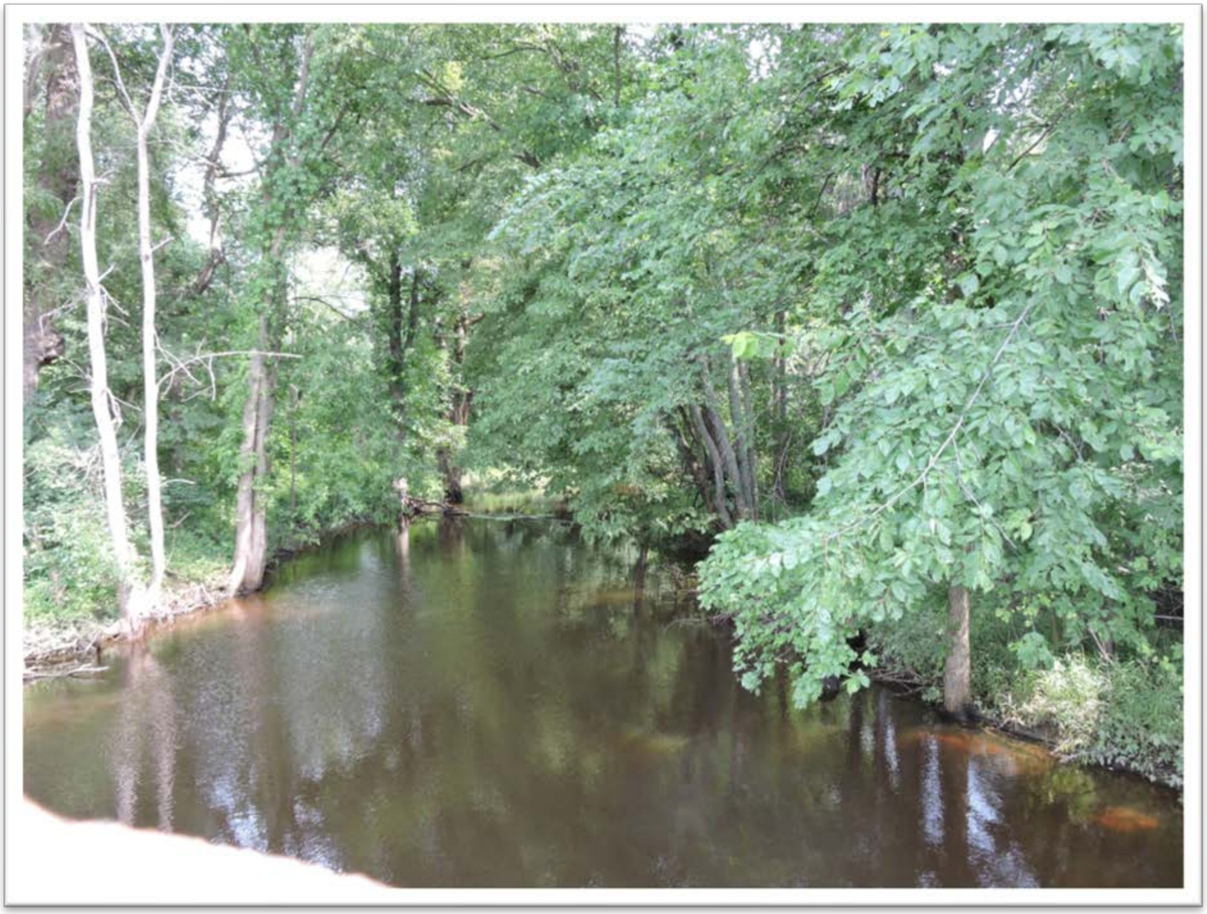
Upper Looking Glass River Watershed Management Plan

January 16, 2018



Shiawassee Conservation District

1900 S. Morrice Road
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In cooperation with the Michigan Department of Environmental Quality Non-Point Source Program

Introduction

The goal of watershed management is to plan and work toward an environmentally and economically healthy watershed that benefits all who have a stake in it. This Watershed Management Plan (WMP) is the result of a Michigan Stormwater, Asset Management and Wastewater (SAW) Program grant awarded to the Shiawassee Conservation District administered by the Michigan Department of Environmental Quality. The WMP is intended to be used by local officials, landowners and others that have an interest in, or impact on, the Upper Looking Glass River Watershed and its water quality. The primary purpose of this WMP is to improve cooperation between all groups in an effort to protect, restore and enhance the natural resources of the Upper Looking Glass River Watershed, the Grand River, and ultimately, Lake Michigan and the Great Lakes basin. A priority for the development of this WMP was to characterize the Watershed to identify primary pollutants, sources and causes. A thorough inventory and invested steering committee contributed toward the success of this watershed planning effort. The recommendations included in this plan are suggestions, providing guidance to where efforts should be focused and approximate costs for those efforts. For specific locations and costs for implementation projects, additional onsite investigations and measurements will be necessary.

Watershed Description

The Looking Glass River flows over gentle, sloping land, with its tributaries and surrounding watershed extending from headwaters in Livingston County to the confluence with the Grand River in Portland. The Upper Looking Glass River Watershed (ULG) is comprised of 12 sub-basins within 16 municipalities and four counties, covering 124,725 acres, including the river's headwaters in Livingston County and extends to the Route 27 business highway east of the City of Dewitt. From its headwaters to its mouth, the Looking Glass River falls about 210 feet in elevation and travels for 65 miles. The dominant land use in the watershed is agriculture comprising 53% of the total land use, with 23% wetlands, 15%forestland, 7% open lands, and 4% urban.

Water Quality Concerns

Water quality problems in the Upper Looking Glass River Watershed are related to land use and primarily caused by nonpoint source pollution. Pollution sources originate from agriculture and rural residential land use practices. Major pollutant concerns include elevated bacteria and pathogens levels, high nutrient levels, accumulated sediment, and trash. Sources of bacteria and pathogens include human and animal waste caused by leaching septic systems, illicit connections, livestock manure management, and excessive wildlife. Nutrient sources include fertilizers, soil erosion, and wastes from livestock, pets and wildlife. Causes include fertilizer/manure applications, cropland runoff, tillage, inadequate riparian buffers, and animal wastes. Sources of sediment include streambank, gully and sheet erosion mainly caused by agricultural land use practices and unstable hydrology. Trash sources include illicit dumping caused by apathy and lack of knowledge for proper disposal. These areas are the primary focus for implementation actions outlined in this WMP.

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List of Acronyms

319	USEPA Federal Clean Water Act Section 319
AHF	Agrichemical Handling Facility
AHGP	Aquatic Habitat Grant Program
BEHI	Bank Erosion Hazard Index
BMPs	Best Management Practices
BOD	Biological Oxygen Demand
CCD	Clinton Conservation District
CCDC	Clinton County Drain Commissioner
CCFB	Clinton County Farm Bureau
CCPF	Clinton County Chapter of Pheasants Forever
CCRC	Clinton County Road Commission
CEDS	Community and Environmental Defense Services
CEE	Channel Erosion Equation
CFR	Code of Federal Regulations
CFU	Colony-Forming Units
CISMA	Cooperative Invasive Species Management Area
CLPC	Clinton Lakes Pheasant Co-op
CNMP	Comprehensive Nutrient Management Plan
CREP	Conservation Reserve Enhancement Program
CSOs	Combined Sewer Overflows
CWA	Clean Water Act
DEQ	Department of Environmental Quality
DO	Dissolved Oxygen
DPW	Department of Public Works
E. coli	*Escherichia coli*
ECS	Environmental Canine Services LLC
EPA	Environmental Protection Agency
FOLG	Friends of the Looking Glass River
FOPL	Friends of Park Lake
FSA	USDA Farm Service Agency
FY	Fiscal Year
GEE	Gully Erosion Equation

GI	Green Infrastructure
GLC	Great Lakes Commission
GLEAS	Great Lakes and Environmental Assessment Section
GLRI	Great Lakes Restoration Initiative
GLRC	Greater Lansing Regional Committee
GRE	Grand River Expedition
HIT	High Impact Targeting
HUC	Hydrologic Unit Code
I&E	Information and Education
IDEP	Illicit Discharge Elimination Program
LEED	Leadership in Energy and Environmental Design
LID	Low Impact Development
L-THIA	Long-term Hydrologic Impact Assessment
MAEAP	Michigan Agriculture Environmental Assurance Program
MARI	Manure Application Risk Index
MDARD	Michigan Department of Agriculture and Rural Development
MDEQ	Michigan Department of Environmental Quality
MDHHS	Michigan Department of Health and Human Services
MDNR	Michigan Department of Natural Resources
MDOT	Michigan Department of Transportation
MFB	Michigan Farm Bureau
MGROW	Middle Grand Organization of Watersheds
MISGP	Michigan Invasive Species Grants Program
MMDHD	Mid-Michigan District Health Department
MNFI	Michigan Natural Features Inventory
MSUE	Michigan State University Extension
N	Nitrogen
NGO	Non-Governmental Organization
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NRCS	Natural Resources Conservation Service
NREPA	Natural Resources and Environmental Protection Act
NWI	National Wetlands Inventory
P	Phosphorus
PBC	Partial Body Contact
PCBs	Polychlorinated biphenyls
PF	Pheasants Forever
PGSC	Clinton County Parks and Greenspace Commission
POS	Point-of-Sale
PSA	Public Service Announcements
QDMA	Quality Deer Management Association
RUSLE2	Revised Universal Soil Loss Erosion Program
SCCMUA	Southern Clinton County Municipal Utilities Authority
SCD	Shiawassee Conservation District
SCDC	Shiawassee County Drain Commissioner
SCHD	Shiawassee County Health Department
SCRC	Shiawassee County Road Commission
SESC	Sedimentation and Erosion Control

SIDMA	Social Indicators Data Management and Analysis Tool
STEPL	Spreadsheet Tool for Estimating Pollutant Load
TBC	Total Body Contact
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
ULG	Upper Looking Glass
UMC	Upper Misteguay Creek Watershed
USDA	United States Department of Agriculture
USDA NRCS	United States Department of Agriculture Natural Resources Conservation Service
USDA RD	United States Department of Agriculture Rural Development
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
USLE	Universal Soil Loss Equation
WCR	Wetland Coastal Resources
WEPS	Wind Erosion Prediction System
WHGP	Wildlife Habitat Grant Program
WIN PST	Windows Pesticide Screening Tool program
WMP	Watershed Management Plan
WQS	Water Quality Standards
WRD	Water Resources Division
WWTP	Owosso Wastewater Treatment Facility

Appendices

Section 1 Description of the Upper Looking Glass River Watershed

1.1 Watershed Characteristics

1.1.1 Geographic Scope

The Looking Glass River flows over gentle, sloping land, with its tributaries and surrounding watershed extending from headwaters in Livingston County to the confluence with the Grand River in Portland. The watershed encompasses 23 townships and numerous villages and cities over six counties on the river's 65-mile journey through mid-Michigan. The Looking Glass River basin occupies an area of 195 square miles and includes 16 sub-basins. Most of the watershed is in Shiawassee and Clinton Counties, with small areas in the counties of Ingham, Ionia, Livingston, and Eaton. It is part of the Grand River Watershed, which ultimately flows into Lake Michigan (Public Sector Consulting 2008).

The Upper Looking Glass River Watershed (ULG) is comprised of 12 sub-basins within 16 municipalities and four counties, covering 124,725 acres, including the river's headwaters in Livingston County and extends to the Route 27 business highway east of the City of Dewitt. From its headwaters to its mouth, the Looking Glass River falls about 210 feet in elevation and travels for 65 miles. The dominant land use in the watershed is agriculture comprising 53% of the total land use, with 23% wetlands, 15% forestland, 7% open lands, and 4% urban.

Many of the problems in the watershed are due to nonpoint source pollution discharged to the river via a system of drainage ditches. Pollution originates from a variety of sources, including agriculture and rural residential land use practices. Major pollutant concerns include high bacteria and pathogens levels, nutrients, accumulated sediment, and trash. Bacteria sources include human and animal waste caused by leaching septic systems, illicit connections, livestock, manure, pets and wildlife. Pesticides and nutrients from fertilizers and eroded sediments from agriculture and residential land uses are common. Figure 1.1 illustrates the sub-watershed delineations. Table 1.1 lists the sub-watersheds and their acreage in each county. Table 1.2 depicts population sizes of municipalities in the ULG.

Watershed	Acres	Shiawassee County	Clinton County	Ingham County	Livingston County
Headwaters	11,834	6,539	0	164	5,131
Howard Dr.	21,493	21,494	0	0	0
Kellogg Dr.	17,205	17,205	0	0	0
Buck Br. / Vermillion Cr.	20,735	10,188	0	10,547	0
Vermillion Cr.	16,210	7,119	7,131	1,961	0
Leisure Lks.	11,257	10,636	621	0	0
Mud Cr.	11,011	0	11,008	0	0
Turkey Cr.	14,980	0	14,981	0	0
Total	**124,725**	**73,181**	**33,741**	**12,672**	**5,131**

Table 1.1 Sub-watershed acreage in the Upper Looking Glass River Watershed.

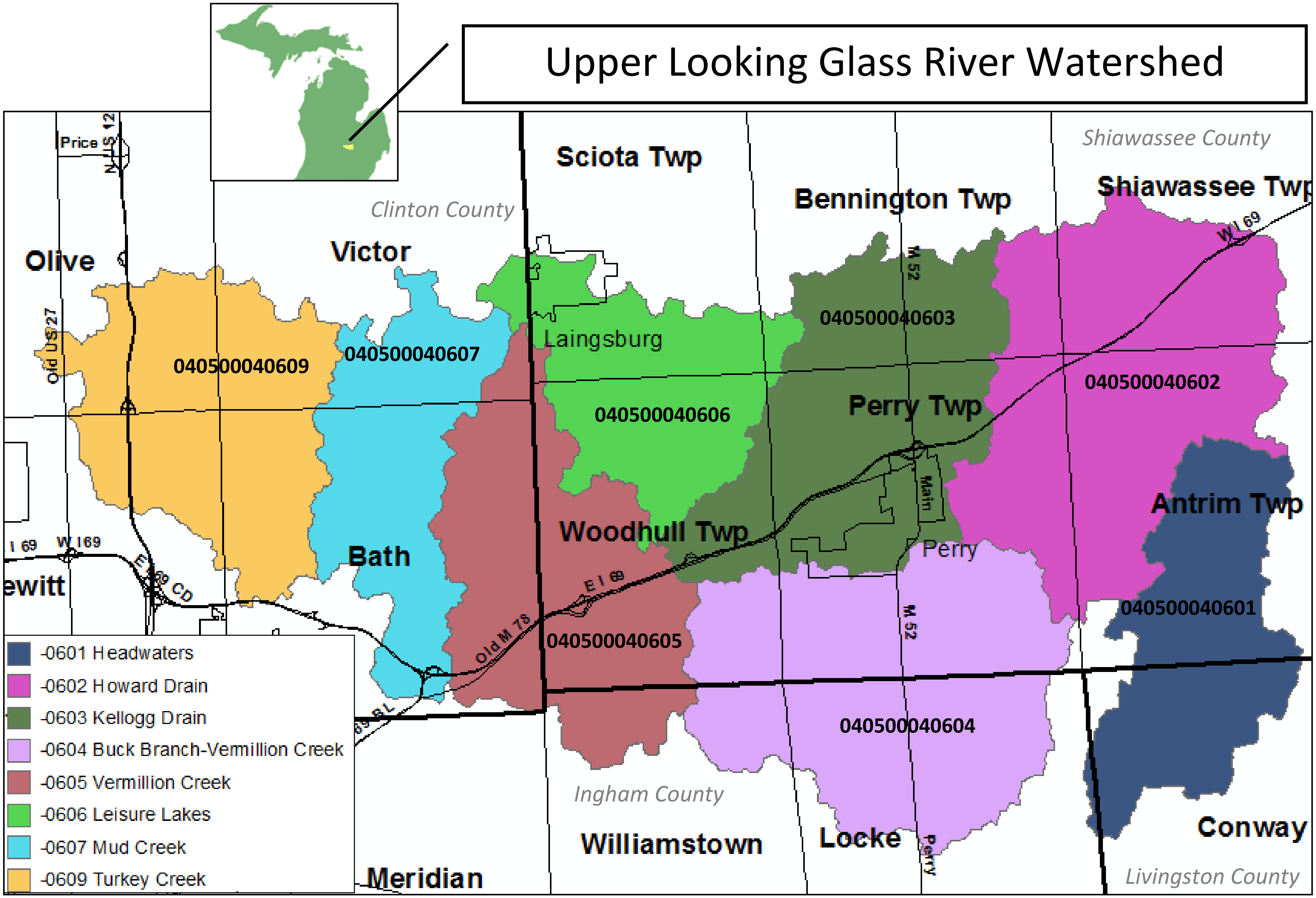

Figure 1.1 Upper Looking Glass River Watershed.

Legal Description	Populations*	Headwaters - Looking Glass River	Howard Drain - Looking Glass River	Kellogg Drain - Looking Glass River	Buck Branch - Vermillion Creek	Vermillion Creek	Leisure Lakes - Looking Glass River	Mud Creek - Looking Glass River	Turkey Creek Drain - Looking Glass River
Shiawassee Twp. (S)	2,840		6,854						
Antrim Twp. (S)	2,161	6,539	8,029						
Bennington Twp. (S)	3,168		1,718	5,424			413		
Woodhull Twp. (S)	3,810			2,479	2,318	7,119	5,614		
Sciota Twp. (S)	1,833						3,851		
Perry Twp. (S)	4,327		4,893	7,514	7,724				
City of Perry (S)	2,107			1,788	146				
City of Laingsburg (S)	1,263						758		
Bath Twp. (C)	11,598					6,562		7,337	4,063
Victor Twp. (C)	3,460					569	621	3,671	3,021
Olive Twp. (C)	2,476								4,429
DeWitt Twp. (C)	14,321								3,468
Williamston Twp. (I)	4,978				1,826	1,961			
Locke Twp. (I)	1,791	164			8,721				
Conway Twp. (L)	3,546	5,131							
Totals	63,679	11,834	21,494	17,205	20,735	16,211	11,257	11,008	14,981

*Populations are from the US Census Bureau

Table 1.2 Acres in Townships for the Upper Looking Glass River Watershed (C=Clinton, I=Ingham, L=Livingston, S=Shiawassee).

1.1.2 Geology, Topography and Climate

The bedrock in the Upper Looking Glass River Watershed varies with glacial movement ranging from sandstone to shale. Glacial features consist of alternating east-west trending moraines, till plains, and outwash plains. The Great Lakes, which were much higher than today, covered most of this till plain, leaving beaches and shorelines, which were erased or buried several times. Fine lake clays and sands were deposited, producing the broad, flat lands, which exist today (Michigan Water Resources Commission, 1963).

Climate in the watershed is typical for southern Michigan, favorable for cash crops and livestock farming, with temperatures ranging from below zero to over 100^{o} F. The growing season ranges from 140 to 160 days. About one-third of the precipitation, which averages 29.38 inches annually, runs off through the river drainage system with the highest flows in the spring and lowest flows generally in late summer (Michigan Water Resources Commission, 1963). Precipitation is heaviest during the growing season with the highest average in June and the second highest average in May. Summers are generally hot and humid, with high temperatures in the mid-90^{o}F range accompanied by humidity up to the mid-90%, resulting in low evaporation (Albert 1994).

1.1.3 Soils

The geology and soils of a watershed also influence the ability of stakeholders to successfully implement certain Best Management Practices (BMPs). The types and location of soils often determine what managerial, structural or vegetative activities are feasible. For example, specific geologic landforms and soils contain highly permeable soils that are more suitable for the installation of BMPs that function to increase infiltration. Likewise, some soil types are susceptible to extensive erosion if managed incorrectly and need to be planned for with particular strategies in mind.

The Upper Looking Glass River Watershed is composed of a variety of soil textures, ranging from soils with moderate infiltration rates to soils having very slow infiltration rates. Agricultural and residential erosion, including sheet/rill, ephemeral, gully and streambank erosion are consistently found throughout the project area.

Hydrologic soil groups are used to estimate runoff from precipitation and soils are designated to one of four soil groups. The soils are classified according to infiltration and transmission rates. The four soil groups are defined in the United States Department of Agriculture Natural Resources Conservation Service (USDA NRCS) Engineering Field Handbook as follows:

> Group A soils have high infiltration rates even when thoroughly wetted (low runoff potential) and consist of deep, well to excessively well-drained sands or gravels. These soils have a high rate of water transmission.
>
> Group B soils have moderate infiltration rates when thoroughly wetted and consist chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.
>
> Group C have slow infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture. These soils have a slow rate of water transmission.

> Group D soils have very slow infiltration rates when thoroughly wetted (high runoff potential) and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a clay-pan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission.

Hydrologic soil groups such as B/C indicate the drained/undrained situation. A hydric soil is a soil that is saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions and sufficiently wet to support the growth and regeneration of hydrophytic vegetation. Hydric soil identification is an important factor in land-use planning, conservation planning and site assessments for wetland restorations.

Soil Associations refer to a group of soils that have been defined and that occur in a characteristic pattern in particular geographic area. Soil associations commonly include the three most prevalent soils by name. Individual soils are usually named for a location where they were first defined. A soil's name provides a concise way to refer to its unique characteristics, such as particle size and makeup, color, pH, water content, mineral composition, percent organic matter, and others (Public Sector Consultants 2008).

The soil associations present in the watershed are:

- Urban land/Marlette/Capac
- Marlette/Capac/Owosso
- Oshtemo/Houghton/Riddles
- Marlette/Capac/Parkhill
- Boyer/Marlette/Houghton
- Houghton/Gilford/Adrian
- Miami/Conover/Brookston
- Boyer/Wasepi/Spinks
- Carlisle/Gilford/Tawas

Appendix 1 provides a complete list of soils found in the project area.

Soil is often designated as important farmland for the purpose of identifying and protecting the productive capacity of the land. The USDA defines prime and unique farmland as:

> Prime farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops. It has the soil quality, growing season and moisture supply needed to economically produce sustained high yields of crops when treated and managed, including water management, according to acceptable farming methods.
>
> Unique farmland is land other than prime farmland that is used for the production of specific high value food and fiber crops. It has the special combination of soil quality, location, growing season and moisture supply needed to economically produce sustained high quality and/or high yields of a specific crop when treated and managed according to acceptable farming methods.

A depiction of prime and unique farmland can be found in Figure 1.2.

Another useful tool in identifying and protecting vulnerable land is the classification of highly erodible soil. Highly erodible soil is categorized by the Natural Resources Conservation Service as being highly erodible from wind erosion or from sheet and rill erosion. Better management of highly erodible soils represented will reduce erosion and have a direct effect on improving water quality. Figure 1.3 depicts highly erodible soils in the Upper Looking Glass River Watershed.

By using the Soil Survey, which can be obtained from the USDA Service Center, all of these soil factors can be considered when making decisions about land use, such as new development, critical area protection and wetland restoration.

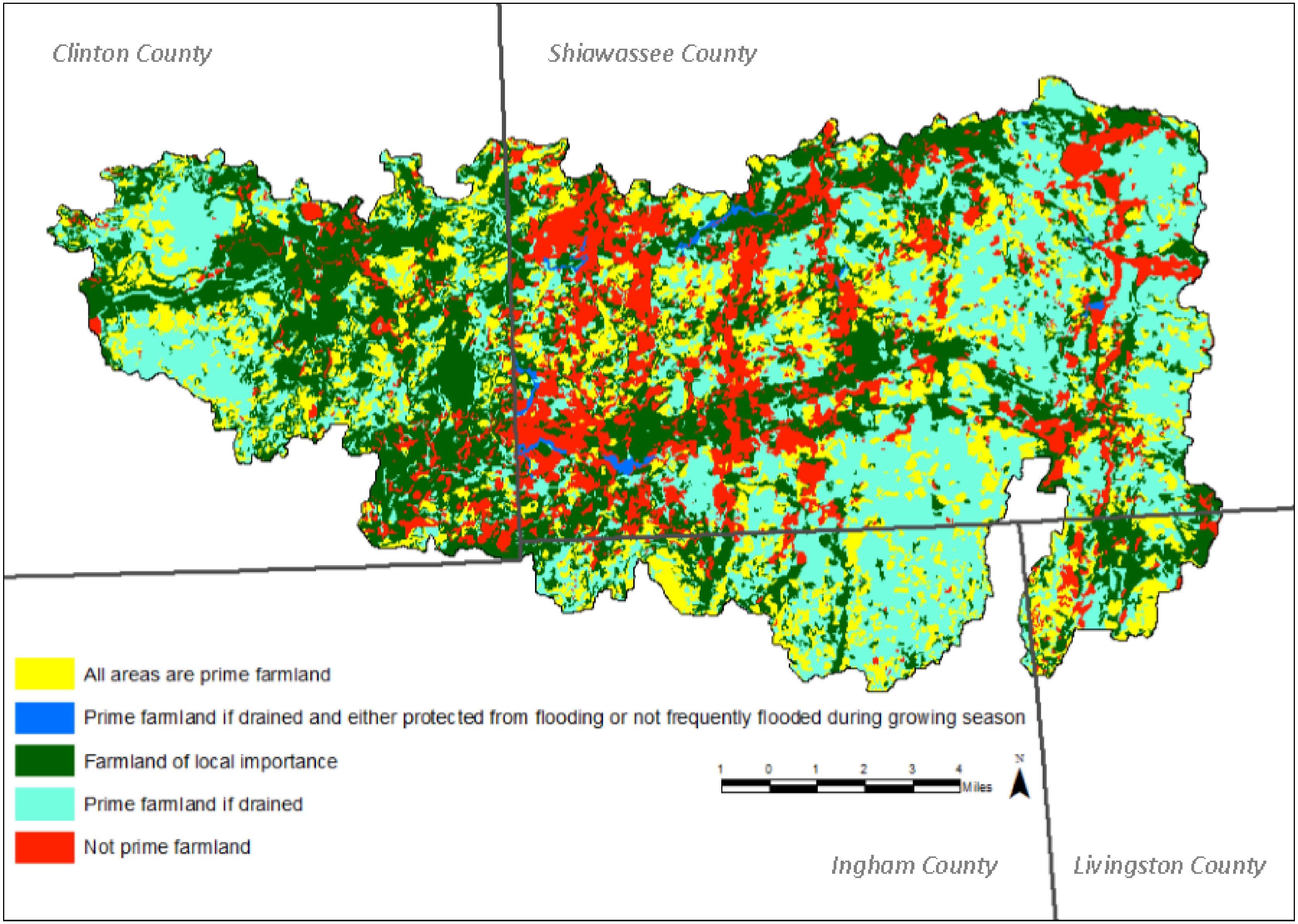

Figure 1.2 Prime Farmland in the Upper Looking Glass River Watershed.

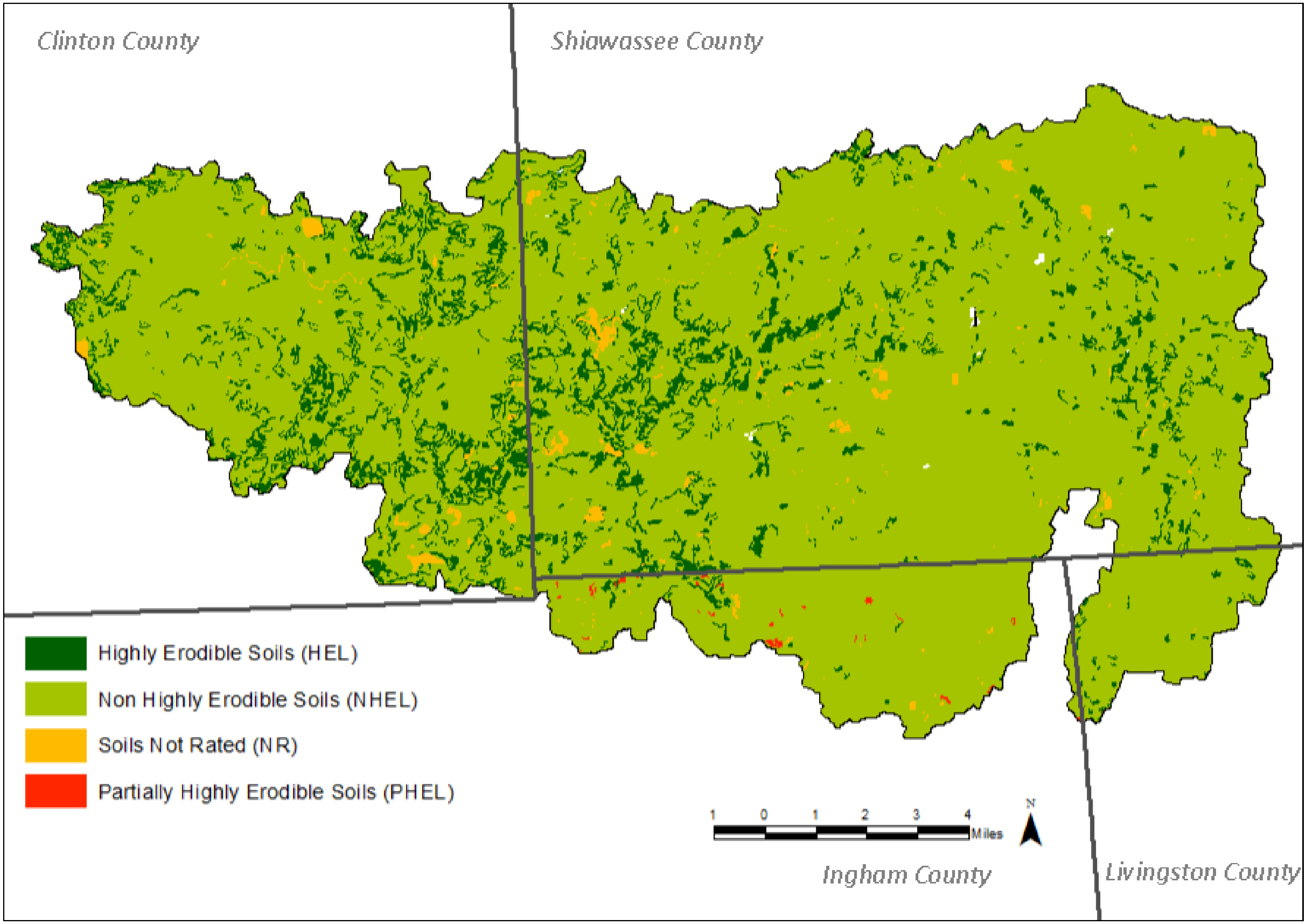

Figure 1.3 Highly Erodible Soils in the Upper Looking Glass River Watershed.

1.2 Hydrology

Hydrology is the scientific study of the movement, distribution, and quality of water on Earth, including the hydrologic cycle, water resources and environmental watershed sustainability. A successful watershed management plan (WMP) analyzes how hydrologic components respond to land use changes and site development. Changes in flow regime are typically caused by alterations in land use or stream form, such as straightening or dredging. Increase in runoff volume or peak flow, typically caused by the installation of storm sewers, can cause significant or extensive erosion. Urbanization in a watershed leads to filling in low areas, which previously provided stormwater storage and paving over pervious land, which had provided infiltration. These actions provide greater runoff volumes with higher and more frequent flood peaks.

1.2.1 Groundwater and Surface Water

The Saginaw aquifer underlies much of the Looking Glass River Watershed. The Upper Looking Glass River Watershed contains both the river's headwaters and associated wetlands. The deep bedrock aquifer underlying the watershed is the source of groundwater the human population uses for direct consumption, and for agricultural and industrial needs (Public Sector Consulting, Inc. 2008).

Groundwater plays an important role in generating streamflow (i.e. baseflow) in the river's headwaters. The average water table depth in the upper watershed ranges from zero to 15 feet. Because of this shallow water table, there is an active exchange of water between the surface and aquifer. Groundwater contributes significantly to the baseflow of the Upper Looking Glass River. Flows measured at DeWitt in October 2001 showed flows ranging from a base of 90 to a peak of 270 cubic feet per second. Groundwater is the primary source of drinking water for residents in the ULG. Well depths range from 26 to 970 feet below the surface with static water levels ranging from the surface (flowing wells) to 300 feet below surface (MDEQ Wellogic).

The Looking Glass River is a warmwater stream that varies from a third-order stream to a fourth-order stream. There are 335.8 miles of stream in the watershed, most of which is under operation by the county drain commissions. There are 539 acres of lakes in the watershed. The largest being Park Lake (182 acres), Round Lake (87 acres), Lake Geneva (58 acres), and Perch Lake (35 acres). Figure 1.4 depicts the surface water and Table 1.3 describes stream lengths in the Upper Looking Glass River Watershed.

There are approximately 539 acres of lakes and ponds in the ULG. Table 1.4 identifies acres of lakes and ponds and Table 1.5 shows prominent lakes in the watershed.

Sub-watershed	Stream Miles	Stream Feet
Headwaters	35	185,994
Howard Drain	65	344,294
Kellogg Drain	49	257,948
Buck Branch	66	348,973
Vermillion Creek	61	323,328
Leisure Lakes	32	171,541
Mud Creek	39	206,585
Turkey Creek	56	295,793
TOTAL	**404**	**2,134,455**

Table 1.3 Lengths of streams in Upper Looking Glass River Watershed Sub-watersheds.

Municipality	Acres
Woodhull	191
Victor	106
Bath	73
Locke	37
Shiawassee	28
Williamston	27
Bennington	21
Perry Twp	21
Antrim	15
Sciota	9
Olive	4
Conway	3
City of Perry	2
City of Laingsburg	2
DeWitt	0
Village of Morrice	0
TOTAL	**539**

Table 1.4 Acres of Lake Covered by Lakes and Ponds in the Upper Looking Glass River Watershed (Source: Public Sector Consultants Inc. 2008).

Antrim Township	Bath Township	Perry Township	Sciota Township	Woodhull Township
Rose Lake	Lake Geneva	Bacon Lake	Loon Lake	Bullhead Lake
Round Lake	Park Lake	Perch Lake	Moon Lake	Colby Lake
Woods Lake		Pickerel Lake		Dunn Lake
		Twin Lake		Marsh Lake
				Moon Lake
				North Graham Lake
				South Graham Lake

Table 1.5 Prominent lakes within the Upper Looking Glass River Watershed (Source: Public Sector Consultants Inc. 2008).

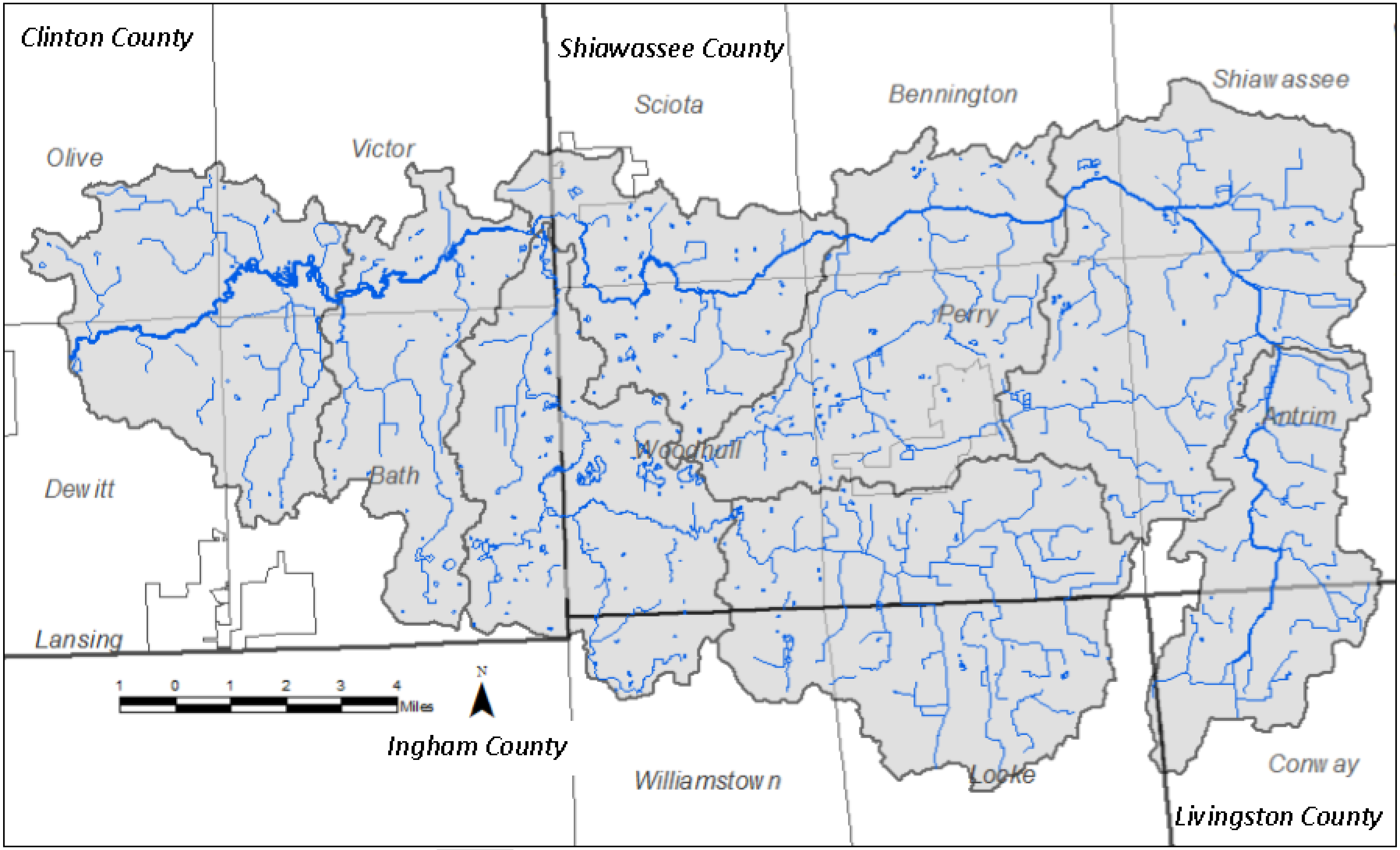

Figure 1.4 Surface water in the Upper Looking Glass River Watershed.

1.2.2 Climate

The climate of the Upper Looking Glass River Watershed is described as having warm summers and cool-to-cold winters. Average temperatures vary depending on season. January is the coldest month averaging 22.7◦F, and August is the warmest month averaging 71.1◦F. The watershed receives approximately 32.8 inches of annual precipitation. February is the driest month receiving 1.6 inches and June is the wettest receiving 3.7 inches. The greatest amount of snowfall falls in January averaging 13.4 inches, the equivalent to 1.3 inches of rainfall. Wind generally comes from a west/southwest direction at nine miles per hour (mph) during the summer and 12 mph during the winter. Peak gusts generally occur in the spring/early summer.

1.2.3 Morphology and Physical Description

The Looking Glass River falls approximately 210 feet in elevation and travels for 65 miles to where it empties into the Grand River. The Upper Looking Glass River Watershed contains large tracts of wetland and forested floodplain. However, much of the river and stream morphology have been altered from its natural design. Channels are commonly straightened and/or dredged to improve drainage from nearby low-lying farm fields and housing. The alteration of the river's natural meander creates some negative impacts in the watershed. Figure 1.5 depict stream order in a typical stream system.

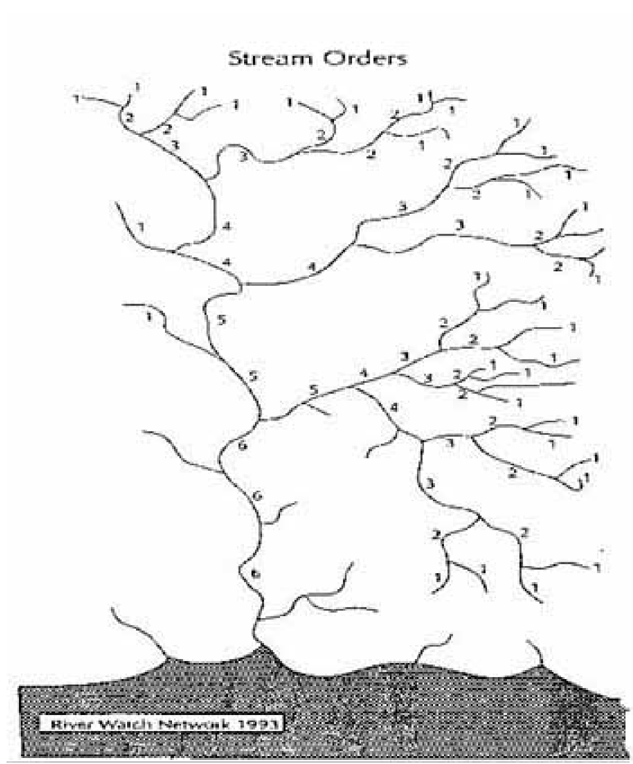

Figure 1.5.A representation of a river network with stream order marked.

1.3. Unique Features of the Upper Looking Glass River Watershed

1.3.1. Special Resources

Michigan has a number of significant natural features providing public, wildlife, and aquatic species benefits. The Upper Looking Glass River Watershed is home to a diversity of wildlife such as ducks, geese, herons, sandhill cranes, king fishers, songbirds, raptors (eagles, hawks, merlins, falcons, kestrels, owls), fox, black, red and "flying" squirrels, opossums, muskrats, minks, raccoons, red fox, coyotes, whitetail deer and others. Fish species in the river include pike, largemouth and smallmouth bass, rock bass, bluegills and other cichlids, carp, mullets, bowfin, and other warm water fish and minnows, wide range of turtles; salmon and steelhead seasonally in the lower stretches (Friends of the Looking Glass 1999).

1.3.2. Recreational Uses

Recreational uses are held in high regard in the Upper Looking Glass River Watershed. Activities include, canoeing, kayaking, bird watching, hunting, fishing, camping, hiking, off-roading, and water sports. These activities are also beneficial to local economies. In Michigan, outdoor recreation generates $18.7 billion in consumer spending, 194,000 direct Michigan jobs, $5.5 billion in wages and salaries, and $1.4 billion in state and local tax revenue (Outdoor Industry Association 2012). Conserving access to outdoor recreation protects the economy, the businesses, the community, and the people who depend on the ability to play outdoors.

1.3.3. State Wildlife Areas and Parks

In Michigan, you are never more than half an hour from a state park, state forest campground or state trail system. There is one state wildlife area located in the Upper Looking Glass River Watershed.

Rose Lake Wildlife Area

Rose Lake Wildlife Area is located in Woodhull and Bath Townships and includes 4,140 acres. Once a working farm, this site now contains a diverse mixture of habitats including lakes, wetlands, old fields and forest. Work roads that double as hiking/biking trails traverse the area. The topography is flat to gently rolling. Because of the diversity of habitats found here, many different kinds of wildlife may be viewed at Rose Lake. A great variety and abundance of songbirds are seen here. Sandhill cranes are known to nest here and may be seen flying to and from nesting marshes from May through August. Great blue herons are commonly seen in the lakes and wetland areas, and American bitterns may also be seen by the careful observer. Bitterns are small, elusive wading birds with brown striped necks. When approached, they will stand erect, aim their pointed bills straight upward, and blend right in with the sedges, cattails, and other aquatic plants that give them refuge.

1.3.4. Threatened, Endangered and Special Concern Species

Many threatened, endangered, and special concern species call the Upper Looking Glass River Watershed home. These species should be taken into consideration during land use planning and zoning. These same considerations should also be made during the planning and implementation of Best Management Practices. Failure to do so may affect biological diversity that is critical to the health and stability of our natural environment. Endangered species are determined to be in danger of extinction throughout all or a significant part of their range. Threatened species are vulnerable to the possibility of becoming endangered. Species that are on the Endangered and Threatened Species Lists are protected by law and not to be disturbed without going through a complex legal procedure. Special concern species do not have legal protection, but do have a precarious continued existence and need protection to stop them from slowly disappearing.

The Michigan Department of Natural Resources (MDNR) provides information on threatened, endangered and special concern species in Michigan by watershed. This work is coordinated by the Michigan Natural Features Inventory (MNFI). Table 1.6 exhibits the endangered, threatened, and special concern species found in the Upper Looking Glass River Watershed.

Common Name	Scientific Name	State Status*	Federal Status**	Category	Last Observed Date
Barrens buckmoth	*Hemileuca maia*	SC		Animal	1953
Blanchard's cricket frog	*Acris crepitans blanchardi*	T		Animal	8/25/1948
Blanding's turtle	*Emydoidea blandingii*	SC		Animal	5/12/2012
Cerulean warbler	*Dendroica cerulea*	T		Animal	6/22/1996
Clinton's bulrush	*Scirpus clintonii*	SC		Plant	6/8/1990
Common moorhen	*Gallinula chloropus*	T	PS	Animal	6/12/1996
Cooper's milk vetch	*Astragalus neglectus*	SC		Plant	8/1882
Culvers root borer	*Papaipema sciata*	SC		Animal	9/29/1973
Eastern massasauga	*Sistrurus catenatus catenatus*	SC	C	Animal	5/31/2006
Elktoe	*Alasmidonta marginata*	SC		Animal	7/6/2001
Ellipse	*Venustaconcha ellipsiformis*	SC		Animal	6/30/2010
False hop sedge	*Carex lupuliformis*	T		Plant	7/1891
Great Blue Heron Rookery	*Great Blue Heron Rookery*				6/19/1982
Hairy angelica	*Angelica venenosa*	SC		Plant	9/16/1948
Henslow's sparrow	*Ammodramus henslowii*	E		Animal	6/29/2007
King rail	*Rallus elegans*	E		Animal	Pre-1973

Least shrew	*Cryptotis parva*	T		Animal	10/26/1960
Pinetree cricket	*Oecanthus pini*	SC		Animal	10/8/2013
Purple milkweed	*Asclepias purpurascens*	T		Plant	7/16/189
Rainbow mussel	*Villosa iris*	SC		Animal	6/30/2010
Regal fern borer	*Papaipema speciosissima*	SC		Animal	1997
Regal fritillary	*Speyeria idalia*	E		Animal	1975
Round pigtoe	*Pleurobema sintoxia*	SC		Animal	7/6/2001
Showy orchid	*Galearis spectabilis*	T		Plant	5/26/1895
Slippershell	*Alasmidonta viridis*	T		Animal	6/30/2010
Spike rush	*Eleocharis radicans*	X		Plant	8/6/2011
Swamp metalmark	*Calephelis mutica*	SC		Animal	1981
Torrey's bulrush	*Scirpus torreyi*	SC		Plant	8/8/1893
Vasey's rush	*Juncus vaseyi*	T		Plant	6/8/1990
Virginia water-horehound	*Lycopus virginicus*	T		Plant	9/20/1952
White or prairie false indigo	*Baptisia lactea*	SC		Plant	7/1/1928

State Status*	Federal Status**
E – Endangered	LE – Listed Endangered
T – Threatened	LT – Listed Threatened
SC – Special Concern	C – Candidate
X – Presumed Extirpated	PS – Partial Status

Table 1.6 Endangered, Threatened, and Special Concern species in the Upper Looking Glass River Watershed (source: Michigan Natural Features Inventory).

1.3.5. Eskers

An esker is a geographic natural feature that is formed when glacial meltwater carves subsurface river tunnels within the ice sheet. As the flow of water decreases or is blocked, sediment accumulates beneath the glacier. When the glacier recedes, a snake-like ridge composed of sand and gravel remains. There are a number of eskers found in the Looking Glass River Watershed, including the longest esker in

Michigan extending from DeWitt to Mason running through Holt and Lansing. Much of the Mason Esker has been excavated for concrete roadway construction.

1.3.6. Wetlands

Wetlands serve important functions to protect surface water and land, including water quality improvement, floodwater storage, water filtration, fish and wildlife habitat, aesthetics, and biological productivity. The value of a wetland is an estimate of the importance or worth of one or more of its functions to society. For example, a value can be determined by the revenue generated from the sale of fish that depend on the wetland, by the tourist dollars associated with the wetland, or by public support for protecting fish and wildlife.

National Wetlands Inventory (NWI) boundaries were determined by the Water Resources Division of the Michigan Department of Environmental Quality (MDEQ) from aerial imagery last updated in 2005. The 2005 NWI data was used in the MDEQ analysis of wetlands status and trends pre-settlement to 2005. However, this data may not accurately reflect current conditions on the ground due to limitations of aerial photo interpretation including errors of omission (misinterpretation of aerials).

According to this report, the pre-settlement wetlands in the Upper Looking Glass River Watershed totaled 40,926 acres with an average size of 14 acres. In 2005, 27,050 acres of wetlands remained, with the average size being 6.5 acres. This 13,876 acreage difference translates to a 34% total wetland loss, leaving 66% of the pre-settlement acres remaining in the watershed. Figure 1.6 depicts pre-settlement wetlands and Figure 1.7 depicts wetlands as of 2005. A summary of the Upper Looking Glass River Watershed Wetlands Status and Trends Report can be found in Appendix 2.

Of the remaining acres, most are considered Freshwater Forest/Shrub type wetlands. Freshwater emergent type wetlands are the second most common followed by riverine. Freshwater ponds, lakes and other freshwater wetland types are also present in the watershed (Figure 1.8 and Table 1.7). Protecting the considerable amount of wetlands in the ULG should be a priority of this management plan.

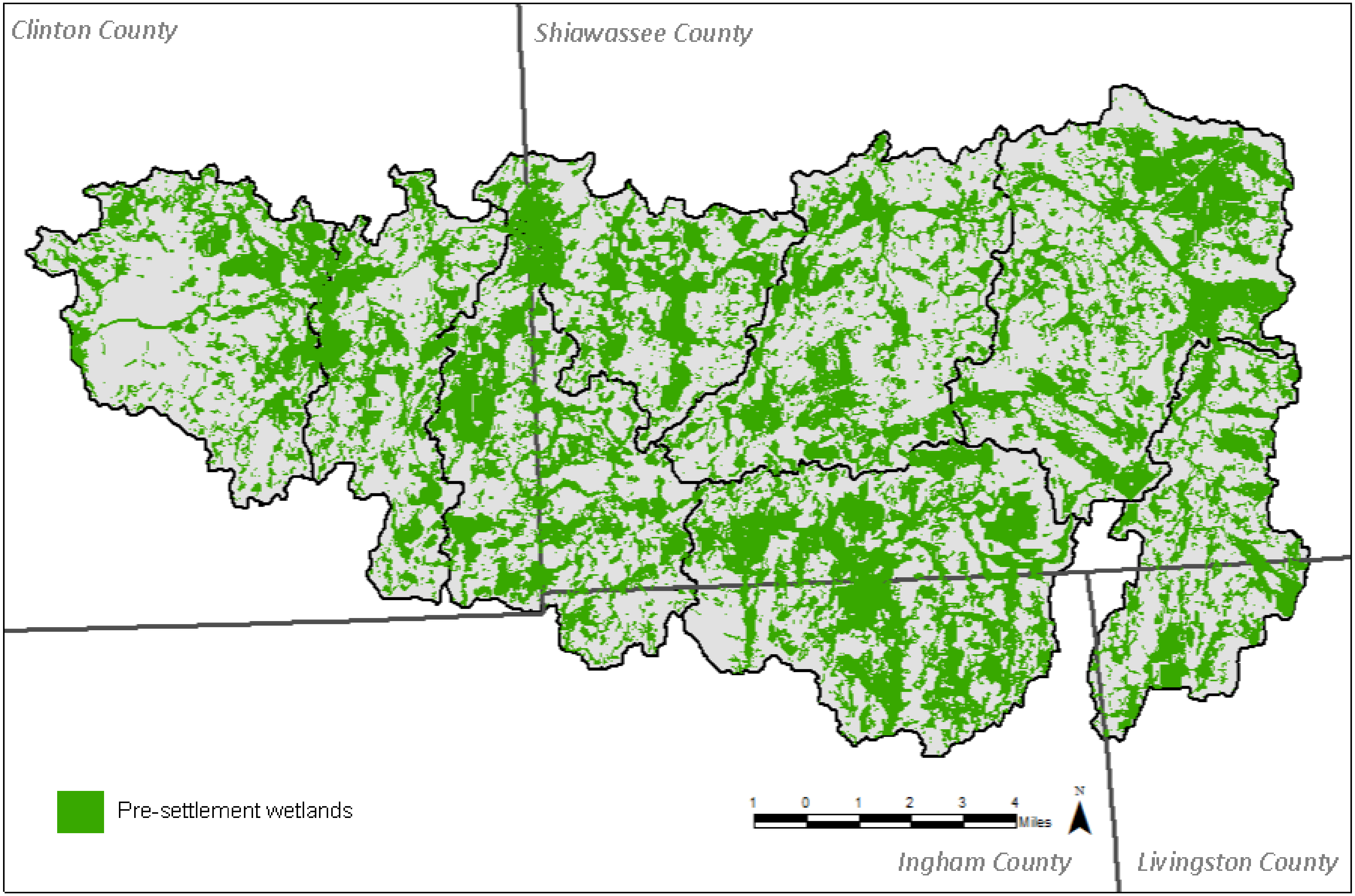

Figure 1.6 Pre-settlement wetlands in the Upper Looking Glass River Watershed (Source: MDEQ 2015).

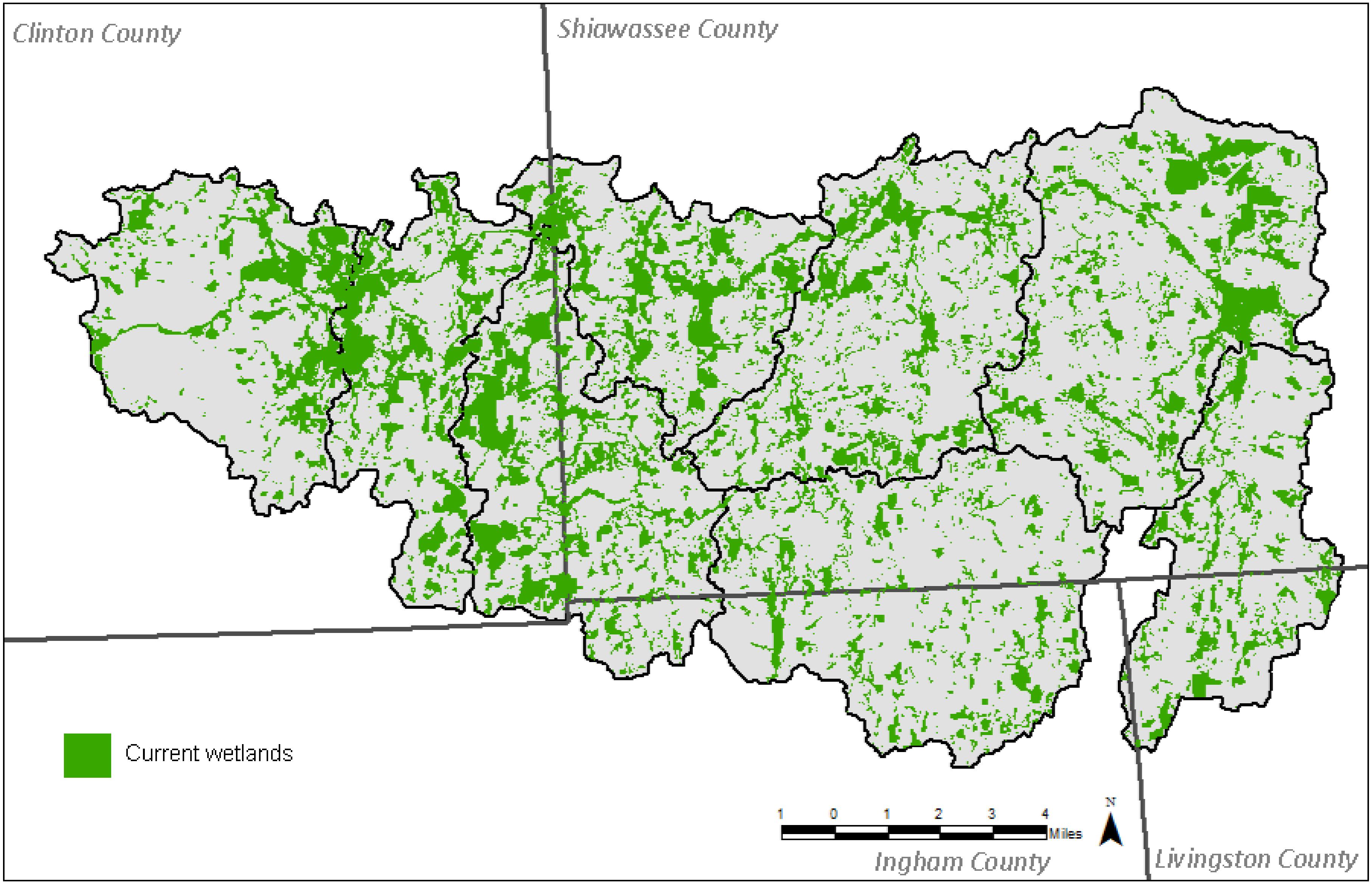

Figure 1.7 Current wetlands in the Upper Looking Glass River Watershed (Source: MDEQ 2015).

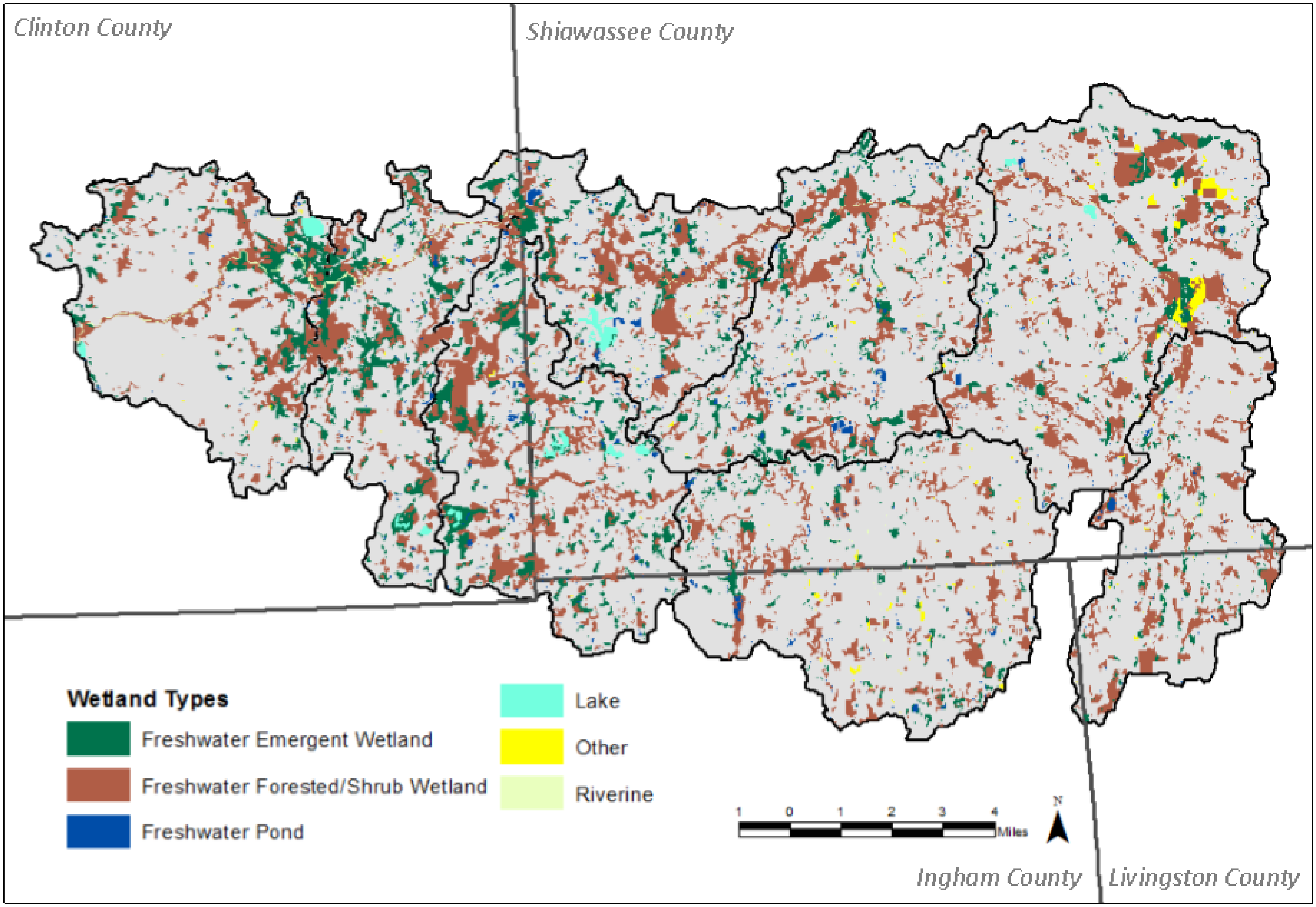

Figure 1.8 Wetland types in the Upper Looking Glass River Watershed (Source: US Fish and Wildlife Service 2017).

