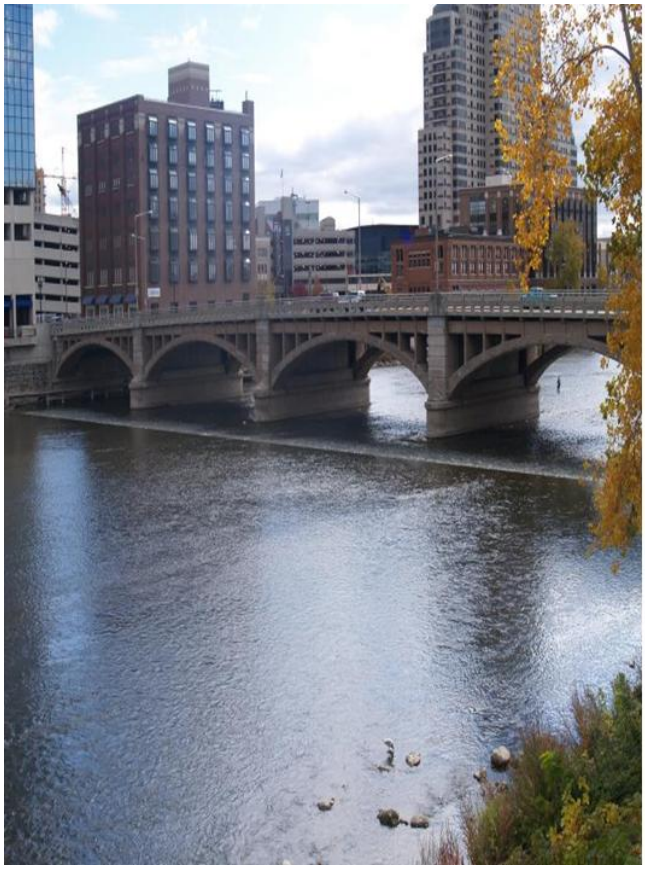
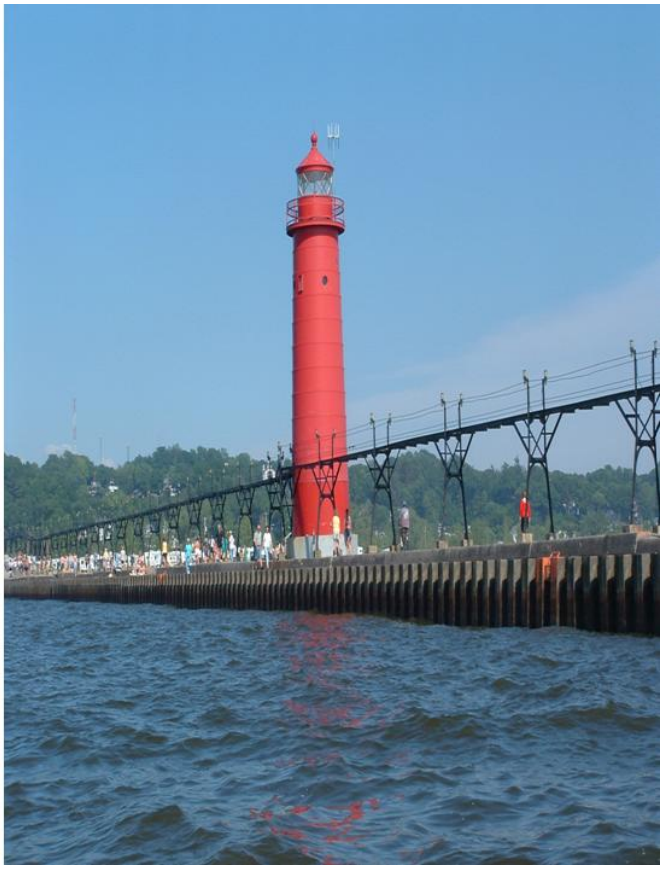
Lower Grand River Watershed Management Plan





August 2011
MDEQ Tracking Code 2007-0137

LOWER GRAND RIVER ORGANIZATION of WATERSHEDS

Michigan's Nonpoint Source Program

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LIST OF ABBREVIATIONS/ACRONYMS

AWH	alterations to wetland habitats
AWRI	Annis Water Resources Institute
BEDHD	Barry-Eaton District Health Department
BEHI	Bank Erosion Hazard Index
BMP	Best Management Practices
BS	bacterial slimes
C-CAP	Coastal Change Analysis Program
CES	Center for Environmental Study
cfs	cubic feet per second
CMI	Clean Michigan Initiative
CNMP	Comprehensive Nutrient Management Plan
CRWC	Coldwater River Watershed Council
CSC	Coastal Services Center
CSO	combined sewer overflows
DIP	Data, Information, and Procedures
DO	dissolved oxygen
E. coli	Escherichia Coli
EMC	event mean concentration
FTC&H	Fishbeck, Thompson, Carr & Huber, Inc.

LIST OF ABBREVIATIONS/ACRONYMS (continued)

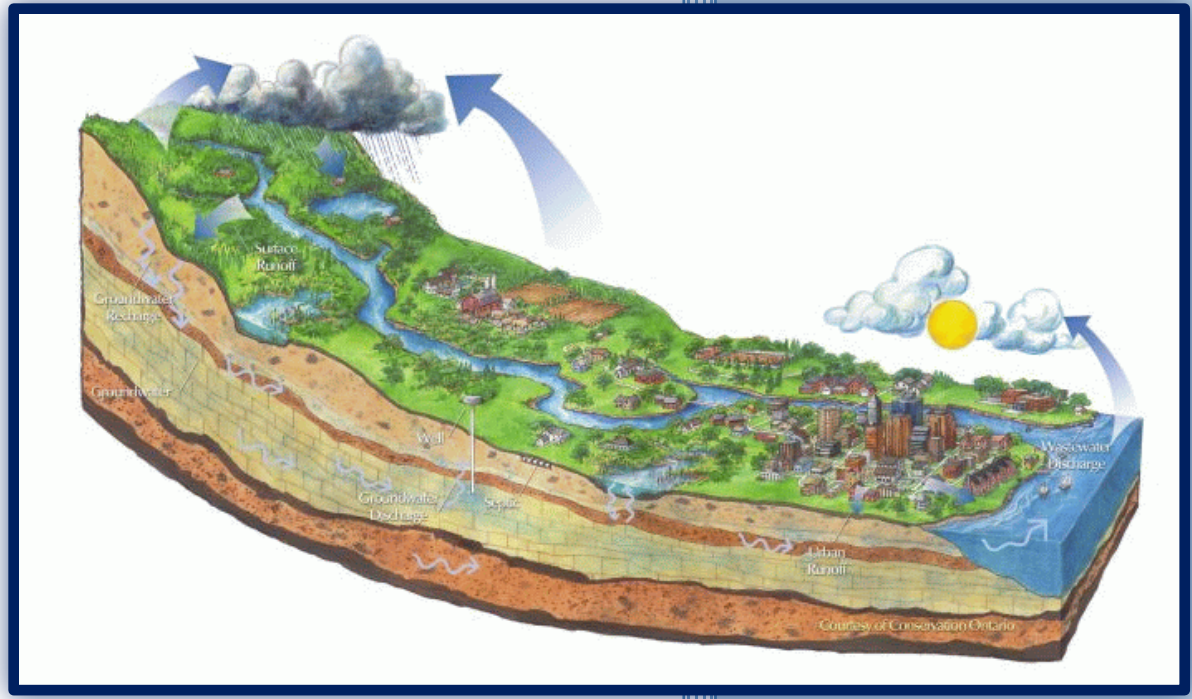
GILC	Green Infrastructure Leadership Council
GIS	Geographic Information System
GLC	Great Lakes Commission
GLEAS	Great Lakes and Environmental Assessment Section Procedure 51 (P51)
GLRI	Great Lakes Regional Information
GVMC	Grand Valley Metropolitan Council
GVSU	Grand Valley State University
IDEP	Illicit Discharge Elimination Plan
I&E	Information and Education
KCHD	Kent County Health Department
LGR	Lower Grand River
LGROW	Lower Grand River Organization of Watersheds
LGRW	Lower Grand River Watershed
LID	Low Impact Development
LLWFA	Landscape Level Wetland Functional Assessment
MACC	Macatawa Area Coordinating Council
MARB	Market Avenue Retention Basin
MCGI	Michigan Center for Geographic Information
MDA	Michigan Department of Agriculture
MDEQ	Michigan Department of Environmental Quality
MDNRE	Michigan Department of Natural Resources and Environment
MDOT	Michigan Department of Transportation
mg/L	milligrams per liter
mi^2	square miles
mL	milliliter
MNFI	Michigan Natural Features Inventory
MPO	Metropolitan Planning Organizations
MS4	Municipal Separate Storm Sewer System
MSU	Michigan State University
MSUE	Michigan State University Extension
NA	not assessed
NOAA	National Oceanographic and Atmospheric Administration)
NPDES	National Pollutant Discharge Elimination System
NPS	nonpoint source
NRCS	Natural Resource Conservation Service
NS	not supporting
OASA	other anthropogenic substrate alterations
OFRA	other flow regime alterations
PCAs	Potential Conservation Areas
PCBs	polychlorinated biphenyls
PDR	Purchase of Development Rights
PEP	Public Education Plan
SEMCOG	Southeast Michigan Council of Governments
SESC	Soil Erosion and Sedimentation Control
SS	sedimentation/siltation
SMU	subwatershed management unit
s.u.	standard unit
SWMP	Storm Water Management Program
SWPPI	Storm Water Pollution Prevention Initiative

LIST OF ABBREVIATIONS/ACRONYMS (continued)

TDS	total dissolved solids
TSS	total suspended solids
TMDL	total maximum daily loads
TOST	Time of Sale or Transfer
TN	total nitrogen
TP	total phosphorus
TSS	total suspended solids
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
WMEAC	West Michigan Environmental Action Council
WMP	Watershed Management Plan
WPA	Works Progress Administration
WRP	Wetlands Reserve Program
WQBEL	water quality-based effluent limits
WQS	Water Quality Standards
ZCTA	ZIP Code Tabulation Area

LIST OF APPENDICES

Chapter 1 - Introduction



1.0 INTRODUCTION

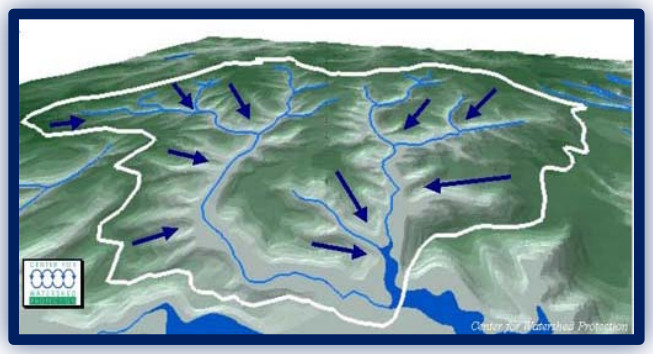
OBJECTIVES

- Why is a Watershed management plan needed?
- What is the ultimate goal of the Watershed management plan?
- Who is involved in creating the management plan?
- How was the Public involved in the process?

1.1 WATERSHED MANAGEMENT PLAN PURPOSE

A Watershed is an area of land, defined by hills and ridges that drain to a common body of water (Exhibit 1). The purpose of a Watershed Management Plan (WMP or Plan) is to document the sources and causes of water pollution and outline a strategy to address activities which impair water quality within a Watershed. The WMP gives an action-oriented approach to address the needs and proposed solutions for effectively managing and restoring all of the designated uses in the Watershed. Input from community members and stakeholders in the Watershed is considered during the development of a WMP, to provide a reflection of the community's desires and goals for their Watershed.

Exhibit 1 – Watershed Illustration



Key Elements of a Watershed Management Plan:

1. Understanding Watershed characteristics
2. Identifying and involving local agencies and citizens in the Watershed planning process
3. Identifying designated and desired uses
4. Defining critical areas which are contributing a majority of the pollutants
5. Identifying and prioritizing pollutants, sources, and causes
6. Determining objectives and tasks for meeting Watershed goals
7. Identifying and analyzing existing local projects, programs, and ordinances that impact water quality within the Watershed
8. Informing and involving the public
9. Developing an evaluation process

The WMP continues in the spirit of the 2004 CMI approved plan and 2007 Phase II WMP. Participants in the previous plans' development were determined to maintain the enthusiasm generated in the communities during the earlier planning efforts for improving the water quality in the Watershed. In response to that concern, and the strong desire to protect the overall health of the Lower Grand River Watershed (LGRW or Watershed), the Lower Grand River WMP was prepared in accordance with the nine key elements identified above. The purpose of this plan is to provide a description of the Watershed conditions, impairments, and offer recommendations to correct impairments. In addition, the Plan provides a detailed implementation plan and assigns responsibility to stakeholders to ensure corrective actions are put into practice.

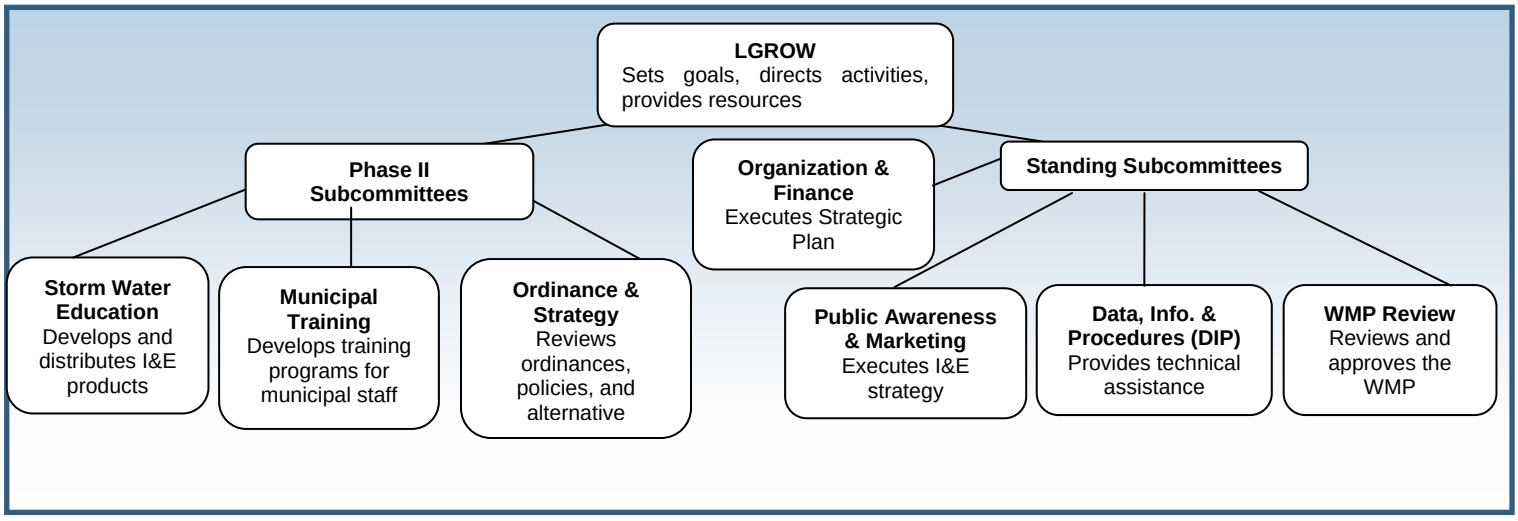
1.2 DESIGNATED USES

All surface waters of the state of Michigan are protected for the following designated uses:

- Agriculture
- Industrial water supply at the point of intake
- Public water supply at the point of intake
- Navigation
- Warmwater and/or coldwater fishery
- Other indigenous aquatic life and wildlife
- Partial body contact recreation
- Total body contact recreation between May 1 and October 31

This WMP outlines a strategy to identify and restore the designated uses impacted by nonpoint source (NPS) pollution.

1.3 LOWER GRAND RIVER ORGANIZATION OF WATERSHEDS AND SUBCOMMITTEES



Lower Grand River Organization of Watersheds

The Lower Grand River Organization of Watersheds (LGROW) was officially formed in 2009 to provide basin-wide oversight, implement Watershed-wide initiatives, and prioritize water quality concerns. The role of the LGROW in this project was to direct project activities, set goals and objectives, and ensure the project remained on schedule. Additional information about LGROW is included in Chapter 9.

Mission of LGROW: *Discover and restore all water resources and celebrate our shared water legacy throughout our entire Grand River Watershed community.*

Our **Vision** for the Watershed: *Swimming, drinking, fishing, and enjoying our Grand River Watershed: Connecting water with life.*

Core Values of the LGROW:

- Watershed activities are diverse, inclusive, and collaborative
- Watershed efforts are sustainable and of high quality
- Watershed images and messages create a widely shared sense of legacy and heritage
- Watershed methods and products are holistic and employ a systems approach
- Watershed organization and program evaluate progress and reward success

Members of the LGROW participated in various Subcommittees. Subcommittees were formed to allow additional participation in completing the details of the projects and specific tasks of the work plan. These six Subcommittees included are described below.

Organization and Finance Committee

The goal of the Organization and Finance (OAF) Subcommittee is to oversee the implementation of LGROW's Strategic Plan and to assist in recruiting membership in LGROW. The OAF is also responsible for LGROW's financial records and fee structure.

Public Awareness and Marketing Subcommittee

The goal of the Public Awareness and Marketing (PAM) Subcommittee is to involve interested stakeholders in the Watershed to assist in the implementation of the Information & Education (I&E) strategy. The PAM Subcommittee focused on the development of I&E products and their dissemination throughout the Watershed. Activities completed during this project included the development of display boards, a social survey, and newspaper inserts.

Data, Information, and Procedures Subcommittee

The goal of the Data, Information, and Procedures (DIP) Subcommittee is to pool data about the Watershed and to be a clearinghouse for information about the LGRW. The Subcommittee is to create a framework for coordination to provide a credible and usable source of information in a data repository for the Watershed. The Subcommittee has reviewed data collected and evaluated results of field assessments.

WMP Review Subcommittee

The WMP Review Subcommittee was responsible for reviewing the draft and final components of the WMP. The members ensured recommendations were in accordance with goals and objectives of the Watershed.

Storm Water Education Subcommittee

The goal of the Storm Water Education Subcommittee is to implement the Public Education Plan (PEP) as part of the National Pollutant Discharge Elimination System (NPDES) Phase II Storm Water Program. Subcommittee members direct and guide the outreach campaign, develop and review products, and coordinate regional education efforts. Activities completed during the project include the development of lamppost banners, roadway signage, display boards, and bus advertisements. News articles as well as radio and television advertisements were also developed and distributed.

Municipal Training Subcommittee

The goal of the Municipal Training Subcommittee is to integrate storm water pollution reduction strategies into municipal operations. The Subcommittee develops and offers training opportunities for municipal staff to meet the requirements of the NPDES Phase II Storm Water Program.

Ordinance and Strategy Subcommittee

The goal of the Ordinance and Strategy Subcommittee is to review existing ordinances and policies for within the Watershed, to assess their effectiveness for protecting Watershed health. As part of this process, recommendations for improving the current storm water ordinance in Kent County were developed.

A complete listing of the Subcommittee members can be found in Appendix 1.1.

1.4 PUBLIC PARTICIPATION PROCESS

The Public Participation Process (PPP) for soliciting involvement in the development of the Lower Grand River WMP as part of the LGRW Initiatives Project is described below.

Meetings

Meetings of the Grand River Forum were held to generate interest in the project and invite stakeholders to participate on one or more Subcommittees. All Grand River Forum and Subcommittee meetings were open to the public. The WMP Review Subcommittee offered Watershed stakeholders an opportunity to participate in the development of the WMP. Grand River Forum and Subcommittee meetings were advertised using e-mail distribution lists and/or postcard invitations. Subcommittee participation was tracked using attendance sheets.

Television

The Grand River Forum meeting held on November 6, 2009, was covered by the local news. The intent was to raise awareness about the LGROW and their activities. Fox 17 and WZZM 13 were in attendance, and coverage on the meeting aired that evening.

Website

The Watershed website, www.lowergrandriver.org, is the current online resource for information about the Watershed. All of the draft WMP chapter narratives, tables, figures, and appendices were posted on the website for public review and comment.

E-mail Distribution Lists

E-mail distribution lists were created and maintained by both Fishbeck, Thompson, Carr & Huber, Inc. (FTC&H) and Grand Valley Metro Council (GVMC). Lists were used to invite Watershed stakeholders to Grand River Forum and Subcommittee meetings to solicit public input on the project and the WMP.

A PPP for the NPDES Phase II Storm Water Program was developed as a requirement for the NPDES Phase II Storm Water Regulations for communities with municipal separate storm sewer systems (MS4) in the urbanized areas of the LGRW. This effort was targeted to those communities, but the methods are transferrable to all entities in the Watershed.

MS4 Permit Requirement

The PPP developed for the MS4 communities was submitted to the MDNRE and approved on May 7, 2010. The PPP is currently being implemented and is located in Appendix 1.2.

1.5 PUBLIC COMMENTING

Public comment was solicited using a variety of communication methods. Members of the public were invited to participate in meetings of the Grand River Forum and Subcommittees to provide comment on the WMP. The first draft of the WMP was presented at a public meeting on June 17, 2010, at the Walker City Commission Chambers. The WMP was posted to the LGRW website to be available for review by the stakeholders. Comments were solicited from the public and any comments were incorporated into the final WMP. The final draft of the WMP was submitted to MDNRE in August 2010 for review and approval.

In addition, the Subwatershed Management Unit Summary Sheets were reviewed by stakeholders in each Subwatershed Management Unit. Appendix 1.3 includes the list of reviewers for each summary sheet.

The draft of the WMP was presented at numerous meetings to gain additional input and increase awareness of how stakeholders can use the WMP to improve water quality in the Watershed.

- June 22, 2010, NPDES MS4 Full Watershed Meeting – LGROW representatives explained how MS4 communities will use the WMP to comply with the storm water permit requirements.

- June 28, 2010, Grand Rapids Downtown Development Authority (DDA) – LGROW representatives met with DDA staff to review the WMP, to ensure that the river and riverfront restoration within the City limits was included in the WMP as a recommended project, and that the correct information was provided.

- June 29, 2010, Plaster Creek Stewards Summer Workshop – Attendees of the workshop discussed how the Plaster Creek WMP fit into the larger Lower Grand River WMP. Members reviewed the action plan identified for Plaster Creek and made suggestions and additional recommendations.

- July 8, 2010, Fifth Third Ballpark – LGROW representatives met with the organizational and marketing staff to discuss how they fit into the WMP, and the possibility of practices to reduce storm water runoff be included in the WMP.

- July 21, 2010, Grand River Expedition 2010 – As the morning orientation for the paddlers, a presentation was made in the Village of Lyons Devore Park. An overview of the Watershed and its priority pollutants was presented and the WMP was explained. The paddlers requested that the copy of the WMP remain with them so they could review it and add comments. They were especially interested in reviewing the summary sheets.

- July 30, 2010, Grand River Whitewater – LGROW representatives met with the organizers of the Grand River Whitewater to discuss the WMP and how their projects could be included in the WMP under habitat restoration.

- August 4, 2010, Grand Valley State University (GVSU) – The Low Impact Development (LID) projects proposed by GVSU were reviewed with staff to ensure that all components were included as recommendations for reducing hydrologic impacts to the Grand River.

- August 10, 2010, Gerald R. Ford International Airport – The facilities director of the airport met with LGROW representatives to learn more about LGROW and how the airport's efforts of reducing the impacts of glycol runoff could be enhanced by being included as a recommendation in the WMP.

In summary, approximately 175 people were directly contacted to review and provide input to the WMP. In addition, as of August 13, 2010, the Annis Water Resources Institute (AWRI) had recorded 300 hits on the website where the WMP is posted, with 200 downloads of the documents.

Chapter 2 – Watershed Characteristics

2.0 WATERSHED CHARACTERISTICS

OBJECTIVES

- What are the features of the surrounding landscape?
- What effect does hydrology and soil type have on the Watershed?
- What natural resources does the Watershed provide?
- How is land within the Watershed being used?

2.1 CULTURAL HISTORY

The Lower Grand River Watershed (LGRW or Watershed), home to the mound-building Hopewell Indian Tribe and later to the European settlers, is a region rich in cultural history and natural resources. Native Americans and European settlers alike depended on the Grand River for food, transportation, and recreation. In 1826, a trading post was established along the Grand River by a French trader named Louis Campau. The easiest way of communicating during this time was through the Grand River; chiefly by the use of Indian canoes.

Steamboats traversed the Grand River from Grand Haven all the way to Lyons from the 1830s to the 1870s. *The Grand River Times* described the Grand River in 1837 as "one of the most important and delightful (rivers) to be found in the country" with "clear, silver-like water winding its way through a romantic valley."

Industrialization in the nineteenth century impacted the Grand River greatly. In 1889, Everette Fitch described the damaging effects on the Grand River. She wrote, "The channel was, as usual, covered with a green odiferous scum, mixed with oil from the gas works." The Grand River was greatly abused by water-powered, river-dependant industries; large increases in population; stripping of the forests; and discharges of chemical and sewage wastes.

By the mid 1960s, the Grand River needed a massive cleanup effort. The Michigan Grand River Watershed Council, authorized by Governor Romney in 1966, spearheaded most of the river cleanup efforts. The council studied navigation, flood prevention, fish and wildlife, recreation, and water quality. Using funds from the 1968 Clean Water Bond, many municipal wastewater treatment plants were able to upgrade technologies, and volunteers had supplies they needed to clean up trash and debris and plant trees along the river's banks.

Ice Jam and Flood Jan. 24, 1907. Bridge St. Bridge, Grand Rapids, Mich.

By the end of the 1960s, water quality had improved to the point that recreationists were once again looking to the Grand River for waterskiing, boating, fishing, and swimming opportunities.

An ambitious project called the Grand River Salmon Plan began in 1977, and brought salmon and other sport fish all the way to the state capitol by constructing a series of fish ladders over the six dams that obstructed fish passage upstream of Grand Rapids.

In the 1990s, the City of Grand Rapids began a massive undertaking of removing combined sewers. The combined sewers delivered both sanitary and storm water to the City of Grand Rapid's Wastewater

Treatment Plant. During periods of heavy rainfall, the sewers would overflow into the Grand River. Occasionally, this would result in bacteria counts that warranted beach closures downstream. Over the last 5 years, the City of Grand Rapids has removed 95% of the combined sewer overflows. Similar projects are taking place upstream in the Cities of Lansing and Jackson.

2.2 GEOGRAPHIC SCOPE AND BOUNDARIES

The LGRW encompasses 1,861,468 acres (2,909 square miles) and encompasses large portions of Ottawa, Muskegon, Kent, Montcalm, Ionia, Barry, and Eaton Counties. Counties with very small portions in the Watershed include: Newaygo, Allegan, and Mecosta Counties as shown in Figure 2.1. The Lower Grand River (LGR) is located in central Michigan and originates below the Looking Glass River confluence, near the City of Portland, flowing northwest to its convergence with Lake Michigan. The main branch of the LGR is 51 miles long, and the major tributaries flow for a total of 209 miles. In addition to the many subwatersheds with direct drainage to the Grand River, the Watershed includes three major subwatersheds: Thornapple River Watershed, Flat River Watershed, and Rogue River Watershed. These major subwatersheds include 31 smaller Subwatershed management units. The major subwatersheds and the 31 Subwatershed management units are shown in Figure 2.2 and their areas are provided in Tables 2.1a and 2.1b. Watershed boundary data was from Michigan Center for Geographic Information (MCGI) framework Watershed boundaries. The MCGI framework Watershed boundaries were combined to define a more recognizable local creek or river system, defining larger units so that data could be summarized at that geographic level instead of to over 100 tiny subwatersheds (original number of subwatersheds in LGRW using MCGI data). The Watershed contains two urban areas: the Grand Rapids Metropolitan area and the Muskegon Metropolitan area, which includes the Grand Haven, Tri-cities areas.

Table 2.1a – Subwatershed Management Units in Major Subwatersheds
(Source: GVSU, AWRI, 2008 for use in LLWFA)

Major Subwatershed: Thornapple River

Subwatershed Management Unit	Acres
Cedar Creek	29,624
Coldwater River	120,739
Fall Creek	15,870
Glass Creek	23,511
High Bank Creek	21,810
Lower Thornapple River	126,293
Mud Creek	38,600
Upper Thornapple River	166,535
Total:	542,982

Major Subwatershed: Flat River

Subwatershed Management Unit	Acres
Coopers, Clear, and Black Creeks	65,401
Dickerson Creek	48,388
Lower Flat River	78,873
Upper Flat River	138,115
Wabasis and Beaver Dam Creek	30,124
Total:	360,901

Major Subwatershed: Lower Grand River

Subwatershed Management Unit	Acres
Bass River	32,020
Bear Creek	20,332
Bellemy Creek	20,648
Buck Creek	32,392
Crockery Creek	102,318
Deer Creek	22,374
Direct Drainage to Lower Grand River	275,237
Indian Mill Creek	10,979
Lake Creek	18,172
Libhart Creek	35,176
Mill Creek	12,955
Plaster Creek	36,448
Prairie Creek	65,534
Rush Creek	38,041
Sand Creek	35,085
Spring Lake/Norris Creek	32,383
Total:	790,094

Major Subwatershed: Rogue River

Subwatershed Management Unit	Acres
Lower Rogue River	93,534
Upper Rogue River	73,988
Total:	167,522

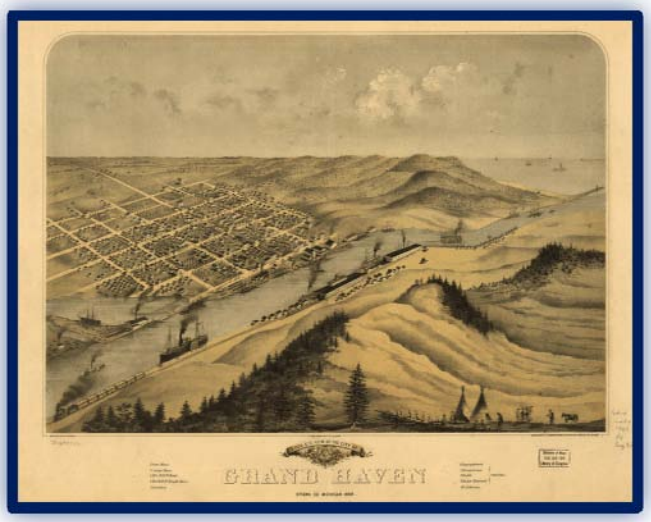
Table 2.1b – Acreages of Subwatershed Management Units
(Source: GVSU-AWRI, 2008 for use in LLWFA)

ID	Subwatershed Management Units	Acres	Square Miles
1	Bass River	32,020	50
2	Bear Creek	20,332	32
3	Bellemy Creek	20,648	32
4	Buck Creek	32,392	51
5	Cedar Creek	29,624	46
6	Coldwater River	120,739	189
7	Coopers, Clear, and Black Creeks	65,401	102
8	Crockery Creek	102,318	160
9	Deer Creek	22,374	35
10	Dickerson Creek	48,388	76
11	Direct Drainage to Lower Grand River	275,237	430
12	Fall Creek	15,870	25
13	Glass Creek	23,511	37
14	High Bank Creek	21,810	34
15	Indian Mill Creek	10,979	17
16	Lake Creek	18,172	28
17	Libhart Creek	35,176	55
18	Lower Flat River	78,873	123
19	Lower Rogue River	93,534	146
20	Lower Thornapple River	126,293	197
21	Mill Creek	12,955	20
22	Mud Creek	38,600	60
23	Plaster Creek	36,448	57
24	Prairie Creek	65,534	102
25	Rush Creek	38,041	59
26	Sand Creek	35,085	55
27	Spring Lake / Norris Creek	32,383	51
28	Upper Flat River	138,115	216
29	Upper Rogue River	73,988	116
30	Upper Thornapple River	166,535	260
31	Wabasis and Beaver Dam Creek	30,124	47
	Total:	**1,861,499**	**2,908**

2.3 GEOLOGY AND TOPOGRAPHY

The bedrock formations of the Watershed consist primarily of shale, sandstone, limestone, and gypsum. These formations formed from sediments that were deposited from 345 to 370 million years ago, in seas which occupied a depression known as the Michigan basin. Another sea occupied central Michigan from 135 to 181 million years ago and deposited red muds, gypsum, and fine sands. A remnant of this formation occurs in the central part of the Watershed. The Pleistocene epoch began about 1 million years ago. At least four major glaciers advanced and retreated over Michigan during the Pleistocene epoch. As the last glacier retreated, the load of earthen materials incorporated in the ice was deposited, forming several types of glacial features (till plains, moraines, outwash, lake plains, and spillways). The thickness of the glacial drift overlying bedrock varies from 0 feet (in western Kent County) to more than 500 feet (at the northern end of the basin).

The topography within the LGRW (Figure 2.3) is influenced by glacial deposition of sediment and the effect of water deposition and drainage over time. Watershed topography is undulating and dissected by water courses with occasional small plains studded with bogs and small lakes. The elevations in the Watershed range from 780 feet, at the most eastern edge of the Watershed, to 571 feet at its confluence with Lake Michigan at the City of Grand Haven.



