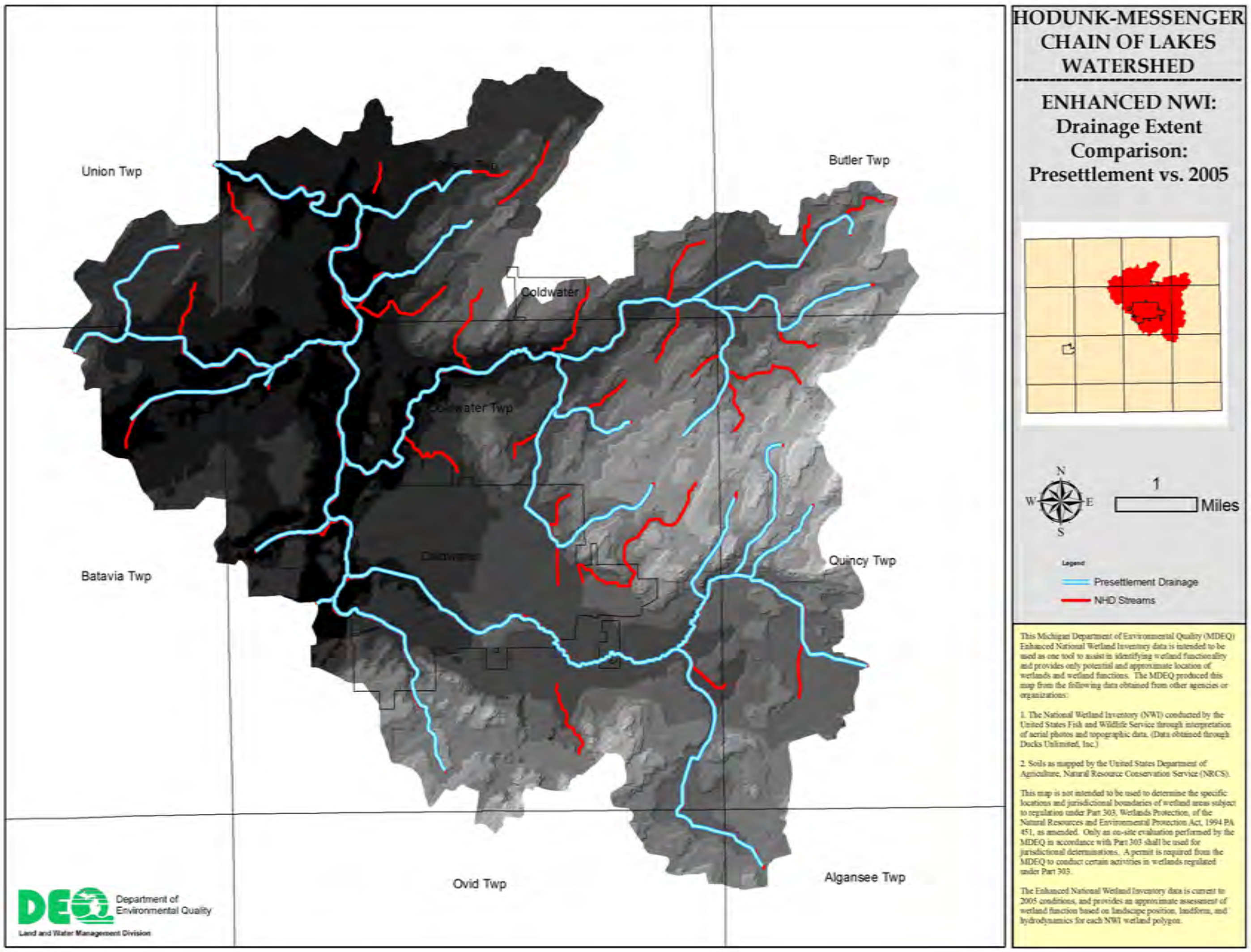
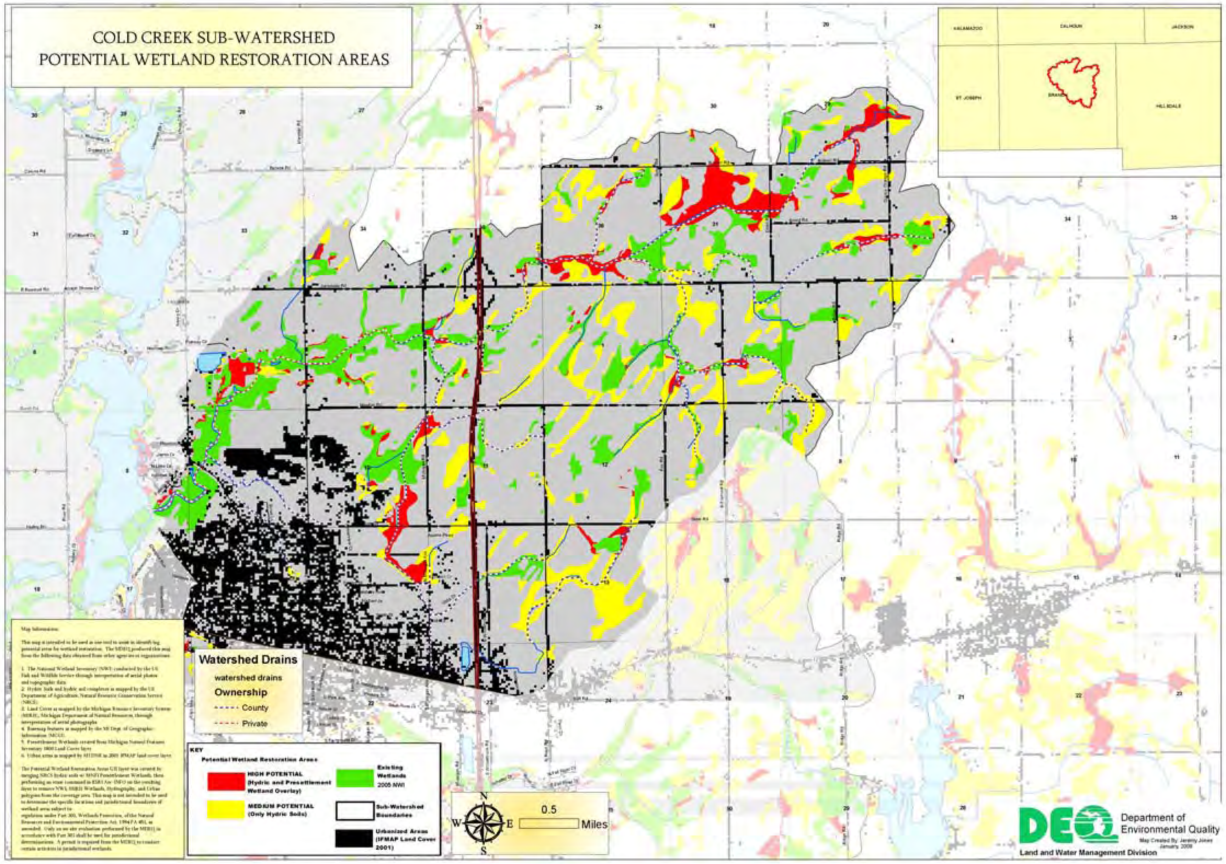
DRAINAGE EXTENT



COLD CREEK SUB-WATERSHED



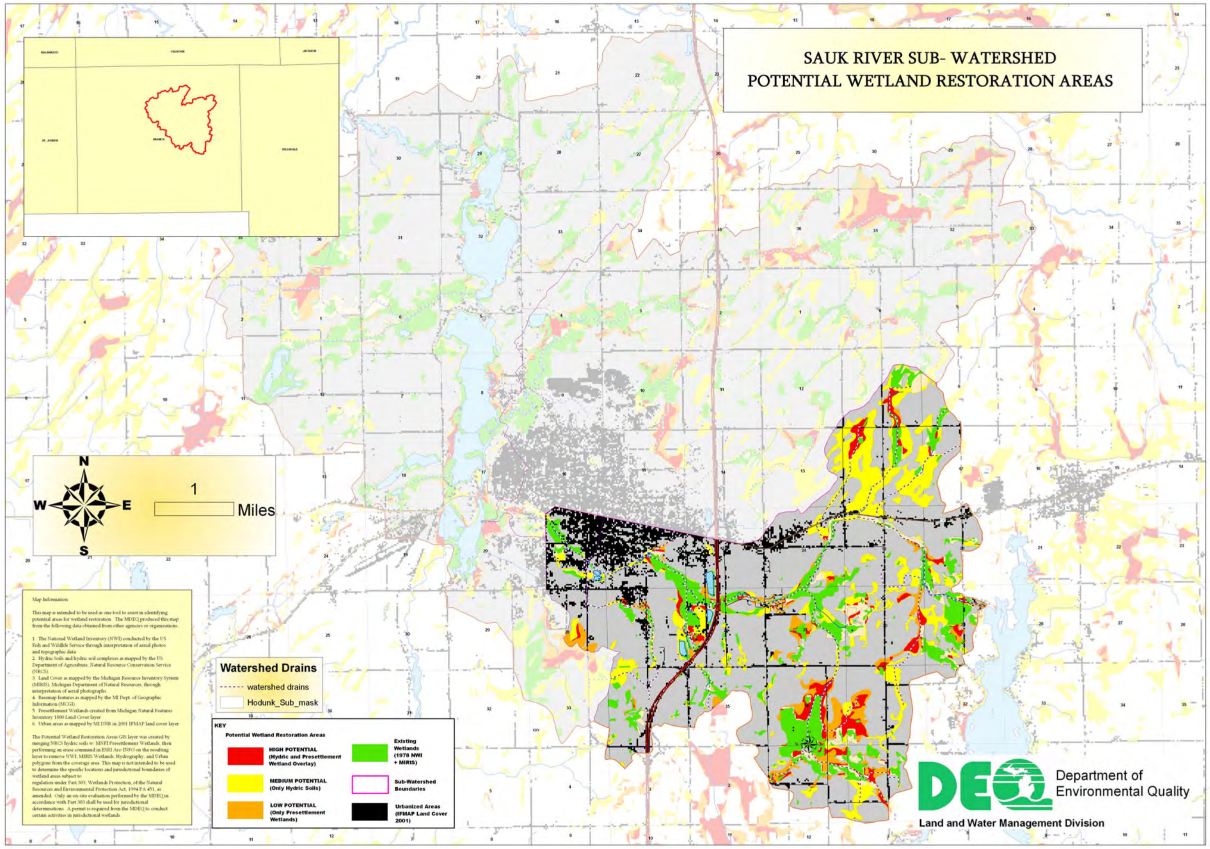
COLD CREEK SUB-WATERSHED: RESOURCES STATUS AND TRENDS

Pre-Settlement Wetland conditions	**1978 Wetland Condition*****
2,854 acres of wetlands	1,254 acres of wetlands
121 polygons	219 polygons
Average size – 24 acres	Average size – 5.7 acres

43% of original wetland acreage remains

57% loss of total wetland resource

SAUK RIVER SUB-WATERSHED



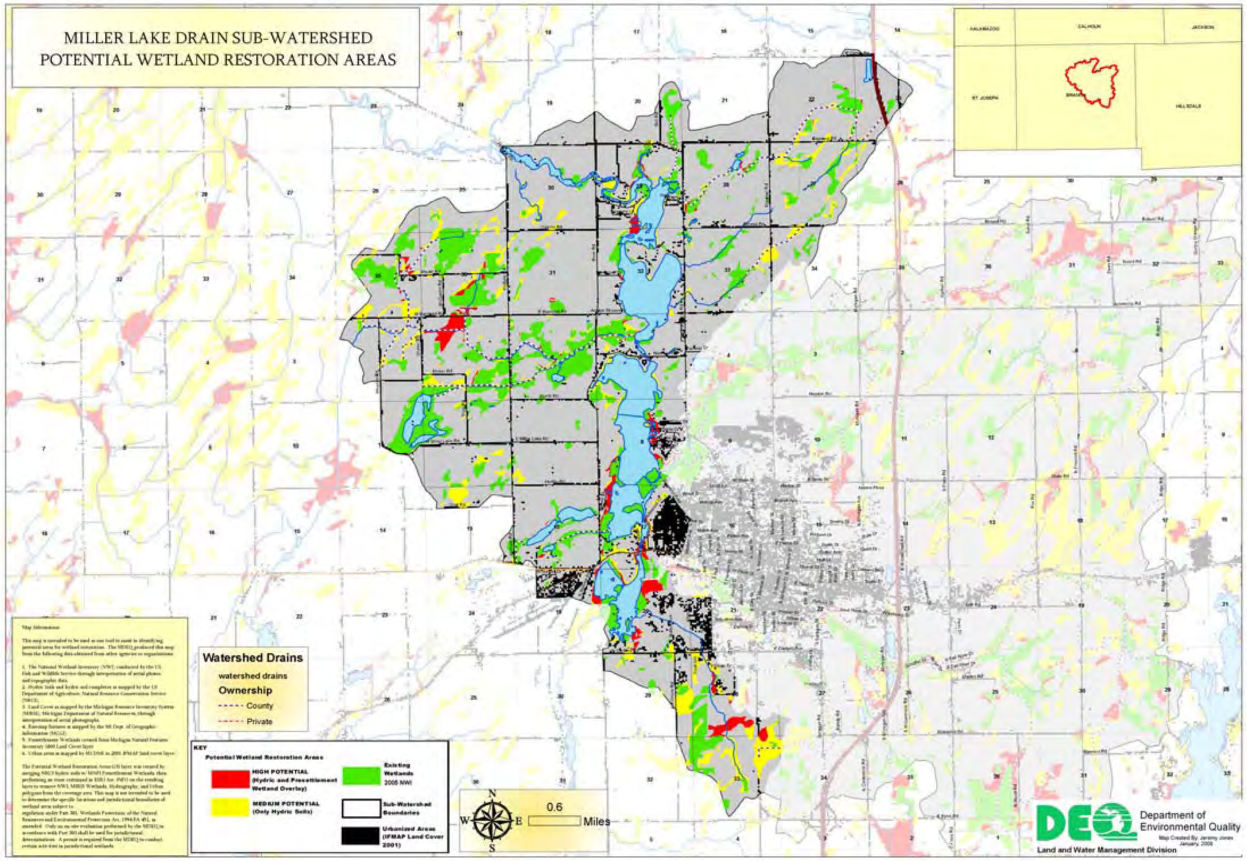
SAUK RIVER SUB-WATERSHED: RESOURCES STATUS AND TRENDS

Pre-settlement Wetland conditions	1978 Wetland Condition***
2,897 acres of wetlands	1,149 acres of wetlands
143 polygons	245 polygons
Average size – 20 acres	Average size – 4.7

39% of original wetland acreage remains

61% loss of total wetland resource

MILLER LAKE DRAIN SUB-WATERSHED



MILLER LAKE DRAIN SUB-WATERSHED: RESOURCES STATUS AND TRENDS

Pre-settlement Wetland conditions	1978 Wetland Condition***
3,060 acres of wetlands	1,928 acres of wetlands
161 polygons	362 polygons
Average size – 19 acres	Average size – 5.3 acres

62% of original wetland acreage remains

38% loss of total wetland resource

NWI TYPE COMPARISON

Table 1: Generalized NWI type comparison

Wetland Type	Pre- European Settlement Acres	2005 Acres of Wetlands	Net Acres Remaining
Palustrine Emergent	540	1,019*	188%
Palustrine Forested	8,244	2,995**	36%
Palustrine Shrub-Scrub	1,097***	479****	44%
Other Palustrine			
Ponds	10	176	176%
Total	9,891	4,669	47%

*Includes mixed emergent wetland classes and mixed communities where subclasses include Forested and Shrub-Scrub Areas
**Includes mixed forested wetland classes and mixed communities where subclasses include Emergent and Shrub-Scrub Areas
*** Includes mixed Shrub-Scrub/Emergent communities
****Includes mixed shrub-scrub wetland classes and mixed communities where subclasses include Emergent, Forested and Shrub-Scrub

DETAILED FUNCTIONAL COMPARISONS

Table 3: Detailed Functional Comparisons

Function	Potential Significance	Pre-European Settlement Acreage	2005 Acreage	% Change in Acreage
Flood Water Storage	High	3,534.67	875.90	-76
	Moderate	3,630.10	647.26	-83
	Total	7,164.77	1,523.16	-79
Streamflow Maintenance	High	8,704.71	5,263.87	-40
	Moderate	823.04	677.62	-18
	Total	9,527.75	5,941.49	-38
Nutrient Transformation	High	3,702.29	3,090.53	-17
	Moderate	6,180.45	877.11	-86
	Total	9,882.74	3,967.64	-60
Sediment and Retention of Other Particulates	High	4,004.40	2,300.01	-43
	Moderate	26.20	1,640.71	626+ *
	Total	4,030.60	3,940.72	-3
Shoreline Stabilization	High	4,032.32	2,345.45	-42
	Moderate	3,214.01	1,429.53	-56
	Total	7,246.33	3,774.98	-48
Fish Habitat	High	9,387.20	3,616.67	-62
	Moderate	405.60	1,385.14	341+ *
	Total	9,792.80	5,001.81	-49
Stream Shading	High	2,867.92	1,056.92	-64
	Moderate	308.12	450.32	146+ *
	Total	3,176.04	1,507.24	-53

* Increases in the moderate category in the functions above can be attributed to the mapping differences in the two wetland layers and may not represent the current conditions on the ground.

DETAILED FUNCTIONAL COMPARISONS CONT….

Table 3: Detailed Functional Comparisons

Function	Potential Significance	Pre-European Settlement Acreage	2005 Acreage	% Change in Acreage
Waterfolw/Waterbird Habitat	High	1,399.89	1,222.48	-13
	Moderate	2,132.68	1,991.38	-7
	Total	3,532.57	3,213.86	-10
Shorebird Habitat	High	<Null>	9.63	100+ *
	Moderate	9,043.70	4,401.10	-52
	Total	9,043.70	4,410.73	-52
Interior Forest Bird Habitat	High	1,231.11	489.47	-61
	Moderate	8,111.21	2,984.41	-64
	Total	9,342.32	3,473.88	-63
Amphibian Habitat	High	1,137.41	900.54	-21
	Moderate	100.12	492.75	492+ *
	Total	1,237.53	1,393.29	112+ *
Ground Water Influence	High	<Null>	<Null>	<Null>
	Moderate	11,566.31	6,352.26	-46
	Total	11,566.31	6,352.26	-46
Conservation of Biodiversity	High	<Null>	192.63	<Null>
	Moderate	<Null>	<Null>	<Null>
	Total	<Null>	192.63	<Null>

* Increases in the moderate and high categories in the functions above can be attributed to the mapping differences in the two wetland layers and may not represent the current conditions on the ground.

FUNCTIONAL UNIT COMPARISON

Table 5: Functional Unit comparison

Function	Pre-European Settlement Functional Units	2005 Functional Units	Predicted % of Original Capacity Left	Predicted % Change in Functional Capacity
Flood Water Storage	10,699.44	2,399.06	22	-78
Streamflow Maintenance	18,232.46	11,205.36	61	-39
Nutrient Transformation	13,585.03	7,058.17	51	-49
Sediment and Other Particulate Retention	8,035.00	6,240.73	77	-23
Shoreline Stabilization	11,278.65	6,120.43	54	-46
Fish Habitat	19,180.00	8,618.48	44	-56
Stream Shading	6,043.96	2,564.16	42	-58
Waterfowl and Waterbird Habitat	4,932.46	4,436.34	89	-11
Shorebird Habitat	9,043.70	4,420.36	48	-52
Interior Forest Bird Habitat	10,573.43	3,963.35	37	-63
Amphibian Habitat	2,374.94	2,293.83	96	-4
Ground Water Influence	11,566.31	6,352.26	54	-46
Conservation of Biodiversity	<Null>	385.26	100	<Null> *

*Due to differences in mapping technique between pre-settlement and current wetland coverage, status and trends information for this function is not applicable.