Wetland Type	General Description	Approximate Acres
Freshwater Forest/Shrub	Forested swamp or wetland shrub bog or wetland	17,500
Freshwater Emergent	Herbaceous marsh, fen, swale and wet meadow	6,800
Riverine	River or stream channel	1,500
Freshwater pond	Pond	600
Lakes	Lake or reservoir basin	350
Other Freshwater	Farmed wetland, saline seep and other miscellaneous wetland	300
Total		**27,050**

Table 1.7 Wetland Types in the Upper Looking Glass River Watershed (values are approximate).

1.4. Existing monitoring data

Over the years, habitat, macroinvertebrate communities, and water chemistry of the ULG have been assessed through a series of investigations by State agencies. In addition, for the development of the 2006 Phase II Looking Glass River Watershed Management Plan and the 2008 Upper Looking Glass River Watershed Management Plan, consulting firms, and the volunteer-based watershed group, Friends of the Looking Glass River, conducted multiple surveys. This section summarizes the findings from these analyses. Figure 1.10 depicts a map of existing monitoring data in the ULG.

1.4.1. Water Quality and Pollution Control in Michigan, Integrated Report – TMDL and 4c listings

The MDEQ performs routine water quality monitoring to assess the quality of waters of the state and determine if designated uses are being met. Based on this data, the MDEQ develops a water quality and pollution control in Michigan 2016 sections 303(d), 305(b), and 314 integrated report every two years. A waterbody is placed in Category 5 of this report when water quality data collected demonstrates a declining trend that is expected to cause that waterbody to not attain water quality standards (WQS) by the next listing cycle (2018). Assessment units placed in Category 5 form the basis for the Section 303(d) list Total Maximum Daily Load (TMDL) development schedule. A statewide TMDL was developed in 2013 for polychlorinated biphenyls (PCBs) impairing Fish Consumption. The 2016 Integrated Report lists 304.3 miles of stream in the ULG as having impairments due to PCBs in fish tissue and PCBs in the water column (MDEQ 2016).

If an assessed waterbody is considered threatened, it is placed in Category 4 of the Integrated Report. Under Category 4, available data and/or information indicates that at least one designated use is not being supported or is threatened, but a TMDL is not needed. According to the 2016 Integrated Report, 13.3 miles of the Clise Drain is listed as a Category 4c, meaning the impairment is not caused by a pollutant and the impairment is due to lack of flow or stream channelization (MDEQ 2016). Table 1.8 lists all the impaired waterbodies in the ULG.

For the development of the 2016 Integrated Report, several streams were not assessed or lacked sufficient information to determine a status of the designated use. Table 1.9 lists stream miles that were not assessed or lacked information for determination.

Watershed (Name and HUC)	Stream(s)	Impaired Use	Stream Miles	Cause
Headwaters Looking Glass 040500040601-01	Headwaters Looking Glass River	Fish Consumption	33.67	PCBs in Fish Tissue, PCBs in Water Column
Howard Drain 040500040602-01	Grub Creek and Looking Glass River	Fish Consumption	58.7	PCBs in Fish Tissue, PCBs in Water Column
Kellogg Drain 040500040603-02	Osborn Creek and Looking Glass River	Fish Consumption	21.47	PCBs in Fish Tissue, PCBs in Water Column
Kellogg Drain 040500040603-03	Perry Drain No. 2 and Austin Drain (Kellogg Drain)	Fish Consumption	15.56	PCBs in Fish Tissue, PCBs in Water Column
Buck Branch – Vermillion Creek 040500040604-01	Buck Branch and Vermillion Creek	Fish Consumption	42.02	PCBs in Fish Tissue, PCBs in Water Column

Buck Branch – Vermillion Creek 040500040604-02	Vermillion Creek & tributaries downstream to Hidden Lake	Fish Consumption	17.47	PCBs in Fish Tissue, PCBs in Water Column
Vermillion Creek 040500040605-03	Looking Glass River and Vermillion Creek	Fish Consumption	35.07	PCBs in Fish Tissue, PCBs in Water Column
Leisure Lakes – Looking Glass River 040500040606-02	Looking Glass River	Fish Consumption	19.15	PCBs in Fish Tissue, PCBs in Water Column
Mud Creek – Looking Glass River 040500040607-01	Looking Glass River and Mud Creek	Fish Consumption	23.74	PCBs in Fish Tissue, PCBs in Water Column
Turkey Creek Drain – Looking Glass River 040500040609-01	Ives Drain and Looking Glass River	Fish Consumption	24.13	PCBs in Fish Tissue, PCBs in Water Column
Turkey Creek Drain – Looking Glass River 040500040609-01	Clise Drain	Fish Consumption	13.25	PCBs in Fish Tissue, PCBs in Water Column
Turkey Creek Drain – Looking Glass River 040500040609-01	Clise Drain	Warmwater Fishery	13.25	Direct Habitat Alterations and Other flow regime alterations

Table 1.8 Impaired Reaches in the Upper Looking Glass River Watershed listed on the 2016 Integrated Report (Source: MDEQ 2016).

Designated Use	2016 Integrated Report Status	Stream Miles
Total Body Contact*	Not Assessed	286.37
Partial Body Contact*	Not Assessed	286.37
Total Body Contact*	Insufficient Information	17.47
Partial Body Contact*	Insufficient Information	17.47
Warmwater Fishery	Not Assessed	180.86
Warmwater Fishery	Insufficient Information	74.95
Indigenous Aquatic Life and Wildlife	Insufficient Information	94.56

*Table 1.9 Upper Looking Glass River Watershed Streams not assessed or lacking information from the 2016 Integrated Report (Source: MDEQ 2016). *Although streams were not assessed or lacked sufficient information, waterbodies do meet MDEQ criteria for impaired status due to E. coli.*

1.4.2. Statewide Michigan PCB Total Maximum Daily Load, August 2013 (LimnoTech 2013)

Section 303(d) of the Federal Clean Water Act and the United States Environmental Protection Agency's (USEPA) Water Quality Planning and Management Regulations (Title 40 of the Code of Federal Regulations [CFR] Part 130) requires states to develop TMDLs for all Category 5 water bodies that are not meeting WQS for a specific pollutant. These water bodies are included on a state's Section 303(d) list. The TMDL process establishes the allowable loadings of a pollutant to a water body based on the relationship between pollution sources and water quality conditions of a water body. This allowable loading represents the maximum quantity of a pollutant that the water body can receive without exceeding WQS. The TMDL process provides states with the basis for establishing water quality-based controls, which provide the pollutant reductions necessary for a water body to attain WQS.

The 2012 Sections 303(d), 305(b), and 314 Integrated Report identified 22,115 miles of rivers and streams and 144,692 acres of inland lakes and reservoirs as not supporting their designated use due to high concentrations of PCBs in fish tissue in Michigan. An additional 49,691 miles of rivers and streams and 614 acres listed in the Integrated Report are not supporting their designated use due to PCBs in the water column. The scope of this PCB TMDL covers inland water bodies in the state of Michigan, primarily impacted by atmospheric depositions of PCBs. The entirety of the Upper Looking Glass River Watershed is impacted by PCBs and therefore falls under this TMDL.

PCBs are a class of synthetic, chlorinated organic chemicals produced mainly for their excellent insulating capabilities and chemical stability. They were produced in the form of complex mixtures for industrial use in the U.S. from 1929 to 1977, mostly by the company, Monsanto (De Voogt and Brinkman, 1989). PCBs were used in the U.S. for a number of applications, primarily closed system and heat transfer liquids, plasticizers, hydraulic fluids and lubricants. In Michigan, PCBs were used often in the production of recycled carbonless copy paper.

The USEPA banned production of PCBs in 1979 due to their toxic properties. PCBs have been shown to cause adverse health effects, including cancer, impacts to the nervous, immune, reproductive, and endocrine systems, among other adverse effects. PCBs are relatively persistent, hydrophobic, and accumulate in suspended and bottom sediments of aquatic systems. In addition, because of their chemical properties, PCBs concentrate in fatty tissues of organisms and cause bioaccumulation of the chemical in living tissues. Because the industrial use of PCBs has been banned, the primary sources of PCBs to water are historical sediment contamination and ongoing atmospheric deposition.

Overall, PCB concentrations in fish tissue and air are decreasing in Michigan. Still many of Michigan's surface waters are impaired due to PCBs and consequently do not support the other indigenous aquatic life and wildlife designated use and/or the fish consumption use. For this TMDL, a single statewide average was calculated for reduction percentage of PCBs. The fish tissue residue value of 0.023 mg/kg (wet weight) in edible fish portions was utilized as the target standard for achievement. Lake trout was chose as the target fish species used to determine what levels PCBs in fish tissue would need to be reduced in order to meet the TMDL target. Lake trout were chosen because they are a native species, a trophic level 4 fish, and preferred sport fish species in Michigan. In addition, lake trout have among the highest PCB issue levels because of their location towards the top of the food chain, high lipid content, and long life, increasing their potential for high bioaccumulation of toxic contaminants.

To achieve the TMDL described in this report, a 94 percent reduction in year 2010 atmospheric gas phase PCB concentrations would be required to meet fish tissue target of 0.023 mg/kg. PCBs are synthetic and there are no natural sources. Most PCBs that remain in the environment are stored in sediment or tissue and introduced into water bodies through outdated or illegal landfills and scrap yards and leaks or explosions of electrical equipment and other equipment that still contain PCBs. PCBs can also be reintroduced to water bodies through the movement of contaminated sediments, volatilization from water or soil, wet and dry deposition and re-volatilization. There are also several facilities in Michigan with permits that authorize the release of PCBs into the air.

Implementation measures to achieve the targeted TMDL include, observe reductions in atmospheric PCB concentration, cleanup of legacy sources, restriction of landfill disposal of PCBs, regulations governing transport of PCBs, and federal toxic substances control act. Post-TMDL monitoring will include components of the MDEQ quality monitoring including, fish contaminant monitoring program, water chemistry monitoring, and water body National Pollutant Discharge Elimination System (NPDES) monitoring program. Additional monitoring will be conducted through legacy site cleanup monitoring and atmospheric PCB monitoring through the Great Lakes Integrated Atmospheric Deposition Network Program.

See Appendix 3 for full report.

1.4.3. Biological and Water Chemistry Surveys of Selected Stations in the Looking Glass River Watershed Shiawassee and Clinton Counties, Michigan July and September 2012 (MDEQ 2013)

In 2013, as part of a five-year watershed review cycle, staff from the Department of Environmental Quality (DEQ) Water Resources Division (WRD) conducted a qualitative biological assessment of the Looking Glass River Watershed in Clinton and Shiawassee Counties. Selected water bodies were assessed in July and September 2012 using the Surface Water Assessment Section Procedure 51 for wadeable streams and visual assessment.

For this survey, five of the 10 sites in the Looking Glass River Watershed evaluated for aquatic habitat and macroinvertebrate community evaluations fell within the ULG. Additionally, four sites were assessed visually only. Three of those sites fell within the ULG.

Macroinvertebrate communities in the ULG sites scored at the low end of acceptable and glide/pool habitat was rated as marginal to good. Substrates consisted of silt. Large woody debris was present and large amounts of floating macrophytes were observed. Visual assessments showed that previously grazed areas no longer had livestock present.

Two maintained county drains were also surveyed in the ULG, Vermillion Creek, and Osborn Creek. Macroinvertebrates in Vermillion Creek scored at the low end of acceptable and were dominated by one taxon indicating environmental stress. Algae covered the bottom of the stream and deposits of fine sediment were up to two feet deep burying most woody debris. In addition to agricultural pressure, a golf course could also be a source of nutrients contributing to the large amount of algae present. In Osborn Creek, macroinvertebrates scored acceptable and silts dominated the substrate with clay and some marl. Riparian habitats were mowed and herbicides applied. Visual assessment of nutrient concerns were inconclusive due to lack of water present.

Table 1.10 displays biological assessment results. See Appendix 4 for the full report.

1.4.4. Biological and Water Chemistry Surveys of Selected Stations in the Looking Glass River Watershed Shiawassee and Clinton Counties, Michigan July and August 2007 (MDEQ 2008).

MDEQ Surface Water Assessment Staff assessed biological, chemical, and physical habitat conditions of the Looking Glass River Watershed in Clinton and Shiawassee Counties in July and August 2007. Macroinvertebrate communities and physical habitat were qualitatively assessed at 23 stations and fish communities were assessed at one of those stations using the Great Lakes and Environmental Assessment Section (GLEAS) Procedure 51 for wadeable streams. Twelve of these sites fall within the ULG.

In the upper portion of the watershed, the Looking Glass River is a straightened and dredged channel. Riffle/run habitat was marginal, glide/pool habitat was marginal to good, and macroinvertebrates scored from marginal to the low end of marginal. This upper portion of the river was highly incised and flashy flows, sedimentation, erosion, and large amounts of silt deposits were observed. Woody debris was either lacking or embedded.

Seven tributaries were assessed at nine sites within the ULG. Three of the tributaries were managed agricultural ditches. These sites were channelized, lacked woody debris, and had minimal grass in the riparian zone. Algae and/or duckweed and extensive siltation were observed, yet macroinvertebrates scored acceptable. Three of the tributaries fell within wetlands and two sites were in a wooded floodplain. At these sites, macroinvertebrates scored from the low end of acceptable to acceptable and glide/pool habitat rated as good. Silt had accumulated to two feet in the channels and wooded floodplain sites were highly incised with eroded streambanks. One tributary was observed as having a maintained yard to the stream edge. At this survey location, woody debris was lacking, riffle/run habitat was good, and the macroinvertebrate community rated acceptable.

Table 1.10 displays biological assessment results. See Appendix 5 for the full report.

1.4.5. A Biological Assessment of Stony Creek, Goose Creek and the Looking Glass River, Clinton, Ionia, and Shiawassee Counties, Michigan June 2002 (MDEQ 2003)

Qualitative biological sampling was conducted on the Maple River and Looking Glass River as part of the Upper Grand River biological survey by the Surface Water Quality Assessment Section (SWQAW) in June and August 2002. The objective of the survey was to document the effects of land use practices and nonpoint and point source discharges on the biological, physical, and chemical parameters of the watershed. Macroinvertebrate communities and physical habitat were qualitatively assessed at 9 stations in the Looking Glass River Watershed using the GLEAS Procedure 51 for wadeable streams.

The macroinvertebrate community met water quality standards at all stations. Two stations were sampled to determine effects of the Southern Clinton County Authority Wastewater Treatment Plant. No evidence of impact from the facility was concluded. Habitat rated as slightly to moderately impaired with one site located on Grub Creek scoring poorly. At this channelized stream site, natural riparian vegetation was absent, flow was flashy, and streambed was highly embedded with sand. At all locations, substrates were dominated by sand and silts likely due to lack of topographic relief and low flows. Water chemistry and sediment data did not indicate any parameters exceeding water quality standards.

Table 1.10 displays biological assessment results for all surveys. See Appendix 6 for the full report.

Site #	Stream Name	Year Surveyed	Habitat Evaluation		Macroinvertebrates	
			Rating	Score	Rating	Score
1	Looking Glass River Colby Lake Rd	2012	Marginal	101	Acceptable	1
2	Looking Glass River Babcock Rd	2012	Good	144	Acceptable	-3
8	Vermillion Creek Beardslee Rd	2012	Marginal	73	Acceptable	-4
9	Vermillion Creek Old 78 Rd	2012	Good	114	Acceptable	3
10	Osborn Creek Shaftsburg Rd	2012	Marginal	99	Acceptable	0
SV-1	Looking Glass River Old State Rd	2012	-	-	-	-
SV-2	Unnamed Tributary to Looking Glass River Colby Rd	2012	-	-	-	-
SV-3	Unnamed Tributary to Looking Glass River Colby Rd	2012	-	-	-	-
1	Grub Drain Cork Rd	2007	Good	121	Acceptable	0
2	Unnamed Tributary Winegar Rd	2007	Marginal	103	Acceptable	-4
3	Clise Drain Cutler Rd	2007	Marginal	60	Acceptable	-2
4	Mud Creek Angle Rd	2007	Good	126	Acceptable	-2
5	Kellogg Drain Winegar Rd	2007	Marginal	80	Acceptable	1
6	Vermillion Creek Lansing Rd (Old 78)	2007	Good	110	Acceptable	1
7	Vermillion Creek Peacock Rd	2007	Good	116	Acceptable	1
8	Vermillion Creek Cutler Rd	2007	Good	143	Acceptable	-3
9	Looking Glass River Godfrey Rd	2007	Marginal	96	Acceptable	2

10	Looking Glass River Cork Rd	2007	Good	121	Acceptable	-1
11	Looking Glass River Morrice Rd	2007	Marginal	87	Acceptable	2
12	Looking Glass River Colby Lake Rd	2007	Marginal	95	Acceptable	-3
7	Grub Creek Britton Rd	2002	Poor	52	-	-
8	Perry Drain Perry Drain #2	2002	Marginal	78	Acceptable	-4
9	Looking Glass River Beardslee Rd	2002	Marginal	93	Acceptable	0
10	Vermillion Creek Peacock Rd	2002	Good	146	Acceptable	4
11	Looking Glass River Upton Rd	2002	Good	112	Acceptable	2

Habitat Scoring		Macroinvertebrate Scoring	
Poor <56	Good 105-154	Poor <-4	Excellent > +4
Marginal 56-104	Excellent >154	Acceptable -4 to +4	

Table 1.10 Upper Looking Glass MDEQ Biological Survey Results for years 2002, 2007, and 2012.

1.4.6. Biological and Nutrient Studies of Perry #2 and Kellogg Drain

Two studies were conducted on Perry Drain #2 to determine nutrient loads effects. In the spring of 2002, a nutrient study was conducted to determine if the nutrient load from the Countryside Wastewater Storage Lagoon (WWSL) was being retained within the stream or if it was being transported downstream without impacting water quality A summary of this study indicates that the phosphorous from the effluent is retained within the drain (MDEQ 2003).

A biological and nutrient survey was also conducted on the Perry Drain #2 in July 2001. The purpose was to determine if discharges from the Perry WWSL and Countryside Wastewater Storage Lagoon were having an impact on water quality in Perry #2 Drain, Kellogg Drain, or the Looking Glass River. This survey described the Perry Drain #2 as impaired due to excessive nutrients, which was exaggerated by a loss of habitat due to channel alteration and disruption of the natural hydrology. Dense aquatic vegetation was present in portions of the stream with slow flows and full sunlight. Nutrient concentrations were similar to effluent dominated systems and indicated that the stream’s nutrient assimilation capacity may have been reached or exceeded (MDEQ 2001).

Reports of the 2001 and 2002 studies can be found in Appendix 7 and Appendix 8, respectively.

1.4.7. Historical Survey Data Review

A review of biota populations and habitat was presented in the Looking Glass River Watershed Management Plan developed for Greater Lansing Regional Committee (GLRC) on Phase II Nonpoint Source Pollution Prevention (Tetra Tech 2007).

A 1975 study was conducted by the MDNR. Macroinvertebrate populations and diversity were rated as good to excellent near Laingsburg. Populations declined as the river flowed west outside of the project area through DeWitt. Populations and diversity downstream of DeWitt were significantly impaired, lacking intolerant species all together. However, once the river flowed past DeWitt, populations rebounded (Evans 1976).

MDNR also investigated the Looking Glass River as part of a 1992 study. Habitats were rated as poor to severely impaired near Laingsburg while macroinvertebrates were in fair condition. The study suggested that macroinvertebrates, fish populations, and diversity fluctuated between moderately and slightly impaired throughout the entire Looking Glass River main channel. Sediment deposits were a significant factor in habitat loss for macroinvertebrates in the upstream reaches. The channel appeared to become more stable between Laingsburg and DeWitt. Several small gravel pits were found in this reach with at least one discharging highly turbid stormwater. Vermillion Creek biota and habitat were also assessed during this study. Habitat here ranged from poor at Beardslee Road to good at Woodbury Road (Scott 1993).

A 2002 MDEQ study collected macroinvertebrate and physical habitat data at sites on the Looking Glass River and Vermillion Creek. Macroinvertebrates were found to be acceptable to excellent and habitat was moderately impaired upstream of DeWitt (Roush 2003).

In 2002 and 2003, the Friends of the Looking Glass River (FOLG) conducted volunteer monitoring in the Looking Glass River, Vermillion Creek, Remy-Chandler Drain, Clise Drain, and Summers Drain. All were shown to have fair to good stream quality as indicated by macroinvertebrate sampling. Adjacent land use indicated water quality degradation sources, including channelization, bank, and shoreline erosion, and agricultural activities (MDEQ 2005).

1.4.8. 2008 Upper Looking Glass River Watershed Management Plan Assessments

For the development of the 2008 Upper Looking Glass River Watershed Management Plan, the Friends of the Looking Glass surveyed 25 miles of the main stem of the river and conducted a qualitative assessment of the riverbanks, noting instances of erosion. Using this assessment, Wetland Coastal Resources (WCR) staff evaluated 115 high risk sites using the bank erosion hazardous index (BEHI) model (Rosgen 2001). The majority of erosion problems were located along previously channelized portions of the river. These channelized areas have fine-textured substrates and high, over-steepened banks that rise above bankfull elevation (Public Sector Consultants 2008).

WCR also conducted sampling of macroinvertebrates, fish, and physical habitat in the fall 2006. Macroinvertebrates and physical habitat were sampled at ten sites, while fish species were sampled at five sites using the GLEAS, Procedure 51. Macroinvertebrate communities were rated from poor to acceptable, with one site on the river receiving a positive score. Low macroinvertebrate ratings correspond to the accumulation of sediment at the sample points. All but one site rated as acceptable for fish species. The Clise Drain site received a poor rating (Public Sector Consultants 2008).

A Long-term hydrologic impact assessment (L-THIA) modeling analysis was also utilized to identify critical areas for the development of the 2008 WMP. The L-THIA used existing climate and soil data, along with current or future land use scenarios, to predict changes in the quantity and quality of water in the watershed. Each sub-watershed was analyzed based on existing land-use, and 10- and 20-year build-out scenarios were produced. The analysis resulted in a side-by-side comparison of each sub-watershed and allowed sub-watersheds to be prioritized according to impact on existing water quality (Public Sector Consultants 2008).

The L-THIA analysis determined existing land use in the Buck Branch Watershed (HUC 0405000406006) as having the greatest impact on water quality. According to the L-THIA model, this agricultural-dominated sub-watershed contributes the largest average runoff and most fecal coliform, nitrogen, phosphorus, and suspended solids. The model showed that the Kellogg Drain Watershed (HUC 0405000406004) and Mud Creek Watershed (HUC0405000406011) contribute the most heavy metals and fecal strep. The Looking Glass above Mud Creek Watershed (HUC 040500040601) appears to have the least impact. The 10- and 20-year models suggest the dominant change in land use will be from agriculture to residential. Little to no change is expected in average runoff volume and minor increases in heavy metals will occur. The largest change in water quality is expected from the volume of biochemical oxygen demand, chemical oxygen demand, oil, grease, and fecal strep (Public Sector Consultants 2008).

1.4.9. 2006 Looking Glass River Watershed Management Plan Assessments

Several assessments were conducted for the development of the 2006 Looking Glass River Watershed Management Plan developed for GLRC on Phase II (Tetra Tech 2007). In 2001, the FOLG conducted a Road-Stream Crossing survey visually assessing 160 road-stream crossings along the Looking Glass River from Shiawassee County to the confluence with the Grand River. The river assessment identified bottom substrate, bank vegetation type, land use, and potential pollution sources (Tetra Tech 2007). From this assessment, a list of recommended actions was developed and included:

1. Improve canoeing and recreation
2. Streambank stabilization
3. Stabilize disturbed ground
4. Decrease embeddedness
5. Increase shade cover
6. Establish 30 foot riparian buffer
7. Establish 100 foot riparian buffer
8. Illicit Discharge Elimination Program (IDEP) investigations and trash clean up
9. Other actions

In addition, for the development of the 2006 plan, an upland field assessment of the urbanized portion of the watershed, visual observation along Vermillion Creek, and a Frog and Toad survey were conducted.

Technical staff from Tetra Tech conducted field assessments to verify sources and causes of pollutants identified during the FOLG road-stream crossing survey. Field methods used for conducting upland field investigations were developed by the Center for Watershed Protection. Several assessments, including a Neighborhood Source Assessment, Pervious Area Assessment, Hotspot Assessment, and Street and Storm Drain Assessment were conducted. From these, a list of potential solutions and retrofit projects were suggested to lessen the impact of development and urbanization of the Watershed (Tetra Tech 2007).

Visual assessments were also conducted at three road-stream crossings on Vermillion Creek. A riparian buffer was observed in the upper end of the stream, generally narrowing as land use became predominately agricultural. A single family residential development was noted to have minimal buffer, offering an opportunity for homeowner education. In 2004, MDEQ cited pathogens in Vermillion Creek. While no specific sources of pathogens were observed, poor agricultural practices may be the cause in the upstream portions of Vermillion Creek (Tetra Tech 2007).

The Frog and Toad Survey was conducted by 12 volunteers who surveyed four sections within the Looking Glass River Watershed. The results included Tri-County area data from the MDNR going back to 1996 and were summarized in the 2006 Looking Glass River WMP and follow the expected frog calls for Zone 1 in Michigan, found in Figure 1.9.

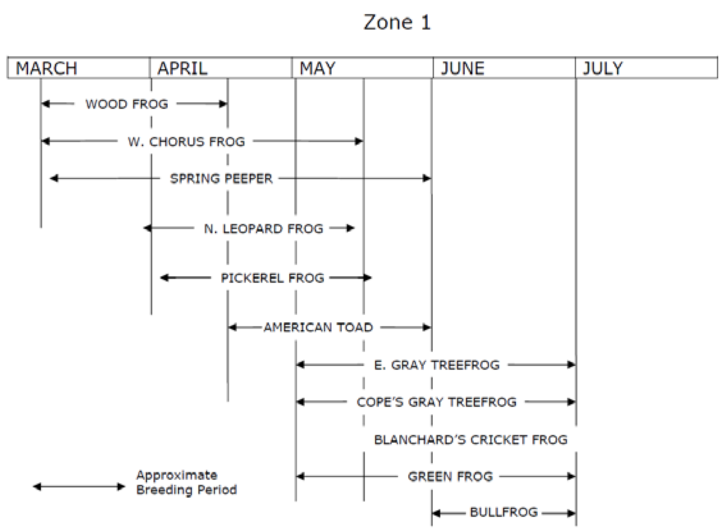

Figure 1.9 Calling Calendar for Frogs and Toads in Michigan.

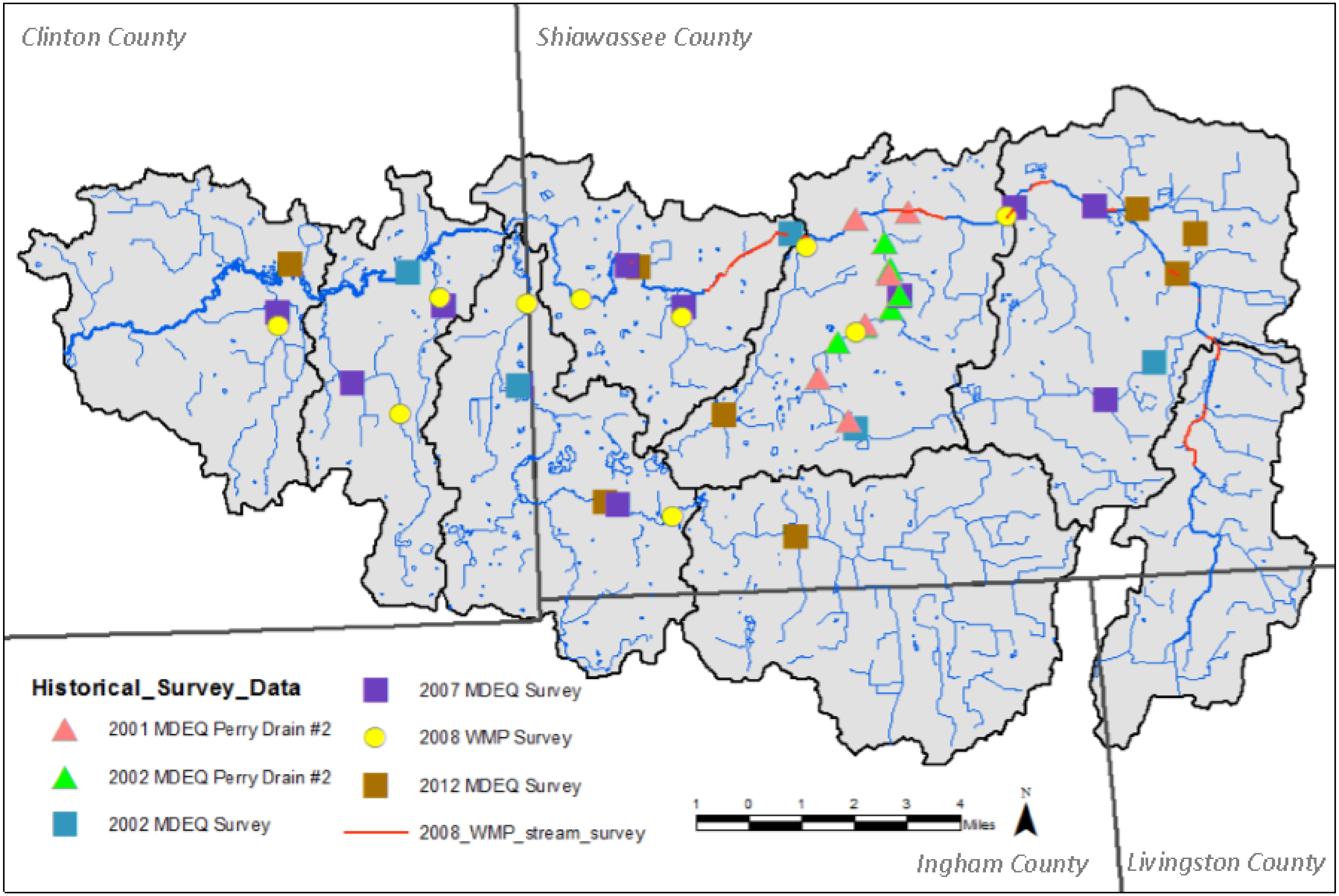

Figure 1.10 Historical Survey Data in the Upper Looking Glass River Watershed.

Section 2 Watershed Conditions

2.1. Designated and Desired Uses

Water bodies have designated uses that are defined by the State of Michigan (State), as well as certain desired uses that vary from location to location. Local residents, industries, tourists, and recreational users involved with that particular water body will decide these desired uses.

2.1.1 Designated Uses

The State has developed Water Quality Standards (WQS) under Part 4 of the Administrative Rules issued pursuant to Part 31 of the Natural Resources and Environmental Protection Act (1994 PA 451, as amended). Rule 100 (R323.1100) of the WQS states that all surface waters of the State are designated for, and shall be protected for, all of the following uses:

- Agricultural use
- Coldwater fishery
- Fish consumption
- Industrial water supply
- Navigation
- Other indigenous aquatic life and wildlife
- Partial body contact recreation
- Public water supply at the point of intake
- Total body contact recreation between May 1 and October 31
- Warmwater fishery

Designated uses are intended to protect public health and welfare, enhance and maintain water quality, protect natural resources, and meet state and federal law requirements.

Current water quality impairments and specific threats to water quality must be identified and noted to create a focused Watershed Management Plan (WMP) for addressing nonpoint source (NPS) pollutants. The status of a designated use in a watershed can be unimpaired, impaired, threatened, or under review/unknown. Designated uses are considered impaired if the water does not meet the State's WQS. The MDEQ does not currently recognize threatened as a category of designated use status. Therefore, for the purpose of this WMP, designated uses are considered threatened when WQS may not be met in the future. Table 2.1 describes designated use impairments by Sub-Watersheds in the ULG. Pollutants and sources are identified as known (k) if they were documented and measured during any inventory methods. Pollutants and sources were identified as threatened (t) if the conditions were documented as similar to a known and measured occurrence in the watershed or similar watersheds

The following reasoning was used to determine the designated use status:

- Agriculture: met in all sub-watersheds because water was determined to be safe and available for irrigation, livestock watering and produce spraying.
- Navigation: if the channel/ditch is wide and deep enough to canoe, navigation is possible. Areas were threatened due to logjams and obstructions identified during stream inventories.

- Warmwater Fishery: threatened due to observed habitat and substrate alterations during stream inventories.
- Other Indigenous Aquatic Life and Wildlife: Impaired due to poor macroinvertebrate community ratings during Biological Assessment conducted by MDEQ. Threatened if conditions were observed as being similar to known impaired reaches during stream inventories.
- Partial Body Contact Recreation: all sub-watersheds meet the MDEQ criteria for impaired due to water samples collected during inventory exceeding water quality standard (1,000 cfu/100 mL).
- Total Body Contact Recreation: all sub-watersheds meet the MDEQ criteria for impaired between May 1 and October 1 due to water samples collected during inventory exceeding 30-day mean values for water quality standard (130 cfu/mL) and contain more than a maximum of 300 cfu/mL.
- Coldwater Fishery: no streams are designated as coldwater fishery.
- Public Water Supply: not a use at this time.
- Industrial Water Supply: not a use at this time.
- Fish Consumption: all streams are impaired due to presence of PCBs in water column and fish tissue.

Sub-Watershed	Total Body Contact Recreation	Partial Body Contact Recreation	Navigation	Agriculture	Warmwater Fishery	Other Indigenous Aquatic Life and Wildlife	Fish Consumption
Headwaters	LI* (s) (bacteria)	LI* (s) (bacteria)	M (k)	M (k)	T* (s) (DHA, OFA)	T* (s) (Sediment)	I** (k) (PCBs)
Howard Drain	LI* (s) (bacteria)	LI* (s) (bacteria)	M (k)	M (k)	T* (s) (DHA, OFA)	T* (s) (Sediment)	I** (k) (PCBs)
Kellogg Drain	LI* (s) (bacteria)	LI* (s) (bacteria)	M (k)	M (k)	T* (s) (DHA, OFA)	T* (s) (Sediment)	I** (k) (PCBs)
Buck-Branch-Vermillion Creek	LI*‡ (s) (bacteria)	LI*‡ (s) (bacteria)	M (k)	M (k)	T* (s) (DHA, OFA)	T* (s) (Sediment)	I** (k) (PCBs)
Vermillion Creek	LI* (s) (bacteria)	LI* (s) (bacteria)	M (k)	M (k)	T* (s) (DHA, OFA)	T* (s) (Sediment)	I** (k) (PCBs)
Leisure Lakes	LI* (s) (bacteria)	LI* (s) (bacteria)	M (k)	M (k)	T* (s) (DHA, OFA)	T* (s) (Sediment)	I** (k) (PCBs)
Mud Creek	LI* (s) (bacteria)	LI* (s) (bacteria)	M (k)	M (k)	T* (s) (DHA, OFA)	T* (s) (Sediment)	I** (k) (PCBs)
Turkey Creek	LI* (s) (bacteria)	LI* (s) (bacteria)	M (k)	M (k)	I (K) OFA, DHA	M (k)	I** (k) (PCBs)

M = Met or unimpaired | I = Impaired | T = Threatened | k = Known | s = Suspected | DHA = Direct Habitat Alterations

LI = Likely Impaired, ie meets the MDEQ criteria for impairment

PCBs = polychlorinated biphenyls | OFA = Other Flow Regime Alterations

*Streams in this sub-watershed were not assessed for the development of the 2016 MDEQ Integrated Report

**Statewide TMDL developed for 22,115 miles of rivers and streams and 144,692 acres of inland lakes and reservoirs as not supporting their designated use due to high concentrations of polychlorinated biphenyls (PCBs) in fish tissue.

‡Insufficient information for streams in this sub-watershed to assess designated use for the 2016 MDEQ Integrated Report.

Table 2.1 Designated use impairments for the Upper Looking Glass River Watershed.

Provided below is a brief description of each of the State-authorized designated uses.

Agricultural

Surface waters used for irrigation, livestock watering, and produce spraying must be consistently available and safe. In addition to water use on farms, agricultural water supply includes irrigation for maintaining vegetative growth in nurseries, parks, and golf courses. Water resources should be free of pathogens and chemicals that could pose a health risk to livestock and humans. This designated use is currently being met.

Warmwater Fishery

A warmwater fishery is defined by the Michigan Department of Environmental Quality (MDEQ) as a water body that is capable of supporting fish species that thrive in relatively warm water (temperatures between 68°F and 77°F [Creal and Wuycheck 2002]) including bass, pike, walleye, and pan fish. Dissolved Oxygen (DO) is a crucial component for a healthy warmwater fishery. Surface water dissolved oxygen levels should be 5 mg/l or higher for sufficient fishery habitat.

This designated use is currently impaired in HUC 040500040609, including Clise Drain due to Direct Habitat Alterations and Other flow regime alterations (MDEQ 2016). Stream reconnaissance inventory data supports the assumption that this designated use is not being met in many of the UMC streams (see Section 3.1.3). It is advised to investigate the listing of other streams in the UMC with impairment status on the Michigan Integrated Report. Furthermore, Best Management Practices (BMPs) should be adopted to improve this designated use.

Coldwater Fishery

A coldwater fishery has summer water temperatures below 60°F and is able to support natural or stocked populations of trout. This designated use is currently not applicable.

Other Indigenous Aquatic Life and Wildlife

In addition to fish, other aquatic life and wildlife in the ecosystem should be considered in all management strategies. A stable and healthy habitat supports populations of wildlife that provide outdoor recreational opportunities like fishing, bird watching, and hunting. Healthy habitats have water conditions that are capable of supporting native plant and animal species. Swamps and fens adjacent to the Looking Glass River support many species of important wildlife and plants. During the stream reconnaissance, instances were documented that presented conditions where this designated use would not be met in many of the ULG streams (see Section 3.1.3). It is advised to investigate the listing of other streams in the ULG with impairment status on the Michigan Integrated Report. Furthermore, BMPs will be required to restore this designated use.

Partial Body Contact Recreation

Water-related activities, like fishing and boating, that do not require full body immersion are referred to as Partial Body Contact recreation. Water quality must meet standards of equal to or less than 1,000 counts/100 mL of *E. coli* for recreational uses (MDNRE, 1999). A site on Vermillion Creek was listed on the MDEQ 303(d) 2006 report. The problem creating the impairment was a septic discharge pipe. The pipe was removed and the impairment was documented as corrected by the Shiawassee County Health Department. The MDEQ monitored in the area in late summer 2007, and found no indication of a septic discharge pipe and the site was removed from the 303(d) list (Public Sector Consultants 2008). However, this designated use was not assessed or lacked sufficient information for determining attainment status on the 2016 Michigan Integrated Report.

Investigations were conducted as part of the development of this WMP involving the use of scent-trained canines and water quality analysis. These canines used are the first ever trained to identify human waste in surface water. Surface water samples from 46 streams analyzed by scent-trained canines during an investigation indicated that human waste was present in 48% of the samples. *E. coli* analysis during the canine investigation found water exceeded WQS for Partial Body Contact Recreation in 37% of samples (see Section 3.1.1). In addition, a six week repetitive water sampling series found the exceedances of the WQS for PBC at all 17 stream locations surveyed (see Section 3.1.2) meeting MDEQ's criteria as impaired.

Total Body Contact Recreation

Total Body Contact recreation refers to any activity that will result in the submersion of the head (e.g., swimming). Safety concerns arise when the eyes and nose are submerged, and the possibility of ingesting the water exists. WQS for total body contact recreation must be met between May 1 and October 31. During this time, *E. coli* must be at or below 130 counts per 100 mL, as a 30-day geometric mean. In addition, at no time shall waters of the state protected for TBC contain more than a maximum of 300 *E. coli*/100 mL. This designated use was not assessed or lacked sufficient information for determining attainment status on the 2016 Michigan Integrated Report.

Evidence that this designated use is not being met was discovered through the investigations conducted as part of the WMP inventory process. Surface water samples from 50 streams analyzed by scent-trained canines indicated that human waste was present in 48% of the samples. *E. coli* analysis during the canine investigation found water exceeded WQS for Total Body Contact Recreation in 35% of samples (see Section 3.1.1). In addition, a six week repetitive water sampling series found the 30-day geometric mean exceeded the WQS for Total Body Contact recreation at all seventeen stream locations surveyed with averages ranging from 682-4,400 cfu/mL (see Section 3.1.2).

Navigation

Waterways that provide adequate depth and width for recreational canoeing and kayaking must maintain open, navigable conditions. This designated use is currently being met.

Industrial Water Supply

Industry depends on large quantities of cool, clean water for material washing or as a coolant. This designated use is currently being met.

Public Water Supply at the Point of Intake

Municipal water supplies must have safe and adequate supplies of surface water. Water quality must be sufficient for conventional water treatment to produce safe and palatable water for human consumption and food processing. This designated use is not applicable as there are no public water supplies at the point of intake in the Watershed.

Fish Consumption

The State of Michigan also considers Fish Consumption a designated use for all waterbodies. For all streams within the ULG the Fish Consumption designated use is considered non-attaining due to elevated levels of PCB's found in several locations. There is a generic, statewide, mercury-based fish consumption advisory that applies to all of Michigan's inland lakes. See Section 1.4.1 for a summary of the statewide TMDL for PCBs or Appendix 3 for the full report. See Table 2.2 for current fish consumption advisories in the Looking Glass River.

Type of Fish	Chemical of Concern	Size of Fish (inches)	MI Servings per month*
Brown Trout	Dioxin	Any Size	Limited
Burbot	PCBs	Any Size	12
Carp	Mercury	Any Size	4
Black Crappie	Mercury	Any Size	4
Bluegill	Mercury	Any Size	8
Carp	PCBs	Any Size	2
Catfish	PCBs & Mercury	Any Size	4
Largemouth Bass	Mercury	Under 18"	2
		Over 18"	1
Muskellunge	Mercury	Any Size	1
Northern Pike	Mercury	Under 30"	2
		Over 30"	1
Rock Bass	Mercury	Any Size	4
Smallmouth Bass	Mercury	Under 18"	2
		Over 18"	1
Suckers	Mercury	Any Size	8
Sunfish	Mercury	Any Size	8
Walleye	Mercury	Under 20"	2
		Over 20"	1
White crappie	Mercury	Any Size	4
Yellow Perch	Mercury	Any Size	4

* Serving size: if person weighs 45 pounds, 2 ounces; if person weighs 90 pounds, 4 ounces; 180 pounds, 8 ounces
For every 20 pounds less than the above weights, subtract 1 ounce of fish
For every 20 pounds over than the above weights, add 1 ounce of fish
If you are under the age of 15, have health problems (such as cancer or diabetes), or are planning on having children soon, currently pregnant, or breastfeeding, the Michigan Department of Health & Human Services (MDHHS) suggests you avoid eating all fish listed as "Limited" because of higher levels of chemicals. If none of these applies, it is usually all right to eat fish listed as "limited" once or twice per year.

Table 2.2 Statewide Safe Fish Guidelines (Source: MDHHS).

Designated Use Impairment Summary

A summary of designated use impairments by sub-watershed can be found in Table 2.1. The table describes the current condition of the designated use and whether it is impaired by a known or suspected source. The pollutants and sources of pollutants are identified as known (k) if they were documented and measured during the inventory process and/or existing monitoring data review. Pollutants and sources were identified as suspected (s) if indications or impacts of them were observed, but the pollutants or sources themselves were not measured. Potential (p) pollutants were identified based upon land use conducive to serving as a source of that pollutant, but no visual observation or measurements were made. Additional inventories should be conducted within five years to reassess the watershed and determine if suspected sources have become known. The Steering Committee evaluated each designated use and prioritized the pollutants based on the degree of impairment, and the feasibility of reducing the pollutant to desirable levels. A summary of this evaluation can be found in Section 3.3.

2.1.2 Desired Uses

Desired Uses include the ways in which people use the watershed and the ways which people think it should be protected and/or preserved for future generations. They may be very general, very specific, or somewhere in between. These are resources that are not listed as a designated use in the Part 4 Rules that still have significant local importance.

These uses for the Watershed's resources have been included in this WMP as desired uses and were defined and ranked by the Watershed Steering Committee. Table 2.3 lists desired uses with rankings identified by the Steering Committee. Further discussion regarding goals, objectives, costs, and implementation schedule of the desired uses can be found in Section 4 – Goals and Objectives and Section 5 – Implementation Plan.

Desired Uses	Steering Committee Ranking
Habitat Improvement and Preservation	1
Critical Area and Natural Resource Protection	2
Agricultural Land Preservation	3
Adequate Drainage	4
Recreation/Aesthetics	5
Wetland Restoration	6
stormwater Management/LID	7
Business/Commerce	8

Table 2.3 Desired uses for the Upper Looking Glass River Watershed as defined and ranked by the Watershed Steering Committee.

2.2 Water Quality Standards

2.2.1 Designated Use Standards

For the purpose of defining water quality within this WMP, the following standards were applied. This information will be useful in setting up a long-term monitoring program in the Upper Looking Glass River Watershed. Table 2.4 lists water quality parameters and minimum requirements for each designated use described in Section 2.1.

Designated Use	Water Quality Parameter	Minimum Requirements
Partial body contact recreation	Bacteria (*Escherichia coli)*	Surface water levels of ≤1,000 *E. coli* per 100 mL water Counts not more than 1,000 of *E. coli* per 100 mL
Total body contact recreation	Bacteria (Escherichia coli)	Surface water levels of ≤300 *E. coli* per 100 mL water in a single sampling event Counts not more than 130 of *E. coli* per 100 mL as a 30-day geometric mean
Warmwater fishery and other indigenous aquatic life and wildlife	Dissolved Oxygen (DO)	Surface water levels of 5 mg/L or higher
Warmwater fishery and other indigenous aquatic life and wildlife	pH	Surface water ranges from pH of 6.5 to 9.0
Warmwater fishery and other indigenous aquatic life and wildlife	Phosphorus	Point source discharges of 1 mg/L of total phosphorus as a monthly average Nonpoint sources ambient stream conditions of 20.63 - 80.00 µg/L or target 33.00* (see Tables 2.6 and 2.7) **informal targets based on monitoring data*
Warmwater fishery	Temperature	Heat load increased from receiving water by less than 5˚F
Fish consumption and other indigenous aquatic life and wildlife	Polychlorinated biphenyl (PCB)	Fish tissue rate of 0.023 mg/kg or lower
All designated uses	Total Suspended Solids (TSS)	No official standard has been established; however, MDEQ accepts an informal standard of 80 mg/L total suspended solids for wet weather events

Table 2.4 Water Quality Parameters and Minimum Requirements for Designated Uses.

2.2.2 Physical Characteristics

Water quality standards are established and applicable to the Great Lakes, the connecting waters and all other waters of the state, to protect the state's natural resources, and to serve the purpose of Public Law 92-500, as amended. According to Michigan's Part 4, Water Quality Standards (WQS), Environmental Protection Act, 1994, PA 451, as amended (NREPA), the surface waters of the state shall not have any of the following unnatural quantities that are or may become injurious to any designated use:

- Turbidity
- Color
- Oil films
- Floating solids
- Foams
- Settleable solids
- Suspended solids
- Deposits

2.2.3 Water Quality Criteria

The term “water quality criteria” is used in two sections of the Clean Water Act, Section 304(a)(1) and Section 303(c)(2). The term has a different impact in each section. In Section 304, the term represents a scientific assessment of ecological and human health effects that the Environmental Protection Agency (EPA) recommends to States and authorized Tribes for establishing water quality standards that ultimately provide a basis for controlling discharges or releases of pollutants or related parameters. Ambient water quality criteria associated with specific water body uses when adopted as State or Tribal water quality standards under Section 303 define the level of a pollutant (or, in the case of nutrients, a condition) necessary to protect designated uses in ambient waters. Quantified water quality criteria contained within State or Tribal water quality standards are essential to water quality-based approach to pollution control. Whether expressed as numeric criteria or quantified translations of narrative criteria within State or Tribal water quality standards, quantified criteria serve as a critical basis for assessing attainment of designated uses and measuring progress toward meeting the water quality goals of the Clean Water Act.

EPA developed Section 304(a) water quality criteria for nutrients because States and Tribes consistently identify excessive levels of nutrients as a major reason why half of the surface waters surveyed in the country do not meet water quality objectives, such as full support of aquatic life. EPA expects to develop nutrient criteria that cover four major types of water bodies – lakes and reservoirs, rivers and streams, estuarine and coastal areas, and wetlands across fourteen major ecoregions of the United States. EPA’s Section 304(a) water quality criteria for nutrients provide numeric water quality criteria, as well as procedures by which to translate narrative criteria within State or Tribal water quality standards. In the case of nutrients, EPA Section 304(a) criteria establish value for causal variables (e.g., total nitrogen and total phosphorus) and response variables (e.g., turbidity and chlorophyll *a*). EPA believes that State and Tribal water quality standards need to include quantified endpoints for causal and response variables to provide sufficient protection of uses and to maintain downstream uses. These quantified endpoints are most often expressed as numeric water quality criteria or as procedures to translate a State or Tribal narrative criterion into quantified endpoint.

The Upper Looking Glass River Watershed falls in the Aggregate Ecoregion VII, which falls within the Level III ecoregion (Ambient Water Quality Criteria Recommendations Information Supporting the development of State and Tribal Nutrient Criteria Rivers and Streams in Nutrient Ecoregion VII). Ecoregion VII has a short growing season and is dominated by forests, dairy operations, and livestock farming. It was mostly glaciated and includes flat plains, rolling till plains, hummocky stagnation moraines, hills, and low mountains. Many wetlands and lakes occur. Soil, climate, vegetation, land use, and surface water characteristics are transitional between those of Region VIII and those of regions to the south. Overall, it is not as flat or as cropland-dominated as the Corn Belt and Northern Great Plains (VI) and not as lake-studded nor as forest-dominated as Region VIII. The Mostly Glaciated Dairy Region (VII) has a mix of nutrient-rich and nutrient-poor soils that contrast with the mostly fertile soils of Region VI and the relatively thin and nutrient-poor soils of Region VIII. Surficial water characteristics are also transitional between more northerly and more southerly regions and have been affected by land use. Many lakes are found in Region VII; their median total phosphorus concentration is less than half of Region VI's and about twice that of Region VIII's median concentration. Livestock, cropland agriculture, and urban areas have contributed nutrients and fecal coliform bacteria to streams. Total nitrogen and total phosphorus concentrations from nonpoint sources are usually above the levels found in Region VIII but below those measured in the Corn Belt and Northern Great Plains (VI) (U.S. EPA 2000). See Figure 2.1 and Figure 2.2 for maps of ecoregions of Michigan.

Tables 2.5 and 2.6 contain a summary of Aggregate and level III ecoregion values for Total Phosphorus, Total Nitrogen, water column Chlorophyll *a*, and turbidity.

Nutrient Parameters Aggregate Nutrient Ecoregion VII	Aggregate Nutrient Ecoregion VII Reference Conditions
Total phosphorus (µg/L)	33
Total nitrogen (mg/L)	0.54 (reported); 0.54 (calculated)
Chlorophyll *a* (µg/L) (Fluorometric method)	1.54
Chlorophyll *a* (µg/L) (Spectrophotometric method)	3.5
Turbidity (NTU)	1.7
Turbidity (FTU)	2.32

Table 2.5 Nutrient parameters for Aggregate Nutrient Ecoregion VII - Reference Conditions.

For seven sub-ecoregions within Ecoregion VII, the ranges of nutrient parameter criteria are:

Nutrient Parameters Aggregate Nutrient Ecoregion VII	Aggregate Nutrient Ecoregion VII based on 25th Percentiles ONLY Reference Conditions
Total phosphorus (µg/L)	20.63 - 80.00
Total nitrogen (mg/L)	0.46 - 1.88
Chlorophyll *a* (µg/L)	1.64 - 14.69
Turbidity (NTU)	0.84 - 14.50
Turbidity (FTU)	2.08 - 5.49

Table 2.6 Nutrient parameters ranges for Aggregate Nutrient Ecoregion VII based on a range of level III sub-ecoregions reference conditions.

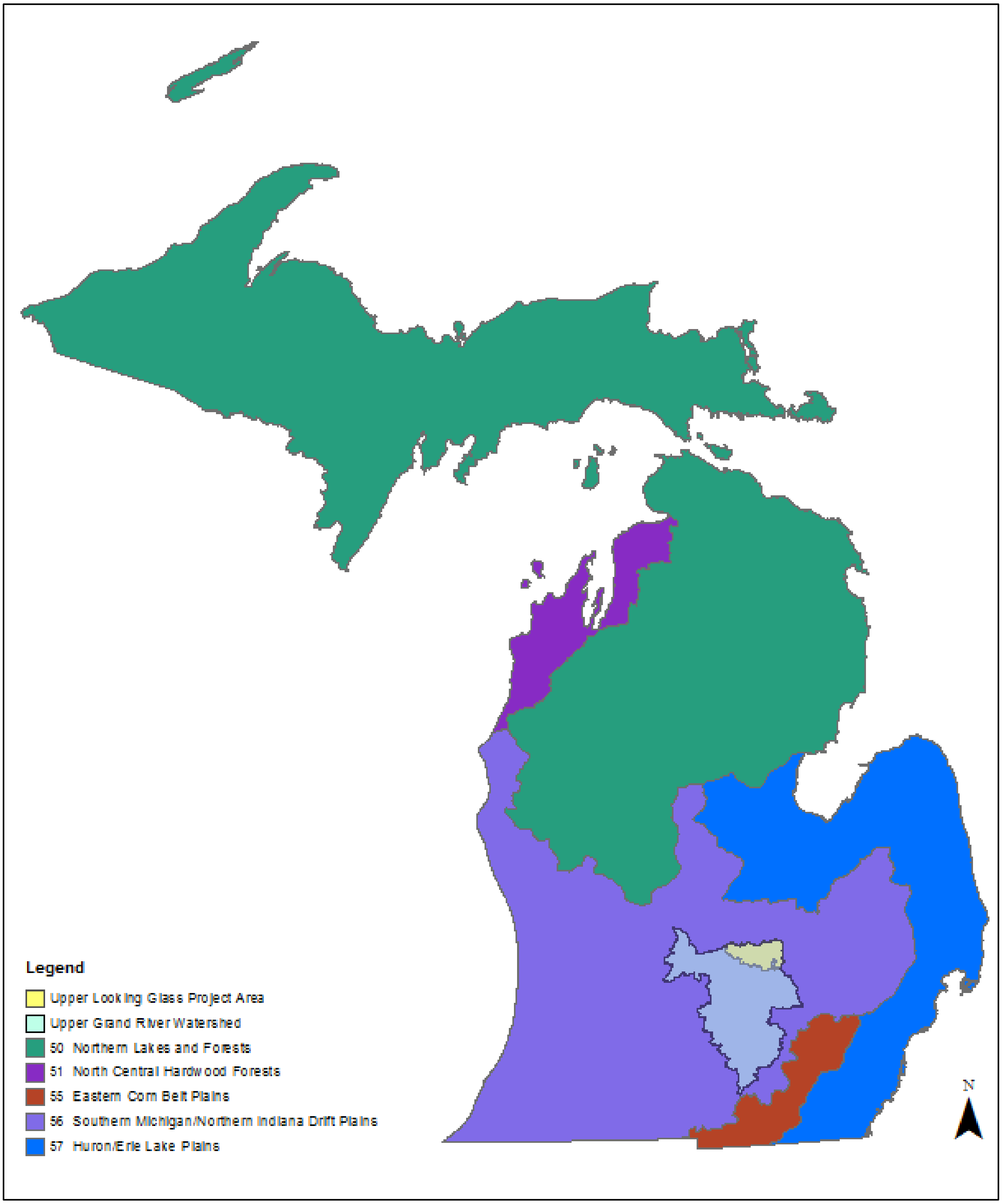

Figure 2.1 Level III Ecoregions of Michigan. The entirety of the ULG falls within the Southern Michigan Northern Indiana Drift Plains Ecoregion (56).

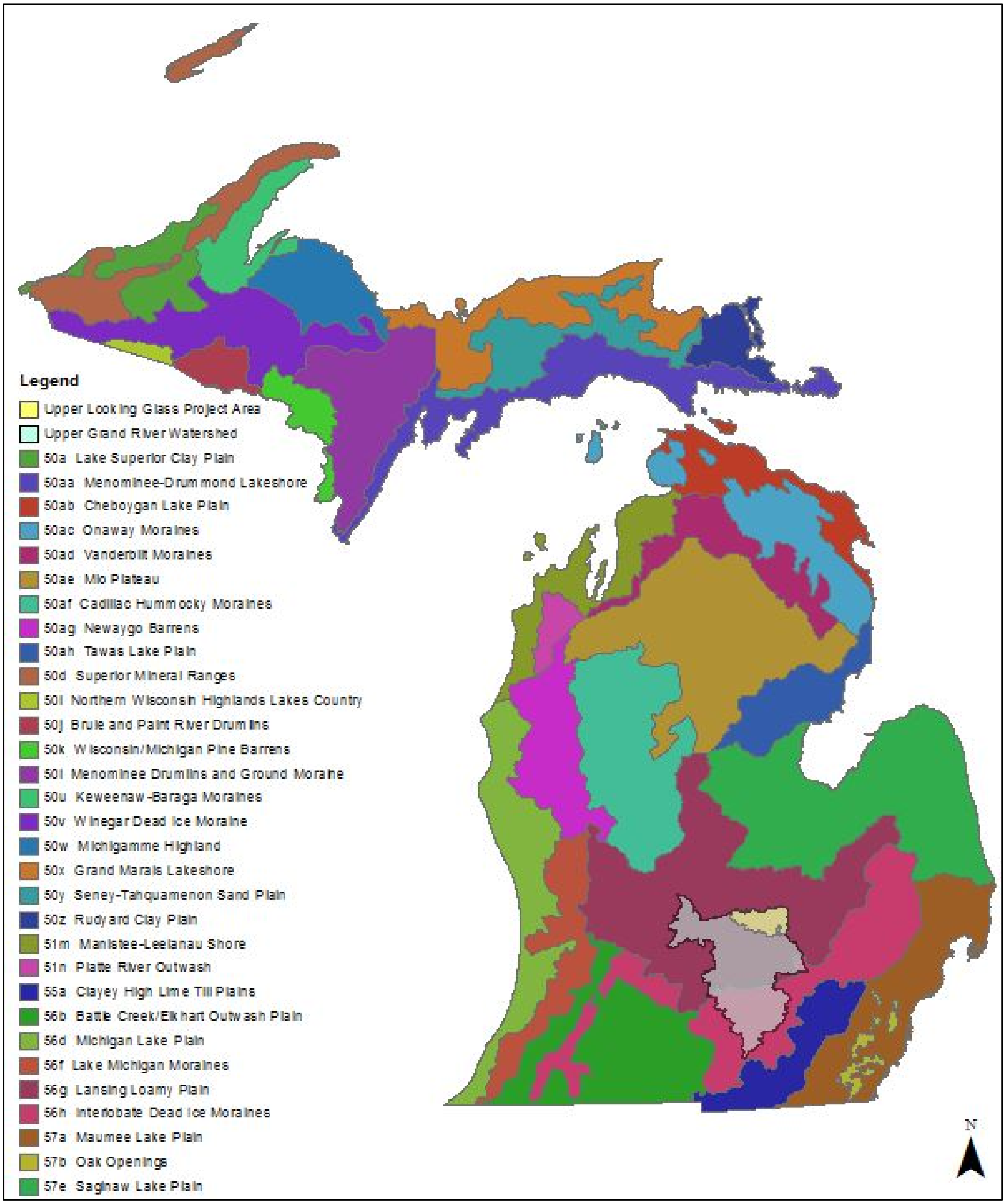

Figure 2.2 Level IV Ecoregions of Michigan. The entirety of the ULG falls within the Lansing Loamy Plain Ecoregion (56g).

2.3 Nonpoint Pollutants, Sources, and Causes

NPS pollution is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters and ground waters. Types of nonpoint sources of pollutants include agricultural, urban, residential, and other. Each category is explained below.

2.3.1 Impacts of Pollutants

Below is a brief description of the NPS and the degradation they impose on designated uses.

Impacts of Sediment on Designated Uses

Sediment in any amount can have disastrous consequences on land and water resources. Impacts of erosion and sedimentation include the loss of fertile topsoil, degraded fish spawning areas, less desirable fish and wildlife habitat, impaired and destroyed wetland communities, and decreased recreational opportunities. Increased flooding can occur due to reduced channel and storm drain capacity to convey water. Excessive sediment also carries and deposits nutrients and impedes navigation of the watercourse.