The LGR sub-basin ranges from fairly rugged topography in the entrenched main stream of the Grand River (in the Grand Rapids area) to a low, flat plains area along the lower reaches of the river toward Grand Haven. Many of the tributary streams in this area flow through steep, walled valleys where they join the entrenched valley of the Grand River. The streams are commonly 20 or more feet below the surrounding uplands (Grand River Basin Coordinating Committee, 1972).

2.4 SOILS

The debris deposited by the glaciers forms the parent material for the soils throughout the Watershed. The almost infinite variety of combinations of mineral materials located in many conditions of topography and climate have resulted in a great number of soil types of varying fertility. Sandy and loamy soils are common throughout the basin.

Hydrologic Soil Groups

Hydrologic soil groups are a classification system that describes the soil's storm water runoff-producing characteristics. The chief characteristic is the inherent capacity of soil to permit infiltration when bare of vegetation. Figure 2.4 illustrates the hydrologic soils groups within the Watershed. A description of the hydrologic soils groups is found in Table 2.2; and the total acres and percent of area represented for each hydrologic soil group in the Watershed are shown in Table 2.3.

Table 2.2 – Hydrologic Soil Groups
(Source: *SCS Soil Survey*)

Hydrologic Soil Group	Definition
A	High Infiltration (low runoff potential, high rate of water transmission, well drained to excessively drained sands or gravely sands)
B	Medium Infiltration (moderate rate of water transmission, moderately well to well drained, moderately fine to medium coarse texture)
C	Low Infiltration (slow rate of water transmission, has layer that impedes downward movement of water, moderately fine to fine texture)
D	Very Low Infiltration (high runoff potential, very slow rate of water transmission, clays with high shrink/swell potential, permanent high water table, clay pan or clay layer at or near surface, shallow over nearly impervious material)

Table 2.3 – Acreages of Hydrology Soils Groups
(Source: SSURGO soils, USDA NRCS. Obtained from the NRCS Data Gateway)

Subwatershed Management Unit	Hydrologic Soil Group Area (%)							Total Acres
	A	A/D	B	B/D	C	C/D	D	
Bass River	26%	14%	10%	9%	31%	0%	9%	32,020
Bear Creek	42%	10%	37%	5%	3%	0%	1%	20,332
Bellemy Creek	5%	7%	47%	11%	26%	0%	3%	20,648
Buck Creek	20%	7%	23%	4%	19%	0%	0%	32,392
Cedar Creek	40%	10%	22%	7%	13%	0%	4%	29,623
Coldwater River	8%	7%	40%	18%	24%	0%	1%	120,737
Coopers, Clear, and Black Creeks	31%	13%	39%	9%	2%	0%	3%	65,400
Crockery Creek	19%	11%	19%	13%	24%	3%	10%	102,316
Deer Creek	12%	2%	22%	12%	12%	1%	39%	22,374
Dickerson Creek	37%	22%	32%	4%	2%	0%	0%	48,387
Direct Drainage to Lower Grand River	21%	4%	33%	10%	14%	1%	2%	275,232
Fall Creek	45%	6%	19%	5%	11%	0%	6%	15,870
Glass Creek	53%	11%	21%	2%	5%	0%	4%	23,511
High Bank Creek	32%	9%	18%	15%	19%	0%	3%	21,809
Indian Mill Creek	13%	3%	42%	6%	14%	0%	0%	10,979
Lake Creek	8%	8%	58%	15%	8%	0%	0%	18,172
Libhart Creek	2%	5%	37%	39%	15%	1%	0%	35,175
Lower Flat River	23%	9%	50%	6%	6%	0%	1%	78,872
Lower Rogue River	32%	8%	41%	5%	8%	0%	1%	93,532
Lower Thornapple River	34%	6%	28%	7%	19%	1%	1%	126,290
Mill Creek	20%	4%	36%	6%	26%	1%	6%	12,955
Mud Creek	5%	6%	23%	23%	43%	0%	0%	38,600
Plaster Creek	6%	2%	4%	4%	45%	4%	0%	36,447
Prairie Creek	11%	13%	34%	9%	26%	1%	4%	65,533
Rush Creek	19%	6%	25%	11%	29%	1%	5%	38,040
Sand Creek	10%	5%	19%	14%	23%	2%	26%	35,084
Spring Lake / Norris Creek	32%	20%	22%	0%	11%	3%	3%	32,383
Upper Flat River	38%	13%	38%	6%	0%	0%	0%	138,113
Upper Rogue River	34%	18%	31%	8%	7%	0%	1%	73,987
Upper Thornapple River	4%	5%	45%	18%	26%	0%	0%	166,532
Wabasis and Beaver Dam Creek	32%	12%	46%	3%	2%	0%	1%	30,123
Total:								**1,861,468**
Percent in LGRW	**22**	**9**	**33**	**10**	**16**	**1**	**3**	

Hydric soil is soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part. Hydric soil is an indicator of the current or historic presence of wetlands. Many wetlands are protected under federal, state, and local regulations.

Hydric soil is often high in organic matter, making it nutrient-rich and productive when drained for agricultural purposes. This explains why, historically, so many wetlands were drained in Michigan. Due to its naturally high water table, hydric soil is generally poorly suited for development, especially for septic fields. Such soils are, therefore, potential locations for successful wetland restoration projects.

Figure 2.5 indicates the location of hydric soil within the Watershed, as indicated in Soil Survey of Ottawa, Muskegon, Kent, Montcalm, Ionia, Barry, and Eaton Counties, Michigan.

Soils Relationship to Development

Development often occurs in soils which are highly permeable, and therefore reduces overall permeability on an urbanizing landscape. This can generate more runoff and impact hydrology and water quality. Low Impact Development (LID) is rapidly becoming the mainstream technique for storm water management. The purpose of LID is to mimic nature by managing rainfall using design techniques that infiltrate, filter, store, evaporate, and detain runoff close to the source. Many LID techniques rely on infiltrating storm water and runoff; therefore, it is important to consider soil properties, as well as geology, when implementing LID (Southeast Michigan Council of Governments [SEMCOG], 2008). LID is an extremely beneficial management technique for treating storm water in urbanizing areas of the Watershed.

Soils Relationship to Prime Farmland

The U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) defines prime farmland as land with the best combination of physical and chemical characteristics for producing crops. This land must be available for agricultural use in order to receive a prime farmland designation. Prime farmland has the combination of soil properties, growing season, and moisture supply needed to produce sustained high yields of crops in an economic manner, if it is treated and managed according to acceptable farming practices. Prime farmland soils may include those that are productive if artificially drained or managed to prevent flooding. Approximately 74% of the land in the Watershed is considered to be prime farmland, under this definition; but the placement of the farms and resulting impact from those farms has increased the potential for Nonpoint Source (NPS) pollution in the Watershed.

Soils Relationship to Erosion

The rate storm water infiltrates through soil has important implications with regard to storm water management. When infiltration occurs slowly, precipitation tends to flow over the ground surface during intense rain events and quickly enter storm sewers, ditches, creeks, and other water bodies. Water flows with higher energy, resulting in erosion, flooding, and impaired water quality.

There are three types of waterborne erosion: sheet, rill, and gully. Sheet erosion occurs when rainfall hits the ground and runs across its surface in a large sheet, picking up loose soil particles. Little to none of the water infiltrates. Rill erosion occurs when precipitation cuts small drainage pathways into the surface of the land, giving the precipitation little time to infiltrate. Gully erosion occurs when rills become much larger and deeper. Rills can be easily obliterated by normal tillage practices, whereas gullies cannot. Soil erosion susceptibility is greatest for loose soils on steep slopes. This Watershed has many soils that are susceptible to all three types of erosion.

2.5 HYDROLOGY

The LGR flows 260 miles and drains 2,909 square miles. The Watershed is characterized by poor natural drainage, resulting in numerous lakes, swamps, and artificial drains as shown in Figure 2.6.

The LGR includes three major tributaries that flow into the Grand River: the Thornapple River, the Flat River, and the Rogue River. The Thornapple River flows 78 miles northward and drains 848 square miles. It enters the Grand River between the Cities of Lowell and Grand Rapids. The Flat River is 70 miles long and drains 564 square miles in the northeast portion of the Watershed, entering the Grand River after passing through the City of Lowell. The Rogue River is 50 miles long and drains 262 square miles in the northwest portion of the Watershed, entering the Grand River north of the City of Grand Rapids (Grand River Basin Coordinating Committee, 1972).

Steamboat operators and log driving companies dredged the river and constructed pilings for log sorting pens in the 1800s. The Army Corps of Engineers constructed numerous wing dams, river training walls, and other navigation channel structures in the late 1800s and early 1900s. The City of Grand Rapids built major floodwalls before World War I and obtained Works Progress Administration (WPA) funds to work on flood protection and river beautification during the 1930s. In addition, significant sections of the Grand River bed and adjacent floodplain have been filled within the City of Grand Rapids.

An extensive system of county drains is located throughout the LGRW. Agricultural drains hasten storm water drainage from cultivated fields and other areas, reducing the frequency of flooding in these areas. However, rapidly flowing water is more likely to erode streambeds and carry sediment to the Grand River and its adjacent floodplain. Fields drained with tiles also create a hazard for surface water contamination from pesticides, fertilizer, and *E. coli*.

Precipitation and Climate

The LGRW enjoys a moderate continental climate and annually experiences 155 frost-free growing days. Air masses originate from the Gulf of Mexico, northern Canada, and the north Pacific. The presence of Lake Michigan has a slight moderating effect on annual temperatures and results in increased snowfall along the coast. Mean January temperature in the LGRW is approximately 23°F; the mean July temperature is approximately 71°F. The average rainfall throughout the LGRW is approximately 32 inches. Annual snowfall ranges from 80 inches along Lake Michigan to 40 inches along the eastern edge of the Watershed (Bieneman, 1999).

Surface Water

The Watershed has an extensive network of streams, creeks, constructed drainageways, and inland lakes as shown in Appendix 2.1. The named streams and tributaries for each Subwatershed Management Unit are listed in Tables 2.4 through 2.7.

LGRW Direct Drainage

The 2005 Report by Rockafellow (MI/DEQ/WB-05/097) indicated that the physical habitat and macroinvertebrate community of the LGR main stem were not evaluated due to the size and depth of the Grand River in the lower reaches. However, several water samples were collected and analyzed for multiple parameters to aid in the development of water quality-based effluent limits (WQBELs) for facilities that discharge to the LGR. No exceedances of the Michigan Water Quality Standards were documented during this survey of the LGR.

A qualitative macroinvertebrate sampling study was completed for sites in the Lower Grand River in 2009. Out of 35 stations sampled, only the North Branch of Crockery Creek was rated poor. All others were ranked acceptable; with the exception of Prairie Creek, which earned an excellent rating at one location.

More information can be found at the following website once the report is available:
http://www.michigan.gov/deq/0,1607,7-135-3313_3686_3728-54941--,00.html

Table 2.4 – Streams in the Lower Grand River Watershed Direct Drainage (Not Found in Any Other Major Subwatershed)

Subwatershed Management Unit	Stream Name
Bass River	Bass Creek, Bass River, Bear Creek, Grand River, Little Bass Creek, Unnamed Tributaries
Bear Creek	Armstrong Creek, Bear Creek, Stout Creek, Unnamed Tributaries, Waddell Creek
Bellemy Creek	Bellamy Creek, Spring Brook, Unnamed Tributaries
Buck Creek	Buck Creek, Pine Hill Creek, Sharps Creek, Unnamed Tributaries
Crockery Creek	BR J Smith Drain, Brandy Creek, Canada Drain, Crockery Creek, Indian Run, Lawrence Drain, North Branch Crockery Creek, Rio Grande Creek, Sanford Drain, Smith Drain, Unnamed Tributaries
Deer Creek	Deer Creek, Grand River, Unnamed Tributaries
Direct Drainage to Lower Grand River	Bellamy Creek, Black Creek, Bruce Bayou, Buck Creek, Crooked Creek, De Young Swamp, Dermo Bayou, Egypt Creek, Flat River, Floodway, Goose Creek, Grand River, Grand River Basin, Honey Creek, Indian Channel, John Ball Lake, Lamberton Creek, Lee Creek, Libhart Creek, Lloyd Bayou, Millhouse Bayou, Ottawa Creek, Peacock Creek, Pine Creek, Pottawattomie Bayou, Red Creek, Scotch Creek, Scott Creek, Sessions Creek, Stearns Bayou, Sunny Creek, Tibbets Creek, Timberlin Creek, Toles Creek, Unnamed Tributaries
Indian Mill Creek	Brandy Wine Creek, Grand River, Indian Creek, Indian Mill Creek, Unnamed Tributaries
Lake Creek	Lake Creek, Little Creek, Unnamed Tributaries
Libhart Creek	Libhart Creek, Little Libhart Creek, Taylor Creek, Unnamed Tributaries, West Branch Knoll and Kneale Drain
Mill Creek	Grand River, Mill Creek, Strawberry Creek, Unnamed Tributaries
Plaster Creek	Little Plaster Creek, Plaster Creek, Unnamed Tributaries, Whisky Creek
Prairie Creek	Bacon Creek, Grand River, Prairie Creek, Unnamed Tributaries
Rush Creek	Dora Byron Drain, East Branch Creek, East Branch Rush Creek, Grand River, Rush Creek, Unnamed Tributaries
Sand Creek	Alpine Drain, Inter County Drain, Sand Creek, Unnamed Tributaries
Spring Lake/Norris Creek	Norris Creek, Rhymer Creek, Stevens Creek, Unnamed Tributaries, Vincent Creek, Willow Hill Creek

Thornapple River Subwatershed

The Thornapple River Subwatershed is the largest tributary to the LGR. The Thornapple River flows 78 miles from its headwaters in Eaton Rapids Township to its confluence with the Grand River near the Village of Ada. Some portions of the Thornapple River have been channelized or dredged, resulting in a loss of habitat for sport fish. However, several tributaries including Quaker Brook, Coldwater River, and High Bank Creek are cold water streams.

The Thornapple River is moderately impaired by agricultural runoff, channel modification, and to some degree, wastewater treatment plant discharges. While these impairments are evident, the overall habitat and water quality has been rated as “good” by the Michigan Department of Natural Resources and Environment (MDNRE). Priority concerns resulting from these impairments are groundwater and fisheries habitat protection. Tributaries and the main channel itself are recovering from historic dredging activities and are providing excellent substrate for macroinvertebrates and fish spawning. Many of these tributaries, with continued improvements, will provide valuable opportunities for fishing and wildlife viewing.

Table 2.5 – Streams in Thornapple River Subwatershed

Subwatershed Management Unit	Stream Name
Cedar Creek	Cedar Creek, Kellie Creek, North Branch Cedar Creek, Unnamed Tributaries
Coldwater River	Bear Creek, Burd Drain, Coldwater River, Duck/Black Creek, Kilgus Branch, Kilgus Branch Stream, Little Thornapple River, Messer Brook, Peddler Lake Drain, Pratt Lake Creek, Tupper Creek, Tyler/Bear Creek, Unnamed Tributaries, Woodland Creek
Fall Creek	Fall Creek, Unnamed Tributaries
Glass Creek	Glass Creek, Unnamed Tributaries
High Bank Creek	High Bank Creek, Mud Creek, Unnamed Tributaries
Lower Thornapple River	Bassett Creek, Butler Creek, Duncan Creek, Glass Creek, Grand River, High Bank Creek, Hill Creek, Thornapple River, Turner Creek, Unnamed Tributaries
Mud Creek	Doolin Drain, Hagar Creek, Mud Creek, Unnamed Tributaries
Upper Thornapple River	Allen and Crane Drain, Baker Drain, Bundige and Wilcox Drain, Burkhead Drain, Butternut Creek, Carmen Drain, Church Drain, Cole Wright Helms Drain, Darken and Boyer Drain, Densmore Perkins Fish Creek Drain, Fast and Bodell Drain, Garvey Drain, Gruesbeck Drain, Haner Creek, Hayon Creek, King Drain, Lacey Creek, Little Thornapple River, Milbourn and Garvey Drain, Morfey Brook, Munton Drain, Palmiter and Phelps Drain, Quaker Brook, Scipio Creek, Shanty Brook, Sharp Drain, Thornapple and Old Maid Drain, Thornapple Drain, Thornapple River, Thornapple-ext Drain, Unnamed Tributaries

Flat River Subwatershed

The Flat River Subwatershed flows 70 miles from the southeast corner of Mecosta County, in the Six Lakes area, through Montcalm and Ionia Counties and enters the Grand River in the City of Lowell, in eastern Kent County. Fifty percent of the Flat River Subwatershed is used for agriculture. The Flat River is described as the most scenic river in the southern Lower Peninsula. The Flat River Subwatershed is an excellent small-mouth bass fishery. The MDNRE designated the Flat River as a Natural River under the Natural Rivers Act of 1970.

The townships along the Flat River decided that local interests would be able to provide the most protection for the Flat River and its scenic values. Six of the nine townships along the segments of the Flat River that were designated Natural River areas adopted ordinances which include a zoning overlay zone that controls how development can impact the Flat River's water quality, habitat, and scenic views. The other three townships are using the Natural River Plan that was drafted by the MDNRE to help protect the Flat River.

The Flat River offers a number of opportunities for public recreation. Along the Flat River's 70 miles of scenic natural beauty, visitors can find many acres of naturally vegetated wetlands and hardwood forests. There are five dams that must be portaged between the Six Lakes area and the mouth of the Flat River in the City of Lowell. Along the way, canoeists will see two of Michigan's four remaining wood covered bridges. Approximately 7% of the shoreline along the Flat River is owned by the MDNRE as State Game Areas.

Table 2.6 – Streams in Flat River Subwatershed

Subwatershed Management Unit	Stream Name
Coopers, Clear, and Black Creeks	Black Creek, Butternut Creek, Clear Creek, Coopers Creek, Unnamed Tributaries
Dickerson Creek	Dickerson Creek, Unnamed Tributaries
Upper Flat River	Flat River, Page Creek, Power Canal, Seely Creek, Toles Creek, Unnamed Tributaries, Flat River, Stony Creek, Townline Creek, Unnamed Tributaries, Wabasis Creek
Lower Flat River	Dickerson Creek, Flat River, Page Creek, Power Canal, Seely Creek, Toles Creek, Unnamed Tributaries
Wabasis and Beaver Dam Creek	Beaver Dam Creek, Unnamed Tributaries, Wabasis Creek, Wabasis Road

Rogue River Subwatershed

The Rogue River Subwatershed is located mostly in Kent and Newaygo Counties. At one time it received discharges from agriculture, landfills, and industry that turned the Rogue River into a virtually fishless habitat. Today, these discharges have been largely controlled, and the Rogue River has since returned to a top-class trout stream.

Water quality in the Rogue River is partially protected under the Natural Rivers Act of 1970. Approximately half of the Rogue River Subwatershed's 180 miles of streams are designated as a Natural River. This designation creates an overlay district around the designated stream segments where development must preserve water quality, wildlife and aquatic life habitat, and scenic views.

Prior to settlement, the Rogue River Subwatershed was mostly covered in white pine forests. Today, the majority of the Rogue River Subwatershed is used for agricultural purposes. The lower portion of the Rogue River Subwatershed is mostly residential and urban. Residential development is the fastest expanding land use and threatens water quality with NPS pollution.

The majority of flow in the Rogue River comes from groundwater sources. This characteristic is what accounts for the cool/coldwater fisheries.

Table 2.7 – Streams in Rogue River Subwatershed

Subwatershed Management Unit	Stream Name
Lower Rogue River	Ball Creek, Barkley Creek, Becker Creek, Cedar Creek, Duke Creek, Grand River, Little Cedar Creek, Nash Creek, Rogue River, Rum Creek, Shaw Creek, Stegman Creek, Unnamed Tributaries
Upper Rogue River	Barber Creek, Duke Creek, Forest Creek, Frost Creek, Geers Drain, Hickory Creek, Hillbrand Drain, Lockwood Drain, Post Creek, Ransom Creek, Rogue River, Spring Creek, Unnamed Tributaries, Walter Creek, White Creek

High Flows

The MDNRE Land and Water Management Division estimated the flooding frequency discharges for the Grand River at locations indicated in Table 2.8. The discharge, measured in cubic feet per second (cfs) are the predictions of the chance of storm events to occur within a certain number of years.

Table 2.8 – Flow Rates by Storm Event Predictions for the LGR
(Source: MDNRE, Land and Water Management Division)

County	Location	Date of Measurement	Drainage Area (mi^2)	Discharge Frequencies (% chance)	Flow Rate (cfs)
Ionia	I-96	11/05/2001	1,401.11	10-year (10%)	12,000
				50-year (2%)	19,000
				100-year (1%)	22,000
Ionia	Lyons Dam	2/27/2008	1,752.89	10-year (10%)	15,000
				50-year (2%)	23,000
				100-year (1%)	37,000
Kent	At Islands (Lowell)	2/19/2002	3,620.00	10-year (10%)	25,000
				50-year (2%)	37,000
				100-year (1%)	42,000
Kent	3,700 feet upstream of M-44	11/02/2001	4,550.41	10-year (10%)	31,000
				50-year (2%)	45,000
				100-year (1%)	51,000
Ottawa	Upstream of Crockery Creek	8/15/2000	5,296.42	10-year (10%)	35,000
				50-year (2%)	52,000
				100-year (1%)	59,000
Ottawa	US-31	10/30/2002	5,570.00	10-year (10%)	37,000
				50-year (2%)	53,000
				100-year (1%)	61,000

mi^2 square miles
cfs cubic feet per second

Information for Table 2.8 was extracted from the MDNRE Flood Flow Discharge Database found at http://www.deq.state.mi.us/flow/ on February 11, 2010.

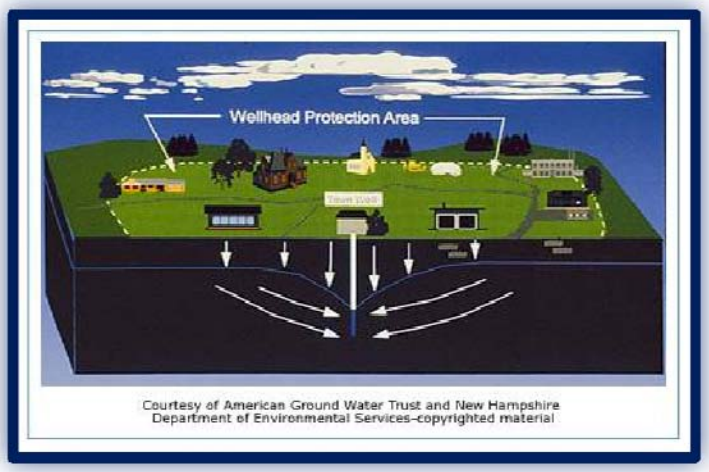
Increased drainage in certain areas can result in excessive flows in receiving streams. This excessive flow can be exhibited by higher peak flows, longer peak flow periods, or both. The results of these excess flows are increased streambank erosion, increased streambed scouring, sediment re-suspension, habitat destruction, and decreased diversity and number of fish and aquatic organisms.

Relative to those that maintain a steadier flow, streams that rise and fall quickly during a storm are considered flashy. Streams become flashy when there is an increase in runoff from the surface which enters the streams, such is the case where increased impervious area in a Watershed creates increased surface runoff to the streams. Based on the study completed by the MDNRE (Fongers, 2008) on the flashiness index of the LGR and its tributaries, it appears that the flashiness index for the Red Cedar River and the Thornapple River is increasing over time, at the locations near the gage station in East Lansing (gage data from 2004) and near Caledonia (gage data from 1994), Michigan, respectively. An increase in flashiness, often due to changing land use, is a common cause of stream channel instability and channel erosion. The MDNRE study indicated that large-scale solutions, for example, regional storm water management practices or LID retrofits, may be needed to help reduce the flashiness and stabilize the river flows.

Groundwater (Recharge Areas) and Wellhead Protection

Groundwater is a crucial part of the Watershed. While this project deals mostly with surface water and the problems associated with NPS pollution, groundwater and surface water are intimately connected, and will have great influence on each other. Groundwater and surface water interact in areas known as recharge or discharge zones. The LGR has both recharge and discharge areas. Groundwater recharge areas are critical to protecting drinking water sources and maintaining high quality streams.

In areas where groundwater is used as the municipal drinking water supply, a critical area that contributes water to the municipal water supply well is called a wellhead protection area. Wellhead protection plans involve activities and management practices for protecting public groundwater supply systems from contamination, which limits the types and feasibility of infiltration practices. Table 2.9 identifies the municipalities within the Watershed having designated wellhead protection areas to protect groundwater recharge areas. These areas are illustrated in Figure 2.7.



Dams

Dams have potential to drastically affect the ecological and physical conditions of riverine systems. The physical characteristics of rivers downstream of a dam are often substantially different from physical characteristics of the rivers upstream of a dam where they enter an impoundment. Normal high and low water conditions within the riverine system are normally altered by dams, resulting in changes in stream channel, fisheries, and other aquatic habitats. In addition, dams limit the normal movement of fish and other aquatic organisms along a river's length.

Significant alterations have been made to the Grand River and its tributaries since the 1800s. The first dam built across the Grand River, in Grand Rapids, was completed in 1849 and rebuilt in 1866. Today, approximately 129 dams or impoundments are located in the Grand River Watershed to control water levels and/or to generate power (GLIN, 2008). The dams are noted on Figure 2.8. A complete list of dams and their locations can be found in Appendix 2.1. The Sixth Street dam, in downtown Grand Rapids, was constructed in 1910 to control water levels. A pool-and-weir type fishway (the "fish ladder") was constructed adjacent to the dam in 1975 to allow salmon to migrate upstream (Huggler, 1990). More "fish ladders" followed at the Lyons, Webber, Portland, Grand Ledge, and North Lansing dams. This project, called the Grand River Salmon Plan, allowed unrestricted fish passage from Lake Michigan to the City of Lansing.

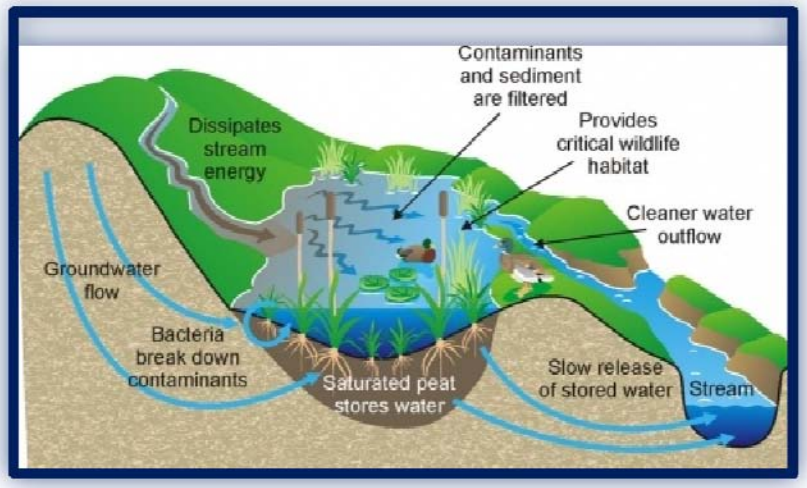
Table 2.9 – Wellhead Protection Areas
(Source: MDEQ, http://gwmap.rsgis.msu.edu/)

Community	County	Type
Hastings Township	Barry	Source Water Protection Area
Thornapple Township	Barry	Wellhead Protection Area
Irving Township	Barry	Wellhead Protection Area
Vermontville Township	Eaton	Wellhead Protection Area
Castleton Township	Eaton	Wellhead Protection Area
Oneida Township	Eaton	Wellhead Protection Area
Lyons Township	Ionia	Source Water Protection Area
Boston Township	Ionia	Wellhead Protection Area
Odessa Township	Ionia	Wellhead Protection Area
Orange Township	Ionia	Wellhead Protection Area
Ronald Township	Ionia	Wellhead Protection Area
Lyons Township	Ionia	Source Water Protection Area
Portland	Ionia	Wellhead Protection Area
Rockford	Kent	Wellhead Protection Area
Plainfield Township	Kent	Wellhead Protection Area
Sparta Township	Kent	Wellhead Protection Area
Cannon Township	Kent	Wellhead Protection Area
Cedar Springs	Kent	Wellhead Protection Area
Grattan Township	Kent	Wellhead Protection Area
Vergennes Township	Kent	Wellhead Protection Area
Greenville	Montcalm	Wellhead Protection Area
Home Township	Montcalm	Wellhead Protection Area
Home Township	Montcalm	Source Water Protection Area
Otisco Township	Montcalm	Wellhead Protection Area
Ravenna Township	Muskegon	Source Water Protection Area
Grant Township	Newaygo	Wellhead Protection Area

Note: Wellhead protection areas listed are ether partially or entirely located in the Lower Grand River Watershed.

2.6 NATURAL RESOURCES

Wetlands



Wetlands are a critical component to Watershed health, as they improve water quality by trapping pollutants and serving as natural detention areas. The Watershed is home to numerous types of wetlands, a majority of which are classified as palustrine by the National Wetland Inventory. Palustrine wetlands are associated with streams, creeks, swales, or are separate wetland features in the landscape. Other types of wetlands in the Watershed are riverine, associated with river systems, and lacustrine, associated with or adjacent to lakes. Wetlands in the Watershed range

from forested wetlands with red and silver maple and sycamore, to emergent vegetation such as cattail marshes. Many shrub-scrub wetlands are also present. Figure 2.9 is a map of the approximate vegetation in the 1800s. According to the MDNRE, approximately 170,000 acres of wetlands (42%) have been drained/lost since the 1800s.

Figure 2.10 is a map of Wetland Restoration Potential created by the MDNRE. The map shows hydric soils, circa 1800 wetlands, and existing wetlands. The overlapping areas of the hydric soils and circa 1800 wetland areas indicate areas with a high potential for wetland restoration. The MDNRE has completed a Landscape Level Wetland Functional Assessment (LLWFA) of existing and historically lost wetlands for various watersheds around the state and has a long-term goal to complete LLWFA for the entire state. Additional information about the MDNRE LLWFA report can be found in Section 3.3.6. A complete LLWFA report is found in Appendix 3.5.

Wetlands are invaluable for a variety of water quality functions they naturally perform. These include, but are not limited, to the following:

- Denitrification: Studies show that in certain instances, wetlands can remove from 70 to 90 percent of nitrates. One study in the southeastern U.S. projected a 20-fold increase in nitrogen loadings to streams, as a result of a total conversion to adjacent bottomland hardwood forested wetlands to cropland.

- Trapping sediments can keep large amounts of phosphorous from entering adjacent rivers and reduces sedimentation.

- Flood control: Studies in the Midwest show floodwater flows can be reduced by 80 percent in watersheds with wetlands, as opposed to those without them.

- Groundwater Recharge: Returning water to underground aquifers is known as "groundwater recharge." Much of the water in a wetland used for recharge would have been deposited there during wet periods, so the wetland would not only stem flooding by retaining water, but by having that water available to recharge groundwater (information from North Carolina State University webpage).

A major function of wetlands is the preservation of water quality. Wetlands are similar to living filters. They trap pollutants such as nutrients and sediments, which can impair/impact the designated/desired uses of total and partial body contact, public water supply, and warmwater fishery. Wetlands also act as natural detention areas by storing flood waters and releasing them slowly, which reduces peaks flows and protects downstream property owners from flooding. The State of Michigan has set a goal of 10% wetland restoration, which will be used as a basis for setting the goal for this Watershed.

According to the MDNRE website (www.michigan.gov/wetlands), Michigan received authorization from the federal government in 1984 to administer Section 404 of the federal Clean Water Act in most areas of the state. A state-administered 404 program must be consistent with the requirements of the federal Clean Water Act and associated regulations set forth in the Section 404(b) (1) guideline. In other states, where an applicant must apply to the U.S. Corps of Engineers and a state agency for wetland permits, applicants in Michigan generally submit only one wetland permit application to the MDNRE. Currently, wetlands are regulated at the State under Part 303, Wetlands Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (Part 303).

Part 303 indicates that a wetland is regulated if it is any of the following:

- Connected to one of the Great Lakes or Lake St. Clair.
- Located within 1,000 feet of one of the Great Lakes or Lake St. Clair.
- Connected to an inland lake, pond, river, or stream.
- Located within 500 feet of an inland lake, pond, river, or stream.
- Not connected to one of the Great Lakes or Lake St. Clair, or an inland lake, pond, stream, or river, but are more than 5 acres in size.
- Not connected to one of the Great Lakes or Lake St. Clair, or an inland lake, pond, stream, or river, and less than 5 acres in size, but the MDNRE has determined that these wetlands are essential to the preservation of the State's natural resources and has notified the property owner webpage).

The law requires that persons planning to conduct certain activities in regulated wetlands apply for and receive a permit from the State before beginning the activity. In accordance with Part 303, a local unit of government can also regulate wetlands by ordinance, in addition to state regulation, if certain criteria are met.

The Communities of Cannon Township, Grattan Township, and Spring Lake Township have wetland ordinances, but the majority of communities do not offer wetland protection at the local level.