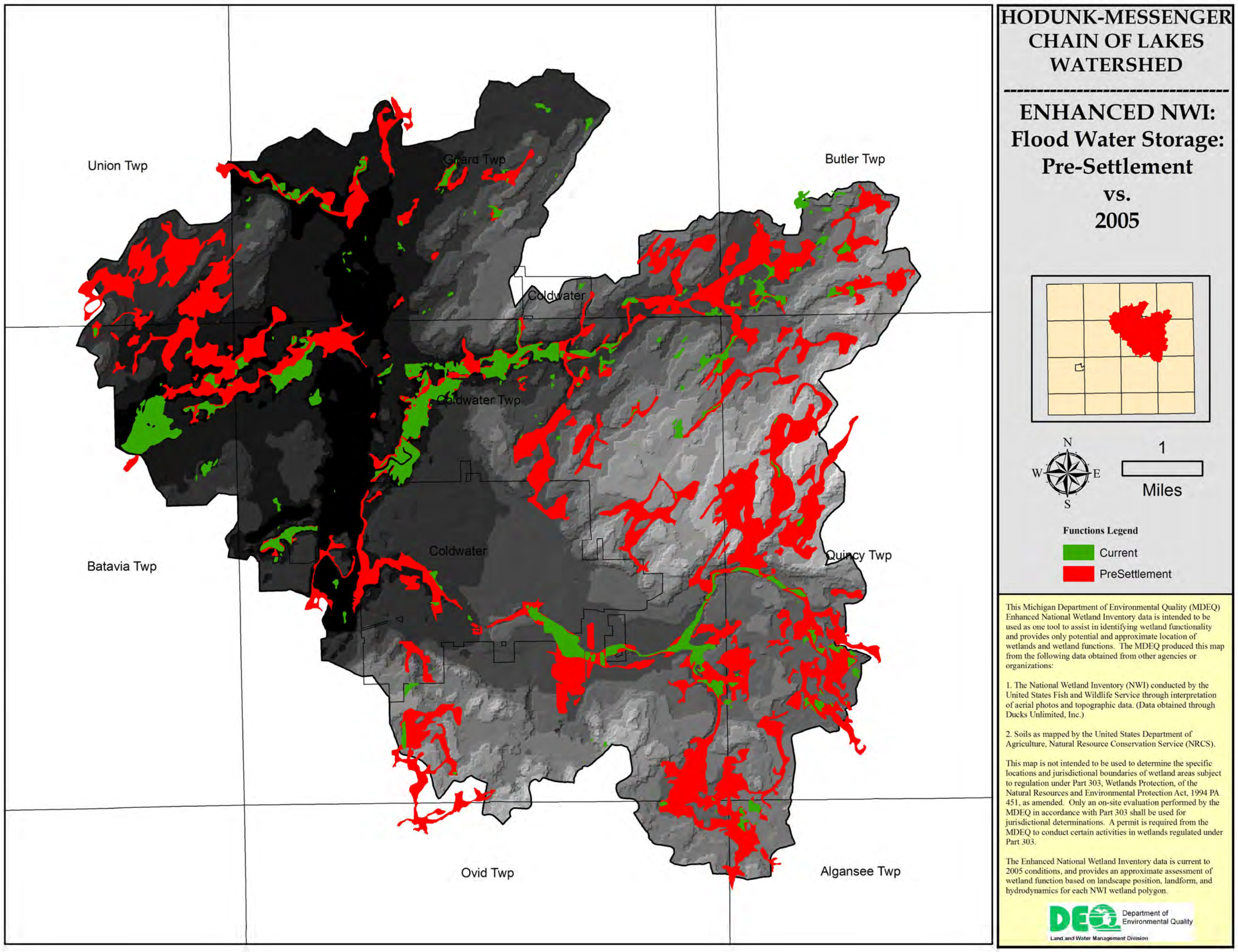
LIMITATIONS OF THE WETLAND FUNCTIONS FOR WATERSHED ASSESSMENT

- Source data are a primary limiting factor.
- Wetland mapping limitations due to scale, photo quality, and date and time of year of the photos.
- Difficulty of photo interpreting certain wetland types
  - Forested wetlands
  - Drier-end wetlands
- Functional assessment is a preliminary one based on:
  - Wetland Characteristics interpreted through remote sensing
  - Professional Judgment of various specialists to develop correlations between those wetlands and their functions.
- Watershed-based Preliminary Assessment of wetland functions:
  - Applies general knowledge about wetlands and their functions
  - Develops a watershed overview that highlights possible wetlands of significance
  - Does not consider the condition of the adjacent upland
  - Does not obviate the need for more detailed assessment of various functions
- This analysis is a “Landscape Level” assessment and used to identify wetlands that are likely to perform a given function at a level above that of other wetlands not designated.

FLOOD WATER STORAGE

- This function is important for reducing the downstream flooding and lowering flood heights, both of which aid in minimizing property damage and personal injury from such events.
- The following map illustrates wetlands that perform the above ecological service at a level of significance above that of wetlands not designated. Wetlands deemed to be performing this function are mapped in two distinct time periods; Pre-European settlement (red), and wetlands circa 2005 (green).

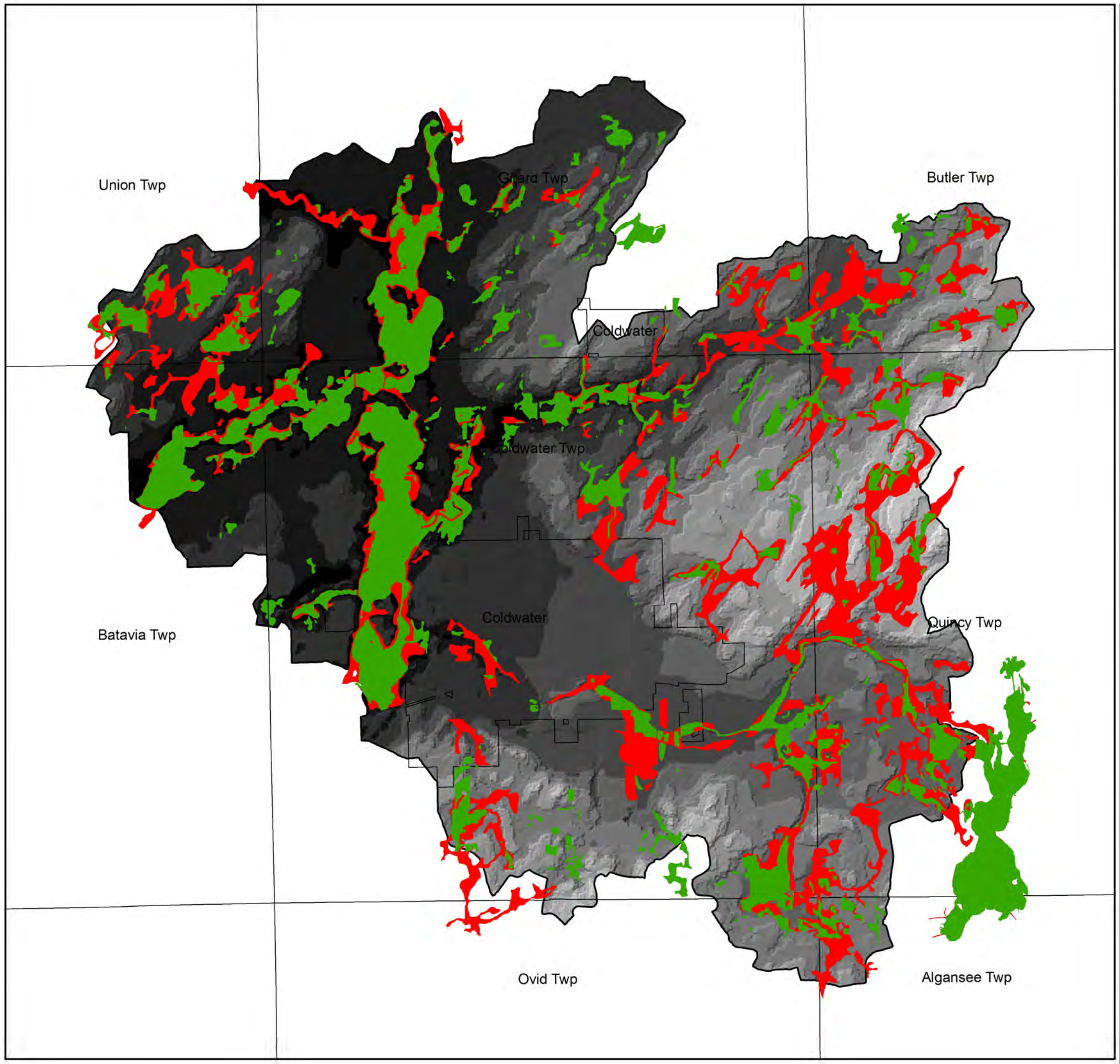
FLOODWATER STORAGE



STREAMFLOW MAINTENANCE

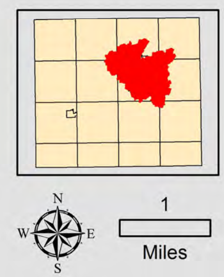
- Wetlands that are sources of groundwater discharge that sustain streamflow in the watershed. Such wetlands are critically important for supporting aquatic life in streams. All wetlands classified as headwater wetlands are important for streamflow.
- The following map illustrates wetlands that perform the above ecological service at a level of significance above that of wetlands not designated. Wetlands deemed to be performing this function are mapped in two distinct time periods; Pre-European settlement (red), and wetlands circa 2005 (green).

STREAMFLOW MAINTENANCE



HODUNK-MESSENGER CHAIN OF LAKES WATERSHED

ENHANCED NWI: Streamflow Maintenance: Pre-Settlement vs. 2005



Functions Legend

- Current
- PreSettlement

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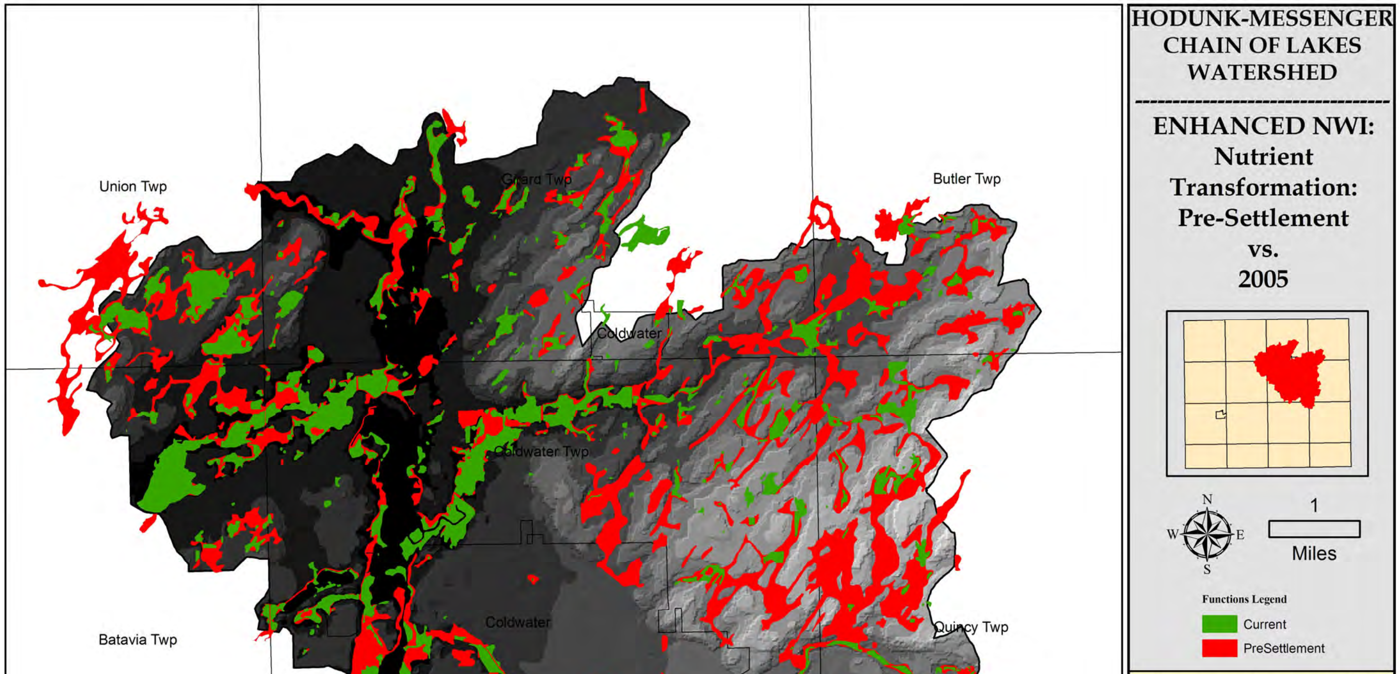
DEQ Department of Environmental Quality
Land and Water Management Division

NUTRIENT TRANSFORMATION

- Wetlands that have a fluctuating water table are best able to recycle nutrients. Natural wetlands performing this function help improve local water quality of streams and other watercourses.
- The following map illustrates wetlands that perform the above ecological service at a level of significance above that of wetlands not designated. Wetlands deemed to be performing this function are mapped in two distinct time periods; Pre-European settlement (red), and wetlands circa 2005 (green).

NUTRIENT TRANSFORMATION



This Michigan Department of Environmental Quality (MDEQ) Enhanced National Wetland Inventory data is intended to be used as one tool to assist in identifying wetland functionality and provides only potential and approximate location of wetlands and wetland functions. The MDEQ produced this map from the following data obtained from other agencies or organizations:

1. The National Wetland Inventory (NWI) conducted by the United States Fish and Wildlife Service through interpretation of aerial photos and topographic data. (Data obtained through Ducks Unlimited, Inc.)

2. Soils as mapped by the United States Department of Agriculture, Natural Resource Conservation Service (NRCS).

This map is not intended to be used to determine the specific locations and jurisdictional boundaries of wetland areas subject to regulation under Part 303, Wetlands Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. Only an on-site evaluation performed by the MDEQ in accordance with Part 303 shall be used for jurisdictional determinations. A permit is required from the MDEQ to conduct certain activities in wetlands regulated under Part 303.

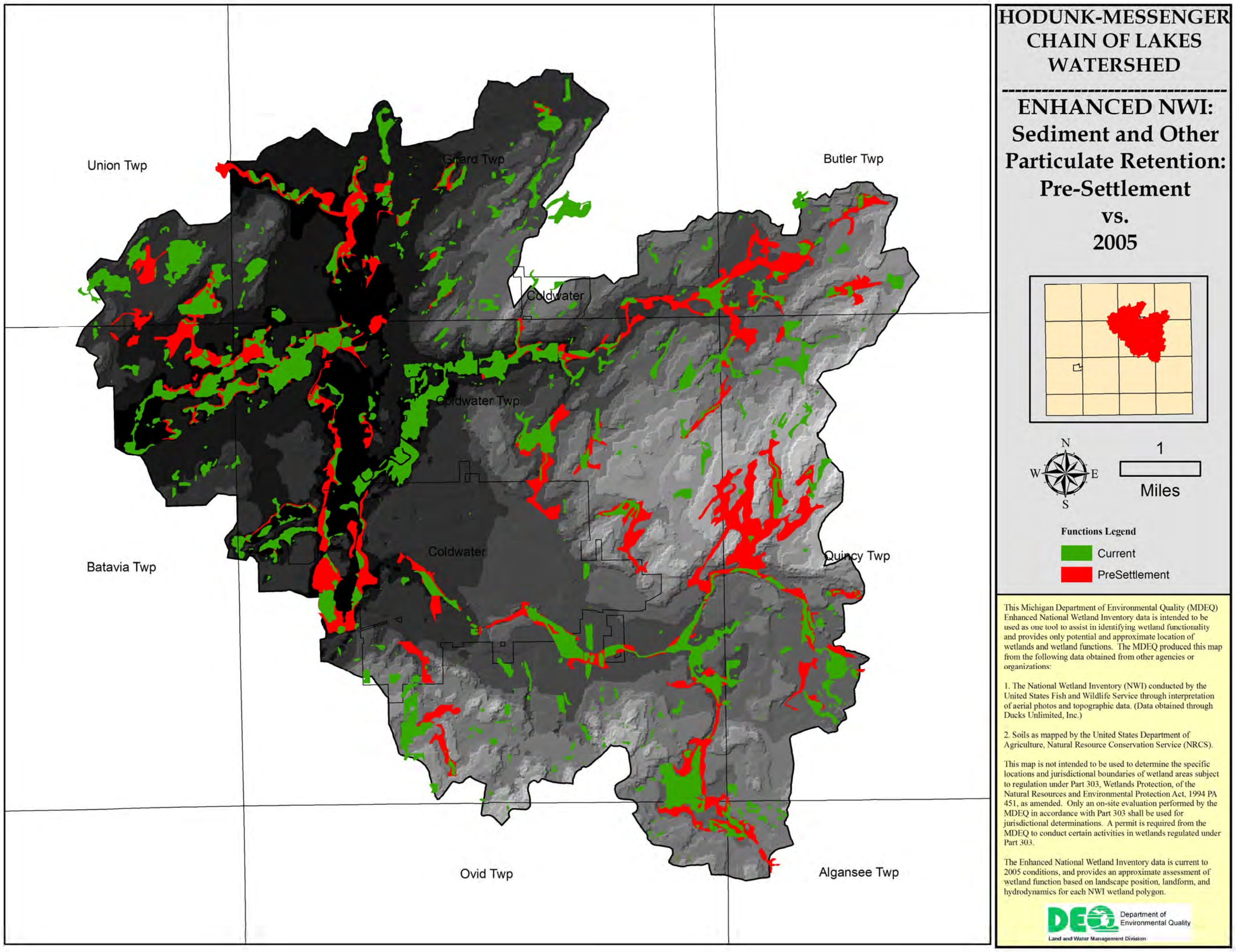
The Enhanced National Wetland Inventory data is current to 2005 conditions, and provides an approximate assessment of wetland function based on landscape position, landform, and hydrodynamics for each NWI wetland polygon.

Department of Environmental Quality
Land and Water Management Division

SEDIMENT AND OTHER PARTICULATE RETENTION

- This function supports water quality maintenance by capturing sediments with bonded nutrients or heavy metals. Vegetated wetlands will perform this function at higher levels than those of non-vegetated wetlands.
- The following map illustrates wetlands that perform the above ecological service at a level of significance above that of wetlands not designated. Wetlands deemed to be performing this function are mapped in two distinct time periods; Pre-European settlement (red), and wetlands circa 2005 (green).