Impacts of Pathogens/Bacteria on Designated Uses

Bacterial pollution impairs the watercourse's designated uses of partial and total body contact recreation. Pathogens and bacteria are present in manure and septic runoff, and high concentrations in surface water may pose severe human health risks. The impact of *E. coli* pollution is a public health and safety issue. Fecal coliform bacteria, found in manure or septic waste, is also an indicator of other serious pathogens and disease-carrying organisms.

Impacts of Nutrients on Designated Uses

Nutrients, including phosphorus and nitrogen, are necessary for the growth and reproduction of aquatic plants and for a healthy river, when in balance. However, excessive nutrients can cause dense algal growths known as algal blooms. After the elevated nutrient source has been depleted, an algal bloom will die and decompose, reducing DO levels. Healthy warmwater fish and macroinvertebrate populations require DO levels to remain around 5 mg/L, while coldwater fish require DO levels of 7 mg/L. When lower DO levels are sustained for a period of time, fish and macroinvertebrate communities change to more tolerant species, and the stream or lake will no longer support a diverse species population.

Impacts of Pesticides and Chemicals on Designated Uses

Pesticides and chemicals leach through the soil and enter the groundwater and surface water and may have negative impacts on wildlife. Certain chemicals may also cause other environmental problems such as increased health risks or drinking water problems. Stormwater runoff may cause large concentrations of pesticides to enter the water within a short time period.

Impacts of Thermal Pollution on Designated Uses

Thermal pollution occurs when a water body is greatly influenced by an influx of water above or below its natural temperature, usually making the water body warmer. Thermal pollution can result in both increased water temperatures and reduced DO levels, which is detrimental to aquatic life and fisheries.

2.3.2 Agricultural Sources

Cropland

Based on the farming practices observed, it was determined that croplands have an impact on water quality by being a source of sediment, nutrients, and pesticides. Shiawassee County's major industry is agriculture, ranking 6th in Michigan for soybean production, 5th for wheat for grain, with other major crops including, corn for grain, corn for silage and forage (USDA 2012 Census of Agriculture). Runoff from cropland reaches the Looking Glass River via entry through county drains or drainage tiles.

From stream reconnaissance surveys, causes of the cropland pollution were identified as tillage practices, lack of buffers, flashy streamflow in dense drainage ditches, over or improper application of manure/fertilizers, and over or improper application of herbicides and pesticides. During this inventory, agricultural runoff was noted as a concern in 105 instances, inadequate buffer was noted at 74 sites, tillage causing erosion was identified at 29 locations, and manure in runoff was noted on seven occasions. See Section 3.1.3 for a discussion of Stream Reconnaissance findings.

Livestock and Manure

Livestock in the project area are identified as having an impact on water quality by being a source of nutrients and pathogens and bacteria. According to the 2012 Census of Agriculture, there are 17,575 cattle, 1,046 hogs, 1,116 sheep, and 2,143 laying chickens in Shiawassee County and 59,231 cattle, 7,265 hogs, 1,882 sheep, and 3,409 laying chickens in Clinton County.

Poor grazing management can result in contamination of surface and ground waters through bacterial contamination, nutrient over-enrichment, and soil erosion from pastures. Considering that a manure pile covers less than 1 square foot and a urine spot covers 4 to 7 square feet, the soil under each dairy cow manure pile or urine spot receives the equivalent of 500 to 1,000 pounds of nitrogen per acre. Uncontrolled grazing presents other disadvantages, but the primary concern is the loss of vegetative cover due to frequent grazing, trampling, or grazing the plants too close to the soil. This often weakens root systems and exposes and compacts the soil. These degradations to soil quality can increase the soil erosion and nutrient losses from pastures and can, in turn, pollute surface waters (Ranells et al 2001).

Manure is a valuable fertilizer resource and can reduce a producer's commercial fertilizer costs. If mishandled, however, manure can contaminate surface and ground waters. Accumulated manure can cause health, odor and water quality problems if not properly dealt with. One option is to collect the waste daily, load it in a spreader, and spread it on cropland, hay land, or pasture. This is time consuming and also has to be done regardless of the soil moisture, weather, or time of year. Spreading on saturated soils compacts and compromises soil quality; spreading on frozen soils can lead to offsite runoff of manure. The alternative to daily spreading is to stockpile or store the manure for a period of time, at which point it may be spread or hauled away and utilized beneficially elsewhere.

Manure storage is generally a large capital cost item. The large capital cost of storage contributes to a large annual cost for depreciation, interest, repairs, taxes, and insurance. Proper storage, handling, and application of manure from dairy operations can protect water resources and increase profits for animal and crop enterprises.

Lack of buffer or setback at holding facilities, manure storage areas adjacent to the channel, and uncontrolled animal access are contributing factors leading to excess nutrients, bacteria and pathogens. Livestock yards were identified in the vicinity of 20 streams surveyed and potentially contributing to bacteria, pathogens and nutrients. Manure in runoff was noted seven times. Direct access to the stream by livestock was observed on four occasions (See Section 3.1.3 for a detailed discussion of stream reconnaissance findings).

During wastewater investigations conducted (Section 3.1.1), 46 samples were collected from road/stream crossing in the Watershed and investigated by canines scent-trained to identify human waste in surface water. Twenty-two of these samples were not alerted to as having human waste present. These samples were analyzed by the MDEQ Drinking Water Laboratory to determine number of *E. coli* colony forming units per 100mL of water (cfu/100mL). Of these 22 samples, five exceeded the WQS for Total Body Contact Recreation (300 cfu/100mL) and 11 samples exceeded WQS for Partial Body Contact Recreation (1,000 cfu/100mL). In samples with no canine alert to human waste, *E. coli* levels ranged from 20 to 3,870 cfu/100mL indicating a non-human source of bacteria. A 30-day geometric mean of water samples taken from seventeen stream locations across the watershed found *E. coli* levels that exceeded the Partial Body Contact Recreation standard at all locations (Section 3.1.2).

Biosolid Nutrient Application

According to the U.S. Environmental Protection Agency, when properly treated and processed, sewage sludge becomes biosolids which are the nutrient-rich organic materials resulting from the treatment of domestic sewage in a wastewater treatment facility. Biosolids can be recycled and applied as fertilizer to improve and maintain productive soils and stimulate plant growth. The U.S. EPA has established a protective regulatory framework to manage the use and disposal of sewage sludge. Effective sewage sludge and biosolids management options help ensure that useful materials are recycled on land and harmful materials are not released to water bodies.

Over-application or application of biosolids at improper times or rates can lead to runoff containing excessive nutrients, bacteria, and pathogens. Biosolid sites are permitted at 33 locations in the ULG (see Figure 2.3).

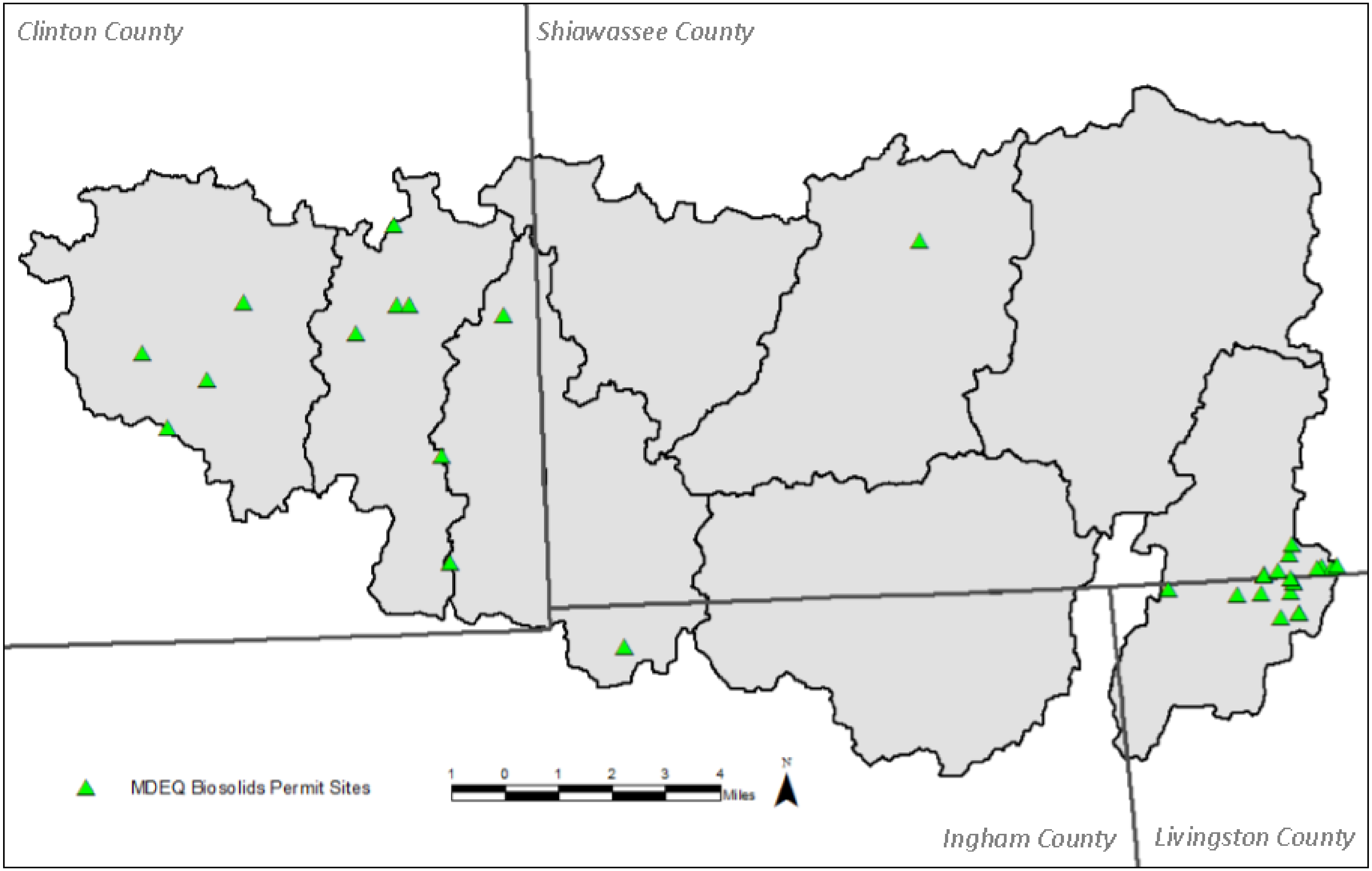

Figure 2.3 MDEQ permitted biosolid application sties in the Upper Looking Glass River Watershed (Source: MDEQ).

2.3.3 Urban and Residential Sources

Household Wastewater

In most rural locations, household wastewater is treated through an on-site septic system that is the homeowner's responsibility to maintain. Septic systems and illicit connections are identified as having an impact on water quality by being a potential source of nutrients, pathogens and bacteria.

Failing septic systems and illicit connections are a particular concern because they contribute harmful *E. coli* bacteria to surface water. *E. coli* is hazardous because it can produce a powerful toxin that can cause serious illness. Symptoms are variable and include severe bloody diarrhea, abdominal cramping, vomiting, and skin, ear, respiratory, eye, neurologic and wound infections. Children under the age of five, the elderly, and people whose health is immune-compromised are especially at risk. Septic systems are also a concern when it comes to phosphorus. The concentration of phosphorus in the wastewater is usually hundreds of times higher than needed for algal growth. In freshwater, phosphorus controls the amount of biological growth taking place. An abundance of phosphorus causes excessive aquatic plants and algae to grow quickly. As these plants die, they decompose and leave water with very little oxygen. As more oxygen is depleted, water bodies cannot support life at all and become aquatic "dead zones".

Excessive phosphorus can also trigger toxic blooms of algae. The resulting water has a foul odor and is not safe for drinking, fishing, or recreation. Harmful algal blooms have been linked with degraded water quality, destruction of economically important fisheries, and public health risks.

Conditions where septic systems pollute surface water include, drain fields with shallow or coarse soils, a high water table, close proximity to lakes or streams, high density of systems, or out of date or under capacity systems. Alternative and modified systems are available but not common practice as of yet. Regular maintenance and water conservation are the most important means to protecting surface water from septic systems.

There are about 1.3 million on-site wastewater treatment systems in Michigan, most of which are septic systems for single-family homes. State officials estimate that 10 percent of those (130,000) have failed and are polluting the environment. In response to elevated levels of *E. coli* in Shiawassee County, the Shiawassee County Health Department (SCHD) issued a countywide program called "*Point of Sale Inspections*" in 2001, where a well and septic system must be inspected and approved prior to the land being sold. Results of point of sale inspections are as followed:

Approximately 25% of inspected systems were found to be "Not in Compliance" with current septic field construction requirements. This percentage was consistent for both townships within the watershed and all townships in the county, so it is a fair indication that there are a significant number of "dated" septic systems with the potential to generate pollution beyond currently acceptable limits. Across the county, SCHD has found that about 7% (essentially 1 out of 15) of the systems that have been inspected are in some state of failure. In these instances, excessive pollution is likely resulting. Table 2.7 lists the likely number of homes with septic systems and Figure 2.4 shows these numbers by Section for the ULG. These values were determined by an aerial inventory of homes in the watershed. Estimates of failure are based on MDEQ statewide estimates and Shiawassee County Point of Sale Ordinance findings.

	Probably Number of Homes with Septic Systems	10% Failure Estimate	7% Failure Estimate	25% Systems Out of Compliance Estimate	Mean Number of Systems per Section
Headwaters	477	48	33	119	14
Howard Drain	998	100	70	250	18
Kellogg Drain	1,183	118	83	296	27
Buck Branch	786	79	55	197	16
Vermillion Creek	1,096	110	77	274	25
Leisure Lakes	817	82	57	204	24
Mud Creek	867	87	61	217	26
Turkey Creek	851	85	60	213	24
Upper Looking Glass River Watershed	7,075	708	495	1,769	22

Table 2.7 Likely number of homes with septic systems in the Upper Looking Glass River Watershed. Estimated number of failures based on MDEQ statewide estimate of failure and Shiawassee County Point of Sale Ordinance findings.

Illicit discharges are generally any discharge into a storm drain system this is not composed entirely of stormwater. The exceptions include water from firefighting activities, uncontaminated groundwater, potable water, and discharges from facilities already under a National Pollutant Discharge Elimination System (NPDES) permit. Illicit discharges are a problem because, unlike wastewater, which flows to a wastewater treatment plant, stormwater generally flows to waterways without any additional treatment. Illicit discharges often include pathogens, nutrients, surfactants, and various toxic pollutants.

There are three municipal wastewater treatment facilities and one private treatment lagoon system in the ULG in Shiawassee County. The City of Laingsburg has a wastewater stabilization sewage lagoon servicing its residents. The Laingsburg facility discharges into the Looking Glass River. The Countryside Village MHP in Perry maintains a wastewater stabilization sewage lagoon, which discharges into Perry Drain No. 2. The City of Perry, Department of Public Works (DPW) also has a wastewater stabilization lagoon. All three maintain NPDES permits. The City of Perry Sewer System, maintained by the DPW, is comprised of seven pump stations located throughout the city. The DPW staff also maintains a Lagoon system on Bath Road near the railroad tracks,

Just outside of the Project Area is the City of DeWitt, which provides most of the city with municipal sanitary sewer services. Sanitary sewage generated in DeWitt is treated at the Clean Water Plant, which is operated by the Southern Clinton County Municipal Utilities Authority (SCCMUA). The City's sanitary sewage collection system is comprised of several miles of sanitary sewer lines, force mains and three pumping stations capable of treating up to 5,000,000 gallons of sanitary sewage a day.

SCCMUA was formed in the mid-1970s by the City of DeWitt and Bath, DeWitt and Watertown Charter Townships to address the need for a regional wastewater treatment plant. SCCMUA is also responsible for contractually operating and maintaining the sanitary sewer systems in these four communities. SCCMUA discharges into the Looking Glass River in Clinton County and maintains a current NPDES permit.

During stream reconnaissance surveys, 36 sites investigated had a tile outlet observed. Sixteen of the tiles observed had algae growing in the stream where it discharged indicating a nutrient source. Most instances these tiles drained agricultural land. However, since septic systems did not become commonplace until the 1940s, it is possible that household wastewater may be entering the agricultural tile drain from old homes that bypass an onsite wastewater system.

This suggestion is supported by the investigative findings that 48% of stream samples examined by scent-trained canines alerted to having human waste present. Water samples analyzed by the canines were analyzed by the MDEQ Drinking Water Laboratory to determine number of *E. coli* colony forming units per 100mL water. Sixteen samples exceeded WQS for Total Body Contact Recreation (300 cfu/100mL), with 11 of these samples having a positive canine alert for human waste. Eleven samples exceeded WQS for Partial Body Contact Recreation (1000 cfu/100mL), of these, three were alerted for human waste by the canines. Furthermore, a 30-day geometric mean of water samples taken from seventeen stream locations across the watershed found *E. coli* levels that exceeded the Partial Body Contact Recreation standard at all locations.

See section 3.1.1 and 3.1.2 for a discussion on wastewater investigations and Section 3.1.3 for a detailed discussion on stream reconnaissance findings.

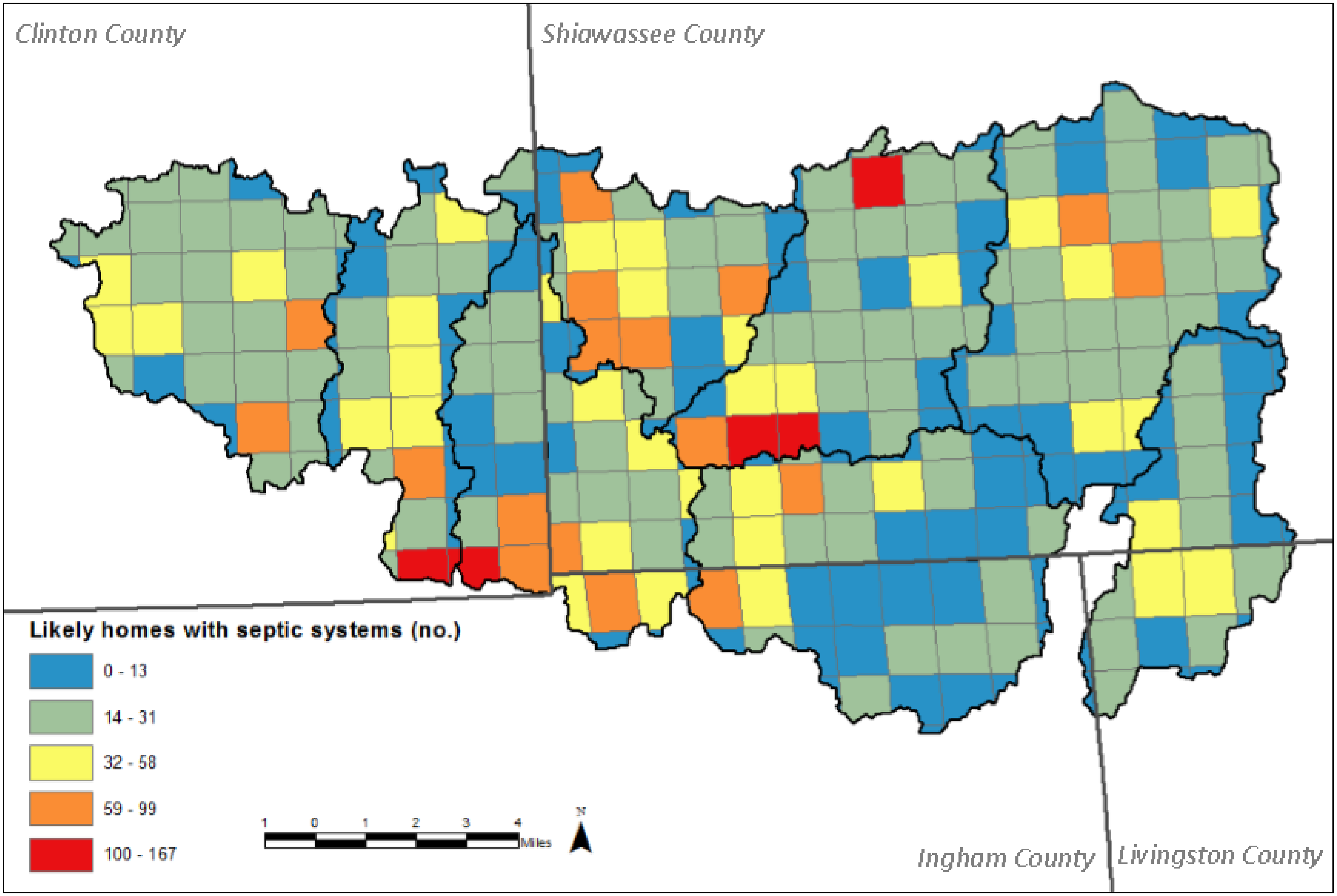

Figure 2.4 Approximately number of rural homes in the Upper Looking Glass River Watershed that are likely to have onsite wastewater treatment via septic system determined by aerial inventory.

Golf Courses

There are three golf courses in the Upper Looking Glass River Watershed, Pine Hills in Laingsburg, Glenbrier in Perry Township, and Natures View in Bath Township. In general, golf courses apply large amounts of fertilizers and pesticides to maintain vigorous greens. In many cases, chemical application rates can rival and even exceed those used in intensive agriculture. Golf courses are also intensive water consumers, placing strong demands on groundwater resources. In comparison to other land uses, a study conducted by the Community and Environmental Defense Services (CEDS) revealed that the impact of the typical golf course is about twice that of a farm and more like the degradation associated with a residential community. This study revealed the potential causes of the degradation by golf courses to include:

- stream channelization
- destruction of wetlands,
- lack of a wooded buffer along waterways
- elevated water temperature due to:
    - lack of shading vegetation
    - reduction of groundwater inflow
    - release of heated water from the surface of ponds
    - entry of heated stormwater runoff from impervious surfaces
- reduction of base (dry-weather) stream flow due to ground or surface water withdrawals for irrigation
- release of toxic substances and oxygen deficient water from ponds
- intermittent pollution incidents such as spills of pesticides, fertilizers, or fuel
- loss of pesticides or fertilizers by way of ground or surface water runoff
- entry of stormwater pollutants washed from parking lots and the other impervious surfaces associated with a golf course
- accelerated channel erosion due to increased stormwater runoff velocity or prolonging the amount of time channels are exposed to erosive velocities,
- elimination of the scouring benefits of flooding by storing runoff in ponds,
- poor erosion and sediment control during the construction phase
- inadequate treatment of sewage and other wastewater generated on the golf course (Klein 1999)

2.3.4 Other Nonpoint Sources

Agricultural Drainage Tiles

Agricultural drainage tiles are a source of several pollutant types. From crop fields, tiles can be a source of potential nutrients from over applied fertilizers and manure, chemicals from pesticides and inorganic fertilizer seepage, and sediment if tiles are broken. Tile outlets can be a cause of gully erosion if flows from the outlet are fast enough and the outlet is not armored. In some instances, older farm home septic waste was connected to a farm tile for drainage, contributing harmful bacteria and nutrients to this water.

During the stream reconnaissance (Section 3.1.3) field tiles were observed in 36 instances during the stream reconnaissance survey and tiles were found to cause gully erosion in 18 occasions. Algae was noted at 16 streams and excessive or moderate aquatic vegetation was observed at 17 streams with tile outlets.

Streambank, Sheet, and Gully Erosion

Soil erosion contributes to sedimentation of waterways. Sediment is made of loose particles of clay, silt, or sand, which can become dislodged or detached from earth surfaces through the process of soil erosion. Once soil particles have been eroded, they become free flowing in air or water and eventually settle out onto land, stream bottoms, or lake beds. Either free flowing or deposited, sediment is considered a pollutant and among the most abundant type of non-point source pollution.

Impacts of erosion and sedimentation include the loss of fertile topsoil, degraded fish spawning areas, less desirable fish and wildlife habitat, impaired and destroyed wetland communities, and decreased recreational opportunities. Increased flooding can occur due to reduced channel and storm drain capacity to convey water. Excessive sediment also carries and deposits nutrients and impedes navigation of the watercourse.

Of the 138 streams that were assessed during the stream reconnaissance surveys, streambank erosion was documented at 34 stretches and gully erosion was documented at 41 stretches. For the gully and streambank erosion sites documented, dimensions of erosion were collected and pollutant loads were calculated for sediment, nitrogen and phosphorus using the MDEQ Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual (MDEQ, June 1999). Using data from the stream reconnaissance assessments, an estimated 252.2 tons of sediment, 486.1 lbs of phosphorus, and 242.8 lbs of nitrogen per year is contributed the Looking Glass River and its tributaries as a result of streambank and gully erosion. For a full summary of pollutant loads for the streambank and gully erosion values from the stream reconnaissance, see Section 3.2.2.

Erosion from cropland fields was documented at 90 sites during the SCD stream reconnaissance surveys. Pollutant load estimates for sheet erosion were gathered from the High Impact Targeting (HIT) tool and using the STEPL model for crop fields adjacent to stream reaches surveyed. Estimates from the HIT analysis indicate approximately 24,031 tons of sediment annually are contributed from cropland, assuming no conservation measures are in place. Estimates of sheet erosion from crop fields adjacent to stream inventory segments were determined using the STEPL model. Pollutant loads estimate are 812 tons sediment, 27,897 lb nitrogen, 5,232 lb phosphorus, and 60,560 lb BOD annually assuming no conservation in place. However, these estimates may be high as a considerable amount of conservation measures were observed during the stream reconnaissance. A summary of the HIT tool can be found in Section 3.1.3 and STEPL discussion in Section 3.2.2.

Road Stream Crossings

The Looking Glass River Watershed is crisscrossed with roads nearly every mile. Road and bridge crossings alter stream habitat and have significant effects on biological communities. Soil erosion at stream crossings is common throughout the watershed due to sloped banks and cleared vegetation. Road surfaces and ditches also wash sediment into waterways.

Undersized bridges, bridge pillars and piers, and misaligned culverts also affect water quality and habitat resources. When bridges are too short to span the floodway, they cause an increase in velocity at high flows and collect debris. When piers and pillars are placed in the stream, they collect debris, which can accelerate water velocity, cause erosion, destabilize banks, prevent upstream movement of aquatic organisms, and present a human safety hazard (Leonardi 2001).

Misaligned and poorly placed culverts can cause bottom cutting at outlets and increased streambank erosion from the sheer force of water hitting the banks at an improper angle. During the stream reconnaissance survey, erosion was noted at 10 road stream crossings either at the shoulder/ditch, culvert outlet, or embankment. A road-stream crossing inventory was conducted as part of the WMP development. From this inventory, it was found that 27% of culverts were misaligned, 10% of culverts were perched, 7% were rusted through. Erosion was noted at 44% of crossings, 37% had a gully present, 15% were more than 1/3 plugged, and 7% had scour on the banks. Gravel roads made up 68% of all roadways and 54% of crossings had invasive plants present (see Section 3.1.4 for a full discussion).

Wildlife, Waterfowl, and Domestic Animals

Wildlife has a significant influence on water quality in the ULG. In fragmented agricultural and forest landscapes, wildlife can contribute a large portion of the fecal pollution to a watershed (Daszak et al AD 2000). According to 2004 MDNR Deer check data, deer herd estimates for Shiawassee County ranged between 15,500 (29 deer per square mile in 1994) and 29,400 (54 deer per square mile in 1998) between 1994 and 2005. The average deer density was 34 deer per square mile with an above average buck intensity harvest and average doe to buck ratio of 1:9 does/buck. White-tailed deer are an important reservoir for pathogens and contribute significant microbial pollution (Guber et al 2015). Deer damage in the form of vegetation loss, gully erosion caused by crossing streams and scat droppings by various wildlife types were widespread during stream reconnaissance surveys. Crop damage is scattered and occurs primarily in fields planted to corn, soybeans, and alfalfa. Landscaping damage around homes occurs moderately and more so in severe winters. Although “browse lines” are visible in some areas, forest regeneration impacts are a potential, but undocumented, consequence of over abundant deer population in the county. Since 1998, numerous individuals have started voluntary quality deer management practices within Shiawassee County and this increase in selective harvest could eventually alter deer herd population structure and productivity (Flegler, E., Dominic, D. 2005).

In 2015, three registered facilities for privately-owned cervidae were present in Shiawassee County. Cervidae include caribou, fallow deer, sika deer, white-tailed deer, elk, moose, reindeer, and others. Concentrated cervid populations are potential contributors to bacteria and pathogens, especially if allowed direct access to streams, runoff from facilities and in regards to management of waste. Cervid populations are also contributors to soil erosion from heavy foot traffic, especially on streambanks and if allowed access to streams. Additionally, having a high concentration of animals may lead to a higher instance of disease (Flegler, E., Dominic, D. 2005).

Wildlife such as raccoon, muskrat, and waterfowl also contribute bacteria and nutrients to surface water. Animal waste contains disease-causing pathogens, such as salmonella, *E. coli* and fecal coliform, which can be 10 to 100 times more concentrated than in human waste. More than 40 diseases can be transferred to humans through animal waste. Furthermore, droppings from one goose, duck, gull or waterfowl is enough to contaminate 10,000 gallons of water. The “load” from three of these birds contains about the same amount of phosphorus as a “load” from one human, and geese produce several “loads” in a single day. Waterfowl, deer, and muskrats were commonly observed in streams during investigations.

Wildlife was noted as a source of pollutant during the stream reconnaissance at sites and cause for specific pollutant at 15 locations. Of these sites, six had algae present and seven had moderate or excessive aquatic plant growth indicating the elevation of nutrients in the water.

Domestic animals kept as pets also contribute bacteria and nutrients to surface water. Pet waste left on the ground by pet owners that do not scoop their poop pose an issue for water quality. Poop can not only directly wash into surface water but bacteria from the poop can live in the soil for 18 months to get washed away into rivers, lakes, and streams during spring snow melts or heavy rainfalls. A single gram of dog doo can contain 23 million fecal coliform bacteria and can spread diseases like Giardia and Salmonella. Bacteria from dog doo accounts for up to 20% of the bacteria in urban waterways. Nutrients like nitrogen and phosphorus that are found in dog doo act like a fertilizer in streams. They cause algae to grow which reduces the available oxygen for fish. According to the 2015-2016 National Pet Owners Survey, there are 77.8 million dogs as pets and 54.4 million households own dogs in the U.S. 65% of all U.S. households, or about 79.9 million families, own a pet. This survey indicated that about 40%, or 8 billion pounds of dog waste, is not picked up by the owner, contributing to water quality concerns.

Drain Maintenance

The entirety of the ULG is very effectively drained. The term dense drainage network refers to the well, and sometimes improperly, maintained system of field tiles, roadside ditches, designated county drains, and private drains that transport the water and sediment from the watershed. No matter where a drop of water falls within the watershed, it does not travel far before entering the drainage system. These drainage networks often suffer from streambank erosion, gully erosion, downcutting, undercutting, sedimentation, and turbid water delivery to downstream water bodies.

In Shiawassee County there are approximately 500 maintained County Drains comprising 2,500 miles. These drains are under the ownership and maintenance of the Shiawassee County Drain Commission. In 2015, 47 requests were made to the Shiawassee Drain Commission to remove excess sediment and/or debris from county operated drains. This high number of requests indicates sedimentation is a significant issue in Shiawassee County. From the stream reconnaissance surveys, sedimentation causes included upland land use practices in both agricultural, urban and residential areas (conventional tillage practices, lawn care practices, stormwater runoff), riparian activities (planting crops and mowing to streambanks), and in-stream hydrologic alterations (dredging and channelization). Ecological effects include benthic habitat destruction, disruption of habitat and food sources for aquatic and terrestrial organisms, increases in water temperature due to vegetation loss altering fishery habitats, increase in potential for streambank erosion, downcutting and sedimentation downstream due to increased stream flows. Sediment was found to be a pollutant of concern in 126 of 138 stream reaches inventoried during the stream reconnaissance.

Storm sewers are found in urban areas and are designed to capture excess water from roads, parking lots, sidewalks, and roofs. Storm sewers are direct conduits to surface waters in that anything that goes into a storm drain ends up in the nearest stream without being treated. Areas of the ULG with a storm sewer system include the City of Perry, Village of Morrice, and Village of Laingsburg.

Section 3 Watershed Inventory

3.1 Watershed Inventory and Conditions

The Upper Looking Glass River Watershed was thoroughly investigated to determine land use impacts on water and habitat quality, as well as to identify potential pollutants. This information was utilized to determine primary pollutant types, sources, and causes affecting the ULG. This information was presented to the Steering Committee for prioritization and goal development (Sections 4). Furthermore, inventory data was a key factor in developing the implementation plan in Section 5 and Information and Education approach described in Section 6.

Several different inventories were conducted to obtain an understanding of conditions in the ULG. Existing documents and data were reviewed (Section 1.4), canine wastewater investigations were performed (Section 3.1.1), a water quality study was completed (Section 3.1.2), a comprehensive stream reconnaissance survey was conducted to characterize water quality parameters throughout the watershed (Section 3.1.3), and a road/stream crossing survey was used to assess the condition and impacts to water quality from the crossings (Section 3.1.4). The following sections summarize findings from these investigations:

3.1.1 Wastewater Investigations

Bacteria in water present hazardous conditions to humans and animals. A high level of *Escherichia coli* (*E. coli*) bacteria indicates the presence of untreated waste and suggests the presence of other pathogenic microorganisms. Two investigations were performed to identify levels of *E. coli* and track sources of the pollutant. The following describes the use of scent-trained canines to identify streams with human sources of wastewater and the water quality *E. coli* study.

Canine Scent Survey

Canine scent tracking results narrow the area of interest of on-site wastewater treatment system failure contributing to water quality impairments. During August 2015, the Shiawassee Conservation District (SCD) partnered with Environmental Canine Services, LLC (ECS) and the Clinton Conservation District (CCD) to conduct human source tracking with scent-trained canines to identify streams with human waste in the ULG.

ECS dogs are the World's first canines scent-trained to identify human waste in surface water. These scent-trained canines provide a rapid means for detecting and source tracking human fecal contamination in stormwater, streams, rivers, lakes, and oceans. ECS canines are specially trained to identify and source track human sewage contamination while ignoring animal fecal contamination sources. Their alerts signify that they smell the presence of human sewage, but do not provide information about the sewage concentration or what levels of harmful bacteria are present (ECS 2015).

Water samples were taken by staff from the SCD and CCD at stream crossings in the ULG over a two day period. Two ECS trained dogs performed the scent investigations. Additionally, water samples were taken at each site and analyzed by the Water Tech Laboratory in Howell to quantify *E. coli* counts at monitoring sites. Water Tech Laboratory is an independent commercial laboratory established in 1988 to provide accurate water testing analysis services in a timely fashion.

The Upper Looking Glass River Watershed canine investigation was conducted over a two day period in August 2015. In total, water samples were collected from 46 sites and investigated separately by two different dogs with the same level of training. Of the 46 samples taken, the dogs alerted positively to

48% or 22 samples indicating human waste present in these stream reaches. *E. coli* readings ranged from 20 – 3,870 CFU/100mL. Of the sites investigated, 16 samples exceeded the Total Body Contact limit (≤300 CFU/100mL), of which 5 were alerted to by the canines as having human waste present. Samples collected from 17 sites exceeded the Partial Body Contact limit (≤1000 CFU/100mL), of which 11 were alerted to by the canines as having human waste present. Follow up field investigation was conducted at 16 sites by the canines.

Day 1 – August 18, 2015

Day 1 investigations included 24 samples plus two replicate samples collected from Upper Looking Glass River Watershed stream crossings located in Shiawassee County. Scent testing was conducted by the canine Crush. Buckets were scent tested by Crush in rows of five with one quality control sample of distilled water in each row. Eight of the 24 samples and both replicate samples were positively alerted to, indicating the presence of human sewage. However, conflicting responses were made of the original and replicate samples. Subsequent scent testing of the original and replicate samples, and a sample which had an unclear response in the first round of testing, still resulted in conflicting results. It is common for a canine scenting replicate or repeat samples to give different responses. It indicates that the sewage from those samples is very low, causing it to not always be detectable each time it is scented (ECS 2015).

Field investigations were conducted based on scent responses with the goal of isolating potential contamination areas. Crush scent tested upstream until a negative response was made indicating the area of contamination was limited to the downstream reach of that site.

Five sites were chosen for field investigation from the eight sites that were positively alerted to during the bucket analysis. Crush alerted at four of the five upstream investigation sites for bucket site #21, all four upstream sites for bucket site #18, one upstream site of bucket site #12, and two upstream sites for bucket site #6. Crush alerted at bucket site #7 in the field but not in either of the duplicate bucket samples. She did not alert at one of the upstream sites for bucket site #21, one upstream site for bucket site #6, and only one upstream bucket from site #23. Figure 3.1 shows the canine Crush with Aryn Hervel during the day 2 investigation.

Day 2 – August 19, 2015

Day 2 investigations included 22 samples plus four replicate samples collected from ULG stream crossings located in Clinton County. Buckets were scent tested by the canine Kenna in rows of five with three quality control sample of distilled water. Two sets of bucket sample investigations were conducted followed by field investigations.

During the first bucket sample investigation, 14 of the 22 samples and all three replicate samples were positively alerted to, indicating the presence of human sewage. During the second bucket sample investigation, Kenna alerted on all four repeat bucket samples, confirming the original alert on two and conflicting alerts on the other two. Kenna also investigated bucket samples from two field investigations, confirming her first alert on one, but with a conflicting response on the other. It is common for a canine to give different responses and likely indicates the sewage scent from those samples is very low causing it to not always be detectable each time it is scented.

As in Day 1, field investigations were conducted based on scent responses with the goal of isolating potential contamination areas. Kenna scent tested upstream until a negative response was made indicating the area of contamination was limited to the downstream reach of that site. Kenna either scent tested the stream directly or a sample container of water from the site.

Three sites were chose from the 14 positive bucket sample responses for field investigation. Kenna alerted at one of the two upstream sites for bucket sample #30 and the only upstream site for sample #32. She did not alert at one upstream site for sample #30 and the only upstream site for sample #33. Additionally, Kenna did not alert at site #4 confirming Crush's response from Day 1. Figure 3.2 show the canine Kenna with handler Laura Symonds and ECS president Karen Reynolds during the day 2 investigation. Table 3.1 and Figure 3.3 provide a summary of the results. Figure 3.4 shows comparisons of *E. coli* measured from water samples taken during canine investigation. See Appendix 9 for full report.

Figure 3.1 ECS canine Crush with Aryn Hervel alerting to the scent of human waste in this bucket taken from a ULG stream during the August 2015 survey.

Figure 3.2 ECS canine Kenna with handler Laura Symonds and ECS president Karen Reynolds, alerting to human waste from a sample taken from a ULG stream during the August 2015 survey.

	All Samples		Human Positive Samples		Human Negative Samples	
Coliform Forming Unit (cfu) Range	20 - 3,870		40 - 2,250		20 - 3,870	
Number of samples	46		22	48%	24	52%
Number of samples above 1,000 cfu	17	37%	11	50%	6	25%
Number of samples between 999-300 cfu	16	35%	5	23%	11	46%

Table 3.1 Canine scent survey results for the 46 water samples taken during the August 2015 survey of the Upper Looking Glass River Watershed.

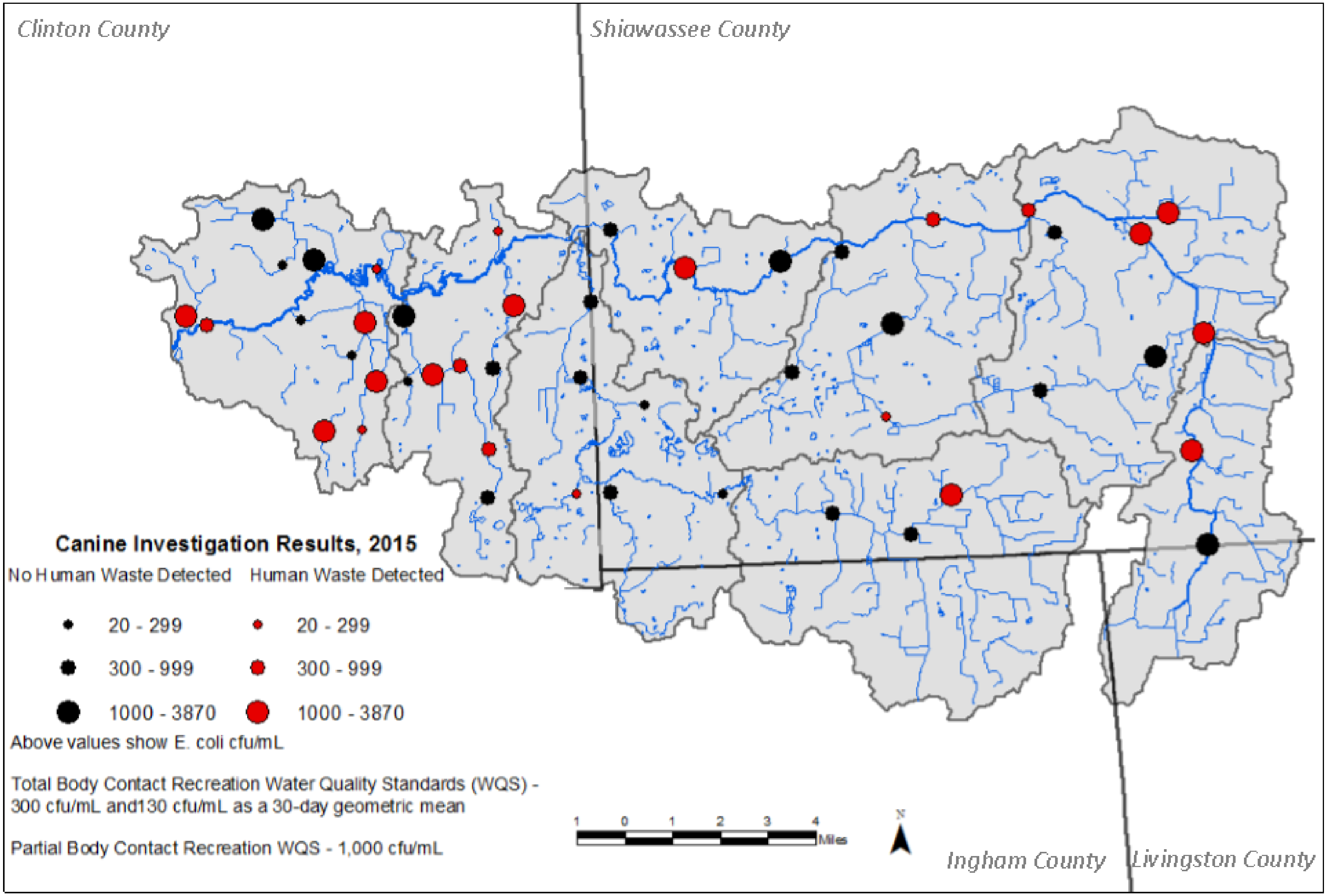

Figure 3.3 Spatial results from the canine scent survey conducted in 2015 in the Upper Looking Glass River Watershed. Values listed are E. coli colony forming units detected in water by laboratory analysis.

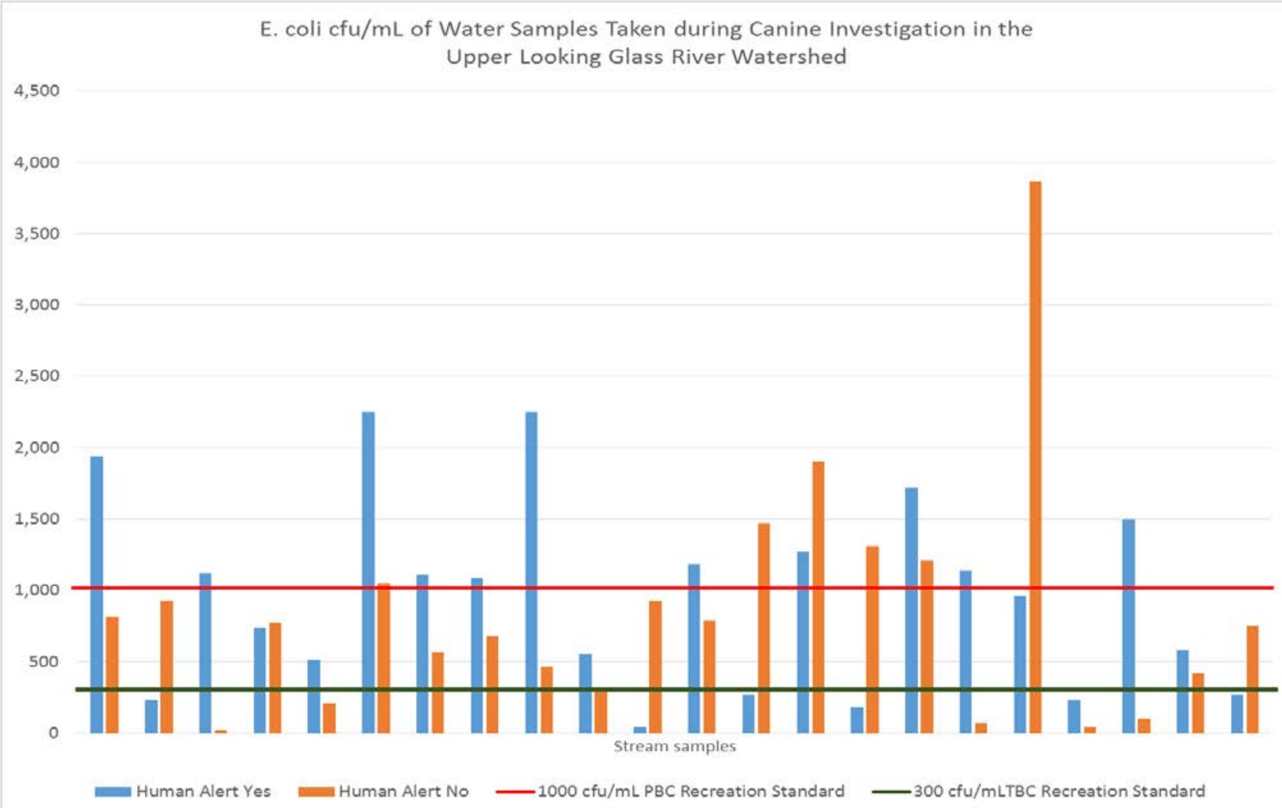

Figure 3.4 Comparison of E. coli (cfu/mL) levels to recreational WQS from water samples taken during Canine Investigation for the Upper Looking Glass River Watershed in 2015.

3.1.2 Water Quality Study

With technical assistance from MDEQ, a monitoring plan was developed in which a 30-day geometric mean for *E. coli* was established at selected sites. Samples were taken for a period of 6 weeks at 17 locations at the most downstream locations in each sub-watershed. Three samples were taken at each site representing the left, center, and right locations in the stream (Figure 3.5).

E. coli results collected from sites identified through the initial canine assessment were compared to the daily maximum and 30-day geometric mean described in the Part 4 rules, WQS, promulgated under Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, as follows:

R 323.1062 Microorganisms

Rule 62(1): All waters of the state protected for Total Body Contact Recreation shall not contain more than 130 *E. coli* per 100 milliliters (mL), as a 30-day geometric mean. Compliance shall be based on the geometric mean of all individual samples taken during 5 or more sampling events representatively spread over a 30-day period. Each sampling event shall consist of 3 or more samples taken at representative locations within a defined sampling area. At no time shall the waters of the state protected for Total Body Contact Recreation contain more than a maximum of 300 *E. coli* per 100 mL. Compliance shall be based on the geometric mean of 3 or more samples taken during the same sampling event at representative locations within a defined sampling area.

All surface waters of the state are protected for total body contact according to the Part 4 rules, as follows:

R 323.1100 Designated Uses

Rule 100(2): All surface waters of the state are designated and protected for Total Body Contact Recreation from May 1 to October 31 in accordance with the provisions of R 323.1062. Total Body Contact Recreation immediately downstream of wastewater discharges, areas of significant urban runoff, Combined Sewer Overflows (CSOs), and areas influenced by certain agricultural practices is contrary to prudent public health and safety practices, even though WQS may be met.

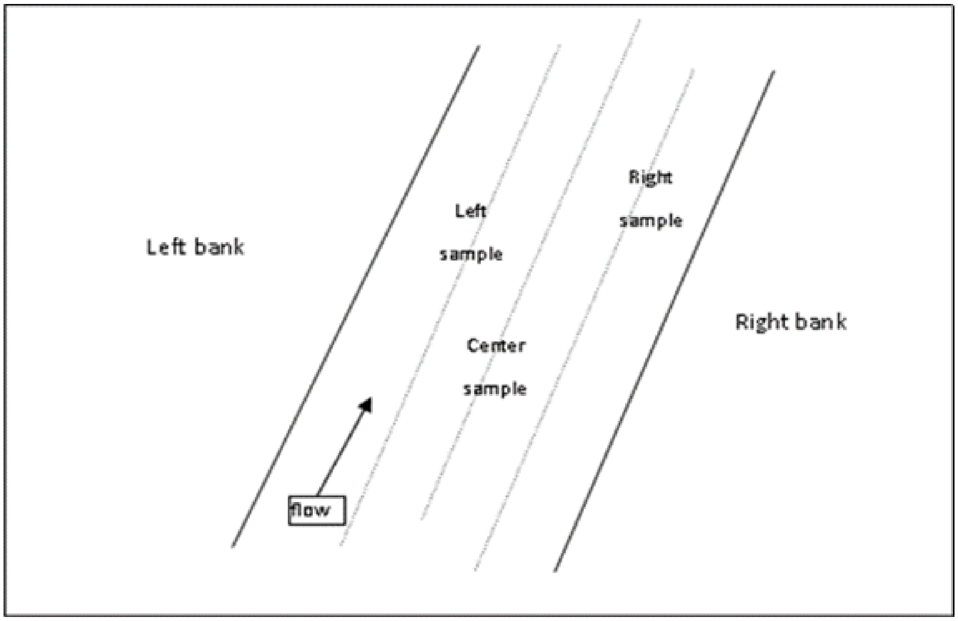

Figure 3.5 Sampling scheme for E. coli samples taken on a river or stream (Source: MDEQ)

The Owosso Wastewater Treatment Plant performed analysis following standard methods. Results from the water quality analysis found exceedances of the 300 and 1,000 *E. coli* per 100 mL WQS at all 17 locations. Samples counts were analyzed with readings up to 6,000 CFU. See Appendix 10 for E. coli study QAPP and Appendix 11 for full analysis of results. Table 3.2 and Figure 3.6 summarizes for sampling locations and numeric results. Figure 3.7 compares *E. coli* levels to recreation standards.

Site ID	Site description	Latitude	Longitude	Township name	Section	1st 30-day geometric mean CFU	2nd 30-day geometric mean CFU
Site 1	Looking Glass River - E Britton Rd	42.83548	-84.10857	Antrim	9	1,569	1,476
Site 2	Cox Drain - E Britton Rd	42.83524	-84.12334	Antrim	8	875	912
Site 3	Looking Glass River - Cork Rd	42.87889	-84.15258	Shiawassee	31	708	936

Site 4	Howard Drain - S Gale Rd	42.87402	-84.17201	Bennington	36	3,680	4,142
Site 5	Austin Creek - Miller Rd	42.86345	-84.22887	Bennington	33	2,026	2,494
Site 6	Osburn Creek - Tyrrell Rd	42.87007	-84.25984	Bennington	32	1,620	2,156
Site 7	Jones & Dunn Drain - Winegar Rd	42.85546	-84.30813	Woodhull	2	2,917	4,400
Site 8	Vermillion Creek - E Cutler Rd	42.857	-84.36407	Victor	36	868	1,051
Site 9	Graneer Drain - E Cutler Rd	42.83791	-84.40531	Bath	11	868	1,182
Site 10	Mud Creek - E Cutler Rd	42.85451	-84.44157	Victor	33	1,159	1,386
Site 11	Sleight Drain - Ballentine Rd	42.86024	-84.45852	Victor	32	748	794
Site 12	Ives Drain - E Round Lake Rd	42.87151	-84.47815	Victor	30	1,682	2,022
Site 13	Turkey Creek Drain - E Round Lake Rd	42.85653	-84.5318	Dewitt	34	922	960
Site 14	Vermillion Creek - Woodbury Rd	42.80326	-84.34801	Woodhull	28	1,067	792
Site 15	Vermillion Creek - Beardslee Rd	42.79085	-84.26714	Perry	30	1,424	1,392
Site 16	Buck Branch - W Locke Rd	42.78361	-84.2389	Perry	32	682	1,035
Site 17	McCrea Drain - W Locke Rd	42.78347	-84.21698	Perry	33	1,768	1,304

Table 3.2 E. coli investigation results for the Upper Looking Glass River Watershed.

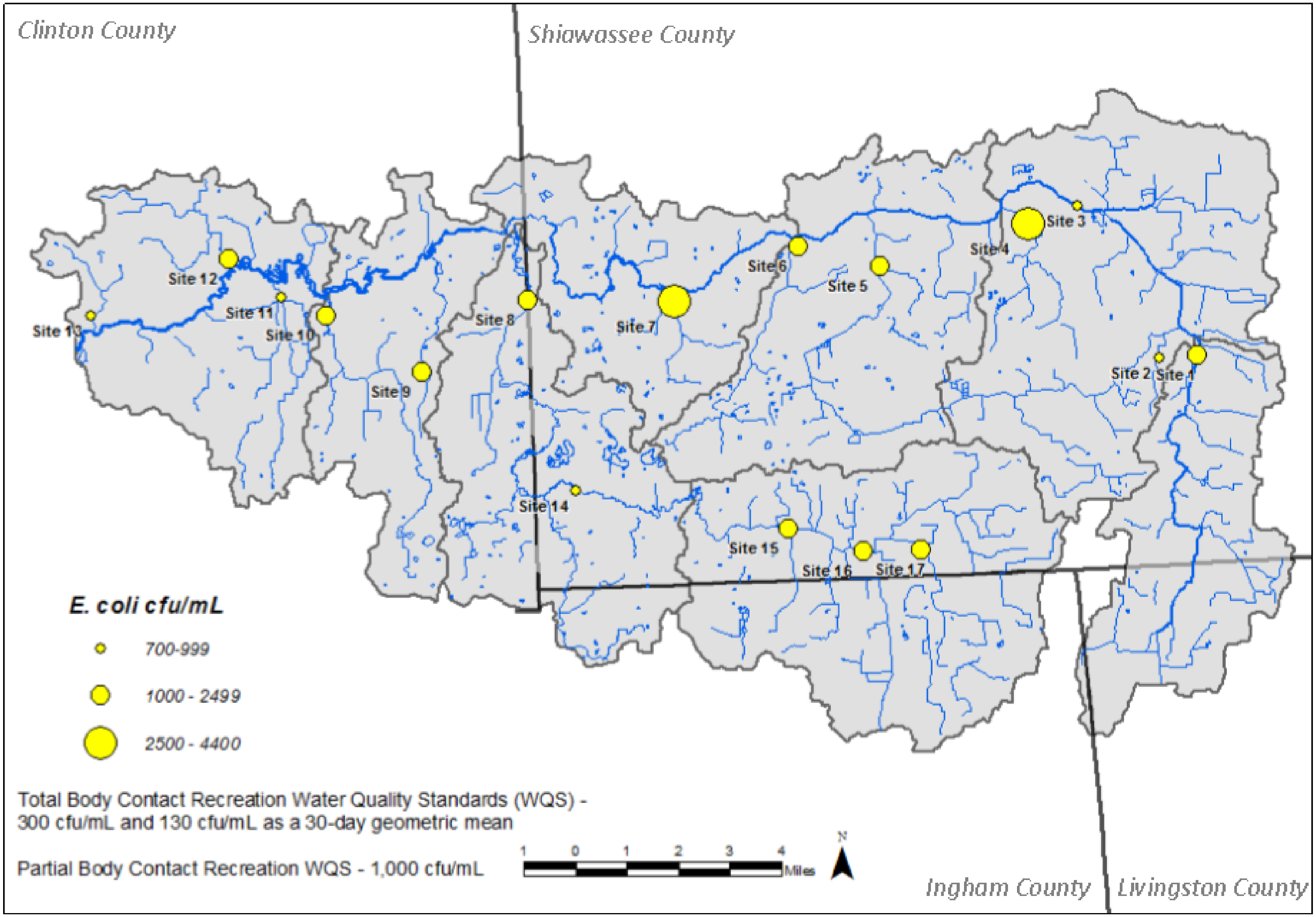

Figure 3.7 Spatial results from the 6-week E. coli investigation conducted in 2016 in the Upper Looking Glass River Watershed.

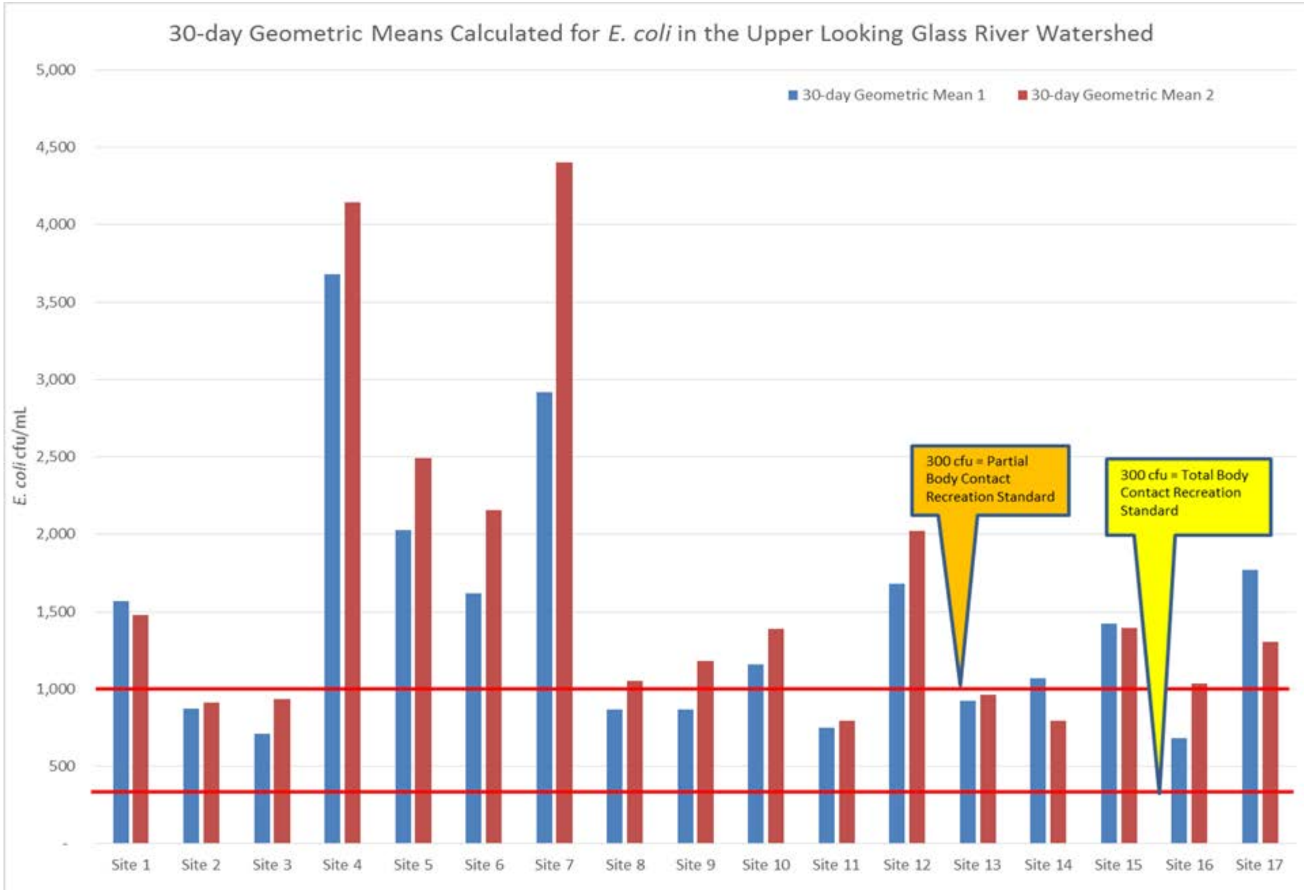

Figure 3.7 Comparison of the E. coli results (cfu/mL) from 6-week water analysis for the Upper Looking Glass River Watershed in 2016.