Fish and Wildlife

A diversity of aquatic and terrestrial habitat types are found throughout the Watershed that harbors various amphibian, reptile, avian, mammal, and fish species. Many of these species are important from a recreational and economical perspective. Well-organized conservation and outdoor sporting groups exist throughout the Watershed, such as Ducks Unlimited, Pheasants Forever, Trout Unlimited, Michigan United Conservation Clubs, to protect and enhance habitat for animals such as whitetail deer, wild turkeys, pheasants, grouse and many species of fish. Many nontarget species are also likely to benefit from these efforts.

Coldwater Fishery

The State of Michigan designates certain coldwater streams as trout streams under provisions of Fisheries Order 210.10 (http://www.michigan.gov/documents/dnr/FO_210.10_317504_7.pdf). Designated trout streams take water temperature, habitat, fish population, structure, and other factors into consideration, and are protected through restrictive fishing regulations and discharge guidelines.

Figure 2.11 identifies the designated trout streams. Table 2.10 lists the stream miles in the management units that are designated trout streams.

Table 2.10 – Designated Trout Streams
(Source: DNR-DFI 101 FO-210.08. Obtained from the Michigan Center for Geographic Information, 2010)

Subwatershed Management Unit	Designated Trout Stream Miles	Total Stream Miles	Designated Trout Stream Miles (%)
Bass River	1.7	102.5	2%
Bear Creek	10.7	48.4	22%
Bellemy Creek	11.6	55.3	21%
Buck Creek	15.6	82.9	19%
Cedar Creek	6.5	44.7	15%
Coldwater River	26.1	244.7	11%
Coopers, Clear, and Black Creeks	1.3	118.0	1%
Crockery Creek	29.0	300.3	10%
Deer Creek	1.5	64.5	2%
Dickerson Creek	10.8	102.2	11%
Direct Drainage to LGR	72.8	820.0	9%
Fall Creek	0.0	20.1	0%
Glass Creek	6.5	37.8	17%
High Bank Creek	2.4	34.4	7%
Indian Mill Creek	5.4	27.4	20%
Lake Creek	9.2	43.1	21%
Libhart Creek	0.0	85.1	0%
Lower Flat River	3.9	190.6	2%
Lower Rogue River	38.5	226.7	17%
Lower Thornapple River	7.0	345.5	2%
Mill Creek	7.6	34.8	22%
Mud Creek	0.0	69.2	0%
Page Creek	4.1	4.1	100%
Plaster Creek	0.0	92.2	0%
Prairie Creek*	25.9	144.4	18%
Rush Creek	0.0	112.3	0%
Sand Creek	19.4	84.6	23%
Spring Lake/Norris Creek	9.4	61.8	15%
Upper Flat River	1.8	248.2	1%
Upper Rogue River	24.4	167.6	15%
Upper Thornapple River	8.1	401.1	2%
Wabasis and Beaver Dam Creek	0.0	47.0	0%
Total:	**357.1**	**4,457**	8%

*Note: Prairie Creek has been identified as high priority breeding ground for trout *(Source: MDNRE, 2010)*

Exotic and Invasive Species

Exotic species are defined as those that have been introduced from another geographic region to an area outside its natural range, while invasive species are those that heavily colonize or take over a particular habitat. Many invasive species exist in the LGRW, as indicated in the following table.

Table 2.11 – Invasive Species
(Source: *USGS, Michigan Natural Features Inventory*)

	Scientific Name	Common Name
Trees	*Elaeagnus angustifolia*	Russian Olive
	Elaeagnus umbellata	Autumn Olive
	Robinia pseudoacacia	Black Locust
	Salix fragilis	Crack willow
Shrubs	*Berberis thunbergii*	Japanese Barberry
	Ligustrum vulgare	Privet
	Lonicera maackii	Amur Honeysuckle
	Lonicera morrowii	Morrow's Honeysuckle
	Lonicera tatrica	Tartarian Honeysuckle
	Lonicera xbella	Bell's Honeysuckle
	Rhamnus cathartica	Common Buckthorn
	Rhamnus frangula	Glossy Buckthorn
	Rosa multiflora	Multiflora Rose
Woody Vines	*Lonicera japonica*	Japanese Honeysuckle
	Toxicodendron radicans	Poison Ivy
Herbaceous Plants	*Agrostis gigantea*	Redtop
	Alliaria petiolata	Garlic Mustard
	Cardamine impatiens	Narrow-leaved Bitter-cress
	Centaurea maculosa	Spotted Knapweed
	Cirsium arvense	Canada Thistle
	Cirsium palustre	European Swamp Thistle
	Echinochloa crusgalli	Barnyard grass
	Epilobium hirsutum	Great hairy willow herb
	Euphorbia esula	Leafy Spurge
	Hesperis matronalis	Dame's Rocket
	Lysimachia nummularia	Moneywort
	Lythrum salicaria	Purple Loosestrife
	Melilotus alba	White Sweet Clover
	Melilotus officinalis	Yellow Sweet Clover
	Nasturtium officinale	Water-cress
	Pastinaca sativa	Wild Parsnip
	Phalaris arundinacea	Reed Canarygrass
	Phragmites australis	Gian Reed
	Polygonum cuspidatum	Japanese Knotweed
	Polygonum persicaria	Lady's Thumb
	Polygonum sachalinense	Giant Knotweed
	Rumex obtusifolius	Bitter dock
	Solanum dulcamara	Bittersweet nightshade
	Sonchus arvensis	Field sow thistle
	Typha angustifolia	Narrow-leaved Cat-tail
	Vincetoxicum spp.	Swallow-worts

Table 2.11 – Invasive Species
(Source: *USGS, Michigan Natural Features Inventory*)

	Scientific Name	Common Name
Aquatic Plants	*Myriophyllum spicatum*	Eurasian Water Milfoil
	Potamogeton crispus	Curly Pondweed
Fish	*Cyprinus carpio*	Common Carp
	Neogobius melanostomus	Round goby
	Petromyzon marinus	Sea lamprey
	Morone americana	White perch
	Gymnocephalus cernuus	Eurasian ruffe
	Alosa pseudoharengus	Alewife
Crustaceans	*Orconectes rusticus*	Rusty crayfish
	Bythotrephes cederstroemi	Spiny water flea
Mollusks	*Dreissena polymorpha*	Zebra mussel
	Dreissena rostriformis bugensis	Quagga mussel
	Bithynia tentaculata	Mud bithynia, faucet snail

Protected Species

Michigan has a number of significant natural features located across the state. These natural features can provide public benefits that may include bird watching, hunting, fishing, camping, hiking, off-roading, and water sports. However, these areas also include critical habitat for different species of plants, mammal, amphibians, reptiles, birds, fish, and macroinvertebrates.

The MDNRE provides information on threatened and endangered plants and animals in Michigan. This work is coordinated by the Michigan Natural Features Inventory (MNFI). Results of the MNFI (http://web4.msue.msu.edu/mnfi/) data indicate that nine species in the Watershed are endangered, and there are many of special concern, threatened, or extirpated. The categories used to describe these species and a complete list of threatened, endangered, and state special concern species previously documented in the LGRW can be found in Appendix 2.2.

Endangered species are in danger of extinction and are protected by law; they may not be killed, harassed, handled, or possessed without a permit. A threatened species is any species that is likely to become an endangered species within the foreseeable future. Both endangered and threatened species are protected under Michigan's Endangered Species Act (Part 365 of PA 451, 1994 Michigan Natural Resources and Environmental Protection Act).

Special concern species are not protected under the Endangered Species Act. These species are of concern due to declining or relict populations in the state. If these species continue to decline, they would be recommended for threatened or endangered status. It is important to maintain self-sustaining populations of special concern species in order to prevent them from becoming endangered or threatened species in the future. Tables 2.12a and 2.12b list the endangered species.

Table 2.12a – Endangered Animal Species in LGRW
(Source: Michigan Natural Features Inventory)

Subwatershed Management Unit	Common Name	Type of Animal
Bear Creek	Pugnose shiner	Fish
Cedar Creek	Henslow's sparrow	Bird
Coldwater River	Henslow's sparrow	Bird
Coopers, Clear, and Black Creeks	Henslow's sparrow	Bird
	Pugnose shiner	Fish
Dickerson Creek	Regal fritillary	Butterfly
Direct Drainage to Lower Grand River	Henslow's sparrow	Bird
	Snuffbox	Mussel
	Peregrine falcon	Bird
Glass Creek	Henslow's sparrow	Bird
	Pugnose shiner	Fish
High Bank Creek	King rail	Bird
Lower Flat River	Pugnose shiner	Fish
Lower Rogue River	King rail	Bird
Lower Thornapple River	Henslow's sparrow	Bird
	Three-staff underwing	Moth
	Mitchell's satyr	Butterfly
Mill Creek	Snuffbox	Mussel
Mud Creek	King rail	Bird
Plaster Creek	Snuffbox	Mussel
Upper Flat River	Henslow's sparrow	Bird
Upper Thornapple River	Henslow's sparrow	Bird
	Indiana bat	Bat
	King rail	Bird

The MNFI notes a wide variety of habitats that support the listed species. These include forests (mesic southern, mesic northern, dry mesic, and southern floodplain), prairie (dry sand, hillside, wet, and wet-mesic), wetlands (bog, southern swamp, emergent marsh, Great Lakes marsh, inter-dunal, hardwood-conifer swamp, prairie fen, and coastal plain marsh), Great Lakes barrens, and open dunes.

Sensitive Areas

Critical and unique habitat for fish and wildlife within the Watershed are provided in the wetland areas and in the river corridor areas located in the Watershed. The wetland areas provide habitat for waterfowl, reptiles, mammals, amphibians, insects, and birds. The forested areas along the watercourses and drainageways provide shade to the watercourses, resulting in cooler water and improved water quality, habitat for various birds and mammal species and provide migration corridors for wildlife species.

Table 2.12b – Endangered Plant Species in LGRW
(Source: Michigan Natural Features Inventory)

Subwatershed Management Unit	Common Name
Bear Creek	Virginia bluebells
	Orange- or yellow-fringed orchid
Buck Creek	Virginia bluebells
Coldwater River	Kitten-tails
	Virginia bluebells
	Orange- or yellow-fringed orchid
Direct Drainage to Lower Grand River	Kitten-tails
	Side-oats grama grass
	White gentian
	Downy gentian
	Virginia bluebells
	Orange- or yellow-fringed orchid
	Mermaid-weed
	Three-square bulrush
Indian Mill Creek	Virginia bluebells
Lake Creek	Kitten-tails
Lower Flat River	Kitten-tails
	Virginia bluebells
	Orange- or yellow-fringed orchid
Lower Rogue River	Kitten-tails
	Orange- or yellow-fringed orchid
Lower Thornapple River	Kitten-tails
	Side-oats grama grass
	American chestnut
	Virginia bluebells
	Orange- or yellow-fringed orchid
	Spotted pondweed
Plaster Creek	Virginia bluebells
Sand Creek	Virginia bluebells
Upper Rogue River	Orange- or yellow-fringed orchid
Upper Thornapple River	Virginia bluebells
	Prairie white-fringed orchid
Wabasis and Beaver Dam Creek	Orange- or yellow-fringed orchid

Dedicated/Protected Lands

The Watershed has protected lands in the form of state, county, township, city, and village parks. Approximately 44,396 acres of State Game Area are currently protected in the Watershed. Some private land has also been protected, including efforts by local land trusts, and other private acquisitions. Lands in the Watershed are also enrolled in the PA-116 program, a State program to protect farmland from development for a specified number of years. Figure 2.12 is a map showing the prime farmlands in the Watershed which are available for Purchase of Development Rights (PDR) through the Michigan Farmland Preservation Program. Figure 2.13 illustrates the government and protected lands in the Watershed.

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

restriction may also be referred to as a conservation easement. This is an excellent step toward more permanent land protection measures.

The Wetlands Reserve Program (WRP) is a voluntary program offering landowners the opportunity to protect, restore, and enhance wetlands on their property. NRCS provides technical and financial support to help landowners with their wetland restoration efforts. The NRCS goal is to achieve the greatest wetland functions and values, along with optimum wildlife habitat, on every acre enrolled in the program. This program offers landowners an opportunity to establish long-term conservation and wildlife practices and protection beyond that which can be obtained through any other USDA program.

Additional land protection programs are discussed in Chapter 6.

Natural Rivers

The State has designated the Rogue River and the Flat River as Natural Rivers under the Part 305, Natural Rivers, of the Natural Resources and Environmental Protection Act 451 of 1994. The State designates a river or portion of a river as a natural river area for the purpose of preserving and enhancing its values for water conservation, its free flowing condition, and its fish, wildlife, boating, scenic, aesthetic, floodplain, ecologic, historic, and recreational values and uses. As stated on the MDNRE website, (http://www.michigan.gov/dnr/0,1607,7-153-30301_31431_31442---,00.html), the Natural Rivers Program is an effective management tool, due to the development standards and their influence on private as well as public lands. All lands, public and private, within the Natural River district, which includes 400 feet on either side of a designated river, are included in the designation, creating a seamless corridor of protected land. Also, local units of government are able to adopt Natural River zoning standards to become the Program administrators on private lands within their jurisdiction.

2.7 LAND USE AND LAND COVER

Open Space

Open space for this Watershed includes wetlands, forests, croplands, rangeland, and open waters and streams. The Lower Grand River Watershed has approximately 90 percent open space distributed throughout the Watershed. Urbanized areas are located in the midwest and mid-sections of the Watershed, with the City of Grand Rapids being the largest, and make up 10 percent of the basin. The major land use within the Watershed is agriculture, which comprises approximately 51 percent of the Watershed. Figure 2.13 shows the natural connections in the Watershed, while Figure 2.14 depicts the current land use in the Watershed in 2006. Table 2.13 below depicts land use characteristics of each of the 31 Subwatershed Management Units.

Agricultural Lands

Currently, most of the land not covered by residences, urban centers, and forests is cultivated. Primary agricultural products include fruit, dairy products, potatoes, poultry, and vegetables through truck gardening (cucumbers, onions, mint, and celery). Kent and Ottawa Counties are the most significant counties within the LGRW in terms of value of agricultural products. Ottawa County is the highest producing agricultural county in the State of Michigan (West Michigan Strategic Alliance, 2002). However, urbanization is impacting agricultural land, resulting in significant yearly loss of farmland to residential and commercial development.

Livestock operations within the Watershed range in size. Beef cattle, dairy cows, hogs, and sheep are some of the livestock raised in the Watershed.

Table 2.13 – Land Use by Subwatershed
(Source: NOAA (National Oceanographic and Atmospheric Administration) CSC (Coastal Services Center)/Coastal Change Analysis Program (C-CAP), 20060519, NOAA C-CAP Land Cover and Change Data, Charleston, SC. 2006.)

Subwatershed Management Unit	Agriculture (acres)	Forest (acres)	Lakes (acres)	Open Land (acres)	Urban (acres)	Wetland (acres)
Bass River	20,297	4,986	134	1,216	2,364	2,997
Bear Creek	6,795	7,292	464	684	2,486	2,610
Bellemy Creek	15,823	2,306	29	286	312	1,893
Buck Creek	5,835	3,546	58	1,131	20,604	1,203
Cedar Creek	12,720	9,613	1,206	1,072	495	4,502
Coldwater River	88,956	16,516	1,202	1,915	3,047	9,103
Coopers, Clear, and Black Creeks	34,018	12,118	2,009	2,240	2,830	12,164
Crockery Creek	67,969	15,300	428	3,232	4,909	10,441
Deer Creek	17,778	944	68	385	1,844	1,355
Dickerson Creek	26,710	7,920	1,023	1,299	1,162	10,252
Direct Drainage to Lower Grand River	90,255	72,677	10,625	11,412	64,409	25,797
Fall Creek	5,746	5,422	776	636	813	2,471
Glass Creek	6,771	10,874	811	1,114	307	3,626
High Bank Creek	12,515	4,652	786	615	442	2,769
Indian Mill Creek	4,246	1,348	9	269	4,717	390
Lake Creek	12,594	2,921	390	375	798	1,095
Libhart Creek	29,901	2,123	29	350	695	2,065
Lower Flat River	36,785	20,843	2,921	3,116	4,587	10,621
Lower Rogue River	39,614	22,124	1,450	3,629	17,554	9,163
Lower Thornapple River	53,907	36,968	3,033	4,235	17,197	10,913

Table 2.13 – Land Use by Subwatershed
(Source: NOAA (National Oceanographic and Atmospheric Administration) CSC (Coastal Services Center)/Coastal Change Analysis Program (C-CAP), 20060519, NOAA C-CAP Land Cover and Change Data, Charleston, SC. 2006.)

Subwatershed Management Unit	Agriculture (acres)	Forest (acres)	Lakes (acres)	Open Land (acres)	Urban (acres)	Wetland (acres)
Mill Creek	8,455	1,503	142	261	2,245	349
Mud Creek	28,954	4,295	361	527	674	3,767
Plaster Creek	6,167	3,724	55	734	23,622	2,146
Prairie Creek	45,031	7,569	341	1,047	1,339	10,156
Rush Creek	14,263	3,470	378	1,124	17,469	1,303
Sand Creek	22,396	4,029	100	779	4,996	2,783
Spring Lake / Norris Creek	5,647	13,851	1,204	3,083	4,809	3,752
Upper Flat River	69,602	28,078	2,989	9,418	7,781	20,140
Upper Rogue River	33,188	21,836	1,003	3,951	3,699	10,265
Upper Thornapple River	115,384	24,344	679	3,388	5,808	16,771
Wabasis and Beaver Dam Creek	13,469	8,516	1,108	1,611	1,236	4,183
Total:	951,791	381,710	35,812	65,133	225,252	201,047
Percent in Watershed:	**51**	**21**	**2**	**3**	**12**	**11**

2.8 POLITICAL BOUNDARIES

Community Profiles

The Watershed is contained within parts of Ottawa, Muskegon, Kent, Montcalm, Ionia, Barry, Eaton, Newaygo, Allegan, and Mecosta Counties. Located in West Michigan, the Watershed includes many larger communities which offer employment, shopping centers, and cultural activities. The LGRW contains two urban areas: the Grand Rapids Metropolitan area and the Muskegon Metropolitan area, which includes the Grand Haven, Tri-cities areas. Community profiles are described in greater detail in the Social Profile in Chapter 7.

Demographics

Major metropolitan areas account for 12 percent of the area in the Watershed. The City of Grand Rapids and the Tri-Cities area of Grand Haven, Ferrysburg, and Spring Lake are experiencing slight population growth as people are slowly moving back into urban centers. Although the population of the State of Michigan overall has declined, results of the 2010 U.S. Census should indicate the densities in urban areas are increasing. Figure 2.15 depicts total population in the Watershed. Table 2.14 illustrates 2000 U.S. Census information. Demographics of the Watershed are described in greater detail in the Social Profile in Chapter 7.

2.9 DEVELOPMENT TRENDS

The impact of this reversal of urban sprawl will be seen in a reduction of large-lot residential areas; less large shopping centers; and fewer new roads, parking lots, rooftops, and driveways that increase the LGRW's imperviousness. The urban areas will have challenges with this population growth. Aging infrastructure will be further stressed as it is needed to service more people. In addition, urban areas that own or operate a municipal separate storm sewer system (MS4) must comply with increased regulations to reduce impacts of storm water runoff. The National Pollutant Discharge Elimination System (NPDES) stormwater permits state requirements for addressing exceedances of water quality standards, provide

public education, find and eliminate illicit connections, provide construction site and post-construction stormwater controls, and conduct pollution prevention and good housekeeping measures on their properties. References to these regulations will be found throughout this document to assist the following communities that are required to have storm water permits:

- Kent County Administration and Drain Commissioner
- Kent County Road Commission
- Ottawa County Administration and Drain Commissioner
- Ottawa County Road Commission
- Allendale Charter Township
- Cascade Charter Township
- City of East Grand Rapids
- City of Ferrysburg
- Georgetown Charter Township
- City of Grand Haven
- City of Grand Rapids
- Grand Rapids Charter Township
- City of Grandville
- City of Hudsonville
- City of Kentwood
- Plainfield Charter Township
- City of Rockford
- Village of Sparta
- Village of Spring Lake
- City of Walker
- City of Wyoming

Table 2.14 – Population (2000 census)

Subwatershed Management Unit	Total Population (2000 Census)	Population Density (people/sq. mile)	Housing Density (houses/sq. mile)	% Area Within Watershed
Bass River	11,707	234.0	68.5	1.7%
Bear Creek	6,719	211.5	75.5	1.1%
Bellemy Creek	11,244	224.2	54.2	1.7%
Buck Creek	94,086	1,859.0	741.6	1.7%
Cedar Creek	3,554	76.8	35.2	1.6%
Coldwater River	14,298	75.8	28.6	6.5%
Coopers, Clear, and Black Creeks	9,256	90.6	37.0	3.5%
Crockery Creek	12,144	76.0	27.1	5.5%
Deer Creek	6,015	172.1	63.0	1.2%
Dickerson Creek	5,042	66.7	27.8	2.6%
Direct Drainage to Lower Grand River	291,053	706.1	280.3	14.2%
Fall Creek	4,524	182.5	76.0	0.9%
Glass Creek	2,582	70.3	28.9	1.3%
High Bank Creek	2,304	67.6	29.0	1.2%
Indian Mill Creek	13,671	796.9	320.0	0.6%
Lake Creek	3,041	107.1	43.8	1.0%
Libhart Creek	2,993	54.5	20.9	1.9%
Lower Flat River	16,735	135.8	52.5	4.2%
Lower Rogue River	45,543	311.6	112.9	5.0%
Lower Thornapple River	41,754	222.2	83.4	6.5%
Mill Creek	6,157	304.2	117.0	0.7%
Mud Creek	3,144	52.1	20.1	2.1%
Plaster Creek	115,497	2,028.1	776.5	2.0%
Prairie Creek	7,211	70.5	25.1	3.5%
Rush Creek	49,139	827.0	293.6	2.0%
Sand Creek	11,174	203.8	74.4	1.9%
Spring Lake/Norris Creek	15,177	299.9	122.8	1.7%
Upper Flat River	21,350	98.9	44.4	7.4%
Upper Rogue River	11,712	101.3	38.3	4.0%
Upper Thornapple River	26,533	98.4	38.0	9.3%
Wabasis and Beaver Dam Creek	5,976	126.9	48.4	1.6%
Total:	**871,335**			**100.0%**

Chapter 3 – Watershed Conditions

3.0 WATERSHED CONDITIONS

OBJECTIVES

- What are the designated and desired uses of our surface waters?
- What standards are used to judge water quality?
- What is the current condition of the Watershed?
- What are the impacts of pollutants on the Watershed?

3.1 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.

3.1.1 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 PA451, 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
- Other indigenous aquatic life and wildlife
- Warmwater fishery
- Coldwater fishery (where designated)
- Partial body contact recreation
- Total body contact recreation between May 1 and October 31
- Navigation
- Industrial water supply
- Public water supply at the point of intake

Current water quality impairments and specific threats to water quality have been 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 impaired, threatened, met or under review/unknown. Designated uses are considered impaired if the water does not meet the State's WQS. Designated uses are considered threatened when WQS may not be met in the future. Based upon data review and field assessments, the Steering Committee was able to determine the status of each designated use within the Watershed. Table 3.5 in Section 3.5 summarizes the status of each designated use.

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

<u>Agricultural</u>
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.

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 bird watching and hunting. Healthy habitats have water conditions that are capable of supporting native plant and animal species.

Warmwater Fishery

A warmwater fishery is defined by the Michigan Department of Natural Resources and Environment (MDNRE) as a water body that is capable of supporting fish species that thrive in relatively warm water, including bass, pike, walleye, and panfish, with temperatures not exceeding a monthly limit of 77°F in July and August and a dissolved oxygen (DO) level of >5 mg/L (milligrams per liter) (Creal and Wuycheck, 2002).

Coldwater Fishery

A coldwater fishery is able to support natural or stocked populations of trout and has summer water temperatures between 41°F and 55°F, with a DO >7 mg/L, and a maximum temperature of 68°F. Several designated trout streams are in the Watershed, as indicated in the Fisheries section in Section 2.6 of Chapter 2.

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 less than 1,000 counts of *Escherichia coli (E. coli)* 100 mL for recreational uses (MDNRE, 1999).

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 contact body recreation must be met between May 1 and October 31. During this time, *E. coli* must be below 130 counts per 100 mL, as a 30-day geometric mean (MDNRE, 1999).

Navigation

Waterways that provide adequate depth and width for recreational canoeing and kayaking must maintain open, navigable conditions.

Industrial Water Supply at Point of Intake

Industry depends on large quantities of cool, clean water for material washing or as a coolant. The Watershed contains 21 industrial water intakes. Intakes are for industrial, power generation, and irrigation uses.

Public Water Supply at 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. The Watershed contains no intakes for public water supply.

3.1.2 Desired Uses

Resources that are not listed as a designated use in the Part 4 Rules may still have significant local importance. These uses for the Watershed's resources have been included in this WMP as desired uses.

Part of the mission of LGROW is to maintain social and economic viability in the Watershed while supporting a healthier environment. Table 3.1 depicts desired uses identified by the Steering Committee.

Table 3.1 – Desired Uses

Desired Use	Goals
Recreation	Improve sport fisheries through stocking and habitat restoration and protection. Promote recreation within the river: canoeing, fishing, limited motor driven boating, restaurants and bars, and potentially connection to Lake Michigan. Increase the number of recreational (boating, swimming, fishing) access points and trails. Encourage linkages between trail systems. Provide for aesthetic viewscapes in the Watershed.
Habitat Preservation	Restore and protect habitat for native wildlife and aquatic species. Promote and support the "City Green" initiative to increase stream buffers and canopy cover. Restore and protect wetland areas. Establish riparian corridors and connections. Restore and protect natural stream morphology and floodplains.
Use of Natural Resources	Promote and apply alternative energy technologies. Encourage residents to reduce, reuse, and recycle. Promote energy conservation and efficiency. Promote the West Michigan Sustainable Purchasing Consortium to encourage the use of recycled paper products.
Planning and Development	Increase accessibility to natural features, in part by, connecting the public transit system to green spaces. Reduce urban/suburban heat islands through "greening" of the Watershed. Encourage urban planning and environmentally friendly development guidelines. Preserve Green Space in undeveloped adjacent areas. Promote development in commercial areas facing and along the river rather than backing up to river, the desired use of the river would be as a focal point. Incorporate flood protection into master recreation and access plan
Education	Encourage citizen awareness and stewardship. Target key Watershed stakeholders, including the agricultural community, local governments, and schools.
Other	Promote efforts to buy and produce locally grown food. Promote the arts in coordination with fundraising opportunities. Develop regional indicators to evaluate our progress at meeting desired uses. Change public perception of the Grand River. Make it a highly desired amenity.

3.2 WATER QUALITY STANDARDS

For purposes of defining water quality within this WMP, the following standards were applied:

- **Temperature:** Heat load cannot cause exceedance of monthly limits (maximum 68°F in June, July, and August for coldwater streams; and maximum 77°F in July and August [Creal and Wuycheck 2002]).
- **DO:** For coldwater streams, a 7 mg/L minimum applies and in warmwater streams a 5 mg/L minimum applies. Also, no water body can be lowered more than an additional 1 mg/L DO during warm weather seasons.
- **Total Suspended Solids:** MDNRE accepts an informal target of 80 mg/L total suspended solids for wet weather events
- **Pathogens:** Geometric daily mean of 130 count/100 mL for total body contact recreation (May 1 to October 31), Geometric daily mean of 1,000 count/100 mL for partial body contact recreation, single grab sample of 300 count/100 mL at beaches.
- **Total Phosphorus**: Total Phosphorus Water Quality Standards are 1 mg/L as a maximum monthly average from point source discharges. MDNRE may set higher or lower limits in order to meet narrative standard, which states "Nutrients shall be limited to the extent necessary to prevent stimulation of growth of aquatic rooted, attached, suspended, and floating plants, fungi, or bacteria which are or may become injurious to the designated uses of the surface waters of the state." Target nutrient values for Morrison Lake, located in the Lake Creek Subwatershed Management Unit, are based on the Total Maximum Daily Loads (TMDL): "Spring turnover period meets the target value of 0.030 mg/L over a sustained period of time and under various flow regimes". Other water bodies in the Watershed that are on the 303(d) list as having excessive nutrients, phosphorus, algal blooms, or other impairments related to nutrients will have specific standards set with the development of a TMDL Table 3.2 includes a list of those waterbodies.
- **pH:** 6.5 to 9 s.u. (standard unit).

Water quality standards, and the MDNRE rules by which they are determined, as applied to designated uses for all waters of the state can be found in Appendix 3.1.

3.3 WATERSHED INVENTORY AND CONDITIONS

An assessment of the Watershed's overall health was completed to determine water quality conditions and to identify potential pollutants entering the Lower Grand River Watershed (LGRW). Existing documents and data were reviewed for the entire LGRW, as cited in the following sections. In addition, NPS inventories were conducted in Deer Creek and Bass River to characterize water quality conditions.

3.3.1 303(d) Listed Waters

Section 303(d) of the Clean Water Act requires the Michigan Department of Environmental Quality to assess all water resources, and prepare a biennial Integrated Report on the quality of its water resources as the principal means of conveying water quality protection/monitoring information to the U.S. Environmental Protection Agency (USEPA). The Integrated Report satisfies the listing requirements of Section 303(d) and the reporting requirements of Section 305(b) and 314 of the Clean Water Act. 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. 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. Table 3.2 includes a list of stream reaches in the Watershed having an approved TMDL or scheduled for the development of a TMDL. Municipal Separate Storm Sewer System (MS4) Communities required to address the TMDLs in waterbodies within their jurisdiction are also listed. This WMP focuses on TMDLs listed in the MDNRE 2010 Integrated Report concerning sedimentation/siltation (SS), dissolved oxygen (DO), phosphorus (PHOS), *E. coli*, and bacterial slimes (BS). Figure 3.1 A-D depicts the location of these stream reaches within the Watershed. All waterbodies on the 303(d) list within the Watershed, including those with polychlorinated biphenyls (PCBs) and mercury, can be found in Appendix 3.2.