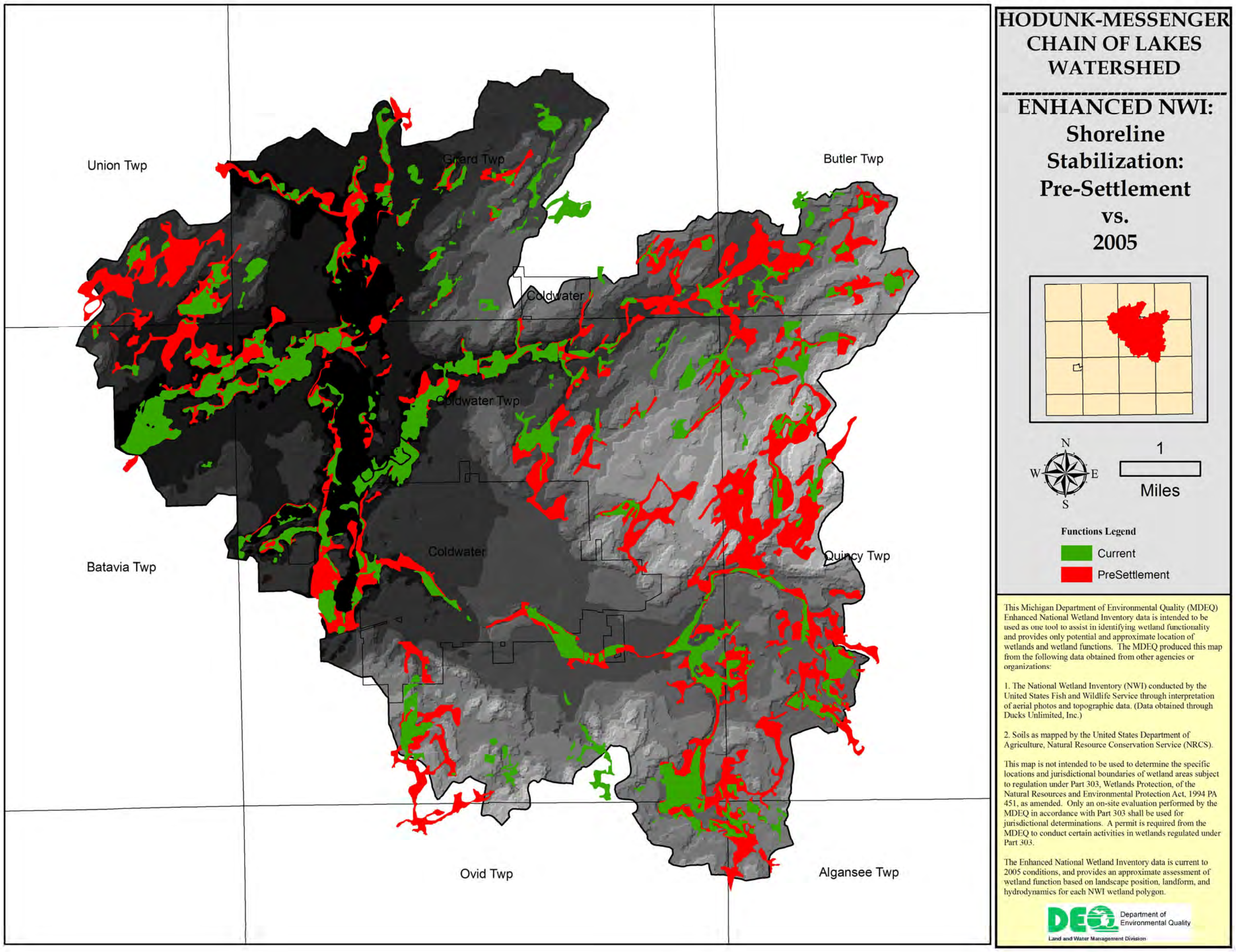
SEDIMENT AND OTHER PARTICULATE RETENTION



SHORELINE STABILIZATION

- Vegetated wetland along all waterbodies (e.g. estuaries, lakes, rivers, and streams) provide this function. Vegetation stabilizes the soil or substrate and diminished wave action, thereby reducing shoreline erosion potential.
- The following map illustrates wetlands that perform the above ecological service at a level of significance above that of wetlands not designated. Wetlands deemed to be performing this function are mapped in two distinct time periods; Pre-European settlement (red), and wetlands circa 2005 (green).

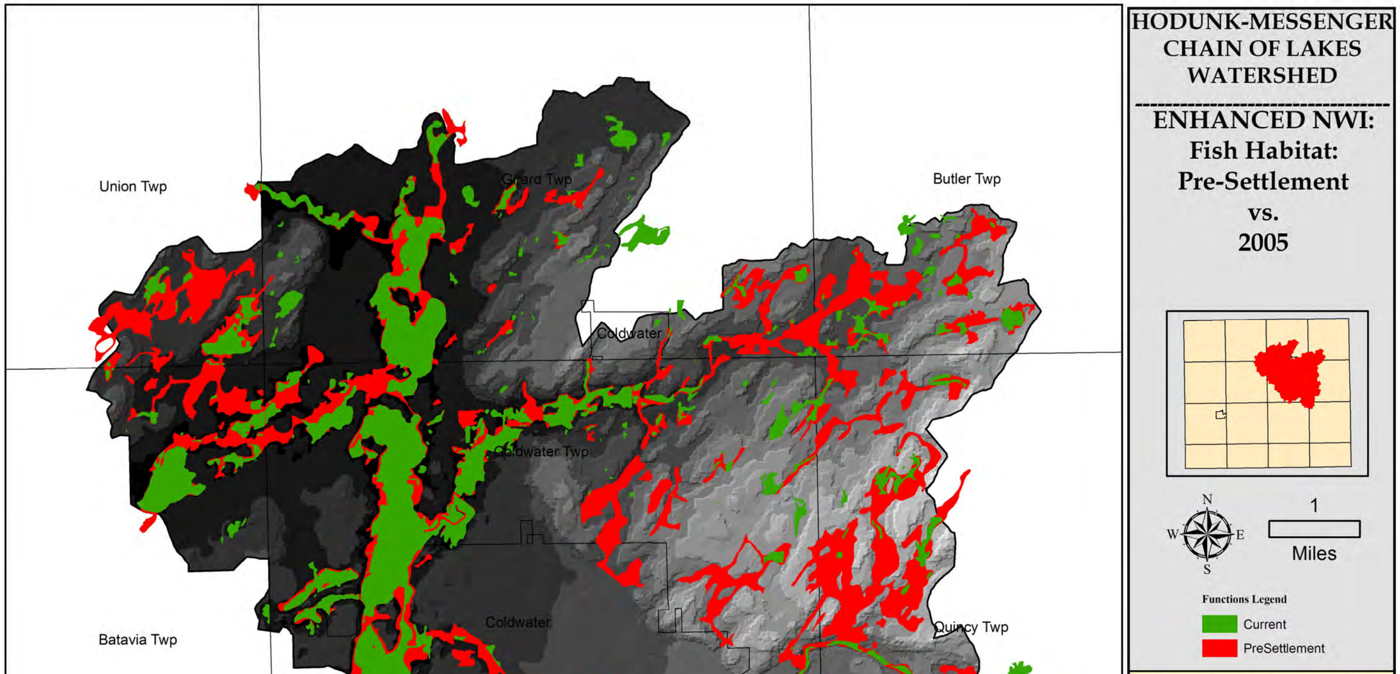
SHORELINE STABILIZATION



FISH HABITAT

- Wetlands that are considered essential to one or more parts of fish life cycles. Wetlands designated as important for fish are generally those used for reproduction, or feeding.
- The following map illustrates wetlands that perform the above ecological service at a level of significance above that of wetlands not designated. Wetlands deemed to be performing this function are mapped in two distinct time periods; Pre-European settlement (red), and wetlands circa 2005 (green).

FISH HABITAT



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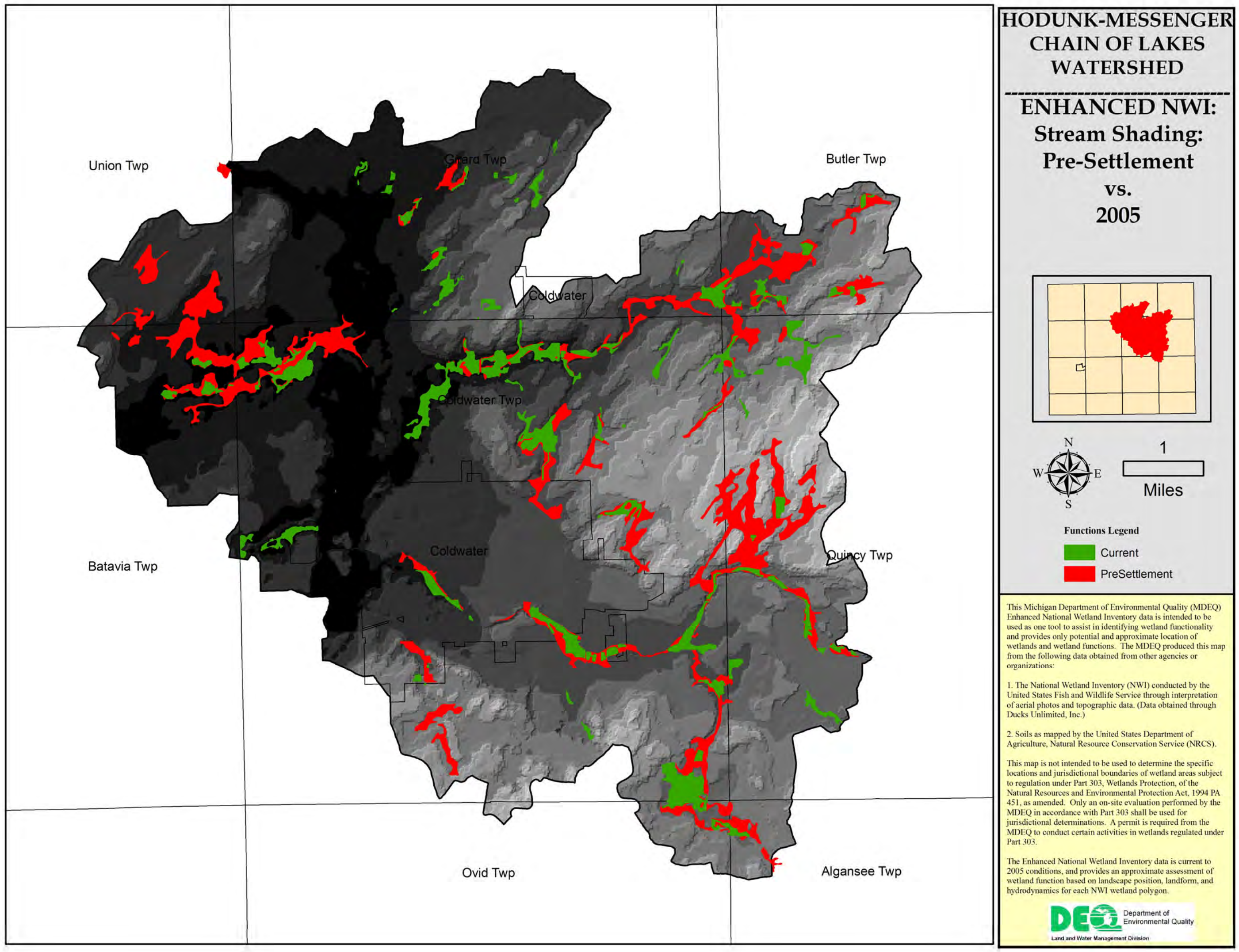
The Enhanced National Wetland Inventory data is current to 2005 conditions, and provides an approximate assessment of wetland function based on landscape position, landform, and hydrodynamics for each NWI wetland polygon.

Department of Environmental Quality
Land and Water Management Division

STREAM SHADING

- Wetlands that perform water temperature control due to the proximity to streams and waterways. These wetlands generally are Palustrine Forested or Scrub-Shrub.
- The following map illustrates wetlands that perform the above ecological service at a level of significance above that of wetlands not designated. Wetlands deemed to be performing this function are mapped in two distinct time periods; Pre-European settlement (red), and wetlands circa 2005 (green).

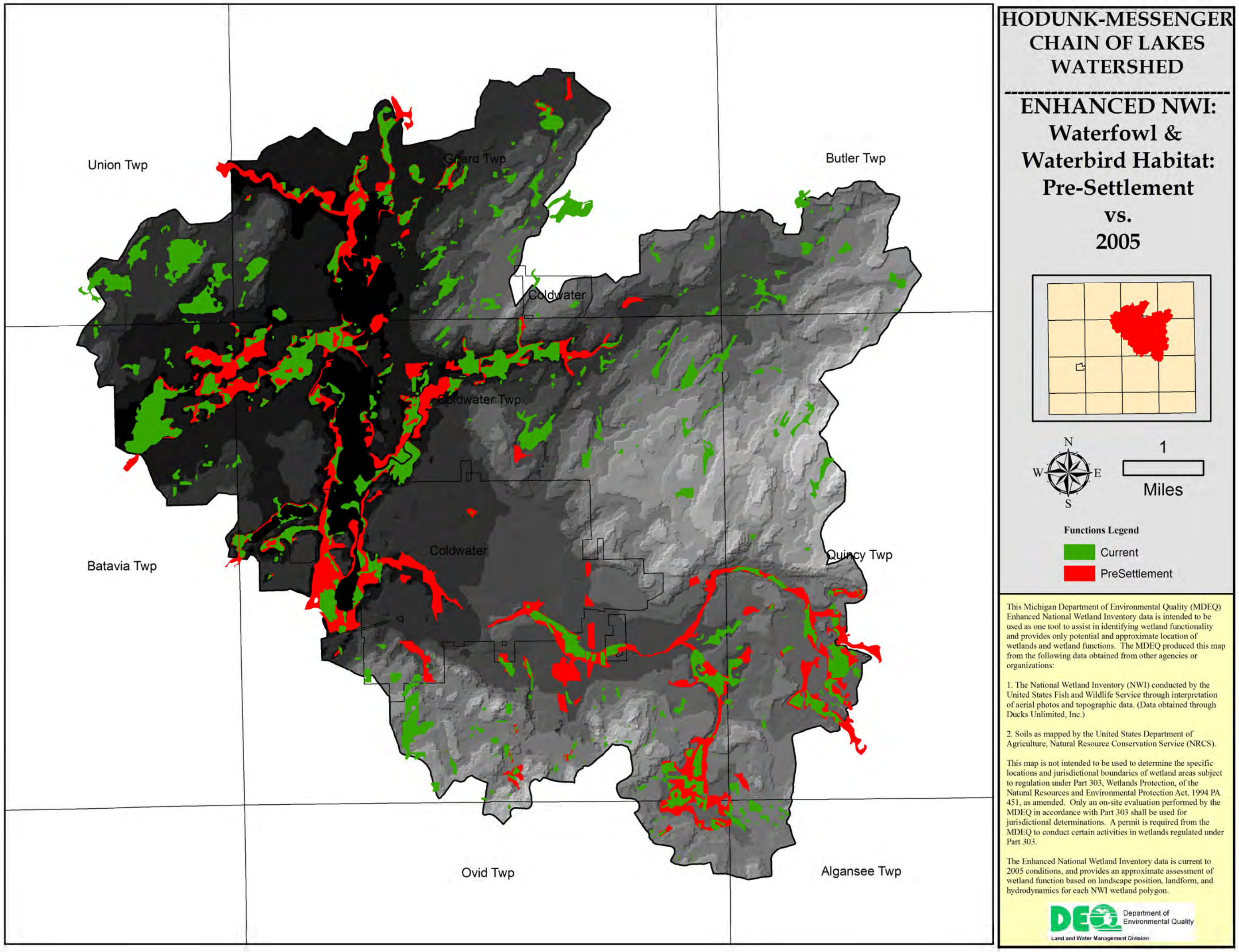
STREAM SHADING



WATERFOWL AND WATERBIRD HABITAT

- Wetlands designated as important for waterfowl and waterbirds are generally those used for nesting, reproduction, or feeding. The emphasis is on the wetter wetlands and ones that are frequently flooded for long periods.
- The following map illustrates wetlands that perform the above ecological service at a level of significance above that of wetlands not designated. Wetlands deemed to be performing this function are mapped in two distinct time periods; Pre-European settlement (red), and wetlands circa 2005 (green).

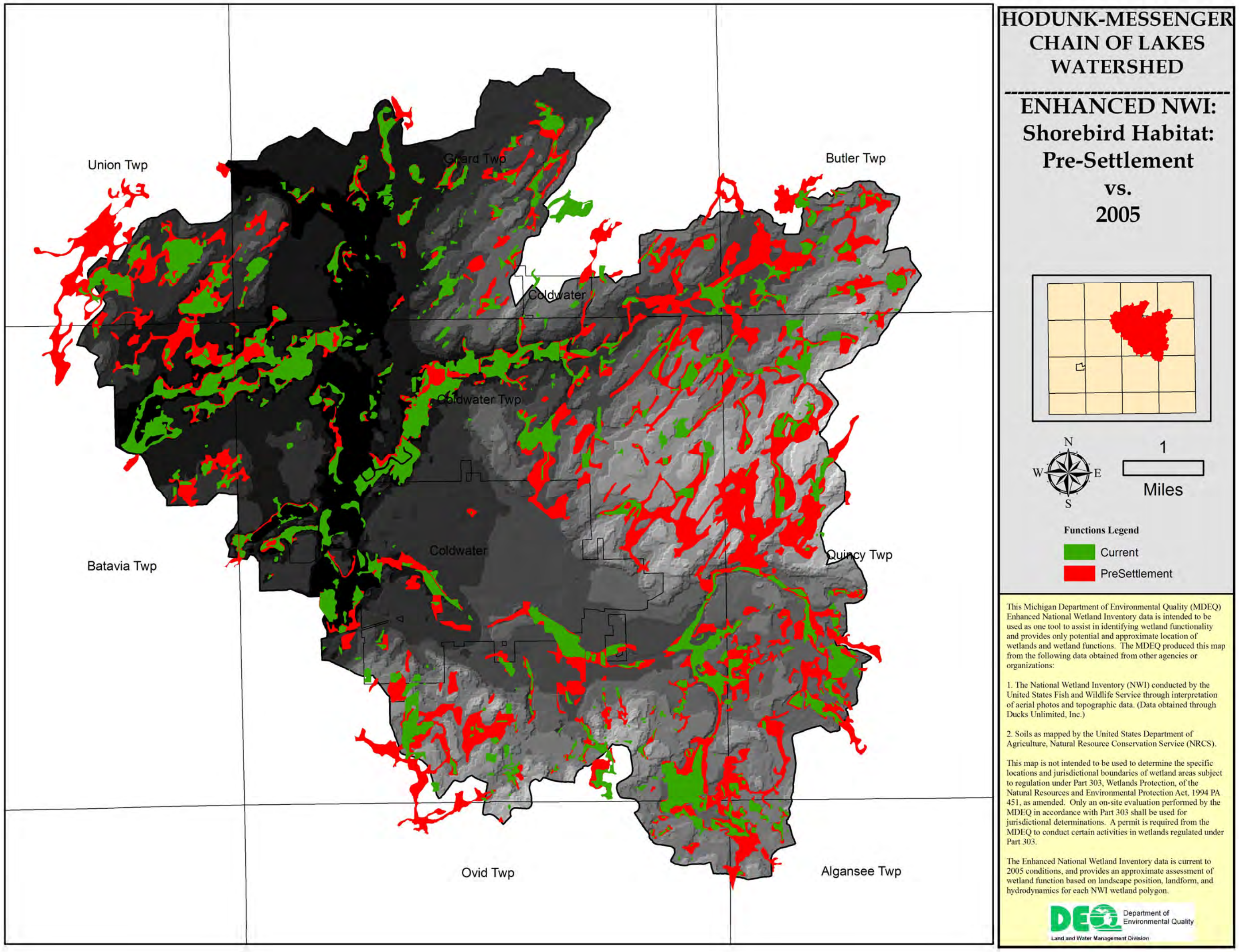
WATERFOWL AND WATERBIRD HABITAT



SHOREBIRD HABITAT

- Shorebirds generally inhabit open areas of beaches, grasslands, wetlands, and tundra and undertake some of the longest migrations known. Along their migration pathway, many shorebirds feed in coastal and inland wetlands where they accumulate fat reserves needed to continue their flight. Common species include; plovers, oystercatchers, avocets, stilts, and sandpipers. This function attempts to capture wetland types most likely to provide habitat for these species.
- The following map illustrates wetlands that perform the above ecological service at a level of significance above that of wetlands not designated. Wetlands deemed to be performing this function are mapped in two distinct time periods; Pre-European settlement (red), and wetlands circa 2005 (green).