3.1.3 Stream Reconnaissance Summary

Methods

An assessment of the physical habitat and biological community of the Upper Looking Glass River Watershed and its tributaries was completed by the Shiawassee and Clinton Conservation Districts during the field seasons of 2014 through 2016. The purpose of the assessment was to characterize the quality of the watercourses and to provide information necessary for making recommendations for improvements in water quality. The survey was based on the Procedure No. 51 (P51) biological assessment. P51 is a rapid assessment technique that is used by the MDEQ to rate streams based upon their physical habitat and aquatic community. Selecting streams to inventory presented a challenge. The SCD utilized tools such as aerial photo review and the HIT to determine high priority sites to survey.

HIT Tool

HIT is a web-accessible tool that is designed to focus limited conservation resources on the most serious erosion and pollution problem. HIT relies on advanced geographical information systems technology and innovative applications of computer modeling. The HIT system provides data on sediment delivery and agricultural erosion based on soil types, slopes, proximity to water, and management practices. The HIT tool estimates the amount of sediment that deposits into waterways by each sub-watershed annually and in tons per acre per year. The SCD used the HIT model to rank the sub-watersheds in the ULG based on tons of sediment per acre per year. The predicted rate of sedimentation in each sub-watershed was considered when prioritizing which stream reaches to inventory during the stream reconnaissance. Estimates of nitrogen and phosphorus were then calculated using these sediment values and dominant soil types for the watershed using the “Pollutants controlled: Calculation and documentation or Section 319 watershed training manual” (MDEQ, June 1999). Based on HIT and nutrient calculations, the Howard Drain is the most critical sub-watershed to investigate. Figure 3.8 and Table 3.3 summarizes estimated sediment values from the HIT analysis.

Sub-Watershed	Acres	Sediment rate of loss (t/ac/yr)	P rate of loss (t/ac/yr)	N rate of loss (t/ac/yr)	Total Sediment loss (t/yr)	Total P loss (t/yr)	Total N loss (t/yr)
Headwaters	11,834	0.26	0.23	0.46	3,104	2,699	5,398
Howard Drain	21,493	0.19	0.17	0.33	4,077	3,545	7,090
Kellogg Drain	17,205	0.2	0.18	0.35	3,495	3,039	6,078
Buck Branch	20,735	0.2	0.17	0.35	4,120	3,583	7,165
Vermillion Creek	16,210	0.15	0.13	0.25	2,367	2,058	4,117
Leisure Lakes	11,257	0.14	0.12	0.25	1,590	1,383	2,765
Mud Creek	11,011	0.14	0.12	0.24	1,495	1,300	2,600
Turkey Creek	14,980	0.25	0.22	0.44	3,783	3,290	6,579
All	**124,725**				**24,031**	**20,897**	**41,793**

Table 3.3 Estimated sediment and nutrient loadings from Upper Looking Glass River sub-watersheds based on HIT model and Pollutants controlled: Calculation and documentation or Section 319 watershed training manual.

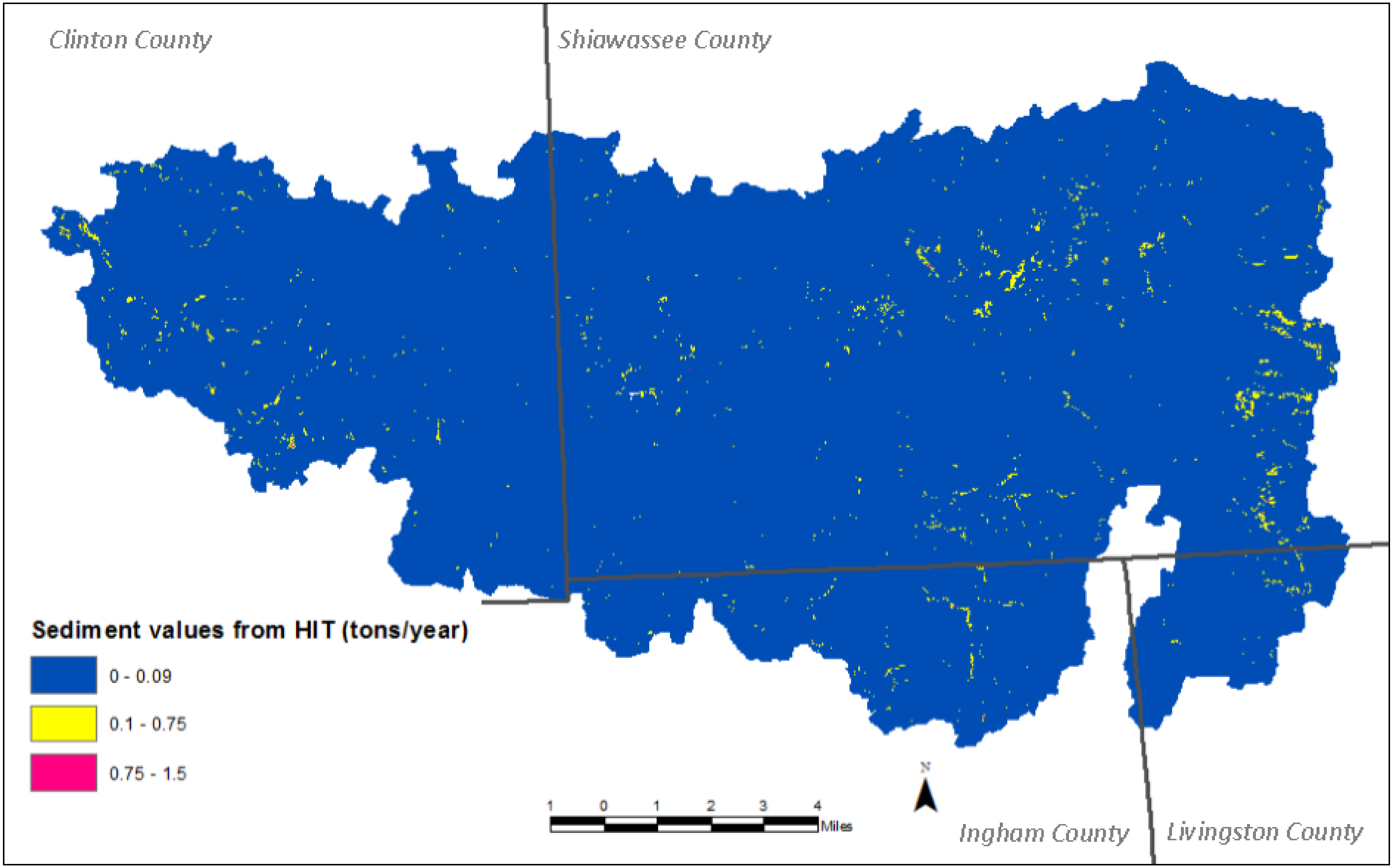

Figure 3.8 Estimated sediment values of agricultural soils lost to erosion as modeled by the High Impact Targeting (HIT) tool for the Upper Looking Glass River Watershed.

During the 2014 through 2016 field seasons, staff from the Shiawassee and Clinton Conservation Districts surveyed 138 stretches of streams in all eight sub-basins of the ULG. Surveys were conducted via teams of two individuals with one team member either wading in the stream or on the streambank obtaining photo records and one team member following along the opposite streambank documenting field observations on a Watershed Survey Data Sheet (data sheet). Data sheets included a list of assessment questions. The assessment was divided into themed sections containing a number of observational questions. Data sheets included information found in Table 3.4. See Appendix 12 for stream reconnaissance data sheet.

Pollutant Source	Dominant pollutant influence
General Information	Current precipitation
	Days since last rain
	Water color
	Water odor
	Aquatic vegetation
	Type of algae present
	Streamflow
	Stream substrate bottom
	Channel dimensions
	Riparian habitat
	Buffer width
	Land use
Stream Crossing	Type of crossing
	Construction material
	Length of culvert
	Dimensions of culvert
	Alignment of culvert
	Perching of culvert
	Turnouts present
	Extent of obstructions, if any
	Road surface type
	If erosion present, location, extent, and dimensions
Gully Erosion	If present, number, location, apparent cause, and dimensions
Streambank Erosion	If present, location, dimensions, years present, severity, and apparent cause
Livestock Type and Access	If present, animal type(s), location, and approximate number
	Was feedlot runoff or erosion present
	If present, erosion type, extent, and dimensions
Nonpoint Agricultural Sources	Location and approximate acres of contributing agricultural land
	Distance of agricultural source to stream
	If present, cropland erosion and runoff type, extent, and dimensions
Tile Outlet - Erosion and Discharge	Location, number, and diameter of tile pipes
	Pipe material
	If flowing, color and odor of discharge

Tile Outlet - Erosion and Discharge	If present, erosion type, extent, and dimensions
Residential Influence	Pollutant type
	Riparian activity
Invasive Species	Species type and location
	Density and area
Additional Comments	

Table 3.4 Information collected during stream reconnaissance surveys (see sample form in Appendix 11).

Results by Sub-Watershed

In total 29 miles of stream were inventoried in the ULG during the field seasons between 2014 and 2016. A summary of findings by sub-watershed are listed below. Table 3.5 lists the number of times a pollutant was noted. Table 3.6 lists the number of times a pollutant source was identified. Table 3.7 lists the number of times a pollutant cause was inferred. Figure 3.17 identifies stretches surveyed with numerical designation. Appendix 13 lists Stream Inventory Site Number Key and Appendix 14 provides a summary of stream segment pollutants, sources and causes identified during stream reconnaissance.

Headwaters Looking Glass River Watershed (HUC 040500040601)

`*General Findings:* A total of 31 stretches covering 9.9 miles of streams and ditches were surveyed in the Headwaters of the Looking Glass River sub-watershed. The land use in this sub-basin is a mix of agriculture, forest, and wetlands with some light residential areas. Pollutants, sources, and causes described below were observed during stream surveys performed by SCD staff.

Pollutants Identified: Sediment, nutrients, trash, and bacteria were the observed pollutants during stream reconnaissance. Of the 31 stretches surveyed, sediment was observed in 29 instances and 25 sites had evidence of nutrient loading indicated by the presence of algae and observed manure runoff. Bacteria was presumed at five locations where manure was visible in the stream. Trash was observed at three locations. Invasive Phragmites and watercress were also observed in several instances.

Pollutant Sources: Sources of sediment included gully erosion, which was observed at nine surveyed sites and streambank erosion at 11 sites. Roadways were noted as a source of sediment at 10 sites. Sources of bacteria, nutrients, and sediment observed included livestock, visible in eight locations and cropland runoff seen at 22 sites. Livestock pastures adjacent to streams were found in eight surveyed locations with algae observed at five of these sites. Wildlife pressure was widely visible throughout the survey area. Tiles discharging nutrients (indicated by the presence of algae and extensive aquatic vegetation at the outlet) were observed in three instances. The entire watershed is rural and most homes rely on on-site septic systems. Residential pressure was also observed potentially contributing pollutants at seven location and illicit dumping of trash noted twice.

Pollutant Causes: Causes were varied and included agricultural and residential influences. Agricultural runoff was observed as a source of pollution at 26 survey locations. Inadequate crop buffer was common, being noted at 17 sites contributing to erosion and potential nutrient loading. Tillage practices were contributing to sheet erosion at seven sites and roadway washing was a cause of roadway erosion at six sites. Two failing tiles or culverts were the cause of erosion. Hydrology was the cause of erosion at 10 sites. Logjams were observed in two instances potentially causing streambank erosion. Manure in runoff was observed twice, a pastured location and crop field where manure was applied as a fertilizer. Livestock pastures lacking setback were noted at nine sites. Chickens were observed in one location foraging on the edge of one streambank. Horse pastures were adjacent to the stream in three instances with one having access to the water with a visible crossing through the ditch. Residential mowing of streambanks in five sites created the potential for pollutants in runoff to enter the stream. Flooding was noted as a cause of pollutants at one location.

Comments: Implementation of agricultural BMPs such as filter strips, residue management, cover crops, pasture management and fencing, manure management, streambank armoring, septic system upgrades, residential riparian education, and information on composting and recycling would greatly reduce non-point source pollutants in this sub-watershed. Invasive species control measures and wetland protection activities would help protect high quality areas in the watershed (see Figure 3.9 for survey photos).

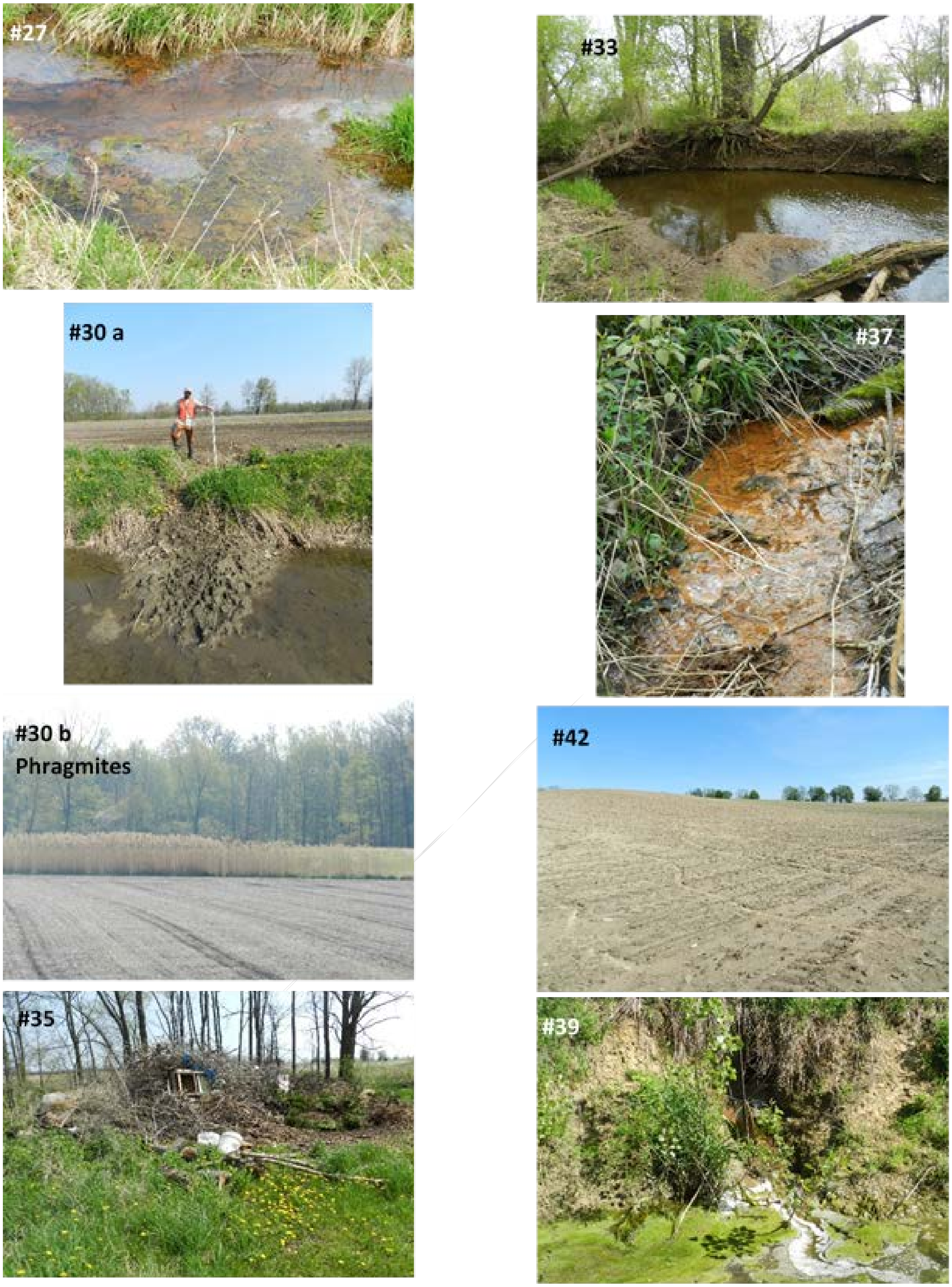

Figure 3.9 Photos from stream reconnaissance survey of the Headwaters Watershed 2014-2016. Source: Shiawassee Conservation District. 27 – Algal growth, red tint to water color and a sheen on the surface; 33 – Streambank erosion; 30 a – Gully at a deer crossing; 37 – Algae covering the substrate; 30 b – Invasive Phragmites stand; 42 – Rill erosion in crop field with little to no residue cover; 35 – Trash and yard waste pile near streambank; 39 – Tile outlet failure created a gully, outlet water with white foam, extensive algae

Howard Drain Watershed (HUC 040500040602)

General Findings: A total of 10 stretches covering 2.3 miles of streams and ditches were surveyed in the Howard Drain Watershed. The land use in this sub-basin is a mix of agriculture and forest/wetland areas with some light residential areas within the Village of Morrice. Interstate I-69 and several well-traveled state highways run through the central portion of the watershed. Pollutants, sources, and causes described below were observed during stream surveys performed by SCD staff.

Pollutants Identified: Sediment, nutrients, bacteria, and trash were the observed pollutants during the stream reconnaissance. Of the 10 stretches surveyed, all had sediment as a significant pollutant, nine had evidence of nutrient loading indicated by the presence of algae. Bacteria was presumed at one location by the presence of animal waste observed, and trash piles were present in two locations. Reed canary grass and Phragmites were also observed throughout the watershed.

Pollutant Sources: Sources of sediment included gully erosion, which was observed at one surveyed sites and streambank erosion at two sites. Roadways were noted as a source of sediment at five sites. Sources of bacteria, nutrients, and sediment observed included livestock, visible in two locations and cropland runoff seen at nine sites. Horses grazing along the ditch were observed in two locations. Wildlife pressure was widely visible throughout the survey area and noted at three sites. One instance of a tile discharging nutrients (indicated by the presence of algae and extensive aquatic vegetation at the outlet) was observed. The entire watershed is rural and most homes rely on on-site septic systems. Residential pressure was also observed potentially contributing pollutants at one location and illicit dumping of trash noted once.

Pollutant Causes: Causes were varied and included agricultural and residential influences. Agricultural runoff was observed as a source of pollution at nine survey locations. Inadequate crop buffer was common, being noted at seven sites contributing to erosion and potential nutrient loading. Tillage practices were contributing to sheet erosion at four sites and roadway washing was a cause of roadway erosion at two sites. Four failing tiles or culverts were the cause of erosion. Logjams were observed in three instances potentially causing streambank erosion. Hydrology was the cause of erosion at 10 sites. Livestock pastures were noted in the vicinity of two sites. At two locations, horse pasture without fencing or a buffer area and stream crossing was observed. A horse crossing was observed at one location where sediment and algae was noted. Flooding was noted as a cause of pollutants at two locations. Excessive wildlife was noted as a cause of bacteria and nutrients at two sites.

Co*mments:* Implementation of agricultural BMPs such as filter strips especially on sod farms, a no- or reduced tillage system, wetland restoration/protection activities, horse pasture management and fencing, septic system upgrades, residential riparian education, and information on composting and recycling would greatly reduce non-point source pollutants in this sub-watershed. Invasive species control measures and wetland protection activities would help protect high quality areas in the watershed (see Figure 3.10 for survey photos).

Figure 3.10 Photos from stream reconnaissance survey of the Howard Drain Watershed 2014-2016. Source: Shiawassee Conservation District. 100 – Producer plants to the streambank, no buffer, streambank erosion; 101 – Stream clogged up with debris and plant growth, extensive algae; 103 – Bare soil with sheet and rill erosion; 111 – Accumulation of debris in stream channel; 112 a – Tree roots growing around culvert; 112 b – Deer crossing created a gully; 113 a - Extensive duckweed and algae, inadequate buffer; 113 b – No buffer

Kellogg Drain Watershed (HUC 040500040603)

General Findings: A total of 25 stretches covering 5.2 miles of streams and ditches were surveyed in the Kellogg Drain Watershed. The land use in this sub-basin is a mix of agriculture and forest/wetland areas, and urban including the City of Perry. Interstate I-69 and several well-traveled state highways run through the central portion of the watershed. Pollutants, sources, and causes described below were observed during stream surveys performed by SCD staff.

Pollutants Identified: Sediment, nutrients, bacteria, and trash were the most commonly observed pollutants. Of the 25 stretches surveyed, 24 had sediment as a significant pollutant, 16 had evidence of nutrient loading indicated by the presence of algae. Bacteria was presumed at four locations by the presence of animal waste observed. Trash was present in two locations and organic debris observed once in a residential area. Invasive species of Phragmites and Watercress were also observed.

Pollutant Sources: Sources of sediment included gully erosion, which was observed at 11 sites, streambank erosion at four sites. Roadways were noted as a source of sediment at five sites. Sources of bacteria, nutrients, and sediment observed included livestock, visible in seven locations, cropland runoff seen at 17 sites, and wildlife noted at four sites, but activity was widely visible throughout the survey area. On three instances, a tile discharging nutrients (indicated by the presence of algae and extensive aquatic vegetation at the outlet) was observed, including a pipe extending from a sewage lagoon discharging large amounts of green-tinted water during the survey. Although there are areas with sewer in this watershed, a majority of watershed is rural and most homes rely on on-site septic systems. Residential pressure was also observed potentially contributing pollutants at seven location and illicit dumping of trash and/or organic debris noted twice.

Pollutant Causes: Causes were varied and included agricultural, urban, and residential influences. Agricultural runoff was observed as a source of pollution at 20 survey locations. Inadequate crop buffer was observed at 14 sites contributing to erosion and potential nutrient loading. Tillage practices were contributing to sheet erosion at eight sites and roadway washing was a cause of roadway erosion at four sites. Seven failing tiles or culverts were the cause of erosion. Logjams were observed in four instances potentially causing streambank erosion. Hydrology was the cause of erosion at 10 sites. Livestock pasture runoff was an issue at five locations, including places where manure stacks were observed directly on the streambank. Manure runoff either from a livestock yard, storage, or crop field application was noted three times. Residential pressures included, mowing of streambanks in three sites creating the potential for pollutants in runoff to enter the stream. In one residential stream, the carcasses of animals without skins were observed indicating possible poaching may be occurring. Lagoons from a trailer park in the Perry City Limits were being discharged at the time of the survey. The water was green and tinted the entire stretch for over a half mile. Excessive wildlife was noted as a cause of bacteria and nutrients at four sites.

Comments: Implementation of agricultural BMPs to address the improper manure storage are priority. Development of a Conservation Nutrient Management Plan is recommended for livestock producers. Practices such as manure storage facility fencing, use exclusion, watering facilities, prescribed grazing, and pasture management would all help with pollutants from livestock sources. Conservation tillage, filter strips, and grassed waterways are also recommended. Lagoon discharge monitoring, septic system upgrades are suggested for sources of bacteria and nutrients. Residential education on riparian landscaping for water quality, composting, septic system care, and poaching would also greatly reduce non-point source pollutants. Invasive species control measures and wetland protection activities would help protect high quality areas in the watershed (see Figure 3.11 for survey photos).

Figure 3.11 Photos from stream reconnaissance survey of the Kellogg Drain Watershed 2015-2016. Source: Shiawassee Conservation District. 1 a – Trash pile near stream; 1 b – Extensive aquatic plant growth; 1 c – Livestock lot adjacent to stream with inadequate buffer; 3 – Livestock pasture with uncontrolled access to stream; 4 –Residential mowing to streambank, inadequate buffer, white foam buildup in water; 6 – Buildup of a tan colored foam; 7 – Green colored water flowing out of outlet pipe; 10 a – Tile outlet created a gully; 10 b – Large gully; 67 – Invasive Phragmites and reed canary grass; 19 – Adequate buffer; 20 – Lots of debris in stream

Buck Branch Watershed (HUC 040500040604)

General Findings: A total of 34 stretches covering 9.3 miles of streams and ditches were surveyed in the Buck Branch Watershed. The land use in this sub-basin is a mix of agriculture and forest/wetland areas, and light residential, including the southern tip of the City of Perry. Highway Michigan-52 transects the watershed. Pollutants, sources, and causes described below were observed during stream surveys performed by SCD staff.

Pollutants Identified: Sediment, nutrients, bacteria, trash, and organic debris were the most common pollutants identified during the stream reconnaissance survey. Sediment was noted at 34 locations and 29 sites had evidence of nutrient loading indicated by the presence of algae. Bacteria was presumed at four locations by the presence of animal waste observed. Trash was present in one location and organic debris observed once. Phragmites and reed canary grass were observed during the inventory.

Pollutant Sources: Sources of sediment included gully erosion, which was observed at five sites and streambank erosion at 10 sites. Roadways were noted as a source of sediment at 18 sites. Sources of bacteria, nutrients, and sediment observed included livestock, visible in seven locations, cropland runoff seen at 31 sites, and wildlife noted at two sites, but activity was widely visible throughout the survey area. On six instances, a tile discharging nutrients (indicated by the presence of algae and extensive aquatic vegetation at the outlet) was observed, including one adjacent to a rural home where significant algae was observed. Although there are areas with sewer in this watershed, a majority of watershed is rural and most homes rely on on-site septic systems. Residential pressure was also observed potentially contributing pollutants at eight locations and illicit dumping of trash and/or organic debris noted twice. Potential runoff from a golf course where mowing was occurring to the streambanks was noted at three sites.

Pollutant Causes: Causes were varied and included agricultural and residential influences. Agricultural runoff was observed as a source of pollution at 31 survey locations. Inadequate crop buffer was common, being noted at 26 sites contributing to erosion and potential nutrient loading. Tillage practices were contributing to sheet erosion at six sites and roadway washing was a cause of roadway erosion at 16 sites. Four failing tiles or culverts were the cause of erosion. Logjams were observed in two instances potentially causing streambank erosion. Hydrology was the cause of erosion at 12 sites. Livestock pastures were noted in the vicinity of five sites. Manure runoff either from a livestock yard was noted twice. Residential pressures included, mowing of streambanks in five sites creating the potential for pollutants in runoff to enter the stream. Flooding was noted as a cause of pollutants at five locations. Woody debris was the cause of streambank erosion in two instances, one such tree was knocked over by a severe storm. Excessive wildlife was noted as a cause of bacteria and nutrients at two sites.

Comments: The Buck Branch Watershed has some high quality wetland and woodland areas. Several of the areas surveyed had good vegetative cover and buffer areas and no-till was observed in the watershed, protecting from soil loss on cropland. Suggested practices include filter strips, grass treatment area for pastureland, pasture management, nutrient and pesticide management, residue management, septic system upgrades, and bank stabilization structures. Education on landscaping for water quality, composting, septic system care, and animal waste management are recommended. Invasive species control measures and wetland protection activities would help protect high quality areas in the watershed (see Figure 3.12 for inventory photos).

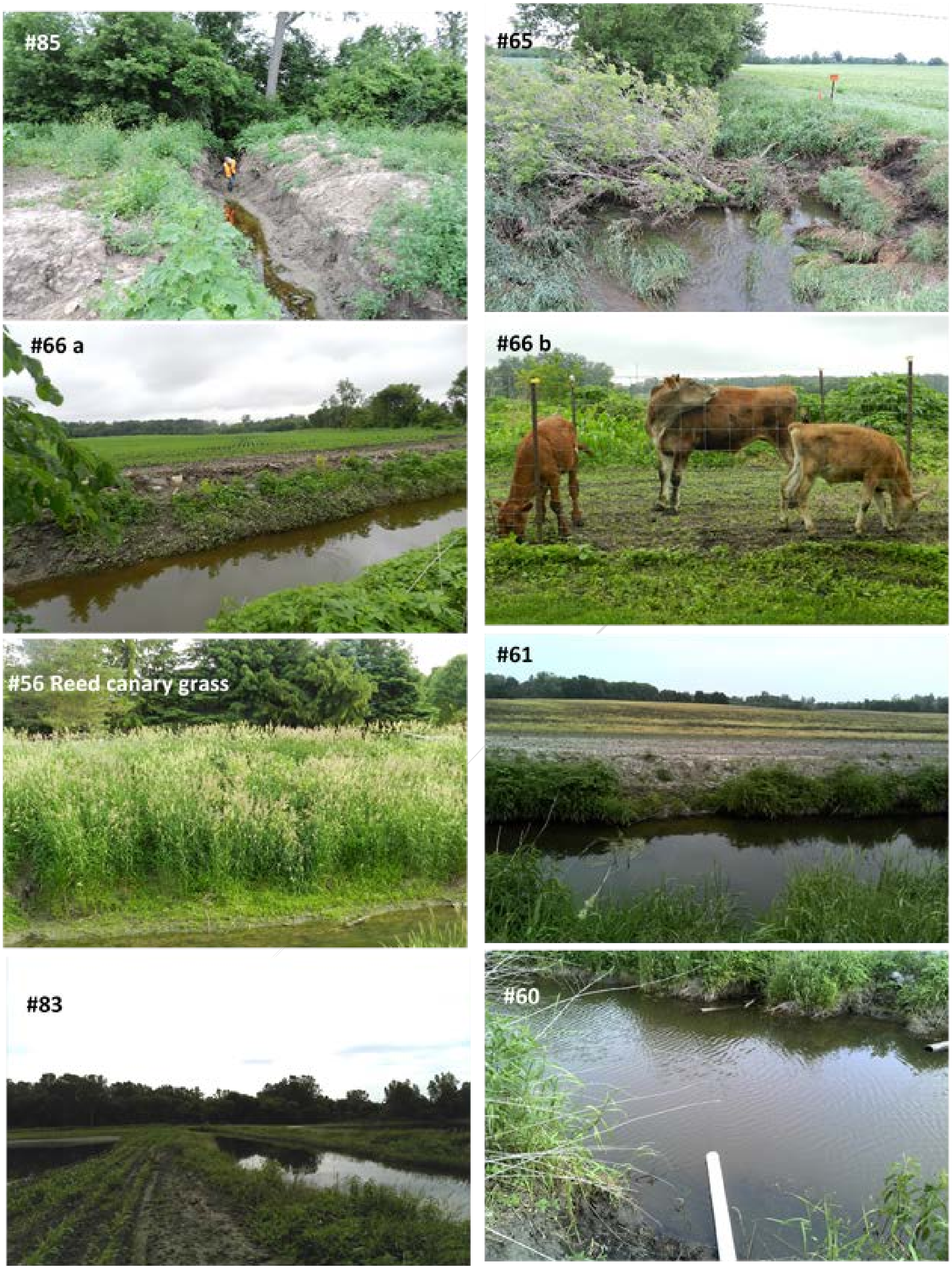

Figure 3.12 Photos from stream reconnaissance survey of the Buck Branch Watershed 2015-2016. Source: Shiawassee Conservation District. 85 – Extensive gully erosion; 65 – Excessive undercutting and streambank erosion caused tree to fall into stream; 66 a – No buffer; 66 b – Livestock adjacent to stream; 56 – Invasive reed canary grass; 61 – Tilled to streambank, no buffer; 83 – Streambank overflow caused ponding in crop field, inadequate buffer; 60 – Multiple tile outlets with evidence of erosion above outlets

Vermillion Creek Watershed (HUC 040500040605)

General Findings: A total of 10 stretches covering about 0.7 miles of streams and ditches were surveyed in the Vermillion Creek Watershed. The land use in this sub-basin is dominated by forest/wetland areas, but also includes agriculture and residential. Interstate I-69 transects the mid-southern portion of the watershed. Pollutants, sources, and causes described below were observed during stream surveys performed by SCD staff.

Pollutants Identified: Sediment and nutrients were the pollutants identified during the stream reconnaissance. Of the stretches surveyed, seven had sediment as a significant pollutant. Nutrients were observed as a pollutant at three locations as indicated by the presence of algae. Invasive purple loosestrife and reed canary grass were observed during the inventory.

Pollutant Sources: Sources of sediment and nutrients included streambank erosion, noted twice, cropland runoff, noted once, residential runoff, noted once, and runoff from roads, observed once. Residential properties adjacent to streams with little to no buffer were observed at four locations. Most homes in the watershed rely on on-site septic systems. Wildlife pressure was widely visible throughout the survey area.

Pollutant Causes: Causes were varied and included agricultural and residential influences. Agricultural runoff was observed as a source of pollution at one survey location. Inadequate crop buffer was noted at three sites contributing to erosion and potential nutrient loading. Roadway washing was a cause of roadway erosion at one site. Logjams were observed in two instances potentially causing streambank erosion. Hydrology was the cause of erosion at four sites. Residential pressures included, mowing of streambanks in three sites creating the potential for pollutants in runoff to enter the stream. Flooding was noted as a cause of pollutants at six locations.

Comments: The Vermillion Creek Watershed has some high quality wetland and woodland areas. Several of the areas surveyed had good vegetative cover and buffers. Suggested practices include filter strips and septic system upgrades on residential properties and wetland preservation in areas with existing wetlands. Education on landscaping for water quality, composting, septic system care, and pet waste management are recommended. Invasive species control measures and wetland protection activities would help protect high quality areas in the watershed (see Figure 3.13 for inventory photos).

Figure 3.13 Photos from stream reconnaissance survey of the Vermillion Creek Watershed 2015-2016. Source: Shiawassee Conservation District. 97 – I-69 passing over stream; 115 – No buffer on left bank, mowing to streambank; 118 – Invasive purple loosestrife and reed canary grass; 120 – Lack of buffer, undercutting of left streambank; 147 a – High duckweed density; 147 b – Drainage tile outlet; 96 – Flooded area adjacent to stream; 148 – Black colored water with high turbidity

Leisure Lakes Watershed (HUC 040500040606)

General Findings: A total of two stretches covering 1 mile of streams and ditches were surveyed in the Leisure Lakes Watershed. The land use in this sub-basin is a mix of agriculture, forest/wetland areas, and residential, including the majority of the City of Laingsburg. Pollutants, sources and causes described below were observed during stream surveys performed by SCD staff.

Pollutants Identified: Sediment was the most common pollutant identified during the stream reconnaissance survey. Sediment from roads was detected as a pollutant. *E. coli* bacteria was measurable at three sites analyzed during the canine survey with one of the sites having human waste alerted to by the dogs. *E. coli* bacteria level was above the TBC standard at all three sites and above the PBC water quality standard at two sites analyzed during the canine survey. Results from the 2016 *E. coli* water quality study showed that *E. coli* levels exceeded PBC standards at the sample site (4,574 CFU/mL) in this sub-watershed (Sec. 2.3.1). This was the highest recorded *E. coli* level in the ULG. No evidence of illicit connection pipes were found. Invasive reed canary grass and garlic mustard were observed during the inventory.

Pollutant Sources: Unimproved road runoff was found to be a source of sediments in the Leisure Lakes Watershed. Possible sources of bacteria include wildlife, human waste and livestock manure. Many homes in the watershed rely on on-site septic systems.

Pollutant Causes: Road runoff was found to be a contributor to pollution in the Leisure Lakes Watershed. Residential pressure could be causing stress on the watershed, most homes rely on on-site septic systems, many of which are dated. Flooding was also a concern in this watershed potentially contributing to pollutant loading.

Comments: The Leisure Lakes Watershed has some high quality wetland and woodland areas. The areas surveyed had good vegetative cover and buffers. Suggested practices include septic system upgrades on residential properties and wetland preservation in areas with existing wetlands. Education on landscaping for water quality, composting, septic system care, and animal waste management are recommended. Invasive species control measures and wetland protection activities would help protect high quality areas in the watershed (see Figure 3.14 for inventory photos). The Leisure Lakes Watershed was surveyed less than the rest of the ULG because of the relatively large woodland and wetland buffer areas along many of the waterways in this sub-watershed.

Figure 3.14 Photos from stream reconnaissance survey of the Leisure Lakes Watershed 2015-2016. Source: Shiawassee Conservation District. 13 – Deer carcass found in stream; 149 – Invasive reed canary grass; 26 – Flooded area of Jones & Dunn Drain; 27 – Short culvert, road right at stream, gravel from road eroding into stream; 28 – Stream and culvert obstructed

Mud Creek Watershed (HUC 040500040607)

General Findings: A total of six stretches covering 2 miles of streams and ditches were surveyed in the Mud Creek Watershed. The land use in this sub-basin is a mix of forest/wetland areas, agriculture and residential. Interstate I-69 passes through the southern tip of this watershed. Pollutants, sources and causes described below were observed during stream surveys performed by SCD staff.

Pollutants Identified: Sediment and nutrients were the most common pollutants identified during the stream reconnaissance survey. Three streams had evidence of nutrient loading indicated by the presence of algae. Five of the nine streams identified as containing *E. coli* by scent-trained canines were alerted to as having human waste present. *E. coli* bacteria was measurable and above the TBC standard at eight sites and above the PBC water quality standard at three sites analyzed during the canine survey. Results from the 2016 *E. coli* water quality study showed that *E. coli* levels exceeded PBC standards at both sample sites (1,377 and 1,423 CFU/mL) in this sub-watershed (Sec. 2.3.1). Invasive honeysuckle, Phragmites, garlic mustard, reed canary grass, Dame's rocket, autumn olive, Japanese barberry, common buckthorn, yellow sweet clover, and multiflora rose were observed during the inventory.

Pollutant Sources: Gully erosion was found to be the most common source of sediments and nutrients in the Mud Creek Watershed. Three of the six stretches were documented as having gully erosion. Streambank erosion was also noted as a potential source of pollutants. Wildlife pressure, especially deer, was observed in one location, but activity was widely visible throughout the survey area. One tile failure was found to have created a large gully in an agricultural crop field. Sources of bacteria include wildlife and human waste as well as potentially from livestock. Most homes in the watershed rely on on-site septic systems. Residential pressure was also observed contributing nutrients, sediment, and trash at one location.

Pollutant Causes: Agricultural tile failures, tile outlets, unstable hydrology and inadequate buffers on both residential and agricultural lands were the most common contributors to pollution found in the Mud Creek Watershed. Residential mowing to the streambank was found in two instances indicating that education on streambank landscaping for water quality is needed. Residential pressure is causing stress on the watershed, most homes rely on on-site septic systems, many of which are dated.

Comments: The Mud Creek Watershed has some high quality wetland and woodland areas. Most of the areas surveyed had good vegetative cover and buffers. Suggested practices include septic system upgrades on residential properties and wetland/woodland preservation in areas with existing wetlands and woodlands. Education on landscaping for water quality, composting, septic system care, and animal waste management are recommended. Invasive species control measures and wetland protection activities would help protect high quality areas in the watershed (see Figure 3.15 for inventory photos). The Mud Creek Watershed was surveyed less than most of the ULG because of the relatively large woodland and wetland buffer areas along the limited number of waterways in this sub-watershed.

Figure 3.15 Photos from stream reconnaissance survey of the Mud Creek Watershed 2015-2016. Source: Shiawassee Conservation District. 141 – Invasive Phragmites and reed canary grass; 143 a – Invasive garlic mustard and Dame's rocket along streambank; 143 b – Streambank erosion, failed drainage outlet, gully erosion and inadequate buffer; 143 c – Tile failure that created a gully over 80ft in length; 146 – Drainage outlet causing erosion at the streambank

Turkey Creek Watershed (HUC 040500040609)

General Findings: A total of 20 stretches covering 8 miles of streams and ditches were surveyed in the Turkey Creek Watershed. The land use in this sub-basin is dominated by agriculture with some forested and residential areas. US-127 transects the west portion of the watershed in a north-south direction. Pollutants, sources and causes described below were observed during stream surveys performed by SCD staff.

Pollutants Identified: Sediments and nutrients were the two most common pollutants identified during the stream reconnaissance survey. Of the stretches surveyed, 14 had sediment as a significant pollutant and 10 had evidence of nutrient loading. Yard waste was observed at three locations. *E. coli* bacteria was measurable at 12 sites analyzed during the canine survey with seven of the sites having human waste alerted to by the dogs. *E. coli* bacteria level was above the TBC standard at nine sites and above the PBC water quality standard at six sites analyzed during the canine survey. Results from the 2016 *E. coli* water quality study showed that *E. coli* levels exceeded PBC standards at all three sample sites (1,294, 2,545 and 1,178 CFU/mL) in this sub-watershed (Sec. 2.3.1). Invasive honeysuckle, reed canary grass, garlic mustard, Dame's rocket, Canada thistle, curly leaf pondweed, common buckthorn, and autumn olive were observed during the inventory.

Pollutant Sources: Gully erosion was found to be the most common sources of sediments and nutrients in the Turkey Creek Watershed. Gully erosion was observed at 12 surveyed sites and streambank erosion at five sites. Eight stretches were documented with residential properties and 15 stretches were documented with agricultural lands adjacent to streams. Most of these areas lacked an adequate buffer along the streams. Wildlife pressure was widely visible throughout the survey area. Tile outlets were common along agricultural areas with some found to be causing erosion. One location found livestock near the stream. Possible sources of bacteria include wildlife, human waste and livestock manure. Most homes in the watershed rely on on-site septic systems. Residential pressure was also observed contributing nutrients, sediment, yard waste, and trash.

Pollutant Causes: Causes were varied and included agricultural and residential influences. Narrow and no buffers along the streambanks of agricultural and residential lands were a common contributor to pollution found in the Turkey Creek Watershed. Conventional tillage occurring on cropland and tile failures in this watershed add to erosion and polluted runoff into streams. Livestock, wildlife, and homes with outdated or lack of septic systems, may be causing *E. coli* pollution. Residential pressure is causing stress on the watershed, indicating a need for education on septic systems and streambank landscaping for water quality.

Comments: The Turkey Creek Watershed is stressed by agricultural and residential land uses. Suggested practices include filter strips, tile repairs, no-till/reduced tillage, cover crops, residue management, grade stabilization structures, water control structures, drainage water management, grassed waterways, septic system upgrades on residential properties and wetland restoration/preservation. Education on riparian landscaping for water quality, composting, septic system care, and animal waste management are recommended. Investigation into residential tiles are suggested for sources of bacteria and nutrients. Invasive species control measures and wetland protection activities would help protect high quality areas in the watershed (see Figure 3.16 for inventory photos).

Figure 3.16 Photos from stream reconnaissance survey of the Turkey Creek Watershed 2015-2016. Source: Shiawassee Conservation District. 125 – Deer carcass found in stream; 126 – Large gully originating from crop field; 127 – Stream flooding into crop field, little to no buffer; 128 – Dredged stream with little to no buffer, conventional tillage on adjacent crop land; 130 – Tile failure that created a large gully at the streambank; 131 – Excess duckweed and algal growth; 132 – Tile failure that created a very large gully leading to streambank; 140 – Yard waste dumped along streambank with little buffer

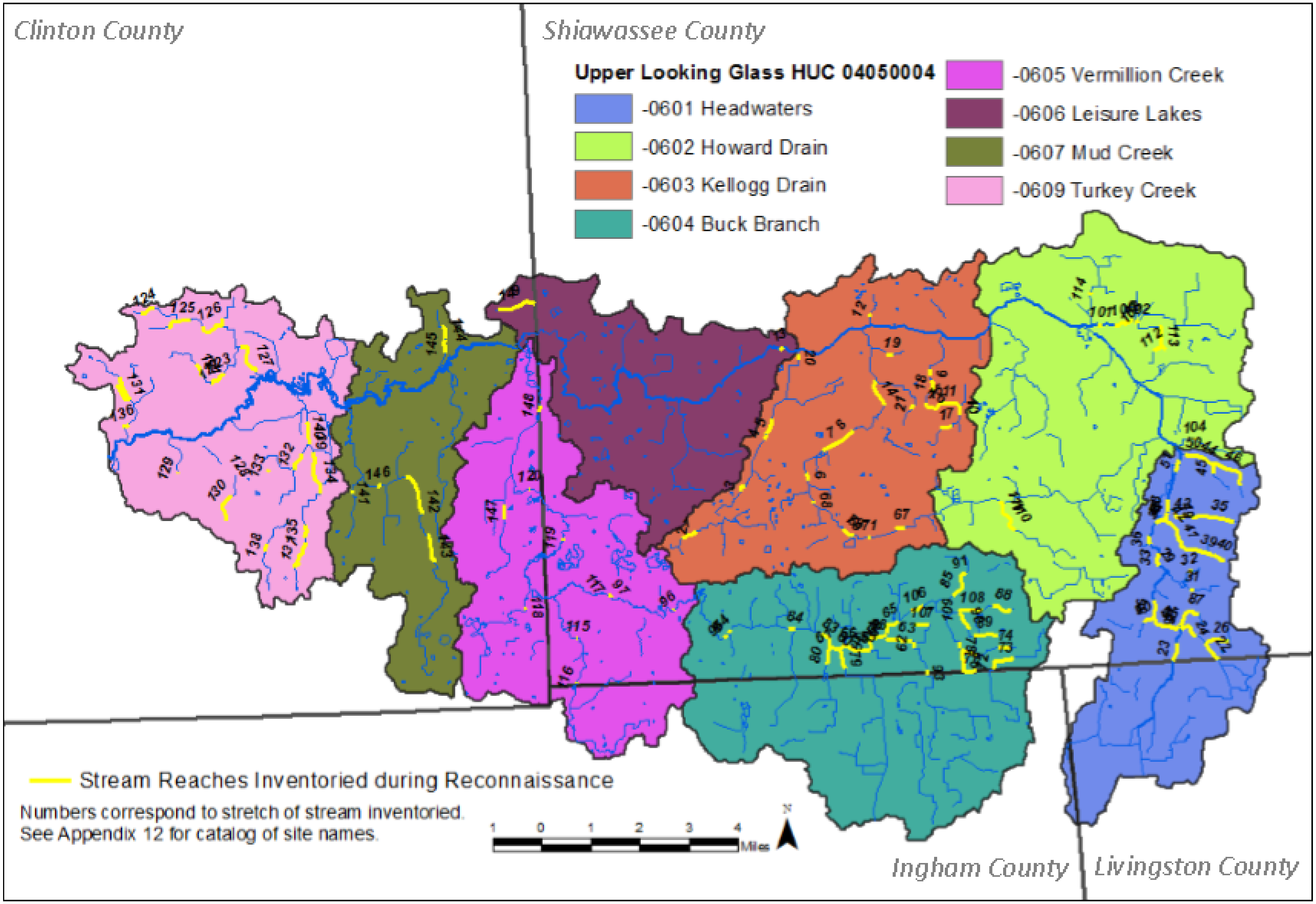

Figure 3.17 Surveyed areas in the Upper Looking Glass River Watershed during the Stream Reconnaissance Survey, Fall 2014 through Winter 2016.

Pollutant Type	Headwaters	Howard Drain	Kellogg Drain	Buck Branch	Vermillion Creek	Leisure Lakes	Mud Creek	Turkey Creek	Total Occurrences
# of Survey Stretches	31	10	25	34	10	2	6	20	138
Distance surveyed (miles)	9.9	2.3	5.2	9.3	0.7	0.9	2.4	7.6	38.3
Sediment	29	10	24	34	7	1	3	18	126
Nutrients	25	9	16	29	3	0	4	13	99
Bacteria*	5	1	4	4	0	1	0	2	17
Trash	3	1	2	1	0	0	1	1	9
Organic Debris	0	0	1	1	0	0	1	2	5
Total Pollutant Occurrences	62	21	47	69	10	2	9	36	256

*Table 3.5 Number of times pollutants were identified during stream reconnaissance surveys in the Upper Looking Glass River Watershed. *Bacteria indicated by observation of manure and/or scat.*

Pollutant Source	Headwaters	Howard Drain	Kellogg Drain	Buck Branch	Vermillion Creek	Leisure Lakes	Mud Creek	Turkey Creek	Total Occurrences
# of Survey Stretches	31	10	25	34	10	2	6	20	138
Distance surveyed (miles)	9.9	2.3	5.2	9.3	0.7	0.9	2.4	7.6	38.3
Cropland	22	9	17	31	1	1	3	9	93
Roadway	10	5	5	18	1	1	0	0	40
Livestock/Manure /Pasture	8	2	7	5	0	0	1	0	23
Streambank Erosion	11	2	4	10	2	0	1	4	34
Gully Erosion	9	1	11	5	0	0	3	12	41
Residential	7	1	7	8	4	0	4	9	40
Wildlife	0	3	4	2	0	0	2	4	15
Illicit Dumping	2	1	2	2	0	0	1	2	10
Tile with Algae	3	1	3	6	0	0	0	3	16
Golf course	0	0	0	3	0	0	0	0	3
Total Source Occurrences	72	25	60	90	8	2	15	43	315

Table 3.6 Number of times pollutant sources were identified during stream reconnaissance surveys in the Upper Looking Glass River Watershed.

Pollutant Type	Headwaters	Howard Drain	Kellogg Drain	Buck Branch	Vermillion Creek	Leisure Lakes	Mud Creek	Turkey Creek	Total Occurrences
# of Survey Stretches	31	10	25	34	10	2	6	20	138
Distance surveyed (miles)	9.9	2.3	5.2	9.3	0.7	0.9	2.4	7.6	38.3
Agricultural Runoff	26	9	20	31	1	2	2	14	105
Inadequate Buffer	17	7	14	26	3	0	1	6	74
Manure in Runoff	2	0	3	2	0	0	0	0	7
Excessive Wildlife	0	2	4	2	0	1	2	4	15
Residential Mowing	5	0	3	5	3	0	0	9	25
Hydrology	10	3	4	12	4	0	2	5	40
Livestock in Vicinity	9	2	5	5	0	0	1	0	22
Road Washing	6	2	4	16	1	1	0	0	30
Tillage	7	4	8	6	0	0	0	4	29
Failing Tile or Culvert	2	4	7	4	0	0	3	7	27
Logjam	2	3	4	2	2	0	2	2	17
Lack of Education	2	1	2	2	0	0	0	2	9
Lagoon discharge	0	0	3	0	0	0	0	0	3
Flooding	1	2	0	5	6	0	3	4	21
Total Occurrences	89	39	81	118	20	4	16	57	424

Table 3.7 Number of times pollutant causes were identified during stream reconnaissance surveys in the Upper Looking Glass River Watershed.

3.1.4 Road-Stream Crossing Survey and Evaluation

Road-stream crossing surveys are important in helping to determine impairments to a watershed. A road-stream crossing survey can locate erosion issues that can contribute to sediment and nutrient loading in the waterway. These surveys can also locate potential points of failure that can be harmful to humans and wildlife. Many fish species and macroinvertebrates rely on small migrations up and down streams to survive. A road-stream crossing survey can show where there are connectivity issues that cause hindered passage for aquatic organisms. When a culvert under a road is the wrong size, misaligned with the stream or perched, there is a significant barrier to passage for most aquatic organisms. Misaligned, improperly sized, or perched culverts also lead to erosion issues. A misaligned crossing causes scouring where the stream tries to take a more natural path, while interrupted flow from undersized culverts often causes erosion issues around the sides of the crossing or on the stream banks. Extreme weather events can cause washouts of undersized or misaligned road-stream crossings and lead to further passage issues for aquatic migration. Gullies and washouts at road-stream crossings are often patched with riprap to help alleviate erosion, but this is only a temporary fix and is frequently not properly addressed until a larger issue arises.

Upper Looking Glass Watershed Road-Stream Crossing Evaluation

The Michigan Department of Natural Resources (DNR) has a protocol for road-stream crossing surveys used widely across the state. This protocol assures that all road-stream crossing surveys are conducted in a way that assures the integrity of the data as well as gathers suitable information so that many different groups can use the data in an impactful way. For this WMP, the DNR road-stream crossing survey was adapted to evaluate crossings for potential issues in a qualitative way to estimate the probability of impairments on road-stream crossings throughout the watershed (see Appendix 15 for data sheet). The parameters of the evaluation included: 1) limiting road-stream crossings surveyed to those just upstream of the main stem of the Looking Glass River, 2) a shortened road-stream crossing survey datasheet that included only information that could be quickly observed, and 3) assessing the road-stream crossing data as a representation of the rest of the watershed rather than as a single data point.

This evaluation was also used to determine whether a road-stream crossing survey using the full DNR protocol would be valuable to assess watershed condition in the future. It will serve as an indicator of the potential impact that road-stream crossings are having on the watershed and can supplement data collected through the stream reconnaissance survey. The Clinton Conservation District and Shiawassee Conservation District investigated 41 sites between October and December 2016. 73% of surveyed crossings are in Shiawassee County and 27% in Clinton County, which is an accurate representation of the land mass of the watershed in each of the counties. Figure 3.21 and Table 3.8 includes all crossings evaluated. Also included are sediment losses in tons per year for erosion noted during the survey. Rates were calculated using the MDEQ Pollutants Controlled Calculation and Documentation for Section 319 Watershed Training Manuals (MDEQ 1999). See Appendix 16 for site ID and pollutant summary.

Sub-watershed	Latitude	Longitude	Drain Name	Sediment value (tons/yr)
Headwaters	42.785	-84.104	Colburn & Keeder JT Drain	0.2
Headwaters	42.792	-84.104	Unknown	0.4
Headwaters	42.798	-84.104	Unknown	0
Headwaters	42.804	-84.105	Unknown	0
Headwaters	42.810	-84.105	Griffith & Morgan Drain	0.4
Headwaters	42.821	-84.103	Peck & Clay Drain	0.7
Headwaters	42.826	-84.116	Unknown	0
Headwaters	42.838	-84.101	Arnold & Hill Drain	0.3
Howard Drain	42.842	-84.101	Skinner Drain	0
Howard Drain	42.835	-84.123	Cox Drain	0
Howard Drain	42.835	-84.131	Grub Creek	0.4
Howard Drain	42.855	-84.108	Fox Drain	0
Howard Drain	42.857	-84.124	Unknown	0
Howard Drain	42.857	-84.147	Atherton Drain	0
Howard Drain	42.877	-84.138	Obert Drain	0.1
Howard Drain	42.887	-84.141	Perry Township Drain	0
Howard Drain	42.874	-84.172	Howard Drain	1.1
Kellogg Drain	42.864	-84.207	Bennington & Perry Drain	0
Kellogg Drain	42.883	-84.230	Wright Drain	0
Kellogg Drain	42.871	-84.231	Kellogg Drain	0
Kellogg Drain	42.871	-84.224	Morris #2 Drain	3
Kellogg Drain	42.871	-84.221	Morris #2 Drain	0
Howard Drain	42.872	-84.169	Howard Drain	0.4
Kellogg Drain	42.885	-84.229	Wright Drain	0
Kellogg Drain	42.870	-84.260	Osburn Creek Drain	0
Leisure Lakes	42.855	-84.308	Jones & Dunn Drain	0
Leisure Lakes	42.855	-84.311	Unknown	0
Leisure Lakes	42.868	-84.315	Cook & Rome Drain	0.1
Howard Drain	42.856	-84.147	Atherton Drain	0
Howard Drain	42.835	-84.132	Grub Creek	0
Vermillion Creek	42.857	-84.364	Vermillion Creek	0
Mud Creek	42.880	-84.401	No Name	0

Mud Creek	42.854	-84.442	Mud Creek	0.2
Leisure Lakes	42.889	-84.365	Miller Drain	0
Mud Creek	42.838	-84.405	Graneer Drain	0
Turkey Creek	42.923	-84.287	See Drain	0
Turkey Creek	42.857	-84.532	Turkey Creek	0
Turkey Creek	42.842	-84.510	No Name	0.1
Turkey Creek	42.860	-84.458	Sleight Drain	0
Turkey Creek	42.855	-84.484	Clemens Drain	1.4
Turkey Creek	42.842	-84.492	No Name	1.4

Table 3.8 Road-Stream crossing locations and erosion rates calculated for Upper Looking Glass River inventory

Results

The primary issues observed at road-stream crossings during this evaluation are summarized in Table 3.9. A percent of total crossings is given for each potential issue.

	Physical		Erosion		Other
59	% with upstream ponding	**44**	% with erosion present	**68**	% gravel road-surface
32	% with scour pools	**37**	% with gullies at crossing	**54**	% with invasive species
27	% Misaligned	**15**	% plugged more than 1/3		
10	% Perched	**7**	% with scour on banks		
7	% Culvert rusted through				

Table 3.9 Road-Stream Crossing Impairments by percent of total surveyed crossings

Physical Issues

Over half of crossings surveyed had upstream ponding indicating that crossing structures are undersized. In contrast, less than a third had scour pools, potentially due to the flat topography, and therefore, a slow-moving nature to the watershed's drainage. Fish passage may be a minor issue; perched culverts comprise 10% of the surveyed crossings. Figure 3.18 depicts an example of road crossing upstream ponding in the watershed.

Figure 3.18 Upstream ponding from an undersized and perched culvert, Howard Drain culvert at Tyrrell Road – Howard Drain sub-watershed, Shiawassee County, Site 23.

Erosion Issues

Erosion was present at 44% of the crossings surveyed, with a total erosion of approximately 11 tons of sediment per year. Approximately, 48% of the sediment comes from destabilized banks near crossings. The bank destabilization could potentially be a result of crossings that are misaligned, undersized or have otherwise congested flow. Many road-stream crossings also have gullies formed from sediment eroding from the sides and tops of the crossing structures (Figure 3.19).

Figure 3.19 Severe gully erosion at Turkey Creek crossing at Cutler Road - Turkey Creek sub-watershed, Clinton County, Site 37.

Other Issues

Gravel roads make up 68% of the road surfaces at the survey sites. As compared to crossings with paved road surfaces, maintenance of gravel road surfaces can play a significant role in the integrity of a road-stream crossings with gravel surfaces. Improper crossing construction can lead to easy flow paths from the roadway into the stream. Two crossings have road gravel that falls directly into the waterway (See Figure 3.20). Erosion from roadways is potentially a large contributor to sediment and chemicals in the stream.

Figure 3.20 Road gravel eroding directly into waterway at unknown stream crossing at Winegar Road - Leisure Lakes sub-watershed, Shiawassee County, Site 27.

Summary

A comprehensive road-stream crossing survey utilizing the Michigan DNR protocol in the ULG would be valuable to assessing the watershed condition in the future. Each of the sub-watersheds had crossings with an indication of "needs future evaluation". This shows that the problems are likely not isolated to a certain land use or area. While sedimentation due to erosion occurred more often in heavy agricultural sub-watersheds, there are also problems with erosion from gravel roads (present throughout the watershed) and in areas of residential influence. The ULG will benefit from a comprehensive road-stream crossing survey utilizing the protocol set by the Michigan DNR because it will help to establish partnerships and improve overall water quality. Figure 3.21 shows stream crossing locations investigated with estimated sediment loss rates from erosion.

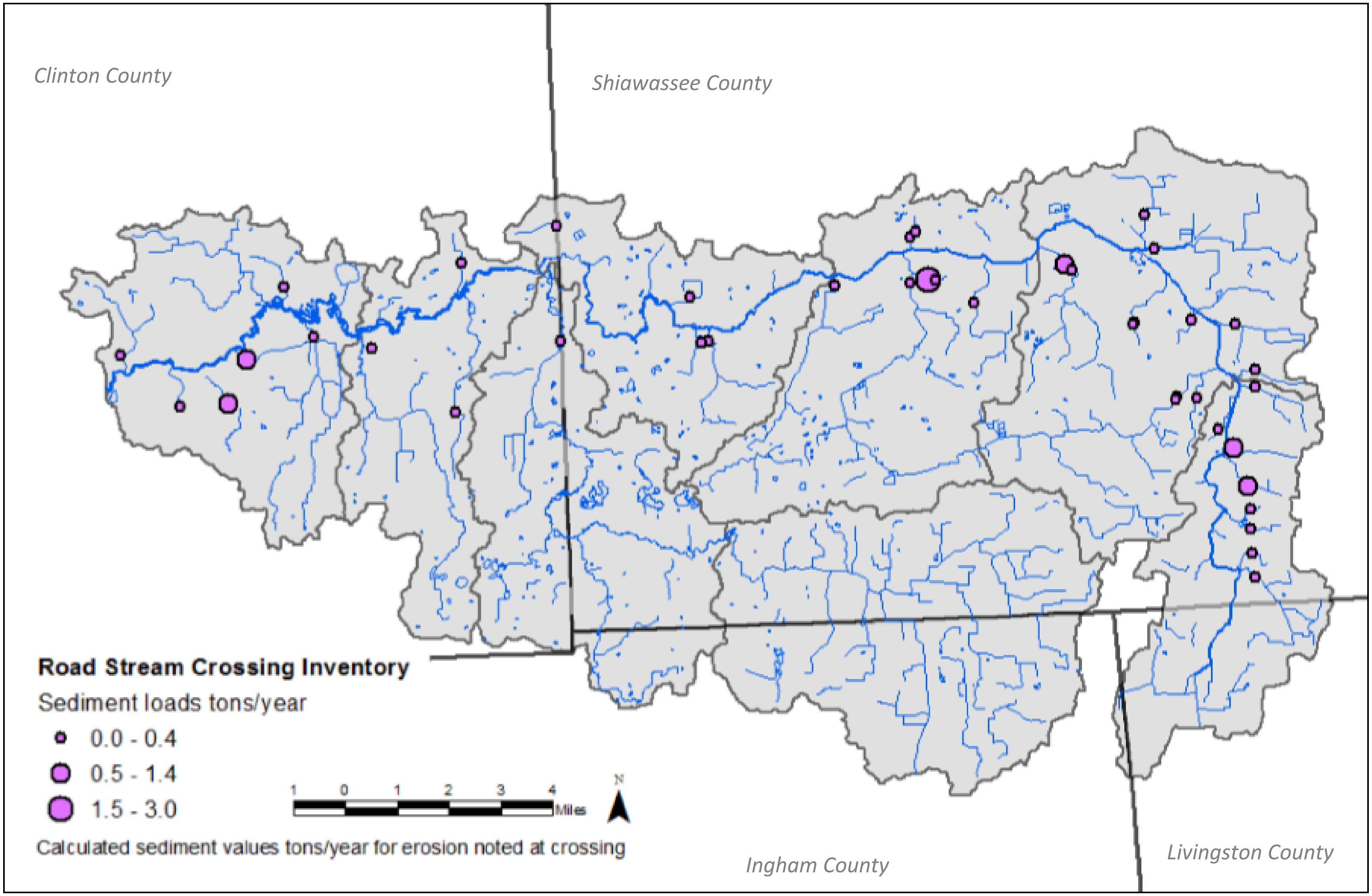

Figure 3.21 Road stream crossing inventory locations with sediment loss calculated (tons per year) for erosion noted at time of investigation in the Upper Looking Glass River Watershed, Winter 2016.