Table 3.2 – Summary of 2010 Integrated Report for Waterbodies in the LGRW

Subwatershed Management Units	Waterbody (MS4 Communitiy)	Impacted Miles/ Acres	Other Indigenous Aquatic Life & Wildlife	Other TMDL Date	Warmwater Fishery	Warmwater TMDL Date	Cold Water Fishery	Cold Water TMDL Date	Partial Body Contact Recreation	Partial TMDL Date	Total Body Contact Recreation	Total TMDL Date
Bass River	Bass River	45.3 M			NS - SS	2005			NS - E. co*li*	2005	NS - E. co*li*, SS	2005
	Bass Creek, Bass River, Bear Creek, and Little Bass Creek (Allendale Twp., George-town Twp.)	55.6 M			NS - SS	2005			NS - E. co*li*	2005	NS - E. co*li*, SS	2005
Buck Creek	Buck Creek and Pine Hill Creek (Grandville, Kentwood, Wyoming, KCDC)	11.4 M							NS - E. co*li*	2006	NS - E. co*li*	2006
Coldwater River	Little Thornapple River and Woodland Creek	24.6 M	NS - Unknown	2016								
	Tyler/Bear Creek	18.5 M							NS - E. co*li*	2005	NS - E. co*li*	2005
	Coldwater River	39.3 M							NS - E. co*li*	2005	NS - E. co*li*	2005
Coopers, Clear, and Black Creeks	Lincoln Lake Pine Resort Beach- NW of Greenville	0.2 M							NS - E. co*li*	2006	NS - E. co*li*	2006
Crockery Creek	Rio Grande Creek	31.8 M							NA		NS - E. co*li*	2003

Table 3.2 – Summary of 2010 Integrated Report for Waterbodies in the LGRW

Subwatershed Management Units	Waterbody (MS4 Community)	Impacted Miles/ Acres	Other Indigenous Aquatic Life & Wildlife	Other TMDL Date	Warmwater Fishery	Warmwater TMDL Date	Cold Water Fishery	Cold Water TMDL Date	Partial Body Contact Recreation	Partial TMDL Date	Total Body Contact Recreation	Total TMDL Date
Deer Creek	Beaver Creek, Deer Creek, and Little Deer Creek	63.6 M			NS - PHOS, DO	2012			NS - E. co*li*	2012	NS - E. co*li*	2012
Direct Drainage to Lower Grand River	York Creek (Walker, KCDC)	5.9 M					NS-AWH & SS	2005				
	Grand River (Grand Rapids, Grand Rapids, Twp., Grandville, Plainfield Twp., Walker, Wyoming, KCDC, OCDC, OCRC)	4.0 M							NS - E. co*li*	2006	NS - E. co*li*	2006
	Unnamed Tributary to Grand River	7.2 M					NS-OASA, OFRA	2016				
	Unnamed Tributary to Grand River (Grand Rapids Twp., KCDC)	3.0 M					NS - SS	2005				
	Grand River (Grand Rapids, Grand Rapids, Twp., Grandville, Plainfield Twp., Walker, Wyoming, KCDC, OCDC, OCRC)	3.0 M							NS - E. co*li*	2006	NS - E. co*li*	2006

Table 3.2 – Summary of 2010 Integrated Report for Waterbodies in the LGRW

Subwatershed Management Units	Waterbody (MS4 Community)	Impacted Miles/ Acres	Other Indigenous Aquatic Life & Wildlife	Other TMDL Date	Warmwater Fishery	Warmwater TMDL Date	Cold Water Fishery	Cold Water TMDL Date	Partial Body Contact Recreation	Partial TMDL Date	Total Body Contact Recreation	Total TMDL Date
Direct Drainage to Lower Grand River (cont.)	Maplewood Lake Park Beach	0.2 M							II		NS - E. co*li*	2021
	Ottawa Creek	7.7 M	NS - BS	2016								
	Grand River Grand Haven Boaters Park Beach	1.0 M							NS - E. co*li*	2016	NS - E. co*li*	2016
Indian Mill Creek	Indian Mill Creek	2.4 M	NS - SS	2016								
Lake Creek	Morrison Lake	294.5 A	NS- Excess Algae and PHOS	2008	NS - PHOS	2008						
Lower Thornapple River	Unnamed Tributary to Thornapple River	3.6 M	NS - BS	2016								
Mill Creek	Strawberry Creek (KCDC)	3.6 M					NS- OASA, OFRA, SS	2005				
	Mill Creek	17.6 M	NS- OASA, OFRA	NA			NS- OASA, OFRA	NA				
Mud Creek	Gravel Brook, Hagar Creek , and Mud Creek	44.1 M			NS - OASA, OFRA	NA						
Plaster Creek	Plaster Creek (Cascade Twp., Grand Rapids, Grand Rapids, Twp., Kentwood, Wyoming, KCDC	42.6 M	NS - SS	2002					NS - E. co*li*	2002	NS - E. co*li*	2002
	Little Plaster Creek, Plaster Creek, and Whisky Creek	32.5 M	NS - SS	2002					NS - E. co*li*	2002	NS - E. co*li*	2002

Table 3.2 – Summary of 2010 Integrated Report for Waterbodies in the LGRW

Subwatershed Management Units	Waterbody (MS4 Community)	Impacted Miles/ Acres	Other Indigenous Aquatic Life & Wildlife	Other TMDL Date	Warmwater Fishery	Warmwater TMDL Date	Cold Water Fishery	Cold Water TMDL Date	Partial Body Contact Recreation	Partial TMDL Date	Total Body Contact Recreation	Total TMDL Date
Rush Creek	Rush Creek	35.0 M	NS-OASA, OFRA	NA								
Sand Creek	East Fork Sand Creek and Unnamed Tributaries to East Fork Sand Creek (Walker)	22.4 M					NS-OFRA & SS	2005				
	Sand Creek (Walker)	38.0 M					NS-OFRA & SS	2005				
	Sand Creek (Walker)	24.3 M					NS-OFRA & SS	2005				
Upper Thornapple River	Unnamed Tributary to Butternut Creek	3.5 M	NS-Unknown	2016								
	Little Thornapple River	34.0 M	NS-OASA, OFRA	NA								
	Thornapple River	27.0 M			NS - DO	2023						

Notes:
NA = Not Assessed, NS = Not Supporting, II = Insufficient Data, OASA = Other anthropogenic substrate alterations, OFRA = Other flow regime alterations, SS = Sedimentation/Siltation, PHOS = Phosphorus, AWH = Alterations in wetland habitats, DO = Dissolved Oxygen, BS = Bacterial Slimes

3.3.2 Water Chemistry

Sixteen subwatershed management units within the Watershed contain stream reaches that require TMDLs. Pollutants identified as impacting these waterbodies include: sediment, *E. coli*, phosphorus, PCBs, and mercury. Bacterial slimes, alterations to wetland habitats, reduced DO, other anthropogenic substrate alterations, and other flow regime alterations were also noted as concerns. These water quality impairments have resulted in the degradation of fish and macroinvertebrate communities.

In 2005, the MDNRE collected water quality samples from 44 locations along the Lower Grand River and its tributaries. Up to 34 parameters were assessed, including total dissolved solids, total phosphorus, and nitrogen (various forms). Water quality standards were not exceeded in samples collected from the Lower Grand River. Samples from several tributaries to the Lower

Grand River, however, were elevated. Nutrient levels (i.e., ammonia, total phosphorus) at 28 locations exceeded average reference values established for the ecoregion. Elevated nutrient concentrations in Libhart, Tibbets, and Crooked Creeks were attributed to storm water runoff inputs. Agriculture practices were suspected of elevating nutrient levels in Deer Creek (MDNRE 2003).

In 2005 to 2007, monitoring teams collected water samples from Buck Creek, Plaster Creek, and Coldwater River Watersheds to conduct *E. coli* testing. The Kent County Health Department performed the analysis and several samples were also sent to MSU for Molecular Source Tracking to determine the source of *E. coli.* The results in the Coldwater River Watershed identified human sources near the Village of Freeport. Samples from other areas identified bovine sources. More information can be found in the WMPs for those watersheds.

Additional water quality data can be found at www.michigan.gov/deq by searching "water quality monitoring". Information is available on beach water monitoring, inland lakes monitoring, surface water assessments, and the MiSWIM Information Management System.

3.3.3 Biological Communities (Procedure 51)

The MDNRE conducts biological sampling using the Procedure 51 sampling protocol, typically, every five years in major Watersheds. This assessment includes a survey of the macroinvertebrate community, fishery, and habitat. The purpose of these assessments is to characterize the quality of the watercourses and to provide information necessary for making recommendations for improvements in water quality. The biological conditions of the major Subwatersheds within the Watershed are described below.

Flat River

According to the 2009 report (Walterhouse 2009), "Water quality throughout the Flat River Watershed was adequate to support excellent to acceptable biological communities at locations with suitable riparian and in-stream habitat. Compared to other Watersheds in southern Michigan, the degree of historic channelization and dredging of many of the streams, particularly the headwater streams, and the draining of wetlands is limited in the Flat River Watershed. The Flat River Natural River Plan (MDNR, 1979) provides an outline for preservation of the Watershed and contains suggested management controls and guidelines for management of the Flat River and tributaries."

Grand River

In 2005, the MDNRE conducted biological assessments of the Lower Grand River and 29 of its tributaries (Rockafellow 2005). Assessments focused on watercourses from Portland downstream to Grand Haven, excluding the Rogue River, Flat River, and Thornapple River. NPS sites Nonpoint source sites of pollution were documented, such as unrestricted cattle access was observed in Libhart Creek, Sessions Creek, and Red Creek; a septic system discharge and barnyard runoff were observed to be degrading Plaster Creek at 68th Street; road stream crossing impacts were also noted in Plaster Creek; gully erosion along M-21 was contributing excessive sediment to Timberland Creek; steep gravel roads adjacent to Toles Creek were contributing sediment loads; rapid development within the Honey Creek Subwatershed was noted as increasing the potential for sediment loading; an unstable hydrologic regime was documented in York Creek and attributed to the high percentage of impervious surfaces, and as a result, gully and streambank erosion were evident in York Creek; the highest nutrient concentrations were documented in Deer Creek and sources were attributed to dairy operation, manure runoff, and agricultural practices.

In 2009, the MDNRE collected macroinvertebrate samples at 35 stations along the Lower Grand River and its tributaries. Only the north branch of Crockery Creek (24th Avenue) was found to have a poor macroinvertebrate community. Other stations were rated as acceptable or excellent based on this data. The final biosurvey report was not available for this plan, but is due for completion in 2010.

Rogue River

According to the 2009 report (Walterhouse 2009), "Water quality throughout the Rogue River Watershed was adequate to support excellent to acceptable biological communities at locations with suitable riparian and in-stream habitat. Compared to other Watersheds in southern Michigan, the degree of historic channelization and dredging of the main stem and its tributaries is limited, with the major exception of the headwaters of the Rogue River in Newaygo County. The draining of wetlands is also limited in the Rogue River Watershed compared to other Watersheds in southern Michigan." The approved includes more in-depth information about the condition of the watershed.

Thornapple River

According to the 2008 report (Rippke 2009), "Habitat scores ranged from poor at one site (Station 16) to excellent at three sites (Stations 5, 13, and 24). In general, flow flashiness, low frequency of riffles and bends, lack of channel sinuosity, and high sediment deposition were noted as problems at poor and marginal sites. All of these are symptoms caused by the channelization and straightening of the water bodies, particularly in headwaters. At stations where habitat was determined to be marginal, channel alteration was consistently noted as a problem and was often accompanied by a narrow or absent vegetated riparian buffer." Habitat at the three locations with excellent habitat scores was characterized by ample exposed cobble and woody debris. The 2008 report also stated that "Macroinvertebrate communities were sampled at 36 sites and scored excellent at 5 sites, acceptable at 27 sites, marginal at 1 site, and poor at 3 sites." The poor macroinvertebrate community ratings indicate that those 3 stream reaches, Little Thornapple River at M-43, Little Thornapple River at Vermontville Hwy, and Church Drain at Stewart Road, may not be attaining the "other indigenous aquatic life and wildlife" designated use. The approved Coldwater River Watershed Management Plan includes more in-depth information about the condition of the watershed.

Subwatershed Management Units

Biological assessments for Subwatershed Management Units in the Watershed can be found at http://www.michigan.gov/deq/0,1607,7-135-3313_3686_3728-54941--,00.html. The approved Watershed Management Plans for Buck Creek, Plaster Creek, and Sand Creek provide more information for those watersheds.

Additional information on studies and reports for each Subwatershed Management Unit can be found in the Watershed Assessment Matrix (http://www.gvsu.edu/wri/isc/lower-grand-watershed-interactive-tool-wit-create-a-watershed-management-plan-32.htm) and in the Subwatershed Management Unit Summary Sheets in Appendix 4.1.

3.3.4 Stream Inventory

As part of this project, the Annis Water Resources Institute completed NPS pollution inventories of Deer Creek and Bass River during the summer of 2009. The data sheet template, as well as detailed results of the inventory, can be found in Appendix 3.3. A number of additional stream inventories have been completed in the Watershed by the MDNRE and other environmental organizations. Stream assessments completed within the past 10 years are illustrated in Figure 3.2. The specific locations of NPS sites can be found on the Subwatershed Management Unit Summary Sheets in Appendix 4.1. Table 3.3 indicates the number and categories of NPS pollutant sites that were identified. The greatest sources of NPS pollution were the debris/trash/obstructions and urban/residential categories.

Table 3.3 – NPS Inventory Summary

Pollutant Source	Number of Sites per Subwatershed Management Unit										
	Plaster Creek[1]	Buck Creek[2]	Coldwater River[3]	Indian Mill Creek[4]	Sand Creek[5]	Upper and Lower Rogue River[6]	Upper and Lower Thornapple River[7]	Spring Lake[8]	Deer Creek[9]	Bass River[9]	Total
Nonpoint Agriculture Source	2		1	9	3	9	127		9	16	**176**
Streambank Erosion	8	16	1	16	19	1	42	7	2		**112**
Tile Outlet	2	2		5	3			62	4	2	**80**
Livestock Access		1	15	1	5	7	14		4		**47**
Debris/Trash/Obstructions	41	60	60	37	6		122				**326**
Urban/Residential	14	12	2	59	39		42		7	19	**194**
Construction	6	4		1					2		**13**
Other	4					6					**10**
Gully Erosion	1	3	4	1	6						**15**
Rill Erosion				3							**3**
Downcutting					1	4					**5**
Stream Crossing/Road Stream Crossing	6	1			13	5	170	13	2	1	**211**
Total NPS Sites	**84**	**99**	**83**	**132**	**95**	**32**	**517**	**82**	**30**	**38**	**1,192**

[1] Grand Valley Metropolitan Council (GVMC), Plaster Creek Watershed Management Plan, 2008

[2] GVMC, Buck Creek Watershed Management Plan, 2004.

[3] GVMC, Coldwater River Watershed Management Plan, April 2009.

[4] Sievert, Mary & Janice Tompkins. 2010. Summary of Indian Mill Creek Watershed Assessment. MNDRE, Field Operation Section, Water Division, Grand Rapids, MI.

[5] GVMC, Sand Creek Watershed Management Plan, July 2004.

[6] Annis Water Resources Institute, Rogue River Watershed Management Plan, December 2000.

[7] Barry Conservation District, Thornapple River Watershed Management Plan Draft, July 2009.

[8] Progressive AE. *Spring Lake Watershed Management Plan*. 2001

[9] Inventory of main branches of Deer Creek and Bass River was completed for this project.

3.3.5 Hydrologic Study

As part of this project, a hydrologic report for the LGRW was completed, including Michigan state-wide rating curves for extended detention control of the stream protection volume (Appendix 3.4). The focus of this study was to evaluate the impact urban development has on the stability of stream channels in the Watershed. More specifically, the intent was to compare the erosion potential of several common storm water management approaches for stream protection, to ensure that effective controls are being requested by local units of government within the Watershed. Several conclusions and recommendations were made as a result of this study.

This study concluded that both low impact development (LID) based retention practices and extended detention of storm water runoff can be effective tools for maintaining the stability of receiving stream channels in the Watershed. Since LID based retention practices seek to return the site hydrology to pre-developed conditions, it should be considered the preferred approach. If site or soil conditions do not allow full implementation of LID based practices, then extended detention, or a combination of LID and extended detention, should be used. The report also provided a set of rating curves which can be used to size extended detention basins. The report recommends that:

- LID based retention practices be the first priority for local storm water rules and ordinances for site development,
- Communities can choose to include extended detention as an alternative when site or soil conditions preclude effective use of LID based practices, and
- Communities adopt the rating curves to size extended detention basins.

3.3.6 Landscape-Level Wetland Functional Assessment

The MDNRE and AWRI completed a Landscape Level Wetland Functional Assessment (LLWFA) of all existing and historically lost wetlands in the Watershed. This methodology inventoried existing wetlands and determined what functions they are performing based on a possible list of 13 functions. Wetland functions include storing floodwater, providing wildlife habitat, and capturing sediment and nutrients, among others. In addition, historically lost wetlands were reviewed to determine the functions they once provided. The status and trends of wetland functions in the Watershed could then be determined. Appendix 3.5 includes a summary of the status and trends of wetland functions in the Watershed.

Results from the LLWFA indicated that 42% of wetlands have been lost in the Watershed since European settlement. Average wetland size has been reduced from 17 acres to 4.5 acres. The functions of shoreline stabilization (-62%) and sediment and other particulate retention (-59%) have experienced the largest losses in acreage. Other highlights of the project are as follows (AWRI, 2010):

- The greatest loss of wetland acreage occurred in the following Subwatershed Management Units:
  1) Direct drainage to the Grand River
  2) Upper Thornapple River
  3) Crockery Creek
  4) Coldwater River
  5) Bass River
- The highest percent loss of wetlands occurred in the following Subwatershed Management Units:
  1) Bass River
  2) Libhart Creek
  3) Rush Creek
  4) Buck Creek
  5) Spring Lake/Norris Creek

- In terms of the loss of wetland acreage by ecosystem function, the most impacted ecological services are:
  1) interior forest bird habitat
  2) floodwater storage
  3) nutrient transformation
  4) sediment and other particulate retention
  5) stream shading
- In terms of the loss of functional capacity, the most impacted ecological services are:
  1) sediment and other particulate retention
  2) interior forest bird habitat
  3) stream shading
  4) floodwater storage
  5) nutrient transformation
- The most abundant vegetated wetlands today are the forested wetlands (108,274 acres or 56% of all vegetated wetlands). The watershed has lost 233,545 acres of forested wetlands, a 68% reduction from Pre-European settlement times
- Emergent marsh (27%) and scrub shrub wetlands (16%) account for 53,183 and 30,476 acres, respectively, of current day vegetated wetlands in the watershed
- The topographic location or geomorphic setting of today's wetlands are terrene (i.e. surrounded by uplands: 45%), lotic stream (i.e., small creeks: 41%), lotic river (i.e.,large rivers: 9%), and lentic (i.e., lakes: 5%)
- Approximately 36% of terrene wetlands, 86% of lotic stream wetlands, and 57% of lentic wetlands are in a headwater position
- Since Pre-European settlement times, wetlands within a headwater position have been reduced from 242,533 acres to 120,297 acres, a reduction of 102%
- Overall, considering open water and vegetated wetlands, approximately 51% of all wetlands are in a headwater position
- Approximately 62% of all vegetated wetlands are in a distinct depression or basin, 25% are flat or nearly level, 8% are within a floodplain, and 3% are fringe wetlands within the banks of a river or stream, or within the shallow water zone of a lake
- In regards to hydrodynamics or water flow path, 51% of all wetlands (open water and vegetated) have water that flows into and passes through it (throughflow), 24% are isolated and have no obvious surface water connection to other wetlands or waters, 18% have water out flowing only, and 7% have bidirectional water flow where water levels fluctuate within a lake or river
- Of all lotic river or stream wetlands, 18,258 acres or 19% are impacted by draining and ditching. Of all terrene wetlands, 3,100 acres or 3.5% are impacted by draining and ditching
- Lotic stream wetlands have been reduced by 35% since Pre-European settlement times, losing approximately 43,341 acres. The mean size of the wetlands also has decreased from 37.2 acres to 12.8 acres
- Terrene wetlands have been reduced by 62% since Pre-European settlement times, losing approximately 142,536 acres. The mean size of the wetlands also has decreased from 12 acres to 3 acres

AWRI's website has the report posted that provides a description of all of the terms and more detailed information (http://www.gvsu.edu/wri/isc/lower-grand-river-watershed-wetlands-initiative-project-overview-313.htm)

Wetland Action Plans were completed for the Rogue River, Spring Lake/Norris Creek, and Dickerson Creek Subwatershed Management Units, and are included in Appendix 6.3.

3.3.7 Sewer Service Areas

Municipal sewer services are available within the metropolitan areas located in the Watershed. Outlying regions rely on individual septic systems. Historically, sanitary and storm water sewers were combined within the City of Grand Rapids. As a result, raw sewage overflowed into the Grand River during periods of heavy precipitation. In the late 1980s, the City of Grand Rapids (City) embarked on a comprehensive program to eliminate all combined sewer overflows (CSO) in the City. The result of these efforts has been

over a 99% reduction in CSOs to date with less combined sewer overflow every year. Overflows are reported as two types as part of the State of Michigan CSO reporting requirements. In-system overflows occur when a sanitary sewer becomes overloaded due to storm water. The sanitary sewer overflows to a nearby storm sewer, and the untreated mixture of storm water and sanitary sewage flows to the Grand River. The Market Avenue Retention Basin (MARB) receives overflows when the wastewater plant reaches its treatment capacity of 90 million gallons per day. This flow is a mixture of storm water and sanitary sewage. MARB can store 30 million gallons, which is sufficient for most wet weather events. When volumes exceed 30 million gallons, MARB provides settling, floatable removal, disinfection using Sodium Hypochrite, and dechlorination utilizing Sulfer BiSulfate. The overflow to the river is designated as "partially treated" and is typically comparable to the wastewater plant effluent quality. The disinfection process typically results in fecal coliform (*E. coli* is a subset of fecal coliform) counts of less than 200 colonies per 100 milliliters. Only six in-system overflow points remain in the City, and the three that overflow most often will be eliminated by the end of 2010.

Other cities in the LGRW have separate sewer systems that were built after the era of combined sewer systems. However, the Cities of Jackson and Lansing, which are upstream from the Lower Grand River Watershed, both have combined sewer overflow problems that are being addressed with sewer separation projects similar to the City of Grand Rapids.

Although sanitary sewers sometimes overflow and spill untreated wastewater into the Grand River tributaries, connections to the sanitary sewer system do eliminate chronic pathogen and nutrient problems associated with failing septic systems. A number of tributaries in the Watershed have been placed on the state 303(d) list for nonattainment of state water quality standards for pathogens, as listed in Table 3.2. This problem can be partially attributed to the high rate of septic system failure in a number of communities. Figure 3.3 illustrates the approximate number of septic systems located within the Watershed. Many more problems may exist in areas where the water is not tested for the presence of disease-causing organisms.

3.3.8 Point Source

The MDNRE provides lists of NPDES storm water and industrial permits active within the Watershed's hydrologic boundary. A complete list of point source permittees can be found at http://www.deq.state.mi.us/owis/Page/main/Home.aspx. National Pollutant Discharge Elimination System (NPDES) MS4 Storm Water permittees located in the Watershed are listed in Table 3.4.

Table 3.4 – NPDES MS4 Storm Water Permitees

County	Permittee	
Ottawa County	Allendale Charter Township	Ferrysburg
	Georgetown Charter Township	Grand Haven
	Hudsonville	Spring Lake
Kent County	Cascade Charter Township	Plainfield Township
	East Grand Rapids	Rockford
	Grand Rapids	Sparta
	Grand Rapids Charter Township	Walker
	Grandville	Wyoming
	Kentwood	

3.4 WATERSHED POLLUTANT SUMMARY

Seven impairments have been identified as having an impact on designated uses of the Watershed. Provided below is a brief description of these impairments and the degradation they impose on the designated uses.

Impacts of Sediment on Designated Uses

The deposition of an excessive amount of sediment in a stream covers spawning habitat and generally degrades the aquatic habitat of fish and macroinvertebrate species. Excessive sediment also carries and deposits nutrients, impedes navigation of the watercourse, and degrades industrial water supplies.

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 not 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 Unstable Hydrology on Designated Uses

Unnatural changes in stream flow or discharge (volume rate of water flow) can alter a stream's hydrologic regime. Aquatic habitats can subsequently become modified, resulting in degraded fish and invertebrate communities. These communities can be dominated by species tolerant to degraded conditions and, therefore, lack diversity and richness.

Impacts of Thermal Pollution on Designated Uses

Thermal pollution occurs when a waterbody is greatly influenced by an influx of water above or below its natural temperature, usually making the waterbody warmer. Thermal pollution can result in both increased water temperatures and reduced DO levels. This is detrimental to the aquatic life, especially if the water temperature historically supports a coldwater fishery and can no longer do so because of temperature increase. Extended or frequent detention of storm water could potentially create shallow ponds that heat up and have thermal impacts to streams.

Impacts of Chemicals on Designated Uses

Chemicals, such as pesticides, herbicides, and road salts, can leach through the soil and enter the groundwater and surface water, and may have negative impacts on wildlife. Certain chemicals also cause other environmental problems such as increased health risks or drinking water problems. Storm water runoff causes large concentrations of chemical contaminants to enter the water within a short time period.

Impacts of Habitat Fragmentation on Designated Uses

Habitat loss is a major concern for restoring and protecting wildlife and aquatic life. As wetland habitats become fragmented they lose their assimilative functions. Destruction and loss of habitat greatly impede plant and animal species, and can ultimately leave them without shelter or food sources. As habitat continues to degrade, populations will decrease and may cease to exist.

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 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 a serious health problem and an indicator of other serious pathogens and disease-carrying organisms. For this reason, surface waters utilized for agricultural uses (e.g., irrigation, livestock watering, and produce spraying) should not contain elevated levels of pathogens.

3.5 DESIGNATED USE SUMMARY

The Integrated Report determined the impairment status of the designated uses for all 31 Subwatershed Management Units. Field assessments, data reviews, and pollution assessments, as described previously in this WMP, were used by the Steering Committee to determine if a designated use was threatened. Table 3.5 depicts the status of each designated as either met (M), impaired (I) or threatened (T) and identifies the pollutant causing the impairment or threat.

Table 3.5 – Status of Designated Uses

Subwatershed Management Units	Agriculture	Other Indigenous Aquatic Life & Wildlife	Warmwater Fishery	Coldwater Fishery	Partial Body Contact Recreation	Total Body Contact Recreation	Navigation	Industrial Water Supply*	Public Water Supply
Bass River	Met	Threatened by Sediment, Nutrients	Impaired by Sediment; Threatened by Nutrients	Not Assessed	Impaired by *E. coli*	Impaired by *E. coli*, Sediment	Met	Not a Use	Not Assessed
Bear Creek	Met	Met	Not Assessed	Met	Not Assessed	Not Assessed	Met	Not a Use	Not Assessed
Bellemy Creek	Met	Met	Not Assessed	Not Assessed	Not Assessed	Not Assessed	Met	Not a Use	Not Assessed
Buck Creek	Met	Threatened by Sediment	Threatened by Sediment, Nutrients	Threatened by Sediment, Nutrients, Road Salt	Impaired by *E. coli*	Impaired by *E. coli*	Met	Not a Use	Not Assessed
Cedar Creek	Met	Met	Not Assessed	Not Assessed	Not Assessed	Not Assessed	Met	Not a Use	Not Assessed
Coldwater River	Met	Impairment Unknown; Threatened by Sediment, Nutrients, Hydrology	Threatened by Sediment, Hydrology	Threatened by Sediment, Nutrients, Temperature, Hydrology	Impaired by *E. coli*	Impaired by *E. coli*	Met	Not a Use	Not Assessed
Coopers, Clear, and Black Creeks	Met	Met/Not Assessed	Not Assessed	Not Assessed	Impaired by *E. coli*	Impaired by *E. coli*	Met	Not a Use	Not Assessed
Crockery Creek	Met	Threatened by hydrology	Not Assessed	Not Assessed	Not Assessed	Impaired by *E. coli*	Met	Not a Use	Not Assessed

Table 3.5 – Status of Designated Uses

Subwatershed Management Units	Agriculture	Other Indigenous Aquatic Life & Wildlife	Warmwater Fishery	Coldwater Fishery	Partial Body Contact Recreation	Total Body Contact Recreation	Navigation	Industrial Water Supply*	Public Water Supply
Deer Creek	Met	Threatened by Sediment, Nutrients	Impaired by Phosphorus and Low Dissolved Oxygen; Threatened by Sediment	Not Assessed	Impaired by *E. coli*	Impaired by *E. coli*	Met	Not a Use	Not Assessed
Dickerson Creek	Met	Met	Not Assessed	Not Assessed	Not Assessed	Not Assessed	Met	Not a Use	Not Assessed
Direct Drainage to Lower Grand River	Met	Impaired by Bacterial Slimes; Threatened by Hydrology	Threatened by Hydrology	Impaired by Altered Wetland Habitat, Sediment, OASA, OFRA; Threatened by Hydrology	Impaired by *E. coli (except insufficient Info for Maplewood Lake)*	Impaired by *E. coli*	Met	Met	Not Assessed
Fall Creek	Met	Met	Not Assessed	Not Assessed	Not Assessed	Not Assessed	Met	Not a Use	Not Assessed
Glass Creek	Met	Met	Not Assessed	Met	Not Assessed	Not Assessed	Met	Not a Use	Not Assessed
High Bank Creek	Met	Met	Not Assessed	Not Assessed	Not Assessed	Not Assessed	Met	Not a Use	Not Assessed
Indian Mill Creek	Met	Impaired by Sediment	Not Assessed	Threatened by Sediment	Not Assessed	Not Assessed	Met	Not a Use	Not Assessed
Lake Creek	Met	Impaired by Excess Algae and Phosphorus	Impaired by Phosphorus	Not Assessed	Not Assessed	Not Assessed	Met	Not a Use	Not Assessed

Table 3.5 – Status of Designated Uses

Subwatershed Management Units	Agriculture	Other Indigenous Aquatic Life & Wildlife	Warmwater Fishery	Coldwater Fishery	Partial Body Contact Recreation	Total Body Contact Recreation	Navigation	Industrial Water Supply*	Public Water Supply
Libhart Creek	Met	Met	Not Assessed	Not Assessed	Not Assessed	Not Assessed	Met	Not a Use	Not Assessed
Lower Flat River	Met	Met/Insufficient Information	Met/Not Assessed	Not Assessed	Not Assessed	Not Assessed	Met	Not a Use	Not Assessed
Lower Rogue River	Met	Met/Not Assessed	Threatened by Sediment, Nutrients, Hydrology	Threatened by Sediment, Nutrients, Temperature, Hydrology	Threatened by *E. coli*	Threatened by *E. coli*	Met	Met	Not Assessed
Lower Thornapple River	Met	Impaired by Bacterial Slimes; Threatened by Hydrology	Met/Not Assessed/Insufficient Information	Not Assessed	Threatened by *E. coli*	Threatened by *E. coli*	Met	Not a Use	Not Assessed
Mill Creek	Met	Impaired by OASA, OFRA	Not Assessed	Impaired by OASA, OFRA, & Sediment	Not Assessed	Not Assessed	Met	Not a Use	Not Assessed
Mud Creek	Met	Met	Impaired by OASA, OFRA	Not Assessed	Not Assessed	Not Assessed	Met	Not a Use	Not Assessed
Plaster Creek	Met	Impaired by Sediment; Threatened by Nutrients, Temperature, Hydrology	Threatened by Sediment, Nutrients, Temperature, Hydrology	Not Assessed	Impaired by *E. coli*	Impaired by *E. coli*	Met	Not a Use	Not Assessed

Table 3.5 – Status of Designated Uses

Subwatershed Management Units	Agriculture	Other Indigenous Aquatic Life & Wildlife	Warmwater Fishery	Coldwater Fishery	Partial Body Contact Recreation	Total Body Contact Recreation	Navigation	Industrial Water Supply*	Public Water Supply
Prairie Creek	Met	Met/Insufficient Information	Not Assessed	Not Assessed	Not Assessed	Not Assessed	Met	Not a Use	Not Assessed
Rush Creek	Met	Impaired by OASA, OFRA; Threatened by Hydrology	Not Assessed	Not Assessed	Not Assessed	Not Assessed	Met	Not a Use	Not Assessed
Sand Creek	Met	Threatened by Sediment, Nutrients, Temperature, Hydrology	Not Assessed	Impaired by OFRA & Sediment, Threatened by Nutrients, Temperature, Hydrology	Threatened by *E. coli*	Threatened by *E. coli*	Met	Not a Use	Not Assessed
Spring Lake / Norris Creek	Met	Threatened by Sediment, Nutrients	Threatened by Sediment, Nutrients	Not Assessed	Threatened by *E. coli*	Threatened by *E. coli*	Met	Met	Not Assessed
Upper Flat River	Met	Met	Not Assessed	Not Assessed	Not Assessed	Not Assessed	Met	Not a Use	Not Assessed
Upper Rogue River	Met	Met/Insufficient Information	Threatened by Sediment, Nutrients, Hydrology	Threatened by Sediment, Nutrients, Temperature, Hydrology	Threatened by *E. coli*	Threatened by *E. coli*	Met	Not a Use	Not Assessed

Table 3.5 – Status of Designated Uses

Subwatershed Management Units	Agriculture	Other Indigenous Aquatic Life & Wildlife	Warmwater Fishery	Coldwater Fishery	Partial Body Contact Recreation	Total Body Contact Recreation	Navigation	Industrial Water Supply*	Public Water Supply
Upper Thornapple River	Met	Impaired by OASA, OFRA; Threatened by Hydrology	Impaired by Low Dissolved Oxygen; Threatened by Hydrology	Not Assessed	Threatened by *E. coli*	Threatened by *E. coli*	Met	Not a Use	Not Assessed
Wabisis and Beaver Dam Creek	Met	Met/Insufficient Information	Not Assessed	Not Assessed	Not Assessed	Not Assessed	Met	Not a Use	Not Assessed

Notes: OASA = Other anthropogenic substrate alterations, OFRA = Other flow regime alterations

* Source = withdrawals registered with the MDNRE Water Use Program per correspondence with Mr. Andrew LeBaron (2/25/2010)

Chapter 4 – Identification and Prioritization of Pollutants, Sources, and Causes

4.0 IDENTIFICATION AND PRIORITIZATION OF POLLUTANTS, SOURCES, AND CAUSES

OBJECTIVES

- What are the sources/causes of the major pollutants in the Watershed?
- What areas contribute the most pollutants to the Watershed?
- In which areas would restoration have the greatest positive impact?
- Which areas are good candidates for protection?

4.1 IDENTIFYING SOURCES AND CAUSES

Once specific pollutants were identified, the focus of investigation turned to possible sources. In order to reduce the pollutants impairing the designated uses of the Watershed, it was necessary to determine where the pollutants originate as well as why the pollutant is impairing the Watershed. The sources and causes of pollutants were identified through review of Watershed inventories, studies, and reports, as previously discussed in Section 3.3, Watershed Inventory and Conditions. In addition, field investigations of Bass River and Deer Creek were conducted. The Steering Committee also provided input on the sources and causes of pollutants throughout the project. By identifying the cause of the pollutant source, implementation efforts can be directed to correct the condition that is generating the pollutant. This helps to ensure the most appropriate designs and successful control measures are implemented or installed.

4.2 NONPOINT SOURCES

To identify sources of nonpoint pollution, field investigations were conducted and existing Watershed inventories, studies, and reports were reviewed. Assessment focused on impairments identified in the State's 303(d) Integrated Report and the pollutants identified in Section 3.4, but any notable observations regarding other potential pollutants were also recorded. Several of the major sources of nonpoint source (NPS) pollution are discussed below.

Livestock

Beef cattle, dairy cows, hogs, and sheep are some of the livestock raised in the Watershed. Livestock operations range in size and include corporations as well as family-owned businesses. Livestock were identified as having an impact on water quality by being a source of nutrients and pathogens. Allegan, Ionia, and Ottawa Counties are ranked as the highest livestock producers in the State. The following statistics are from the 2007 USDA Census of Agriculture report (USDA, Agriculture Census, 2007); only areas with greater than 50% of area in Watershed are included.