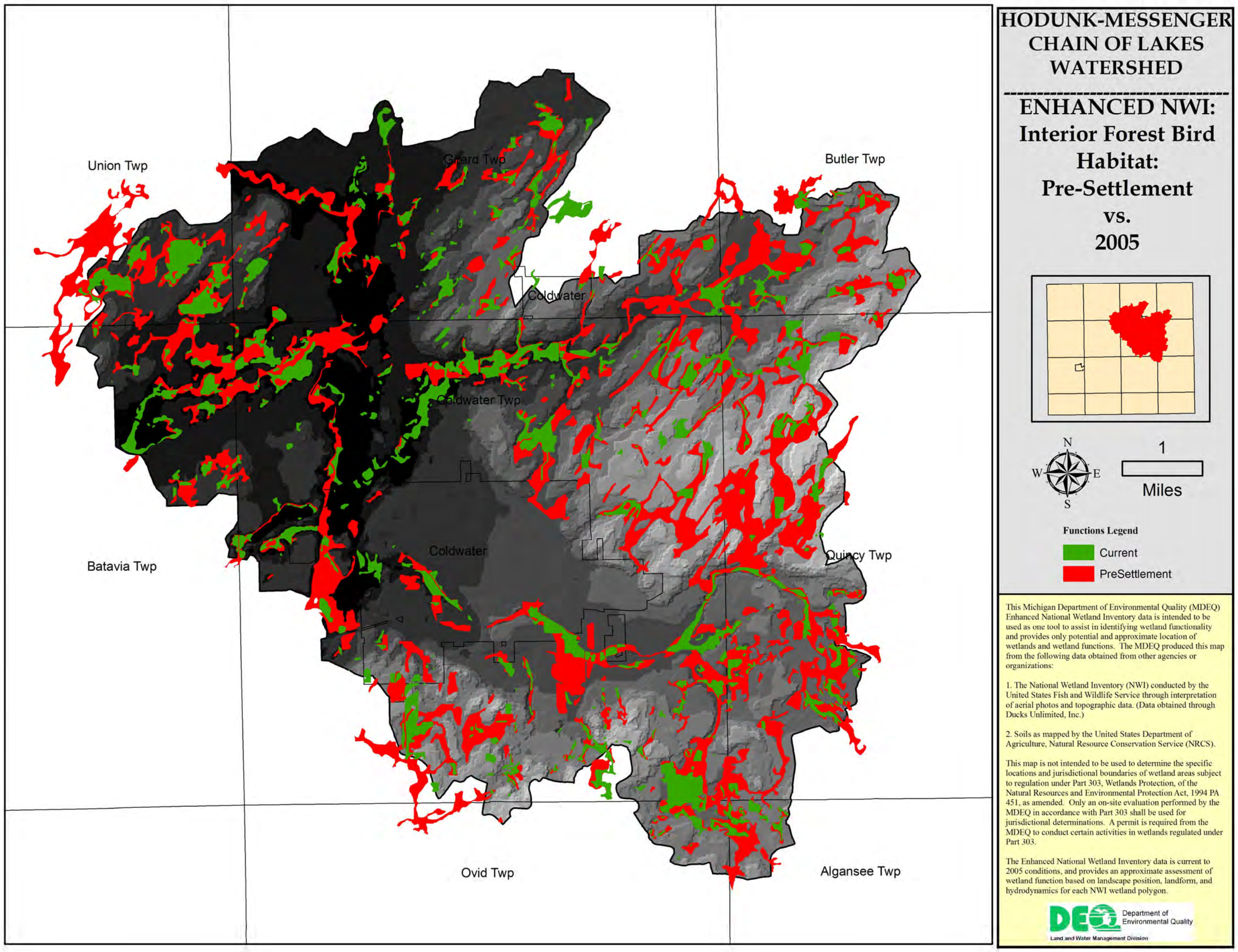
SHOREBIRD HABITAT



INTERIOR FOREST BIRDS

- Interior Forest Birds require large forested areas to breed successfully and maintain viable populations. This diverse group includes colorful songbirds such as; tanagers, warblers, vireos that breed in North America and winter in the Caribbean, Central and South America, as well as residents and short-distance migrants such as; woodpeckers, hawks, and owls. They depend on large forested tracts, including streamside and floodplain forests. It is important to note that adjacent upland forest to these riparian areas are critical habitat for these species as well. This function attempts to capture wetland types most likely to provide habitat for these species.
- The following map illustrates wetlands that perform the above ecological service at a level of significance above that of wetlands not designated. Wetlands deemed to be performing this function are mapped in two distinct time periods; Pre-European settlement (red), and wetlands circa 2005 (green).

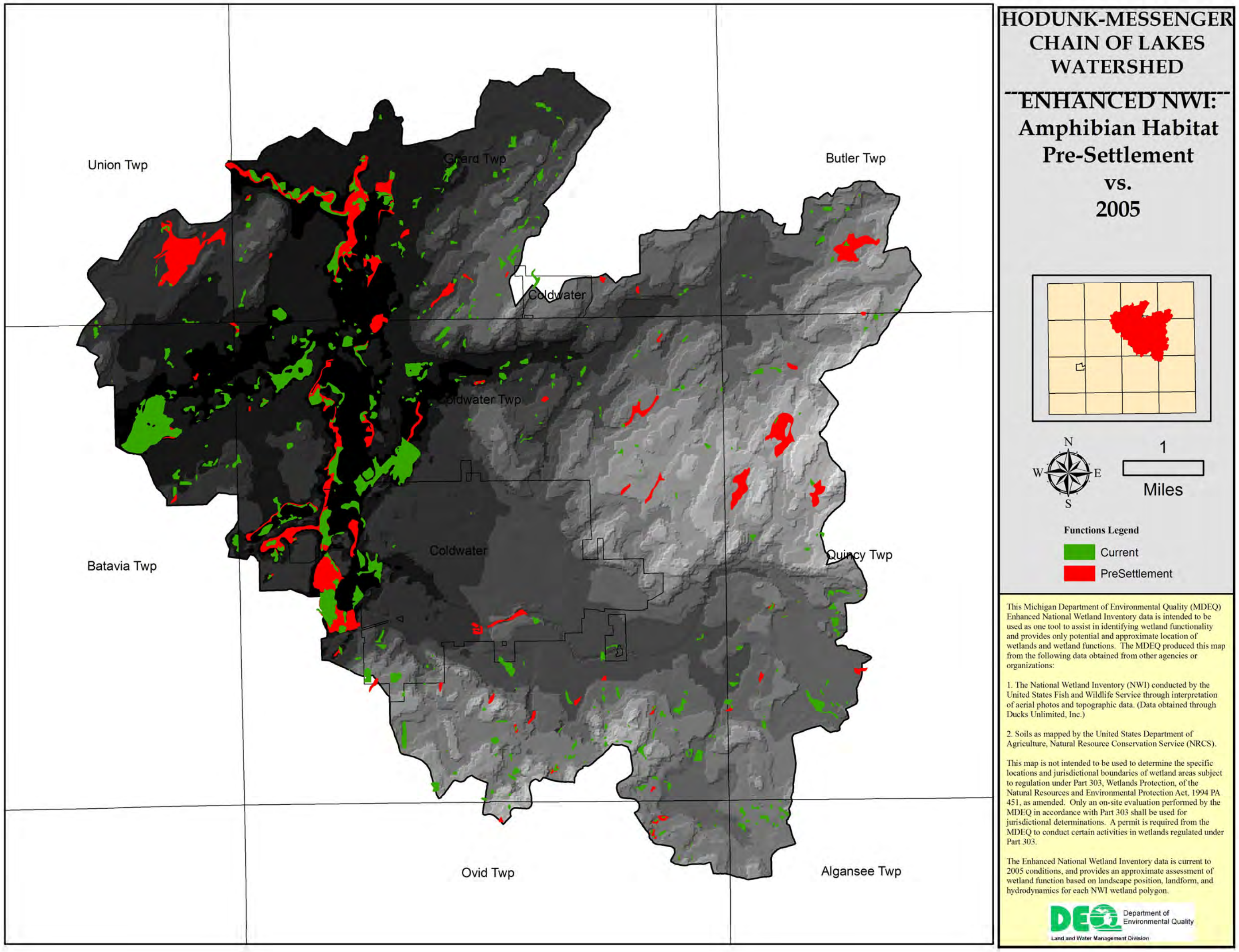
INTERIOR FOREST BIRDS



AMPHIBIAN HABITAT

- Amphibians share several characteristics in common including wet skin that functions in respiration and gelatinous eggs that require water or moist soil for development. Most amphibians have an aquatic stage and a terrestrial stage and thus live in both aquatic and terrestrial habitats. Aquatic stages of these organisms are often eaten by fish and so for certain species, successful reproduction may occur only in fish-free ponds. Common sub-groups of amphibians are salamanders, frogs, and toads. This function attempts to capture wetland types most likely to provide habitat for these species.
- The following map illustrates wetlands that perform the above ecological service at a level of significance above that of wetlands not designated. Wetlands deemed to be performing this function are mapped in two distinct time periods; Pre-European settlement (red), and wetlands circa 2005 (green).

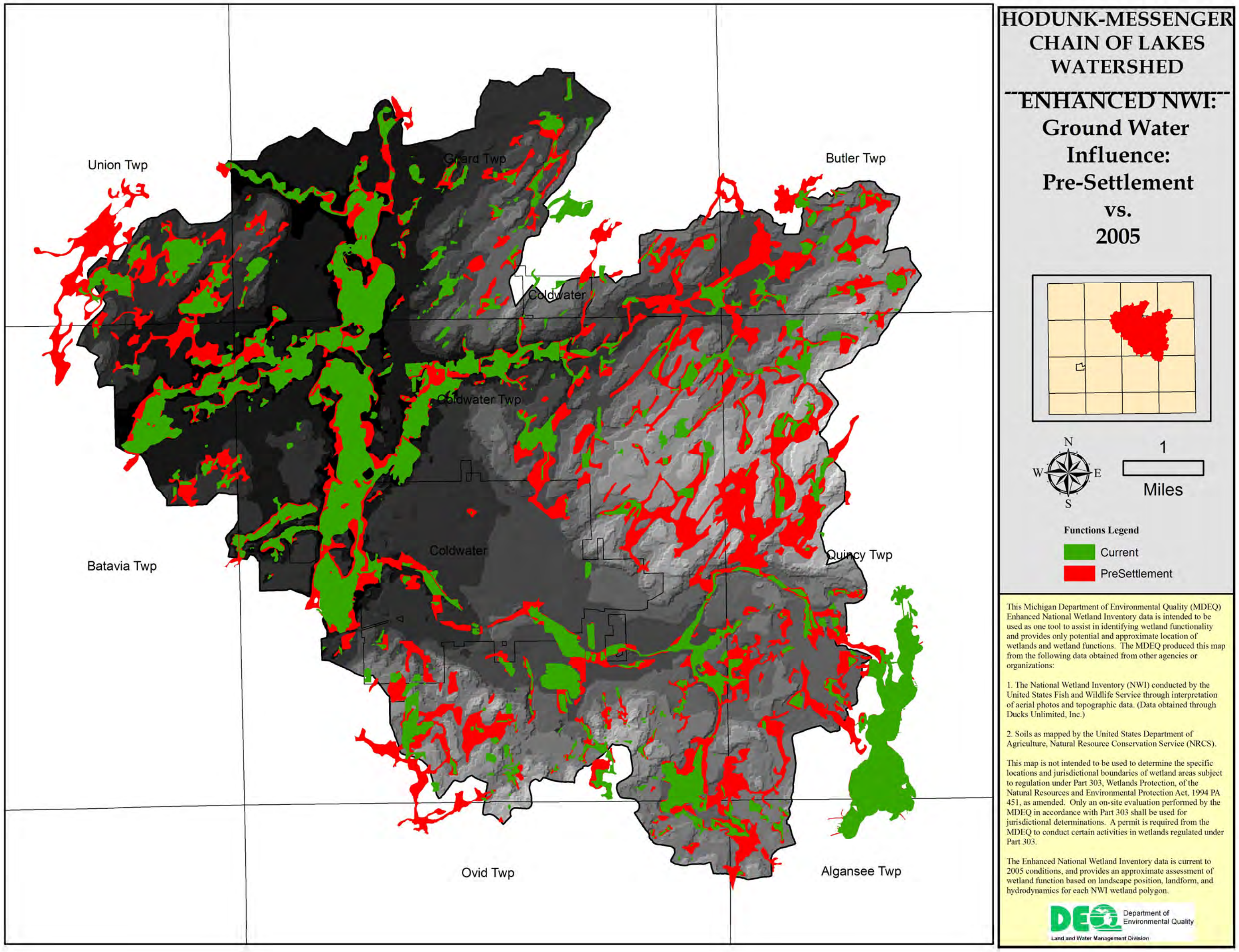
AMPHIBIAN HABITAT



GROUND WATER INFLUENCE

- Wetlands categorized as High or Moderate for Groundwater Influence are areas that receive some or all of their hydrologic input from groundwater reflected at the surface. The DARCY (definition of acronym) model was the data source utilized to determine this wetland/groundwater connection, which is based upon soil transmissivity and topography. Wetlands rated for this function are important for maintaining streamflows and temperature control in waterbodies.
- The following map illustrates wetlands that perform the above ecological service at a level of significance above that of wetlands not designated. Wetlands deemed to be performing this function are mapped in two distinct time periods; Pre-European settlement (red), and wetlands circa 2005 (green).

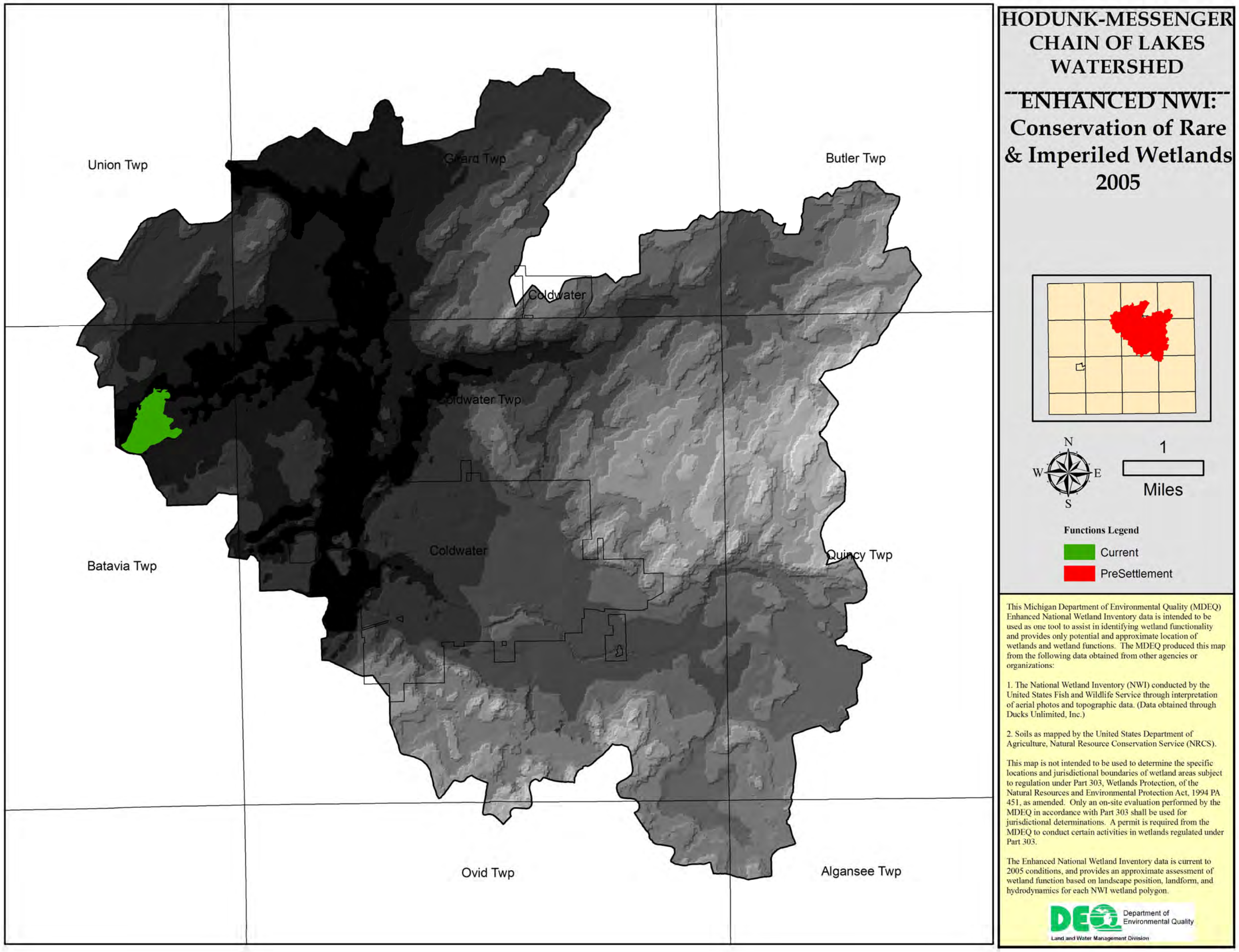
GROUND WATER INFLUENCE



CONSERVATION OF RARE AND IMPERILED WETLANDS

- Wetlands that are considered rare either globally or at the state level. They are likely to contain a wide variety of flora and fauna, or contain threatened or endangered species.
- This function is derived from the Michigan Natural Features Dataset (MNFI) that only serves to inventory sites where staff biologists have performed surveys. Due to this the dataset should not be used as a comprehensive inventory of Rare and Imperiled wetlands.
- The following map illustrates wetlands that perform the above ecological service at a level of significance above that of wetlands not designated. Wetlands deemed to be performing this function are mapped in (green) circa 2005.

CONSERVATION OF RARE AND IMPERILED WETLANDS



Appendix K

Priority Conservation Areas in the Hodunk Messenger Chain of Lakes Watershed Report

Background

In addition to recommending practices that will improve and enhance the level of water quality found within the Hodunk-Messenger Chain of Lakes Watershed, recommendations must also be made that identify and prioritize areas for protecting in order to sustain the level of water quality in the future. Large tracts of natural vegetation and presumably undisturbed soils within a given watershed provide important ecological services for the maintenance of water quality. Such services include water retention, pollutant filtration and wildlife habitat.

In the Hodunk-Messenger Chain of Lakes Watershed a total of 68 unfragmented natural areas have been identified and prioritized. It should be stressed that every one of these areas should be protected to some extent in order to avoid further degradation to the health of the watershed. However, in the interest of time and land use decision making, these areas have been analyzed and ranked in order of priority so that deciding on what areas to protect first may be a bit easier.

The parameters and process for identifying priority conservation areas (PCAs) in this manner have been modeled after the work of John Paskus and Michigan Natural Features Inventory (MNFI). The following discussion gives a brief description of the criteria and methods used for classifying PCAs in the Hodunk-Messenger Chain of Lakes Watershed.