3.1.5 Inventory Summary

Table 3.10 and Figure 3.22 summarizes findings from inventories conducted in the Upper Looking Glass River Watershed for the development of this watershed management plan.

Sub-Watershed	Sediment load calculated per mile of stream inventoried (tons/ac)	Number of sites where algae noted during stream survey*/number of sites surveyed	Number of water samples taken with human waste /number samples taken	Number of canine investigate samples exceeding WQS for TBC (>300 cfu)	Number of canine invested samples exceeding WQS for PBC recreation (>1,000cfu)	Number of samples exceeding TBC recreation WQS WITH human waste detected	Number of samples exceeding PBC recreation WQS WITH human waste detected	Number of 30-day geometric means calculated above TBC recreation WQS	Number of 30-day geometric means calculated above PBC recreation WQS
Headwaters	4.9	17/31	1/2	2	2	1	1	1	1
Howard Drain	1.6	8/10	4/7	7	4	4	3	1	4
Kellogg Drain	6.8	11/25	3/6	4	1	1	1	2	2
Buck-Branch	10	17/34	1/3	3	1	1	1	3	3
Vermillion Creek	3.3	2/10	1/6	3	0	0	0	2	1
Leisure Lakes	0	0/2	1/3	2	3	1	1	1	1
Mud Creek	4.3	1/6	5/9	7	4	4	3	2	2
Turkey Creek	7.8	9/20	7/12	7	6	5	4	3	1
See Sections 3.1 for a discussion about watershed inventory findings. See Section 3.2.2 for Sediment load calculation procedure. *Excessive algal growth indicates elevated nutrient levels, which could be caused by the presence of *E. coli*									

Table 3.10 Summary of pollutant findings from inventories in the Upper Looking Glass River Watershed.

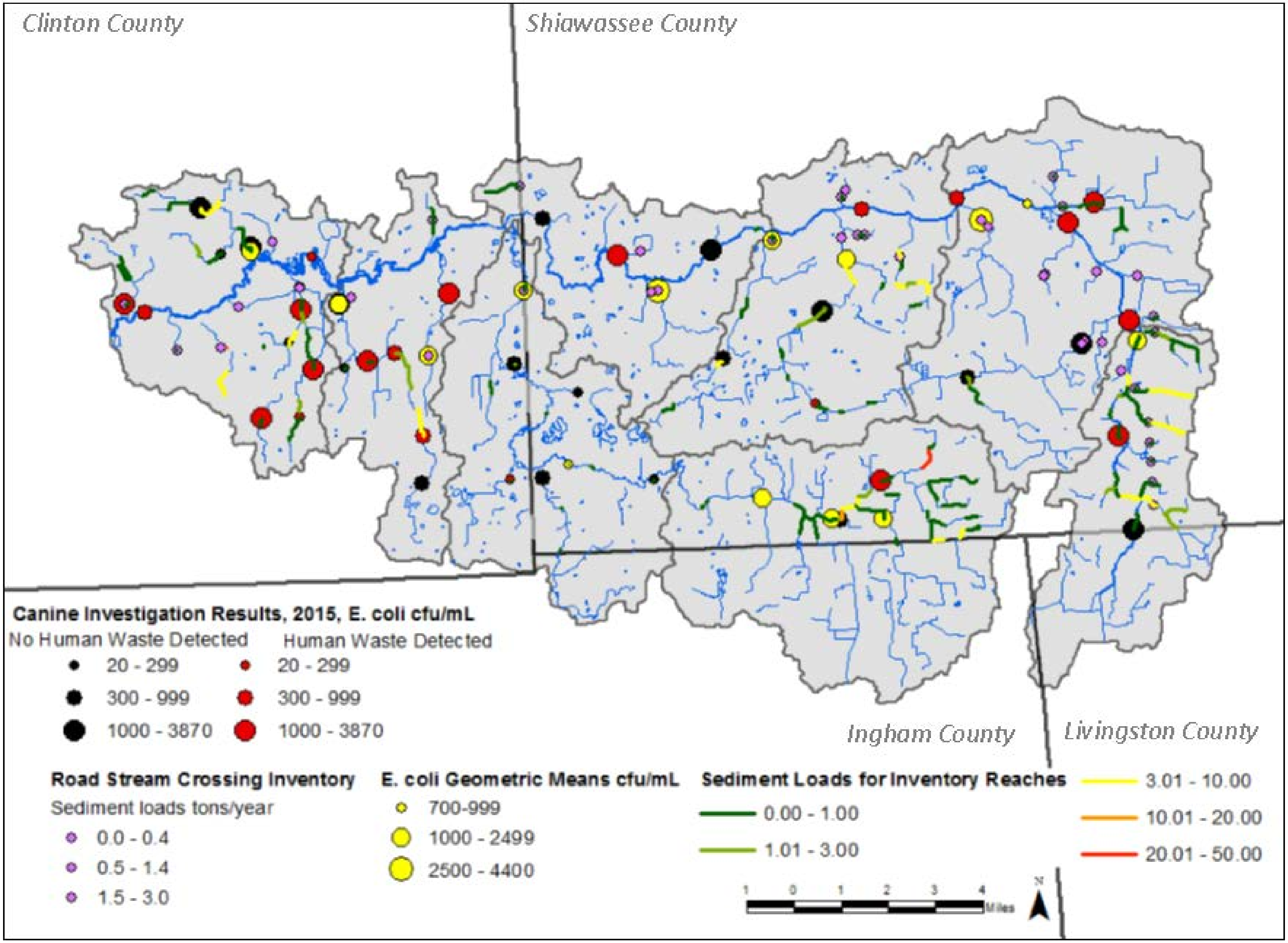

Figure 3.22 Inventory findings from Canine Investigation, Water Quality Study, Stream Reconnaissance Survey and Road Stream Crossing Inventory in the Upper Looking Glass River Watershed.

3.2. Critical Areas

Critical areas were identified for each prioritized pollutant type based on findings from the inventory process. Pollutants and sources were inferred using data collected through stream reconnaissance, surveys, canine investigations, water quality sampling results, road stream crossing survey, review of existing monitoring data, pollutant loads calculations from inventories, and guidance from Steering Committee members. Critical areas are described in this Section.

3.2.1. Bacteria and Pathogen Focus

Bacteria and pathogens in surface water create hazards for human and environmental health. The presence of Escherichia coli (*E. coli*) in water is a strong indication of recent sewage or animal waste contamination. *E. coli* is a type of fecal coliform bacteria commonly found in the intestines of animals and humans. Water for drinking and recreation is often tested for fecal coliform to indicate whether *E. coli* and other bacteria are present. *E. coli* contamination can come from many sources, including illicit connection discharge pipes, failing or failed septic systems, municipal water treatment plant overflows, or runoff containing pet waste or manure.

E. coli is hazardous because it can produce a powerful toxin that can cause serious illness. Symptoms are variable and include severe bloody diarrhea, abdominal cramping, vomiting, and skin, ear, respiratory, eye, neurologic and wound infections. Children under the age of five, the elderly, and people whose health is immune-compromised are especially at risk.

When *E. coli* exceeds the allowable level in recreational waters, beaches, lakes, and rivers, swimming and fishing areas are often closed. The thresholds of bacterial levels for public water systems set by the Safe Water Drinking Act are more stringent to keep drinking water safe. However, much of the U.S. population uses groundwater that is not regulated. It is the homeowner's responsibility to have their well water routinely tested to ensure that well water is safe for drinking.

The U.S. Environmental Protection Agency (USEPA) Clean Water Act requires Michigan water bodies that are not attaining one or more designated use to establish Total Maximum Daily Loads (TMDLs) to enable water quality standards to be met and maintained. A TMDL is a calculation of the maximum amount of a pollutant that a water body can receive and still meet applicable water quality standards. The TMDL process establishes the allowable loadings of pollutants for a water body based on the relationship between pollution sources and in-stream water quality conditions. TMDLs provide a basis for determining the pollutant reductions necessary from both point and NPS pollution to restore and maintain the quality of their water resources. Based on levels of *E. coli* in water samples collected over a period of at least 30 days, streams in the Upper Looking Glass River Watershed do not meet WQS for Total Body Contact Recreation and Partial Body Contact Recreation. Results from the analysis conducted were submitted to the MDEQ for inclusion in a Statewide Total Maximum Daily Load (TMDL) report, which is currently under development for *E. coli*. As a result, Upper Looking Glass Waterbodies will likely be listed as impaired in the 2018 Water Quality and Pollution Control in Michigan Sections 303(d), 305(b), and 314 Integrated Report.

The Clean Water Act (CWA) requires Michigan to prepare a biennial report on the quality of its water resources as the principal means of conveying water quality protection/monitoring information to the United States Environmental Protection Agency (USEPA) and the United States Congress. The Integrated Report satisfies the listing requirements of Section 303(d) and the reporting requirements of Section 305(b) and 314 of the CWA. The Section 303(d) list includes Michigan water bodies that are not attaining one or more designated use and require the establishment of TMDLs to meet and maintain Water Quality Standards.

Human Sources

Human sources of bacteria and pathogens were identified as an issue in the Watershed based on an analysis of canine scent results (Section 3.1.1), laboratory analysis of water samples (Section 3.1.2), and the likelihood of rural homes with septic systems (Section 2.3.3) that may be failing. Targeting rural homes with a septic system approval date of 1997 or older with system replacements will greatly improve water quality. Figure 3.23 displays critical areas of the Watershed where rural homes should be investigated for replacement. Figure 3.23 also shows homes in the Watershed that may have the capacity to connect to municipal service once it has been deemed that a septic system has outlasted its lifespan. These areas are considered critical based on data collected during canine investigations indicating human waste is present, high levels of *E. coli* bacteria in water samples taken during this investigation, 30-day geometric mean of *E. coli* exceeding WQSs (Section 3.1.2), and estimated number of homes with septic system as determined by aerial survey of rural homes in the ULG (Section 2.3.3). State of Michigan estimates that a minimum of 10% of septic systems are in a state of failure. That, combined with findings from the Shiawassee County Point of Sale Program that 25% of systems are not in compliance with the ordinance and 7% are failing, confirms that human waste is present in surface water as a result of failing septic system.

Non-human Sources

Non-human sources of bacteria and pathogens include waste from domestic and wild animals. In the Watershed, domestic animals, manure application, and wildlife presence were noted during the stream reconnaissance inventory (Section 3.1.3). Water samples analyzed for *E. coli* levels during the canine investigation showed 17 samples exceeded WQS for Partial and/or Total Body Contact Recreation that did NOT have an alert to human waste (Section 3.1.1). Wildlife also contributes non-human source as noted during the stream reconnaissance (Sections 3.1.3) and 30-day geometric mean of *E. coli* exceeding WQSs (Section 3.1.2). Figure 3.24 identified targeted critical locations for targeting agricultural sources of pathogens and bacteria.

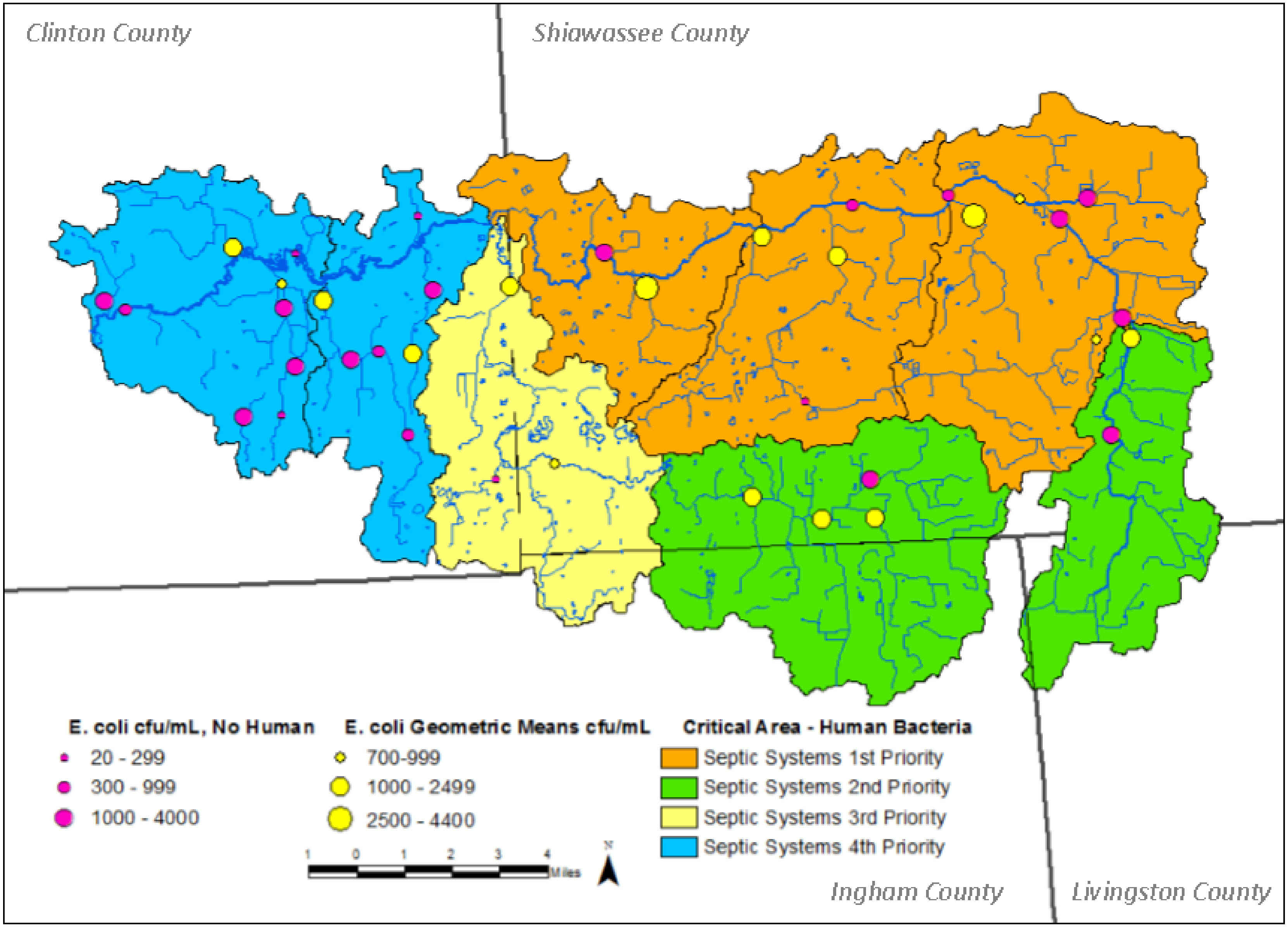

Figure 3.23 Critical areas for targeting human sources of bacteria based on inventory data collected during watershed planning process.

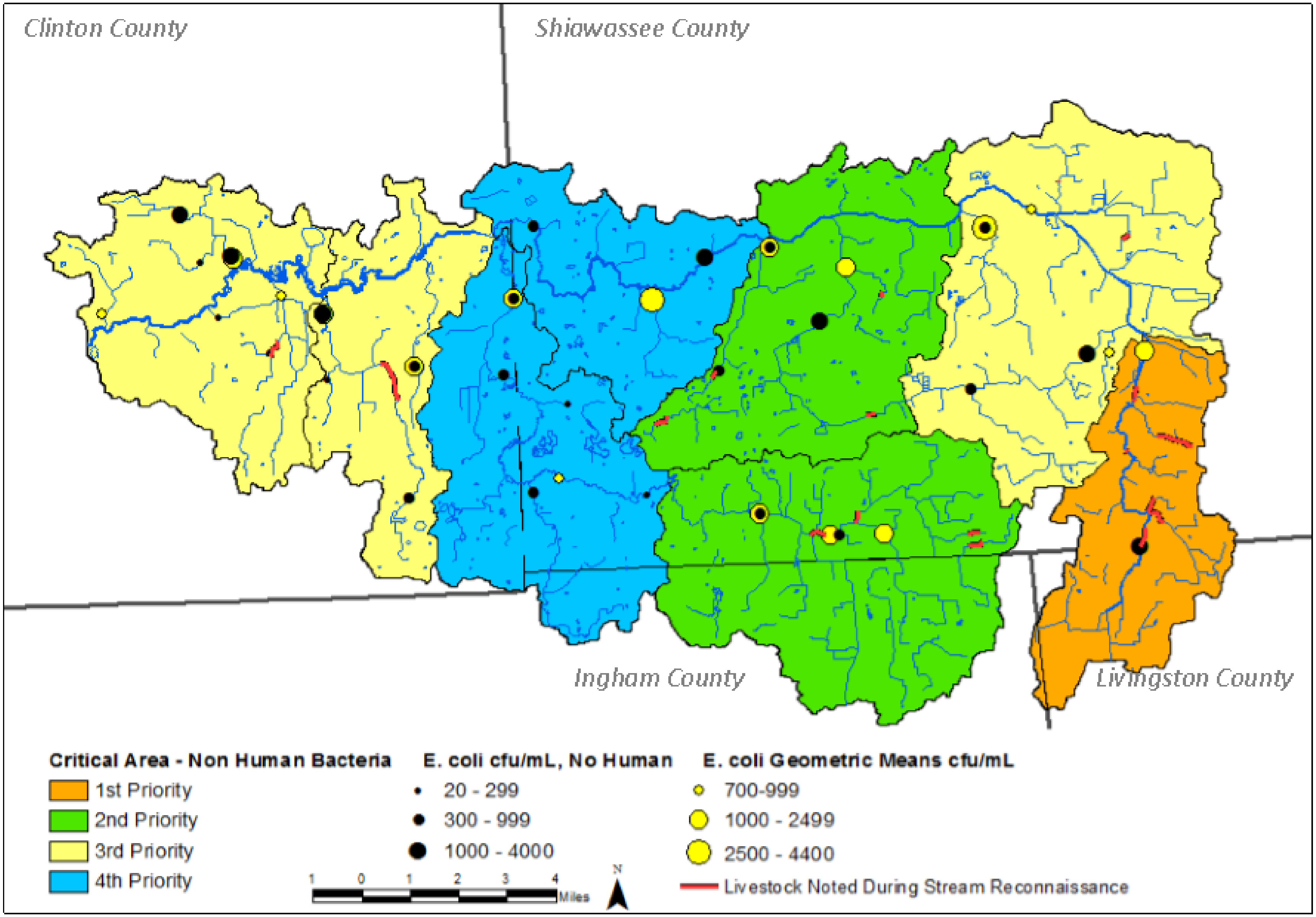

Figure 3.24 Critical areas for targeting agricultural sources (non-human) of bacteria based on inventory data collected during watershed planning process.

3.2.2. Sediment and Nutrients Focus

A stream reconnaissance survey was conducted to inventory the Upper Looking Glass River Watershed (see section 3.1.3). Estimated values of sediment, phosphorus and nitrogen were calculated from identified streambank and gully erosion sites. In addition, dominant pollutant types, pollutant sources and pollutant causes were identified and Best Management Practices were suggested for each stretch of streams surveyed (see Section 5). Table 3.11 for pollutant load values from stream reconnaissance survey for gully erosion and Table 3.12 for streambank erosion pollutant load values from stream reconnaissance survey. See Figure 3.25 for sediment load values from stream reconnaissance survey and priority areas for implementing practices that address sediment sources. Figure 3.26 shows the amount of sediment attached phosphorus values from known erosion sites identified during stream reconnaissance survey as well as results from the phosphorus analysis during water quality study (Section 3.1.2). Figure 3.27 shows sediment attached nitrogen values based on erosion rates identified during stream reconnaissance survey.

Sub-Watershed	Season Surveyed	Distance Covered (miles)	Estimated Sediment Load (t/yr)	Estimated P (lb/yr)	Estimated N (lb/yr)
Headwaters	Spring ‘15	9.9	34.0	67.9	34.0
Howard Drain	Summer ’15, Winter ‘15	2.3	1.4	1.8	0.9
Kellogg Drain	Winter ’14, Spring ‘15	5.2	30.6	58.2	29.1
Buck Branch –	Spring-Summer ‘15	9.3	66.4	128.3	64.1
Vermillion Creek	Summer ’15, Fall ‘16	0.7	0.0	0.0	0.0
Leisure Lakes	Winter ’14, Fall ‘16	0.9	0.0	0.0	0.0
Mud Creek	Summer ‘16	2.4	10.2	20.4	10.2
Turkey Creek	Spring-Summer ‘16	7.6	25.0	47.6	23.8
Totals		38.3	167.6	324.2	162.1

Table 3.11 Estimated pollutant loads for site specific gully erosion occurrences identified during the stream reconnaissance survey.

Sub-Watershed	Season Surveyed	Distance Covered (miles)	Estimated Sediment Load (t/yr)	Estimated P (lb/yr)	Estimated N (lb/yr)
Headwaters	Spring ‘15	31	14.5	28.1	14.1
Howard Drain	Summer ’15, Winter ‘15	10	2.3	4.3	2.1
Kellogg Drain	Winter ’14, Spring ‘15	25	4.5	9.4	4.7
Buck Branch	Spring-Summer ‘15	34	26.3	47.0	23.3
Vermillion Creek	Summer ’15, Fall ‘16	10	2.3	4.6	2.3
Leisure Lakes	Winter ’14, Fall ‘16	2	0.0	0.0	0.0
Mud Creek	Summer ‘16	6	0.2	0.2	0.1
Turkey Creek	Spring-Summer ‘16	20	34.6	68.2	34.1
Totals		138	84.6	161.9	80.7

Table 3.12 Estimated pollutant loads for site specific streambank erosion occurrences identified during the stream reconnaissance survey.

These pollutant load values were calculated using the "Pollutants controlled: Calculation and documentation or Section 319 watershed training manual" (MDEQ, June 1999). For gully pollutant load values, the Gully Erosion Equation (GEE) was utilized and for streambank pollutant load values, Channel Erosion Equation (CEE) was utilized.

For sediment loads from gully erosion:

$$GEE = \frac{\text{Top Width (ft)} + \text{Bottom Width (ft)}/2 \times \text{Length (ft)} \times \text{Soil Weight (tons/ft}^3)}{\text{Number of Years}}$$

For nutrient loads from gully erosion:

Nutrient load (lb/yr) = Sediment load (T/yr) x Nutrient conc. (lb/lb soil) x 2000 lb/T x correction factor

For sediment loads from streambank erosion:

CEE = Length (ft) x Height (ft) x Lateral Recession Rate (ft/yr) x Soil weight (tons/ft^3)

For nutrient loads from streambank erosion:

Nutrient load (lb/yr) = sediment load (T/yr) x Nutrient conc. (lb/lb soil) x 2000 lb/T x correction factor

STEPL

Spreadsheet Tool for Estimating Pollutant Load (STEPL) is a customizable spreadsheet-based model for use in Excel developed by Tetra Tech for the U.S. EPA. Using simple algorithms, it calculates nutrient and sediment loads from different land uses and the load reductions from the implementation of BMPs. Annual nutrient loading (nitrogen, phosphorus and 5-day biological oxygen demand) is calculated based on the runoff volume and pollutant concentrations. The annual sediment load from sheet and rill erosion is calculated based on the Universal Soil Loss Equation (USLE) and the sediment delivery ratio. Loading reductions resulting from the implementation of BMPs are computed from the known BMP efficiencies.

Table 3.13 shows pollutant load estimates for agricultural fields adjacent to inventoried stream stretches assuming no conservation practices are in place. These estimates were determined using the STEPL model.

Sub-Watershed	Nitrogen (lb/yr)	Phosphorus (lb/yr)	BOD (lb/yr)	Sediment (lb/yr)
Headwaters	6,685	1,251	14,255	186
Howard Drain	2,282	412	5,174	77
Kellogg Drain	5,716	1,094	13,099	153
Buck Branch	7,202	1,312	15,208	209
Vermillion Creek	175	46	379	8
Leisure Lakes	181	49	395	8
Mud Creek	631	139	1,347	22
Turkey Creek	5,024	930	10,703	148
Totals	27,897	5,232	60,560	812

Table 3.13 Pollutant loads for fields adjacent to stream reconnaissance survey reaches determined using STEPL.

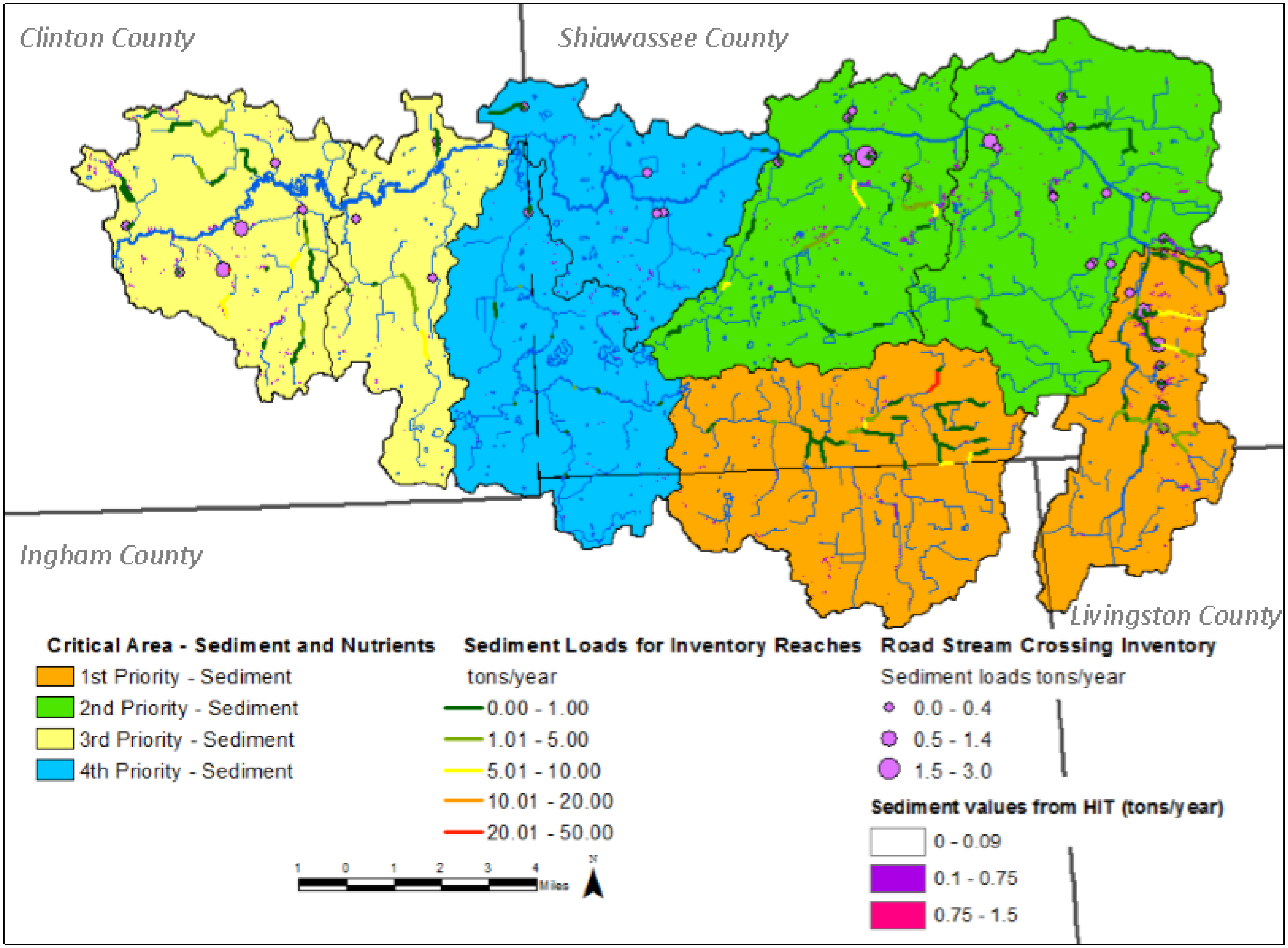

Figure 3.25 Sediment loads calculated from gully and streambank erosion noted during stream reconnaissance, gully loads from road stream crossing inventory, and sediment values estimated using HIT. Critical areas are identified based on calculated sediment loads from inventories described in 3.1.

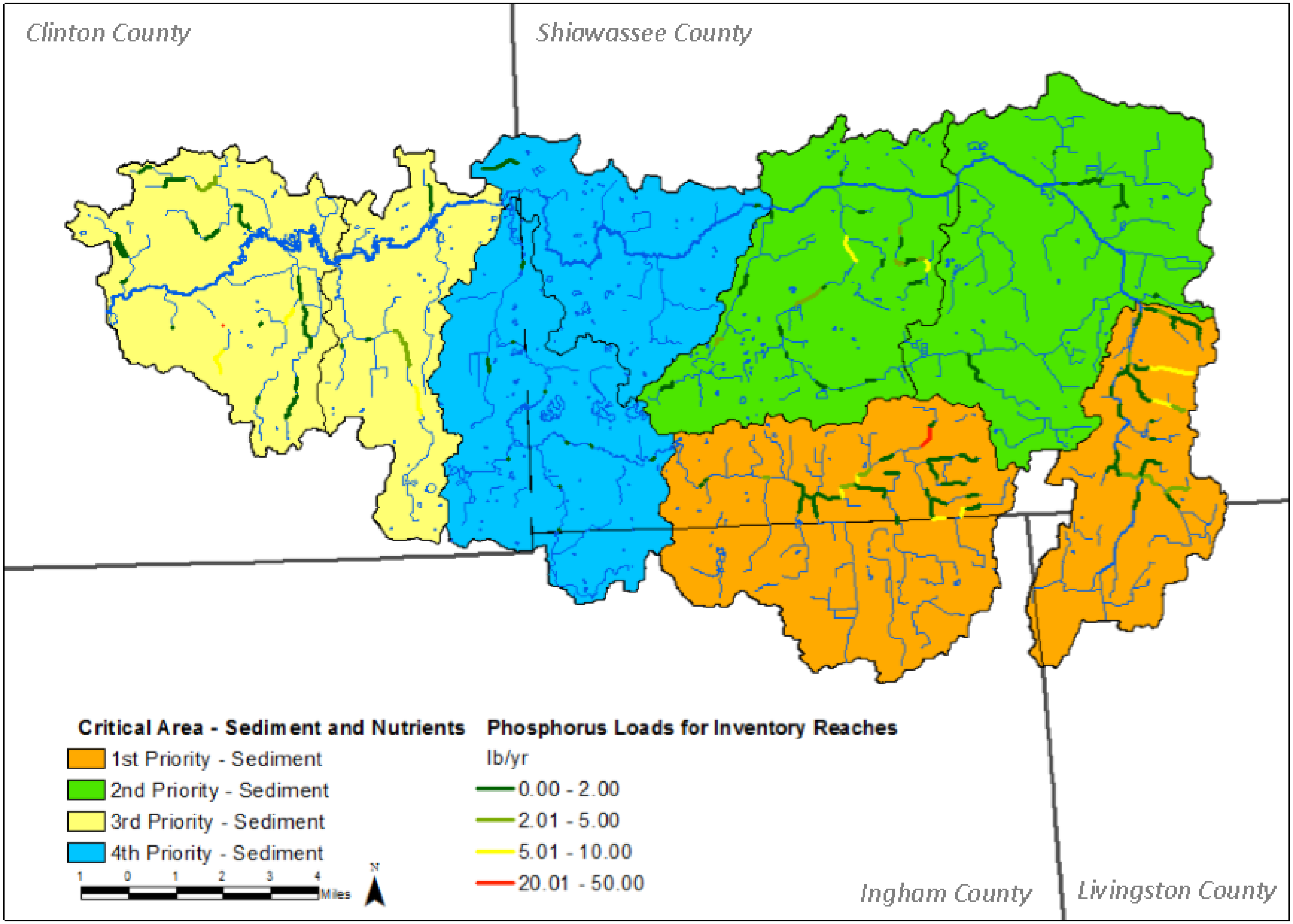

Figure 3.26 Phosphorus loads calculated from streambank and gully erosion noted during stream reconnaissance.

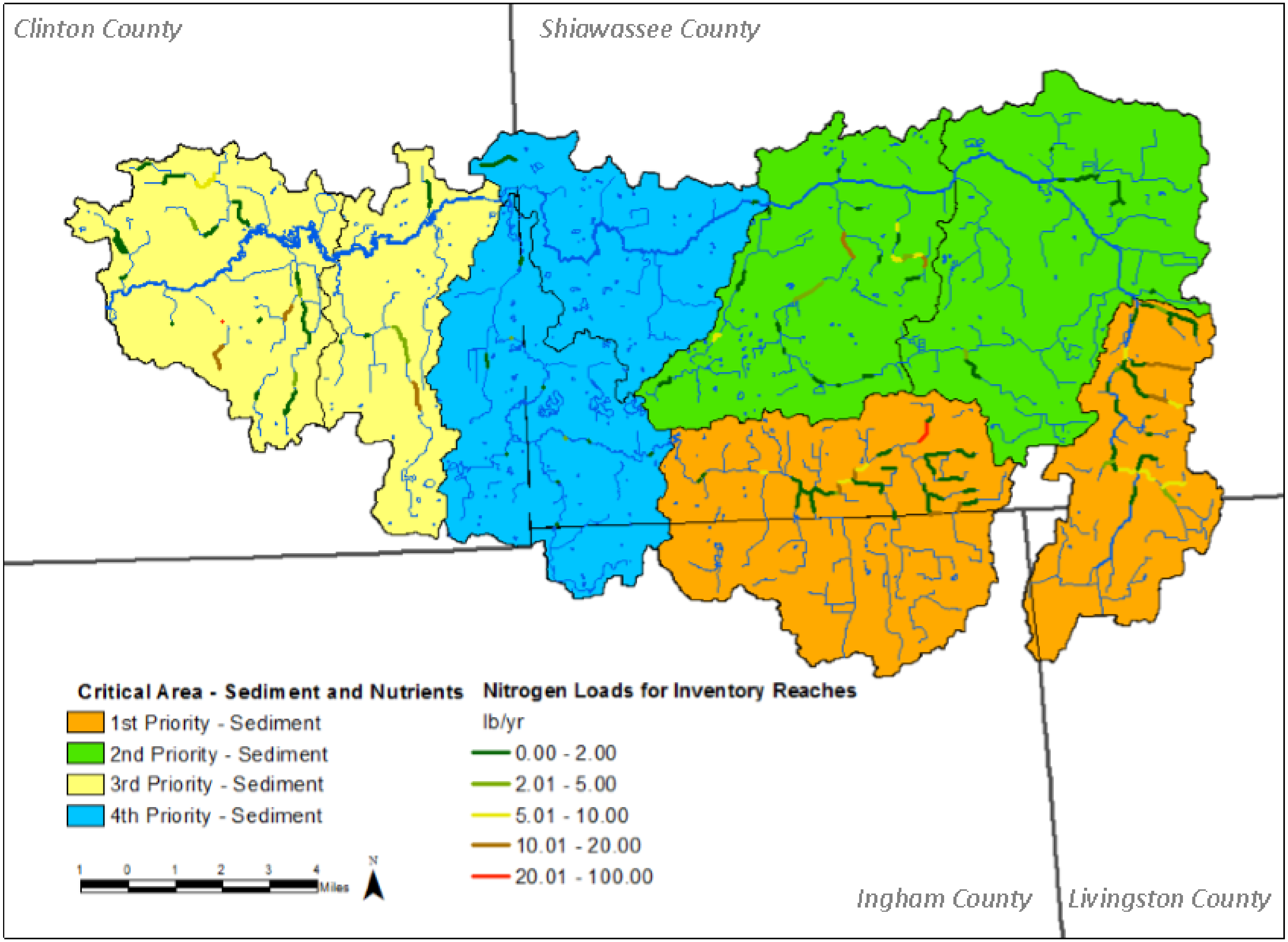

Figure 3.27 Nitrogen loads calculated from streambank and gully erosion noted during stream reconnaissance.

3.2.3. Urban Focus

Urban runoff can be attributed to the amount of rainfall, soil conditions and degree of urbanization. Pervious surfaces allow rainwater to infiltrate but in urban areas where parking lots, roofs and streets are prevalent, rainwater collects and must be drained through a stormwater drain system. If this drainage system does not connect to a wastewater treatment facility, the rainwater and everything in it travels into local streams and rivers. Some of the pollutants found in urban runoff include, nitrogen, phosphorus, sediment, lead, zinc, copper, cadmium, chromium, and arsenic. In addition, urbanization affects water quality characteristics, including water temperature, pH, dissolved oxygen, alkalinity, hardness, and conductivity (MDEQ 1999).

Urban areas constitute about 4% of the total land use in the Watershed. In these limited areas, urban BMPs that include Low Impact Development (LID) techniques along with education to target residential and commercial lawn care, pet waste management, recycling and composting practices and general awareness of watershed issues are recommended.

Critical areas for targeting urban pollution reduction efforts include the City of Perry, Village of Morrice Village of Laingsburg, Village of Shaftsburg, other concentrated residential areas and transportation routes. Figure 3.20 illustrates the urban areas in the Watershed.

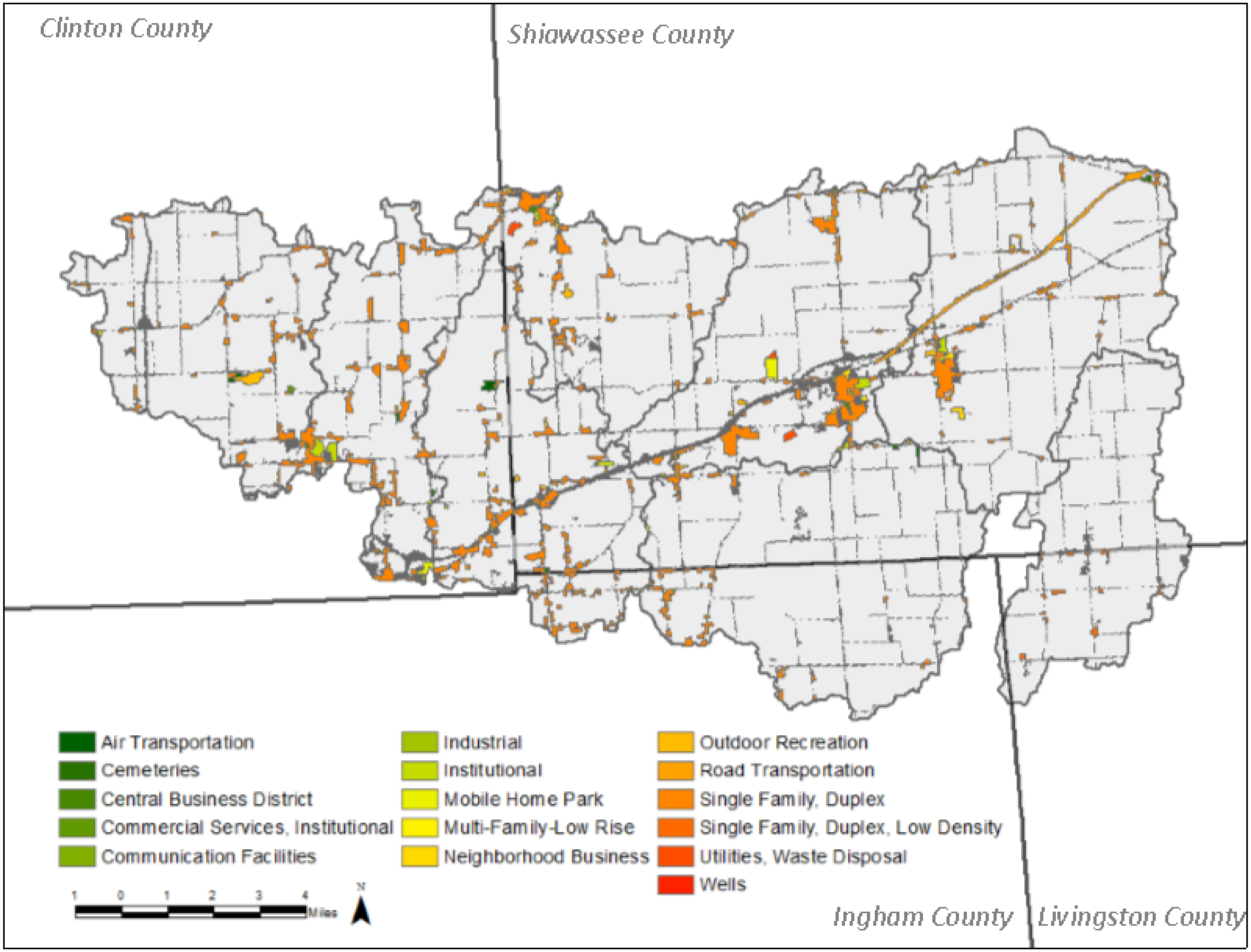

Figure 3.28 Urban areas in the Upper Looking Glass River Watershed (source MDNR 1999).

3.3 Prioritization of Identified Nonpoint Source Pollutants

3.3.1 Steering Committee

Stakeholder involvement has been effective in improving the understanding of the watershed plan development process. In order to coordinate the watershed management plan with the priorities and concerns of the local community, each step of the process has been directed and evaluated by representatives of the community during the five Steering Committee Meetings held over the course of the planning phase. Members of the Upper Looking Glass Watershed Steering Committee include those listed in Table 3.14:

Name		Title	Affiliation
Crambell,	Josh	Board Member	Shiawassee Conservation District
Elliott	Casey	Environmental Health Director	Shiawassee County Health Department
Gouin	Bob	Environmental Health Director	Mid-Michigan District Health Department
Grinnell	Sidney	Perry Township Supervisor	Perry Township
Hanses	Phill	Drain Commissioner	Clinton Drain Office
Higbee	Melissa	Executive Director	Shiawassee Conservation District
Jullie	Jenna	Deputy Drain Commissioner	Shiawassee Drain Office
Kanan	Donna	Conservation Specialist	Shiawassee Conservation District
Lipsey	Tamara	Aquatic Biologist	MDEQ
Marinez	Michael	Conservation Specialist	Shiawassee Conservation District
Meyer	Cheri	Environmental Quality Analyst	MDEQ
Miller	Gloria	Board Member	Friends of the Looking Glass
Morrison	Jon	Deputy Drain Commissioner	Clinton Drain Office
Newman	Anthony	Drain Commissioner	Shiawassee Drain Office
Nichols	Kay	Supervisor	Woodhull Township
Shorkey	Brian	Planner	Bath Township
Sweeney	Kelcie	Watershed Coordinator	Clinton Conservation District
Switzer	John	District Manager	Clinton Conservation District
Thelen	Marilyn L.	Sr. Educator	Integrated Cropping & Livestock Systems Michigan State University Extension
Tuller	Tina	District Conservationist	NRCS - Owosso
Vincent	Peter	Environmental Quality Analyst	MDEQ
Wendt	Andrea	Watershed Technician	Shiawassee Conservation District

Table 3.14 Upper Looking Glass Watershed Steering Committee

3.3.2 Goal of Prioritization

To achieve the greatest pollutant reduction while addressing areas that meet MDEQ's criteria as impaired. This will be achieved by treating the fewest sources, leading to the greatest improvement in water quality that is also the most economical.

Land Use

Land use in the ULG is diverse compared to other mid-Michigan watersheds in the area. According to 2011 land use data available through the United States Geological Survey (USGS), 54% of the ULG is considered agricultural land use. This is in comparison to 73% agricultural land in Shiawassee County, the dominant county in which the ULG is located. Table 3.15 and 3.16 describes the land use, type and acres in 1978 and 2011, respectively. Table 3.17 illustrates difference in land use percentages between 1978 and 2011. Figure 3.29 shows land use for 1978 and Figure 3.30 shows land use for 2011.

Land Use	Type	Acres
Agriculture	Christmas tree plantation	12
	Confined feeding	49
	Cropland	64,747
	Orchards, Vineyards	1,147
	Other Agriculture	297
	Permanent pasture	1,025
	Total Agriculture	67,277
Forest	Aspen, birch	139
	Central hardwood	4,936
	Pine	701
	Shrub land	4,297
	Total Forest	10,074
Open	Flats	92
	Herbaceous open land	15,552
	Lake, pond	507
	Open pit	340
	Reservoir	4
	Sand and gravel	90
	Total Open	16,585
Wetland	Aquatic bed wetland	257
	Emergent wetland	1,891
	Lowland conifer	168
	Lowland hardwood	14,537
	Shrub/scrub wetland	6,093
	Wooded wetland	1,825
	Total Wetland	24,771
Urban	Air transportation	72
	Cemeteries	53
	Central business district	33
	Commercial services, institutional	10
	Communication facilities	5

Urban	Industrial	8
	Institutional	210
	Mobile home park	127
	Multi-family low rise	14
	Neighborhood business	125
	Outdoor recreation	211
	Road transportation	304
	Single family, duplex	4,725
	Single family, duplex low density	87
	Utilities, waste disposal	78
	Wells	3
	Total Urban	6,067

Table 3.15 1978 land use acres in the Upper Looking Glass River Watershed. Source: MDNR 1999.

Land Use	Type	Acres
Agriculture	Hay/pasture	28,837
	Cultivated crop	37,536
	Total Agriculture	66,373
Forest	Shrub/shrub	167
	Mixed forest	522
	Evergreen forest	1,133
	Deciduous forest	16,496
	Total Forest	18,318
Open	Barren land	369
	Herbaceous	636
	Unclassified	1,100
	Open water	6,521
	Total Open	8,627
Urban	Developed, high intensity	71
	Developed, low intensity	513
	Developed, open space	3,874
	Total Urban	4,457
Wetland	Emergent herbaceous wetland	398
	Woody wetland	28,043
	Total Wetland	28,440

Table 3.16 2011 Land use acres for the Upper Looking Glass River Watershed. Source: USGS 2011.

	Agriculture	Forest	Open	Urban	Wetland
2011	53%	15%	7%	4%	23%
1978	54%	8%	13%	5%	20%

Table 3.17 Comparison of Upper Looking Glass River Watershed land use statistics between 1978 and 2011. Sources: MDNR 1999 and USGS 2011.

The Steering Committee was asked to prioritize land use for development of the implementation plan. Agriculture was the top priority, Forest and Open Land were tied for second most important, Wetland was next and Urban was the lowest priority for watershed implementation efforts. See Table 3.18 for a summary of Land Use prioritization results.

Land Use	Steering Committee Ranking
Agriculture	1
Forest	2*
Open Land	2*
Wetland	3
Urban	4

*Table 3.18 Land Use rankings by Steering Committee members. *Ranking tied.*

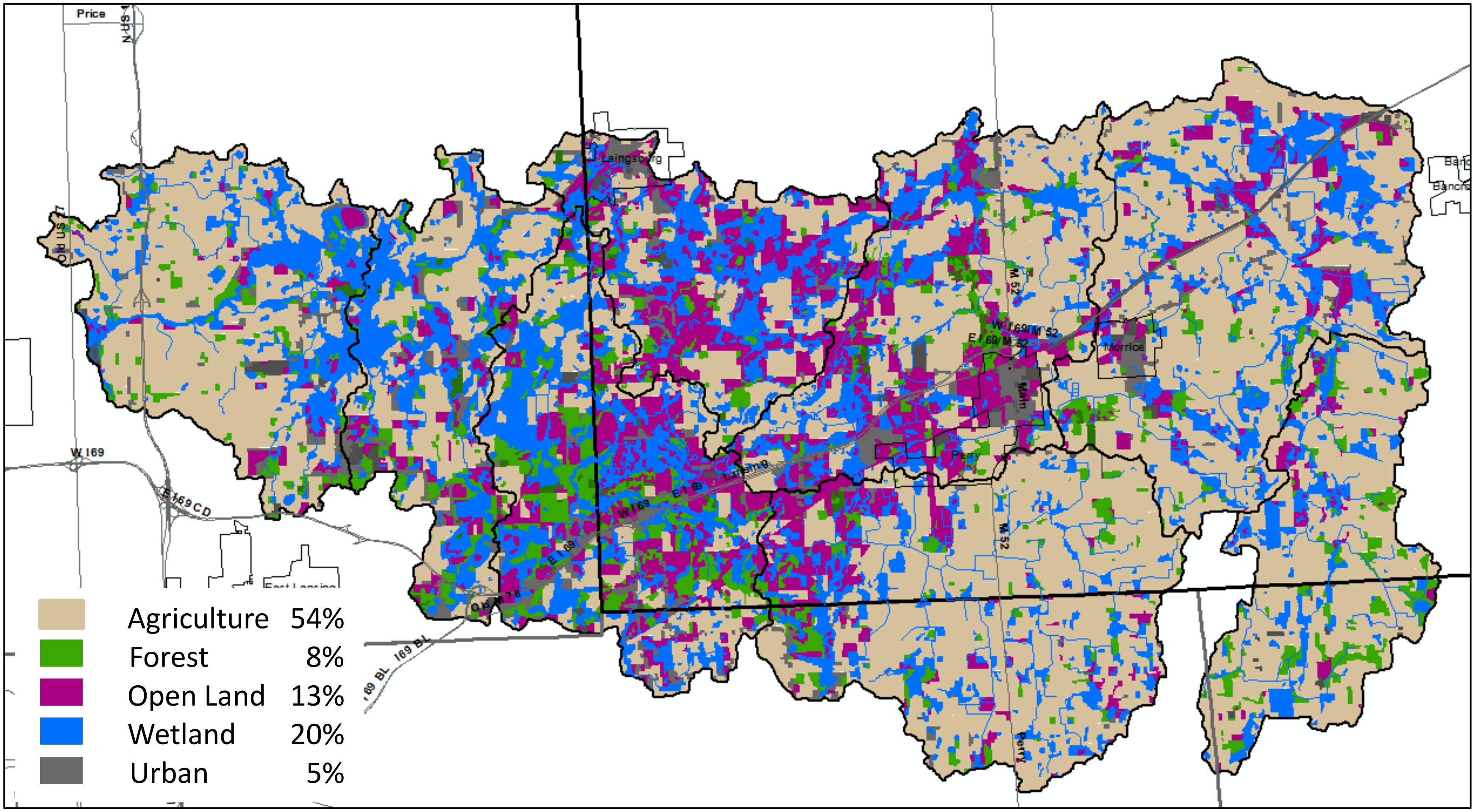

Figure 3.29 1978 land use for the Upper Looking Glass River Watershed. Open land includes: Flats, Herbaceous Open land, Lake and Ponds, Open Pit, Reservoir, and Sand and Gravel. Source MDNR 1999.

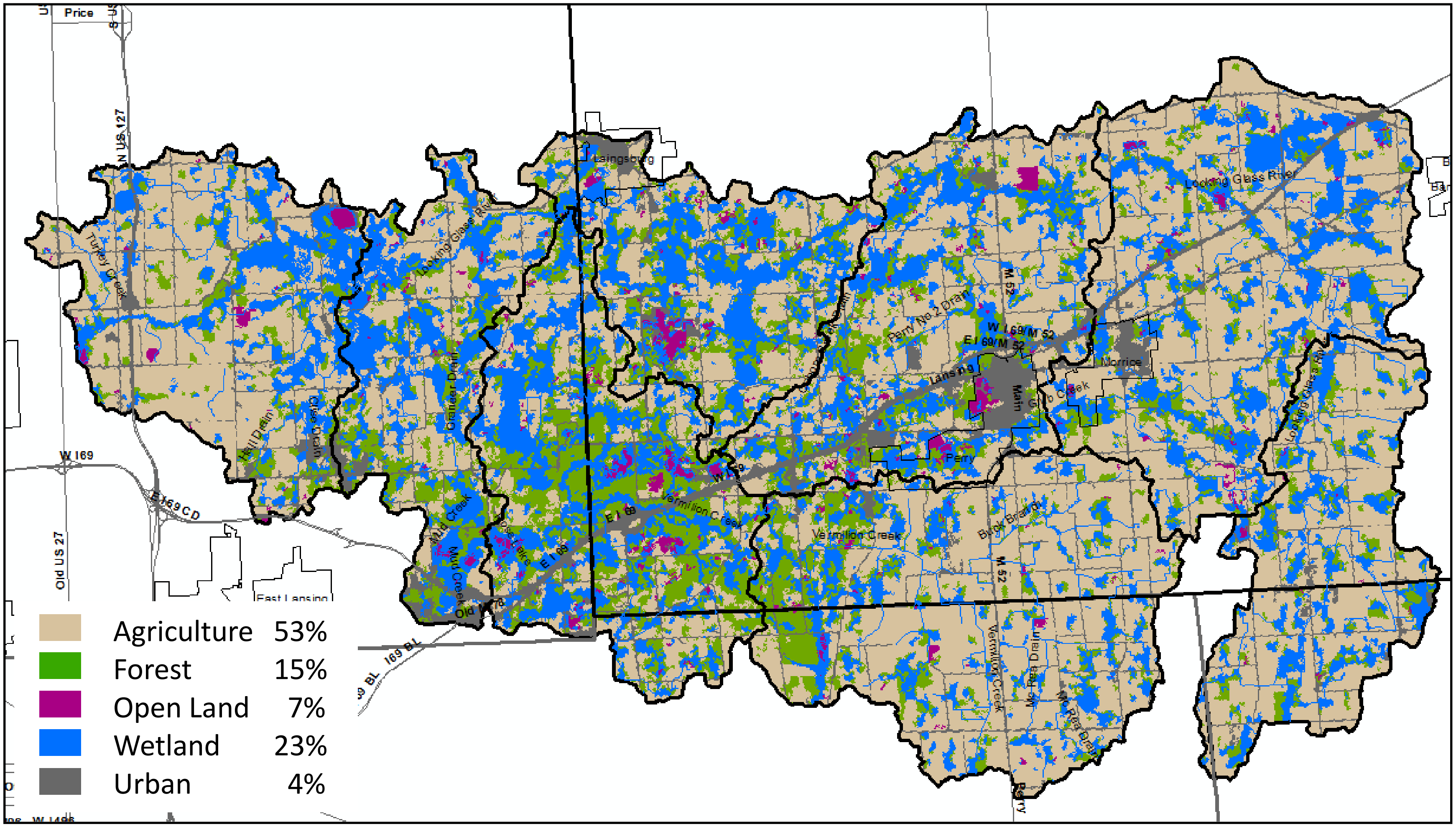

Figure 3.30 2011 land use for the Upper Looking Glass River Watershed. Source: USGS 2011.

Pollutants, Sources and Causes by Land Use

Since the ULG land use is more diverse than other mid-Michigan watersheds, Committee members were first presented and asked to prioritize pollutants within a land use. They were then asked to prioritize pollutant sources for each land use. These matched findings from inventories conducted. Causes identified during stream inventories were presented to provide a better understanding of the extent of each pollutant and source.

Agricultural Pollutants:

- Bacteria/pathogens
- Nutrients
- Pesticides, chemicals
- Sediment
- Other, as defined by Steering Committee member

Agricultural Sources and Causes:

- Cropland runoff
    - Improper or over application of manure/fertilizer/pesticides
    - Inadequate buffer
    - Tillage practices
- Farmstead runoff
    - Illicit dumping of materials
    - Impervious areas
    - Inadequate buffer
    - Vehicle leakage
- Feedlot/pasture runoff
    - Inadequate buffer
- Livestock stream access
    - Need for fencing, watering facility, etc.
- Manure application
    - Need for improved nutrient management
- Manure storage
    - Lack of storage facility/knowledge lacking
- Sheet, rill, gully, streambank erosion
    - Dense drainage network/hydrology
    - Inadequate buffer
    - Tillage practices
- Wildlife
    - Overpopulation and clustering of wildlife
    - Lack of suitable habitat elsewhere
- Other, as defined by Steering Committee member

Natural Area* Pollutants:

- Bacteria/pathogens
- Nutrients
- Sediments
- Other, as defined by Steering Committee member

Natural Area* Sources and Causes:

- Gravel roads
    - Concentrated flows to roadside ditches
    - Roadway washing and flooding
- Gully, streambank erosion
    - Unstable hydrology
    - Wildlife activity
- Illicit connections
    - Lack of education
    - Old farm home plumbing
- Logjams
    - Need for forest management
- Riparian canopy lacking
    - Natural buffer disturbed

- Septic systems
  - Out of date septic systems
  - Poor septic system maintenance
  - Lack of education
- Wildlife
  - Excessive wildlife
  - Lack of suitable habitat elsewhere
- Other, as defined by Steering Committee member

*Natural Areas include forest, open land and wetland area

<u>Urban Pollutants:</u>

- Bacteria, pathogens
- Chemicals
- Nutrients
- Oils, road salts
- Sediment
- Trash and compostable material
- Other, as defined by Steering Committee member

<u>Urban Sources and Causes:</u>

- Golf courses
  - Inadequate buffer
  - Nutrient application
- Illicit connections
  - Expense/no access to hook up to municipal system
- Impervious surface runoff
  - Stormwater runoff
- Municipal waste
  - Discharges
- Pet waste
  - Lack of education
  - No waste receptacles available
- Residential yard/garden runoff
  - Excessive nutrient/pesticide application
  - Inadequate buffer
  - Lack of education
- Road/stream crossing
  - Concentrated runoff
  - Impervious areas
- Septic systems
  - Expense/no access to hook up to municipal system
  - Out of date septic systems
  - Poor/no system maintenance
- Wildlife
  - Lack of suitable habitat elsewhere
- Other, as defined by Steering Committee member

3.3.3 The Prioritization Process

Committee members were then asked to rank pollutants and sources in order of priority under the following criteria during a Steering Committee Team Meeting:

- Pollutant
  - Is there a public health concern resulting from this pollutant?
  - How often does the pollutant show up in the inventories conducted?
  - How readily does the pollutant move from the source to the water?
  - How many uses does the pollutant impair?
- Source
  - What is the magnitude and severity of the source?

- What is the distance of the source to water?
- Can the source be addressed immediately or will it have to wait?
- What are the costs for addressing the source?
- What is the willingness of landowners, decision-makers and other stakeholders to participate to address the source?
- Is there technical and/or financial assistance available to assist in addressing the source?

Identified causes for each source were presented at the time of prioritization as an aid to assist Committee members in the prioritization process.

3.3.4 Prioritization Results

Pollutants and their sources were ranked by the Steering Committee through the process described in section 3.3.3. The results of this ranking are shown in Table 3.19:

Agricultural Pollutants	Steering Committee Ranking
Pathogens and Bacteria	1
Nutrients	2
Sediment	3
Pesticides and Chemicals	4
Other: wildlife	5
Other: cattle	6*
Other: drainage systems	6*
Agricultural Sources	**Steering Committee Ranking**
Cropland runoff	1
Livestock stream access	2
Manure application	3
Manure storage	4
Feedlot/pasture runoff	5
Farmstead runoff	6
Sheet, rill, gully, streambank erosion	7
Wildlife	8
Natural Area† Pollutants	**Steering Committee Ranking**
Sediment	1
Pathogens and Bacteria	2
Nutrients	3
Natural Area† Sources	**Steering Committee Ranking**
Septic systems	1
Illicit connections	2
Gravel roads	3
Gully, streambank erosion	4

Riparian canopy lacking	5
Logjams	6
Wildlife	7
Urban Pollutants	**Steering Committee Ranking**
Chemicals	1
Nutrients	2
Oils, road salts	3
Pathogens and Bacteria	4
Trash	5
Sediment	6
Urban Sources	**Steering Committee Ranking**
Illicit connections	1
Impervious surface runoff	2
Septic systems	3
Residential yard/garden care	4
Road/stream crossing	5
Golf courses	6
Pet waste	7
Wildlife	8

Table 3.19 Steering Committee pollutant and sources prioritization results.
*ǂNatural Areas include forest, open land, and wetland land uses. *Ranking tied.*

These results suggest that bacteria and pathogens are the number one concern in Agricultural areas with top priority sources being cropland runoff, livestock access and manure application/storage. Sediment is the number one concern in Natural Areas with bacteria and pathogens a close second. Natural Areas priority sources are septic systems, illicit connections and gravel roads. In Urban areas the top priority pollutants are chemicals with priority sources being illicit connections, impervious surface runoff and septic systems. The remainder of the Watershed Management Plan focuses on implementation efforts to address these pollutants and sources identified through the inventory process.