County	Cattle	Hogs & Pigs
Allegan	44,971	195,695
Ionia	48,572	47,124
Ottawa	38,242	50,912
Barry	26,818	6,229
Kent	25,350	15,363
Eaton	10,141	6,809

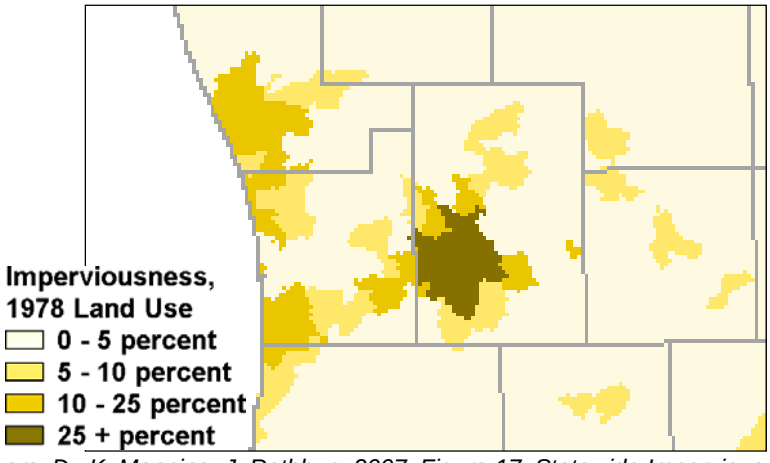
Cropland

Crops harvested in the Watershed include corn, hay, wheat, and soybeans. Croplands were identified as sources of pathogens, sediment, nutrients, chemicals, and herbicides. In addition, drainage of croplands impacts the Watershed's hydrology. A lack of stream buffers adjacent to croplands contributes to elevated stream temperatures. Specific information about cropland is the Watershed is below (USDA, Agriculture Census, 2007); only areas with greater than 50% of area in Watershed are included.

County	Total Acres of Cropland	Total Acres of Orchards	Number of Farms
Allegan	226,541	2,060	1,595
Ionia	193,376	772	1,183
Eaton	176,885	78	1,231
Kent	131,529	9,881	1,193
Ottawa	130,023	4,360	1,451
Barry	119,985	35	1,164

Impervious Surfaces

Urban runoff from impervious surfaces contributes excessive sediment and nutrients to surface waters of the Watershed and has been undeniably linked with increased flashiness (Fongers, 2008). Table 2.13 lists the urban land use as 12% of the Watershed, or 225,252 acres. Large volumes of storm water runoff impact the natural hydrology within several subwatershed management units. The MDNRE has conducted hydrologic studies in several subwatershed management units to relate the amount of imperviousness in a Watershed to the contribution of urban runoff to streams. A study was completed in Indian Mill Creek Watershed in 2010 to better understand the Watershed's hydrologic characteristics (Fongers, 2010).The percent of imperviousness in the urban areas of the Watershed ranged from 20% to 85%. A study was completed in Strawberry Creek (Mill Creek subwatershed management unit) to "better understand the watershed's hydrologic characteristics and reported continued channel instability subsequent to a streambank stabilization project." (Fongers, 2008). Strawberry Creek's percent of imperviousness in the urban areas ranges from 35% to 95%. The image below illustrates the percent imperviousness in the counties within the Lower Grand River Watershed. The Grand Rapids metropolitan area shows greater than 25% imperviousness. More information is given in Section 4.3.



(Source: Fongers, D., K. Manning. J. Rathbun. 2007. Figure 17–Statewide Imperviousness, 1978 Land Use)

Construction Sites

Soil exposed by vegetative disturbance of land clearing and grading, when not protected by proper soil erosion and sedimentation practices, makes its way into waterbodies through wind and water erosion. Municipal Separate Storm Sewer System (MS4) communities are addressing this issue as part of the National Pollutant Discharge Elimination System (NPDES) storm water permit, but construction practices in nonpermitted communities should have the same level of enforcement to minimize the impact to waterbodies

Illicit Connections to Storm Sewers

A connection to a storm sewer or other storm water conveyance system is considered “illicit” when it contains anything other than storm water, requires treatment before it is discharged, or if it should be routed to a sanitary sewer. MS4 communities have screened their storm sewer discharges for illicit connections, and all of those found in the initial screening have been addressed. Screening will occur again in the summer of 2011 in the MS4 communities.

Septic Systems

Septic systems were identified as a source of pathogens and nutrients due to aging systems and improper maintenance. The density of septic systems within the Watershed is illustrated in Figure 3.3. The Barry-Eaton District Health Department (BEDHD) is the only agency in the Watershed to have developed regulations that govern the inspection of septic systems at time of sale or transfer (TOST). The 12-month report on the finding of the enforcement of the TOST program found that it has been an effective tool in identifying and correcting public health hazards. Prior to the enactment of the regulation, the Environmental Health Division forecasted a 10% failure rate based on inspections performed, upon request, by BEDHD. The overall incidence of failure realized in the first twelve months under the TOST program is 23%. The actual failure rate can be associated with the fact that “all transfers are now evaluated and that those evaluations are being performed by qualified people under established evaluation criteria with direct oversight by BEDHD.” (BEDHD, 2008)

In late 2008, the Kent County Board of Commissioners established a Subcommittee to review septic issues. The Subcommittee’s charge and purpose was to review ordinances around the state, benchmark best practices, and make a recommendation to the Legislative Committee regarding how the County should proceed on these issues. Over the past year, the Subcommittee has interviewed several stakeholders, reviewed ordinances across Michigan, spent several meetings discussing potential options, and attempted to quantify/compare the known data with other sources. As of August 2010, the Subcommittee is preparing a report to release this year with various recommendations. At this time, it is not known what those recommendations may be. The impacts of establishing some type of ordinance are under review. It is expected that the report and recommendations will be released in fall 2010. Exhibit 4.1 illustrates where septic systems were repaired between 2005 and 2010.

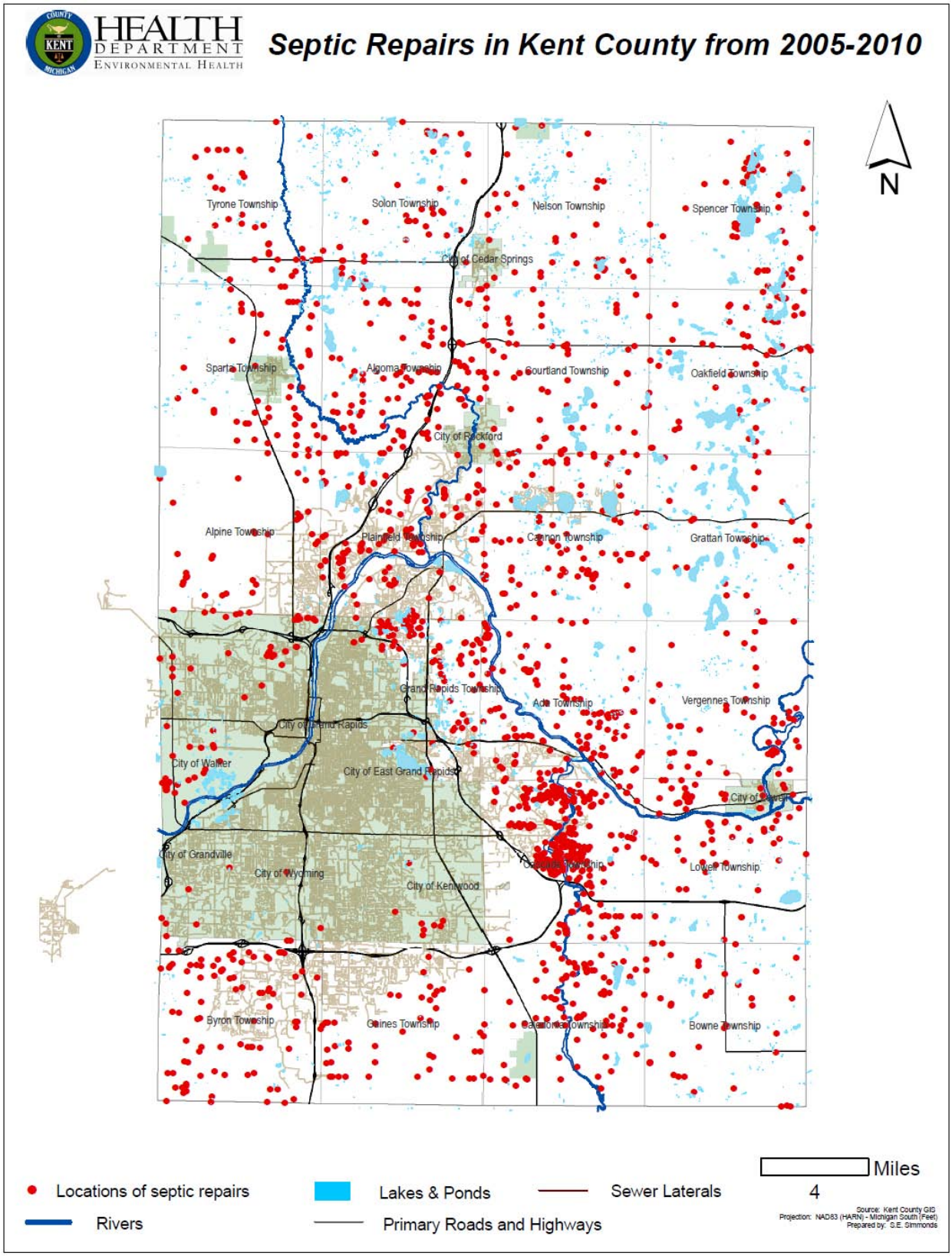


Exhibit 4.1 – Recent Septic System Repairs in Kent County

Channelization

Manmade alterations to drainage patterns, and land use changes resulting in a net loss of natural areas, affect a stream's natural hydrology. Hydrologic changes that increase a stream's flow cause channel instability, leading to increased erosion.

Streambank Erosion

Streambanks were identified as a source of excessive sediment due to unstable hydrology, livestock access, and removal of riparian vegetation. Excessive sediment can cover aquatic habitats, impacting the feeding and reproduction of fish and wildlife communities.

A comprehensive summary of pollutants identified throughout the Watershed can be found in Table 4.1. The status of impaired and threatened designated uses and the impacted subwatershed management units are listed. Table 4.1 also prioritizes pollutants of concern contributing to the degradation of the designated uses and their known or suspected sources and causes. The Watershed Management Plan (WMP) Review 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. The pollutants, sources, and causes are identified as known (k) if they were documented in an existing Watershed inventory, study, or report. Pollutants, sources, and causes were identified as suspected (s) if indications or impacts were observed, but were not measured. Pollutants, sources, and causes were identified as potential (p) if conditions were typical for pollutants, sources, and causes to exist, but none were observed. Additional inventories should be conducted within 5 years to reassess the Watershed and determine if suspected or potential sources have become known.

Table 4.1 – Pollutant Sources and Causes of Impairments

Pollutant of Concern (by priority)	Designated Use	Subwatershed Management Unit Affected by Pollutant (bold = MS4 Community)	Source of Pollution (by priority)	Cause of Pollutants (by priority)	Documented Presence in Watershed
1. Pathogens and Bacteria (k)	Total Body Contact Recreation (I/T); Partial Body Contact Recreation (I/T)	*Impaired Uses:* **Bass River; Buck Creek; Direct Drainage to Lower Grand River; Plaster Creek;** Coldwater River; Coopers, Clear, and Black Creeks; Crockery Creek; Deer Creek *Threatened Uses:* Upper/Lower Rogue River; Spring Lake/Norris Creek; Sand Creek. Upper/Lower Thornapple	1. Cropland (k)	1. Over or improper application of manure (k)	951,791 acres of cropland in LGRW; 176 animal agriculture facilities in LGRW
			2. Livestock (k)	1. Uncontrolled access (k)	47 livestock access sites identified in NPS inventories
				2. Lack of buffer or setback at holding facilities adjacent channel (k)	47 livestock access sites identified in NPS inventories
			3. Septic tanks (k)	1. Aging systems (k)	86,694 septic systems in the LGRW, reported in 1990 census
				2. Lack of septic system regulation (k)	No septage ordinances in the LGRW. Septic system regulations exist only in Barry and Eaton Counties.
			4. Ducks and geese (k)	1. Maintained lawn to edge of water (k)	*1,203 miles of unvegetated riparian area in LGRW
				2. Overpopulation of waterfowl (k)	*1,203 miles of unvegetated riparian area in LGRW
			5. Sanitary sewer (s)	1. Aging/leaking sanitary sewer (s)	Miles of aging/leaking sanitary sewer to be determined
2. Sediment (k)	Warm Water Fishery (I/T); Other Indigenous Aquatic Life and Wildlife (I/T); Cold Water Fishery (I/T)	*Impaired Uses:* **Bass River; Direct Drainage to Lower Grand River (York Creek)**; **Mill Creek (Strawberry Creek); Plaster Creek;** Coldwater River; Indian Mill Creek; Mud Creek; Sand Creek *Threatened Uses:* Deer Creek; Buck Creek; Upper/Lower Rogue River; Spring Lake/Norris Creek	1. Cropland (k)	1. Tillage practices (k)	951,791 acres of cropland in LGRW
				2. Lack of buffers (k)	*1,203 miles of unvegetated riparian area in Watershed
				3. Dense drainage network (k)	4,457 miles of streams/drains in the LGRW
			2. Urban landscapes (k)	1. Impervious surfaces (k)	225,252 acres of urban land in the LGRW
				2. Dense drainage network (k)	4,457 miles of streams/drains in the LGRW

Table 4.1 – Pollutant Sources and Causes of Impairments

Pollutant of Concern (by priority)	Designated Use	Subwatershed Management Unit Affected by Pollutant (bold = MS4 Community)	Source of Pollution (by priority)	Cause of Pollutants (by priority)	Documented Presence in Watershed
				3. Construction sites (k)	13 construction sites identified during NPS inventories
			3. Streambanks (k)	1. Altered morphology and hydrology (k)	112 sites identified in NPS inventories
				2. Uncontrolled livestock access (k)	47 livestock access sites identified in NPS inventories
				3. Removal of vegetation (k)	*1,203 miles of unvegetated riparian area in LGRW
			4. Rill and gully erosion (k)	1. Agriculture practices (k)	951,791 acres of cropland in LGRW
				2. Concentrated flow from roadside ditch (k)	211 stream crossing sites identified in NPS inventories
			5. Lakeshore erosion (k)	1. Boat traffic/seawalls/wave action (k)	339,216 ft of lake shoreline in LGRW
3. Nutrients (k)	Warm Water Fishery (I/T); Other Indigenous Aquatic Life and Wildlife (I/T); Cold Water Fishery (T)	*Impaired Uses:* Lake Creek; Deer Creek; Upper Thornapple River (Low Dissolved Oxygen) *Threatened Uses:* Bass River; Buck Creek; Coldwater River; Plaster Creek; Upper/Lower Rogue River; Spring Lake/Norris Creek; Sand Creek	1. Livestock (k)	1. Over or improper application of manure (k)	176 animal agriculture facilities
				2. Uncontrolled access (k)	47 livestock access sites identified in NPS inventories
				3. Lack of buffer or setback at holding facilities adjacent channel (k)	47 livestock access sites identified in NPS inventories
			2. Septic tanks (k)	1. Aging systems (k)	86,694 septic systems in the LGRW, reported in 1990 census
				2. Lack of septic system regulation (k)	Barry and Eaton Counties have contract with MDNRE to conduct their own inspection and enforcement activities. All other Counties default to MDNRE for those services.

Table 4.1 – Pollutant Sources and Causes of Impairments

Pollutant of Concern (by priority)	Designated Use	Subwatershed Management Unit Affected by Pollutant (bold = MS4 Community)	Source of Pollution (by priority)	Cause of Pollutants (by priority)	Documented Presence in Watershed
			3. Cropland and urban landscapes (k)	1. Over or improper application of fertilizers (k)	951,791 acres of cropland in LGRW
				2. Lack of riparian buffer (k)	*1,203 miles of unvegetated riparian area in LGRW
			4. Ducks and geese (k)	1. Maintained lawn to edge of water (k)	*1,203 miles of unvegetated riparian area in LGRW
				2. Overpopulation of waterfowl (k)	*1,203 miles of unvegetated riparian area in LGRW
			5. Sanitary sewer (s)	1. Aging/leaking sanitary sewer (s)	Miles of aging/leaking sanitary sewer to be determined
4. Unstable Hydrology (k)	Coldwater Fishery (T); Other Indigenous Aquatic Life and Wildlife (T); Warm Water Fishery (T)	*Threatened Uses:* Coldwater River; Crockery Creek; Direct Drainage to Lower Grand River; Lower/Upper Thornapple River; Plaster Creek; Upper/Lower Rogue River; Rush Creek; Sand Creek	1. Wetland loss (k)	1. Drainage/filling for agriculture/development (k)	Approximately 170,000 acres of wetlands have been drained/lost since the 1800s
			2. Tiles and drainage networks (k)	1. Agriculture land use practices (k)	951,791 acres of cropland in LGRW
				2. Urban land use practices (k)	225,252 acres of urban land in the LGRW
			3. Filling of floodplains (k)	1. Filling for agriculture/development (k)	19,447 acres of floodplain in Kent County, data for the rest of LGRW is not available
			4. Channelization (k)	1. Agricultural practices (k)	951,791 acres of cropland in LGRW
5. Temperature (k)	Coldwater Fishery (T); Other Indigenous Aquatic Life & Wildlife (T); Warm Water Fishery (T)	*Threatened Uses:* Coldwater River; Plaster Creek; Sand Creek; Upper/Lower Rogue River	1. Lack of stream canopy (k)	1. Removal of riparian vegetation (k)	*1,203 miles of unvegetated riparian area in LGRW
			2. Excessive sediment (k)	1. See causes under sediment	See documented presence in watershed under sediment.

Table 4.1 – Pollutant Sources and Causes of Impairments

Pollutant of Concern (by priority)	Designated Use	Subwatershed Management Unit Affected by Pollutant (bold = MS4 Community)	Source of Pollution (by priority)	Cause of Pollutants (by priority)	Documented Presence in Watershed
6. Habitat Fragmentation (k)	Coldwater Fishery (I); Other Indigenous Aquatic Life & Wildlife (I/T); Warm Water Fishery (I/T)	*Impaired Uses:* Direct Drainage to Lower Grand River (York Creek) *Threatened Uses:* Entire Watershed	1. Destruction of habitat, including wetlands and floodplains (k)	1. Urban and agriculture development (k)	225,252 acres of urban land and 951,791 acres of agricultural land in the LGRW.
7. Chemicals (k)	Warm Water Fishery (T); Coldwater Fishery (T); Other Indigenous Aquatic Life and Wildlife (I/T)	*Impaired Uses:* Lower Thornapple *Threatened Uses:* Entire Watershed	1. Cropland (k)	1. Over or improper application of herbicides and pesticides (k)	951,791 acres of cropland in LGRW
			2. Industrial activity (k)	1. Industrial emissions and discharges (k)	10,555 acres of industrial land use in LGRW.
			3. Agriculture and urban areas (k)	1. Over or improper application of herbicides and pesticides (k)	951,791 acres of cropland in LGRW
			4. Pharmaceutical waste	1. Improper disposal of unused drugs	**80% of streams could contain trace levels of chemical compounds
8. Invasive Species	Warm Water Fishery (T); Coldwater Fishery (T); Other Indigenous Aquatic Life and Wildlife (T)	*Threatened Uses:* Entire Watershed	1. Accidental introduction	1. Man-made channels	Chicago shipping channel potential conduit for Asian Card to enter Lake Michigan and the Grand River
				2. Bait buckets and ballast water	Great Lakes shipping and boating industry
				3. Road fill	Garlic Mustard and phragmites prolific along road sides

*Miles of unbuffered channel assumes that 27% of stream length is unbuffered.
**A study by the US Geological Survey concluded that 80% of streams sampled contained detectable levels of compounds found in common medications (Yellow Jugs Old Drugs Project (http://www.greatlakescleanwater.org/)
I = Impaired
T = Threatened
k = Known
s = Suspected
p = Potential
MS4 Community = Municipal Separate Storm Sewer System permitees under National Pollutant Discharge Elimination System (NPDES) storm water regulations
High Priority = Designated Use is impaired due to the presence of a TMDL or pending TMDL (Total Maximum Daily Load)
Medium Priority = Designated use is threatened but TMDL has not been scheduled

4.3 POLLUTANT LOADING BY SUBWATERSHED

Pollutant loadings were calculated by subwatershed management unit. Pollutant loadings enable the Steering Committee to have a comprehensive understanding of which areas contribute the most pollutants into the Watershed to assist in developing corrective measures. Table 4.1a presents loadings from the NPS sites for sources of Streambank Erosion, Tile Outlet, Livestock Access Sites, Rill and Gully Erosion, and Road/Stream Crossing Sites. Pollutant loads for Bass River and Deer Creek were calculated with this project, since the inventories were completed with this current project. Loads for other SMUs were only presented in the table if they were available from previous studies or WMPs. Table 4.2 presents sediment, phosphorus, and nitrogen loadings from the NPS sites. The pollutant loadings from the NPS sites were calculated using the Michigan Department of Natural Resources and Environment (MDNRE) *Pollutant Controlled Calculations and Documentation for Section 319 Watersheds Training Manual*, June 1999.

Three different computer models were used to calculate watershed-wide pollutant loadings: High-Impact Targeting System (HIT), Soil and Water Assessment Tool (SWAT), and P-LOAD. 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 subwatershed annually and in tons per acre per year. The HIT model results were used to help prioritize the SMUs based on tons of sediment per acre per year. MSU performed the modeling, and published the results on AWRI's website (http://www.gvsu.edu/wri/isc/hit-model-home-page-317.htm). SWAT is a public domain model actively supported by the USDA Agricultural Research Service. SWAT is a river basin scale model developed to quantify the impact of land management practices on water, sediment, and agricultural chemical yield in large, complex watersheds. The SWAT model was performed by ACOE in 2006 (http://www.glc.org/tributary/models/grand.html). The results were used to help prioritize the SMUs based on tons of sediment per acre per year.

The P-LOAD model, which is a simplified, GIS-based model, was used to calculate pollutant loads for watersheds based on land use/cover, 30-year average annual precipitation, and Event Mean Concentration (EMC) values for each corresponding land use. Table 4.2 includes loadings as determined by the P-LOAD model. The P-LOAD model was run to estimate annual loads (lbs) of total suspended solids (TSS), total phosphorus (TP), and total nitrogen (TN). Land use for the Lower Grand River Watershed consisted of 1999-2001 IFMAP data for the entire Watershed. Sub-basin boundaries were used as provided by the MDNRE. The average annual precipitation for Muskegon was 32.56 inches and 36.04 for Grand Rapids, and was obtained from NOAA based on data from 1961–2000. The default value of 0.9 was used as the ratio of storms producing runoff. EMC values were obtained through a study done by the USGS in 2006 titled, *Estimation of Nonpoint-Source Loads of Total Nitrogen, Total Phosphorous, and Total Suspended Solids in the Black, Belle, and Pine River Basins, Michigan, by Use of the PLOAD Model*. The EMC and imperviousness percentage values are shown in Table 4.1b.

Table 4.1a – Sediment and Nutrient Loadings by Source - NPS Sites

Subwatershed	Sediment Loading (tons/yr)						Phosphorus Content (lbs/yr)	Nitrogen Content (lbs/yr)
	Streambank Erosion	Gully Erosion	Tile Outlet	Road/Stream Crossing	Livestock Access	Total (tons/yr)		
Rogue River (Lower & Upper Rogue)	556			1,491	99	2,146	1,826	3,652
Coldwater River	453				30	483	427	854
Plaster Creek	13.5	1.1	0.2	15.8		31	27	54
Buck Creek	18	0.3			6.6	25	21	36
Bass River			0.1	0.6		0.7	0.6	1
Indian Mill Creek	110.9	2.1			0.3	113	95	189
Deer Creek	0.1		1	0.1	6	7	6	13
TOTAL	**1,151.5**	**3.5**	**1.3**	**1507.5**	**141.9**	**2,806**	**2,396**	**4,798**

Table 4.1b – EMC and Imperviousness Percentage Values used in P-LOAD Model

Land Use/Cover	Imperviousness %	TN	TP	TSS
Residential	25	2.25	0.50	25
Commercial	80	1.92	0.34	35
Industrial	80	1.92	0.34	35
Other Developed Areas	80	1.92	0.34	35
Cropland	2	2.50	0.40	27
Orchards/Vineyards/Other	25	1.92	0.37	17
Confined Feeding/Permanent Pasture	2	2.50	0.40	27
Other Agricultural Land	2	2.31	0.39	25
Open Field	2	0.94	0.15	19
Forest	2	0.94	0.15	16
Water	100	0.65	0.08	3
Wetlands	2	0.75	0.11	8
Barren/Sand Dune	50	0.65	0.08	30
Transitional Land	50	0.65	0.08	30

Table 4.2 – Sediment and Nutrient Loading - NPS Sites & P-LOAD

Subwatershed Management Unit	Sediment			Phosphorus			Nitrogen		
	Sediment Loading NPS (tons/yr)	Sediment Loading P-LOAD Model (tons/yr)	Total Sediment Loading (NPS + P-LOAD) (tons/yr)	Phosphorus Content NPS Sites (lbs/yr)	Phosphorus Content P-LOAD (lbs/yr)	Total Phosphorus Loading (NPS + P-LOAD) (lbs/yr)	Nitrogen Content NPS Sites (lbs/yr)	Nitrogen Content P-LOAD (lbs/yr)	Total Nitrogen Content Loading (NPS + P-LOAD) (lbs/yr)
Direct Drainage to Lower Grand River		4,676	4,676		118,380	118,380		686,410	686,410
Rogue River (Lower & Upper Rogue)	2,146	1,901	4,049	1,826	49,110	50,936	3,652	287,600	291,252
Coldwater River	483	1,137	1,620	427	21,419	21,846	854	128,520	129,374
Upper Thornapple River		1,584	1,584		32,689	32,689		198,190	198,190
Lower Thornapple River		1,452	1,452		22,890	22,890		133,690	133,690
Plaster Creek	31	1,315	1,347	27	16,050	16,077	54	89,100	89,154
Upper Flat River		1,239	1,239		29,150	29,150		174,000	174,000
Buck Creek	25	1,000	1,025	21	28,040	28,061	36	153,400	153,436
Crockery Creek		850	850		18,340	18,340		107,730	107,730
Lower Flat River		833	833		24,920	24,920		144,320	144,320
Rush Creek		742	742		18,330	18,330		103,000	103,000
Coopers, Clear, and Black Creeks		637	637		16,680	16,680		100,640	100,640
Prairie Creek		600	600		23,430	23,430		143,660	143,660
Sand Creek		457	457		12,620	12,620		75,200	75,200
Dickerson Creek		422	422		16,800	16,800		101,300	101,300
Spring Lake/Norris Creek		371	371		8,930	8,930		52,600	52,600
Mud Creek		350	350		6,384	6,384		38,765	38,765
Libhart Creek		339	339		9,280	9,280		55,440	55,440
Bass River	1	302	303	0	6,380	6,380	1	38,800	38,801
Wabasis and Beaver Dam Creek		294	294		6,230	6,230		36,500	36,500
Indian Mill Creek	113	282	395	95	7,450	7,545	189	42,500	42,689
Deer Creek	7	244	251	6	3,600	3,600	13	20,900	20,913
Cedar Creek		238	238		9,690	9,690		57,600	57,600

Table 4.2 – Sediment and Nutrient Loading - NPS Sites & P-LOAD

	Sediment			Phosphorus			Nitrogen		
Subwatershed Management Unit	Sediment Loading NPS (tons/yr)	Sediment Loading P-LOAD Model (tons/yr)	Total Sediment Loading (NPS + P-LOAD) (tons/yr)	Phosphorus Content NPS Sites (lbs/yr)	Phosphorus Content P-LOAD (lbs/yr)	Total Phosphorus Loading (NPS + P-LOAD) (lbs/yr)	Nitrogen Content NPS Sites (lbs/yr)	Nitrogen Content P-LOAD (lbs/yr)	Total Nitrogen Content Loading (NPS + P-LOAD) (lbs/yr)
Bear Creek		209	209		3,690	3,690		21,600	21,600
Lake Creek		202	202		3,330	3,330		19,200	19,200
Mill Creek		200	200		7,420	7,420		43,300	43,300
Bellemy Creek		191	191		3,640	3,640		22,040	22,040
High Bank Creek		184	184		4,270	4,270		26,400	26,400
Glass Creek		168	168		1,030	1,030		6,340	6,340
Fall Creek		160	160		3,520	3,520		20,900	20,900
Total:	**2,806**	**22,579**	**25,388**	**2,396**	**533,692**	**536,088**	**4,798**	**3,129,645**	**3,134,443**

Total Maximum Daily Load (TMDL) reports are completed by the MDNRE according to the schedule in the Integrated Report to address the water bodies currently listed as impaired. Total daily loads are estimated using the L-THIA or the P-LOAD model. 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. A summary of the reports for all scheduled TMDLs are included in Appendix 3.2. Specific loadings listed in the TMDL reports calculated for certain waterbodies are listed in Table 4.2a.

Table 4.2a –Pollutant Loadings Reported in TMDL Report in Stream Reaches With Approved TMDLs

Subwatershed Management Units	HUC Codes	Waterbody	Impacted Miles/ Acres	Total Phosphorus (lbs/year)	Biota, TSS Load (tons/yr)	*E. coli* – Range of concentration, 30-Day Geometric Mean (count/100 mL)	*E. coli* – Dry Weather Sampling Results, Range of Concentration, 30-Day Geometric Mean (count/100 mL)
Bass River	04050006 0706-01	Bass Creek	45.3 M		1,357	2 - 10,389 (2005 TMDL)	
	04050006 0707-01	Bass Creek, Bass River, Bear Creek and Little Bass Creek	55.6 M				
Buck Creek	04050006 0510-02	Buck Creek and Pine Hill Creek	11.4 M			40 - 5,846 (2006 TMDL)	75 - 2,420 (Table 3.3a Buck Creek WMP Addendum 8/2007)
Coldwater River	4050007 0302-01	Little Thornapple River and Woodland Creek	24.6 M	UNKNOWN – 2016 TMDL			
	04050007 0306-01	Tyler/Bear Creek	18.5 M			25 – 814 (2005 TMDL)	
	04050007 0307-03	Coldwater River	39.3 M			56 – 547 (2005 TMDL)	11 - >2,420 (Table 4 Coldwater River WMP, 4/2009)
Coopers, Clear, and Black Creeks	04050006 0107-02	Lincoln Lake Pine Resort Beach- NW of Greenville	0.2 M			20 - 2,141 (2006 TMDL)	
Crockery Creek	04050006 0603-02	Rio Grande Creek	31.8 M			68 - 1.076 (2003 TMDL)	

Table 4.2a –Pollutant Loadings Reported in TMDL Report in Stream Reaches With Approved TMDLs

Subwatershed Management Units	HUC Codes	Waterbody	Impacted Miles/ Acres	Total Phosphorus (lbs/year)	Biota, TSS Load (tons/yr)	*E. coli* – Range of concentration, 30-Day Geometric Mean (count/100 mL)	*E. coli* – Dry Weather Sampling Results, Range of Concentration, 30-Day Geometric Mean (count/100 mL)
Direct Drainage to Lower Grand River	04050006 0507-02	York Creek	5.9 M		170		
	04050006 0507-06	Grand River	4.0 M			31 - 1,261 (2006 TMDL)	
	04050006 0512-03	Grand River	3.0 M			31 - 1,261 (2006 TMDL)	
	04050006 0705-02	Maplewood Lake Park Beach	0.2 M				
	04050006 0705-03	Ottawa Creek	7.7 M				
	04050006 0712-01	Grand River Grand Haven Boaters Park Beach	1.0 M				
Lake Creek	04050006 0311-03	Morrison Lake - S. of Rt. 96 Due S. of Saranac	294.5 A	919			
Mill Creek	04050006 0503-02	Strawberry Creek	3.6 M		103.6		
Plaster Creek	04050006 0505-02	Plaster Creek	42.6 M		1,676	216 - 6,903 (2002 TMDL)	96 - >24,200 (Table 3.1 Plaster Creek WMP, 10/2008)
	04050006 0506-02	Little Plaster Creek, Plaster Creek and Whisky Creek	32.5 M				
Sand Creek	04050006 0701-01	East Fork Sand Creek and Unnamed Tributaries to East Fork Sand Creek	22.41 M		1,733		<33 - >6000 (Table 13, Sand Creek WMP 2004)
	04050006 0702-01	Sand Creek	38.0 M				
	04050006 0703-01	Sand Creek	24.3 M				

4.4 IDENTIFICATION OF CRITICAL AREAS FOR RESTORATION

4.4.1 SUBWATERSHED MANAGEMENT UNIT PRIORITIZATION

Critical areas for restoration are those subwatershed management units that have the most potential of contributing the greatest amounts of NPS pollution which impair or threaten water quality in the Watershed. The Steering Committee ranked the subwatershed management units by their critical areas for restoration based on five categories:

1. Sediment loadings – estimated sediment loads (via streambank erosion and sedimentation) by subwatershed management unit using the average of the P-LOAD, SWAT, and HIT model results (data normalized by subwatershed management unit area).