Methodology

1.) Using the most recent USDA-NRCS Land Use/Land Cover data for Branch County from the 2001 National Land Cover Dataset (NLCD), the general land cover classes for the Hodunk-Messenger Chain of Lakes Watershed were obtained
2.) Once all land covers in the watershed were identified, a filter was run to separate out all land cover classes that were not of natural vegetation (all development, active agriculture, old fields and urban recreational fields)
3.) All natural land cover types were then combined
4.) Major roads were then buffered by 100 feet and removed
5.) The remaining blocks of natural land cover were delineated and all blocks less than 20 acres in size were removed
6.) The 68 sites that remained were then analyzed for the following criteria:

[5]**Total Size**
The total size of a site is an important factor for viability of species and ecosystem health. Larger sites tend to have higher species diversity, higher reproductive success, and improve the chances of plant and animal species surviving a catastrophic event. The total size of a site was defined as the total areas of the polygon.

*__Size of Core Area__
Negative impacts are associated with the perimeter of a site on "edge-sensitive" animal species, particularly amphibians, reptiles and forest and grassland songbirds. Buffers vary by species, community type and location, but most studies recommend a buffer somewhere between 200-600 feet to minimize negative impacts. 300 feet is considered a sufficient buffer for most "edge-sensitive" species and is what was used in this project. A core area was defined as the total area

[5] *Adapted from the Berrien, Cass and Van Buren Counties Potential Conservation Areas Report prepared by John Paskus, Senior Conservation Scientist and Helen Enander, Information Technologist II of Michigan Natural Features Inventory*

minus 300 feet measured inward from the edge of the polygon (round shapes will have a larger core size compared to long narrow shapes).

[*]Stream Corridor (length)
Waterways provide a travel corridor for wildlife and connect isolated patches of natural vegetation, particularly in fragmented landscapes. Sites that were part of a riparian corridor were scored on the length of stream or river present within the site.

[*]Landscape Connectivity
Connectivity between habitat patches improves gene flow between populations, allows species to recolonize unoccupied habitat, improves resilience of the ecosystem, and allows ecological processes, such as flooding, fire, and pollination to occur at a more natural rate and scale. Landscape connectivity was measured by building a ¼-mile buffer around each polygon and measuring the percentage of area that falls within other PCAs. Landscape connectivity was also measured by the number of individual PCAs in close proximity to the site. The greater the number of polygons in close proximity, the higher the probability for good connectivity. A 100-ft buffer was used for the measure of sites within close proximity based on the typical width of transportation right-of-ways, pipelines, and power line corridors.

[*]Restorability of Surrounding Lands
Restorability is important for increasing the size of existing natural communities, providing linkages to other habitat patches and providing a natural buffer from development and human activities. Restorability was measured by the potential for restoration activities in the surrounding ¼-mile around each PCA site. This was accomplished by building a ¼-mile buffer around each site, removing other PCA sites that were located within this buffer, and then measuring the percentage of remaining land that was grassland, shrub lands, old fields and agricultural lands (undeveloped).

[*]Vegetation Quality
The quality of vegetation in each site is very critical in determining the quality of the natural area. Vegetation can reflect past disturbance, external impacts, soil texture, moisture gradient and geology. Without being able to physically verify the vegetation quality of all PCA sites, a map was created to compare current land cover data to pre-settlement land cover data. All areas of vegetation that appeared to have remained unchanged were then used as a substitute indicator of vegetation quality. The percentage of a site that was comprised of unchanged vegetation was then measured. The actual size in acres of unchanged vegetation within a site was also calculated in order to balance out the bias of small sites with a high percentage of unchanged vegetation.

[6]Bio-Rarity Score
The location of quality natural communities and rare species tracked by MNFI are usually indicative of the quality of a site. The occurrences of all rare species and the ecosystems that support them in Michigan are tracked and recorded by MNFI. A bio-rarity score is then applied to all areas in Michigan based on the likelihood of a rare species being found, global rarity of the species, state rarity, and condition or viability (higher score applied to more threatened species). The Bio-Rarity dataset for Branch County was acquired from MNFI and used to score the individual PCA sites within the Hodunk-Messenger Chain of Lakes Watershed.

Scoring results

Table K-1 explains the scoring criteria that were applied to each of the 68 PCAs in the watershed. Each PCA was scored for each criterion, and points were allocated accordingly (*Table K-2* shows a detailed

[6] *Adapted from the Berrien, Cass and Van Buren Counties Potential Conservation Areas Report prepared by John Paskus, Senior Conservation Scientist and Helen Enander, Information Technologist II of Michigan Natural Features Inventory*

breakdown of how each PCA scored for each criterion). Once a PCA was scored for all criteria, total points accumulated per PCA were added up.

Priority for conservation was assigned based on the total point score of a given PCA (the higher the score, the higher the priority). Out of 41 points possible, the highest scoring PCA in the Hodunk-Messenger Watershed was a 21. The lowest scoring PCA in the watershed scored a three. The average PCA score in the watershed was an 11.

Table K-1:

Criteria	Description	Detail	Points
Total Size	Total size of the polygon in acres.	20-40 ac. 41-80 81-240 >240	0 1 2 4
Size of Core Area	Total area minus 300 feet buffer from edge of polygon.	0-60 acres 61-120 121-230 >230	0 2 4 8
Length of Stream Corridor	Length of stream or river within the polygon.	0 0-400 meters 401-800 801-1600 1601-3200 >3200	0 1 2 3 4 6
Landscape Connectivity (percentage)	Percentage of potential conservation areas within 1/4 mile	0-11% >11-22 >22-33 >33	0 2 3 4
Landscape Connectivity (proximity)	Number of potential conservation areas within 100 feet	0 1 2 3 4+	0 1 2 3 4
Restorability of Surrounding Lands	In a surrounding 1/4 mile buffer, the % of agricultural lands and old fields, minus other potential conservation areas.	0-35% 36-65% >65%	1 2 3
Vegetation Quality (percentage)	Measure percentage of potentially unchanged vegetation within a polygon	1-10% 10.1-30 30.1-65 65.1-100	0 1 2 4
Vegetation Quality (Area)	Measure the actual area within a polygon of potentially unchanged vegetation regardless the size of the polygon	0-10 ac 10.1-40 40.1-80 80.1-160 >160	0 1 2 3 4
Bio Rarity Score	Occurrences of quality natural communities and rare species tracked by MNFI (values were determined using the Jenk's optimization formula).	0-5.75 5.76-19.5 19.51-41.5 41.51-68	1 2 3 4

To aid in implementation efforts, the resulting PCAs were broken down into 4 priority groups: Low, Medium, High and Highest. PCAs were split into these priority groups relative to other PCAs in the watershed, as opposed to ranking them relative to the highest possible score of 41. If the latter classification method were utilized, all PCAs in the watershed would come out being a medium to low priority. Therefore, in order to classify PCAs relative to the watershed, a "natural break" method was used to split up groups. Rather than use absolute values, this method breaks data into classes based on natural groups or bunches in the data distribution (would occur at the low points or valleys in a histogram). Natural breaks that occurred in the Hodunk-Messenger PCA data formed the following groups:

Low – 0-5 points
Medium – 6-12
High – 13-18
Highest – >18

Each PCA was placed into one of the four categories, based on its score. Based on this grouping, three PCAs in the Hodunk-Messenger were found to be low priority, 38 medium, 23 high and three were found to be highest priority. Conservation efforts of the watershed implementation project should first be concentrated on the PCA in the "Highest" category, followed by the PCAs in the "High" category, so on and so forth.

Table K-2:

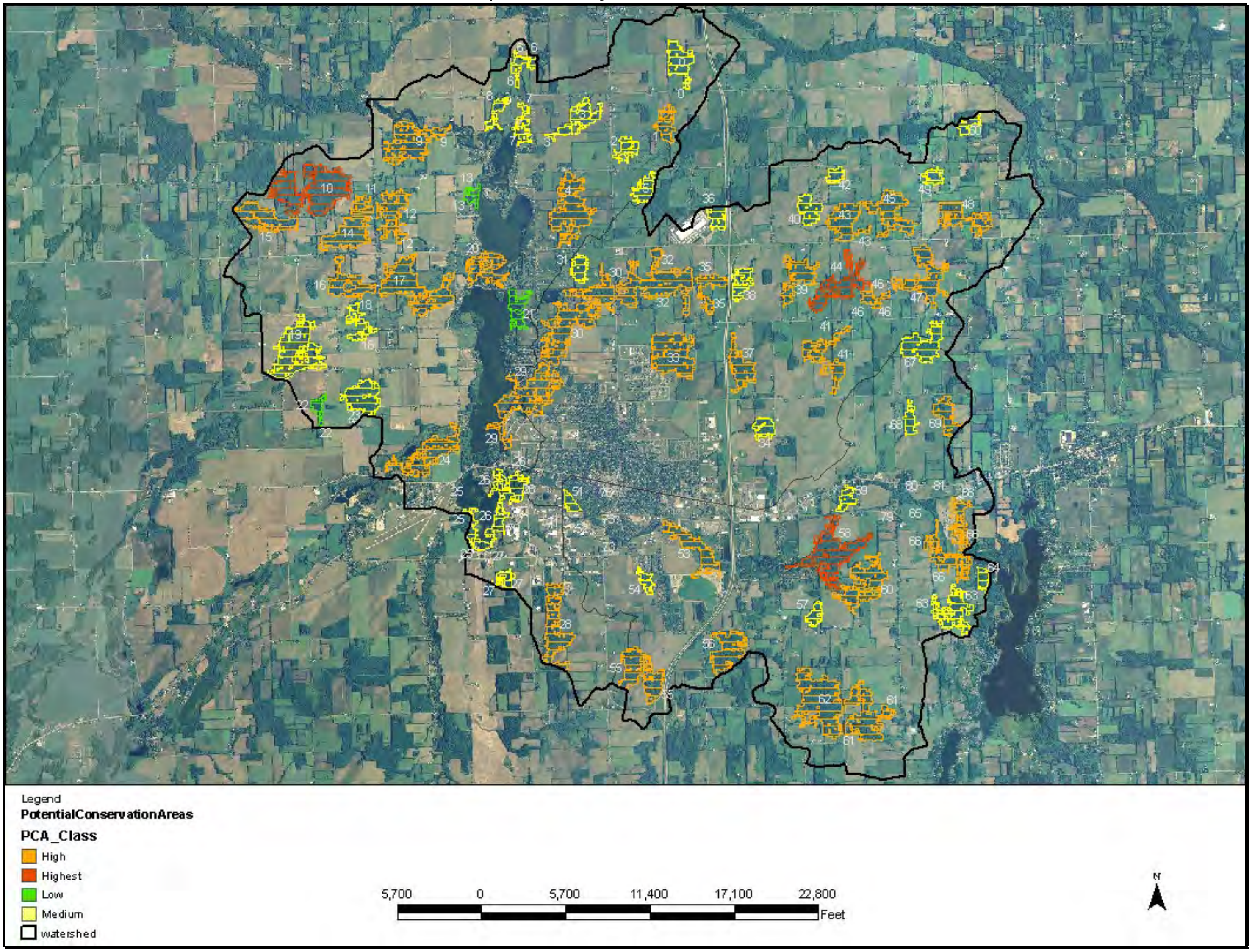
	Total size (acres)	Total size POINTS	Size of Core area	Size of Core area POINTS	Stream Corridor (length)	Stream Corridor (length) POINTS	Landscape Connectivity (percentage)	Landscape Connectivity (percentage) POINTS	Landscape Connectivity (proximity)	Landscape Connectivity (proximity) POINTS
1	72.5	1	5 acres	0	224.84 meters	1	0%	0	0	0
2	41.4	1	0.01	0	548.54	2	0	0	0	0
3	32.4	0	0	0	0	0	0	0	0	0
4	70.7	1	1.06	0	1,516.27	3	1.2	0	0	0
5	156.9	2	17.21	0	1,574.61	3	0.91	0	0	0
6	44.7	1	4.11	0	0	0	0	0	0	0
7	34.3	0	0	0	0	0	1.3	0	0	0
8	35.8	0	0	0	1,374.15	3	3.7	0	0	0
9	24.1	0	0	0	629.32	2	5.36	0	0	0
10	132.2	2	9.36	0	1,790.49	4	0	0	0	0
11	253.3	4	61.34	2	1,337.59	3	11.12	2	0	0
12	28.2	0	0	0	0.00	0	33.14	4	2	2
13	82.6	2	1.25	0	0.00	0	10.7	0	1	1
14	21	0	0	0	0.00	0	0	0	0	0
15	103.3	2	22.68	0	748.32	2	12.39	2	1	1
16	100.6	2	2.72	0	1,087.51	3	8.7	0	0	0
17	76.5	1	1.55	0	1,399.34	3	16.12	2	1	1
18	191	2	33.21	0	2,383.57	4	4.23	0	0	0
19	38.9	0	0	0	271.22	1	9.49%	0	1	1
20	173.3	1	13.89	0	452.23	2	0	0	0	0
21	76.3	1	0	0	535.69	2	3.34	0	0	0
22	48.3	1	0.01	0	0.00	0	3.15	0	0	0
23	20.1	0	0	0	0.00	0	0.66	0	0	0
24	90.3	2	7.41	0	0.00	0	0.7	0	0	0
25	116.6	2	0.62	0	899.73	3	0	0	0	0
26	35	0	0	0	0.00	0	4.3	0	1	1
27	85.8	2	2.85	0	935.50	3	5.1	0	1	1
28	21.3	0	0	0	0.00	0	0	0	0	0
29	121.2	2	3.17	0	259.17	1	0	0	0	0
30	177.1	2	5.33	0	1,989.83	4	3.1	0	1	1
31	226.7	2	13.05	0	3,616.04	6	10.4	0	1	1
32	35.1	0	0.48	0	0.00	0	14.9	2	0	0
33	185.7	2	8	0	2,046.24	4	8.4	0	0	0

34	150.3	2	20.94	0	1,653.96	4	0.1	0	0	0
35	34.2	0	0.4	0	485.75	2	0	0	0	0
36	44	1	0	0	1,441.08	3	17.1	2	0	0
37	33.5	0	0.75	0	224.02	1	0	0	0	0
38	68.2	1	2.01	0	324.50	1	0	0	0	0
39	38.8	0	0	0	280.63	1	4.2	0	0	0
40	75	1	3.79	0	510.52	2	7	0	1	1
41	47.4	1	0	0	594.34	2	6.7	0	0	0
42	86.7	2	0.8	0	848.61	3	0	0	0	0
43	21.2	0	0.72	0	184.50	1	0	0	0	0
44	88.2	2	14.61	0	1,744.00	4	13.2	2	1	1
45	103.9	2	2.38	0	1,367.36	3	10.1	0	2	2
46	100.3	2	11.85	0	911.74	3	6.4	0	1	1
47	25.1	0	0	0	741.65	2	14.8	2	1	1
48	117.7	2	7.01	0	1,522.49	3	2.3	0	0	0
49	78.5	1	0.17	0	930.78	3	0.1	0	0	0
50	23.5	0	0.73	0	0.00	0	0.3	0	0	0
51	24.1	0	0	0	0.00	0	0	0	0	0
52	20.2	0	0.01	0	537.20	2	0	0	0	0
53	83.1	2	2.64	0	1,978.06	4	0	0	0	0
54	21.2	0	0	0	0.00	0	0	0	0	0
55	125.9	2	6.6	0	0.00	0	0	0	0	0
56	96.9	2	6.91	0	571.45	2	0	0	0	0
57	24.1	0	0.06	0	0.00	0	1.6	0	0	0
58	169.7	2	10.55	0	4,655.37	6	8.4	0	1	1
59	25.2	0	0	0	692.65	2	4	0	0	0
60	121.9	2	1.77	0	651.98	2	12.1	2	1	1
61	130.2	2	7.17	0	843.63	3	12.6	2	1	1
62	204.3	2	50.37	0	1,258.04	3	7.2	0	1	1
63	88.9	2	0.03	0	68.52	1	4.2	0	0	0
64	22.8	0	0.86	0	0.00	0	8.4	0	0	0
65	130.2	2	0	0	1,771.56	4	5	0	0	0
66	92.5	2	8.77	0	0.00	0	0.6	0	0	0
67	27.7	0	0.73	0	752.32	2	0.5	0	0	0
68	54.5	1	1.33	0	15.28	1	0.5	0	0	0
Total	**5480.6**									

PCA #	Restorability of surrounding lands	Restorability of surrounding lands POINTS	Vegetation Quality (percentage)	Vegetation Quality (percentage) POINTS	Vegetation Quality (area)	Vegetation Quality (area) POINTS	Bio Rarity Score	Bio Rarity Score POINTS	TOTAL SCORE
1	95.58%	3	58.90%	2	42.7	2	0	1	**10**
2	75.43	3	80.68	4	33.4	1	0	1	**12**
3	94.65	3	100	4	32.4	1	0	1	**9**
4	96.93	3	0.28	0	0.2	0	0	1	**8**
5	94.34	3	72.53	4	113.8	3	0	1	**16**
6	65.41	3	59.06	2	26.4	1	0	1	**8**
7	48.95	2	41.69	2	14.3	1	0	1	**6**
8	74.87	3	0	0	0	0	0	1	**7**
9	74.79	3	0	0	0	0	0	1	**6**
10	74.79	3	87.44	4	115.6	3	0	1	**17**
11	83.71	3	64.11	2	162.4	4	0	1	**21**
12	91.21	3	69.5	4	19.6	1	0	1	**15**
13	94.16	3	92.13	4	76.1	2	0	1	**13**
14	66.76	3	0	0	0	0	1.25	1	**4**
15	94.15	3	71.54	4	73.9	2	0	1	**17**
16	60.58	2	63.72	2	64.1	2	0	1	**12**
17	94.44	3	24.05	1	18.4	1	0	1	**13**
18	87.12	3	30.99	2	59.2	2	0	1	**14**
19	94.53	3	11.57	1	4.5	0	0	1	**7**
20	78.75	3	5.83	0	10.1	1	14	2	**9**
21	48.89	2	65.53	4	50	2	1.25	1	**12**
22	58.04	2	0	0	0	0	5	1	**4**
23	64.12	2	0	0	0	0	0	1	**3**
24	84.75	3	0	0	0	0	0	1	**6**
25	60.97	2	40.74	2	47.5	2	0	1	**12**
26	35.67	2	37.14	2	13	1	1.25	1	**7**
27	55.84	2	14.69	1	12.6	1	1.25	1	**11**
28	62.73	2	86.85	4	18.5	1	0	1	**8**
29	70.08	3	70.21	4	85.1	3	0	1	**14**
30	46.28	2	25.13	1	44.5	2	5	1	**13**
31	87.66	3	27.44	1	62.2	2	0	1	**16**
32	93.63	3	100	4	35.1	1	0	1	**11**
33	95.62	3	56.92	2	105.7	3	0	1	**15**
34	85.36	3	39.45	2	59.3	2	0	1	**14**