Section 4 Goals and Objectives for the Upper Looking Glass River Watershed

4.1 Goals for the Upper Looking Glass River Watershed

The goals of the WMP will be accomplished by implementing techniques to address the causes of the sources of NPS pollution, and by meeting the objectives of harnessing existing positive community awareness, utilizing locally driven experienced agency resources, retaining qualified staff, and selecting qualified contractors.

The main goals of this Watershed Management Plan are:

- Goal 1: Reduce or eliminate threat of human health hazards in rivers and streams caused by pollutants.
- Goal 2: Pursue restoration efforts of designated uses that are confirmed to be threatened or impaired.
- Goal 3: Assess watersheds for designated uses not currently listed as impaired. Restore these designated uses where found to be threatened or impaired.
- Goal 4: Identify and offer protection strategies/opportunities for high quality areas in the watershed.
- Goal 5: Promote opportunities that the watershed can offer for recreation and wise stewardship; implement specific actions that enhance such identified recreation while preserving the integrity of the watershed.
- Goal 6: Identify land use planning measures complementary to watershed protection and/or enhancement.

Restoration goals can be achieved by addressing impairments to warmwater fisheries in the Turkey Creek Sub-Watershed. Another priority is to targeting sources of sediment, nutrients, and bacteria identified during the WMP inventory period. Pollutant sources and causes were identified during stream reconnaissance surveys and water quality investigations (see Section 3.1 for a discussion of inventories, Section 3.2 for descriptions of critical areas, and Section 5.4 for targeted areas for implementation).

Goals to assess and restore watersheds for threats and impairments can be achieved by addressing targeted sites of known pollutant sources and causes in the Watershed. Goals that identify and protect high quality areas and promote recreational opportunities that preserve the watershed involve targeted efforts that include working with local entities to protect the watershed through conservation land use planning. Both approaches involve launching an outreach campaign and implementing Best Management Practices (BMPs) to specifically address the sources and causes of known pollutants.

Specific tasks to meet these goals can be found in Chapter 5 – Implementation Plan and Chapter 6 – Information and Education Strategy.

Section 5 Implementation Plan for the Upper Looking Glass River Watershed

5.1 Best Management Practice

A Best Management Practice (BMP) is a land management practice that is implemented to control sources or causes of pollution. Three types of BMPs can treat, prevent, or reduce water pollution: Structural BMPs are practices that require construction activities to install, such as installing livestock crossings, grade stabilization structures, or rock riprap. Vegetative BMPs are practices that use plants to stabilize eroding areas, such as planting grasses, trees, or shrubs in a riparian buffer. Managerial BMPs are practices that involve changing the operating procedures at a site.

5.2 Recommended Structural and Vegetative BMPS

Information collected from inventories during this project was used to determine needed BMPs for each sub-watershed. A large number of BMPs are recommended to solve nonpoint source pollution problems in the Upper Looking Glass River Watershed; however, certain specific BMPs will be critical to meeting the goals of the Watershed project. The BMPs were selected from a review of existing practices compiled and recommended by Michigan Department of Environmental Quality (MDEQ), Natural Resources Conservation Service (NRCS) Field Office Technical Guide, the State-wide Low Impact Development Manual, and several other sources. A complete list of references can be found in the References Cited section and BMP practice specification sheets can be found in the USDA Natural Resources Conservation Service (NRCS) Field Office Technical Guide. Individual structural and vegetative BMPs were selected to control NPS pollution from areas specifically identified during stream surveys and known areas of concern in the Watershed. The prioritized BMPs are based on innovative drain maintenance practices, findings from the inventory, and prioritized pollutants. The quantities of recommended BMPs are based on the inventories conducted for this project, as well as recommendations from the Steering Committee. The Implementation Action Plan outlined in Table 5.3 includes a detailed list of activities that describe the actions needed to achieve the project goals and objectives. Table 5.4 lists the measurable milestones, monitoring components, evaluation criteria and responsible partners for those actions listed in the Action Plan.

5.3 Managerial Strategies

The information collected from inventories was used to determine the need for managerial strategies in each sub-watershed based on the existing land use policies, agricultural management practices, and government regulations. Numerous strategies can be used to protect land and water in the Upper Looking Glass River Watershed; however, certain specific preservation techniques will be critical to meeting the goals of the Watershed project.

Management strategies are used to control NPS pollutants and are based on prioritized pollutants identified during the inventory process. Examples of Structural and Nonstructural Practices based on Land Use can be found in Table 5.1. Specific practices for this Watershed are outlined in the Implementation Action Plan found in Table 5.3, which includes a detailed list of management activities that describe the actions needed to be taken to achieve the Project goals and objectives.

Land Use	Structural Practices	Nonstructural Practices
Agriculture	Access Control Access Road Agrichemical Handling Facility Anaerobic Digester Animal Mortality Facility Denitrifying Bioreactor Drainage Water Management Grade stabilization structure Heavy use area protection Livestock exclusion fence (prevents livestock from wading into streams) Revetments Riprap Sediment basin Structure for water control Waste storage facility Waste treatment lagoons Water well decommissioning Watering facility Wetland restoration	Brush management Conservation cover Conservation crop rotation Conservation tillage Cover crop Critical Area Planting Deep tillage Educational materials for nps control from agricultural sources Erosion and sediment control plan Field border Filter strips Grassed waterway Integrated pest management Irrigation water management Live fascines Mulching Nutrient management On-farm secondary containment Prescribed grazing Residue and tillage management Restoration and management of rare or declining habitats
Forestry	Broad-based dips Brush Management Culverts Establishment of riparian buffer Mulch Tree shrub establishment Windbreak/shelterbreak establishment/renovation	Education campaign on forestry-related NPS controls Erosion and sediment control plans Forest stand improvement Planning and proper road layout and design Pre-harvest planning Riparian forest buffer Training loggers and landowners about forest management practices, forest ecology, and silviculture
Instream/ Aquatic	Aquatic Organism Passage Channel Bed Stabilization Natural channel design Streambank and shoreline protection	Stream habitat improvement management Wetland creation, enhancement, restoration and easement Wetland wildlife habitat management
Urban	Bio-retention cells Brush layering Infiltration basins Green roofs Live fascines	Planning for reduction of impervious surfaces (eliminating or reducing curb and gutter) Management programs for onsite and wastewater treatment systems Educational materials

	Marsh creation/restoration	Erosion and sediment control plan
	Establishment of riparian buffers	Fertilizer management
	Riprap	Ordinances/conservation easements
	Stormwater ponds	Pet waste programs
	Stormwater runoff control	Pollution prevention plans
	Sediment basins	Setbacks
	Tree revetments	Storm drain stenciling
	Vegetated gabions	Zoning overlay districts
	Water quality swales	Preservation of open space
	Clustered wastewater treatment systems	Development of greenways in critical areas
	Urban Canopy	Trainings on proper structure installation
	Wetland restoration	
	Porous Pavement	

Table 5.1 Examples of Structural and Nonstructural Management Practices

5.4 Targeting for Implementation

Target areas for implementation include those where water quality monitoring results exceeded WQS for PBC and TBC. Other measurements taken into consideration include findings from the canine scent survey and high sediment loads calculated for gully and streambank erosion noted during the stream reconnaissance. Sub-watersheds listed in order of priority for addressing nonpoint source pollutants include: 1) Headwaters -0601, 2) Howard Drain -0602, 3) Kellogg Drain -0603, 4) Buck Branch -0604, 5) Turkey Creek – 0609, 6) Mud Creek – 0607, 7) Leisure Lakes -0606, and 8) Vermillion Creek -0605. See Figure 5.1 for priority watersheds.

The intent of implementation is to reduce nonpoint source pollutants from entering waterways in the ULG. The top priority is to address sources of bacteria and pathogens causing health and environmental risks. During the water quality investigation that were part of the WMP inventory period, human bacteria sources were identified and E. coli levels were found to be above targets for designated use attainment. Sediment sources are the second priority for implementation efforts followed by nutrients and pesticides. Evidence of these pollutants were found in excess during the WMP stream reconnaissance. Stormwater runoff, trash and other hazardous materials, and invasive species were also identified as concerns in the stream reconnaissance survey and should be addressed through implementation efforts.

This section discusses target areas and specific objectives for implementation efforts seen as priority during the development of the WMP. Figures in this section identify target areas at the time of WMP development. However, priority areas may shift over time as new data becomes available, practices are adopted, and as landowner/producer interest arises. This information is listed in order of priority at the time of WMP development.

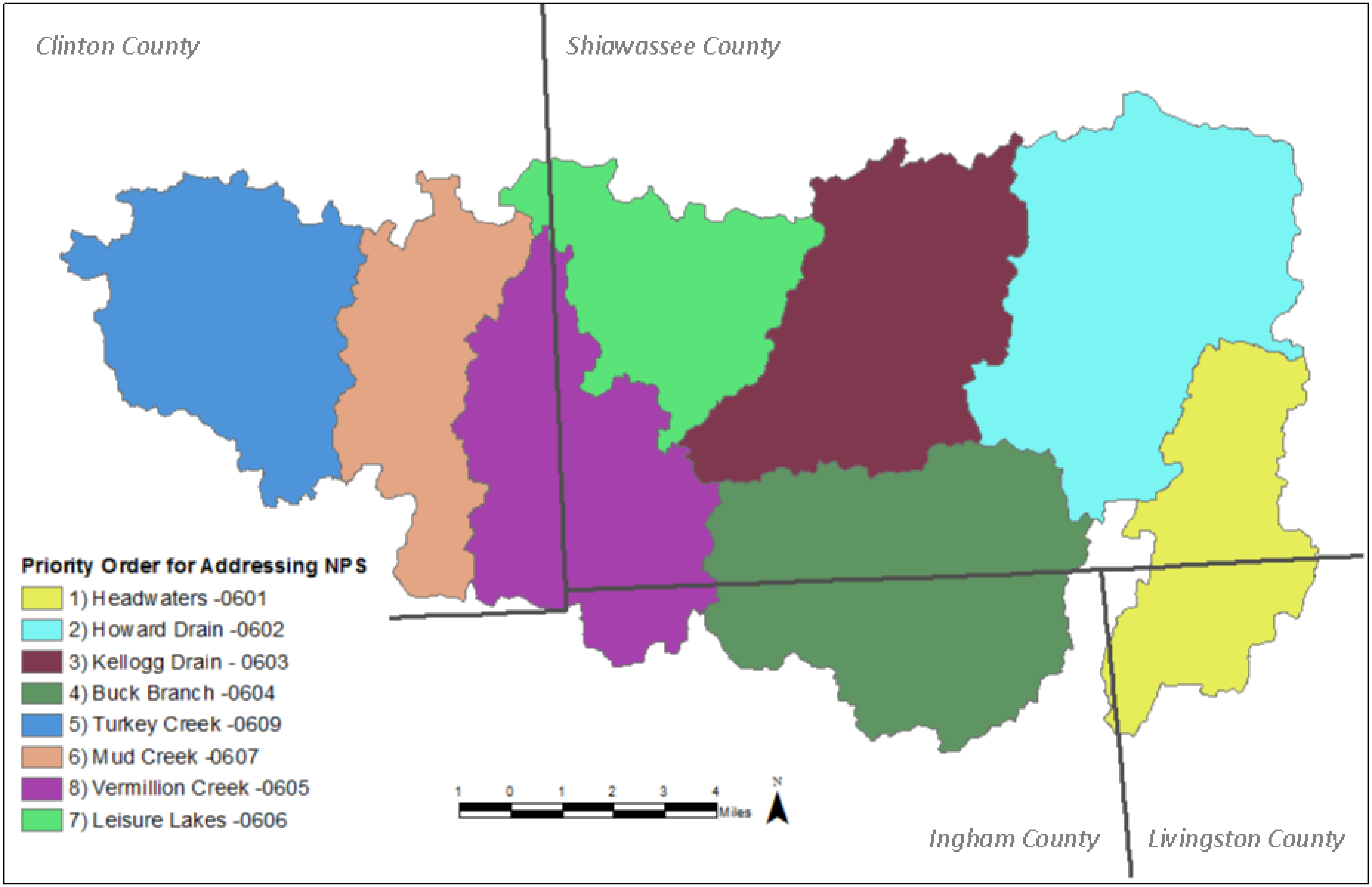

Figure 5.1 Upper Looking Glass River Sub-watersheds listed in order of priority for addressing nonpoint source pollutants.

5.4.1 Pollutant: Bacteria

Human sources of bacteria are a top priority for implementation of this WMP. Causes of human bacteria include failing septic systems and illicit connections. Implementation objectives include upgrades and installation of private and public septic systems in areas not covered by municipal systems, removing illicit connections, and connecting home sewer lines to municipal sewer systems where feasible. Areas outside of Shiawassee County would benefit from an ordinance requiring a functional septic system prior to the sale of a property as in Shiawassee County. Education objectives should focus on proper septic system maintenance and knowing the signs of system failure. Targeted areas for septic system and municipal connection efforts are broken down into priority regions as described in Figure 5.2. These were determined based on data collected during the inventory period, including canine scent investigation results and aerial inventory of rural homes.

Nonhuman sources of bacteria include agriculture, wildlife, and domestic animals and pets. Lack of crop buffer and/or holding facility buffer, runoff from feedlot/pasture area especially those lacking buffers, and animal access to the channel are priority causes in agricultural areas. Implementation objectives include improved nutrient management when applying manure as a fertilizer, upgrades to manure storage facilities, filter strips along waterways, and controlled livestock access through fencing, inventory period, including canine scent investigation results, stream reaches where livestock was identified during stream reconnaissance, and known livestock operations. Targeted priority areas for implementation of measures to control agricultural sources of bacteria can be found in Figure 5.3.

An abundance of deer, raccoon and waterfowl contribute to the elevated *E. coli* levels in the ULG. Animal tracks and scat were observed during the stream reconnaissance and water sampling events. These sites were analyzed and priority areas for wildlife management activities identified in Figure 5.4. Pet waste left on impervious surfaces also adds bacteria when washed into surface water. Target areas for pet waste signage and receptacles are in urban concentrated areas found in Figure 5.4.

It is worth noting that nearly a quarter of the ULG is considered wetland. The amount of microbial pollutants in wetland soils is significantly higher than in standing higher. Bacteria can survive longer in soil than in water (Howell, Coyne, and Cornelius 1996). Fecal coliforms can persist in sediments for as long as 6 weeks (Knox et al. 2007). This may account for the high levels of *E. coli* bacteria found in the ULG during the inventory period. For management recommendations, it is important to keep in mind that the degree to which sediments are deposited in a wetland has a significant effect on the bacteria levels once the water leaves the wetland. Managing wetlands in the ULG to allow for alternating periods of flooding and drying may decrease the survival of microbes in wetland soil (O’Geen 2015).

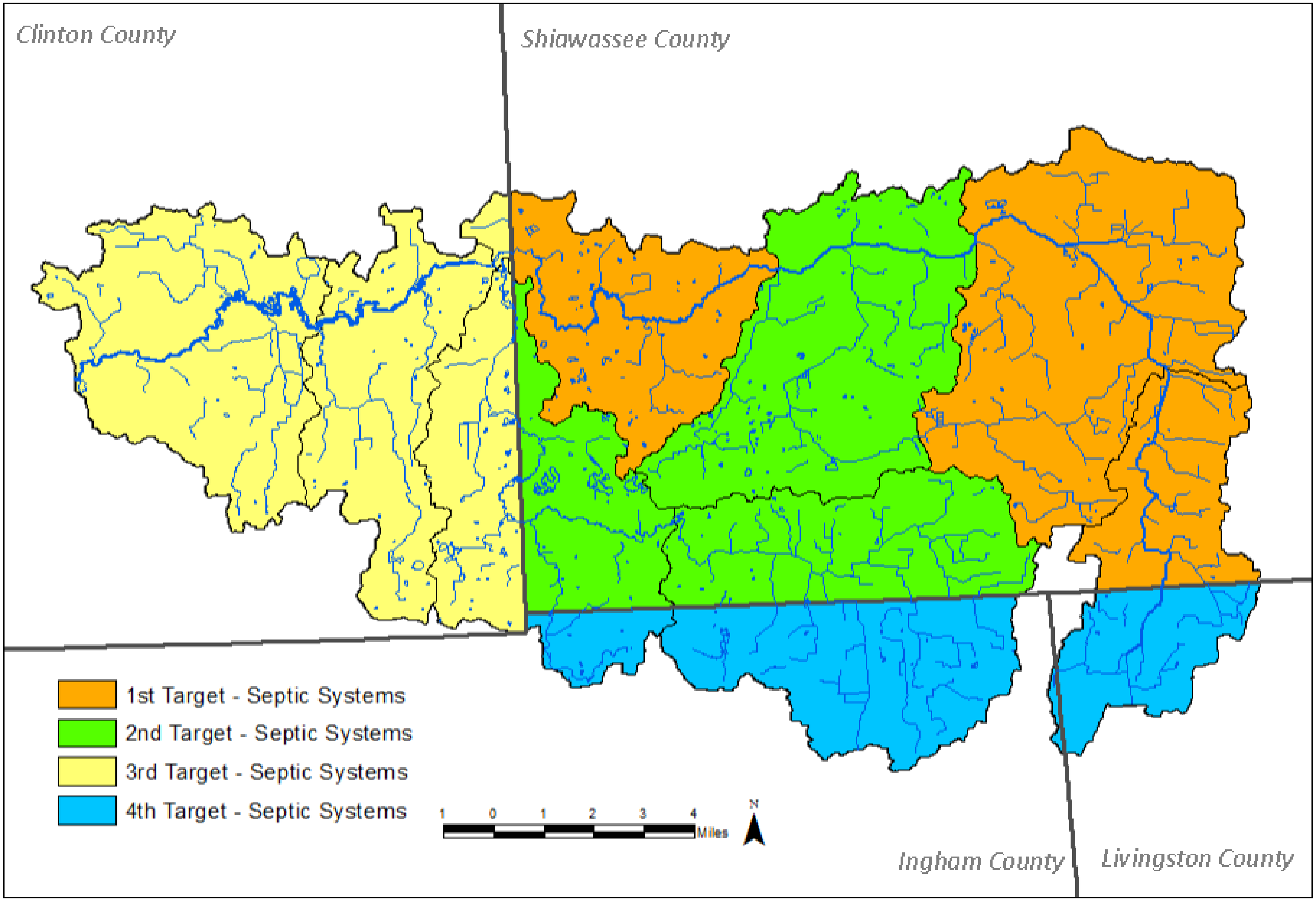

Figure 5.2 Target areas for replacing septic systems in the Upper Looking Glass River Watershed.

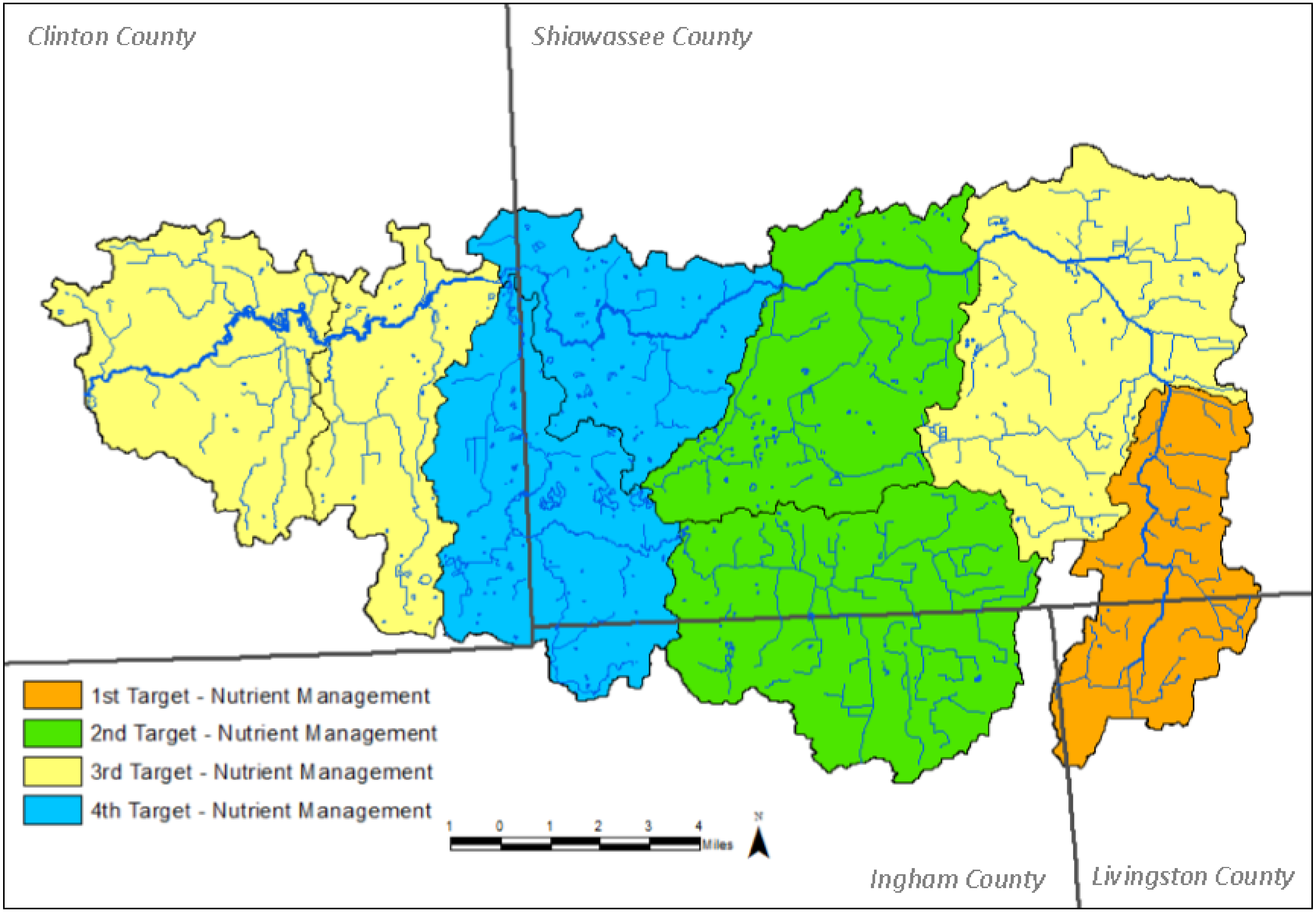

Figure 5.3 Target areas for implementing nutrient management measures for agriculture in the Upper Looking Glass River Watershed.

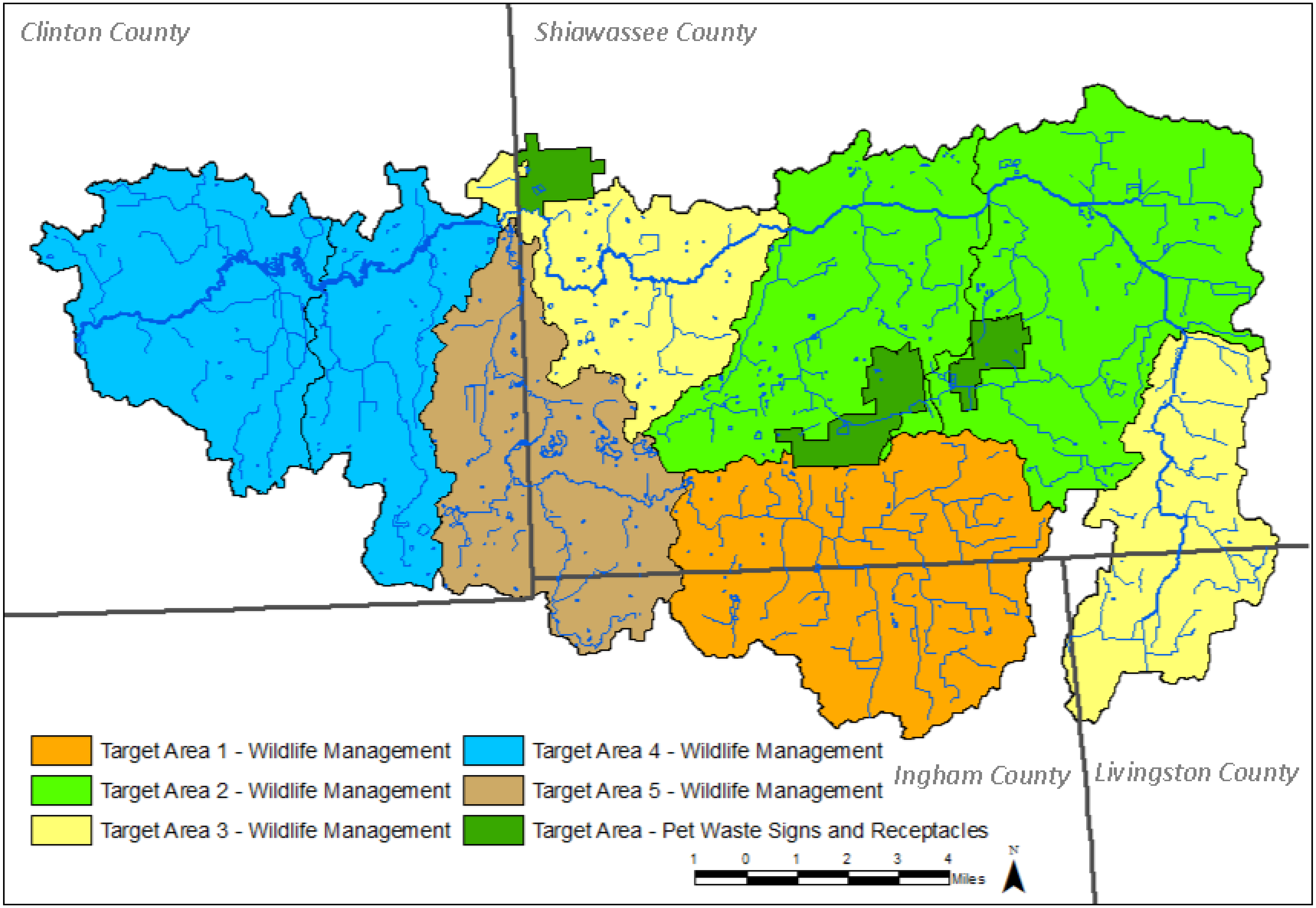

Figure 5.4 Target areas for implementing wildlife management measures, pet waste signage and receptacles, and pet waste education in the Upper Looking Glass River Watershed.

5.4.2 Pollutant: Sediment, Nutrients and Pesticides

Sediment is a significant pollutant in the ULG. It was noted during the stream reconnaissance at nearly every site investigated. Over half of the land use in the ULG is agriculture, making it the primary source of sediment. Gully, streambank and sheet erosion, tillage practices, plow furrows, gravel road washing, and unstable hydrology were all common causes of sediment identified. Wildlife and livestock have caused erosion when accessing or crossing streams. Unstable hydrology caused by a network of agricultural ditches and drained agricultural fields have created down cutting of streambeds carrying away sediments with streamflow. Lack of buffer was very common in both agricultural and residential areas causing runoff carrying sediment and depositing it in waterways.

In many areas, issues with sediment, nutrients, and pesticides were interrelated. As sediment is lost, nutrients and pesticides are also taken with it. Soil particles, especially clay soils common in the ULG, have large surface areas for nutrients and other chemicals to become attached. Nutrient loading of ditches adjacent to crop fields was observed often during stream reconnaissance. Pesticide application without setback from surface water was also noted on several occasions during the stream reconnaissance. For these reasons, the target areas for sediment are also targets for addressing nutrients and pesticides.

The impact wetlands have on nutrients in the ULG can be seen throughout the nearly ¼ of the land use that is considered wetland. Wetlands protect water quality by removing nitrogen, phosphorus and pesticides from agricultural runoff. In most cases, nutrients are recycled within a wetland. Emergent and submerged plants bring nutrients from the sediment into the water column, acting as "nutrient pumps." Algae and floating plants serve as "nutrient dumps" by taking nutrients from the water and depositing them back in the sediment when they die and settle on the bottom (Miller 1990). A wetland's natural filtering ability can become overloaded, disrupting the nutrient cycle. The excessive amount of algae and aquatic plants observed in the ditches during the stream reconnaissance may be an indication of a disruption to the nutrient cycle in the ULG. Fortunately, steps can be taken to prevent overload by reducing nutrients and chemicals lost from agricultural fields (Miller 1990).

Implementation of practices to control soil erosion and manage nutrient and pesticide applications will improve overall water quality. This will align with the objective to protect and restore threatened designated uses in the ULG, a priority for this WMP. Filter strips along all drains, ditches, and streams would significantly reduce the amount of sediment, nutrients, and pesticides entering the water. Grade stabilization structures and grassed waterways will stabilize gully erosion and aid in drainage in crop fields especially where plow furrowing is common practice. Natural channel design measures installed in waterways will help to address unnatural hydrology causing streambank erosion and downcutting. Managerial practices such as no-till farming and cover crops will keep soil in place on fields. Improved nutrient and pest management practices in agricultural areas will reduce over application of fertilizers and pesticides. Fencing and watering facilities for livestock will reduce erosion and nutrient loading from livestock accessing to the stream. Wildlife management strategies will aid in controlling deer populations to reduce their contributions of sediment and nutrients. Low Impact Development (LID) practices such as grassed swales, rain gardens, green roofs and porous pavement will help to reduce these pollutants from urban areas. Backyard conservation programs involving composting methods, soil testing before fertilizing, choosing native plants and water infiltration practices such as rain barrels, and rain gardens is suggested in residential areas. Education should focus on all of these areas. Targets for addressing sediment, nutrients and pesticides can be seen in Figure 5.5. These areas were chosen based on inventory data collected, mainly stream reconnaissance findings.

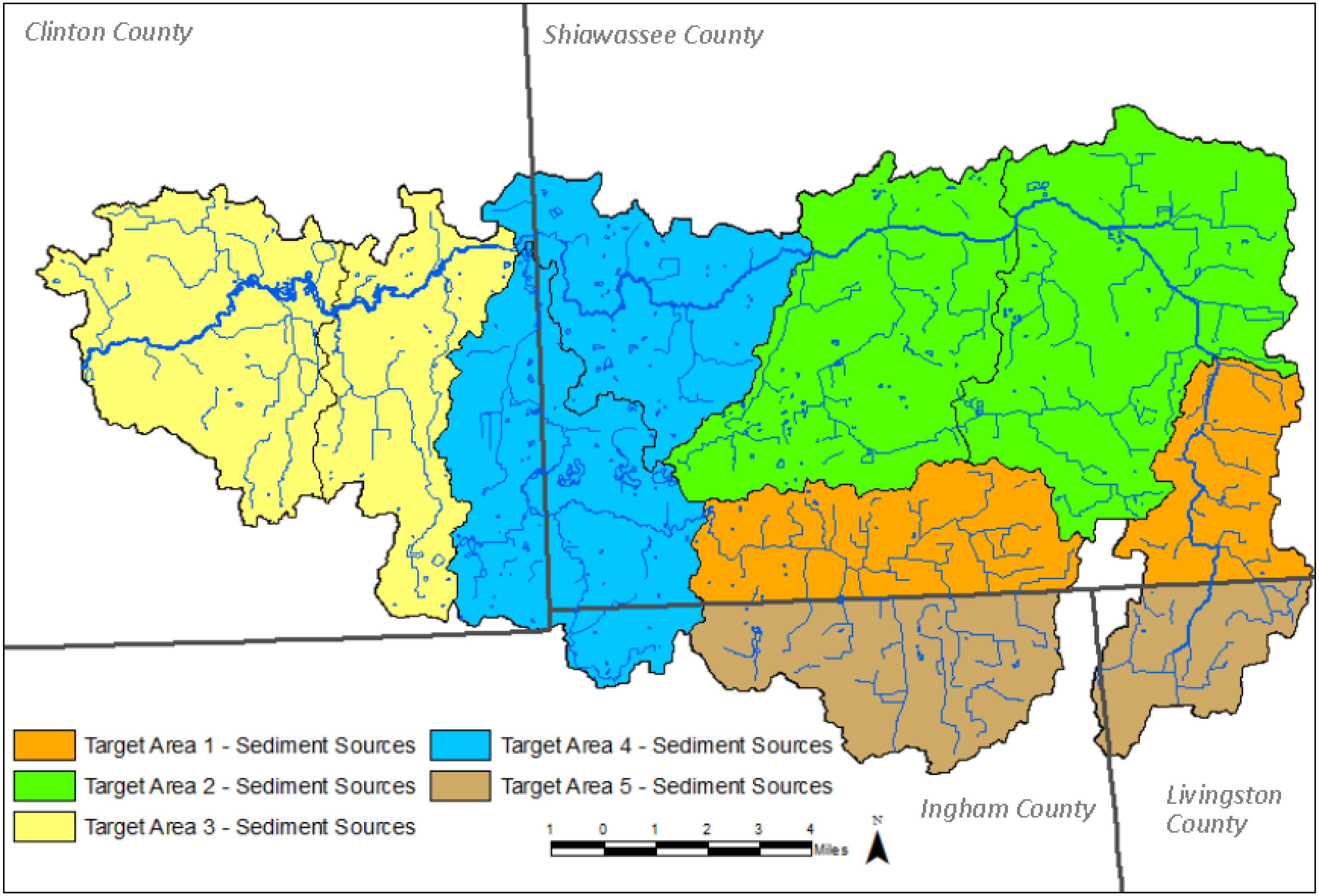

Figure 5.5 Target areas for implementing BMPs to address sediment, nutrients and pesticides in the Upper Looking Glass River Watershed.

5.4.3 Pollutant: Stormwater Runoff

Stormwater runoff is rainfall that flows over the ground surface. It is created when rain falls on roads, driveways, parking lots, rooftops and other paved surfaces that do not allow water to soak into the ground. Stormwater runoff is the number one cause of stream impairment in urban areas. Stormwater runoff in the ULG is not as common as in other watersheds. This is due to the predominant agricultural land use. However, stormwater runoff was seen as an issue in the residential and urban areas, especially in the City of Perry, Villages of Morrice, Laingsburg, Shaftsburg and along transportation routes.

LID practices are recommended to address stormwater runoff. An education campaign with homeowners, businesses, and municipalities about incorporating LID practices and LEED building design would significantly reduce the amount of pollutants entering surface water. Road salts are a common pollutant found in stormwater runoff. Education about the environmental impacts of deicing salts and using salt-free deicers is also suggested. Targets for addressing stormwater runoff include urban and residential areas of the watershed and can be seen on Figure 5.6.

5.4.4 Pollutant: Trash and Other Hazardous Materials

Illicit dumping of various materials was observed during stream reconnaissance. Due to lack of knowledge or empathy, or inadequate access to disposal or recycling facility, trash was deposited along waterways, roadways and in woodlots. An awareness program about the importance of recycling, composting and properly disposing of trash items would help reduced the illicit dumping problem. Regularly scheduled electronic recycling, hazardous house waste collections and incentives to recycle, would encourage environmentally friendly disposal of these items. Target areas seen in Figure 5.7 for addressing trash and other hazardous materials are based on data collected during stream reconnaissance.

5.4.5 Invasive Species

An invasive species is one that is not native and whose introduction causes harm, or is likely to cause harm to Michigan's economy, environment, or human health. Invasive species cause harm when they out-compete native species by reproducing and spreading rapidly in areas where they have no natural predators and change the balance of the ecosystems we rely on.

Invasive species are a concern in the ULG due to the modification of land from its pre-settlement use to a highly agricultural watershed. Common species found during stream reconnaissance included Reed Canary Grass, Narrowleaf Cattail, Autumn Olive, Dames Rocket, and Curly Pondweed. Treatment for species will require a thorough investigation with targeted control measures for the identified species. An outreach campaign focusing on impacts, control methods, and the use of alternative species such as native plants in landscaping would be beneficial to prevent accidental introduction and control further spread of invasive species.

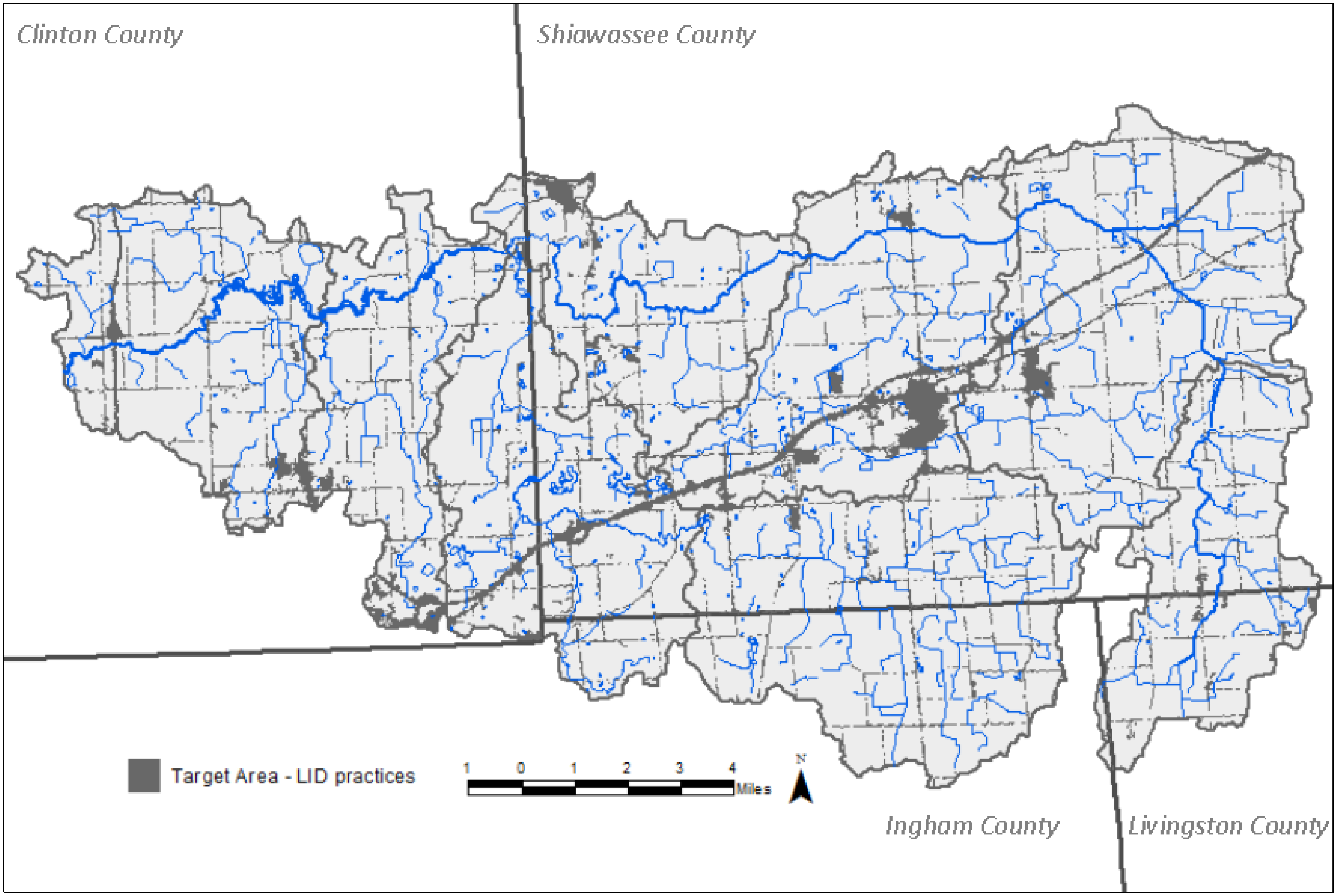

Figure 5.6 Target areas for LID practices in the Upper Looking Glass River Watershed.

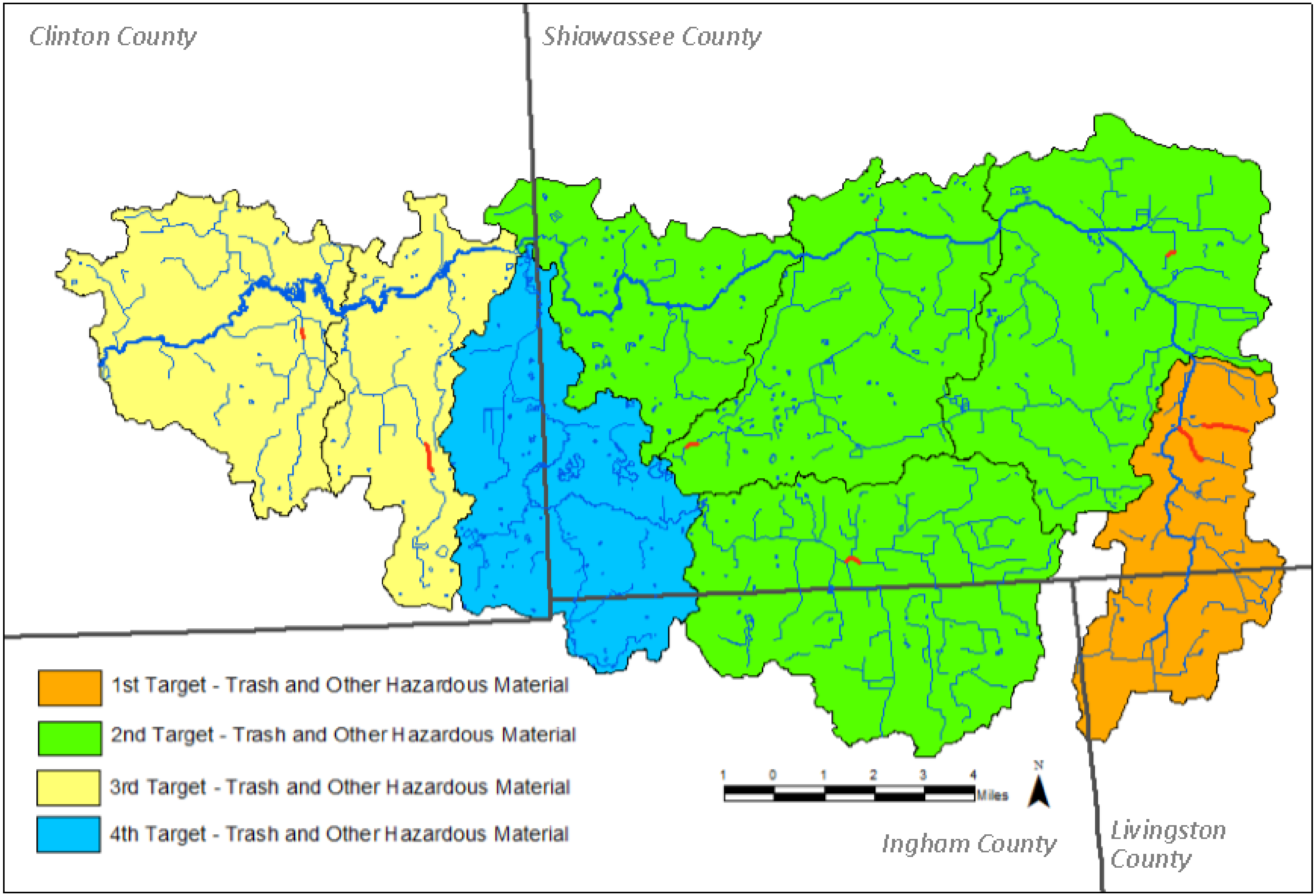

Figure 5.7 Target areas to address trash and other hazardous materials in the Upper Looking Glass River Watershed.

5.4.6 Targeting for Wetland Restoration, Preservation and Watershed Health

Wetlands slow and retain surface water, providing water storage, sediment and nutrient removal, and streambank/shoreline stabilization; therefore, preserving existing wetlands and restoring historically lost wetlands are critical steps toward maintaining and improving water quality within the Watershed. The DEQ has provided tools to help local stakeholders determine wetland priorities for the Upper Looking Glass River Watershed, including status and trends Information, quantifies wetland loss by type (see Section 1.3.6) and potential wetland restoration areas map. A combination of these tools, along with information collected during the watershed inventories, was utilized to identify areas for potential restoration of historically lost wetlands and preservation to protect existing wetlands in the ULG. Figure 5.8 illustrates potential wetland restoration areas and Table 5.2 lists restorable wetland acres in the ULG.

According to the U.S. EPA, a healthy watershed has the structure and function in place to support healthy aquatic ecosystems. Key components of a healthy watershed include:

- Intact and functioning headwater streams, floodplains, riparian corridors, biotic refugia, instream habitat, and biotic communities;
- Natural vegetation in the landscape; and
- Hydrology, sediment transport, fluvial geomorphology, and disturbance regimes expected for its location.

Healthy watersheds are uncommon, particularly in the eastern U.S. as well as in most other parts of the nation that are urbanized, farmed, or mined. Large tracts of protected wildlands, mostly in the western U.S., are where most healthy watersheds can be found. However, some healthy watersheds exist in many regions of the country where water pollution has been prevented or well controlled, and where communities maintain the benefits of their clean waterways.

Areas of the ULG meet the U.S. EPA's definition of a healthy watershed particularly because of the in-tact floodplains, widespread wetlands and riparian corridors, diverse biological communities, natural vegetation and hydrology. This watershed is unique in mid-Michigan because of the considerable amount of presettlement wetlands which remain in place (See Section 1.3.6) in a region that is primarily been cleared and drained for agricultural production.

Healthy watersheds not only affect water quality in a good way, but also provide greater benefits to the communities of people and wildlife that live there. A very wide range of activities could be called healthy watersheds protection. These may include regulatory and non-regulatory approaches essential for addressing future threats such as, emerging water quality problems, loss and fragmentation of aquatic habitat, altered water flow and availability, invasive species and climate change.

This WMP recommends efforts to protect high quality areas in the ULG. Efforts include protection and enhancement of wetland areas, upland wildlife habitat management measures, incentives to sustain conservation practices, and adoption of "green" infrastructure activities. The implementation plan in Section 5.6 describes in detail specific recommentations.

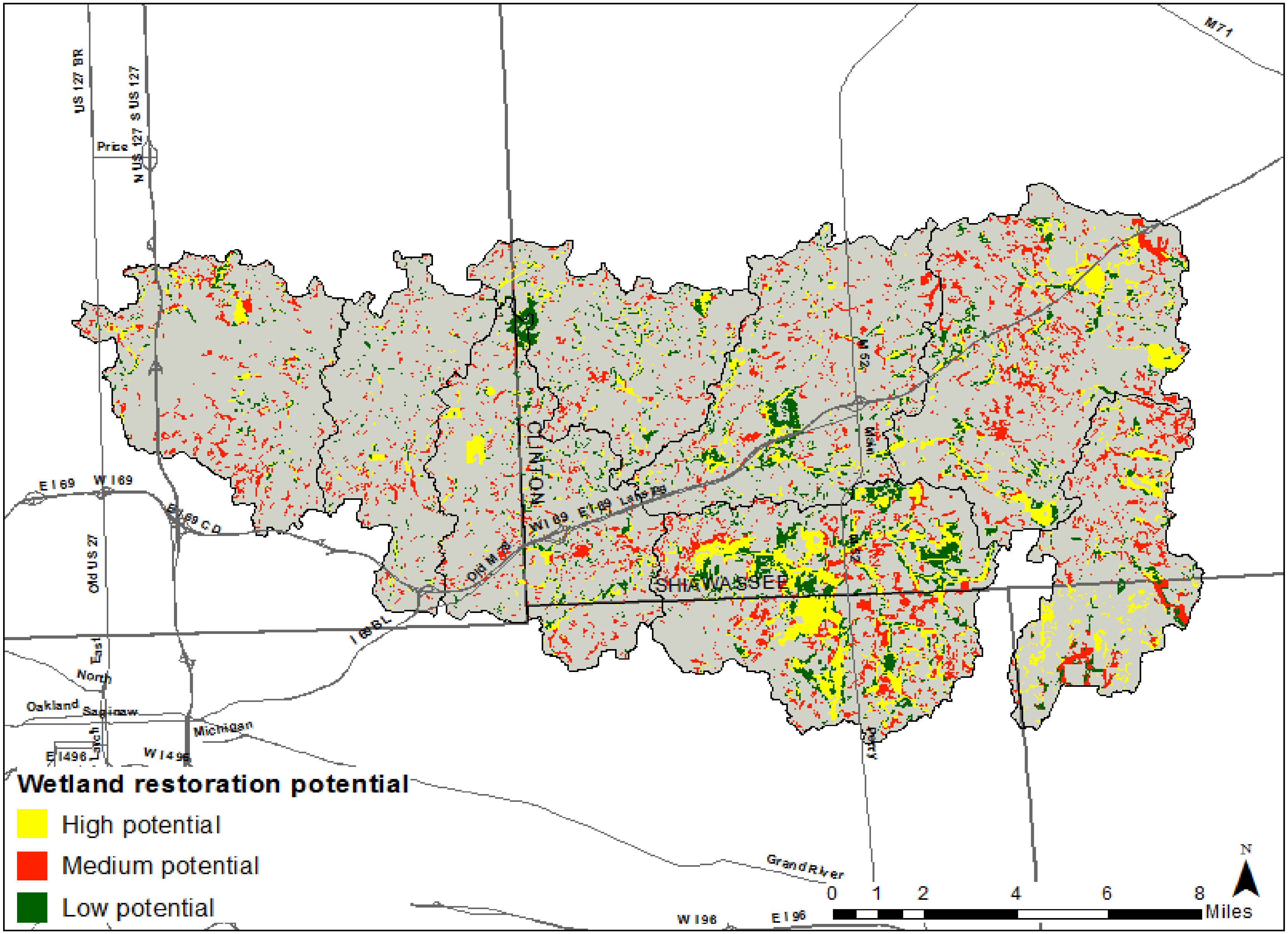

Figure 5.8 Potential wetland restoration areas in the Upper Looking Glass River Watershed (source MDEQ).

Watershed	Restoration Potential high	Restoration Potential medium	Restoration Potential low	Total Restorable Acres
Headwaters	430.95	1,212.01	881.13	2,524.08
Howard Drain	956.05	1,911.06	1,598.87	4,465.99
Kellogg Drain	949.76	994.01	657.35	2,601.12
Buck Branch	2,119.84	2,042.64	3,172.62	7,335.10
Vermillion Creek	648.28	971.25	648.60	2,268.12
Leisure Lakes	558.60	501.47	420.07	1,480.15
Mud Creek	204.85	479.07	156.44	840.36
Turkey Creek	320.43	981.75	374.66	1,676.84
Upper Looking Glass	6,188.77	9,093.27	7,909.74	23,191.78

Table 5.2 Restorable wetland acres for the Upper Looking Glass River Watershed (source: MDEQ and MNFI).

5.5 Phases of Implementation

A key consideration when planning to implement BMPs is how the various BMPs will be phased or sequenced in relation to one another over time. Determining which actions will need to take place before other actions will be important in achieving the full potential of each activity. The best order in which to implement BMPs can be based on a number of factors such as ecological factors, elements of cost, political realities, landowner willingness, length of time for developing the BMP, and/or priority concerns within the sub-watershed. BMPs are typically adopted in three phases. Phases are based on priority for implementation.

Phase I: BMPs that can be initiated immediately and require minimal cost or planning. These include practices that address the upstream sources/causes of a downstream problem. Landowners are typically eager to adopt practices and make changes, but may require some persuasion, technical and/or financial assistance. Examples include education programs, practices necessary to address an immediate problem, such as health concern or flooding, and development of site-specific plans.

Phase II: BMPs that require significant planning and development, design specifications, and require additional costs. These BMPs address sources/causes of a problem and can be structural or non-structural. Examples include new projects/programs, voluntary shifts in operation methodology, ordinances, pilot projects, or demonstration sites, studies, and structural BMPs.

Phase III: BMPs for which success may depend on the success of a previously implemented BMP, mostly structural BMPs but can include long-term management changes or education programs. Examples include instream and streambank restoration projects and adoption of practices defined in a long-term site-specific management plan.

Table 5.3A identifies priority pollutants/items with recommended BMP and Phase. Table 5.3B outlines specific implementation measures in 5.3A with costs and expected pollutant load reduction for the next

10 years. Table 5.4 outlines short and long term milestones, monitoring means, evaluation criteria, and responsible parties for implementation. Implementation objectives are listed on both Table 5.3B and Table 5.4. Table 5.4 lists Milestones for years 1-3 and years 4-10 for the Practices listed in Table 5.3. It should be noted that information regarding the pollutant removal efficiency, costs, and designs BMPs is constantly evolving and improving. As a result, information contained in these tables is dynamic and subject to change.