2. Nutrient loadings – estimated nutrient loads by subwatershed management unit using the P-LOAD model (data normalized by subwatershed management unit area).

3. TMDL nonattainment reaches – subwatershed management units received one point per completed TMDL report, two points per scheduled TMDL report, and one point per pending TMDL report, thereby ranking subwatershed management units by implementation status level.

4. Wetland restoration areas (%) – wetland restoration areas based on hydric soils and presettlement land use, as determined through the Landscape Level Wetland Functional Assessment analysis.

5. NPS sites – number of known NPS sites as determined by field inventories, thereby ranking subwatershed management units by implementation status level.

Each subwatershed management unit was given a ranking under each of the five categories: 1 being the worst condition (e.g., highest number of NPS sites). All five category rankings were then averaged by subwatershed management unit to determine the final ranking. Table 4.3 shows the prioritization of subwatershed management units for restoration based on results of the five assessments listed above. The following highest priority subwatershed management units (listed alphabetically) are the most imperative for restoration due primarily to the high pollutant loadings and total number of known NPS sites.

- Buck Creek
- Direct Drainage to the Grand River
- Indian Mill Creek
- Mud Creek
- Plaster Creek
- Rush Creek
- Sand Creek
- Upper and Lower Rogue River
- Upper Thornapple River

The priorities for high, medium, and low were determined based on the results of the ranking, and are to be considered in their groupings and not according to the individual rankings. All high priorities have a total ranking of 1-10, medium priorities have a total ranking 11-20, and low priorities have rankings 21-31. Figure 4.1 depicts the critical areas for restoration.

Table 4.3 – Critical Areas for Restoration*

Subwatershed Management Unit	Sediment Load (average based on P-LOAD, SWAT, HIT)	Nutrient Load (based on P-LOAD)	TMDL Nonattainment Reaches (report status)	Wetland Restoration Areas (%)	Known NPS Sites (no.)	Average Ranking Score	Priority		Watershed Organization	MS4 Communities
Buck Creek	2	1	8	17	2	6.0	1	High		Grandville, Wyoming, Kentwood, Kent County Drain Commission, Kent County Road Commission
Upper Rogue River	4	2	16	7	7	7.2	2	High	Rogue River Watershed Council	
Upper Thornapple River	7	7	5	8	10	7.4	3	High	Thornapple River Watershed Council	
Direct Drainage to Lower Grand River	9	8	1	14	10	8.4	4	High		Allendale Township, Georgetown Township, Ferrysburg, Grand Haven, Spring Lake, Cascade Township, Plainfield Township, East Grand Rapids, Grand Rapids, Grand Rapids Township, Walker, Grandville, Wyoming, Kentwood, Kent County Drain Commission, Kent County Road Commission, Ottawa County Drain Commission, Ottawa County Road Commission

Table 4.3 – Critical Areas for Restoration*

Subwatershed Management Unit	Sediment Load (average based on P-LOAD, SWAT, HIT)	Nutrient Load (based on P-LOAD)	TMDL Nonattainment Reaches (report status)	Wetland Restoration Areas (%)	Known NPS Sites (no.)	Average Ranking Score	Priority		Watershed Organization	MS4 Communities
Plaster Creek	1	9	3	27	4	8.8	5	High	Plaster Creek Stewards	Cascade Township, East Grand Rapids, Grand Rapids, Grand Rapids Township, Wyoming, Kentwood, Kent County Drain Commission, Kent County Road Commission
Rush Creek	8	6	15	5	10	8.8	5	High		Georgetown Township, Hudsonville, Grandville, Wyoming, Kent County Drain Commission, Kent County Road Commission, Ottawa County Drain Commission, Ottawa County Road Commission
Sand Creek	12	10	8	11	3	8.8	5	High	Sand Creek Watershed Partners	Walker, Kent County Drain Commission, Kent County Road Commission
Indian Mill Creek	5	4	13	22	1	9.0	8	High	Friends of Indian Mill Creek	Grand Rapids, Walker, Kent County Drain Commission, Kent County Road Commission

Table 4.3 – Critical Areas for Restoration*

Subwatershed Management Unit	Sediment Load (average based on P-LOAD, SWAT, HIT)	Nutrient Load (based on P-LOAD)	TMDL Nonattainment Reaches (report status)	Wetland Restoration Areas (%)	Known NPS Sites (no.)	Average Ranking Score	Priority		Watershed Organization	MS4 Communities
Mud Creek	6	5	15	10	10	9.2	9	High	Thornapple River Watershed Council	
Lower Rogue River	3	2	16	20	7	9.6	10	High	Rogue River Watershed Council	Plainfield Township, Rockford, Sparta, Kent County Drain Commission, Kent County Road Commission
Prairie Creek	10	3	16	12	10	10.2	11	Medium		
Bass River	22	20	3	1	6	10.4	12	Medium		Allendale Township, Georgetown Township, Hudsonville, Ottawa County Drain Commission, Ottawa County Road Commission
Spring Lake/Norris Creek	15	14	16	2	10	11.4	13	Medium	Spring Lake-Lake Board, Rein in the Runoff Committee	Ferrysburg, Spring Lake, Ottawa County Drain Commission, Ottawa County Road Commission
Libhart Creek	19	15	16	3	10	12.6	14	Medium		
Lake Creek	13	25	8	9	10	13.0	15	Medium		
Coldwater River	23	24	2	13	5	13.4	16	Medium	Coldwater River Watershed Council, Thornapple River Watershed Council	
Coopers, Clear, and Black Creeks	20	16	8	15	10	13.8	17	Medium		
Bellemy Creek	21	23	16	4	10	14.8	18	Medium		

Table 4.3 – Critical Areas for Restoration*

Subwatershed Management Unit	Sediment Load (average based on P-LOAD, SWAT, HIT)	Nutrient Load (based on P-LOAD)	TMDL Nonattainment Reaches (report status)	Wetland Restoration Areas (%)	Known NPS Sites (no.)	Average Ranking Score	Priority		Watershed Organization	MS4 Communities
Crockery Creek	27	26	8	6	10	15.4	19	Medium		
Deer Creek	14	27	6	21	9	15.4	19	Medium		
Lower Thornapple River	11	17	13	28	10	15.8	21	Low	Thornapple River Watershed Council	Cascade Township, Kent County Drain Commission, Kent County Road Commission
Dickerson Creek	26	11	16	18	10	16.2	22	Low		
Lower Flat River	18	13	16	25	10	16.4	23	Low		
Bear Creek	17	22	16	23	10	17.6	24	Low		Kent County Drain Commission, Kent County Road Commission, Plainfield Township
Mill Creek	30	28	6	16	10	18.0	25	Low		Plainfield Township, Kent County Drain Commission, Kent County Road Commission
Fall Creek	16	18	16	31	10	18.2	26	Low	Thornapple River Watershed Council	
Upper Flat River	25	19	16	24	10	18.8	27	Low		
Cedar Creek	28	12	16	29	10	19.0	28	Low	Thornapple River Watershed Council	
High Bank Creek	24	21	16	26	10	19.4	29	Low	Thornapple River Watershed Council	
Wabasis and Beaver Dam Creek	31	30	16	19	10	21.2	30	Low		
Glass Creek	29	29	16	30	10	22.8	31	Low	Thornapple River Watershed Council	

*The process for ranking the 31 subwatershed management units by these 7 categories is explained in the narrative.

4.4.2 CRITICAL RESTORATION SITES

The identification of critical sites within the critical areas defines the sites to implement Best Management Practices (BMPs). Critical sites were identified during the field investigations conducted in the Watershed. These NPS sites are illustrated on the Subwatershed Management Unit Summary Sheets (Appendix 4.1). Assessments will be needed in the future to identify additional critical sites in subwatershed management units that have not yet been inventoried (Figure 3.2)

4.5 IDENTIFICATION OF PRIORITY AREAS FOR PRESERVATION AND PROTECTION

Priority areas for preservation and protection include subwatershed management units that have the high-quality features necessary for healthy ecosystems. The identification of critical sites within the priority areas is to target ecologically significant parcels to protect.

4.5.1 SUBWATERSHED MANAGEMENT UNIT PRIORITIZATION

The Steering Committee ranked the subwatershed management units by their priority areas for preservation and protection based on four categories:

1. Permanently protected lands (%) – lands permanently protected by the government (e.g., parkland, state game areas);
2. Existing wetlands (%) - wetland areas identified by the National Wetland Inventory;
3. Occurrence of endangered, threatened, or special concern species or rare plant communities (%) – status of species and plant communities was determined by the Michigan Natural Features Inventory (MNFI); and
4. Trout streams (%) – stream reaches designated as suitable for trout by the MDNRE.

Each subwatershed management unit was given a ranking under each of the four categories: 1 being the best condition (e.g., highest percentage of existing wetlands). All four category rankings were then averaged by subwatershed management unit to determine the final ranking. Table 4.4 shows the priority subcatchments for preservation and protection based on their existing high-quality features. Overall, the Glass Creek subwatershed management unit is the most imperative for protection and preservation due primarily to high percentage of permanently protected lands and MNFI occurrences. Figure 4.2 depicts the priority areas for preservation and protection.

Table 4.4 – Priority Areas for Preservation and Protection*

Subwatershed Management Unit	Permanently Protected Lands (%)	Existing Wetlands (%)	Michigan Natural Features Inventory (occurrences by %)	Trout Streams (%)	Average Ranking Score	Priority		Watershed Organization	MS4 Communities
Glass Creek	1	7	1	9	4.5	1	High		
Bear Creek	10	15	2	2	7.3	2	High	Bear Creek Watershed Council	Kent County Drain Commission, Kent County Road Commission, Plainfield Township
Spring Lake/Norris Creek	7	2	9	11	7.3	3	High	Spring Lake-Lake Board, Rein in the Runoff Committee	Ferrysburg, Spring Lake, Ottawa County Drain Commission, Ottawa County Road Commission
Dickerson Creek	2	1	14	15	8.0	4	High		
Mill Creek	17	12	7	3	9.8	5	High		Plainfield Township, Kent County Drain Commission, Kent County Road Commission
Upper Rogue River	3	14	11	12	10.0	6	High	Rogue River Watershed Council	
Wabasis and Beaver Dam Creek	6	13	5	26	12.5	7	High		
Cedar Creek	24	6	8	12	12.5	8	High		
Sand Creek	8	25	15	1	12.3	9	High	Sand Creek Watershed Partners	Walker, Kent County Drain Commission, Kent County Road Commission
Lower Flat River	12	8	12	20	13.0	10	High		
Lower Thornapple River	4	21	6	21	13.0	11	Medium	Thornapple River Watershed Council	Cascade Township, Kent County Drain Commission, Kent County Road Commission

Table 4.4 – Priority Areas for Preservation and Protection*

Subwatershed Management Unit	Permanently Protected Lands (%)	Existing Wetlands (%)	Michigan Natural Features Inventory (occurrences by %)	Trout Streams (%)	Average Ranking Score	Priority		Watershed Organization	MS4 Communities
Direct Drainage to Lower Grand River	5	19	13	17	13.5	12	Medium		Allendale Township, Georgetown Township, Ferrysburg, Grand Haven, Spring Lake, Cascade Township, Plainfield Township, East Grand Rapids, Grand Rapids, Grand Rapids Township, Walker, Grandville, Wyoming, Kentwood, Kent County Drain Commission, Kent County Road Commission, Ottawa County Drain Commission, Ottawa County Road Commission
Indian Mill Creek	13	31	4	6	13.5	13	Medium	Friends of Indian Mill Creek	Grand Rapids, Walker, Kent County Drain Commission, Kent County Road Commission
Lower Rogue River	11	18	20	10	14.8	14	Medium	Rogue River Watershed Council	Plainfield Township, Rockford, Sparta, Kent County Drain Commission, Kent County Road Commission
Fall Creek	20	4	10	26	15.0	15	Medium		
Coopers, Clear, and Black Creeks	19	3	17	24	15.8	16	Medium		
Buck Creek	14	29	16	7	16.5	17	Medium		Grandville, Wyoming, Kentwood, Kent County Drain Commission, Kent County Road Commission
High Bank Creek	26	5	19	18	17.0	18	Medium		
Lake Creek	23	23	18	4	17.0	19	Medium		

Table 4.4 – Priority Areas for Preservation and Protection*

Subwatershed Management Unit	Permanently Protected Lands (%)	Existing Wetlands (%)	Michigan Natural Features Inventory (occurrences by %)	Trout Streams (%)	Average Ranking Score	Priority		Watershed Organization	MS4 Communities
Upper Flat River	9	9	26	25	17.3	20	Medium		
Prairie Creek	30	11	22	8	17.8	21	Medium		
Plaster Creek	15	27	3	26	17.8	22	Medium	Plaster Creek Stewards	Cascade Township, East Grand Rapids, Grand Rapids, Grand Rapids Township, Wyoming, Kentwood, Kent County Drain Commission, Kent County Road Commission
Crockery Creek	16	17	28	16	19.3	23	Low		
Bass River	21	10	25	23	19.8	24	Low		Allendale Township, Georgetown Township, Hudsonville, Ottawa County Drain Commission, Ottawa County Road Commission
Coldwater River	18	26	23	14	20.3	25	Low	Coldwater River Watershed Council	
Bellemy Creek	25	24	31	5	21.3	26	Low		
Upper Thornapple River	27	22	21	22	23.0	27	Low	Thornapple River Watershed Council	
Deer Creek	29	20	29	19	24.3	28	Low		
Mud Creek	28	16	30	26	25.0	29	Low		
Rush Creek	22	30	24	26	25.5	30	Low		Georgetown Township, Hudsonville, Grandville, Wyoming, Kent County Drain Commission, Kent County Road Commission, Ottawa County Drain Commission, Ottawa County Road Commission
Libhart Creek	31	28	27	26	28.0	31	Low		

*The process for ranking the 31 subwatershed management units by these 6 categories is explained in the narrative.

4.5.2 PRIORITY PRESERVATION AND PROTECTION SITES

Other areas in the Watershed have protection strategies but not necessarily based on natural features or water quality.

Prime farmland soils are identified as soils that have the capacity to produce high yields. These areas are important to communities not only economically, but also for retaining the rural character desired by many. Land to preserve for farming has been identified in many communities in the Watershed and ranked as a high priority in their Master Plans. However, ensuring that the agricultural operations on these lands are not impairing water quality should also be a priority.

The MNFI conducted a Potential Conservation Areas (PCAs) study for Barry County in 2007 and Eaton County in 2008. The PCAs are defined as places on the landscape dominated by native vegetation that have various levels of potential for harboring high quality natural areas and unique natural features. These studies were not used to prioritize the Priority Areas for Presentation in the LGRW, since other counties do not have this information; however, a study completed in the other Watersheds is recommended. The PCAs in Barry County and Eaton County are identified in the Subwatershed Management Unit Summary Sheets in Appendix 4.1.

Riparian areas should be kept intact and provide connections to other areas of high quality habitat. Figure 2.13 illustrates the natural connections recommended for the Watershed. These areas correspond to the priority areas for preservation in Figure 4.2, but provide a greater level of detail as to specific sites for preservation.

When the MDNRE Fisheries Assessment for the Grand River is released to the public, a review will be conducted to identify high priority areas for fish habitat preservation. Initially, the Prairie Creek Subwatershed Management Unit has been identified as one of those areas to preserve.

Chapter 5 – Goals and Objectives of the Watershed

5.0 GOALS AND OBJECTIVES OF THE WATERSHED

OBJECTIVES

- How will designated and desired uses be supported by the WMP?
- How will the sources of NPS pollutants be addressed?
- Which tools and programs are available for preservation and conservation?

5.1 GOALS FOR THE WATERSHED

The Steering Committee used past studies, such as the Watershed Management Plans (WMPs) previously discussed in Chapter 3 reports, especially the integrated report with TMDL non-attainment reaches, and the nonpoint source (NPS) inventories, P-LOAD and HIT modeling results to determine the goals for the Lower Grand River Watershed (Watershed or LGRW). The goals are based on reducing and/or eliminating the impacts of NPS pollutants within the Watershed, restoring or maintaining the designated uses, and supporting implementation of desired uses. The goals have been developed on a Watershed-wide basis and have been prioritized based on decisions by the Steering Committee.

The following goals for the Watershed have been determined:

1. Restore and maintain waterbodies for partial body contact recreational use.
2. Restore and maintain waterbodies for total body contact recreational use.
3. Restore and maintain waterbodies for other indigenous aquatic life and wildlife use.
4. Restore and maintain waterbodies for cold water fishery use.
5. Restore and maintain waterbodies for warmwater fishery use.
6. Protect and preserve waterbodies for agricultural use.
7. Protect and preserve waterbodies for navigational use.
8. Protect and preserve waterbodies for industrial water supply.
9. Protect and preserve waterbodies for public water supply.
10. Conserve and preserve high quality areas.
11. Promote and support desired uses identified during development of this WMP, as listed in prioritized order in Table 5.1.
12. Educate stakeholders about the Watershed and the impacts that stakeholders have on the Watershed.
13. Create a sustainable strategy for implementing the WMP.

Table 5.1 relates to the goals and objectives for segments of the impaired or threatened water bodies within the Watershed, as well as to the pollutants, sources, and causes. The information presented in Table 5.1 is prioritized by pollutants, designated uses, goals, sources, causes and objectives as determined by the Steering Committee. At a meeting held in spring 2010, the Steering Committee and current Lower Grand River Organization of Watersheds (LGROW) members, reviewed the findings and information about pollutants, sources, and causes. Discussion ensued about the prioritization of pollutants. Although sediment and Escherichia Coli (*E. coli*) are both viewed as very high priority pollutants, the Committee decided that since the practices that control sediment are well known, *E. coli* should be listed as the No. 1 priority pollutant, since so little is known of how to reduce pathogens. Implementation of practices, monitoring, and education need to be concentrated on determining the best methods to reduce and control contamination from *E. coli.*

5.2 OBJECTIVES FOR THE WATERSHED GOALS

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 objectives for meeting the goals of this WMP are listed in Table 5.1 for each cause of a sources of pollutant that is impairing a designated use. The objectives are more fully described below.

5.2.1 Water Quality Impairments

Water quality objectives will be accomplished by implementing appropriate and effective Best Management Practices (BMPs) to specifically address the sources and causes of each pollutant, as described in Table 5.1.

5.2.2 Preserving and Protecting Designated Uses

The goals of preserving and protecting designated uses currently being met will be achieved by promoting the use of preservation tools. The objectives in Table 5,1, such as “implement watershed focused land-use planning, restore and protect wetlands, restore and protect floodplains and restore and protect the stream buffer and canopy will be accomplished using tools and BMPs listed in Chapter 6.” The Steering Committee discussed the objectives for preservation and protection goals with assistance from the Michigan Department of Natural Resources and Environment (MDNRE) and other land conservation groups in the Watershed, such as the Land Conservancy of West Michigan, the Nature Conservancy, and United Growth for Kent County, to identify the tools and programs available for preservation and conservation.

This objective will be accomplished by developing and implementing specific land preservation and protection measures, using the initial results of the policy review conducted at a county level for the watershed, which is discussed in Chapter 6.

5.2.3 Desired Uses

Part of the mission of LGROW is to maintain social and economic viability in the Watershed while supporting a healthier environment, which relates to many of the desired uses, as listed in Table 3.1 as recreation (access and viewscapes), habitat preservation (riparian areas and floodplains), use of natural resources (energy and climate change), planning and development (master plans and zoning), education (awareness and stewardship), and other topics (local food, community art). Some of these overlap with objectives in Table 5.1, but overall the desired uses will be addressed by developing and implementing a long-term strategy to achieve these desired uses. Table 6.2, Measurable Milestones, and Chapter 9 outline the long-term strategy and sustainability plan for the Watershed.

5.2.4 I&E Strategy

Goal 12, “Educate stakeholders about the Watershed and the impacts that stakeholders have on the Watershed”, will be addressed with the implementation of the information and education (I&E) strategy. Objectives for Goal 12 are presented in Chapter 7 - I&E Strategy.

5.2.5 Sustainable Strategy

Objectives for the Goal 13, “Create a sustainable strategy for implementing the WMP”, are presented in Chapter 9. LGROW will continue to work toward sustaining the momentum for meeting the goals and objectives established for the Watershed by supporting Watershed groups and organizations that are working toward improving water quality and the quality of life in the Lower Grand River Watershed.

Table 5.1 – Goals and Objectives

Prioritized Pollutants and Impairments to Designated Uses	Prioritized Designated Use	Prioritized Goal	Sources (by priority)	Causes (by priority)	Prioritized Objectives
1. Pathogens (Bacteria) (s)	1. Partial Body Contact Recreation (I/T) 2.Total Body Contact Recreation (I/T)	1. Restore and maintain waterbodies for partial body contact recreational use. 2. Restore and maintain waterbodies for total body contact recreational use.	1. Cropland (k)	1. Over or improper application of manure (k)	Implement manure management planning and implementation.
			2. Livestock (k)	1. Uncontrolled access (k)	Implement livestock management practices at access sites.
				2. Lack of buffer or setback at holding facilities adjacent to channel (k)	Implement vegetative buffering practices and manure management planning and implementation.
			3. Septic tanks (k)	1. Aging systems (k)	Encourage proper septic tank management.
				2. Lack of septic system regulation (k)	Encourage septage ordinance.
			4. Ducks and geese (k)	1. Maintained lawn to edge of water (k)	Implement vegetative buffering practices.
				2. Overpopulation of waterfowl (k)	Implement MDNRE population management practices.
			5. Sanitary sewer (s)	1. Aging/leaking sanitary sewer (s)	Implement sanitary sewer maintenance practices.

Table 5.1 – Goals and Objectives

Prioritized Pollutants and Impairments to Designated Uses	Prioritized Designated Use	Prioritized Goal	Sources (by priority)	Causes (by priority)	Prioritized Objectives
2. Sediment (k)	3. Other Indigenous Aquatic Life and Wildlife (I/T) 4. Cold Water Fishery (I/T) 5. Warm water Fishery (I/T)	3. Restore and maintain waterbodies for other indigenous aquatic life and wildlife use. 4. Restore and maintain waterbodies for cold water fishery use. 5. Restore and maintain waterbodies for warm water fishery use.	1. Cropland (k)	1. Tillage practices (k)	Implement cropland management practices.
				2. Lack of buffers (k)	Implement vegetative buffering practices.
				3. Dense drainage network (k)	Implement watershed focused land-use planning.
			2. Urban landscapes (k)	1. Impervious surfaces (k)	Implement Low Impact Development practices to reduce imperviousness and increase infiltration
				2. Dense drainage network (k)	Implement watershed focused land-use planning.
				3. Construction sites (k)	Implement proper soil erosion and sedimentation control techniques.
			3. Streambanks (k)	1. Altered morphology and hydrology (k)	Implement watershed focused land-use planning. Implement channel stabilization and erosion control techniques.
				2. Uncontrolled livestock access (k)	Implement livestock management practices at access sites.
				3. Removal of vegetation (k)	Implement streambank stabilization, bio-engineering, and erosion control techniques.
			4. Rill and gully erosion (k)	1. Agriculture practices (k).	Reduce and control gully erosion.
				2. Concentrated flow from roadside ditch (k)	Implement streambank stabilization and erosion control techniques.
			5. Lakeshore erosion (k)	1. Boat traffic/seawalls/wave action (k)	Reduce and control lakeshore erosion.
3. Nutrients (k)			1. Livestock (k)	1. Over or improper application of manure (k)	Implement manure management planning and implementation.

Table 5.1 – Goals and Objectives

Prioritized Pollutants and Impairments to Designated Uses	Prioritized Designated Use	Prioritized Goal	Sources (by priority)	Causes (by priority)	Prioritized Objectives
				2. Uncontrolled access (k)	Implement livestock management practices at access sites.
				3. Lack of buffer or setback at holding facilities adjacent channel (k)	Implement vegetative buffering practices and manure management planning and implementation.
			2. Septic tanks (k)	1. Aging systems (k)	Encourage proper septic tank management.
				2. Lack of septic system regulation (k)	Encourage septage ordinance.
			3. Cropland and urban landscapes (k)	1. Over or improper application of fertilizers (k)	Implement proper fertilizer application practices.
				2. Lack of riparian buffer (k)	Implement vegetative buffering practices.
			4. Ducks and geese (k)	1. Maintained lawn to edge of water (k)	Implement vegetative buffering practices.
				2. Overpopulation of waterfowl (k)	Implement MDNRE population management practices.
			5. Sanitary sewer (s)	1. Aging/leaking sanitary sewer (s)	Implement sanitary sewer maintenance practices.
4. Unstable Hydrology (k)			1. Wetland loss (k)	1. Drainage/filling for agriculture/development (k)	Restore and protect wetlands.
			2. Tiles and drainage networks (k)	1. Agriculture land use practices (k)	Minimize the impact of tiles and drainage networks on hydrology.
				2. Urban land use practices (k)	
			3. Filling of floodplains (k)	1. Filling for agriculture/development (k)	Restore and protect floodplains.

Table 5.1 – Goals and Objectives

Prioritized Pollutants and Impairments to Designated Uses	Prioritized Designated Use	Prioritized Goal	Sources (by priority)	Causes (by priority)	Prioritized Objectives
			4. Channelization (k)	1. Agricultural practices (k)	Use alternative techniques and stream restoration practices (e.g., two-stage channel design, in-stream structures) when drain maintenance is necessary.
5. Temperature (k)			1. Lack of stream canopy (k)	1. Removal of riparian vegetation (k)	Restore and protect the stream buffer and canopy.
			2. Excessive sediment (k)	1. See causes under sediment	See objectives under sediment.
6. Habitat Fragmentation (k)			1. Destruction of habitat, including wetlands and floodplains (k)	1. Urban and agriculture development (k)	Implement Watershed focused land use planning.
7. Chemicals (k)			1. Cropland (k)	1. Over or improper application of herbicides and pesticides (k)	Implement turf management practices.
			2. Industrial activity (k)	1. Industrial emissions and discharges (k)	Reduce and control industrial emissions and discharges.
			3. Agriculture and urban areas (k)	1. Over or improper application of herbicides and pesticides (k)	Implement turf management practices.
			4. Pharmaceutical waste	1. Improper disposal of unused drugs	Develop pharmaceutical waste collection mechanism
No pollutants impairing or threatening this use.	6. Agriculture (M)	6. Protect and preserve waterbodies for agricultural use.	N/A	N/A	Implement farmland conservation and preservation tools. Encourage use of Generally Accepted Agricultural Management Practices.

Table 5.1 – Goals and Objectives

Prioritized Pollutants and Impairments to Designated Uses	Prioritized Designated Use	Prioritized Goal	Sources (by priority)	Causes (by priority)	Prioritized Objectives
No pollutants impairing or threatening this use.	7. Navigation (M)	7. Protect and preserve waterbodies for navigational use.	N/A	N/A	Promote and continue to implement river friendly channel maintenance techniques and river restoration practices.
No pollutants impairing or threatening this use.	8. Industrial Water Supply (M)	8. Protect and preserve waterbodies for industrial water supply.	N/A	N/A	Continue to monitor water quality for use as industrial water supply
No pollutants impairing or threatening this use.	9. Public Water Supply (N/A)	9. Protect and preserve waterbodies for public water supply.	N/A	N/A	Continue to monitor water quality for use as public water supply

k Known
s Suspected
p Potential
I Impaired
T Threatened
M met
N/A not applicable

Chapter 6 – Implementation Plan

6.0 IMPLEMENTATION PLAN

OBJECTIVES

- What is a BMP?
- What management strategies are needed to achieve the Watershed's goals?
- What results are expected after management strategies have been implemented?

6.1 BEST MANAGEMENT PRACTICES

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, such as installing livestock crossings, grade stabilization structures, or rock rip rap.
- 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.

6.2 RECOMMENDED STRUCTURAL AND VEGETATIVE BMPS

Appendix 6.1a provides detailed information about individual structural and vegetative BMPs and Appendix 6.1b provides detailed information about individual managerial BMPs. The effectiveness of each BMP is included in the Appendix as well. BMPs were selected to be in this list from a review of existing practices compiled and recommended by the Michigan Department of Natural Resources and Environment (MDEQ, 1998), the Michigan Department of Transportation (MDOT) (FTC&H, 2002), Natural Resource Conservation Service (NRCS) *Field Office Technical Guide* (http://www.nrcs.usda.gov/technical/efotg/), the *State-wide Low Impact Development Manual* (Southeast Michigan Council of Governments [SEMCOG], 2008), and several other sources. Appendix 6.1C includes a description of the technical and financial assistance provided by the regulatory agencies identified in Tables 6.1a and 6.1b.

Appendix 6.2 contains a review of county ordinances, rules, and regulations that address water quality issues.

Appendix 6.3 includes Wetland Action plans for three subwatershed management units: (1) Rogue River, (2) Spring Lake-Norris Creek, and (3) Dickerson Creek.

The Steering Committee and Watershed Management Plan (WMP) Review Committee used the information from all of these appendices to determine the appropriate BMPs for the Lower Grand River Watershed (LGRW or Watershed) to meet the goals and objectives. A large number of BMPs are recommended to solve nonpoint source (NPS) pollution problems; however, certain specific BMPs will be critical to meeting the goals of the Watershed project.

Prioritized systems of BMPs and individual BMPs were selected to control NPS of pollution from areas in the Watershed based on prioritized causes and sources of pollutants. The quantities of recommended BMPs are based on data from field inventories, land use information, and recommendations from the Steering Committee and WMP Review Committee. Future inventories will need to be conducted on areas not fully assessed, illustrated in Figure 3.2, in order to quantify the BMPs for those areas. The Action Plan for Restoration, outlined in Table 6.1a, includes a detailed list of activities to achieve the project goals and objectives to restore designated uses. The actions include practices for the critical areas for restoration or areas in need of restoration to meet the designated uses. These areas are described in Section 4.4. Measurable milestones, monitoring components, evaluation criteria, and responsible partners for those actions listed in the Action Plan are listed in Table 6.2.

Overall, contamination from pathogens is the priority pollutant selected for the Watershed. Known sources of pathogens include runoff from cropland manure applications, uncontrolled livestock access, failing septic tanks, over abundance of ducks and geese, and an aging sanitary sewer infrastructure. As determined through the project, addressing improper cropland manure applications will be of top importance. The construction of waste storage and composting facilities and the completion of Comprehensive Nutrient Management Plans are the highest priority BMPs to address elevated pathogens and bacteria in the Watershed.