35	93.37	3	69.59	4	23.8	1	0	1	**11**
36	96.38	3	72.27	4	31.8	1	0	1	**15**
37	58.17	2	77.01	4	25.8	1	0	1	**9**
38	92.66	3	93.4	4	63.7	2	0	1	**12**
39	93.03	3	63.66	2	24.7	1	0	1	**8**
40	94.49	3	61.07	2	45.8	2	0	1	**12**
41	95.45	3	51.05	2	24.2	1	0	1	**10**
42	94.88	3	79.58	4	69	2	0	1	**15**
43	95.91	3	48.11	2	10.2	1	0	1	**8**
44	97.24	3	57.82	2	51	2	0	1	**17**
45	92.46	3	78.83	4	81.9	3	0	1	**18**
46	98.84	3	47.06	2	47.2	2	0	1	**14**
47	88.75	3	49.8	2	12.5	1	0	1	**12**
48	85.08	3	69.16	4	81.4	3	0	1	**16**
49	95.96	3	78.73	4	61.8	2	0	1	**14**
50	91.35	3	48.09	2	11.3	1	0	1	**7**
51	49.15	2	100	4	24.1	1	0	1	**8**
52	35.91	2	44.55	2	9	0	0	1	**7**
53	64.02	2	44.04	2	36.6	1	0	1	**12**
54	81.8	3	53.77	2	11.4	1	0	1	**7**
55	80.45	3	75.38	4	94.9	3	0	1	**13**
56	62.19	2	69.66	4	67.5	2	0	1	**13**
57	94.44	3	56.43	2	13.6	1	0	1	**7**
58	88.66	3	51.21	2	86.9	3	0	1	**18**
59	88.15	3	26.59	1	6.7	0	0	1	**7**
60	97.64	3	52.75	2	64.3	2	0	1	**15**
61	95.46	3	44.78	2	58.3	2	0	1	**16**
62	92.64	3	41.46	2	84.7	3	0	1	**15**
63	67.01	3	51.18	2	45.5	2	0	1	**11**
64	37.36	2	56.58	2	12.9	1	5.63	1	**6**
65	79.9	3	34.02	2	44.3	2	0	1	**14**
66	89.71	3	57.53	2	53.2	2	0	1	**10**
67	96.09	3	40.79	2	11.3	1	0	1	**9**
68	65.01	3	77.25	4	42.1	2	0	1	**12**

Map K-1: Priority Conservation Areas



Appendix L

AREAS OF PRIORITY
IN THE HODUNK-MESSENGER CHAIN OF LAKES WATERSHED
MDEQ #2006-0127

L-1. Potential Restoration Areas

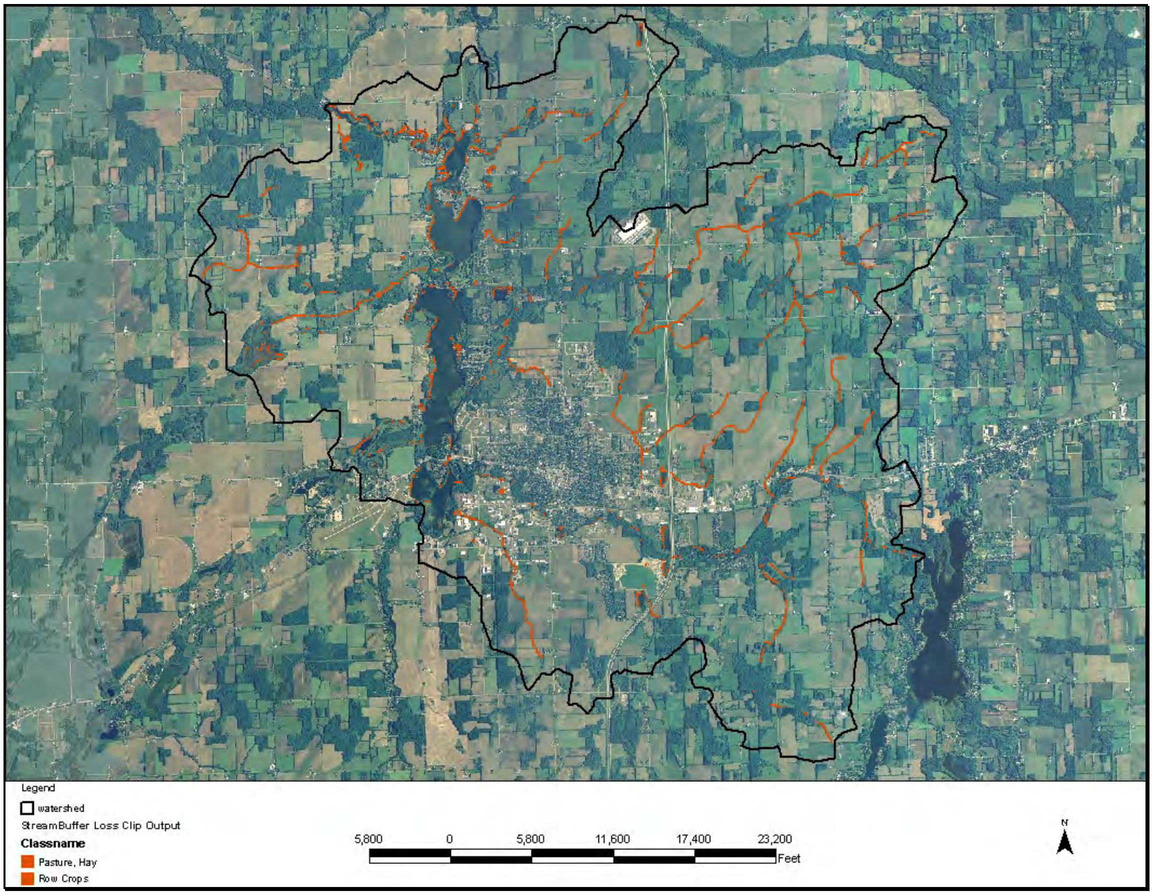
The areas in greatest need of being restored in the Hodunk-Messenger Watershed consist of lost riparian buffers and lost wetlands. Restoration of these features are vital for the reduction of NPS pollutants like sediment, nutrients, hydrology and agrichemicals. Specifically, riparian buffers have the ability to stabilize stream banks, moderate stream temperatures, provide cover and migration corridors for wildlife and provide a protective stream barrier for trapping and filtering sediment and other pollutants. Wetlands, in addition to trapping and filtering pollutants, have the added ability to regulate stream flow, store flood water, and provide permanent and temporary habitats for large numbers of birds, amphibians, reptiles and macro invertebrates. Restoration of these essential features is particularly useful for improving watershed health and stability when applied to the upper, or headwater, regions of watersheds.

As part of a geographic information system (GIS) agricultural land use analysis conducted during the Hodunk-Messenger Watershed Planning Project, streams in the watershed were assessed for their extent of pre-settlement riparian vegetation loss. From this land use analysis, it was determined that there are 112,215.34 feet, or 21¼ miles, of streams in the watershed that presently lack at least 30 feet of their original riparian vegetation. If a recommended minimum of 30 feet on either of a stream were to be re-established with riparian vegetation, it would generate a watershed-wide total of 154.5 acres. (All buffer loss areas that were bordered by impervious surfaces had been omitted from these figures because it was determined to be unlikely to reestablish a set-back distance in these areas).

According to a 2008 Wetlands Status and Trends Report, generated by MDEQ-Land and Water Management Division (LWMD), there have been 4,480 acres pre-settlement wetlands that have been lost. This reduction of wetlands in the watershed is largely attributed to the conversion of wetlands to agricultural fields, with some additional losses incurred through urban and residential development. Of the 51% of wetlands that have been lost over time, MDEQ-LWMD has identified the areas within the watershed that would have the greatest potential of being restored, based on a comparison of pre-settlement wetlands and current hydric soils.

A map defining the exact areas of potential areas for riparian buffer restoration in the watershed (*Map L-1*) is provided below, followed by the full MDEQ-LWMD Wetlands Status and Trends Report on the Hodunk-Messenger Watershed. The wetland status and trends report was generated using 2005 National Wetlands Inventory (NWI) data.

***MAP L-1:* Potential Buffer Restoration Areas**



L-2. Critical Site Profiles

The following critical sites have been identified through watershed planning project assessments as site-specific sources of NPS pollution in the Hodunk-Messenger Chain of Lakes Watershed. These sites are in need of BMP implementation in order to reduce NPS pollutant loads. Critical Site profiles are grouped by sub-watershed, but not necessarily in order of priority.

Cold Creek Sub-watershed

CC 1 Dean Road Pasture

This site has large expanses of open, rolling fields used to pasture livestock. The critical part of this site is that an upper portion of Cold Creek runs through this property with very little to no buffer in place for its entire reach. Another critical aspect about this site is that it occurs on one of the largest expanses of converted wetland in the watershed (*Section L-1*). The stream at this site has been channelized into a very straight and narrow ditch with an extremely steep grade. Evidence of polluted runoff in the form of grayish-green water with abundant algal blooms is observed in the plunge pools near the Dean Road Culvert.

CC 2: Ridge Road livestock operation

This operation, while not as intensive as the Newton Road operation, has free range livestock confined to a very small area around an open stream with no substantial buffer in place.

***Figure L-1*: Livestock Stream Access Site**

CC 3: Cold Creek Impaired Stream bank 1 (*Figures L-2 & L-3*)

This streambank erosion site appears to be rapidly deteriorating based on the badly scored stream banks and the amount of fallen and slumping trees. This site is most likely affected by lack of floodplain upstream, undersized culvert and multitude of log jams that constrict flow downstream. These stressors have caused this site to rapidly widen on either side.

***Figure L-2*: Rapid Streambed Erosion at CC3**

***Figure L-3*: Culvert Directly Upstream of CC3**

CC 4: High BEHI site 1

This is one of two sites with "high" BEHI scores that were observed during stream crossing inventories. This site is on State Road in the Cold Creek Watershed. Bare surfaces and steep bank angles have attributed to the "high" BEHI ranking. Not coincidentally, this site is located in a site that has been formerly converted from wetland.

CC 5: Cold Creek Impaired Stream bank 2 (*Figure L-4*)

This site is not quite as severely impaired as site CCSW 3 but is still showing signs of rapid expansion through erosion. Bare slopes and many fallen and slumping trees are present at this site. Stream bank scouring seems to only be occurring on the outside of the bend at this site. The erosion occurring at this site is compounded by the fact that one side of the stream bank is extremely tall and steep. Large amounts of soiling are observed to be sloughing from the steep stream bank.

***Figure L-4*: Outer Bank of CC5**

CC 6: Newton Road Livestock Operation (*Figures L-5 & L-6*)

This site confines livestock to a small area for feeding directly adjacent to a stream with no type of buffer in place. It is vital that this small livestock operation receive some implementation BMPs to reduce animal waste inputs and feedlot runoff from reaching the stream.

***Figure L-5*: Livestock Near Open Stream**

***Figure L-6*: CC6 Barnyard Runoff**

CC 7: Newton road sand dump (*Figure L-7*)

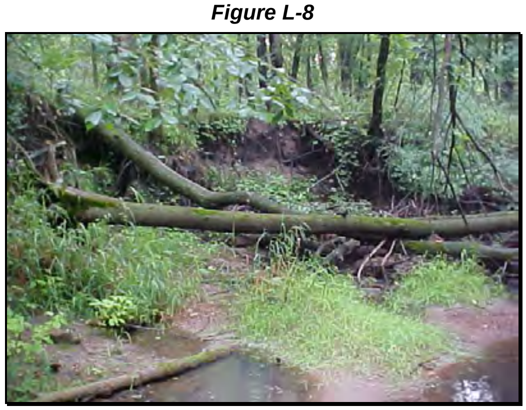
At the back edge of a field on the corner of Michigan Avenue and Newton Road there is a metal chute/slide that is situated directly over a Cold Creek tributary. It would appear from the large island of sand and gravel that this slide is used as a mechanism for dumping waste material. The property containing the metal slide to the river currently maintains horse boarding stables.

Figure L-7

CC 8: Cold Creek Impaired Stream bank 3 (*Figure L-8*)

Due to the highly flashy stream system, there has been severe stream bank scouring observed occurring on a sharp (≥90degrees) bend at this site. This site is heavily wooded and trees are being eroded from the stream edge. Many downed trees are found lying in and around the stream bank at this site. Severe undercutting and slumping observed at this reach of stream indicate that stream bank erosion is occurring and an unhealthy and unstable rate. Matted down swaths of vegetation on higher steps of the stream channel also indicates highly irregular stream flows.

Figure L-8



CC 9-11: Cold Creek obstructions *(Figures L-9 & L-10)*

There are a number of stream obstructions of woody debris that have accumulated in Cold Creek. These obstructions are attributed to severely eroding stream banks caused by stream instability. These obstructions collect garbage, impede and redirect stream flow, cause localized flooding and increase stream bank scouring.

Figure L-9:

Figure L-10:

Miller Lake Drain Sub-watershed

MLD 1, MLD 2, MLD 4 and MLD 7: Lake Access Sites

Lake accesses create unique concerns among critical sites of the watershed. It is at these sites that direct surface water contamination from gasoline, oil, starting fluid and other harmful substances is known to occur. Watershed residents have also claimed multiple reports of excessive garbage at and in the waters near these sites.

It is also at these sites that invasive aquatic species are introduced to the lakes. These sites serve as a gateway for invasive species because many out of town recreationalists visit the Hodunk-Messenger Chain of Lakes from other areas of Michigan and Indiana. Often, boats and trailers are not properly washed of plant material from other lakes, and thus invasives get introduced. It is thought that such species as Zebra mussel and Eurasian milfoil, which are now abundant in the lakes, have been introduced in this manner. Currently, there are two public MDNR boat launches, three county-owned public boat launches, two lake accesses at private campgrounds and one public fishing pier.

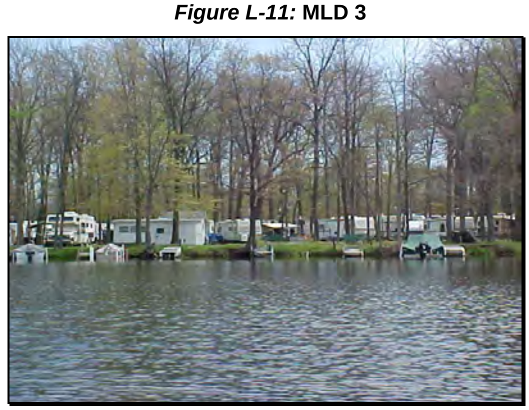
MLD 2: Memorial Park Beach

Memorial Park Beach (on Messenger Lake) is experiencing pathogen contamination of the surface water due to an abundance of feces deposited from the over populated Canada geese. This site is currently not attaining the designated uses of total and partial body contact recreation. Immediate pollutant load reductions are necessary to regain the designated use attainment at this site.

MLD 2, MLD 3, MLD 6 & MLD 8: Lakefront Campgrounds (*Figure L-11)*

Lakeside Campgrounds are abundant along the Chain of Lakes. Even though these areas are a useful recreational resource for the local community, they can also offer a host of NPS pollution risks due to the clustered human activity. Foremost of these risks involve sewage disposal. All campgrounds within the watershed do have some form of bulk sewage containment. However, due to high water tables, over use and age of some storage systems, the functionality of these systems is questionable. Furthermore, there have been unconfirmed reports of direct camper sewage disposal to surface water. Site-specific water

Figure L-11: **MLD 3**



quality monitoring and targeted I/E efforts should be utilized in these areas to reduce these risks. Aside from potential human waste contamination, there have been reports of the persistence of litter or improperly disposed-of trash in and around the campground areas. The issue of shoreline erosion is also apparent among these campgrounds. Wetland conversion, removal of shoreline vegetation, boat traffic and heavy use have combined to create conditions that have accelerated shoreline erosion.

MLD 5: Coldwater Golf Club

The Golf Club of Coldwater is a concern to Lake health because of its situation right along the chain of lakes. Much of the Golf Course's shoreline has been removed of its natural buffer and been replaced by intensely maintained turf grass. This presents a problem because not only does stormwater collect fertilizers and pesticides and run directly into the lake, but the lack of deep rooted vegetation has resulted in extensive shoreline erosion at areas exposed to wave action.

Sauk River Sub-watershed

SR 1: Gravel Pit #1 (*Figure L-12*)

The 1st (upstream) gravel pit along the Sauk River is not as critical as the 2nd (downstream) one because aggregate piles are located further away from the river. However, this gravel pit is situated on land that gradually slopes toward the river and therefore still has the potential to deliver excessive amounts of eroded sediment to the river.

Figure L-12: **SR1, Upstream Gravel Pit**

SR 2: Sauk River Floodplain Dumping Site

This site has experienced years of unpermitted clearing and filling. SR 2 has historically been used as a dumping site for road work and industrial demolition projects. Today, a good portion of the Sauk River floodplain at this site has been cleared of trees and filled with material such as sand, broken concrete, gravel and other fill material. Dumping at the site has been halted by regulatory authorities, but no mitigation project has yet been proposed.

SR 3: Gravel pit #2 (*Figures L-13 & L-14*)

This site is one of two gravel pits bordering the Sauk River. This site, on Michigan Avenue in the Sauk River Sub-watershed, has issues with stacking mined aggregate piles too close to the stream bank. In some cases, gravel and other sediments slough off from piles directly into the river (*Figures L-13& L-14*). This site is desperately in need of sufficient set back zones in and near all riparian areas.

Figure L-13: **Gravel Sloughing off into Stream**

Figure L-14: **Gravel Pile Along Streambank**

SR 4 & SR 6: Sauk River obstructions (*Figures L-15 – L-17*)

Many trees along the bank of the Sauk River have had the soil beneath them eroded away, causing them to lean and fall into the river. These trees are seldom removed from the stream and over time accumulate to create stream obstructions that collect garbage and redirect stream flow, thereby creating stream bank scouring and flooding. There are also known areas on the river that have been intentionally dammed with cut logs and broken concrete.

Figure L-15: **Concrete Ruble**

Figure L-16: **Downed Trees**

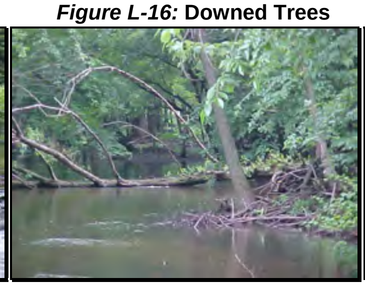
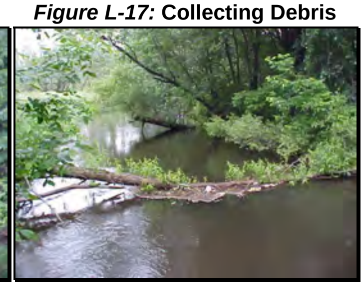


Figure L-17: **Collecting Debris**



SR 5: High BEHI site 2

This road stream crossing erosion hotspot is found on Sprague Road near Waterworks Park in the Sauk River Sub-watershed. Factors like shallow-rooted turf grass to the stream edge, a ninety-degree bank angle and zero surface protection have led to the deterioration of the stream bank at this site. Some of the most concentrated human use along Sauk River takes place at this site as well.

SR 7: 4-H Fairgrounds

Between Sprague and Jefferson Roads, Sauk River is extremely threatened. It is in this reach that the River flows along the Branch County Fairgrounds. On the fairgrounds side of the River, the streambank becomes relatively high and steep and gains an increased risk of erosion and polluted runoff from the fairgrounds. On the Water Works Park Side of the river, turf grass in maintained all the way to the water's edge. Very little to no riparian buffer exists in this area because of the intense human activity on either side.

SR 8: Sauk River Impairment (*Figure L-18*)

This downstream segment of the Sauk River near the mouth at South Lake has some of the steepest streambanks of the entire river. This factor, along with extended stretches of bare, unprotected soils, has earned this site a "high" BEHI rating and is therefore considered impaired and in need of stabilization practices. Local stream obstructions and evidence of heavy use through human access have also contributed to localized erosion problems at this site.

The streambank erosion at this site has become so severe, in fact, that the City's waste water discharge pipe that runs underground along the river has become exposed in several areas.