Priority Item	Source	Recommended BMP	Implementation Phase
Bacteria	Human	Education	I
		Septic system replacement	I
		Illicit connection removal	I
		Municipal system hook up	II
		Upgrade municipal system	II
		Adopt POS Program	II, III
	Livestock	Education	I
		Comprehensive Nutrient Management Plan	I
		Nutrient Management	II
		Waste Storage Facility	III
		Vegetated Treatment Area	III
		Filter Strip	I, II
		Grazing Management Plan	I
		Forage and Biomass Planting	II, III
		Prescribed Grazing	II, III
		Fence	II, III
	Pet Waste	Education	I
		Pet waste signage	I, II
		Pet waste depository station	III
Sediment and Nutrients	Erosion	Education	I, II
		Conservation Cover	I, II
		Conservation Crop Rotation	I, II
		Residue Management, No-Till and Strip Till	I, II
		Cover Crop	I, II
		Filter Strip	I, II
		Riparian Herbaceous Cover	I, II
		Grade Stabilization Structure	II, III
		Grassed Waterway	II, III
	Hydrology	Streambank and Shoreline Protection	III
		Stream Habitat Improvement and Management	III

		Two-stage Ditch	III
		Drainage Water Management	III
		Structure for Water Control	II, III
Sediment, Nutrients, Pesticides	Agricultural Runoff	Education	I
		Nutrient Management	I, II
		Integrated Pest Management	I, II
		Agrichemical Handling Facility	III
	Residential Runoff	Education	I
		Soil testing	II
Stormwater Runoff	Roadway	Education	I
		Repair eroding ditch turnouts, shoulders and embankments	I, II
		Repair failed, over/undersized, eroding, blocked, and misaligned culverts	I, II
		Buffer on road ditches	II, III
		Replace double culverts to provide natural passage	III
	Urban/Residential	Education	I
		Assortment of LID practices, target new construction activities	II, III
		Pervious pavement	III
		Rain barrels	III
		Rain gardens	III
		Vegetated green roof	III
Organic Material, Trash, and Hazardous Material	Illicit Dumping	Education	I
		Electronic recycling program	I, II, III
		Hazardous household waste collections	I, II, III
		Stream cleanup efforts	I, II, III
		Recycling bins	II
		Compost bins	II
Watershed Assessments	n/a	Education	I
		Water sampling	II
		Stream reconnaissance	II
		Septic system approval date inventory	II
		Invasive species inventory	II
Restore High Quality Areas	Invasive species	Education	I
		Brush Management	II, III
		Controlled management techniques	II, III
	Wetlands	Education	I

		Wetland Wildlife Habitat Management	II, III
		Wetland Restoration	III
		Wetland Creation	III
		Agricultural Wetland Mitigation Bank	III
Recreation and Stewardship	Private lands	Education	I
		Upland Wildlife Habitat Management	II, III
	Public	Education	I
		Stream cleanup efforts	I, II, III
		Establish Misteguay Chapter of the Flint River Watershed Coalition	II

Table 5.3A *Targeted pollutants/items with source with recommended BMPs and implementation phase. All items are listed in order of priority. See Table 5.3B for specific details on implementation strategy.*

Implementation Objective	Estimated Quantity	Recommended BMPs	Practice (NRCS practice code, if available)	Implementation Phase(s)	Estimated Average Unit Cost	Technical Assistance	Financial Assistance	Est. Cost (over 10 years)	Pollutant Load Reduction
Goal 1: Reduce or eliminate threat of human health hazards in rivers and streams caused by pollutants									
Implement practices to address sources of human waste in surface waters	205 homes	Address failing septic systems and illicit connection pipes	Replace failing septic systems	Phase I	$24,000 each	SCD, SCHD, local municipalities	SCD Watershed Program, 319, USDA RD, homeowners	$4,920,000	9.48E+15 cfu bacteria/yr, 1,845lb P/yr, 5,333lb N/yr, 74,005lb TSS/yr, 40,795lb BOD_5/yr (source for calculations: University of Minnesota 2013)
	41 homes		Connect individual households to a municipal wastewater treatment system	Phase II	$24,000 each			$984,000	2.5E+15 cfu bacteria/yr, 369lb P/yr, 1,066lb N/yr, 14,801lb TSS/yr, 8,159lb BOD_5/yr (source for calculations: University of Minnesota 2013)
	16 homes	Implement practices to address illicit connection pipes	Connect individual households to a municipal wastewater treatment system	Phase I	$24,000 each	SCD, SCHD, local municipalities	SCD Watershed Program, 319, USDA RD, homeowners	$384,000	9.86E+15 cfu bacteria/yr, 144lb P/yr, 416lb N/yr, 5,776lb TSS/yr, 3,184lb BOD_5/yr (source: University of Minnesota 2013)
	3 systems	Upgrades to existing wastewater treatment facilities	Wastewater treatment upgrades: Lainsgburg Village Lagoon, City of Perry Lagoon, Countryside Village MHP Lagoon	Phase III	$2,000,000 each	SCHD, MDEQ, local municipalities, USDA RD	MDEQ, USDA RD, local municipalities	$6,000,000	Effluent discharges below 200 fecal coliform bacteria per 100mL/month and 1mg/L total P/month (source for calculations: University of Minnesota 2013)
Implement practices to address animal sources of bacteria in surface water	22 sites	Manage the amount, source, placement, form, and timing of the application of nutrients and soil amendments	(102) Comprehensive Nutrient Management Plan; target sites from reconnaissance: 1, 2, 3, 21, 23, 27, 29, 39, 40, 47, 59, 64, 66, 67, 73, 74, 86, 112, 114, 132, 142	Phase I	$12,000 each	SCD, CCD, NRCS	USDA Farm Bill Programs, SCD Watershed grant program	$264,000	variable
	65 known sites then worst 10%; 6,637 ac		(590) Nutrient Management; target sites from stream reconnaissance: 1, 7, 8, 11, 14, 15, 17, 19, 20, 23, 24, 26, 27, 30, 32, 35, 39, 40, 41, 43, 44, 45, 46, 49, 50, 55, 56, 57, 58, 59, 60, 61, 66, 67, 71, 79, 80, 83, 87, 90, 91, 94, 95, 100, 101, 102, 103, 104, 106, 108, 111, 112, 113, 115, 116, 122, 124, 127, 130, 131, 136, 137, 139, 140, 145	Phase II	$24 per acre	SCD, CCD, NRCS	USDA Farm Bill Programs, SCD Watershed grant program	$159,288	variable
	22 sites	Temporarilys store wastes as a component of an ag waste management system	(313) Waste Storage Facility, dry stack, reinforced concrete wall and floor; target sites from stream reconnaissance: 1, 2, 3, 21, 23, 27, 29, 39, 40, 47, 59, 64, 66, 67, 73, 74, 86, 112, 114, 132, 142	Phase III	NRCS typical size 4,000 sqft at $48,000 each ($12/sqft)	SCD, CCD, NRCS	USDA Farm Bill Programs, SCD Watershed grant program	$1,056,000	variable
	22 sites	Treat nutrient rich wastewater and prevent contaimination	(635) Vegetated Treatment Area; target sites from stream reconnaissance: 1, 2, 3, 21, 23, 27, 29, 39, 40, 47, 59, 64, 66, 67, 73, 74, 86, 112, 114, 132, 142	Phases III	NRCS typical size 9,000sqft at $0.29 per sqft $3,000 each	SCD, CCD, NRCS	USDA Farm Bill Programs, SCD Watershed grant program	$66,000	variable
	22 sites	Vegetate waterways adjacent to feedlots and paddock areas	(393) Filter Strip, native species; ; target sites from stream reconnaissance: 1, 2, 3, 21, 23, 27, 29, 39, 40, 47, 59, 64, 66, 67, 73, 74, 86, 112, 114, 132, 142	Phase I, II	$200 per ac based on 1ac typical size	SCD, CCD, NRCS	USDA Farm Bill Programs, SCD Watershed grant program	$4,400	Reduction of 85-90% TSS, 40-65% NO2 (source: LID Manual of Michigan)
	22 plans	Grazing and forage practices to improve the diet and reduce bacteria levels in manure	(110) Grazing Management Plan; target sites from stream reconnaissance: 1, 2, 3, 21, 23, 27, 29, 39, 40, 47, 59, 64, 66, 67, 73, 74, 86, 112, 114, 132, 142	Phase I	$1,500 per plan	SCD, CCD, NRCS	USDA Farm Bill Programs, SCD Watershed grant program	$33,000	variable
	22 sites; 66 acres		(512) Forage and Biomass Planting, warm season, 2 or more species; target sites from stream reconnaissance: 1, 2, 3, 21, 23, 27, 29, 39, 40, 47, 59, 64, 66, 67, 73, 74, 86, 112, 114, 132, 142	Phase II, III	NRCS typical size 30 acres at $300 per ac	SCD, CCD, NRCS		$19,800	variable

Implementation Objective	Estimated Quantity	Recommended BMPs	Practice (NRCS practice code, if available)	Implementation Phase	Estimated Average Unit Cost	Technical Assistance	Financial Assistance	Est. Cost (over 10 years)	Pollutant Load Reduction
Implement practices to address animal sources of bacteria in surface water	22 sites; 66 acres	Grazing and forage practices to improve the diet and reduce bacteria levels in manure	(528) Prescribed Grazing; target sites from stream reconnaissance: 1, 2, 3, 21, 23, 27, 29, 39, 40, 47, 59, 64, 66, 67, 73, 74, 86, 112, 114, 132, 142	Phase II, III	$30 per acre	SCD, CCD, NRCS	USDA Farm Bill Programs, SCD Watershed grant program	$1,980	variable
	22 sites	Perimeter fence and interior fencing along waterways where livestock were observed	(382) Fence; target sites from stream reconnaissance: 1, 2, 3, 21, 23, 27, 29, 39, 40, 47, 59, 64, 66, 67, 73, 74, 86, 112, 114, 132, 142	Phase II, III	$2,200 each based on typical NRCS Scenario 1,320 ft	SCD, CCD, NRCS	USDA Farm Bill Programs SCD Watershed grant program	$48,400	variable
	12 signs	Pet waste management practices	Pet waste signage in urban and concentrated residential areas	Phase I, II	$150 per sign	SCD, CCD, FOLG, MGROW	319, NGO	$1,800	variable
	6 stations		Pet waste depository stations in urban and concentrated residential areas	Phase III	$500 per station			$3,000	
Goal 2: Pursue restoration efforts of designated uses that are confirmed to be threatened or impaired									
Implement conservation farming techniques	5,587 acres	Practices to reduce sheet and rill erosion on cropland	(327) Conservation Cover - native grass and forbs; target fields adjacent to stream reaches inventoried during reconnaissance	Phase I, II	$350 per acre based on NRCS scenario cost	NRCS, SCD, CCD	USDA Farm Bill Programs	$1,955,450	208 tons sediment/yr, 1184 lb P/yr, 7716 lb N/yr, 1333 BOD (source: STEPL)
	5,578 acres		(328) Conservation Crop Rotation, standard rotation; target fields adjacent to stream reaches inventoried during reconnaissance	Phase I, II	$5 per acre based on NRCS scenario cost			$27,890	208 tons sediment/yr, 1184 lb P/yr, 7716 lb N/yr, 1333 BOD (source: STEPL)
	5,578 acres		(329) Residue Management, No-Till and Strip Till; target fields adjacent to stream reaches inventoried during reconnaissance	Phase I, II	$25 per acre based on NRCS scenario cost			$139,450	446 tons sediment/yr, 2219 lb P/yr, 14,353 lb N/yr, 2855 BOD (source: STEPL)
	5,578 acres		(340) Cover Crops, multiple species; target fields adjacent to stream reaches inventoried during reconnaissance	Phase I, II	$85 per acre based on NRCS scenario cost			$474,130	208 tons sediment/yr, 1184 lb P/yr, 7716 lb N/yr, 1333 BOD (source: STEPL)
Implement vegetative filtering and buffering practices	54 sites; 74,549 linear ft (14 miles) at 1 acre each	Filter strips along drains in farm fields	(393) Filter Strip, native species; target fields adjacent to stream reaches inventoried during reconnaissance: 3, 5, 7, 8, 10, 14, 15, 16, 17, 21, 24, 26, 27, 30, 35, 39, 42, 44, 55, 57, 58, 59, 60, 63, 64, 65, 66, 73, 74, 78, 83, 84, 90, 91, 93, 94, 100, 107, 108, 109, 110, 111, 112, 113, 121, 123, 125, 127, 128, 130, 131, 133, 135	Phase I, II	$600 per acre based on NRCS scenario cost	NRCS, SCD, CCD	USDA Farm Bill Programs	$32,400	387 tons sediment/yr, 3259 lb P/yr, 17,688 lb N/yr, 2475 BOD (source: STEPL)
Implement vegetative filtering and buffering practices	12 sites; 12,512 linear ft (2.4 miles) at 5 acres each	Residential riparian vegetative buffer using native planting for pollinator species	(390) Riparian Herbaceous Cover, native species, pollinator planting; tgarget sites from stream reconnaissance with residential land use and inadequate buffer and/or mowing to stream edge identified: 4, 7, 12, 59, 90, 112, 113, 115, 116, 123, 135	Phase I, II	$600 each based on NRCS typical scenario cost	NRCS, SCD, CCD	SCD Watershed grant program, landowners, NGO	$7,200	99 tons sediment/yr, 97 lb P/yr, 194 lb N/yr (source for calculations: MDEQ June 1999)
Implement erosion stabilization techniques	42 sites	Stabilize gullies, washouts, and swales on cropland	(410) Grade Stabilization Structure, fabric reinforced vegetated chutetarget sites with gully erosion in agricultural areas identified during stream reconnaissance: 3, 4, 7, 9, 10, 11, 14, 15, 16, 17, 21, 22, 24, 25, 26, 30, 33, 35, 39, 40, 44, 46, 64, 72, 77, 84, 85, 112, 113, 121, 122, 125, 126, 127, 130, 132, 134, 135, 137, 138, 142, 143	Phase II, III	$800 each based on NRCS typical size of 30 sqft	NRCS, SCD, CCD	USDA Farm Bill Programs	$33,600	160 tons sediment/yr, 155 lb P/yr, 309 lb N/yr (source for calculations: MDEQ June 1999)
	42 sites		(412) Grassed Waterway; target sites with gully erosion in agricultural areas identified during stream reconnaissance: 3, 4, 7, 9, 10, 11, 14, 15, 16, 17, 21, 22, 24, 25, 26, 30, 33, 35, 39, 40, 44, 46, 64, 72, 77, 84, 85, 112, 113, 121, 122, 125, 126, 127, 130, 132, 134, 135, 137, 138, 142, 143	Phase II, III	$2,000 each based on NRCS typical size of 750 sqft	NRCS, SCD, CCD	USDA Farm Bill Programs	$84,000	160 tons sediment/yr, 155 lb P/yr, 309 lb N/yr (source for calculations: MDEQ June 1999)

Implementation Objective	Estimated Quantity	Recommended BMPs	Practice (NRCS practice code, if available)	Implementation Phase	Estimated Average Unit Cost	Technical Assistance	Financial Assistance	Est. Cost (over 10 years)	Pollutant Load Reduction
Implement erosion stabilization techniques	19 sites	Stabilize gully erosion from tile failures	(410) Grade Stabilization Structure, plunge pool; target sites with gully erosion caused by tile outlets identified during stream reconnaissance: 7, 10, 14, 16, 17, 22, 26, 69, 72, 77 88, 89, 126, 127, 130, 132, 135, 137, 142, 143, 146	Phase II, III	$3,200 each based on NRCS typical scenario cost	NRCS, SCD, CCD	County Drain Assessments, SCD Watershed grant program, USDA Farm Bill Programs	$60,800	50 tons sediment/yr, 51 lb P/yr, 102 lb N/yr (source for calculations: MDEQ June 1999)
Implement erosion stabilization techniques	37 sites	Stabilize eroding streambanks	(580) Streambank and Shoreline Protection - Bioengineered; target sites with streambank erosion from stream reconnaissance: 7, 8, 14, 23, 28, 33, 37, 38, 39, 40, 41, 42, 47, 48, 55, 57, 58, 64, 65, 66, 70, 72, 77, 84, 86, 88, 89, 100, 111, 117, 120, 125, 128, 132, 133, 139, 143	Phase III	$12,000 each based on NRCS typical size of 500ft	NRCS, SCD, CCD	County Drain Assessments, SCD Watershed grant program, USDA Farm Bill Programs	$444,000	90 tons sediment/yr, 85lb P/yr, 170 lb N/yr (source for calculations: MDEQ June 1999)
Implement Stream Habitat Improvements	9 sites	Stabilize streambank erosion, downcutting, undercutting, and sedimentation in forested areas	(395) Stream Habitat Improvement and Management - instream rock and wood structures; target forested sites with streambank erosion from stream reconnaissance: 3, 6, 8, 11, 41, 42, 49, 72, 80, 81, 87, 94, 95, 101, 102, 109	Phase III	$30,000 per acre (based on NRCS typical size of 1 ac)	NRCS, SCD, CCD	County Drain Assessments, SCD Watershed grant program, USDA Farm Bill Programs	$270,000	9 tons sediment/yr, 9 lb P/yr, 18 lb N/yr (source for calculations: MDEQ June 1999) plus Reduction of 85-90% TSS, 40-65% NO_2 (source: LID Manual of Michigan)
	21,454 linear ft	Stabilize and protect banks of streams	(582) Two stage ditch; target 1% of agricultural ditches	Phase III	$10 per linear ft based on NRCS scenario cost	NRCS, SCD, CCD		$214,540	3,991 tons sediment/yr (source for calculations: MDEQ June 1999)
Implement drainage management practices	582 acres	Management excessive water from surface and/or subsurface agricultural drainage system	(554) Drainage Water Management; target acres draining to sites with tiles identified during stream reconnaissance (see 587 for site numbers)	Phase II, III	$10/ac based on NRCS scenario cost	NRCS, SCD, CCD	USDA Farm Bill Programs	$5,820	Dependent on design
	29 structures	Control the stage, discharge, distribution, delivery, or direction of water flow	(587) Structure for Water Control; target sites with tiles from stream reconnaissance: 7, 10, 14, 16, 19, 26, 39, 40, 59, 60, 61, 63, 66, 72, 73, 75, 77, 88, 89, 90, 110, 113, 121, 125, 127, 130, 132, 135, 137, 143	Phase II, III	$2,000 each; NRCS typical area for a structure is 10-20 ac	NRCS, SCD, CCD	USDA Farm Bill Programs, SCD Watershed grant program	$58,000	Dependent on design
Goal 3: Assess watersheds for other designated uses. Restore these designated uses where found to be threatened or impaired.									
Assess watersheds for designated use attainment	17 sample locations	Adopt regular stream sampling strategy to assess stream reaches for impairments	Water sampling for *E. coli,* phosphorus and TSS; target: sample *E. coli* weekly for 6 weeks, P and TSS montly for 6 months at 17 locations	Phase II	$30 per sample analysis plus $10,000 per investigation for coordination; repeat 2 times	SCD, CCD, SCHD, MMDHD municipalities, WWTP	319, SCD, CCD, MDEQ	$31,000	
	46 sample locations		Advanced investigative techniques: scent-trained canines with *E. coli* analysis - target: 46 sample locations, 2 per year at 46 sample locations	Phase II	$10,000 per water sample investigation plus $10,000 per investigation for coordination; repeat 2 times	SCD, CCD, MDEQ	319, MDEQ, SCD, CCD, ECS, SCHD, MMDHD	$80,000	
	40 stream miles	Continue to inventory watershed and update database with findings	Stream reconnaissance activities; target 10% of stream miles	Phase II	$2,500 per stream mile	SCD, CCD, NRCS, MDNR, local partners	319, MDEQ, SCD, CCD, NRCS	$100,000	
	1,770 home records	Continue to inventory watershed and update database with findings	Septic system approval date inventory; target 25% of home records	Phase II	$15 per site record	SCD, CCD, SCHD, MMDHD	319, MDEQ, SCD, SCHD, MMDHD, local municipalities, FOLG	$26,550	
	5,540 ac	Continue to inventory watershed and update database with findings	Invasive species inventory; target: High risk areas of watershed - 10% of forest, open and wetland areas	Phase II	$250 per acre	SCD, CCD, DNR, CISMA	319, MDEQ, SCD, CCD, CISMA	$1,385,000	

Implementation Objective		Recommended BMPs	Practice (NRCS practice code, if available)	Implementation Phase	Estimated Average Unit Cost	Technical Assistance	Financial Assistance	Est. Cost (over 10 years)	Pollutant Load Reduction
Implement measures to address improper application of fertilizers and pesticides	65 known sites then worst 10%; 6,637 ac	Nutrient management measures on cropland	(590) Nutrient Management (grid/zone soil sampling, variable rate, soil/nitrate/plant tissue test without manure); target sites from stream reconnaissance: 1, 7, 8, 11, 14, 15, 17, 19, 20, 23, 24, 26, 27, 30, 32, 35, 39, 40, 41, 43, 44, 45, 46, 49, 50, 55, 56, 57, 58, 59, 60, 61, 66, 67, 71, 79, 80, 83, 87, 90, 91, 94, 95, 100, 101, 102, 103, 104, 106, 108, 111, 112, 113, 115, 116, 122, 124, 127, 130, 131, 136, 137, 139, 140, 145	Phase I, II	$25 per acre; based on NRCS typical size 40 acres	SCD, CCD, NRCS	USDA Farm Bill Programs, 319, Watershed Grant Programs	$165,925	variable
	49 known sites then worst 10%; 6,637 ac	Pest management measures on cropland	(595) Integrated Pest Management; target sites from stream reconnaissance:11, 14, 19, 20, 21, 22, 23, 25, 26, 27, 30, 31, 32, 33, 39, 40, 41, 42, 43, 44, 45, 46, 50, 56, 57, 58, 60, 61, 63, 64, 65, 66, 73, 74, 75, 77, 79, 80, 84, 88, 89, 90, 91, 100, 102, 103, 106, 107, 108	Phase I, II	$25 per acre; based on NRCS typical size 40 acres	SCD, CCD, NRCS	USDA Farm Bill Programs	$165,925	variable
	20 units	Chemical containment on agricultural land	(309) Agrichemical Handling Facility; target operations that currently store agrichemicals with identifed need for upgraded chemical storage	Phase II, III	$15,000 each based on NRCS typical size 2,000 sqft ($7.50 per sqft)	SCD, CCD, NRCS	USDA Farm Bill Programs	$300,000	variable
	150 soil tests	Fertilizers applied incorrectly to home lawns	Reduced rate soil test; target homeowners	Phase I, II	$30/soil test kit & time	SCD, CCD, MSUE	319, MSUE, homeowners	$4,500	variable
Implement measures to address organic material and trash dumping	20 recycling bins	Provide mechanisms to easily compost and recycle materials in urban and residential areas	Install recycling bins and compost bins; target area schools, municipalities, and businesses	Phase II, III	$500/bin	SCD, CCD, FOLG, MGROW	319, local businesses, municipalities, NGO	$10,000	variable
	10 compost bins				$500/bin			$5,000	variable
	30 service contracts				$2,500/unit/yr for collection service			$750,000	variable
	2 events annually		Regularly hold household hazardous waste, electronic, and tire recycling events	Phase I	$30,000 each for combined events	SCD, SCHD, MMDHD	319, MDEQ, CDs local municipalities	$6,000,000	variable
Implement practices to address stormwater runoff	20 units	Practices to protect water from farm fuels	(319) On-Farm Secondary Containment Facility; target operations that currently store fuel with identifed need for upgraded fuel storage	Phase III	$8,000 each based on NRCS typical size 1,100 gallon	SCD, CCD, NRCS	USDA Farm Bill Programs	$160,000	variable
Implement practices to address stormwater runoff	52 miles of road	Practices to address road runoff influence on waterways	20ft buffer on road adjacent ditches; target 10% miles of road ditch	Phase II, III	$170 per acre	SCD, NRCS, SCRC, CCRC, SCDC, CCDC	USDA Farm Bill Programs, Watershed grant program, County Drain Assessments	$21,430	Reduction of 85-90% TSS, 40-65% NO_2
Implement practices to address stormwater runoff	6 sites	Road BMPs to restore and protect water quality and aquatic habitats	Repair eroding ditch turnouts, shoulders and embankments; install outlet protection, and velocity control practices at road crossings; target sites from stream reconnaissance: 4, 19, 21, 64, 69, 112	Phase I, II	$5,000 per site	SCD, NRCS, SCRC, CCRC	SCD Watershed grant program, MDOT, SCRC, CCRC, local municipalities	$30,000	7.43 tons/yr sediment; 13 lb/yr N; 6.87 lb/yr P (source for calculations: MDEQ June 1999)
	10 culverts		Repair failed, failing, oversized, undersized, eroding, blocked and misaligned culverts; target sites from stream reconnaissance: 4, 12, 20, 25, 26, 35, 70, 101, 127, 134	Phase I, II	$5,000 per site	SCD, NRCS, SCRC, CCRC		$50,000	Dependent on design
	6 culverts		Upgrade double culverts to provide for natural channel passage; target sites from stream reconnaissance: 20, 25, 28, 63, 86, 146	Phase III	$100,000 each	SCD, NRCS, SCRC, CCRC, SCDC, CCDC		$600,000	Dependent on design

Implementation Objective	Estimated Quantity	Recommended BMPs	Practice (NRCS practice code, if available)	Implementation Phase	Estimated Average Unit Cost	Technical Assistance	Financial Assistance	Est. Cost (over 10 years)	Pollutant Load Reduction
Goal 4: Identify and offer restoration strategies and protection opportunities for potential high quality areas in the watershed.									
Implement wetland restoration practices	14 ac	Rehabilitate degraded or reestablish wetlands so that soils, hydrology, vegetation and habitat area close to natural conditions	(657) Wetland Restoration (evidence must be present that the hydrology has been manipulated and degratded); target 0.1% of existing wetlands	Phase III	up to $1,800/cu yd	NRCS, USFWS, other NGO	Landowner, producer purchase of certified wetland credits; local land conservancy or other NGO	$252,000	Reduction of 49% Total phosphorus, 35% Soluable Phosphorus, 33% Total Nitrogen, 67% Nitrate, 76% TSS (source: LID Manual of Michigan)
	14 ac	Establish wetland on site not a wetland or convert existing wetland to different type of wetland	(658) Wetland Creation (site historically not a wetland or is a wetland but will be converted to a wetland with a different hydrology, vegetation type, or function); target 0.1% of existing wetlands	Phase III	$2,000/ac	NRCS, USFWS, other NGO		$28,000	Reduction of 49% Total phosphorus, 35% Soluable Phosphorus, 33% Total Nitrogen, 67% Nitrate, 76% TSS (source: LID Manual of Michigan)
	14 ac	Enhance and manage wetland habitats within the landscape for wildlife	(644) Wetland Wildlife Habitat Management; target 0.1% of existing wetlands	Phase II, III	$350/ac	NRCS, USFWS, other NGO		$4,900	Reduction of 49% Total phosphorus, 35% Soluable Phosphorus, 33% Total Nitrogen, 67% Nitrate, 76% TSS (source: LID Manual of Michigan)
Implement wetland protection practices	62 ac	Voluntarily enter land containing wetlands into conservation easement	Agricultural Wetland Mitigation Bank site; target 0.5% of high restoration potential	Phase III	Up to $30,000 per acre to be paid through purchase of credits	NRCS, USFWS, other NGO	Landowner, producer purchase of certified wetland credits; local land conservancy or other NGO	$1,860,000	Reduction of 49% Total phosphorus, 35% Soluable Phosphorus, 33% Total Nitrogen, 67% Nitrate, 76% TSS (source: LID Manual of Michigan)
Implement invasive species control measures	554 acres	Implement measures to address early detection species: Black and Pale Swallow Wort, Chinese Yam, European Frogbit, Japanese Knotweed	(314) Brush Management, mechanical and chemical, small shrubs; target high risk areas of watershed - 1% of forest, open and wetland areas	Phase II, III	$300/ac	NRCS, SCD, CCD	USDA Farm Bill Program	$166,200	variable
	554 acres		Controlled management techniques specific to species of concern; target high risk areas of watershed - 1% of forest, open and wetland areas	Phase II, III	$300/ac	CISMA strike team	USFWS, MDNR	$166,200	variable
	554 acres	Implement measures to address all other invasive species	(314) Brush Management; target high risk areas of watershed - 1% of forest, open and wetland areas	Phase II, III	$30/ac (chemical); $750/ac (hand cut)	NRCS, SCD, CCD	USDA Farm Bill Program	$166,200 - $415,500	variable
Goal 5: Promote opportunities that the watershed can offer for recreation and wise stewardship; implement specific actions that enhance such identified recreation while preserving the integrity of the watershed									
Implement critical land, wildlife habitat, wetland, recreational lands restoration and protection practices	288 acres	Provide and manage upland habitats and connectivity within the landscape for wildlife	(645) Upland Wildlife Habitat Management; target high risk areas of the watershed - 5% of forest areas	Phase II, III	$10.10/ac based on NRCS scenario cost	NRCS, SCD, CCD	USDA Farm Bill Programs	$2,909	variable

Implementation Objective	Estimated Quantity	Recommended BMPs	Practice (NRCS practice code, if available)	Implementation Phase	Estimated Average Unit Cost	Technical Assistance	Financial Assistance	Est. Cost (over 10 years)	Pollutant Load Reduction
Encourage involvement in watershed stewardship activities	2 assessments annually	Macroinvertebrate collection, habitat assessments	Misteguay Chapter volunteer watershed stewardship organization	Phase I, II	$25/hr program coordinator, 10 hours per week	FOLG, CCD, SCD, residents, others	319, SCD, CCD, MiCorps, FOLG, others	$200,000	variable
	10 clean up events on 1% (3 miles) of stream	Stream/River cleanup program	Annual Stream Cleanup Event	Phase I, II, III	$35,000 per clean up event			$350,000	Reduction of trash, recyclable and compostable material
Goal 6: Identify land use planning measures complementary to watershed protection and/or enhancement									
Adopt Low Impact Design practices and measures	2 sites; 1,000 sqft	LID measures to infiltrate stormwater in paved areas	Pervious pavement with infiltration; target urban and concentrated residential areas	Phase III	$6/sqft	SCD, CCD, MDEQ	319, local munitipalities	$6,000	Reduction of 65-100% of TSS, 30-90% Total Phosphorus, 30% NO_3 (source: LID Manual of Michigan)
	2 sites; 2,000 cuft each	LID measures to capture and filter stormwater using plant materials	Rain gardens and bioswales and commercial businesses; target urban and concentrated residential areas	Phase III	$7/cuft	SCD, CCD, MDEQ	319, local munitipalities	$14,000	Reduction of 70-90% of TSS, 60-75% Phosphorus, 55-70% Total Nitrogen, 30% NO_3 (source: LID Manual of Michigan)
	1 site; 1,000 sqft	LID measures to capture and filter stormwater using plant materials	Vegetated green roof; target local municipalities and commercial businesses	Phase III	$20/sqft	SCD, local municipalities	319, local munitipalities	$20,000	Dependent on design
	25 rain barrel cisterns	LID measures to capture and filter stormwater for reuse as gray water for typical residential home	Rain barrel cistern; target homeowners in the watershed	Phase III	$200 each	SCD, CCD	319, homeowners	$5,000	Dependent on design
	25% of new construction projects	Incorporate LID into the site design process for 25 new construction projects	Assortment of LID practices; target new construction activities in the Watershed	Phase II, III	Dependent on practice	SCD, CCD, NRCS, builders and developers	319, local munitipalities	dependent on practice	variable
Expand Point-of-Sale Ordinance to areas outside of Shiawassee County	up to 1,200 homes outside of Shiawassee County with likely septic systems	Septic system inspection for homes during ownership transfer	Ordinance requiring septic systems to meet Sanitary Code to be elgible for ownership transfer in areas outside of Shiawassee County	Phase II, III	$50,000 to develop ordinance and 5,000 to inspect each system	local health departments, MDEQ	homeowners, local health departments, MDEQ	$50,000 (ordinance development); up to $6,000,000 for inspections over 10 years	variable

Section 5.7 Measurable Milestones, Monitoring Components, Evaluation Criteria and Responsible Partners (Table 5.4)

Implementation Objective	Measurable Milestone (1-3 years)	Measureable Milestone (4-10 years)	Monitoring Means	Evaluation Criteria	Responsible Partner
Implement practices to address human sources of waste in surface water	Replace 68 failing septic systems, work with 19 homeowners to connect to a muncipal sewer system; encourage 1 community sewer system to consider upgrades	Work to replace 137 failing septic systems, work with 38 homeowners to connect to a muncipal sewer system; encourage 2 community sewer systems to consider upgrades	Photos of new septic systems and sewer upgrades to reduce bacteria; Pollutant load reduction calculations	Number of new septic systems installed; number of new sewer connections made; number and type of upgrades made to sewer system	SCD, CCD, SCHD, homeowners, municipalities; local communities
Implement practices to address animal sources of bacteria in surface water	Develop 7 CNMPs & 7 grazing plans; adopt 2,212 acres of nutrient management; install 8 waste storage facilities, 8 vegetated treatment areas, 7 acres of riparian pasture buffer, 22 acres of prescribed grazing, 22 acres of forage & pasture planting; install/upgrade 8 sites with pasture fencing; install 4 pet waste signs and 2 disposal stations	Develop 15 CNMPs & 12 grazing plans; adopt 4,425 acres of nutrient management; install 14 waste storage facilities, 14 vegetated treatment areas, 12 acres of riparian pasture buffer, 44 acres of prescribed grazing, 44 acres of forage & pasture planting; install/upgrade 14 sites with pasture fencing; install 8 pet waste signs and 4 disposal stations	CNMP and grazing plans recommendations; photos of BMPs installed to reduce bacteria; Pollutant load reduction calculations	Number of CNMP and grazing plans developed; number and acres of BMPs installed	SCD, CCD, NRCS, landowners, producers; municipalities
Implement conservation farming techniques	Address 1,862 acres through conservation practices	Address 3,725 acres through conservation practices	Photos of BMPs installed to reduce sediment; Pollutant load reduction calculations	Number of acres on which conservation practices were implemented	NRCS, SCD, CCD, landowners, producers
Implement vegetative filtering and buffering practices	Implement 5 miles of filter strips; 1 mile of residential buffers	Implement 9 miles of filter strips, 1.4 miles of residential buffers	Photos of BMPs installed to reduce sediment; Pollutant load reduction calculations	Number of miles filter and buffers were installed	NRCS, SCD, CCD, landowners, producers
Implement erosion stabilization techniques and stabilize altered hydrology	Stabilize 20 gullies, 14 grassed waterways, stabilize 12 eroding streambanks	Stabilize 61 gullies, 28 grassed waterways, stabilize 25 eroding streambanks	Photos of BMPs installed to reduce sediment; Pollutant load reduction calculations	Number of gullies stabilized, feet of streambank stabilized	NRCS, SCD, CCD, landowners, producers
Implement stream habitat improvements	Adopt instream structures at 3 sites, install 7,151 ft of two-stage ditches	Adopt instream structures at 6 sites, install 14,303 ft of two-stage ditches	Photos of BMPs installed to reduce sediment; Pollutant load reduction calculations	Number of instream structures installed, ft of two-stage ditches installed	SCD, CCD, NRCS, SCDC, CCDC, landowners, producers
Implement drainage water management practices	Manage agricultural drainage for 194 acres; install 10 structures for water control	Manage agricultural drainage for 388 acres; install 19 structures for water control	Photos of BMPs installed to reduce sediment; Pollutant load reduction calculations	Acres managed for agricultural drainage land, number of structures for water control installed	SCD, CCD, NRCS, SCDC, CCDC, landowners, producers

Section 5.7 Measurable Milestones, Monitoring Components, Evaluation Criteria and Responsible Partners (Table 5.4)

Implementation Objective	Measurable Milestone (1-3 years)	Measureable Milestone (4-10 years)	Monitoring Means	Evaluation Criteria	Responsible Partner
Assess watersheds for designated use attainment	Conduct water sampling at 17 permanent sites twice per year; stream reconnaissance of 40 miles of waterways; identify septic system approval dates for 1,770 homes; inventory 1850 acres of forest/shrub/wetland for invasive species	Conduct water sampling at 17 permanent locations twice per year; conduct two 6-week *E. coli* repetitive water sampling studies and two 6-month Phosphorus repetitive water sample studies; conduct two investigations with scent-trained canines.; inventory 3690 acres of forest/shrub/wetland for invasive species.	Results from investigations	Analysis of change in water quality from investigations	SCD, CCD, SCHD, Water Quality lab, ECS, CISMA
Implement measures to address improver application of fertilizer and pesticides	Adopt nutrient and pest management on 2,212 acres; 7 AHF installed; 50 residential soil tests conducted	Adopt nutrient and pest management on 4,425 acres; 13 AHF installed; 100 residential soil tests conducted	Photos of BMPs installed to reduce nutrients and phosphorus; Pollutant load reduction calculations	Number of acres on which conservation practices were implemented	SCD, CCD, NRCS, landowners, producers, homeowners
Implement measures to address organic material and trash dumping	Place 7 recycling bins and 3 compost bins; initiate 10 recycling service contracts; hold 6 HHW/E-waste collections	Place 13 recycling bins and 7 compost bins; initiate 20 recycling service contracts; hold 14 HHW/E-waste collections	Recycling and compost bin locations; service contract participants; collection event participation	Amount of recyclable and compostable material collected; amount of HHW and E-waste collected	SCD, CCD, SCHD, municipalities, businesses, schools
Implement measures to address stormwater runoff	Install 7 on-farm secondary containmnet facilities; install filter strips on up to 17 miles of road ditches; repair 2 ditch turnouts and 4 failing culverts; upgrade 2 double culverts to provide natural channel passage	Install 13 on-farm secondary containmnet facilities; install filter strips on up to 35 miles of road ditches; repair 4 ditch turnouts and 6 failing culverts; upgrade 4 double culverts to provide natural channel passage	Photos of BMPs installed to address stormwater runoff; pollutant load calculations	Number of fuel containment facilities; acres/feet/miles of filter strips; number and type of ditch repairs	SCD, CCD, NRCS, SCDC, SCRC, CCDC, CCRC, producers
Implement wetland restoration techniques	Restore, enhance and/or create 4.7 acres of wetland; establish 20 acre wetland mitigation bank site	Restore, enhance and/or create 9.3acrea of wetland; expand wetland mitigation bank site by 42 acres	Photos of wetlands BMPs; location of wetland mitigation bank	Acres of wetland BMPs and wetland mitigation bank stite	SCD, CCD, NRCS, landowners, land conservancy
Implement invasive species control measures	Implement invasive species control measures on 185 acres	Implement invasive species control measures on 369 acres	Photos of treatment sites; follow up inspection and treatments	Acres of invasive species treated	SCD, CCD, NRCS, CISMA, land owners

Section 5.7 Measurable Milestones, Monitoring Components, Evaluation Criteria and Responsible Partners (Table 5.4)

Implementation Objective	Measurable Milestone (1-3 years)	Measureable Milestone (4-10 years)	Monitoring Means	Evaluation Criteria	Responsible Partner
Implement critical land, wetland, recreational lands restoration and protection	Implement 96 acres of Upland Wildlife Habitat Management activities; 6 volunteer microinvertebrate and habitat assessments; 3 stream cleanup events	Implement 192 acres of Upland Wildlife Habitat Management activities; 14 volunteer microinvertebrate and habitat assessments; 7 stream cleanup events	Photos of BMPs installed; participation in stewardship programs	Acreas of upland wildlife habitat management activities; number of stewardship program participants	SCD, CCD, NRCS, FOLG
Adopt Low Impact Development measures	Implement 2 rain gardens/bioswales, distribute 10 rain barrels and encourage LID into site design processes for 10 new construction projects	Implement pervious pavement at 2 locations, install vegetated green roof, distribute 15 rain barrels and encourage LID into site design processes for 15 new construction projects	Photos of BMPs installed; pollutant load reduction calculations	Number and acres of rain gardens, number and sqft of pervious pavement, number and sqft of vegetated green roof, number of rain barrel cisterns placed	SCD, CCD, local businesses, municipalities and schools, landowners, homeowners
Expand POS ordiance to areas outside of Shiawassee County	Investigate expanding Point-of-Sale ordinance feasiblity for areas outside of Shiawassee County	Investigate expanding Point-of-Sale ordinance feasiblity for areas outside of Shiawassee County	Contact with landowners, Health Department officials, political representatives about a POS ordinance	Feedback gathered from stakeholders; progress made on expanding the POS ordinance	local municipalities

Goal	Indicators	Cause or Source of Impact
Pursue restoration efforts of designated uses that are confirmed to be threatened or impaired	26.35 miles of Onion Creek Watershed Other Indigenous Aquatic Life and Wildlife impaired as listed on DEQ Integrated Report	Direct habitat alteration and flow regime changes to channel
	Elevated sediment and nutrient levels in streams	Streambank, gully, sheet erosion; channel dredging
Reduce or eliminate threat of human health hazards in rivers and streams caused by pollutants	Elevated *E. coli* levels found in streams during sampling; alerts to human waste in stream water samples by scent-trained canines	Failing septic systems, illicit connections, runoff from livestock operations, improper manure storage and spreading on crop fields, biosolid applications
Assess watersheds for designated uses not currently	Sediment loads, nuisance plant growth, elevated pathogen levels, macroinvertebrate community ratings	Upland sediment erosion and delivery, streambank and gully erosion, near-stream land disturbances, little to no buffering along streams, failing septic systems, illicit connections,

Identify and offer restoration strategies and protection opportunities for potential high quality areas in the watershed	Elevated pathogen and chemical levels, temperature, sediment and nutrient loads, streams free of logjams	Development and construction activities; riparian vegetation removal, wetland removal
Promote opportunities that the watershed can offer for recreation and wise stewardship; implement specific actions that enhance such identified recreation while preserving the integrity of the watershed	Well vegetated wetlands, woodlots, and riparian corridors; natural public trails; hunting, fishing and kayaking/canoeing opportunities	Removal of vegetation and wetland drainage; upland and streambank sediment erosion, land disturbances; accidental and intentional introduction of invasive species

Identify land use planning measures complementary to watershed protection and/or enhancement	Sediment loads, peak storm water runoff, nutrient and bacteria levels	Elevated nutrients such as phosphorus causing nuisance plant growth; upland and streambank sediment erosion, land disturbances

Management Objective
Implement conservation farming techniques Implement vegetative filtering and buffering practices Implement erosion stabilization techniques Implement stream habitat improvements Implement drainage management practices
Implement practices to address human sources of bacteria in surface waters Implement practices to address animal sources of bacteria in surface waters
Assess watersheds for designated use attainment Implement measures to address improper application of fertilizers and pesticides Implement measures to address organic material and trash dumping Implement practices to address stormater runoff

Implement wetland restoration practices Implement invasive species control measures
Implement critical land, wildlife habitat, wetland, recreational lands restoration and protection Implement outreach campaign

Implement measures to address stormater management
Expand Point-of-Sale ordinance to areas outside of Shiawassee County

Section 6 Information and Education Strategy

6.1 Goals and Objectives of the I&E Strategy

The Information and Education (I&E) Strategy is a tool used to inform and motivate people to take positive actions to restore and protect the Watershed. It is a coordinated strategy tailored to specific water quality concerns and targeted to the different audiences in the watershed.

The I&E strategy includes familiarizing stakeholders with the sources of nonpoint source pollution and educating the public, municipalities, community groups and schools about sources and impacts of pollution on the Watershed. A well-orchestrated I&E strategy will empower watershed users to want to take action to protect and restore natural resources. It will enable individuals to become accountable for the watershed condition and, in turn be the ones who educate others, creating a legacy that spreads conservation and watershed protection for years to come.

Many I&E activities need to be conducted on a Watershed-wide basis since it is important for everyone to understand their roles and responsibilities. Some activities will target specific audiences such as septic system education to homeowners and proper manure management practices to producers. Whereas some activities will target specific pollutants, sources and causes, such as agricultural or residential sources caused by lack of conservation practices. Table 6.1 connects ranked pollutant, sources and causes with target audiences. Also included are key messages, delivery mechanisms milestones, timelines, estimates costs, and sources of assistance, as well as an evaluation mechanism.

The goal of the I&E strategy is to create awareness and inspire positive action by residents to help restore and protect natural resources in the Watershed.

The I&E Strategy has the following objectives:

- Increase public knowledge and broaden awareness of the Watershed, by:
    - Teaching how land use, upstream and riparian, activities affect downstream water quality and the overall health of the Watershed.
    - Teaching the connection between pollutants and their sources and causes and the effects downstream.
    - Creating a sense of individual responsibility for the proper use and care of water resources.
    - Teaching implementation techniques and how they work to reduce nonpoint source pollution.
- Provide education to homeowners with septic systems about proper maintenance and knowing the signs of system failure.
    - Meet with homeowners one-on-one to review a personalized education session discussing septic system care and other environmental risks in and around the home.
    - Host public workshops with specialized presenters who can discuss important aspects of septic system care and knowing signs of failure.
    - Reach out to homeowners at public events such as fairs, home expos, watershed events, etc.

- Assist homeowners with the process of septic system repair, replacement and connection to a municipal waste system.
- Assist livestock and crop producers with properly managing and applying manure and nutrients.
- Assist landowners and producers through developing Conservation Plans and Comprehensive Nutrient Management Plans (CNMP).
- Assist landowners and producers in the adoption of conservation utilizing Michigan Agriculture Environmental Assurance Program (MAEAP) assessment tools and Farm Bill Conservation Programs, where applicable.
- Assist homeowners with education and resources to properly manage hazardous household, compostable and recyclable waste materials in an environmentally safe manner.
- Educate the public about natural resources concerns, water quality and issues affecting the watershed through watershed celebration events.
- Provide opportunities for watershed youth to participate in stream assessment programs through periodic macroinvertebrate collection events and other youth conservation/environmental programs.
- Maintain existing relationships and encourage new relationships with partners outside of the immediate project area to expand water quality efforts throughout the entire Looking Glass River Watershed.
- Encourage changes in local land use policies and standards for long-term changes by providing technical assistance in the review of a County Master Plan and supporting planning and zoning issues that will benefit water quality.
- Encourage use of tools such as the Michigan State University Institute of Water Research eWatershed for watershed users to explore and understand the effects of nonpoint source pollution and how implementing conservation practices improves water quality and watershed condition.

6.2 Target Audiences and Key Messages

Target audiences include individuals or groups known to influence or be impacted by the project and whose support is needed to achieve the goals of the project. Key messages intended for target audiences range from broad to specific, depending on the character of the audience. Each target audience must have a clear understanding of the problems being addressed and how the problems affect them before any behavioral changes are to take place. Table 6.1 links target audiences and key messages with pollutants, sources and causes.

Known, presumed and potential water pollutants include sediment, nutrients, bacteria/pathogens, pesticides, trash and stormwater runoff. Inventories conducted throughout the watershed planning process have identified bacteria/pathogens, nutrients and sediment as known pollutants throughout the Watershed. Stormwater runoff from both agricultural and developed areas are presumed to be a significant source of nonpoint source sediment, nutrients and pesticide pollution. Urban stormwater can potentially contain various pollutants such as sediment, nutrients, organic matter, trash, feces and pathogens, road salts, oil and grease, toxic metals and pesticides.

Reaching target audiences requires messages that are specific to the audience and pollutants that result from their actions. Key Messages incorporate findings from the field inventory and existing data review with actions that would address the pollutant. Messages are organized by pollutants and are specific to audience influence on that pollutant.

Pollutant: Bacteria and Pathogens

Target Audience: Homeowners
Message: Proper septic system care, maintenance, system upgrades and municipal service connections reduces the amount of bacteria and pathogens that enters surface water to help improve water quality and reduce risks to human health.
Message: Illicit connection pipes dispelling home wastewater and "gray" water are illegal and put water bodies at risk by creating hazardous conditions.

Target Audience: Producers and Farmers
Message: Proper manure management, manure spreading plans (nutrient management plans), fencing, watering facilities and other conservation practices reduce the amount of bacteria and pathogens entering surface water from livestock and manure applications to help protect water quality and reduce risks to human health.

Target Audience: General Public
Message: *E. coli* and other bacteria from wastewater causes serious illness in humans and impairs water quality for recreational use.
Message: Proper pick up and disposal of pet waste reduces the amount of bacteria and pathogens entering waterways, help improve water quality, reduce risks to human health and beautify the watershed.

Pollutant: Sediment

Target Audience: Producers and Farmers
Message: Conservation practices installed to address soil erosion from farmland reduces sedimentation of streams and nonpoint source pollutants attached to sediment particles.

Target Audience: Contractors/Developers/City and Village Managers/Engineers
Message: Pollutants resulting from construction activities can be reduced or eliminated by using proper sedimentation and erosion control (SESC) measures and innovative BMPs.
Message: Use of natural stream design regulates flow, reduces stream flashiness, protects against streambank erosion and addresses downcutting.
Message: The use of Low Impact Development (LID) and Green Infrastructure (GI) techniques that work with nature to manage stormwater as close to the source as possible minimizes the effects of impervious surfaces and treats stormwater as a resource rather than a pollutant.

Target Audience: Homeowners/Landowners
Message: Homeowners/Landowners can use sedimentation and erosion control BMPs on their own property to reduce or eliminate sediment from entering surface water from nonpoint sources especially in riparian areas.

Target Audience: General Public

Message: A well vegetated riparian buffer helps protect surface water from polluted runoff.
Message: The health of an aquatic ecosystem can be inferred by the diversity and quantity of benthic macroinvertebrate species and sedimentation impairs aquatic habitats.

Pollutant: Nutrients

Target Audience: Producers and Farmers
Message: Addressing soil erosion reduces nutrient loading by keeping soil particles and associated nutrients from entering waterways.
Message: Applying nutrients at rates recommended by soil testing protects against fertilizers entering surface water, helps improve water quality and reduces risks to human health.
Message: Conservation practices to protect against livestock yard/pasture runoff, livestock stream access and managing manure in an environmentally safe manner protects waterways from nutrient loading.
Message: A well vegetated riparian buffer helps protect surface water from polluted runoff.

Target Audience: Homeowners
Message: Nutrients can leach from aged and poorly maintained septic systems. Proper maintenance including, regularly pumping septic tanks, reducing/using caution with inputs and employing water conservation strategies extends the life of a septic system and protects water quality.
Message: Management of nutrients through soil testing and improved fertilizer application knowledge, composting and allowing riparian areas to remain well vegetated with native plants protects surface water from nutrient loading.

Target Audience: Commercial Lawn Care Companies, Landscapers and Golf Courses
Message: Management of nutrients through soil testing and improved fertilizer application knowledge, setbacks from waterways in applying nutrients and the use of bioengineering to stabilize streambanks decreases the amount of nutrients entering surface water and improves water quality.

Target Audience: Cities, Villages, Townships and other public entities
Message: Management of nutrients through soil testing and improved fertilizer application knowledge, increases in yard proper waste composting and reuse, and the use of bioengineering to stabilize stream banks decreases the amount of nutrients entering surface water and improves water quality.

Pollutant: Pesticides

Target Audience: Producers and Farmers
Message: Knowledge of common agricultural pests, crop nutrient needs and soil nutrient levels helps determine proper treatments to address pest issues and soil nutrient requirements without having excess pesticides and fertilizers that can pollute water resources.
Message: A well vegetated riparian buffer and maintaining setbacks from surface water when applying pesticides helps protect surface water from polluted runoff.

Target Audience: Homeowners
Message: Knowledge of lawn and garden pests, proper application of pesticides and incorporating organic and alternative gardening methods reduces inappropriate use of pesticides.

Pollutant: Stormwater Runoff (Oils, Road Salts, Other Chemicals)

Target Audience: Producers and Farmers
Message: Proper equipment maintenance, use of secondary containment and well vegetated riparian areas helps to protect surface water from polluted runoff.

Target Audience: General Public
Message: Many storm drains empty directly into surface water and the improper disposal of hazardous wastes into catch basins creates health threats and impairs water quality.
Message: Proper maintenance reduces the amount of gasolines and oil from leaky vehicles from entering surface water.
Message: Excessive application of deicing road salts cause damage to plants and surface water by running off impervious surfaces into adjacent road ditches and waterways. Proper application of deicing agents reduces negative consequences and improves water quality.
Message: Restoring and protecting wetlands helps to reduce damage from flooding, filter pollutants, improves water quality and enhances fish and wildlife habitat.

Pollutant: Random Dumping (general trash, compostable material)

Target Audience: General Public, Policing Authorities
Message: Proper disposal and recycling of general trash, electronics, hazardous products and compostable material has a direct effect on improving the health and quality of the watershed.

Table 6.1 describes specific I&E tasks, critical and priority areas for implementation, estimated quantities for implementation, technical and financial assistance, timeframe for implementation over the next 10 years and estimated costs for implementation.

6.3 Delivery Mechanisms and Activities

A combination of outreach activities and media formats are key to reach diverse audiences with environmental stewardship messages. The collective target audience is broad and multiple formats will be necessary to reach each audience and reinforce messages over time. Formats should be phased in as each audience moves from awareness to education to action and finally reinforcement. Initially, efforts should largely focus on media outlets and printed materials, to raise awareness and educate audiences on water quality issues. Formats that focus on solutions and actions should be developed as the audiences become more aware of the existing water quality concerns. These formats could include workshops, presentations and other events.

One of the most effective means of distributing information is to attach it with existing material distributions already received by the target audience. This approach helps to leverage resources, and materials are more likely to be seen by the audience since they are already familiar with the format. The following delivery mechanisms and activities will be used to implement the I & E Strategy:

- Develop and distribute brochures and flyers
- Publish articles in local newspapers, county publications, Conservation District newsletters, website and dispersed through on social media

- Outreach through informational displays at fairs, display events, expos and meetings
- Public Service Announcements (PSA) through local radio and television stations
- Presentations at public, county, township, village and city meetings
- School/classroom presentations and hands-on activities with youth
- Workshops targeting specific pollutants, sources, causes and audiences
- Regular messages about key issues through newspapers, social media, blogs and websites
- Watershed signs at conservation practice demonstration sites in the Watershed
- Watershed tours of featured conservation practice sites
- Comparison plots of conservation practices on farmers' properties
- Community surveys
- Storm Drain stenciling
- Participation in one-on-one *A*Syst education programs, MAEAP and other Farm Bill programs
- Incentive payments to agricultural producers for long-term enrollment in programs
- Financial assistance for septic system replacements and connections to municipal services
- Local Clean Sweep days for farm chemicals and pesticides, and household hazardous waste collection at no charge
- Electronic waste recycling events for public participation at little to no cost
- Riparian tree, native plant and wildflower plantings with workshops discussing the use of native foliage and importance of riparian plantings

Table 6.1 identifies delivery mechanisms and evaluation methods planned for the Upper Looking Glass River Watershed

6.4 Implementation of I&E Strategy

Tasks and Schedules

Implementation of the I&E Strategy follows four steps: (1) awareness, (2) education, (3) action and (4) reinforcement. A list of specific I&E implementation tasks and schedules can be found in Table 6.1.

Awareness

Target audiences should first be given general information defining a watershed and examples of nonpoint source pollution to increase awareness of issues specific to the Watershed. The public should be made aware that they live in a watershed and that their day-to-day activities affect water quality. They will learn about pollutants, sources, causes and the impacts that land use activities have on water quality with wide-ranging approaches to minimize these impacts. Tools to raise awareness include direct mailings, signage, logos, brochures, PSA's, articles in local newspapers and newsletters, and material distributed online at District websites and through social media outlets.

Education

The public will have opportunities for more in-depth education through a variety of opportunities, including public meetings, presentations, workshops, displays, tours, online forums, classroom lessons, social media and articles. Many of these opportunities will allow the public to comment and respond to the findings of the Project. Open meetings and one-on-one contacts will provide further opportunity for the public to offer their opinions and concerns.

Action

An aware and educated audience feels empowered to take positive action. Actions occur when audiences change behaviors and develop programs and events that influence and improve water quality. Such actions include participation in outreach programs, implementing conservation practices to improve water quality and making informed decisions on land use planning. Feeling empowered and taking ownership for the solutions of water quality concerns provides a framework for sustainability and ensures the continuation of the Project's objectives.

Reinforcement

Once an audience makes the leap to take action and change behavior it is critical to reinforce the importance of the new behavior to prevent reversion back to old habits. Following up with audiences reinforces the cycle of awareness, education and action. It also makes the audience feel included in watershed issues, which further empowers the desire to continue the positive behavior or action. Reinforcement actions include adding audience members to mailing and email lists and regularly distributing information and updates on activities in the watershed. Reaching out to audience members through direct mailings, phone calls and social media to make requests for feedback, event participation or volunteer assistance further cements the importance of that audience member in watershed issues. These types of audience members then become advocates for the watershed and can begin the awareness, education, action cycle on their own reaching other audiences helping to sustain the Project's objectives.

The I&E activities outlined in Table 6.1 will be focused first on the critical areas in the Watershed described in previous sections of this WMP. Sustainability for I&E efforts will be developed throughout the Project, since the protection of the Watershed will be a long-term endeavor.

6.5 Potential Partners

Many groups and organizations are active within the Watershed and provide support and assistance during educational efforts. The Steering Committee was formed to actively participate in the development of the WMP. At the Steering Committee meetings, community members had an opportunity to give input and share ideas and concerns. Partners for I&E activities include:

- Shiawassee Conservation District (SCD)
- Clinton Conservation District (CCD)
- U.S. Department of Agriculture Natural Resource Conservation Service (NRCS)
- Michigan Department of Environmental Quality (MDEQ)
- Michigan Department of Agriculture and Rural Development (MDARD)
- Michigan Department of Natural Resources (MDNR)
- Shiawassee County Drain Commissioner (SCDC)
- Clinton County Drain Commission (CCDC)
- Shiawassee County Health Department (SCHD)
- Mid-Michigan District Health Department (MMDHD)
- Shiawassee County Road Commission (SCRC)
- Clinton County Road Commission (CCRC)
- Clinton County Parks and Greenspace Commission (PGSC)

- Michigan Farm Bureau (MFB)
- Clinton County Farm Bureau (CCFB)
- Michigan Agriculture Environmental Assurance Program (MAEAP)
- Township, City, and Village Officials
- Pheasants Forever (PF)
- Clinton County Chapter of Pheasants Forever (CCPF)
- Clinton Lakes Pheasant Co-op (CLPC)
- Quality Deer Management Association (QDMA)
- Friends of Park Lake (FOPL)
- Friends of the Looking Glass River (FOLG)

Table 6.1 identifies partners who may contribute technical and financial assistance.

6.6 Evaluation Measures

Evaluation of the education campaign provides a feedback mechanism for continuous improvement of the I&E Strategy. As described in Table 6.1, criteria are listed to evaluate delivery mechanisms. These criteria define the reach of the delivery mechanism to the target audience and, when tracked, provide a way to determine where to focus additional resources.

Although evaluation of specific components within the I&E Strategy will occur continuously, the I&E Strategy will be periodically reviewed and adjusted as necessary. Questions that should be considered during implementation of the I&E Strategy are listed below.

- Are the planned activities being implemented according to the schedule?
- Is additional technical or financial support needed?
- Are additional activities needed?
- Do some activities need to be modified or eliminated?
- Are the resources allocated adequately to carry out the tasks?
- Are all of the target audiences being reached?
- What feedback has been received and how does it affect the I&E strategy program?
- How do the conservation practice implementation activities correspond to the I&E strategy?

Another mechanism that will be utilized is the Social Indicators Data Management and Analysis tool (SIDMA survey). The SIDMA is intended to be used by resource managers who want to learn more about their watersheds. It is a tool to help organize, analyze, and visualize social indicators information and will be important to the I&E evaluation process.