Table 6.1a – Action Plan for Restoration

Objectives	Recommended Prioritized BMPs	Estimated Quantities*	Estimated Unit Costs	Technical Assistance	Financial Assistance	Total Costs for Entire Watershed (Over 10 years)	Total Costs for Entire Watershed By Objective
Implement manure management planning and implementation.	Waste storage facility; composting facility	176 sites in LGRW. (23 sites in critical areas); assume 25% need waste facilities (NPS inventory),	$50,000 each	NRCS, CDs	USDA Farm Bill programs	$2,200,000	$2,860,000
	CNMPs; promote incorporation	176 sites in LGRW (23 sites in critical areas); assume 75% need CNMPs (NPS inventory)	$5,000 each			$660,000	
Implement livestock management practices at access sites.	Cattle exclusion or controlled access or cattle crossing	47 livestock access sites in LGRW (43 in critical areas); assume 250 ft/site (NPS inventory)	$1.50/ft	NRCS, CDs, MDA, MDNRE, local farmers	USDA Farm Bill programs	$17,625	$191,525
	Alternative water source	47 livestock access sites in LGRW (43 in critical areas) (NPS inventory)	$3,700/each	NRCS, CDs, MDA, MDNRE, local farmers	USDA Farm Bill programs	$173,900	
Implement vegetative buffering practices.	Buffer/filter strips; native plantings	1,203 miles of unvegetated riparian area in Watershed (563 miles in critical areas) (assumes 27%** of total stream miles are un-vegetated, ACOE report) 8 locations in Plaster Creek, 4 locations in Buck Creek, 14 locations in Sand Creek (NPS inventory)	$5,000/acre (assuming 50 ft wide = 7,291 acres)	NRCS, CDs, MSUE, DU, local units of government	USDA Farm Bill programs	$36,455,000	$36,455,000
Encourage proper septic tank management.	Repair or replace aging septic systems	KCHD estimated 8,740 septic systems in need of repair in Kent County (19%). US Census numbers estimated total of 16,473 septic systems in LGRW need repairs (19%)	$7,500/each	County Administration and Health Departments, local units of government	Rural Development, USEPA/ MDNRE 319 grant funding	$124,000,000	$124,000,000
	Identify and correct illicit discharge connections	No illicit connections found during 2003-2004 storm water outfall screening for, but potential exists	To be determined			To be determined	To be determined
	Cluster septic systems for small lot development	Number of small lot developments which could use cluster septic systems to be determined.	$50,000–$100,000			To be determined	To be determined

Table 6.1a – Action Plan for Restoration

Objectives	Recommended Prioritized BMPs	Estimated Quantities*	Estimated Unit Costs	Technical Assistance	Financial Assistance	Total Costs for Entire Watershed (Over 10 years)	Total Costs for Entire Watershed By Objective
Implement LID practices	Bioretention (rain gardens)	194 urban/residential sites in LGRW (147 sites in high critical areas); 7 locations in Buck Creek 2 locations in Plaster Creek, 5 locations in Sand Creek and 59 in Indian Mill Creek, 1,000 cft each	$5–$7/cft of storage to construct	County and Local Planning Commissions, Economic Development Committees; LID for Michigan manual; Material manufacturers	People and Land Grants, Rural Development funding, Community Foundation grants, Corporate donations; Downtown Development Authorities	$1,164,000	$1,514,000
	Capture/Reuse (rain barrels, cisterns)	194 urban/residential sites in LGRW (147 sites in high critical areas)	Rain barrel: $100–$250; Cistern–varies by mftr. and material			To be determined	
	Vegetated roof	194 urban/residential sites in LGRW (147 sites in high critical areas)	$8–$16/sft			To be determined	
	Vegetated swale	194 urban/residential sites in LGRW (147 sites in high critical areas)	$4.50–$20/linear foot			To be determined	
	Infiltration practices (dry wells, infiltration basins, infiltration berms, infiltration trenches, subsurface infiltration beds, bioretention, level spreader, leaching basins)	194 urban/residential sites in LGRW (147 sites in high critical areas). 12 street miles in Village of Spring Lake and 10 public parking lots (110 catchbasins)	Dry well: $4–$9/cft; infiltration basin: varies; Infiltration trench: $20–$30/cft; subsurface infiltration bed: $13/cft; Leach basin: $3,500 each			$350,000 for leach basins	
	Pervious pavement	2 sites in Sand Creek (one unpaved boat lot, and one gravel parking lot)	Porous asphalt: $4–$5/sft; Pervious concrete: $4–$6/sft			To be determined - no information on area to be paved.	
Implement MDNRE wildlife population management practices.	Egg shaking, buffer strips, birth control	Areas requiring wildlife population management to be determined.	To be determined	MDNRE, DU	MDNRE, DU	To be determined	To be determined
Implement sanitary sewer maintenance practices.	Maintain and repair sanitary sewer system as needed. Increase capacity at WWTPs as population growth increases to avoid overflows. State's infrastructure has been rated a D-	Areas needing sanitary sewer improvements to be determined. LGRW population 871,335, 25% would have to pay for infrastructure repair	$2,700/taxpayer[1]	Community engineers, Consulting engineers	State loans/grant programs	$588,151,125	$588,151,125

Table 6.1a – Action Plan for Restoration

Objectives	Recommended Prioritized BMPs	Estimated Quantities*	Estimated Unit Costs	Technical Assistance	Financial Assistance	Total Costs for Entire Watershed (Over 10 years)	Total Costs for Entire Watershed By Objective
Implement cropland management practices.	Crop residue management; cover crop; field tile management; critical area planting; wetland restoration	951,791 acres of cropland in LGRW. (360,302 acres in high critical areas); 50% need additional practices	$300/acre	NRCS, CDs, MSUE	USDA Farm Bill programs, US FWS grant funding, DU funding	$142,768,650	$142,768,650
Implement proper SESC techniques.	SESC measures following approved SESC plan.	13 construction sites in Watershed (11 in critical areas)	$500/site	County Soil Enforcing Agent	Private - owners of construction sites	$6,500	$6,500
Implement channel stabilization and erosion control techniques.	LID storm water criteria or ordinance for new development/ redevelopment projects/ capital improvement projects	5 counties need LID storm water criteria (Kent, Ottawa, and Montcalm Counties are adopting LID criteria)	$20,000/ordinance	County and Local Planning Commissions, Drain Commissioners, Economic Development Committees	People and Land Grants, Rural Development funding	$100,000	$50,000

Table 6.1a – Action Plan for Restoration

Objectives	Recommended Prioritized BMPs	Estimated Quantities*	Estimated Unit Costs	Technical Assistance	Financial Assistance	Total Costs for Entire Watershed (Over 10 years)	Total Costs for Entire Watershed By Objective
Implement streambank stabilization, bio-engineering, and erosion control techniques.	Streambank stabilization	112 streambank erosion sites in LGRW (82 streambank erosion sites in high critical areas) (from NPS inventory, assuming 1,000 ft/site).	$100/ft	NRCS, CDs, consultants, Drain Commissioners, Road Commissions, MDNRE, County and Local Planning Commissions, Drain Commissioners, Economic Development Committees, City engineers	CMI, GLRI, USFWS, SESC grants, GLC	$11,200,000	$52,295,000
	Hydrologic and morphologic studies	14 of 31 subwatershed management units need a hydrologic and/or morphologic studies	$20,000/study			$280,000	
	LID storm water criteria or ordinance for new development/ redevelopment projects/capital improvement projects	5 counties (Kent, Ottawa, and Montcalm Counties are adopting LID criteria)	$20,000/ordinance			$100,000	
	Channel restoration; streambank stabilization	5 sites with down-cutting, 41 road crossing sites in the Watershed (5 sites with down-cutting and 25 crossing sites in critical areas); 1,000 ft/site	$100/ft			$4,600,000	
	Streambank stabilization, storm water runoff control structures	200 ft streambank erosion site in ravine to Brandywine Creek	$200/ft			$40,000	
	Buffer/filter strips; native plantings	1,203 miles of unvegetated riparian area in Watershed (563 miles in critical areas) (assumes 27%** of total stream miles are unvegetated)	$5,000/acre (assuming 50 ft wide = 7,291 acres)			$36,455,000	
Reduce and control rill and gully erosion.	Slope stabilization	3 rill erosion sites in LGRW (all in high critical areas) (250 ft/site)	$5,000/acre (assuming 50 ft wide = 0.86 acres	NRCS, CDs, MSUE	USDA Farm Bill programs, GLC	$4,300	$10,675
	Grassed waterways	15 gully erosion sites (all in high critical areas); 250 ft/site	$1.70/ft (assuming 50 ft wide)			$6,375	
Reduce and control lakeshore erosion.	Shoreline stabilization	339,216 ft of lake shoreline in LGRW (approx. 100,386 ft in critical areas) (assumes 5% of total lake shoreline in Watershed needs stabilization)	$200–500/ft	NRCS, CDs, MSUE	Private owners, Lake Association Fees, GLC	$8,480,400	$8,480,400

Table 6.1a – Action Plan for Restoration

Objectives	Recommended Prioritized BMPs	Estimated Quantities*	Estimated Unit Costs	Technical Assistance	Financial Assistance	Total Costs for Entire Watershed (Over 10 years)	Total Costs for Entire Watershed By Objective
Implement proper fertilizer application practices.	Nutrient Management Plans	951,791 acres of cropland in LGRW (360,302 acres in high critical areas); 30% need additional practices	$250/acre	NRCS, CDs, MSU Extension	USDA Farm Bill programs	$71,384,325	$71,384,325
Restore and protect wetlands.	Wetland restoration; constructed wetlands	170,003 acres of lost wetland in LGRW (81,805 acres of lost wetland in critical areas) (17 average acres/wetland)	$5,000/acre	County and Local Planning Commissions, Economic Development Committees	Wetland Enhancement Reserve Program, People and Land Grants, Rural Development funding	$850,015,000	$850,015,000
Minimize the impact of tiles and drainage networks on hydrology.	Field tile management	951,791 acres of cropland in Watershed (360,302 acres in critical areas); 30% need additional practices	$250/acre	NRCS, CDs, MSUE	USDA Farm Bill programs	$71,384,325	$71,420,325
	Tile outlet repair	80 tile outlet erosion sites in LGRW (12 tile outlet erosion sites in high critical areas)	$450/each	NRCS, CDs, MSUE	USDA Farm Bill programs	$36,000	
Restore and protect floodplains.	Floodplain management strategies	49 of 107 communities located in critical areas do not have hazard mitigation plans (plans can include floodplain management strategies)	$5,000/plan	County and Local Planning Commissions, Economic Development Committees	People and Land Grants, Rural Development funding	$245,000	$245,000
	Reconnect floodplains	To be determined (19,447 floodplain acres in Kent County, data for the rest of LGRW is not available)	$5,000/acre			Unknown, floodplain reconnections to be determined	

Table 6.1a – Action Plan for Restoration

Objectives	Recommended Prioritized BMPs	Estimated Quantities*	Estimated Unit Costs	Technical Assistance	Financial Assistance	Total Costs for Entire Watershed (Over 10 years)	Total Costs for Entire Watershed By Objective
Use alternative techniques and stream restoration practices (e.g. 2-stage channel design, in-stream structures) when drain maintenance is necessary.	Alternative drain maintenance and stream restoration techniques (e.g., 2-stage channel design, in-stream structures)	13,140,715 ft of drains in the Watershed (approx. 1,658,778 ft of drains in critical areas)	$100/ft	Drain Commissioners, MDNRE	Drain assessment fees, grants	Unknown, depends on maintenance schedule	To be determined
Restore and protect the stream buffer and canopy.	Buffer/filter strips; native plantings; land acquisition	1,203 miles of unvegetated riparian area in Watershed (563 miles in critical areas) (assumes 27%** of total stream miles are unvegetated)	$5,000/acre (assuming 50 ft wide = 7,291 acres)	NRCS, CDs, MSUE	USDA Farm Bill programs, West Michigan Land Conservancy	$36,455,000	$36,455,000
Implement turf management practices.	Turf management practices	194 urban/residential nonpoint source pollution sites in the Watershed (165 sites in high critical areas)	Potential cost savings due to less fertilizer/ herbicide/mowing	NRCS, MSUE	Rural Development, USDA Farm Bill programs	To be determined	To be determined
Reduce and control industrial emissions and discharges.	Follow appropriate guidelines/ regulations	10,555 acres of industrial land use in the Watershed (8,844 acres of industrial land use in critical areas)	To be determined	MDNRE	Industries	To be determined	To be determined
						Total	**$1,913,567,525**

* Table 3.3 and quantities identified using Geographic Information System (GIS) and field inventories. Policy review document, etc.

**Percentage was calculated using Figure 3.11 from the *Grand River Sediment Transport Modeling Study*, completed by the U.S. Army Corps of Engineers, Detroit District. Figure 3.11 assumes a linear relationship between the percentage of cropland in the buffer zone and the percentage of stream length having no buffer.

[1] Water Efficiency, March/April 2010. www.waterefficiency.com\

BMP	Best Management Practices
CDs	Conservation Districts
cft	cubic foot
CMI	Clean Michigan Initiative
CNMP	Comprehensive Nutrient Management Plan
DU	Ducks Unlimited
GLC	Great Lakes Commission
GLRI	Great Lakes Restoration Initiative
KCHD	Kent County Health Department
LGRW	Lower Grand River Watershed
LID	Low Impact Development
MDA	Michigan Department of Agriculture
MSUE	Michigan State University Extension
MDNRE	Michigan Department of Natural Resources and Environment
NPS	Nonpoint Source
NRCS	USDA Natural Resources Conservation Service
SESC	Soil Erosion and Sedimentation Control
sft	square foot
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
WWTP	Wastewater Treatment Plant

6.3 MANAGERIAL STRATEGIES

The Steering Committee and WMP Review Committee determined the needed managerial strategies for the 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 Watershed; however, specific preservation techniques will be critical to meeting the goals of the Watershed project.

Beyond federal, state, and local laws to conserve and preserve lands, the greatest opportunity to protect and preserve water quality and natural resources rests with the landowner in how they manage their lands. Most of the land in the Watershed is private ownership. According to United Growth for Kent County (http://www.unitedgrowth.org/preservation/methods.php?id=1), seven main tools are available for land preservation in Michigan: conservation easements, purchase of development rights, open space/conservation development, public purchase, U.S. Department of Agriculture (USDA) Land Conservation Programs, PA 116, and land donations.

The land preservation tools are defined as follows:

- Conservation Easement: A voluntary legal agreement between a landowner and a land trust, conservancy, or government agency that permanently limits the uses of the property.
- Purchase of Development Rights (PDR): Compensates landowners for the appraised, fair market value of their development rights in exchange for a permanent agricultural conservation easement on the property.
- Open Space/Conservation Development: Usually results in smaller, clustered lots and an area of permanently protected open space.
- Public Purchase: Where a governmental unit purchases land. It includes a binding agreement authorized by a public body and recorded with the Register of Deeds for property to be removed from the tax rolls.
- USDA Land Conservation Programs: Land conservation programs through the USDA Natural Resources Conservation Service include Conservation Reserve Program, Wetland Reserve Program, Farmland Preservation Program, and many more.
- PA 116: PA 116, called the Farmland and Open Space Preservation Program, is designed to preserve farmland and open space through agreements that restrict development for a temporary period, and provide tax incentives for participation.
- Land Donation: Total or partial gift of land, possibly with restrictions on future use.

Each land preservation tool can be configured to fit the landowner's idea of what to do with the land. However, each tool differs from the others in significant ways that must be kept in mind when making decisions about how to preserve land. Also, because the specific land conservancy or organization may have a specific mission in what type of land they protect, a discussion must be had to determine the best tool to protect the land.

Many organizations are willing to provide technical assistance to landowners on how to better manage their lands to protect natural resources and water quality. These organizations include Conservation Districts, Michigan State University (MSU) County Extension Offices, Natural Resources Conservation Services, Land Conservancies, Department of Natural Resources and Environment, Department of Agriculture, and U.S. Fish and Wildlife Service.

The management strategies outlined in Table 6.1b are prioritized based on prioritized pollutants. The table includes a detailed list of management activities that need to be completed to achieve the project goals and objectives.

Management practices include protection measures for priority areas for preservation or areas identified for protection to prevent future impacts to water quality, as described in Section 4.5.

6.4 WETLAND RESTORATION/PRESERVATION

Wetlands slow and retain surface water, providing water storage and streambank/shoreline stabilization. Therefore, restoring and preserving wetlands is a critical step toward maintaining and improving water quality within the Watershed.

The Annis Water Resources Institute (AWRI) was awarded funds through the U.S. Environmental Protection Agency (USEPA) to complete a Landscape Level Wetland Functional Assessment (LLWFA) for the Watershed. This project, known as the Lower Grand River Watershed Wetland Initiative, was fortunately taking place at the same time as the Lower Grand River WMP was being updated. Incorporating the results of the wetland investigation effort into the WMP goals for improving water quality has provided an essential planning tool that will help drive wetland conservation and restoration strategies in the Watershed.

The LLWFA was conducted to determine how the wetland resources in the LGRW have changed in geographic extent over the decades since Pre-European settlement of the region, and how this wetland loss has impacted the ecological services provided by those wetlands. The project goal was to use this technique to produce an inventory and analysis of historic wetlands and their functions in the Watershed and to compare these findings to present-day conditions. The process of this landscape level assessment is based on the *Watershed-based Preliminary Assessment of Wetland Function* (W-PAWF) technique developed by the U.S. Fish and Wildlife Services' Northeast Region. This technique applies general knowledge about wetlands and their functions to produce a watershed profile highlighting wetlands of potential significance for a variety of functions. This type of analysis assumes that given sufficient information on geomorphic setting, water source, and water movement, it should be possible to make reasonable judgments on how these physical properties can be translated into wetland functions (Fizzell, 2007). The process was applied to the entire 2,909 square miles of the LGRW.

Specific details regarding the findings of the LLWFA can be located in Section 3.3.6 of the Plan.

For three subwatersheds in the basin, Rogue River, Spring Lake/Norris Creek, and Dickerson Creek, the results of this process were used to create Wetland Action Plans that established priorities for specific conservation and restoration activities (Appendix 6.3). The goals of the Wetland Initiative Action Plans were to: (1) summarize the results of the LLWFA, (2) establish priorities for wetland restoration and preservation, and (3) detail approaches for wetland restoration and preservation for selected subwatersheds.

The information in the Wetland Action Plans can be used to develop policies and practices for wetland restoration and preservation. Wetland preservation/protection can be accomplished in several different ways, such as conservation easements and local wetland ordinances. Additional information on protection tools can be found in Section 6.5.

6.5 LAND USE PLANNING

The way land is managed, through its patterns, relationship to natural resources, and how water is managed onsite, all have impacts on the water quality in the Watershed. Land management generally occurs at the local level. Ordinances can be used as a foundation for the institutionalization of Watershed stewardship behavior.

A preliminary review of current County regulations and policies was conducted to identify local standards and ordinances that impact water quality in the Watershed. Selected plans, ordinances, and policies related to water resource protection that have been adopted in Barry, Eaton, Ionia, Kent, Montcalm, and Ottawa Counties are listed in Appendix 6.2. A spreadsheet was also created to begin a more detailed review for the 77 communities located within High Priority Critical Areas for Restoration. Initial information about their Master Plans and Zoning Ordinances is included on the spreadsheet, but specific information about other rules and regulations for each community has yet to be collected. The information included in Appendix 6.2 for the communities was obtained from a database maintained by the Grand Valley Metropolitan Council. The results of this limited review reveal areas in which Watershed protection is

present or lacking. The information presented in the policy review spreadsheets can be used as a basis to start reviewing the other communities, which can then be referenced to develop goals and objectives for the community Master Plans in the Watershed.

Table 6.1b – Action Plan for Preservation

Objectives	Recommended Prioritized BMPs	Estimated Quantities*	Estimated Unit Costs	Technical Assistance	Financial Assistance	Total Costs for Entire Watershed (Over 10 years)	Total Costs for Entire Watershed By Objective
Implement vegetative buffering practices.	Buffer overlay zone	98 communities in priority areas need buffer overlay zones (communities that include the Rogue River, Flat River, Cities of Grand Haven and Hastings already have buffer zoning)	$5,000/ordinance	County and Local Planning Commissions, Economic Development Committees	People and Land Grants, Rural Development funding, MDNRE (319 Grants)	$490,000	$490,000
	Conservation Easements	7,400 acres (over ten years, based on previous 10 years accomplishments)	To be determined	NRCS, CDs, MSUE	USDA Farm Bill programs, West Michigan Land Conservancy, MDNRE (319 Grants)	To be determined	
Encourage septage ordinance.	Recommend regular inspection and maintenance of septic systems through septic ordinance	5 counties need a septic system ordinance (Muskegon, Newaygo, Montcalm, Kent, Ionia)	$10,000/ordinance	County and Local Planning Commissions, Economic Development Committees, Health Departments	MDNRE (319 Grants), GLRI	$50,000	$50,000
Implement watershed focused land-use planning.	Storm water criteria or ordinance	5 counties need LID storm water criteria (Kent, Ottawa, and Montcalm Counties are adopting LID criteria)	$20,000/ordinance	County and Local Planning Commissions, Economic Development Committees	People and Land Grants, Rural Development funding	$100,000	$548,000
	Floodplain management strategies	49 of 107 communities located in critical areas do not have hazard mitigation plans (plans can include floodplain management strategies)	$2,000/ordinance			$98,000	

Table 6.1b – Action Plan for Preservation

Objectives	Recommended Prioritized BMPs	Estimated Quantities*	Estimated Unit Costs	Technical Assistance	Financial Assistance	Total Costs for Entire Watershed (Over 10 years)	Total Costs for Entire Watershed By Objective
Implement streambank stabilization, bio-engineering, and erosion control techniques.	LID storm water criteria or ordinance for new development / redevelopment projects / capital improvement projects	5 counties need LID storm water criteria (Kent, Ottawa, and Montcalm Counties are adopting LID criteria)	$20,000/ordinance	County and Local Planning Commissions, Drain Commissioners, Economic Development Committees	People and Land Grants, Rural Development funding	$100,000	$590,000
	Buffer overlay zone	98 communities in critical areas need buffer overlay zones. (Rogue River Natural River communities and Grand Haven already have zoning)	$5,000/ordinance			$490,000	
Reduce and control lakeshore erosion.	No wake zone ordinance	118 communities with inland lakes (no wake zone known)	$2,000/ordinance	County and Local Planning Commissions, Lake Associations	People and Land Grants, Rural Development funding; Lake Association Fees, Local Units of Government	$236,000	$236,000
Implement proper fertilizer application practices.	Fertilizer (phosphorus reduction) ordinance	6 counties (Newaygo, Montcalm, Kent, Ionia, Barry, Eaton) need fertilizer (phosphorus reduction) ordinance	$7,000/ordinance	NRCS, MSUE, Ottawa County, Muskegon County	Rural Development, USDA Farm Bill programs	$35,000	$35,000
Restore and protect wetlands.	Wetlands ordinance	141 communities without wetlands ordinance to protect existing wetlands	$5,000/ordinance	County and Local Planning Commissions, Economic Development Committees	Wetland Enhancement Reserve Program, People and Land Grants, Rural Development funding	$350,000	$350,000

Table 6.1b – Action Plan for Preservation

Objectives	Recommended Prioritized BMPs	Estimated Quantities*	Estimated Unit Costs	Technical Assistance	Financial Assistance	Total Costs for Entire Watershed (Over 10 years)	Total Costs for Entire Watershed By Objective
Restore and protect floodplains.	Floodplain management strategies	49 of 107 communities located in critical areas do not have hazard mitigation plans (can include floodplain mgmt strategies)	$2,000/ordinance	County and Local Planning Commissions, Economic Development Committees	People and Land Grants, Rural Development funding	$98,000	$98,000
Restore and protect the stream buffer and canopy.	Buffer overlay zone	98 communities in critical areas need buffer overlay zones (Rogue River Natural River communities and Grand Haven already have zoning)	$5,000/ordinance	County and Local Planning Commissions, Economic Development Committees	People and Land Grants, Rural Development funding	$490,000	$490,000
					Total Cost of Individual BMPs (not by objective)		**$1,459,000**

* Quantities identified using Geographic Information System (GIS) and field inventories. Policy review document, etc.
** Percentage was calculated using Figure 3.11 from the Grand River Sediment Transport Modeling Study, completed by the U.S. Army Corps of Engineers, Detroit District. Figure 3.11 assumes a linear relationship between the percentage of cropland in the buffer zone and the percentage of stream length having no buffer.

BMP Best Management Practices
CNMP Comprehensive Nutrient Management Plan
GLRI Great Lakes Restoration Initiative
LID Low Impact Development
MDNRE Michigan Department of Natural Resources and Environment
NRCS USDA Natural Resources Conservation Service
MSUE Michigan State University Extension
USDA U.S. Department of Agriculture

6.6 ACCOMPLISHMENT ASSESSMENT

Partners in the Watershed have received grants and other funding assistance in the last several years to implement practices to improve water quality. A few of those are highlighted below.

2002 – USEPA Section 319 Planning Grant: The reauthorization of the Clean Water Act in 1987 proposed new regulations to control storm water discharges in designated urban areas. All entities that own or operate municipal separate storm sewer systems within these regulated communities are required to obtain National Pollutant Discharge Elimination System (NPDES) storm water permits. The MDEQ offered two approaches for permit coverage: a jurisdictional approach and a watershed approach. The regulated communities in Kent and Ottawa County opted to pursue the watershed approach. The City of Grand Rapids revised their existing permit to join this effort. Communities in West Michigan were awarded a Clean Water Act Section 319 Nonpoint Source Grant in 2002 though which the watershed project and the NPDES requirements merged to develop a Lower Grand River WMP that incorporates targeted pilot project areas for in-depth study of pollutants, sources, and causes in subwatersheds of the LGRW. Counties included are: Kent, Ottawa, Ionia, Barry, Eaton, Montcalm, Newaygo, and Muskegon.

2004 – Urban Cooperation Board Grant: The Urban Cooperation Board Grant was awarded to the Grand Valley Metropolitan Council (GVMC) to continue the work of developing a sustainable LGRW Council.

2004 – USEPA Section 319 Implementation Grant: A 319 grant was awarded in 2004 to study *E. coli* contamination in three watersheds and update those WMPs to meet federal criteria. WMPs were approved for Buck Creek, Plaster Creek, and the Coldwater River Watershed. Sources of *E. coli* were identified and communities are continuing to implement practices to reduce contamination.

2004 – Clean Michigan Initiative (CMI) Nonpoint Source Grant: The Rogue River Conservation Easements Project created a thorough database of all the land in the Watershed and prioritized which parcels were of highest importance for protection with a conservation easement. The 600 highest priority landowners were identified and contacted through multiple letters, invitations to events, and two project-specific newsletters.

2005 – USEPA Section 319 Implementation Grant: The Low Impact Development (LID) Campaign for Greater Grand Rapids addressed pollutant sources typically found in urban runoff and caused by construction activities. The goal of this project was to increase the use of LID techniques in Greater Grand Rapids.

2005 – CMI Nonpoint Source Grant: The primary goal of this project was to restore and improve the cold water fishery by implementing BMPs that addressed both water quantity and water quality issues at four sites within the Watershed.

2007 – USEPA Section 319 Implementation Grant: An additional 319 grant was awarded to GVMC in 2007 to develop a model storm water ordinance, create a green infrastructure strategy, and continue Information & Education activities. The WMP was updated to comply with the NPDES storm water regulations and develop tools for urban and rural communities to use to manage storm water.

2007 – CMI Phase II Storm Water Funding: Funds were awarded to the NPDES permitees to augment the information and education efforts related to the storm water regulations. Regional educational efforts included the creation of lamp post banners, Watershed boundary signs, bus ads, displays, radio ads, and storm drain markers.

In 2010, the MDNRE, with assistance from a University of Florida Graduate Intern (Mr. Stewart Whitney) and the GVMC, worked to assess the progress and status of BMP implementation in the Watershed from 2004 to 2009. Due to limited time and resources, analysis focused on four counties: Barry, Ionia, Kent, and Ottawa. Watershed stakeholders were divided into nine groups. These groups included: (1) NRCS/Farm Service Agency, (2) Conservation Districts, (3) Land Conservancies, (4) County Drain Commissioners, (5) County Road Commissions, (6) County Health Departments, (7) County Parks and Recreation Departments, (8) Subwatershed Groups, and (9) Local Governments/Counties. A draft questionnaire was developed specifically for each group. Recommended activities from the 2004 WMP were combined with BMP implementation measurement goals from local municipal separate storm sewer system (MS4) projects to develop the initial draft questionnaires. MDNRE staff met with a few individuals in each stakeholder group to get feedback on draft questionnaires. Based on this feedback, the questionnaires were revised, downloaded into an online survey tool, and sent to the stakeholder groups.

The results from this qualitative assessment are compiled in Table 6.2. Future assessments will be needed in order to document progress in BMP implementation, behavioral changes, and water quality protection and restoration. Additional information regarding this issue is further described in Chapters 8 and 9.

Note: Through a meeting and phone conversations with the NRCS and the Farm Service Agency, it was discovered that implemented agricultural structural BMPs are incorporated into a database organized by watershed. A questionnaire was not required for this stakeholder group because the NRCS was able to send an Excel spreadsheet listing the agricultural BMPs that have been implemented in the Watershed from 2004 to 2009.

Table 6.2 – Measurable Milestones

Objectives	Recommended Prioritized BMPs*	BMPs Installed Between 2004 to 2009	Measurable Milestones (1-5 years) Based on Column C	Measurable Milestones (6-10 years) Based on Column C	Components for Monitoring Progress on Implementation	Evaluation Criteria for Determining Water Quality Improvements	Responsible Evaluation Partner
Implement manure management planning and implementation.	Waste storage facility; composting facility	41 waste storage facilities; 4 composting facilities	Install 22 waste storage and composting facilities	Install an additional 22 waste storage and composting facilities	Number of facilities constructed using USDA-NRCS practice summary documentation, 44 waste storage facilities installed (100% of waste storage facilities needed in critical areas are installed)	Water quality monitoring	USDA-NRCS
	CNMPs; promote incorporation	12,620 acres under nutrient management	14,080 acres under nutrient management - assist with completion of CNMPs	An additional 14,080 acres under nutrient management- assist with completion of CNMPs	Number of acres on which BMPs were implemented using USDA-NRCS practice summary documentation, 28,160 acres, assuming 160 acres per site (176 sites) using CNMPs - 100% of sites using CNMPs	Water quality monitoring	USDA-NRCS

Table 6.2 – Measurable Milestones

Objectives	Recommended Prioritized BMPs*	BMPs Installed Between 2004 to 2009	Measurable Milestones (1-5 years) Based on Column C	Measurable Milestones (6-10 years) Based on Column C	Components for Monitoring Progress on Implementation	Evaluation Criteria for Determining Water Quality Improvements	Responsible Evaluation Partner
Implement livestock management practices at access sites.	Cattle exclusion or controlled access or cattle crossing	167,802 ft of fencing; 1,211 acres of access controls	Install 5,750 ft of fencing	Install an additional 6,000 ft of fencing	Number of ft/acres on which BMPs were implemented using USDA-NRCS practice summary documentation, 11,750 ft of fencing installed (100% of the livestock access sites identified in NPS inventory addressed [assuming 250 ft/site needed])	USDA-NRCS yearly status reviews; before and after photos; pollutant reduction calculations; water quality monitoring; TMDL report	USDA-NRCS
	Alternative water source	37 watering facilities	Install alternative watering sources on 23 sites	Install alternative watering sources on 24 sites	Number of facilities constructed using USDA-NRCS practice summary documentation, number of sites where alternative watering sources were installed (100% of sites identified in NPS inventory addressed)	USDA-NRCS yearly status reviews; before and after photos; pollutant reduction calculations; water quality monitoring; TMDL report	USDA-NRCS

Table 6.2 – Measurable Milestones

Objectives	Recommended Prioritized BMPs*	BMPs Installed Between 2004 to 2009	Measurable Milestones (1-5 years) Based on Column C	Measurable Milestones (6-10 years) Based on Column C	Components for Monitoring Progress on Implementation	Evaluation Criteria for Determining Water Quality Improvements	Responsible Evaluation Partner
Implement vegetative buffering practices.	Buffer/filter strips; native plantings	781 acres of filter strips 8 acres of riparian forest buffer	Install 601 miles of buffer/filter strips (assuming buffer = 50 ft wide, approx. 3,642 acres); native plantings	Install an additional 602 miles of buffer/filter strips (assuming buffer = 50 ft wide, approx. 3,648 acres); native plantings	Number of miles on which BMPs were implemented (100% of riparian area noted as bare in NPS inventories is buffered)	USDA NRCS yearly status reviews; photos of BMPs installed; pollutant reduction calculations; water quality monitoring, water temperature	USDA-NRCS
		2,643 lft/87 acres of riparian land in preserves	Preserve 100 acres	Preserve an additional 100 acres	Number of lft/acres of riparian land in preserves	Pollutant reductions following conservation easement calculations	Land Conservancies
		50+ people trained on the use of native vegetation	Train 50 people on the use of native vegetation	Train 50 people on the use of native vegetation.	Number of employees trained on the use of native vegetation	Water quality monitoring	County Parks
		100+ people trained on reduced mowing	Train 50 people on reduced mowing	Train 50 people on reduced mowing	Number of employees trained on reduced mowing	Water quality monitoring	County Parks
	Buffer overlay zone	2 governments adopted stream buffer ordinance	Buffer ordinance adopted by 4 counties in LGRW	Buffer ordinance adopted by an additional 4 counties in LGRW	Adoption of stream buffer ordinances by 100% of the counties in the LGRW (total 10 counties)	Water quality monitoring	Drain Commissioners/ Local Governments
	Conservation Easements	32,696 lft/3,744 acres of riparian land in conservation easements	3,700 acres in conservation easements	3,700 acres in conservation easements	Number of lft/acres of riparian land in conservation easements	Pollutant reductions following conservation easement calculations	Land Conservancies

Table 6.2 – Measurable Milestones

Objectives	Recommended Prioritized BMPs*	BMPs Installed Between 2004 to 2009	Measurable Milestones (1-5 years) Based on Column C	Measurable Milestones (6-10 years) Based on Column C	Components for Monitoring Progress on Implementation	Evaluation Criteria for Determining Water Quality Improvements	Responsible Evaluation Partner
Encourage proper septic tank management.	Repair or replace aging septic systems	899 permits were issued for system repairs	3,468 septic systems repaired or replaced	An additional 3,468 septic systems repaired or replaced	Number of system repairs (total of 6,936 septic systems needing repair/replacement, 100% repaired/ replaced)	Water quality monitoring, photos of BMP installation	Health Departments
	Recommend regular inspection and maintenance of septic systems through septic ordinance	12,344 inspections (2,720 showed signs of failure/health risks)	12,000 inspections	12,000 inspections	Number of inspections	Number of repairs made to septic systems identified as needing repair, water quality monitoring	Health Departments
	Identify and correct illicit discharge connections	27 illicit connection correction	Identify and correct all illicit connections found in future NPS inspections	Identify and correct all illicit connections found in future NPS inspections	Number of illicit connection corrections	Water quality monitoring	Drain Commissioners/ Local Governments
	Cluster septic systems for small lot development	Unknown	Identify areas needing cluster septic systems	Install systems in identified areas	Number of cluster septic systems installed	Water quality monitoring	Health Departments
Encourage septage ordinance.	Recommend regular inspection and maintenance of septic systems through septic ordinance	Barry-Eaton District Health Department enacted regulations to inspect septic systems	Draft septage ordinance	Adopt and implement ordinance for communities in the Watershed	Number of communities in the Watershed adopting the ordinance	Ordinance status	Local Governments, Health Departments