Figure L-18**: South Bank of Sauk River, near mouth**

Photo Courtesy of City Coldwater

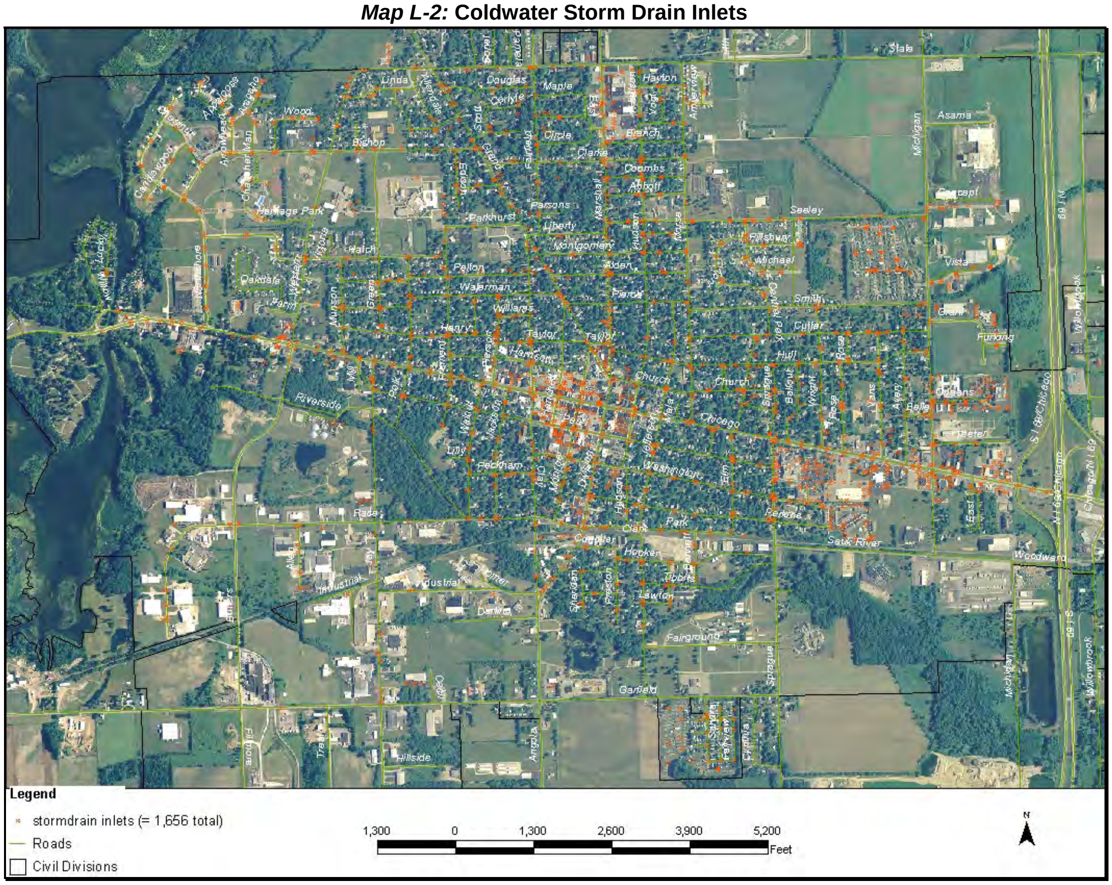
L-3. Critical Area Profiles

Similar to critical *sites* in the sense that they have been identified as sources NPS pollution, these critical *areas* have been known to contribute NPS pollution over broad-ranging, landscape-level locations. Since many of these Critical Areas span a large geographic region or to multiple locations, managerial and educational BMPs are regarded to be the most effective approach for implementing measures to reduce NPS pollutant loads from these sources. The following Critical Area profiles are grouped neither by sub-watershed or priority.

Coldwater's Municipal Storm Sewer System (*Map L-2*)

The storm sewer system of Coldwater is responsible for collecting, conveying and delivering urban stormwater to the local lakes and streams in the Hodunk-Messenger Watershed. During the "first flush" of a rain fall event, up to 90% of all pollutants are washed from impervious surfaces. Furthermore, the rapid delivery of stormwater to surface water bodies creates instability in the local hydrology. Even though improvements in urban stormwater infiltration are necessary for watershed health, this system is less site-specific and will require long-term improvements at many individual sites along the entire storm sewer infrastructure.

Map L-2: **Coldwater Storm Drain Inlets**



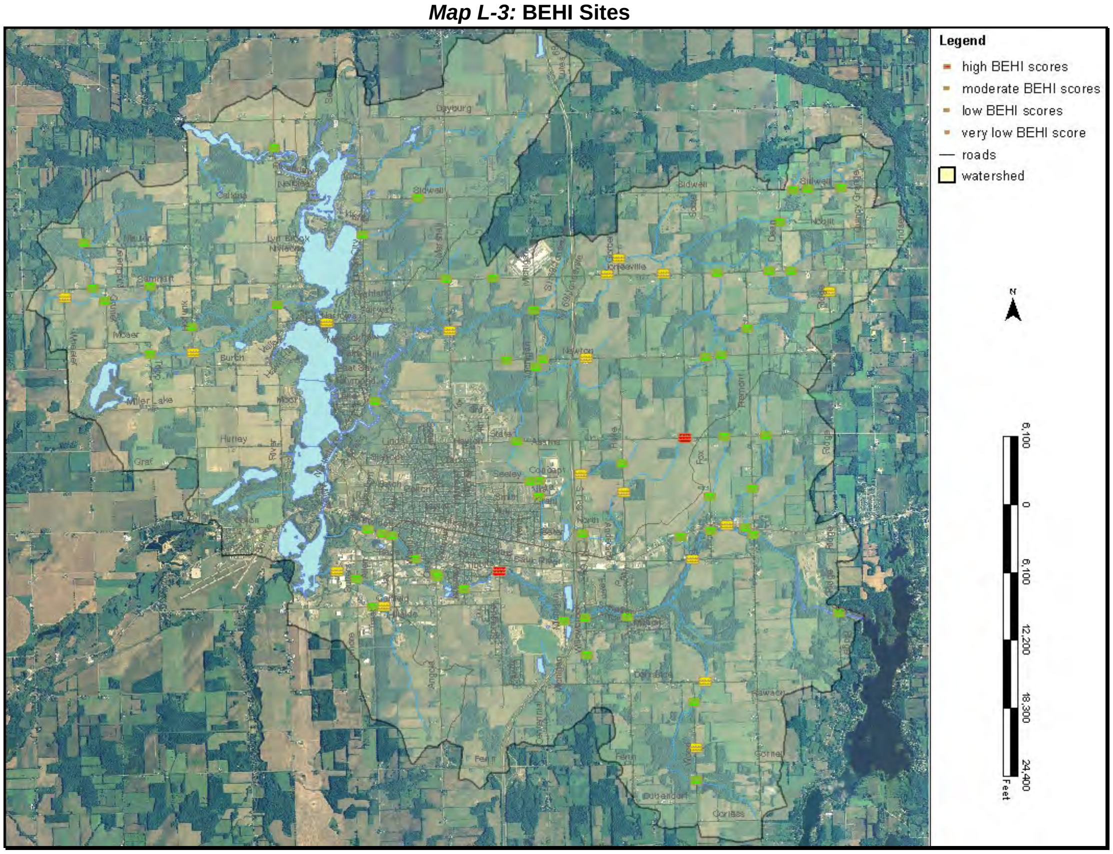
Fields with Highly Erodible Land (HEL)

These fields have at least some soils types present that are determined to have properties that characterize them as highly erodible lands (HEL)(Appendix G). If left bare and exposed, these fields have the potential to contribute large amounts of eroded soil to surface water if proper precautions are not taken. Such precautions include implementing filter strips, riparian buffers and reduced tillage systems.

Moderate BEHI sites (*Map L-3*)

These road stream crossing sites have been classified as having a moderate risk of stream bank erosion. Protective measures should be implemented at these sites only after the two highest priority sites have been addressed (*Section L-2*).

Map L-3: **BEHI Sites**



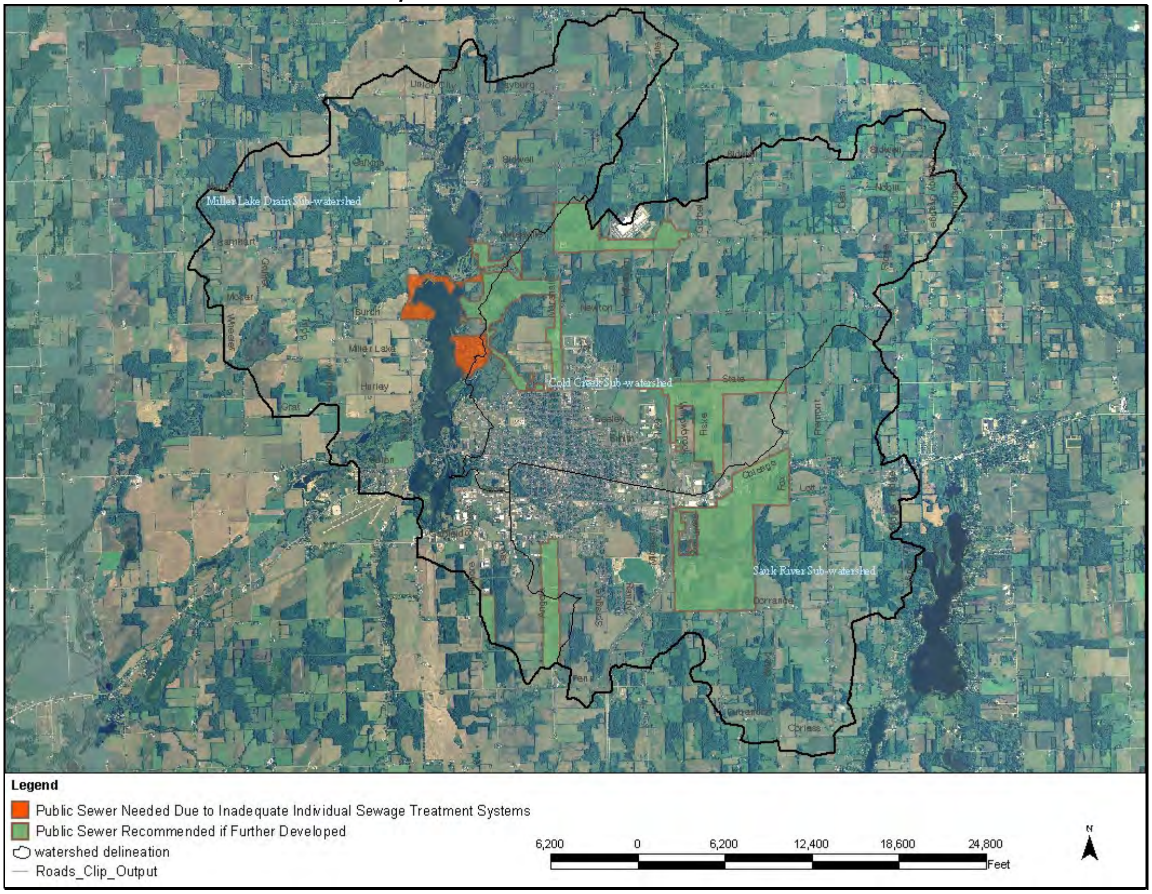
Septic leaching zones (*Map L-4*)

These areas were rated by the Branch-Hillsdale-St. Joseph County Environmental Health Agency in a 1997 survey to be insufficient for the proper use of individual septic systems due high water tables, overly porous soils close proximity of drain fields and well points, and undersized septic storage tanks (*Appendix F*). The Health Agency estimates that approximately 19% of all septic systems fail in a given year in the watershed. These areas prioritized have been as the leading contributors to this statistic.

There are also several isolated parcels within the City of Coldwater that have been identified as still operating on individual septic systems. A city ordinance adopted in 1984 states that any septic system that fails within 150 feet the City’s existing municipal sanitary sewer infrastructure is required to hook up to the sanitary system. The fact that these 26 separate systems still exist indicates that, at least for the time being, they continue to operate properly. Unfortunately, these isolated parcels are not likely to hook up to the municipal sewer system until their individual septic systems fail and contaminate the local ground and surface water supplies.

There is also a septic ordinance at the county level that states that septic systems within 200 feet of an existing sanitary sewer line that fail have to connect to it. This stipulation, however applies to very few developments in the watershed. At present, there is no point-of-sale ordinance for required septic maintenance at any level in the watershed. Such an ordinance would require septic system inspection and compliance to operation standards at any property sale transaction.

***Map L-4*: Sewer Needs in the Watershed**



Waterfront lawns (*Figures L-19 & L-20*)

Waterfront properties are critical areas in the watershed because they have such a high potential to contribute NPS pollution directly to surface water due to their close proximity. A vast majority of waterfront properties lack shoreline buffers and instead have replace natural vegetation with turf grass. Maintenance practices of these waterfront lawns such as mowing, over watering, fertilizing and chemically "weeding" are particularly detrimental because most waterfront lawns slope toward the water.

Many of the waterfront residential areas have been built up on former wetland sites. This development has resulted in instable shorelines that have a tendency to erode rapidly with wave action. Since the waterfront is such a sought after place to live, new developments are constantly being installed. These new developments also cause a considerable risk to lake health, as they seldom have sufficient sediment control measures in place to control soil erosion from delivering displaced soil into the lakes.

Figure L-19

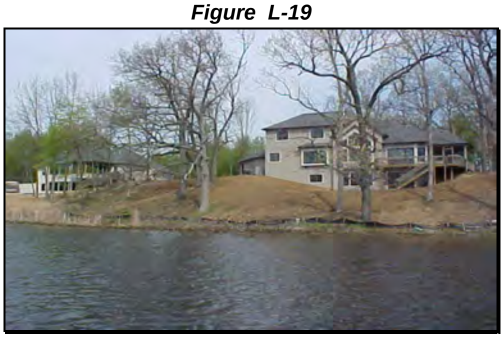
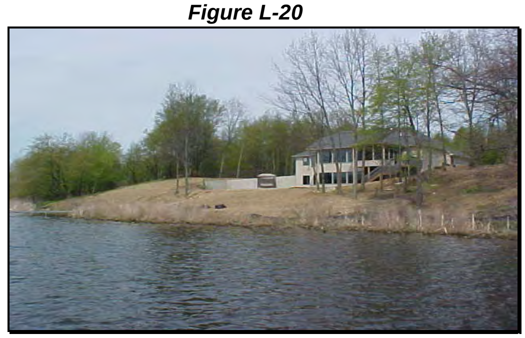


Figure L-20



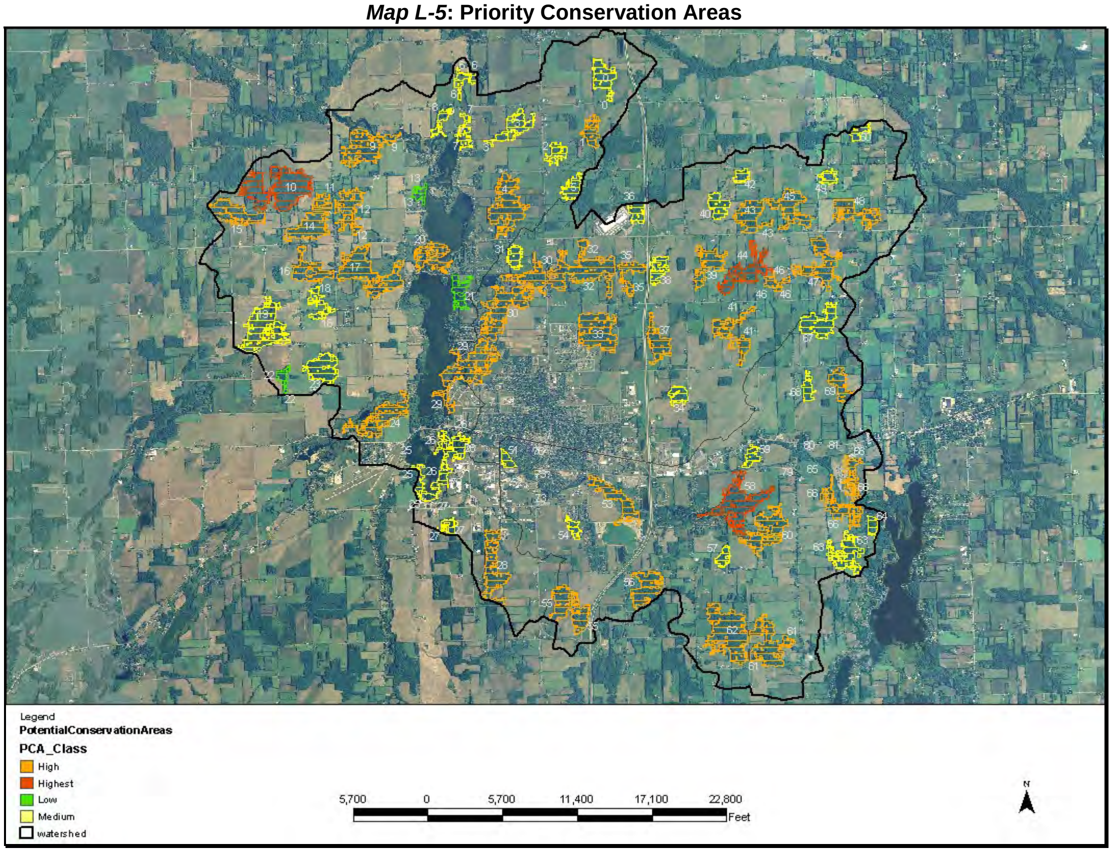
L-4. Conservation Area Profiles

The following areas have been identified as the most vital areas for conservation and preservation within the Hodunk-Messenger Chain of Lakes Watershed. By conserving and preserving these areas, aesthetic characteristic loss and further watershed degradation can be avoided. Several of the following conservation areas have also been targeted for the purpose of fulfilling watershed desired uses.

Highest Ranking PCAs (10, 44 and 58) (*Map L-5*)

These three PCAs have been determined to be the most valuable natural areas in the watershed, based on their total size, core area size, vegetative quality and proximity to surface water and other natural areas. The importance of conserving these areas is underscored by the fact that there is one "highest" PCA in each of the three sub-watersheds. In fact, all of these areas are located in the upper portions of each sub-watershed, where water treatment and hydrologic stability are most important.