Section 6.7 Information and Education Strategy for the Upper Misteguay Creek Watershed (Table 6.1)

Ranked Pollutant	Source/ Cause	Target Audience	Messages	Delivery Mechanism	Milestone & Timeline	Estimated Cost/Assistance	Evaluation
1. Bacteria and Pathogens	1. Failing Septic Systems and Illict Connections	Homeowners	Proper septic system care, maintenance, system upgrades and municipal service connections reduces the amount of bacteria and pathogens that enters surface water to help improve water quality and reduce risks to human health. Illicit connection pipes dispelling home wastewater and “gray” water are illegal and put water bodies at risk by creating hazardous conditions.	1. Educate homeowners about septic system care, illicit connections and health concerns associated with human sources of *E. coli* through articles, newsletters, PSAs and web/social media posts.	18 articles, 18 newsletter enclosures, 36 web/social media posts, 4 PSAs - Years 1-8	$60,200 ($2,000 printing/ postage & 968 hrs @ $25/hr) - SCD, CCD, SCHD, MMDHD, 319, EPA, MDEQ, FOLG	Improved septic system maintenance - regular septic tank pumping, care of drainfield, caution for what goes down the drain; Number of new and replacement septic systems; number of illicit connection pipes removed; number of homes connected to municipal wastewater treatment systems. Pollutant load reductions from practice adoption
				2. Provide septic system education through direct mailings. Target homes with septic system approval dates of 1997 or older.	200 direct mailings to homeowners - Years 1-3	$1,350 ($100 postage & 50 hrs @ $25/hr) - SCD, CCD, EPA, 319, MDEQ, SCHD, MMDHD	
				3. Perform one-on-one Home*A*Syst in-home risk assessments focusing on septic system care and sources of human *E. coli* .	2 to 4 Home*A*Systs per year - Years 2-8	$10,000 ($2,000 materials & 320 hrs @ $25/hr) - SCD, CCD, 319, EPA, MDEQ, MSUE	
				4. Provide education about *E. coli* , on-site wastewater treatment and municipal services through Wastewater Education Workshop Series.	3 Workshops - Years 2-3	$5,400 ($1,000 each workshop & 96 hrs @ $25/hr) - SCD, CCD, 319, EPA, MDEQ, SCHD, MMDHD, others	
1. Bacteria and Pathogens	2. Manure in agricultural runoff	Producers and farmers	Proper manure management, manure spreading plans (nutrient management plans), fencing, watering facilities and other conservation practices reduce the amount of bacteria and pathogens entering surface water from livestock and manure applications to help protect water quality and reduce risks to human health.	1. Educate producers and farmers about the use of BMPs and programs available to implement practices, to reduce pathogens and bacteria from entering surface waters by publishing articles, conducting PSAs and public presentations.	20 articles, 5 PSAs, 20 web/social media posts, 20 public presentations - Years 1-10	$57,000 ($200 each for presentation materials & 2,120 hrs @ $25/hr) - SCD, CCD, NRCS, MDARD, MFB, others	Number of on-farm risk reductions, Conservation Plans developed, Farm Bill Program contracts, types of conservation practices installed; pollutant load reductions from practice adoption
				2. Encourage producers and farmers to participate in MAEAP to ensure the farm is not contributing *E. coli* and other pollutants to surface waters.	250 *A*Systs assessment conducted, 10 MAEAP verifications - Years 1-10	$65,000 annually - SCD, CCD, NRCS, MDARD	
				3. Work with producers and farmers to develop Conservation Plans to ensure that nutrients applied as manure are taken up by plants and do not runoff and pollute surface waters.	10 Conservation Plans - Years 1-5	$150,000 (600 hrs @ $25/hr) - SCD, CCD, NRCS, 319, Farm Bill	
				4. Enroll producers and farmers to implement conservation practices such as Comprehensive Nutrient Management Plans, Nutrient Management, Pasture Management, Manure Storage and management practices through Farm Bill and District programs.	5 Farm Bill Contracts developed - Years 1-5	$75,000 (300 hrs @ $25/hr) - SCD, CCD, NRCS, 319, Farm Bill	

Section 6.7 Information and Education Strategy for the Upper Misteguay Creek Watershed (Table 6.1)

Ranked Pollutant	Source/ Cause	Target Audience	Messages	Delivery Mechanism	Milestone & Timeline	Estimated Cost/Assistance	Evaluation
1. Bacteria and Pathogens	3. Pet waste, domestic animals and wildlife waste	General Public	Proper pick up and disposal of pet waste reduces the amount of bacteria and pathogens entering waterways, help improve water quality, reduce risks to human health and beautify the watershed.	1. Publish articles in newsletters, local newspapers and online about the unhealthy conditions created by pet waste being left on impervious surfaces.	2 articles, 1 PSA, 2 web postings - Years -2-4	$650 (26 hrs @ $25/hr) - SCD, CCD, FOLG, 319, others	Behavioral shift by pet owners to collect pet waste from impervious surfaces
2. Sediment	1. Agricultural runoff	Producers and farmers	Conservation practices installed to address soil erosion from farmland, reduces sedimentation of streams and nonpoint source pollutants attached to sediment particles.	1. Educate producers about conservation practices to address soil erosion and farmland to protect streams from sedimentation through participation in MAEAP.	250 *A*Systs assessment conducted, 10 MAEAP verifications - Years 1-10	$65,000 annually - SCD, CCD, NRCS, MDARD	Number of on-farm risk reductions, Conservation Plans developed, Farm Bill Program contracts, types of conservation practices installed; pollutant load reductions from practice adoption
				2. Work with producers and farmers to develop Conservation Plans and enroll in Farm Bill programs to assist with the cost of practices; provide proper technical assistance in implementation.	10 Conservation Plans - Years 1-5; 5 Farm Bill Contracts developed - Years 1-5	$150,000 (600 hrs @ $25/hr) - SCD, CCD, NRCS, 319, Farm Bill; $75,000 (300 hrs @ $25/hr) - SCD, CCD, NRCS, 319, Farm Bill	
	2. Inadequate buffer on agricultural waterways 3. Tillage 4. Gully erosion			1. Educate producers and farmers about conservation practices such as filter strips, conservation tillage, cover crops, grassed waterways, grade stabilization structures through presentations at Ag Field Day and showcasing practice examples.	10 on-site tours at annual Ag Field Day - Years 1-10	$15,300 ($2,500 materials for each presentation & 2,120 hrs @ $25/hr) - SCD, CCD, NRCS, MDARD, others	Changes in behavior responses to questionnaire provided before and after attendance
2. Sediment	5. Streambank erosion and downcutting due to hydrological fluctuations	Contractors/ Developers/ City and Village Managers/ Municipalities	Use of natural channel design measures regulates flow, reduces stream flashiness and protects against streambank erosion and downcutting	1. Educate about the importance of SESC measures and innovative BMPs such as natural channel design measures through articles, web postings and one-on-one contacts.	1 article; 2 web/social media postings; 10 contacts - Years 3-5	$1,300 (52 hr @ $25/hr) - SCD, CCD, SCHD, MMDHD, SCD, CCDC, 319, others	Types of natural stream design practices adopted, pollutant load reductions
				2. Educate contractors/developers/City and Village Managers/Municpalities on the use of natural stream design through presentation and site visit of locally installed examples of such measures.	1 workshop with tour - Year 5	$2,100 ($500 materials & 64 hrs @ $25/hr) - SCD, CCD, NRCS, SCD, CCDC, 319, others	
	6. Runoff from construction areas		Pollutants resulting from construction activities can be reduced or eliminated by the proper use of sedimentation and erosion control (SESC) measures and innovative BMPs.	1. Educate on the proper installation and maintenance of required soil erosion and sedimentation techniques during construction activities through presentation for local contractors.	1 workshop with tour - Year 6	$1,300 ($500 materials & 32 hrs @ $25/hr) - SCD, CCD, SCHD, MMDHD, MDEQ, 319	Types of enhanced soil erosion control techniques undertaken, pollutant load reductions
				2. Provide technical assistance through development of SESC site plans.	3 SESC plans developed - Years 7-8	$3,900 ($300 printing & 144 hrs @ $25/hr) - SCD, CCD, NRCS, SCHD, MMDHD, MDEQ, 319	
				3. Give recognition to model contractors who use BMPs in the form of an award or certificate.	3 awards - Year 8-10	$2,100 ($600 printing & 60 hrs @ $25/hr) - SCD, CCD, NRCS, SCHD, MMDHD, MDEQ, 319	

Section 6.7 Information and Education Strategy for the Upper Misteguay Creek Watershed (Table 6.1)

Ranked Pollutant	Source/ Cause	Target Audience	Messages	Delivery Mechanism	Milestone & Timeline	Estimated Cost/Assistance	Evaluation
2. Sediment	7. Stormwater runoff	Contractors/ Developers/City and Village Managers/ Municipalities	The use of Low Impact Development (LID) and Green Infrastructure (GI) techniques that work with nature to manage stormwater as close to the source as possible minimizes the effects of impervious surfaces and treats stormwater as a resource rather than a pollutant.	1. Educate contractors/developers/City and Village Managers/Municipalities on the use of LID and GI through presentation and site visit of locally installed examples of such measures.	1 workshop with tour held - Year 10	$2,100 ($500 materials & 64 hrs @ $25/hr) - SCD, CCD, NRCS, MDEQ, 319, others	Types of LID and GI practices adopted, pollutant load reductions
	8. Residential runoff; gravel driveways; poorly vegetated riparian areas; soil erosion	Homeowners and Landowners	Homeowners/ Landowners can use sedimentation and erosion control BMPs on their own property to reduce or eliminate the amount of sediment entering the river from non- point sources.	1. Publish a series of articles and web/social media posts that address erosion and sedimentation from activities in and around the home.	3 articles; 3 web postings - Years 2-5	$750 (30 hrs @ $25/hr) - SCD, CCD, SCHD, MMDHD, FOLG, 319	Before and after evaluation of homeowner habits and changes of behavior
				2. Provide education on nonpoint source pollution in and around the home through the Home*A*Syst program.	2-4 Home*A*Systs annually - Years 2-6	$8,000 ($2,000 materials & 240 hrs @ $25/hr) - SCD, CCD, 319	
	Residential runoff; gravel driveways; poorly vegetated riparian areas; soil erosion	Homeowners and Landowners	Homeowners/ Landowners can use sedimentation and erosion control BMPs on their own property to reduce or eliminate the amount of sediment entering the river from non- point sources.	3. Develop plans with riparian landowners to plant a buffer area of native grasses and wildflowers to protect the integrity of streambanks and reduce occurrences of streambank erosion.	5 riparian landscape plans - Years 5-8	$8,000 ($2,000 printing/ materials/misc & 48 hrs @ 25/hr) - SCD, CCD, 319	Types of lawn alterations to address sediment from eroding streambanks
	9. Construction and home renovations			1. Develop a list of questions for prospective homeowners or homebuilders to ask contractors and developers regarding their company's use of BMPs.	Questionnaire distributed to 20 prospective homeowners or homebuilders - Years 9-10	$1,310 ($510 printing/ postage & 32 hrs @ 25/hr) - SCD, CCD, NRCS, SCHD, MMDHD, 319	Changes in behavior in response to questionnaire
				2. Hold a Workshop on the use of Low Impact Development (LID), Green Infrastructure (GI) and Leadership in Energy and Environmental Design (LEED) in designing, developing and upgrading the home and landscape.	1 workshop - Year 10	$1,800 ($1,000 workshop costs & 32 hrs @ $25/hr) - SCD, CCD, 319, FOLG, others	Types of LID, GI and LEED practices planned or installed, pollutant load reductions

Section 6.7 Information and Education Strategy for the Upper Misteguay Creek Watershed (Table 6.1)

Ranked Pollutant	Source/ Cause	Target Audience	Messages	Delivery Mechanism	Milestone & Timeline	Estimated Cost/Assistance	Evaluation
2. Sediment	10. Stormwater runoff; streambank and gully erosion	General Public	A well vegetated riparian buffer helps protect surface water from polluted runoff.	1. Hold a Native Plants and Riparian Cover Workshop.	2 workshops - Years 6-7	$2,800 ($1,000 each workshop cost & 32 hrs @ $25/hr) - SCD, CCD, 319, FOLG, others	Changes in perception of native plants and riparian areas planted
			The health of an aquatic ecosystem can be inferred by the diversity and quantity of benthic macroinvertebrate species and sedimentation impairs aquatic habitats.	2. Develop Water Quality Monitoring Program to include Macroinvertebrate Collection and Habitat Assessment	Annual water sampling events; results presented by volunteers and students - Years 2-10	$26,600 ($5,000 equipment & 864 hrs @ $25/hr) - FOLG, SCD, CCD, GCD, local schools, others	Increase in volunteer participants; number of events; results from water quality monitoring efforts
3. Nutrients	1. Agricultural runoff containing manure		BMPs to protect against livestock/pasture runoff, livestock stream access and managing manure in an environmentally safe manner protect waterways from excessive nutrient loading.	1. Encourage producers and farmers to participate in MAEAP to ensure farm operations are following environmental regulations.	250 *A*Systs assessment conducted, 10 MAEAP verifications - Years 1-10	$65,000 annually - SCD, CCD, NRCS, MDARD	Number of on-farm risk reductions, number of MAEAP verifications, Conservation Plans developed, Farm Bill Program contracts, types of conservation practices installed; pollutant load reductions from practice adoption
				2. Work with producers and farmers with livestock and/or apply manure to enroll in Farm Bill programs to assist with the cost of conservation practices that address livestock issues and provide proper technical assistance in implementation.	10 Conservation Plans - Years 1-5; 5 Farm Bill Contracts developed - Years 1-5	$150,000 (600 hrs @ $25/hr) - SCD, CCD, NRCS, 319, Farm Bill; $75,000 (300 hrs @ $25/hr) - SCD, CCD, NRCS, 319, Farm Bill	
	2. Agricultural runoff containing nutrients		Addressing soil erosion from gullies, sheet flow and streambanks reduces nutrient loading by keeping soil particles and associated nutrients from entering waterways.	1. Educate farmers and producers about the importance of building soil organic matter and keeping topsoil and associated nutrients from eroding away through press releases, District newsletters, web/social media posts, contacts at display events and County Agricultural Day event.	10 on-site tours at annual Ag Field Day - Years 1-10	$15,300 ($2,500 materials for each presentation & 2,120 hrs @ $25/hr) - SCD, CCD, NRCS, MDARD, others	Changes in behavior responses to questionnaire provided before and after attendance
				2. Encourage farmers and producers to enroll in Farm Bill programs to install BMPs such as grassed waterways, no-till and cover crops to stop soil and associated nutrient from eroding away.	10 Conservation Plans - Years 1-5; 5 Farm Bill Contracts developed - Years 1-5	$150,000 (600 hrs @ $25/hr) - SCD, CCD, NRCS, 319, Farm Bill; $75,000 (300 hrs @ $25/hr) - SCD, CCD, NRCS, 319, Farm Bill	Conservation Plans developed, Farm Bill Program contracts, types of conservation practices installed; pollutant load reductions from practice adoption
			A well vegetated riparian buffer helps protect surface water from polluted runoff.	3. Work with producers and farmers to plant riparian buffer strips along waterways in cropped areas by encouraging Farm Bill program enrollment.			
	3. Agricultural runoff containing fertilizer		Applying nutrients at rates recommended by soil testing protects against excessive fertilizers from entering surface water, helps improve water quality and reduces risks to human health.	1. Educate farmers and producers on soil testing, integrated pest management, nutrient management techniques through press releases, District newsletters, web/social media posts, discussions at display events County Agriculture Day event.	10 on-site tours at annual Ag Field Day - Years 1-10	$15,300 ($2,500 materials for each presentation & 2,120 hrs @ $25/hr) - SCD, CCD, NRCS, MDARD, others	Changes in behavior responses to questionnaire provided before and after attendance

Section 6.7 Information and Education Strategy for the Upper Misteguay Creek Watershed (Table 6.1)

Ranked Pollutant	Source/ Cause	Target Audience	Messages	Delivery Mechanism	Milestone & Timeline	Estimated Cost/Assistance	Evaluation
3. Nutrients	4. Septic system leachage	Homeowners	Nutrients can leach from old and poorly maintained septic systems. Proper maintenance extends the life of a septic system and protects water quality.	1. Educate homeowners about septic system care, illicit connections and health concerns associated with human sources of *E. coli* through articles, newsletters, PSAs and web/social media posts.	18 articles, 18 newsletter enclosures, 36 web/social media posts, 4 PSAs - Years 1-8	$60,200 ($2,000 printing/ postage & 968 hrs @ $25/hr) - SCD, CCD, SCHD, MMDHD, 319, EPA, MDEQ, FOLG	Improved septic system maintenance - regular septic tank pumping, care of drainfield, caution for what goes down the drain.
	5. Fertilizer applications; residential runoff	Homeowners	Management of nutrients through soil testing and educated fertilizer application knowledge, composting and allowing riparian areas to remain well vegetated with native plants protects surface water from excessive nutrient loading.	1. Educate homeowners about soil testing, and how to read and follow a soil test through articles and web postings.	3 articles; 3 web postings - Years 5-7	$750 (30 hrs @ $25/hr) - SCD, CCD, SCHD, MMDHD, FOLG, 319	Changes in perception of native plants; greater understanding about soil tests, obtaining and following a soil test when applying fertilizer by homeowners
				2. Conduct lawn care and native plant and soil test workshop for homeowners	2 workshops - Years 6-7	$2,800 ($1,000 each workshop cost & 32 hrs @ $25/hr) - SCD, CCD, 319, FOLG, others	
				3. Meet one-on-one with homeowners and provide site specific education through the Lawn*A*Syst program.	2-4 Lawn*A*Systs annually - Years 5-7	$8,000 ($2,000 materials & 240 hrs @ $25/hr) - SCD, CCD, 319	
	6. Fertilizer applications; soil erosion	Commercial Lawn Care Companies and Golf Courses	Management of nutrients through improved fertilizer application knowledge, increases in yard waste composting, and the use of bioengineering to stabilize streambanks will decrease the amount of nutrients entering surface water and improve water quality.	1. Educate commercial lawn care companies and golf courses about the importance of soil testing and no-Phosphorus fertilizers to reduce over application of nutrients through direct mailings and one-on-one discussions.	20 direct mailings - Year 6	$135 ($10 postage & 5 hrs @ $25/hr) - SCD, CCD, 319, FOLG, MSUE, others	Before and after evaluation of commercial lawn care companies and golf courses habits and changes of behavior
				2. Educate commercial lawn care companies and golf courses about the use of bioengineering techniques in stabilizing streambanks through presentations and on-site demonstrations tours.	1 on-site demonstration tour - Year 6	$1,800 ($1,000 workshop costs & 32 hrs @ $25/hr) - SCD, CCD, 319, FOLG, MSUE, others	
				3. Educate commercial lawn care companies and golf courses about the use of BMPs by recognizing model BMP users and showcasing sites using BMPs.	3 model BMP users recognized - Year 6	$2,100 ($600 printing & 60 hrs @ $25/hr) - SCD, CCD, 319, FOLG, others	
	7. Municipal fertilizer application; soil erosion	Cities, Villages, Townships other public entities	Manage nutrients through improved fertilizer application knowledge, increased yard waste composting and the use of bioengineering to stabilize erosion to decrease the amount of nutrients entering surface water.	1. Educate local governments on the use of BMPs focusing on riparian planting, natural stream design, composting, rain gardens and rain barrels through direct mailings, presentations and demonstration tours.	10 direct mailings - Year 6; 1 workshop with tour held - Year 6	$1,935 ($ 10 postage & 5 hrs @ $25/hr; $1,000 workshop cots & 32 hrs @ $25/hr) - SCD, CCD, 319, FOLG, MSUE, others	Number of Conservation Plans developed; number of BMPs adopted; pollutant load reductions
				2. Provide technical assistance to local governments on the availability, use and upkeep of BMPs through development of site specific Conservation Plans.	3 Conservation Plans developed - Years 6-7	$3,000 (120 hrs @ $25/hr) - SCD, CCD, 319	

Section 6.7 Information and Education Strategy for the Upper Misteguay Creek Watershed (Table 6.1)

Ranked Pollutant	Source/ Cause	Target Audience	Messages	Delivery Mechanism	Milestone & Timeline	Estimated Cost/Assistance	Evaluation
4. Pesticides	1. Agricultural runoff containing pestidices	Producers and farmers	Knowledge of common agricultural pests, crop nutrient needs and soil nutrient levels helps determine proper treatments to address pest issues and soil nutrient requirements without having excess pesticides and fertilizers that can pollute water resources.	1. Educate farmers and producers about incorporating Integrated Pest Management techniques to their operations through District newsletters, articles, web/social media posts and presentations. Encourage enrollment into Farm Bill programs for assistance with IPM integration into farming operation.	20 articles, 5 PSAs, 20 web/social media posts, 20 public presentations; 10 Conservation Plans developed; 5 Farm Bill Program contracts developed - Years 6-10	$57,000 ($200 each for presentation materials & 2,120 hrs @ $25/hr) - SCD, CCD, NRCS, MDARD, MFB, others; $150,000 (600 hrs @ $25/hr) and $75,000 (300 hrs @ $25/hr) - SCD, CCD, NRCS, 319, Farm Bill	Changes in pest management methods by producers; number of Conservation Plans developed; number of BMPs adopted, pollutant load reductions
	2. Inadequate buffer on agricultural waterways		A well vegetated riparian buffer and maintaining setbacks from surface water when applying chemicals helps protect surface water from polluted runoff.	1. Encourage farmers and producers to enroll in Farm Bill programs to install vegetated buffer areas.	10 Conservation Plans developed; 5 Farm Bill Program contracts developed - Years 3-10	$150,000 (600 hrs @ $25/hr) and $75,000 (300 hrs @ $25/hr) - SCD, CCD, NRCS, 319, Farm Bill	Extent of vegetated riparian buffer areas, pollutant load reductions
	3. Residential runoff containing pesticides	Homeowners	Knowledge of lawn and garden pests, proper application of pesticides and incorporating organic and alternative gardening methods reduces inappropriate use of pesticides.	1. Educate homeowners about targeting lawn and garden pests with proper chemical or non-chemical treatment methods through print and web media.	3 articles, 3 web postings - Years 5-7	$750 (30 hrs @ $25/hr) - SCD, CCD, SCHD, MMDHD, FOLG, 319	Greater understanding in pest management by homeowners determined through before and after surveys
				2. Educate homeowners about targeting lawn and garden pests through lawn/garden care workshop.	2 workshops - Years 6-7	$2,800 ($1,000 each workshop cost & 32 hrs @ $25/hr) - SCD, CCD, 319, FOLG, others	
				3. Provide site specific homeowner education on lawn and garden pest control through one-on-one Lawn*A*Syst programs.	2-4 Lawn*A*Systs annually - Years 5-7	$8,000 ($2,000 materials & 240 hrs @ $25/hr) - SCD, CCD, 319	
5. Stormwater runoff	1. Leaky farm equipment; inadequate buffer on agricultural runoff	Producers and farmers	Proper equipment maintenance, use of secondary containment and well vegetated riparian areas helps to protect surface water from polluted runoff.	1. Encourage farmers and producers to participate in MAEAP to ensure farming operations are following current environmental regulations.	250 *A*Systs assessment conducted, 10 MAEAP verifications - Years 1-10	$65,000 annually - SCD, CCD, NRCS, MDARD	Number of on-farm risk reductions, number of MAEAP verifications
	2. Hazardous material dumping into catch basins	General Public	Many storm drains empty directly into surface water and the improper disposal of hazardous wastes into catch basins creates health threats and impairs water quality.	1. Publish articles in newsletters, local papers and distribute educational information at display events educating on stormwater runoff and the ultimate destination of storm drains.	8 articles; 4 display events; 4 social media postings - Years 2-6	$18,600 ($12,000 display event registration & materials & 264 hrs @ $25/hr) - SCD, CCD, 319, FOLG	Greater understanding of nonpoint source pollution and recycling options for residents
				2. Educate people about proper disposal of hazardous materials; promote hazardous household waste collections and e-Waste recycling events			

Section 6.7 Information and Education Strategy for the Upper Misteguay Creek Watershed (Table 6.1)

Ranked Pollutant	Source/ Cause	Target Audience	Messages	Delivery Mechanism	Milestone & Timeline	Estimated Cost/Assistance	Evaluation
5. Stormwater runoff	2. Hazardous material dumping into catch basins	General Public	Many storm drains empty directly into surface water and the improper disposal of hazardous wastes into catch basins creates health threats and impairs water quality.	3. Develop Water Quality Monitoring Program to include Macroinvertebrate Collection and Habitat Assessment.	Annual water sampling events; results presented by volunteers and students - Years 2-10	$26,600 ($5,000 equipment & 864 hrs @ $25/hr) - FOLG, SCD, CCD, GCD, local schools, others	Increase in volunteer participants; number of events; results from water quality monitoring efforts
				4. Implement an Adopt*A*Catch Basin Neighborhood program where volunteers monitor local catch basins and routinely clean trash and yard waste that has collected at the catch basin.	8 catch basins stenciling projects - Years 6-8	$3,400 ($1,000 stencils & 96 hrs @ $25/hr)	Greater understanding of the destination of catch basin water and nonpoint source pollution
				5. Install stenciling at catch basins to deter dumping and provide educate about stormwater's destination. Stencil on curbside not on road, use bright colors and long lasting paint.			
	3. Runoff from roadways		Proper maintenance reduces the amount of gasolines and oil from leaky vehicles from entering surface water.	1. Educate the general public about the importance of vehicle maintenance to protect water quality through articles, newsletters and web postings.	3 articles, 3 web postings - Years 4-6	$750 (30 hrs @ $25/hr) - SCD, CCD, SCHD, MMDHD, FOLG, 319	Greater understanding of nonpoint source pollution and prevention by vehicle users
4. Stormwater runoff	4. Over/improper application of deicing salts		Deicing salts can cause damage to surface water by running off impervious surfaces into adjacent road ditches and waterways. Proper application of deicing agents reduces negative consequences and improves water quality.	1. Educate the public on proper application of salts and other deicing agents to reduce runoff that contains harmful levels of salts through print and web media.	3 articles, 3 web postings - Years 5-7	$750 (30 hrs @ $25/hr) - SCD, CCD, SCHD, MMDHD, FOLG, 320	Greater understanding of impacts from over application of deicing agents; number of local businesses who carry and utlize deicing alternatives
				2. Promote the use of salt-free deicing agents and responsible use of deicing materials through articles, encouraging local businesses to carry and use alternatives, and during one-on-one discussions.	6 one-on-one contacts with local businesses	$3,000 (120 hrs @ $25/hr) - SCD, CCD, FOLG, 319	
	5. Removal or alterations to existing wetlands		Restoring and protecting wetlands helps to reduce damage from flooding, improve water quality, and enhances fish and wildlife habitat.	1. Educate the public about the value and functions of wetlands and what defines a wetland through articles in local newspapers and district newsletters, and one-on-one discussions.	2 articles, 2 web postings, 10 personal contacts - Years 8-10	$1,300 (52 hrs @ $25/hr) - SCD, CCD, NRCS, U.S. FWS, MDEQ, PF, 319	Greater understanding of the functions and values of wetlands as determined by before and after surveys
				2. Promote land to be enrolled in Farm Bill Easement Programs as a means to restore and protect wetlands.	2 Conservation Plans - Years 8-10	$3,000 (120 hrs @ $25/hr) - SCD, CCD, NRCS, 319	
				3. Promote development and operation of wetland mitigation banks.	1 Wetland Mitigation Bank - Years 8-10	$26,000 (1,040 hrs @ $25/hr) - NRCS, U.S. FWS, MDARD, landowners, producers	Acres of wetlands protected in mitigation banks

Section 6.7 Information and Education Strategy for the Upper Misteguay Creek Watershed (Table 6.1)

Ranked Pollutant	Source/ Cause	Target Audience	Messages	Delivery Mechanism	Milestone & Timeline	Estimated Cost/Assistance	Evaluation
5. Trash and compostable material	1. Random dumping	General Public	Proper disposal of general trash, petroleum products, and compostable material will have a direct effect on improving the health and quality of the watershed.	1. Advertise local trash hauling costs & free or low costs recycling sites to get message out that it is inexpensive through articles, PSA, web postings, social media and District newsletters.	9 articles, 4 PSAs, 18 web postings - Years 2-10	$3,500 (140 hrs @ $25/hr) - SCD, CCD, SCHD, MMDHD, FOLG, 319, others	Greater understanding of recycling options and benefits to the environment
				2. Establish permanent location for electronic recycling and household hazardous water recycling drop off.	Permanent site plans	$40,000 ($30,000 site cost & 400 hrs @ $25/hr)	Pounds of eWaste and HHW collected
				3. Promote composting as an alternative to dumping organic material by holding workshops and providing a step-by-step guide to composting.	1 workshop, 1 composting guide developed - Year 7	$1,800 ($1,000 workshop costs & 32 hrs @ $25/hr) - SCD, CCD, 319, FOLG, others	Perception change and greater understanding of composting as determined by before and after surveys of workshop participant
				4. Develop free curbside recycling and composting program.	Curbside recycling program offered to residents - Year 10	Dependent on participants - SCD, CCD, SCHD, MMDHD, 319, FOLG, others	Number of participants that recycle and compost; pounds of waste collected, recycled or composted

Section 7 Measuring Progress

Measures of success are essential to evaluate success and effectiveness in improving water quality following implementation of the Best Management Practices (BMPs). Many factors must be evaluated in order to determine the success of this Project toward meeting its goals of improving water quality and restoring the designated uses of the Upper Looking Glass River Watershed. Monitoring targets must be established to gage effectiveness and determine whether progress has been made toward meeting the goals of the Watershed.

7.1 Evaluation Program and Framework

A thorough evaluation program was conducted throughout the planning phase and will continue through the implementation phase. This evaluation program will be useful in determining the monitoring targets and as a means to measure water quality improvements, changes in behavior and change toward using conservation methods. Baseline information collected during the planning phase utilized pollutant load models, water quality monitoring data and databases developed for easily accessing information. See Quality Assurance Project Plans for parameters and procedures used for monitoring activities in Appendix 10. Specific techniques include:

- Stream reconnaissance survey database with reports available for each site surveyed clearly defining the current condition of the stream, explanation of resource concerns at the site, type and extent of erosion present, identified water quality concerns, potential and known pollutants, sources and causes, and suggested BMPs to address issues.

- Soil loss calculation database connected to each stream surveyed available as a site-by-site report, cluster of sites report, sub-watershed report or entire Watershed report. Soil losses were determined for each occurrence of sheet, gully and streambank erosion identified during stream surveys and calculated using the Michigan Department of Environmental Quality "Pollutants Controlled Calculation and Documentation for Section 319 Watershed Training Manual".

- High Impact Targeting (HIT) for estimates of soil erosion rates for agricultural areas in the Watershed based on presence or absence of cropland conservation practices. See Section 3.3 for discussion on HIT.

- Urban pollutant loads for Nitrogen, Phosphorus, Biological Oxygen Demand and Sediment derived from the U.S. Environmental Protection Agency Spreadsheet Tool for Estimating Pollutant Loads (STEPL).

- The eWatershed tool modeling results for common scenarios including, Water Quality, Land Protection, Urban Planning, Stormwater Management and Project Mapping. eWatershed is linked with a Field-scale Analysis Calculator that estimates nonpoint source pollutant loads and the impacts of best management practices on those loads.

- Photo summary database with collections of photos organized and attached to each stream survey site. Each photo was labeled to identify location and condition of the site and attached to a GIS layer developed for each stream surveyed.

- Database of landowners adjacent to streams in the Watershed for reference in developing Conservation Plans for issues found during the stream reconnaissance survey.

- Septic system database describing waste disposal system type, drain field description, location, Health Department approval date, type of drain and notes of historical problems and/or illicit conditions for reference during implementation and I&E phase.

7.2 Measurements of Water Quality

Measurements are used to determine the level and rate of water quality improvements, focusing on areas of physical, chemical and biological improvements. Methods of evaluation will be used to monitor the success of the project, both immediately following implementation and for continual monitoring of the water quality.

Measurements are defined by categories of indirect and direct environmental indicators. Indirect indicators are measurements of practices and activities that could indicate water quality improvements but do not actually measure the water quality itself. For example, estimating the pollutant reductions achieved by a practice is stating that a certain amount of the pollutant will be prevented from entering the stream. Another indirect indicator would be the miles of filter strips installed as a percentage of the total miles of riparian areas without buffers. This percentage of installation could be compared to the goals of the Watershed and the success could be measured.

Direct environmental indicators measure the quality of the water through scientific investigation. Sediment load reduction could be measured by total suspended sediment concentration, embeddedness, or pebble counts; and nutrient load reductions could be measured through chemical analysis of the water. Macroinvertebrate surveys are also direct environmental indicators of water quality, since some insects are very sensitive to changes in a stream's health.

Several measurements will be used to determine whether the pollutant load reduction goals are being met through the implementation phase. Pollutant reduction criteria have been established for the known and suspected pollutants of the Watershed as described below.

7.3. Criteria for Water Quality Monitoring

Pathogens and bacteria

The criteria for evaluating pathogens and bacteria are determined based on concentrations of *E. coli* colonies found in surface waters. Evaluation will be determined as WQS improve in water bodies that exceeded partial and total body contact recreation, and where canines alerted to the presence of human waste, elimination of all identified *E. coli* contributing sources, such as failing septic systems, and attaining designated uses. Targets for pathogens to restore the total body contact recreation designated use are a 30-day geometric mean of 130 *E. coli* per 100mL and a daily maximum of 300 *E. coli* per 100mL during the recreation season between May 1 and October 31. Criteria for partial body contact recreation designated use are 1,000 *E. coli* per 100mL and a daily maximum of 1,000 *E. coli* per 100mL.

Sediment

The sediment evaluation criteria will include estimating soil saved values following adoption of conservation measures using methods such as RUSLE and STEPL (to measure sedimentation from sheet erosion), and the MDEQ Pollutants Controlled Calculation and Documentation for Section 319 Watershed Training Manual (to measure sedimentation from gully and streambank erosion). These methods were utilized to determine pollutant loads from erosion in development of this WMP.

Implementation of BMPs that will reduce sedimentation and/or erosion will have soil loss calculations done and a measurable increase in the water quality. Progress will also be assessed through MDEQ biological assessments, performed every five years on a rotational basis using the macroinvertebrate rating, as rated through the Great Lakes and Environmental Assessment Section (GLEAS) No. 51 survey. Evidence of sediment reductions will be catalogued using photos of the site before and after implementation of BMPs.

Nutrients

The nutrient evaluation criteria includes a decrease in phosphorus and nitrogen exceedances compared to state recommendations and as measured by local, county, or state laboratories, or wastewater treatment plants, a decrease in nuisance algal growth and implementation of BMPs on identified NPS sites of nutrient loading. Nutrient reduction goals should achieve a total phosphorus goal of 0.06 mg/L. The measurements for nutrient reduction will include laboratory measurements of water samples from streams and photos of the site before and after implementation of BMPs.

High Temperature

To support warmwater fish species instream temperature should fall between 60°F to 70°F, the typical temperature range for a warmwater fishery standard.

Pesticides and chemicals

The criteria for pesticide evaluation will be based on implementing BMPs in areas where chemical containment facilities are constructed and where Pest Management strategies are used in place of traditional methods. Pesticides and chemicals will be prevented from reaching surface water by using proper application methods and amounts and the use of riparian filter and buffer strips.

Trash, Oil, Heavy Metals, Road Salts in Stormwater Runoff

The criteria for trash, oil, heavy metals and road salts in stormwater runoff will be evaluated based on macroinvertebrate and fish population improvements to include more highly sensitive species especially in outlying tributaries. Additionally, measurements of pH, hardness, dissolved oxygen and specific conductance will give numeric values to pollutant reductions. Criteria will also be based on implementing practices to reduce these pollutants including porous pavers, rain gardens, bioswales, riparian filter and buffer strips along with behavioral changes in reducing or eliminating the use of calcium based deicers, vehicle maintenance, proper trash disposal, and recycling.

7.4 Ongoing Watershed Monitoring Efforts

Ongoing monitoring activities in the Watershed have been conducted by the Michigan Department of Environmental Quality (MDEQ). Considerable information was collected by the SCD through the stream reconnaissance, canine scent investigation and water quality study. The Middle Grand River Organization of Watersheds and the Friends of the Looking Glass River will continue to serve as qualitative observer passionate about paddling and water quality in the Looking Glass Region. A future goal of the FOLG is to establish a regular collection of macroinvertebrates and assessment of habitat condition as part of the environmental monitoring program. This would serve to fulfill the ongoing monitoring efforts in the ULG. Table 7.1 lists water quality monitoring and evaluation recommendations for the Watershed.

Organization	Monitoring Site(s)	Parameter Target	Type of Analysis	Protocol	Status	Frequency	Test Agent
SCD, SCHD, MDEQ	Streams with elevated *E. coli* levels and positive hits for human waste by scent-trained canines	Pathogen Contamination (*E. coli*)	Presence and abundance of coliform bacteria colonies	Standard Methods	Data collected at locations during canine investigation 2015 and water quality study 2016	Annual	MDEQ approved lab
SCD, MDEQ	Streams with excessive erosion noted during stream reconnaissance	Sedimentation	Streambed assessment	GLEAS P51 (Substrate metrics); Wolman (1954)	Data collected during stream reconnaissance 2014-2016	Annual; every 5 years MDEQ	Biologist
SCD, MDEQ	Streams with excessive erosion noted during stream reconnaissance	Streambank Erosion	Erosional assessment	BEHI	Data collected during stream reconnaissance 2014-2016	Annual; every 5 years MDEQ	Hydrologist
MDEQ	Water quality sampling locations and upstream locations with excessive aquatic plant and algae growth	Excessive Nutrients	Water chemistry	Standard Methods	Data collected at locations during water quality study 2016 and stream reconnaissance 2014-2016	Annual; every 5 years MDEQ	Chemist

Organization	Monitoring Site(s)	Parameter Target	Type of Analysis	Protocol	Status	Frequency	Test Agent
MDEQ	Downstream of major tributaries	Heavy Metals and Salts	Water chemistry	Standard Methods	Streams influenced by excessive imperious areas	Every 5 years MDEQ	Chemist
SCD, MDEQ	Downstream of major tributaries	High Temperature	Thermometer readings	Handheld meters and data loggers	Unknown	Every 5 years MDEQ	Biologist
MDEQ	Major tributaries that were the subject of dredging or influenced by water control structures	Unstable Hydrology	Flow measurements and computer modeling	Pygmy meters, HEC RAS Model	Data collected during stream reconnaissance 2014-2016; streams involved in 1959 Looking Glass River Work Plan	annual; every 5 years MDEQ	Hydrologist

Table 7.1 Water Quality Monitoring and Evaluation for the Watershed.

7.5 Environmental Monitoring Component

Regular monitoring should be conducted to further characterize watershed streams as well as following implementation activities to determine impacts of changes. Follow up monitoring should be conducted to compare to baseline information collected during WMP development and applied during regular WMP updates. Described in this section are suggested monitoring types. Refer to Table 7.1 for monitoring and evaluation recommendations.

Biological and Physical Habitat Monitoring

Methods to determine physical habitat should follow procedure utilized during stream reconnaissance inventory as described in Section 3.1.3.

For assessment of macroinvertebrate communities, collection and analysis pursuant to methods described in P51 are useful for documenting change over time at established sites. More basic methods, such as those described by MiCorps, may be more appropriate for volunteer efforts. Volunteer sampling, such as those conducted by the Flint River Watershed Coalition through the Flint River GREEN program, should continue following the MiCorps methods. This biological sampling is especially useful to document community changes following installation of BMPs. MDEQ conducts comprehensive biological monitoring every five years, so all efforts should be coordinated with the MDEQ.

Erosion Assessments and Monitoring

Erosion assessments were completed during the development of this plan. This baseline information provides detailed measures of bank, gully and sheet erosion prior to project implementation, which can later be used to calculate load reductions from installed BMPs. Calculations for determining erosion reductions resulting from implementation can be calculated using a number of methods and modeling tools, including:

- "Pollutants Controlled Calculation and Documentation for Section 319 Watersheds" (MDEQ 1999)
- Wind Erosion Prediction System (WEPS)
- Revised Universal Soil Loss Erosion (RUSLE2) program
- Windows Pesticide Screening Tool (WIN PST) program
- High Impact Targeting (HIT) models
- EPA STEPL (Spreadsheet Tool for Estimating Pollutant Load) and Region 5 Model
- Manure Application Risk Index (MARI)

Since many funding opportunities will be largely based upon showing measureable instream improvements, baseline information collected during the stream reconnaissance surveys will be invaluable for implementation at high priority sites, or other sites of interest, that may be candidates for short-term implementation projects. Additional pollutant load modeling tools can be found at http://water.epa.gov/type/watersheds/named/msbasin/models.cfm.

Bacteria and Pathogen Monitoring

Permitted waste dischargers currently monitor for coliform bacteria as specified in their permits. A monitoring component has been included in this WMP to follow up with *E. coli* monitoring as well as determine additional sources of *E. coli*.

Recommendations for future monitoring of *E. coli* include monitoring by the MDEQ as part of the watershed-wide biological survey every five years, monitoring by municipalities and the health department where septic system failures are suspected and follow up water sampling to monitoring conducted during WMP development. Results from WMP monitoring exceeded standards for *E. coli* indicating that these reaches do not meet WQS for recreational uses of surface water and potentially pose risks to human health. The results were submitted to MDEQ for review and inclusion in a Statewide *E. coli* TMDL currently under development. If these water bodies are included in the Statewide *E. coli* TMDL, regular water sampling will be conducted until the water bodies meet WQS. Sampling will be conducted at the appropriate frequency to determine if the 30-day geometric mean value of 130 *E. coli* per 100mL and daily values of 300 *E. coli* per 100mL and 1,000 *E. coli* per 100mL are being met.

Nutrient Monitoring

Phosphorus is essential for plant life. It is also the limiting nutrient in fresh water systems for plant growth. When there is too much phosphorus in water, it can cause excess algae to grow. As this algae dies, it consumes oxygen in the water resulting in poor habitat for fish and other aquatic species. At times, the algae that grows can become toxic and impair recreation and drinking water sources.

Currently in Michigan, there is not a numerical target for phosphorus levels from nonpoint source runoff to achieve water quality. However, the Part 4 Water Quality Standard states “nutrients shall be limited to the extent necessary to prevent…growth of aquatic…plants, fungi or bacteria which are or may become injurious to the designated uses of the surface waters of the state”.

Because of its chemical nature, phosphorus accumulates in the surface layers of soils. Most phosphorus is attached to sediment and clay soils have higher levels of phosphorus. When soil is left bare, such as after crops are harvested, phosphorus is lost when soils wash off a field. Sites monitored for total phosphorus levels indicated an excessive amount of the nutrient. These results were submitted to MDEQ for evaluation to determine if a TMDL for phosphorus should be developed. The TMDL would describe a numeric target for phosphorus based on watershed criteria and outline a monitoring schedule to assess WQS attainment.

Temperature Monitoring

High water temperature has the potential to have negative impacts on fish and macroinvertebrate communities. Water temperatures should be monitored to ensure that values are within standards set for warmwater streams. Continuously recording data loggers, such as (HOBO Pro v2 [www.onsetcomp.com/products/dataloggers/u22-001) can be secured into a stream location and downloaded periodically. Specific focus should be placed on stream reaches that lack riparian buffer or have recently been denuded of vegetation. Baseline information will be useful and necessary for measuring improvements related to installation of BMPs such as filter strips and riparian buffers.

Hydrologic Monitoring

Altered hydrology was identified in this WMP as being a cause of streambank erosion. Hydrologic/Hydraulic monitoring would be useful for determining changes in flow over time, including effects of changing land use, direct channel impacts or water withdrawal. As well, the information gathered is useful in the design of stream restoration and streambank stabilization projects. This type of monitoring may have to be set up by MDEQ or other professionals.

7.6 Long-Term Sub-Watershed Monitoring

Water Quality Monitoring

Pathogens, bacteria, sediment and nutrients were identified in this WMP as being high priority pollutants. Other priority pollutants include chemicals, pesticides, oil, heavy metals, road salts and trash based on stream reconnaissance surveys, monitoring data and existing land use. Water quality monitoring should be conducted to monitor water chemistry over time, as well as to aid in identification of specific sources and causes of pollution. While particular attention should be given to bacteria and total phosphorus loading, nutrient testing parameters should be similar to those monitored by the MDEQ.

Sites identified in Section 5 of this document as having known, suspected or potential loading impacts are a high priority for monitoring. Sites identified as having failing septic systems, illicit connections, livestock access or livestock holding facilities adjacent to a channel are a high priority for long-term monitoring. The MDEQ currently conducts this monitoring every five years, so additional efforts should be coordinated with the MDEQ to avoid duplicate sampling.

All nutrient parameters must be tested using standard collection methods, chain of custody procedures and an MDEQ-approved lab. Other water quality parameters, such as water temperature, dissolved oxygen, pH and conductivity can be measured using hand-held meters, such as Hanna Instruments (HI98129) and YSI 550A. Quality Assurance Project Plans should be developed for monitoring activities.

Sub-Watershed Monitoring

Permanent monitoring stations should be established near the outlet of each of the four sub-watersheds and at higher order stream confluences upstream of sub-watershed outlets to obtain continuous records of water quality over time (Figure 7.1). *E. coli*, nutrient parameters, total suspended solids, water temperature, embeddedness and macroinvertebrate communities will be useful measures for monitoring larger-scale improvements to water quality, on a sub-watershed scale. Data should be collected by permanent, continuously recording monitoring equipment or by periodic site visits by trained individuals. Figure 7.1 identifies recommended monitoring locations for the ULG.

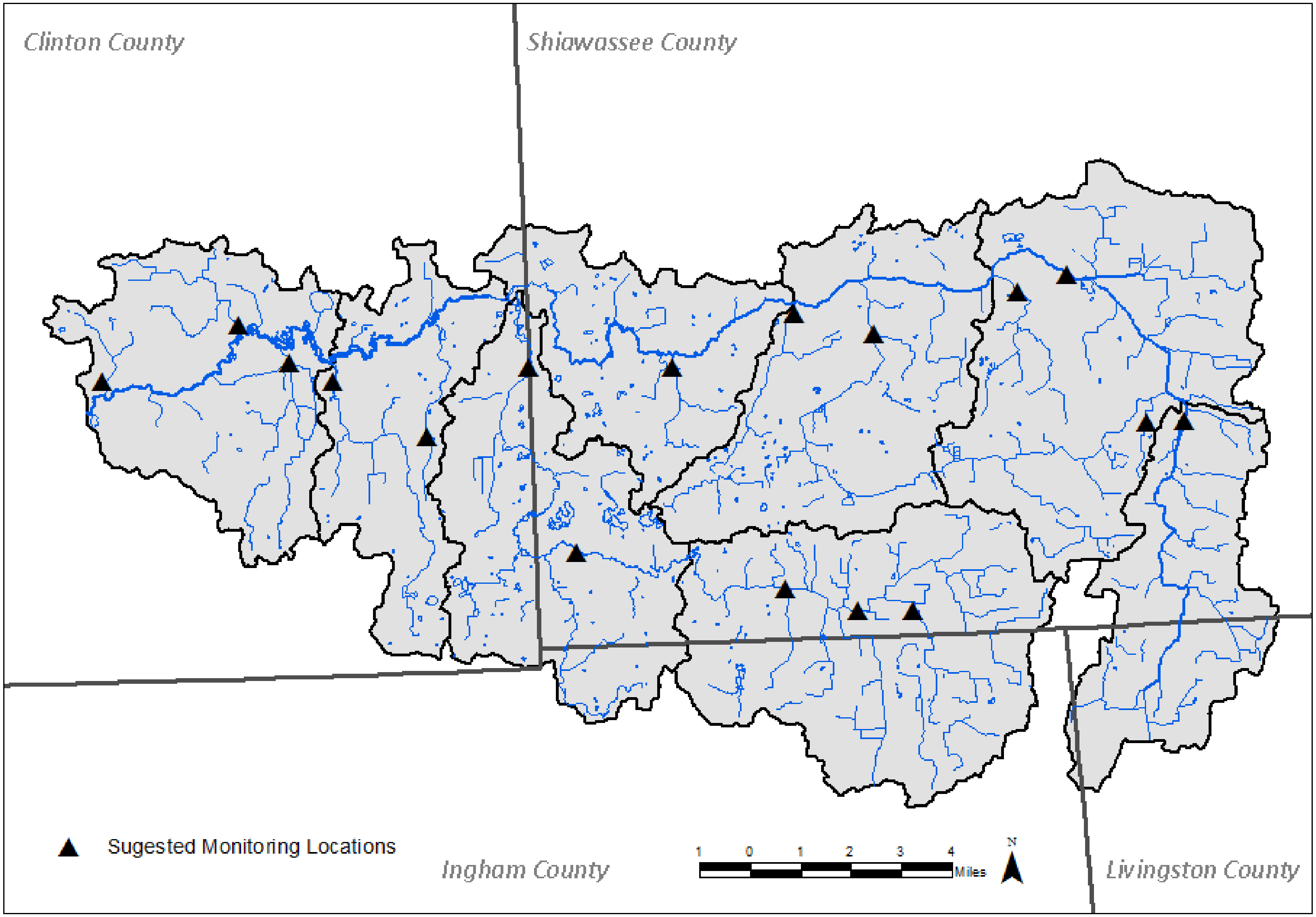

Figure 7.1 Recommended monitoring locations for the Upper Looking Glass River Watershed.

Section 8 Project Sustainability

The recommendations in this Watershed Management Plan (WMP) are options that can be voluntarily implemented to achieve water quality goals. It will be important to sustain the voluntary implementation of the WMP's recommendations to ensure that water quality conditions in the Upper Looking Glass Watershed are protected and improved, thereby avoiding the need for state regulations and mandates. Success of the WMP depends on sustainable support from local governments, organizations, citizens, landowners and businesses. Commitment to a common water quality goal will require the coordination of all these groups.

8.1 Existing Structure

Currently, Steering Committee members and staff at the SCD are in charge of various aspects of the Project, with the common goal of educating the public regarding the wise use of the watershed through the development of an U.S. EPA approved WMP that meets the 9-elements of watershed planning. Local partners currently involved in the development of the WMP include members of the Steering Committee listed in Section 3.2.

8.2 Local Partners

Many groups and organizations are active within the Watershed and will provide support and assistance in implementing the WMP. Partners will be critical to the sustainability of watershed improvement efforts. National, State, local agencies and organizations that will contribute toward sustaining this WMP include:

- USDA Natural Resources Conservation Service
- U.S. Environmental Protection Agency
- U.S. Fish and Wildlife Service
- USDA Farm Service Agency (FSA)
- Michigan Department of Environmental Quality
- Michigan Department of Agriculture and Rural Development
- Michigan Department of Natural Resources
- Michigan Agriculture Environmental Assurance Program
- Local Conservation Districts
- County Drain Commissioners
- Shiawassee County Health Department
- Mid-Michigan District Health Department
- County Road Commissions
- Township, City and Village Officials
- Friends of the Looking Glass River
- Middle Grand River Organization of Watersheds
- Local newspapers and local radio
- Local schools
- Michigan Farm Bureau
- Michigan State University Extension
- Family YMCA
- Landowners, homeowners, producers, farmers and local residents

8.3 Partner Roles and Responsibilities

Various organizations/entities have been assigned responsibility for maintaining key aspects of the WMP. Table 8.1 lists the tasks and entities responsible for maintaining/completing those tasks in the future:

Tasks	Technical Assistance/Partners
Facilitate committee meetings. Coordinate information with other counties in the Watershed.	Shiawassee Conservation District (SCD), County Drain Commissions, Michigan Department of Environmental Quality (MDEQ), Natural Resources Conservation Service (NRCS)
Collect additional data and update the WMP with new data.	SCD, CCD Mid-Michigan District Health Department (MMDHD), Friends of the Looking Glass (FOLG)
Keep in contact with MDEQ and municipalities to determine TMDL listing status and monitoring requirements.	SCD, CCD MMDHD
Research and apply for funding to implement the WMP.	SCD, CCD, MMDHD, local municipalities, FOLG, MGROW, County Drain Commissions
Implement the Information & Education plan.	SCD, CCD, local schools, MDEQ, MDARD, MDNR, FOLG, MGROW
Implement conservation practices.	SCD, CCD, NRCS, County Drain Commissions, County Road Commissions, landowners, producers, homeowners, contractors, others
Coordinate implementation of WMP. Coordinate with partners to ensure implementation actions are on schedule and following engineering plans.	SCD, CCD, NRCS, County Drain Commissioners, County Road Commissioners, others
Implement monitoring plan.	MDEQ, SCD, CCD, MMDHD, MDEQ, FOLG, MGROW, municipalities
Update the WMP.	SCD, CCD, steering committee members

Table 8.1 Tasks and Responsibilities of Project Partners.

8.4 Opportunities for Funding Sources for Implementation

Many opportunities are available for funding watershed efforts. The following is a summary of some of the sources that should be investigated for funding the implementation of this WMP.

8.4.1 Federal and State Sources

Typically, WMP implementation is funded through competitive federal and state grants. A strong WMP with a foundation of local, state and federal support improves grant award funding opportunities.

United States Department of Agriculture

The U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) and Farm Service Agency (FSA) provide technical and financial assistance to landowners to address resource concerns of soil, water, air, plants and animals. These agencies offer cost-share opportunities through many federal programs and coordinate with state and local programs to maximize benefits. Conservation programs through the Farm Bill are available through NRCS and FSA to address natural resource concerns at the local level.

United States Environmental Protection Agency

Congress amended the Clean Water Act (CWA) in 1987 to establish the Section 319 Nonpoint Source Management Program because it recognized the need for greater federal leadership to help focus state and local nonpoint source efforts. Under Section 319, State, Territories and Indian Tribes receive grant money that supports 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. Funds from Section 319 for watershed planning and implementation are allocated through the U.S. Environmental Protection Agency (EPA) to states, territories and Indian Tribes. Local entities can apply for Section 319 funding through their State, Territory or Indian Tribe.

Great Lakes Restoration Initiative

The Great Lakes Restoration Initiative (GLRI) was launched in 2010 to accelerate efforts to protect and restore the largest system of fresh surface water in the world — to provide additional resources to make progress toward the most critical long-term goals for this important ecosystem.

GLRI has been a catalyst for unprecedented federal agency coordination — through the Interagency Task Force and the Regional Working Group, which are led by EPA. This coordination has produced unprecedented results. GLRI resources have supplemented agency base budgets to fund the cleanup actions required to delist five Great Lakes Areas of Concern and to formally delist the Presque Isle Bay Area of Concern — a major change from the 25 years before the Initiative, during which only one Area of Concern was cleaned up and delisted.

GLRI resources have also been used to double the acreage enrolled in agricultural conservation programs in watersheds where phosphorus runoff contributes to harmful algal blooms in western Lake Erie, Saginaw Bay and Green Bay. So far, GLRI resources have been used to fund over 2,000 projects to improve water quality, to protect and restore native habitat and species, to prevent and control invasive species and to address other Great Lakes environmental problems.

During FY15 - 19, federal agencies plan to continue to use GLRI resources to strategically target the biggest threats to the Great Lakes ecosystem and to accelerate progress toward long term goals — by combining GLRI resources with agency base budgets and by using these resources to work with nonfederal partners to implement protection and restoration projects.

To guide this work, federal agencies have drafted GLRI Action Plan II, which summarizes the actions that federal agencies plan to implement during FY15-19 using GLRI funding. These actions will build on restoration and protection work carried out under the first GLRI Action Plan, with a major focus on:

- Cleaning up Great Lakes Areas of Concern
- Preventing and controlling invasive species
- Reducing nutrient runoff that contributes to harmful/nuisance algal blooms
- Restoring habitat to protect native species

Michigan Department of Environmental Quality

The Michigan Department of Environmental Quality (MDEQ) Nonpoint Source Program assists local units of government, non-profit entities and numerous other state, federal, and local partners to reduce nonpoint source pollution statewide. Michigan's Nonpoint Source Program vision is to protect high quality waters from nonpoint source threats and restore waters impaired by nonpoint source pollution or causes. The Nonpoint Source Program Plan outlines a series of goals, objectives, strategies and short-term actions necessary to achieve this vision. In addition, the Program Plan includes measures of success to evaluate progress toward achieving the Program's vision.

The Nonpoint Source Program provides technical assistance grants to assist locally with planning and implementation of watershed management plans to protect the watersheds of the state. Both Federal funds allocated from the USEPA Federal Clean Water Act Section 319 and GLRI programs.

In addition, MDEQ offers volunteer stream monitoring grants to provide funding to local units of government and non-profit entities for volunteer water quality monitoring of Michigan's wadeable streams and rivers to monitor benthic invertebrate communities and habitat.

MDEQ Community Pollution Prevention (P2) Grant Program is authorized under Public Act 384 of 1996 as amended to provide matching grant funds to county governments, local health departments, municipalities, and regional planning agencies for the purpose of preventing pollution. Grant projects focus on achieving measurable reductions in waste, have a local or regional focus, and result in long-term environmental improvements.

Also offered through MDEQ are volunteer river, stream and creek cleanup grants. These grants provide funding to local units of government for volunteer cleanups of rivers, streams and creeks to improve Michigan waterways.

For a full list of grants and loans available through MDEQ, visit http://www.michigan.gov/deq/0,4561,7-135-3307_3515---,00.html.

Michigan Department of Agriculture and Rural Development

The Michigan Department of Agriculture and Rural Development (MDARD) provides technical assistance grants to address natural resource concerns. One example is the Michigan Agriculture Environmental Assurance Program (MAEAP) technical assistance grant, which has been awarded to the Shiawassee Conservation District. This program provides information and technical tools to pesticide and/or nitrogen fertilizer users that help identify risks to groundwater associated with pesticides and nitrogen fertilizer use practices and to coordinate local, state and federal agency resources to help reduce those risks. This program, funded through the purchase of nitrogen fertilizers and pesticides, encourages individuals to take voluntary, proactive steps to protect Michigan's water quality.

Additionally, funding from MDARD has been provided through the Conservation Reserve Enhancement Program (CREP) to improve citizen access to natural resource management assistance, increase the capacity of Conservation Districts to deliver natural resource management assistance, engage stakeholders in natural resource management, and develop and implement a long-range strategy for improving the management of natural resources. These programs are potential funding sources for implementation of portions of this WMP.

Michigan Department of Natural Resources (MDNR)

A wide variety of opportunities for funding are available through MDNR and can be found at this link: http://www.michigan.gov/dnr/0,4570,7-153-58225---,00.html. Below is a summary of grant opportunities that would support efforts in this WMP.

The Aquatic Habitat Grant Program (AHGP) purpose is to improve fish and other aquatic organism populations by protecting intact and rehabilitating degraded aquatic habitat. To facilitate the success of these efforts, the program will provide technical assistance to grantees.

The Wildlife Habitat Grant Program (WHGP) purpose is to provide funding to local, state, federal and tribal units of government, profit or non-profit groups, and individuals to assist the Wildlife Division with developing or improving wildlife habitat for game species. The WHGP is administered by the Michigan DNR through a cooperative effort between Wildlife Division and Grants Management.

The purpose of the Dam Management Grant Program is to provide funding and technical assistance to local and state units of government, non-profit groups and individuals to manage dam removal, repair and major maintenance projects that will enhance aquatic resources and fishing opportunities along with reducing infrastructure costs and improving public safety in Michigan.

Michigan Invasive Species Grants Program (MISGP)

The Michigan Departments of Natural Resources, Environmental Quality and Agriculture and Rural Development have partnered to address strategic issues of prevention, detection, eradication, and control for both terrestrial and aquatic invasive species in Michigan.

The main objectives of the MISGP program are to:

- Prevent new introductions of invasive species through outreach and education.
- Monitor for new invasive species as well as expansions of current invasive species.
- Respond and conduct eradication efforts to new findings and range expansions.
- Manage and control key colonized species in a strategic manner.

Grants are awarded to support MISGP objectives.

Great Lakes Commission

The Great Lakes Commission (GLC) is an interstate compact agency that promotes the orderly, integrated and comprehensive development, use and conservation of the water and related natural resources of the Great Lakes basin and St. Lawrence River. GLC programs provide leadership in the areas of communication and education, information integration and reporting, facilitation and consensus building, and policy coordination and advocacy. Grants to implement a wide variety of programs administered through GLC can be a source of funding activities listed in this WMP.

8.4.2 Local Sources

Conservation Districts

Created to serve as stewards of natural resources, Michigan's Conservation Districts provide linkages between land managers and a host of conservation service providers that include state, federal and local governments, conservation organizations and internet resources. Conservation Districts continually scan the needs of their local communities, work in partnership with others involved to set local priorities and develop action plans to solve natural resource problems.

Conservation Districts provide agricultural producers, homeowners and municipalities in the Watershed with environmental risk assessments of management practices, structures and site conditions on the farm, in the home, and in urban areas. With assistance from Conservation Districts, producers, homeowners and municipalities will then develop and implement management plans to prevent contamination of water and address natural resource concerns.

Additionally, the Shiawassee Conservation District and Clinton Conservation District offers Conservation Planning, Reforestation opportunities, Invasive Species control efforts, Watershed Planning and Implementation, Environmental Education and partners with a wide variety of agencies and organizations to provide technical assistance in funding conservation activities.

County Drain Commissions

Public Act 40 of 1956 as amended, referred to as the "Drain Code", provides county Drain Commissioners with specific authority over drainage ways including watercourses, which have been appropriately dedicated as a county drain. A Drain Commissioner's authority includes taking various actions to provide for flow within a drain, as well as implementation of measures that will purify the flow of water through the drain. All county drains have a designated drainage district area associated with them, which is comprised of the lands that contribute flow to the drain. Costs associated with appropriate activities on a county drain are specially assessed to owners of land within the drainage district. It is anticipated that certain recommendations in this WMP can be implemented under the Drain Code with special assessment of benefitting property owners.

County Road Commissions

Road Commissions are county-level road agencies responsible for maintaining county roads, highways, bridges, culverts and traffic signals.

Bridge embankment runoff, undersized culverts at road stream crossings and runoff from road surfaces have been identified as sources of nonpoint source pollution observed during the Upper Looking Glass River Watershed stream reconnaissance survey. The County Road Commissions are responsible for repairing damaged roads and culverts contributing to nonpoint source pollutants in accordance with recommendations in this WMP.

Friends of the Looking Glass River

Founded in October 1990, Friends of the Looking Glass is a local, nonprofit, board-based environmental action group that centers its efforts within the watershed. The FOLG works to promote the enjoyment of and responsibility for the river, and to help maintain and improve the watershed. The FOLG work to educate the public and promote awareness of the Looking Glass River Watershed. Goals of the FOLG include:

- Promote responsible land use and environmental practices within the watershed.
- Communicate watershed information to managers, decision makers, riparian landowners and the general public.
- Develop networks with stakeholders in the Looking Glass Watershed.
- Promote responsible recreational use of the Looking Glass River.

The FOLG will be a partner in delivering educational message, promoting wise stewardship of natural resources, developing a macroinvertebrate and habitat assessment program and recruiting participation in BMP implementation.

Middle Grand River Organization of Watersheds

MGROW was formed in 2011 from the legacy of the Grand River Expedition 2010. The GRE was initiated by Verlen Kruger in 1990. The mission of MGROW is to protect and preserve the history and the natural resources of the Middle Grand River watershed by promoting education, conservation, recreation and wise use of watershed resources. MGROW has had active partnerships with Tricounty Regional Planning Commission, Eaton Conservation District, Freshwater Future, Capital Region Community Foundation, among others. MGROW sees itself as an umbrella organization that mutually supports other organizations within the watershed. MGROW will provide education to paddlers and others about the importance of wise stewardship in protecting the Looking Glass River as a recreational resource.

Mid-Michigan CISMA

CISMA stands for Cooperative Invasive Species Management Area. The CISMA has many organizations partner together to educate people about invasive species and their effects on our environment. CISMAs also track the spread of invasive species and help facilitate treatment of priorities species and sites. This CISMA covers Clinton, Eaton, Ingham, and Ionia counties and creates a partnership between the four county conservation districts and over 25 local organizations. The MM-CISMA prioritizes three species: black swallow-wort, Japanese knotweed and non-native phragmites. The MM-CISMA raises awareness about other state priority invasive species including aquatic and insect invasive species. MM-CISMA also provides technical and financial resources to landowners in local control of invasive species.

Other Local Opportunities

Local opportunities for funding include grants through the Shiawassee Community Foundation, partnerships with the Shiawassee County YMCA, local fund raising events, educational services, schools, government programs (such as ordinance development and/or expansion) and grant opportunities through local Shiawassee Community foundation and businesses such as Wal-Mart and Meijer Corporations.

8.5 Long Term Planning, Strategy, Plan Maintenance

The WMP outlines the actions that stakeholders can take to continue the implementation of the WMP over the next 10 years. This structure will ensure that the WMP will remain current and continue to improve in content. The Steering Committee will continue to meet and review progress made through implementation of the WMP. WMP progress will be documented in articles, newsletters, web postings, social media and presented publically at the Shiawassee Conservation District Annual Meetings, Field Days, workshops, display events and other outreach events.

Additionally, the WMP will be reviewed five years from the approval year (2018) and inventory databases maintained over this period of time. These databases are available for review, upon request.

Section 9 Additional Information

9.1 Glossary

30-day geometric mean – the average of sampling results over a 30 day sampling period.

Best Management Practices (BMP) - structural, vegetative and managerial practices implemented to prevent or reduce nonpoint source pollution.

Biosolids – organic material that settles out from sewage.

Conservation – preserving, protecting, restoring or sustainable use of natural resources.

Confluence – the junction of two or more streams

Designated Use – water uses that are specified in state or tribal water quality standards for water bodies.

Drain – a channel, ditch or pipe carrying off surplus liquid, especially rainwater or liquid waste.

E. coli – abbreviated Latin name of the bacteria *Escherichia coli*; although the presence of *E. coli* and other bacteria within our intestines are necessary for us to remain healthy, some strains are harmful if they get into our bloodstreams or tissues.

Ecoregion – a major ecosystem defined by distinctive geography and weather pattern.

Endangered Species - any species (plant, animal, fungi, etc.) which is susceptible extinction.

Erosion – the action of processes such as water flow or wind that remove soil, rock or dissolved material from the Earth's surface, and transports it to a different location.

Green Infrastructure – an approach to water management that protects, restores and mimics the natural water cycle using environmentally friendly designs in building and land development planning.

Groundwater – water held underground in soil and rock pores and crevices.

Hydrophytic vegetation – Plants adapted to live in water and/or saturated soil conditions.

Illicit Connection – a physical connection to a drainage system that is not composed entirely of stormwater and is not under a NPDES permit.

Intercounty Drain – a drain that flows through more than one county.

Invasive Species – non-native species that have the potential to become established and spread throughout an area and have potential to cause harm to the environment, economy or human health.

Low Impact Development – land planning and engineering design approach to manage/minimize stormwater runoff.

Macroinvertebrate – an animal without a backbone that can be observed without the aid of magnification.

Nonpoint source pollution – pollution that is not identifiable to one particular source and is occurring at locations scattered throughout the drainage basin or watershed.

Nutrient load – quantity of nutrients entering a system in a given period of time.

Point-of-Sale Ordinance – an authoritative order that requires the inspection and proper functioning of a septic system before a home is to be sold.

Rill erosion – water erosion created when surface runoff concentrates in surface depressions so sufficient soil is removed to form small but well defined channels that do not seriously interfere with normal tillage operations.

Sedimentation – the process of depositing soil particles, clays, sands or other sediments that were picked up by runoff.

Septic System (a.k.a. Onsite Wastewater Treatment System) – water treatment system consisting of a septic tank that collect sewage, where the sewage separates into solid that settles to the bottom and the liquid then flowing into a leach field for treatment by the soil.

Sheet Erosion – soil movement resulting from raindrop splash, wind and surface runoff that occurs uniformly over the slope and removes the lighter soil particles, organic matter and soluble nutrients from the land.

Species of Concern – informal term used to refer species that need proactive protection, but insufficient information is available to list them as threatened or endangered.

Stakeholder – any organization, government entity, or individual that has a stake in or may be affected by a given approach to environmental regulation, pollution prevention or energy conservation.

Stormwater – surface water resulting from rain and snowfall events.

Sub-Watershed – subdivided units of a watershed which collectively flow together to form larger watersheds.

Threaten Species – any species (plant, animal, fungi, etc.) which is susceptible to endangerment in the near future.

TMDL – Total Maximum Daily Load is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards (established by Clean Water Act 303).

Tributary – a river or stream that flows into a larger river or stream.

Turbid – referring to water, level of cloudiness or thickness with suspended matter

Water Control Structure (a.k.a. Dam) – a structure placed in a stream, ditch or subsurface drain which provides control of the amount of water discharge.

Water Quality Standard – provisions of state, territorial, authorized tribal or federal law approved by the U.S. EPA that describes desired conditions of waterbodies or level of protection or mandate how the desired condition will be expressed or established for such waters in the future.

Watershed – area of land/basin where all of the water that falls on/within that basin drain to a common place.

Waterway – flowing channelized water such as a stream or river.

Wetland – area of land with hydric soils and is inundated or saturated by surface or groundwater at a frequency and duration sufficient to support plants adapted to moist/saturated soil conditions.

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