***Map L-5*: Priority Conservation Areas**



High Ranking PCAs (1, 4, 9, 11, 12, 14-17, 20, 24, 28-30, 32, 33, 35, 37, 39, 41, 43, 45-48, 53, 55, 56, 60-62, 66 and 69) *(Map L-5)*

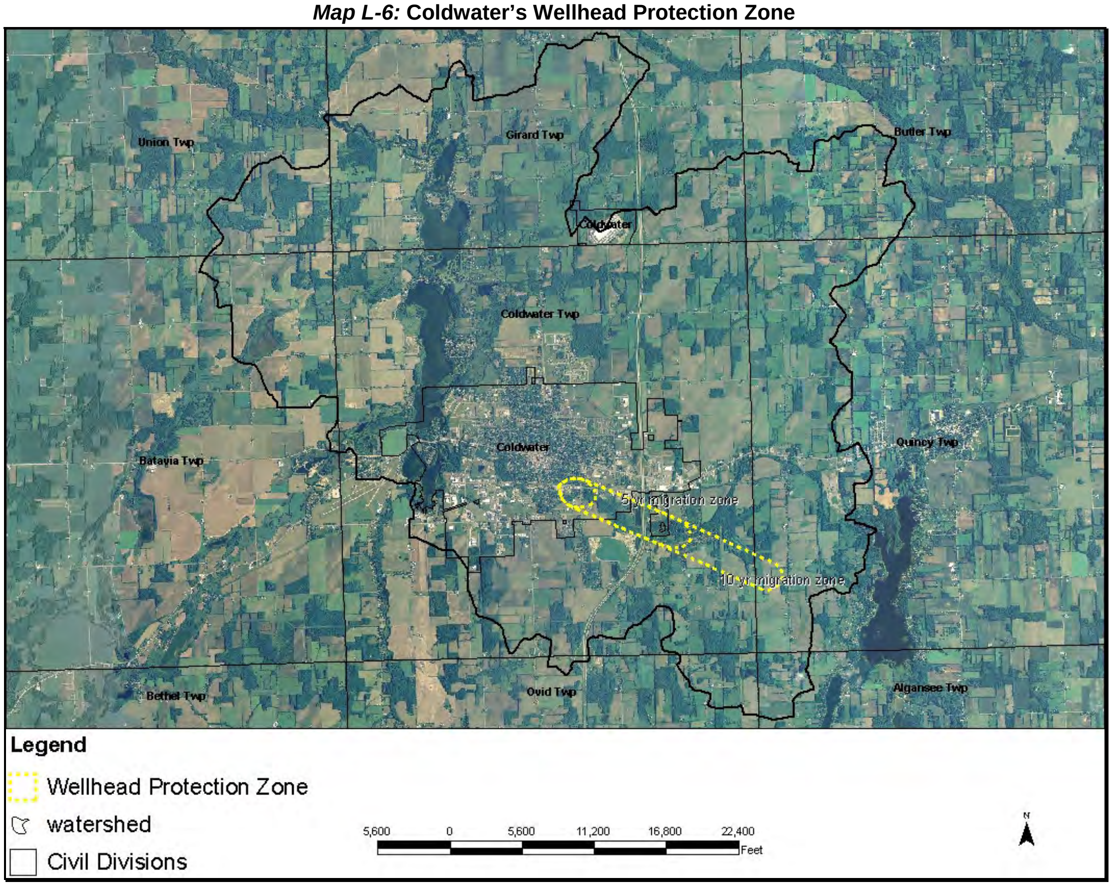
These 33 'High" ranking PCAs have been determined to be valuable natural areas in the watershed based on their total size, core area size, vegetative quality and proximity to surface water and other natural areas. It is indeed vital to preserve these highly valuable natural areas in order to keep their ecological benefits intact. However, preservation activities at these sites should only be undertaken once the 3 "Highest" overall PCAs have been conserved.

Coldwater wellhead protection zone (*Map L-6*)

This delineation represents the northwest trending aquifer of sandy glacial drift material that supplies the potable water supply of the City of Coldwater. The City's well field is located at the far northwest corner of this zone, in Waterworks Park where the 4 municipal wells are located. The rest of the delineation represents the groundwater migration zone. *Map L-6* defines the areas that would take 1-

10 years for groundwater to travel to the municipal wellheads. With this in mind, the entire well head protection zone should be actively preserved in order to prevent any contamination of Coldwater's groundwater supply either presently or in the future.

Map L-6: **Coldwater's Wellhead Protection Zone**



<u>Coldwater Brownfield Site</u>

Once the location of a former Federal Mogul automotive parts plant, this 26 acre site has now been cleared of all developments. This site has earned a "Brownfield" designation because redevelopment and utilization of the site is restricted because of the residual toxins and hazardous materials that have accumulated in the soil. The site is owned by the City of Coldwater, but currently no distinct plans for future re-use or management are known to have been adopted by the City. Conservation of this site would be essential for water quality enhancement and recreational interaction because it is situated along the eastern side of Cemetery Lake and is directly adjacent to the existing Coldwater Linear Trail.

<u>Coldwater Linear Trail</u>

The linear recreational trail way in Coldwater has been determined to be a high priority desired watershed use among local municipalities and watershed residents. To enhance this desired use, it is recommended that additional land and land adjacent to the trail should be preserved in order to connect and extend trail segments, as well as provide a significant green corridor to surround that trail way.

<u>Priority farmland in the watershed</u>

Farmland and open space preservation has been listed as a top priority among the watershed community. Recently, Branch County adopted a Farmland Preservation Ordinance into their comprehensive master plan for the purpose of potentially purchasing development rights of farmland within the county. As municipalities began to acquire the funds necessary to carry out this task, it will be important to steer preservation activities toward the farmland and open space within the watershed that has the highest value for watershed health. For instance, when farmland is properly managed, it can promote infiltration, provide wildlife migration corridors and creates a buffer between urban areas and natural areas. *Appendix G* describes some characteristics of the farmland in the watershed, but as part of implementation, a thorough prioritization of quality farmland in the watershed should be conducted in order to maximize the benefits of PDR activities.

Appendix M

Sample Land Use Planning Recommendations for Water Quality Protection

****The following is an excerpt taken from the Land Use Policy Analysis Report for Coldwater Township developed by McKenna Associates, Inc. This portion, known as a "GreenPrint Plan", offers recommendations for future land use planning activities based on the current land use policies and natural resource base of Coldwater Township. This component of the Land Use Policy Analysis has been reproduced with permission from McKenna Associates, and can also be found on Page 103 of the full analysis report completed in February of 2009.****

McKenna ASSOCIATES INCORPORATED

9. GreenPrint Plan for Coldwater Township

Definition of GreenPrinting

According to *The Trust for Public Lands*, GreenPrinting is a *"smart growth strategy that emphasizes land conservation to ensure quality of life, clean air and water, recreation and economic health....a strategy for growth."*

Land Use Policy Analysis Implementation Actions

This section of the Natural Resources Inventory and Land Use Policy Analysis introduces implementation recommendations developed on the basis of data and analysis formulated during the preparation of this document. The land use tools and techniques reviewed in the previous section are recommended for incorporation into the Comprehensive Plan update, and more importantly, serve as the basis of the GreenPrint Plan described in this section.

The GreenPrint Plan aims to provide a simple and direct means for the Township to pursue natural resource protection and permanent preservation. The GreenPrint Plan has been developed with an understanding of the financial obligations that the plan may impose on the Township and its residents. As such, the GreenPrint Plan will take a number of years to implement, based on the amount of funds made available by various funding sources and the Township itself, in addition to the enactment of new land use regulations.

In general the GreenPrint Plan implementation process will require:

1. **Public Education**
It is recommended that the Township Planning Commission be responsible for the public promotion and education necessary for implementation of the GreenPrint Plan. Public education is critical to developing and maintaining public support and in securing private donations that may be required for state and other funding sources where a local matching component is required as part of the application.

2. **Land Owner Education**
For the GreenPrint Plan to achieve success, private property owners must voluntarily agree to participate in the program. It is recommended that the Planning Commission be charged

with the responsibility to conduct one-on-one or small group meetings with property owners to educate them concerning the goals of the GreenPrint Plan and the methods chosen to implement these goals.

This may be accomplished by the following:

- Township Planning Commission
- Branch County Land Preservation Board
- Branch County Planning Commission
- Branch County Conservation District
- Michigan State University Extension
- Southwest Michigan Land Conservancy
- Any combination of the above.

The Township should be encouraged to undertake this action as a group effort, involving as many partners as possible, but especially involving the Branch County Land Preservation Board.

3. **Regulatory Considerations**

The GreenPrint Plan is based in part on the protection of land within the recommended green space land use category on the to-be-developed 2030 Future Land Use Map through implementation of a series of new land use regulations, mostly implemented through amendment of the current Township Zoning Ordinance. It is recommended that the Planning Commission initiate the process to amend the zoning ordinance, as set forth in the previous section, immediately upon updating the Comprehensive Plan.

4. **Financial Considerations**

Undoubtedly, the most effective method to implement the GreenPrint Plan is to purchase the land desired for permanent preservation or to acquire the development rights (either through purchase or donation) from the property desired for permanent preservation. In either case, the Township will need to formulate a financing strategy that considers use of state grant funds, funding from foundations and conservancies, private donations, and Township resources.

Introduction to the Coldwater Township GreenPrint Plan

Growth and new development in the Township are inevitable, but sprawl development is not. Faced with increased household growth-related challenges, the Township is rejecting the notion that the historic pattern of development, especially low-density, single-dwelling use, autodependent home sites, will be the pattern of future development for the Township.

Coldwater Township seeks to establish itself as a leader in the Michigan smart growth, antisprawl movement through the adoption of goals for future development that subscribe to the principles of smart growth, as established by the Governor's Land Use Leadership Council. The updated Comprehensive Plan will document the future growth and development needs of the Township and identify an appropriate amount of land for future growth. The Plan will be prepared in a way that preserves and protects the natural resources of the Township through permanently protected farmland and open spaces.

The Township Planning Commission and Township Board believe that implementation of the GreenPrint Plan will create a healthier, more livable and economically sound Township for current and future residents. They also believe that the implementation of the GreenPrint Plan will protect the quality of life enjoyed by residents and the environmental quality of the surface waters, wetlands, and woodlots that provide the unique environmental habitat found throughout the Township.

A Description of the GreenPrint Plan

Maps 17 (Zoning) and *18 (Future Land Use)* illustrate the recommended GreenPrint Plan for Coldwater Township. Shown on the maps are ecological units that were identified in the process of preparing the Natural Resources Inventory with their level of importance ranking plus the land area designated for farmland preservation and protection with their level of importance.

While all of the land within the GreenPrint Plan is important, one of three levels of importance has been assigned to each ecological unit and farmland unit. A three tiered *importance designation* was used to indicate the level of urgency for protection and preservation that should be dedicated to the ecological unit. This assignment was done to focus implementation efforts and funds to those land areas that, without protection and preservation, may be lost to development or other uses inconsistent with the natural resource policies of the Township.

In assigning priorities, the following criteria were considered:

High Priority. Units that provide a significant contribution to the ecological needs of the Township and that are subject to imminent danger of being converted to uses that will diminish their ecological contribution to the Township.

Medium Priority. Units that provide a significant contribution to the ecological needs of the Township but are not subject to imminent danger of being converted to uses that will diminish their ecological contribution to the Township within the medium-term (5-10 year period).

Low Priority. Units that are not subject to imminent danger of being converted to uses that diminish their ecological contribution to the Township.

Building a Consensus Implementation Vision

The first step in the implementation of the GreenPrint Plan is to develop a political consensus supporting the Plan and the notion that there will be a concerted effort to purchase land or development rights from private land owners for selected properties within the GreenPrint area. It is recommended that the Planning Commission assume joint responsibility with the Township Board for the creation of this consensus vision. Key issues to be addressed during the development of this consensus must include:

1. Establishing an understanding of the value of land/PDR acquisitions for the preservation of the Township natural resources and the rural character of the Township desired to be maintained by Township residents.
2. Communication of this understanding to each resident and property tax payer of the Township.
3. Identification of the location, cost, and Township benefits of the initial land areas targeted for protection and preservation.
4. Communication of the method of acquisition, including the schedule for acquisition, costs, sources of acquisition funding, the willingness of the property owner to participate in the sale, and the specific importance of the land to be acquired to the Natural Resources Goals of the Township.

Leadership Responsibilities

The success, or lack of success, of the implementation of the GreenPrint Plan will be to a large measure directly correlated to the leadership and passion for implementation of the identified spokesperson for the GreenPrint Plan. Therefore, the spokesperson's duties will by and large measure and define the success of the implementation process. The spokesperson will need to:

1. Command the respect of all advisory committee members, elected and volunteer Township officials, property owners, funders, and Township residents not directly involved in the GreenPrint implementation process.

2. Organize work assignments and motivate the members to accept and complete the work assignments necessary for implementation.

3. Motivate and convince funders, including government granting sources, foundations, conservancies, businesses, private donors, individuals, and the Township Board, to invest in the specific implementation actions (e.g. acquisition of land and/or PDR).

4. Have time available to personally meet with property owners and advisors to consummate individual transactions for implementation.

First Steps Towards Implementation

To begin the implementation process, the Coldwater Township Planning Commission should recommend that the Township Board approve a resolution endorsing (when appropriate) the future updated Comprehensive Plan. These actions establish the Comprehensive Plan as the advisory document for Future Land Use within the Township by both the Planning Commission and Township Board.

Upon formulation of the Future Land Use Policy, the Planning Commission should prepare a schedule of specific actions to be completed by the Township in order to begin the implementation process. Based on the foregoing recommendations, the first step towards implementation will be to establish a working partnership with the Branch County Land Preservation Board and the Southwestern Michigan Land Conservancy.

Appendix N

Hodunk-Messenger Chain of Lakes Watershed Planning Project Participation & Roles

1. WATERSHED PROJECT ADVISORY COUNCIL LIST:

1.) *TONY HEADLEY – Branch-Hillsdale-St. Joe Environmental Health Agency*
2.) *MARK KRAENZLEIN–Branch/Hillsdale/St.Joe Environmental Health Agency*
3.) *TRENT ARVER – Branch County Road Commission*
4.) *KATHY WORST – Branch Conservation District Administrator*
5.) *REBEKAH DEWIND – NRCS District Conservationist*
6.) *JIM COURY – NRCS Potawatomi R,C & D*
7.) *JULIA KIRKWOOD – MDEQ ESSD Project Administrator*
8.) *ROBERTA OSBORNE – Branch MSU-E*
9.) *MIKE HARD – Branch County Drain Commissioner*
10.) *MARY ELLEN NEWTON – Branch Co. Conservation District Vice-President*
11.) *CHRIS BAUER – MDEQ Water Bureau*
12.) *FRED LILUE – Coldwater City Engineer*
13.) *CHRIS HILTON – Coldwater City Planner*
14.) *BILL GREENAWALT – North Chain Lake Association*
15.) *PAUL SEEGERT – MRWA, ground water quality expert*
16.) *ROB ZBICIAK – MDEQ, Land and Water Mgt Div. - wetlands specialist*
17.) *GENE EASTERDAY – Girard Twp. Supervisor, Lake Board*
18.) *JOHN KOPACZ – Coldwater Twp. Supervisor, Lake Board*
19.) *BILL CHINERY – County Commissioner, Hodunk-Mess. Chain Lake Board*
20.) *DIANE BLANCHARD – North Chain Lake Assoc. Pres., Lake Board*
21.) *JACK COLLINS – Morrison Lake resident*
22.) *RUSS SILER – Coldwater Twp. Admin., Lake Board*
23.) *JIM MARSHALL – Potawatomi RC&D*
24.) *JOHN MITCHELL – Fort Custer Environmental Manager*
25.) *TOM SPITZNER – CBPU Water/Sewer Superintendent*
26.) *MELANIE STOUGHTON – MGSP Groundwater Tech*
27.) *DOUG LAKE – Legg Middle School Assistant Principal*
28.) *CHARLIE BOUSHCARD – City Engineer*
29.) *JEFF BROWN – Fishbeck, Thompson, Carr & Huber, inc. Senior Civil Engineer*
30.) *WENDY OGILVIE – Fishbeck, Thompson, Carr & Huber, inc. Senior Environmental Specialist*

2. WATERSHED PROJECT TECHNICAL SUBCOMMITTEE LIST:

(Members listed served as advisors/consultants in the development of the Hodunk-Messenger Comprehensive Watershed Management Plan)

1.) TONY HEADLEY – Branch-Hillsdale-St. Joe Environmental Health Agency
2.) KATHY WORST – Branch Conservation District Administrator
3.) REBEKAH DEWIND – NRCS District Conservationist
4.) JIM COURY – NRCS Potawatomi R,C & D
5.) JULIA KIRKWOOD – MDEQ ESSD Project Administrator
6.) MIKE HARD – Branch County Drain Commissioner

7.) CHRIS BAUER – MDEQ Water Bureau
8.) ROB ZBICIAK – MDEQ, Land and Water Mgt Div. - wetlands specialist
9.) JIM MARSHALL – Potawatomi RC&D Coordinator
10.) JEFF BROWN – F, T, C & H inc. Senior Civil Engineer
11.) WENDY OGILVIE – F, T, C & H inc. Senior Environmental Specialist

3. WATERSHED PROJECT I/E SUBCOMMITTEE LIST:

(Members served as advisors/consultants in the development of the Hodunk-Messenger Chain of Lakes Watershed implementation I/E Strategy)

1.) KATHY WORST – Branch Conservation District Administrator
2.) JULIA KIRKWOOD – MDEQ ESSD Project Administrator
3.) MARY ELLEN NEWTON – Branch Conservation District Vice-President
4.) JIM MARSHALL – Potawatomi RC&D Coordinator

4. MEETINGS:

Watershed Project Advisory Council meetings were conducted on a regular basis throughout the planning project. Stakeholders and resources professionals throughout the region were continually encouraged to attend these meetings. This led to an expansion in the attendance, diversity, experience and knowledge base of the individuals attending the meetings. Advisory Council meetings were conducted on the following days and locations:

Thursday, March 15th, 2007
10am - 12noon
Coldwater USDA Service
Center conference room

Thursday, May 3rd, 2007
10am - 12noon
Coldwater USDA Service
Center conference room

Thursday, July 6th, 2007
10am - 12noon
The Willows Bar and Grill
716 W. Chicago St., Coldwater

Thursday, September 13th, 2007
10am - 12noon
Coldwater USDA Service
Center conference room

Friday, November 9th, 2007
10am - 12noon
Coldwater USDA Service
Center conference room

Friday, January 18th, 2008
10am - 12noon
Coldwater USDA Service
Center conference room

Thursday, April 17th, 2008
10am – 1pm
Branch Area Chamber of
Commerce (basement meeting room)

Thursday, June 26th, 2008
10am - 12noon
Coldwater USDA Service
Center conference room

Thursday, October 30th, 2008
1pm – 3pm
Los Tequilas
(Upstairs meeting room)

Thursday, January 22nd, 2009
9am – 11am
Coldwater USDA Service
Center conference room

Tuesday, April 28th, 2009
10am-12noon
Coldwater USDA Service
Center conference room

In the later stages of the project the Technical Subcommittee was formed to assist with BMP planning and CWMP development. The Technical Subcommittee met on the following days and locations:

Wednesday, July 30th, 2008
10am – 12noon

Friday, September 12th, 2008
9am – 11am

Conference Call	Conference Call
Thursday, October 2nd, 2008 9am – 11am Conference Call	Friday, November 7th, 2008 10am – 12noon Conference Call

Two I/E Subcommittee meetings were also conducted in the course of the project. The first I/E subcommittee meeting dealt with current public outreach and education efforts and the allocation of 319 Planning Grant funds for I/E materials and events. A second I/E meeting was necessary to review and revise a proposed I/E Strategy for implementation. This I/E Strategy was planned by the Watershed Coordinator in close consultation with the I/E Subcommittee. The two I/E meeting took place:

Tuesday, February 19th, 2008 9am-11am Calhoun County Building	Wednesday, August 20th, 2008 1pm-3pm Conference Call

Two public meetings were also held for the purpose of soliciting public participation at the beginning and presenting the outcomes of the planning project at the end. Upon review of the WMP draft after the second meeting, several watershed stakeholders offered useful feedback that was later integrated into certain portions of this document. Overall, these two public meetings gave watershed residents a chance to voice their concerns for the watershed, become involved in watershed project events, and to have a say in the watershed planning process. The times and dates of these meetings are as follows:

Thursday, August 2nd, 2007 6:30pm-9pm Coldwater Township Hall (96 in attendance)	Thursday, May 28th, 2009 7pm-9pm Dearth Community Center (47 in attendance)