Table 6.2 – Measurable Milestones

Objectives	Recommended Prioritized BMPs*	BMPs Installed Between 2004 to 2009	Measurable Milestones (1-5 years) Based on Column C	Measurable Milestones (6-10 years) Based on Column C	Components for Monitoring Progress on Implementation	Evaluation Criteria for Determining Water Quality Improvements	Responsible Evaluation Partner
Implement LID practices	Bioretention (Rain Gardens)	Unknown	Install 13 rain gardens (1,000 cft each)	Install 14 rain gardens (1,000 cft each)	Number of rain gardens planted, rain gardens installed in Buck Creek, Sand Creek and Indian Mill Creek, as identified in NPS inventory	Water quality monitoring	Subwatersheds
	Capture/Reuse (Rain barrels, cisterns)	Unknown	Install 6 rain barrels	Install 7 rain barrels	Number of practices implemented for storm water recapture/reuse, rain barrels installed on sites in Sand Creek and Plaster Creek which were identified in NPS inventory as having erosion problems from residential drain pipes	Pollutant reduction calculations	Local Governments
	Vegetated roof	Unknown	Install 1 vegetated roof	Install 1 vegetated roof	Number of vegetated roofs planted	Pollutant reduction calculations, water quality monitoring	Local Governments
	Vegetated swale	13 acres of grassed waterways	Install 13 acres of grassed waterways (approx. 11,326 ft long x 50 ft wide)	Install 13 acres of grassed waterways (approx. 11,326 ft long x 50 ft wide)	Number of acres on which BMPs were implemented using USDA-NRCS practice summary documentation	Water quality monitoring	USDA-NRCS
	Infiltration practices (dry wells, infiltration basins, infiltration berms, infiltration trenches, subsurface infiltration beds, bioretention, level spreaders)	Unknown	Install 5 infiltration BMPs	Install 5 infiltration BMPs	Number of BMPs installed using infiltration practices	Water quality monitoring	Drain Commissioners
	Pervious pavement	Unknown	Install pervious pavement at 1 site in Sand Creek Subwatershed (area to be determined)	Install pervious pavement at 1 site in Sand Creek Subwatershed (area to be determined)	Acres of pervious pavement installed, 100% of the sites identified in NPS inventory are addressed	Reduction of percent imperviousness in urbanized area	Local Governments

Table 6.2 – Measurable Milestones

Objectives	Recommended Prioritized BMPs*	BMPs Installed Between 2004 to 2009	Measurable Milestones (1-5 years) Based on Column C	Measurable Milestones (6-10 years) Based on Column C	Components for Monitoring Progress on Implementation	Evaluation Criteria for Determining Water Quality Improvements	Responsible Evaluation Partner
Implement MDNR wildlife population management practices.	Egg shaking, buffer strips, birth control	2 "no feeding" signs; 3 shore buffers	Control geese and other wildlife populations by inventorying subwatersheds to identify problem sites	Control geese and other wildlife populations at 50% of sites identified in inventory	Number of “no feeding” signs installed; lft of shore buffers installed	Adoption/enforcement of goose management practices, Water quality monitoring	County Parks/ Local Governments
Implement sanitary sewer maintenance practices.	Maintain and repair sanitary sewer system as needed. Increase capacity at WWTPs as population growth increases to avoid overflows	7.3 miles and 17 additional repairs	Repair 5 miles of sanitary sewer system	Repair 5 miles of sanitary sewer system	Number of repairs or miles of sanitary sewer repair. Increases in WWTP capacity	Water quality monitoring	Local Governments
Implement cropland management practices.	Crop residue management; cover crop; field tile management; critical area planting; wetland restoration	5,346 acres of residue management	Address 5,405 acres through BMP implementation (approx. 3% of cropland in critical areas needing additional practices)	Address 5,405 acres through BMP implementation (approx. 3% of cropland in critical areas needing additional practices)	Number of acres on which BMPs were implemented using USDA-NRCS practice summary documentation	Pollutant reduction calculations	USDA-NRCS
		1,849 acres of cover crop	Implement 2,000 acres of cover crop	Implement 2,000 acres of cover crop	Number of acres on which BMPs were implemented using USDA-NRCS practice summary documentation	Pollutant reduction calculations	USDA-NRCS
		11.6 acres of critical area plantings	Implement 50 acres of critical area plantings	Implement 50 acres of critical area plantings	Number of acres on which BMPs were implemented using USDA-NRCS practice summary documentation	Pollutant reduction calculations	USDA-NRCS
		467 acres of wetland restoration	Construct 600 acres of wetland restoration	Construct 600 acres of wetland restoration	Number of acres on which BMPs were implemented using USDA-NRCS practice summary documentation	Pollutant reduction calculations	USDA-NRCS

Table 6.2 – Measurable Milestones

Objectives	Recommended Prioritized BMPs*	BMPs Installed Between 2004 to 2009	Measurable Milestones (1-5 years) Based on Column C	Measurable Milestones (6-10 years) Based on Column C	Components for Monitoring Progress on Implementation	Evaluation Criteria for Determining Water Quality Improvements	Responsible Evaluation Partner
Implement Proper SESC techniques.	SESC measures following approved SESC plan.	144 SESC violations	Inspect construction sites in the Watershed, work with site manager so there are no SESC violations	Inspect construction sites in the Watershed, work with site manager so there are no SESC violations	Number of SESC violations corrected	Pollutant reduction calculations	Local Governments
Implement streambank stabilization, bio-engineering, and erosion control techniques.	Streambank stabilization	4,700 ft of streambank and shoreline protection	4,700 ft of streambank and shoreline protection (approx. 4% of streambank erosion sites identified in NPS inventories)	4,700 ft of streambank and shoreline protection (approx. 4% of streambank erosion sites identified in NPS inventories)	Number of ft on which BMPs were implemented using USDA-NRCS practice summary documentation	Pollutant reduction calculations	USDA-NRCS
	Hydrologic and morphologic studies; storm water design criteria	Unknown	Complete a hydrologic and morphologic study for 2 Watershed management units (approx. 14% of studies needed in Watershed)	Complete a hydrologic and morphologic study for 2 Watershed management units (approx. 14% of studies needed in Watershed)	Number of hydrologic and morphologic studies completed; number of storm water design criteria adopted	Meeting acceptable ratings in P51 in downstream waterbodies	MDNRE; Local Governments
	LID storm water criteria or ordinance for new development/redevel-opment projects/capital improvement projects	Ottawa County developed a modified ordinance, that allows or promotes LID techniques	Adopt and implement ordinance for communities in the Watershed	Policy Review Document – moving all highlighted items to addressed items	Adoption of a modified ordinance, that allows or promotes LID techniques	Ordinance status	Drain Commissioners
		3 governments adopted a storm water ordinance for channel protection	Adopt and implement ordinance for communities in the Watershed	Policy Review Document – moving all highlighted items to addressed items.	Adoption of storm water ordinances	Ordinance status	Local Governments
	Channel restoration; streambank stabilization	4,700 ft of streambank and shoreline protection	4,800 ft of streambank and shoreline protection (approx. 16% of channel restoration needed in critical areas in the Watershed)	4,800 ft of streambank and shoreline protection (approx. 16% of channel restoration needed in critical areas in the Watershed)	Number of ft on which BMPs were installed using USDA-NRCS practice summary documentation	Pollutant reduction calculations	USDA-NRCS

Table 6.2 – Measurable Milestones

Objectives	Recommended Prioritized BMPs*	BMPs Installed Between 2004 to 2009	Measurable Milestones (1-5 years) Based on Column C	Measurable Milestones (6-10 years) Based on Column C	Components for Monitoring Progress on Implementation	Evaluation Criteria for Determining Water Quality Improvements	Responsible Evaluation Partner
Continued Implement streambank stabilization, bio-engineering, and erosion control techniques.	Buffer/filter strips	781 acres of filter strips	Install 820 acres of buffer/filter strips; native plantings (approx. 24% of un-vegetated riparian area in critical areas)	Install 820 acres of buffer/filter strips; native plantings (approx. 24% of un-vegetated riparian area in critical areas)	Number of acres on which BMPs were implemented using USDA-NRCS practice summary documentation	Water quality monitoring	USDA-NRCS
		8 acres of riparian forest buffer	20 acres of riparian forest buffer installed	20 acres of riparian forest buffer installed	Number of acres on which BMPs were implemented using USDA-NRCS practice summary documentation	Water quality monitoring	USDA-NRCS
		50+ people trained on the use of native vegetation	Train 50 people on the use of native vegetation	Train 50 people on the use of native vegetation	Employee trainings on native vegetation	Water quality monitoring	County Parks
		100+ people trained on reduced mowing	Train 50 people on reduced mowing	Train 50 people on reduced mowing	Employee trainings on reduced mowing	Water quality monitoring	County Parks
Reduce and control gully erosion.	Slope Stabilization	11 grade stabilization structures	Install 10 grade stabilization structures	Install 10 grade stabilization structures	Number of structures installed using USDA-NRCS practice summary documentation	Pollutant reduction calculations	USDA-NRCS
	Grassed waterways	13 acres of grassed waterways	Install 13 acres of grassed waterways (100% of gully erosion sites identified in NPS inventory are addressed)	Install 13 acres of grassed waterways	Number of acres on which BMPs were implemented using USDA-NRCS practice summary documentation	Pollutant reduction calculations, water quality monitoring	USDA-NRCS

Table 6.2 – Measurable Milestones

Objectives	Recommended Prioritized BMPs*	BMPs Installed Between 2004 to 2009	Measurable Milestones (1-5 years) Based on Column C	Measurable Milestones (6-10 years) Based on Column C	Components for Monitoring Progress on Implementation	Evaluation Criteria for Determining Water Quality Improvements	Responsible Evaluation Partner
Reduce and control lakeshore erosion.	No wake zone ordinance	Unknown	Draft "no wake zone" ordinance	Adopt ordinance.	Number of no wake ordinances adopted	Ordinance status	Local Governments
	Shoreline stabilization	4,700 ft of streambank and shoreline protection	5,020 ft of shoreline protection installed (approx. 5% of shoreline in critical areas needing stabilization)	5,020 ft of shoreline protection installed (approx. 5% of shoreline in critical areas needing stabilization)	Number of ft on which BMPs were implemented using USDA-NRCS practice summary documentation	Pollutant reduction calculations	USDA-NRCS
Implement proper fertilizer application practices.	Nutrient Management Plans	Unknown	Develop 5 Nutrient Management Plans	Develop 5 Nutrient Management Plans	Number of nutrient management plans developed	Water quality monitoring	USDA-NRCS
Restore and protect wetlands.	Wetland restoration; constructed wetlands	467 acres of wetland restoration, 2.2 acres of created wetland, 1.9 acres of wetland enhancement	Construct 600 acres of wetland restoration	Construct 600 acres of wetland restoration	Number of acres on which BMPs were implemented using USDA-NRCS practice summary documentation	Pollutant reduction calculations	USDA-NRCS
	Wetlands ordinance	Unknown	Draft wetland ordinance	Adopt wetlands ordinance	Number of communities that have adopted the wetlands ordinances	Water quality monitoring, wetland functional assessment	Local Governments
Encourage proper pet waste management.	Pet waste ordinance	Unknown	Draft ordinance	Adopt ordinance	Number of communities that have adopted the ordinance	Pollutant reduction calculations	Local Governments

Table 6.2 – Measurable Milestones

Objectives	Recommended Prioritized BMPs*	BMPs Installed Between 2004 to 2009	Measurable Milestones (1-5 years) Based on Column C	Measurable Milestones (6 -10 years) Based on Column C	Components for Monitoring Progress on Implementation	Evaluation Criteria for Determining Water Quality Improvements	Responsible Evaluation Partner
Minimize the impact of tiles and drainage networks on hydrology.	Field tile management	Unknown	Identify extent of field tile impacted water bodies	Install field tile management practices at 10 identified sites	Number of field tile management systems used	Pollutant reduction calculations, water quality monitoring	USDA-NRCS
	Tile outlet repair	Unknown	Repair/replace 40 tile outlets (50% of sites identified in NPS inventory)	Repair/replace 40 tile outlets (50% of sites identified in NPS inventory)	Number of tile outlet repairs, 100% of sites identified in NPS inventory are addressed	Pollutant reduction calculations, water quality monitoring	USDA-NRCS
Restore and protect floodplains.	Floodplain mapping overlay district	2 governments adopted floodplain ordinance	Adopt hazard mitigation plans in 10 communities (approx. 20% of communities located in Watershed that need a hazard mitigation plan)	Adopt hazard mitigation plans in 10 communities (approx. 20% of communities located in Watershed that need a hazard mitigation plan)	Adoption of floodplain ordinances/plans	Status of ordinance	Local Governments
	Reconnect floodplains	1,437 acres of parks acquired that protect water quality	Identification of areas to acquire that protect water quality	1,500 acres acquired of parkland to protect water quality	Number of acres of protected floodplain	Pollutant reductions based on conservation easement calculations	County Parks
Use alternative techniques and stream restoration practices (e.g., two-stage channel design, in-stream structures) when drain maintenance is necessary.	Alternative drain maintenance and stream restoration techniques (e.g., two-stage channel design, in-stream structures)	None	10,000 ft of alternative drain maintenance and stream restoration techniques	10,000 ft of alternative drain maintenance and stream restoration techniques	Number of ft of alternative drain maintenance and stream restoration techniques installed	Pollutant reduction calculations, water quality monitoring	Drain Commissioners

Table 6.2 – Measurable Milestones

Objectives	Recommended Prioritized BMPs*	BMPs Installed Between 2004 to 2009	Measurable Milestones (1-5 years) Based on Column C	Measurable Milestones (6 -10 years) Based on Column C	Components for Monitoring Progress on Implementation	Evaluation Criteria for Determining Water Quality Improvements	Responsible Evaluation Partner
Restore and protect the stream buffer and canopy.	Buffer/filter strips; native plantings	781 acres of filter strips	Install 820 acres of buffer/filter strips; native plantings (approx. 24% of un-vegetated riparian area in critical areas)	Install 820 acres of buffer/filter strips; native plantings (approx. 24% of un-vegetated riparian area in critical areas)	Number of acres on which BMPs were implemented using USDA-NRCS practice summary documentation	Water quality monitoring	USDA-NRCS
		8 acres of riparian forest buffer	20 acres of riparian forest buffer installed	20 acres of riparian forest buffer installed	Number of acres on which BMPs were implemented using USDA-NRCS practice summary documentation	Water quality monitoring	USDA-NRCS
	Buffer overlay zone	2 governments adopted stream buffer ordinance	Buffer ordinance adopted by 4 counties in LGRW	Buffer ordinance adopted by an additional 4 counties in LGRW	Adoption of stream buffer ordinances by 100% of the counties in the LGRW (total 10 counties)	Water quality monitoring	Drain Commissioners/ Local Governments
Implement turf management practices.	Turf management practices	100+ people trained on turf management practices	Train 50 people on turf management practices	Train 50 people on turf management practices	Number of employee training sessions on proper use of pesticides, herbicides, and fertilizers	Water quality monitoring	County Parks/ Local Governments
		3 training sessions in Walker on proper storage and disposal of chemicals and other O&M materials	5 training sessions in Watershed on proper storage and disposal of chemicals and other O&M materials	5 training sessions in Watershed on proper storage and disposal of chemicals and other O&M materials	Number of employee training sessions on proper storage and disposal of chemicals and other O&M materials	Water quality monitoring	Local Governments

Table 6.2 – Measurable Milestones

Objectives	Recommended Prioritized BMPs*	BMPs Installed Between 2004 to 2009	Measurable Milestones (1-5 years) Based on Column C	Measurable Milestones (6 -10 years) Based on Column C	Components for Monitoring Progress on Implementation	Evaluation Criteria for Determining Water Quality Improvements	Responsible Evaluation Partner
Implement invasive species management practices	Invasive species management practices	Unknown	Train 50 people on invasive species management practices	Train 50 people on invasive species management practices	Number of employee training sessions on managing invasive species	Water quality monitoring	County Parks/ Local Governments
Reduce and control industrial emissions and discharges.	Follow appropriate guidelines/regulations.	Unknown	5 training sessions in Watershed on guidelines for industrial emissions and discharges	5 training sessions in Watershed on guidelines for industrial emissions and discharges	Number of training sessions, number of held permits	Water quality monitoring	MDNRE
*Sources from BMP selection in Appendix 6.1a & 6.1b.							
Measurements from accomplishment questionnaires							
Measurements from NRCS data sheets							

BMP	Best Management Practices
CDs	Conservation Districts
cft	cubic foot
CNMP	Comprehensive Nutrient Management Plan
LID	Low Impact Development
lft	linear feet
LGRW	Lower Grand River Watershed
MSUE	Michigan State University Extension
MDNRE	Michigan Department of Natural Resources and Environment
NPS	Nonpoint Source
NRCS	USDA Natural Resources Conservation Service
O&M	Operation and Maintenance
SESC	Soil Erosion and Sedimentation Control
sft	square foot
USDA	U.S. Department of Agriculture
WWTP	Wastewater Treatment Plant

6.7 ESTIMATED POLLUTION REDUCTIONS FROM PROPOSED ACTIONS AND BMPS

WMPs need to set goals for reductions and a methodology for reaching reductions where an approved or pending total maximum daily loads (TMDL) exists, which includes 16 subwatershed management units as listed in Table 3.2. WMPs also need to establish goals for reductions for other impairments found or known in the Watershed. Conserving and preserving waterbodies that are currently meeting water quality standards is also a goal of this WMP.

The general MS4 Permit requirements for a TMDL in the Watershed General Permit, Part I.A.b.1, indicate that the Storm Water Pollution Prevention Initiative (SWPPI) or Storm Water Management Program (SWMP) shall identify and prioritize actions to reduce pollutants in storm water discharges from the MS4 to make progress in meeting Water Quality Standards (WQS). These prioritized actions shall be reported to the Department as indicated in their Certificates of Coverage.

6.7.1 Pollutant Loadings and Reduction Goals

6.7.1.1 TMDL Goals

TMDL reports completed by the MDNRE address the water bodies currently listed as impaired, as previously listed in Table 3.2. For these areas where an NPS TMDL for the affected waters has already been developed and approved or is being developed, the goal is to achieve the load reductions called for in the NPS TMDL report.

6.7.1.2 Subwatershed Goals

In subwatersheds where an NPS TMDL has not yet been developed and approved or is not yet being developed, the goal is to reduce NPS pollutant loadings that are contributing to water quality threats and impairments. Where feasible, the goal is to meet water quality standards.

6.7.2 Calculated Pollutant Loadings and Reductions

Pollutant loadings for all 31 subwatershed management units are identified in Table 6.3. These loadings were calculated using the P-LOAD model and data from previous NPS pollution inventories. The estimated pollutant reductions from the NPS sites are included.

Twelve of these management units also have stream reaches with approved TMDLs. Pollutant loads, TMDLs, and needed pollutant reductions for these stream reaches are listed in Table 6.4 for subwatersheds with approved TMDLs for phosphorus, Table 6.5 for subwatersheds with approved TMDLs for biota, and Table 6.6 for subwatersheds with pending TMDLs for phosphorus. For the subwatersheds with approved TMDLs for pathogens, needed pollutant reductions are for all waters to meet water quality standards for *E. coli*.

6.7.3 Recommended Actions to Meet TMDL Goals

Tables 6.4 through 6.6 list the BMPs recommended to address the pollutant sources identified in the TMDL reports. Pollutant reductions were determined by site and for each subwatershed management unit. Tables 6.4 through 6.6 also indicate whether each TMDL in the Watershed will be met if the recommended BMPs are implemented. Calculations for the tables are included in Appendix 6.4.

6.7.4 Recommended Actions to Address Other Identified Impairments

Actions to reduce pollutants in subwatersheds without TMDL targeted reductions will strive to meet water quality standards as the measurement of success. Table 6.3 lists the estimated reductions in subwatersheds with found or known impairments.

As practices are implemented, as recommended in Table 6.1, pollutant reductions will continue to be calculated, and water quality assessed to determine progress toward meeting the TMDL goals and attaining water quality standards. Table 6.2 identifies the “Responsible Evaluation Partner”, who will take the lead in monitoring specific BMPs during implementation. Chapter 8 provides additional information about the approach to the evaluation measures. The feasible and attainable goals for BMP implementation were set for each objective, and measureable milestones were described for 5 years and 10 years. If substantial progress toward meeting the TMDL goals is not being made, implementation schedules and practices will then be adjusted to ensure that the TMDL goals will be met.

Table 6.3 – Pollutant Loadings and Expected Reductions from NPS Sites

Subwatershed Management Unit (SMU) **(BOLD = approved TMDL exists in SMU)**	Sediment	Phosphorus	Nitrogen	BMPs Recommended (Information only for those SMUs inventoried, from Table 6.1)	Reductions Expected from NPS Sites		
	Total Sediment Loading (NPS + P-LOAD) (tons/yr)	Total Phosphorus Loading (NPS + P-LOAD) (lbs/yr)	Total Nitrogen Content Loading (NPS + P-LOAD) (lbs/yr)		Sediment (tons/yr)	Phosphorus (lbs/yr)	Nitrogen (lbs/yr)
Direct Drainage to Lower Grand River (includes Sediment TMDL for York Creek and *E. coli* TMDL for the Grand River)	4,676	118,380	686,410				
Rogue River (Lower & Upper Rogue)	4,049	50,936	291,252	Cattle exclusion, controlled access, cattle crossing, alternative watering source, crop residue management, cover crop, field tile management, critical area planting, wetland restoration, streambank stabilization, and channel restoration	2,148	1,826	3,652
Coldwater River	1,620	21,846	129,374	Cattle exclusion, controlled access, cattle crossing, alternative watering source, buffer/filter strips, turf management practices, bioretention, capture/reuse, vegetated roof, pervious pavement, crop residue management, cover crop, field tile management, critical area planting, wetland restoration, streambank stabilization, slope stabilization, grassed waterways	483	427	854
Upper Thornapple River	1,584	32,689	198,190				
Lower Thornapple River	1,452	22,890	133,690				
Plaster Creek	1,347	16,077	89,154	Buffer/filter strips, turf management practices, bioretention, capture/reuse, vegetated roof, pervious pavement, crop residue management, cover crop, field tile management, SESC measures following approved SESC plan, streambank stabilization, slope stabilization, grassed waterways, tile outlet repair	32	27	54
Upper Flat River	1,239	29,150	174,000				
Buck Creek	1,025	28,061	153,436	Cattle exclusion, controlled access, cattle crossing, alternative watering source, buffer/filter strips, turf management practices, bioretention, capture/reuse, vegetated roof, pervious pavement, SESC measures following approved SESC plan, streambank stabilization, slope stabilization, grassed waterways, tile outlet repair	25	21	36
Crockery Creek	850	18,340	107,730				
Lower Flat River	833	24,920	144,320				
Rush Creek	742	18,330	103,000				
Coopers, Clear, and Black Creeks	637	16,680	100,640				
Prairie Creek	600	23,430	143,660				

Table 6.3 – Pollutant Loadings and Expected Reductions from NPS Sites

Subwatershed Management Unit (SMU) **(BOLD = approved TMDL exists in SMU)**	Sediment	Phosphorus	Nitrogen	BMPs Recommended (Information only for those SMUs inventoried, from Table 6.1)	Reductions Expected from NPS Sites		
	Total Sediment Loading (NPS + P-LOAD) (tons/yr)	Total Phosphorus Loading (NPS + P-LOAD) (lbs/yr)	Total Nitrogen Content Loading (NPS + P-LOAD) (lbs/yr)		Sediment (tons/yr)	Phosphorus (lbs/yr)	Nitrogen (lbs/yr)
Sand Creek	457	12,620	75,200				
Dickerson Creek	422	16,800	101,300				
Spring Lake/Norris Creek	371	8,930	52,600				
Mud Creek	350	6,384	38,765				
Libhart Creek	339	9,280	55,440				
Bass River	303	6,380	38,801	Buffer/filter strips, turf management practices, bioretention, capture/reuse, vegetated roof, pervious pavement, crop residue management, cover crop, field tile management, critical area planting, wetland restoration, streambank stabilization, slope stabilization, grassed waterways, tile outlet repair	1	0	1
Wabasis and Beaver Dam Creek	294	6,230	36,500				
Indian Mill Creek	395	7,545	42,689	Cattle exclusion, controlled access, cattle crossing, alternative watering source, buffer/filter strips, turf management practices, bioretention, capture/reuse, vegetated roof, pervious pavement, crop residue management, cover crop, field tile management, critical area planting, wetland restoration, SESC measures following approved SESC plan, streambank stabilization, slope stabilization, grassed waterways, tile outlet repair	113	95	189
Deer Creek	251	3,600	20,913	Cattle exclusion, controlled access, cattle crossing, alternative watering source, buffer/filter strips, turf management practices, bioretention, capture/reuse, vegetated roof, pervious pavement, crop residue management, cover crop, field tile management, critical area planting, wetland restoration, SESC measures following approved SESC plan, streambank stabilization, slope stabilization, grassed waterways, tile outlet repair	7	0	13
Cedar Creek	238	9,690	57,600				
Bear Creek	209	3,690	21,600				
Lake Creek	202	3,330	19,200				
Mill Creek	200	7,420	43,300				
Total:	**25,388**	**536,088**	**3,134,443**		**2,809**	**2,396**	**4,798**

6.4 – Reduction Goals for Phosphorus in Approved TMDL Subwatershed

Subwatershed Management Unit (SMU)	Source (Identified in TMDL Report)	BMPs Needed Based on Table 6.1	Percent of Total Acres Where BMP Is Proposed	BMP Efficiency*	Loading Estimates** (lbs/year)	Estimated Reduction (lbs/year) from BMPs ***	Reduction Needed	TMDL Met
Morrison Lake (Lake Creek)	MDOT MS4 (WLA)	No MDOT BMPs identified	NA	NA	0.09	0	NA	
	3,428 acres of agriculture, 1,143 acres of forest, grass & pasture (LA)	Cropland management (50% of acres need additional management practices)	50%	100%	801.92	400.5[D]	529	
		Waste storage facility (No CAFOs, approx. 21 smaller farms (avg. 160 acres), 25% need mgt practices	24.5%[A]	100%		200.3[E]		
		CNMP (No CAFOs, approx. 21 smaller farms (avg. 160 acres), 75% need management practices	73.5%[B]	100%		588.7[F]		
		Buffer strips (43 miles of stream, 27% riparian area unbuffered, 11 miles of buffer needed)****	1.2 %[C]	80%		7.7[G]		
	59 acres residential direct drainage (LA)	Vegetated filter strips (buffers needed on 7 acres of residential land)[#]	NA	NA	4.7	2	2.35	
	5 acres residential - high density (LA)	Rain gardens	NA	NA		1		
		Porous pavement	NA	NA		1		
	59 acres of commercial (LA)	Infiltration basins (8 acres managed by infiltration basins)[#]	NA	NA	12.83	8	6.42	
	Precipitation	NA	NA	NA	99	NA	NA	
Total:					919	1,209.2	538	Yes

*See Appendix 6.1 for BMP efficiencies

**Reported in TMDL Report (http://www.michigan.gov/documents/deq/wb-swas-tmdl-morrisonlake_257835_7.pdf) Table 10

*** Agricultural practices calculated from efficiencies, urban reductions calculated from STEPL Model (Worksheets in Appendix 6.4)

****ACOE Sediment Transport study estimate (USACE, W.F. Baird & Associates Ltd., *Grand River Sediment Transport Modeling Study,* May 23, 2007**.)**

[#]Estimated quantity based on Phosphorus load in TMDL report to enter into STEPL

A: 21*160*0.25 = 840 acres need mgt practices; 840/3428*100 = 24.5%

B: 21*160*0.75 = 2520 acres need mgt practices: 2520/3428*100 = 73.5%

C: (11 miles*5280 ft/mi*30 ft wide buffer)/43560 ft/ac = 40 acres; 40/3428 = 1.2%

D: (load*percent total acres addressed*BMP efficiency): 801*0.5*1 = 400.5

E: (load*percent total acres addressed*BMP efficiency): 801*0.25*1 = 200.3

F: (load*percent total acres addressed*BMP efficiency): 801*0.735*1 = 588.7

G: (load*percent total acres addressed*BMP efficiency): 801*0.012*0.8 = 7.7

BMP best management practices

CNMP Comprehensive Nutrient Management Plan

SMU subwatershed management unit

TMDL total maximum daily loads

Table 6.5 – TMDL Reduction Goals for Biota

Subwatershed Management Unit (SMU)	Source (Identified in TMDL Report [WLA or LA] and NPS Inventory)	BMPs (All BMPs Recommended Go Above & Beyond the MS4 Permit)	Sediment Load from TMDL Report (tons/yr)	Estimated Reduction (tons/yr) from BMPs on NPS Sites	Estimated Reduction (tons/yr) from BMPs Over Entire SMU	Reduction Needed from TMDL Report (tons/yr)	TMDL Load Met
York Creek (Direct Drainage to Lower Grand River)	Urban Storm Water (WLA)	84 acres of residential contribution identified in Table 2 of TMDL report (10% of 838) treated with infiltration basins	154.41	NA	9.7 [A]	2.81	**Yes** (Total of 11.7 tons reduced from Agricultural and Urban sources exceeds the WLA and LA reductions needed from the TMDL report of 7.80 tons)
	Agricultural Runoff (LA)	Buffer strips (0.5 miles of stream identified in Figure 2 of TMDL report, 27% riparian area unbuffered [1], 0.135 miles of buffer needed*0.01 miles contributing width = 0.00135 sq.mi. = 0.864 acres)	16.04	NA	2 [A]	4.99	
Plaster Creek	Urban Storm Water (WLA)	14 rain gardens (average 0.5 acres contributing area with storm sewers)	1,676.26	NA	0.8 [A]	406.23	**Yes** (Total of 771.1 tons reduced from Agricultural and Urban sources exceeds the WLA and LA reductions needed from the TMDL report of 406.23 tons)
	Urban Storm Water (WLA)	6 sites of Soil Erosion and Sedimentation Control practice – settling basins (avg. 0.5 acres)		NA	0.4 [A]		
	Urban Storm Water (WLA)	100 contributing acres of transportation for water quality inlets		NA	41.8 [A]		
	Agricultural Runoff (LA)	Buffer strips (91 miles of stream identified in WMP, 27% riparian area unbuffered [1], 25 miles of buffer needed*25% implementation = 6.25 miles*0.01 miles contributing width = 0.0625 sq.mi. = 40 acres)		NA	63 [A]		
	Cropland – Gully Erosion (LA)	1 grassed waterway [2]		1.1 [B]	NA		
	Cropland – Tile Outlet Erosion (LA)	2 tile outlet repair [2]		0.2 [B]	NA		
	Cropland Erosion (LA)	2 fields (avg. 40 acres) reduced tillage practices [2]		NA	623 [A]		
	Road/Stream Crossings (LA)	6 stream crossing stabilizations [2]		15.8 [B]	NA		
	Streambank Erosion (LA)	8 streambank stabilization [2]		31 [B]	NA		

Table 6.5 – TMDL Reduction Goals for Biota

Subwatershed Management Unit (SMU)	Source (Identified in TMDL Report [WLA or LA] and NPS Inventory)	BMPs (All BMPs Recommended Go Above & Beyond the MS4 Permit)	Sediment Load from TMDL Report (tons/yr)	Estimated Reduction (tons/yr) from BMPs on NPS Sites	Estimated Reduction (tons/yr) from BMPs Over Entire SMU	Reduction Needed from TMDL Report (tons/yr)	TMDL Load Met
Sand Creek	Urban Storm Water (WLA)	No urban BMPs identified	1,053.17	NA	NA	134.73	**Yes** (Total of 1,204.5 tons reduced from NPS Agricultural sources exceeds WLA and LA reductions needed from the TMDL report of 395.68 tons)
	NPS Agriculture (LA)	19 streambank erosion sites treated with stream stabilizations	582.13	997.5 [A]	NA	260.95	
		6 gully erosion treated with grassed waterways		207 [A]	NA		
Bass River	Urban Storm Water (WLA)	653 acres of unsewered residential contribution identified in Table 2 of TMDL report (10% of 6,537) treated with infiltration basins	731.00	NA	37.7 [A]	25.62	**Yes** (Total of 647.4 tons reduced from Agricultural and Urban sources exceeds the WLA and LA reductions needed from the TMDL report of 264.55 tons)
	Urban Storm Water (WLA)	19 sites of urban runoff - vegetated buffer strip (7 miles of urban stream, identified by NPS inventory, 27% riparian area unbuffered [1], 1.9 miles of buffer needed*0.01 miles contributing width = 0.019 sq.mi. = 12.2 acres)		NA	0.7 [A]		
	NPS Agriculture (LA)	2 tile outlet repair, 1 stream crossing stabilization	626.13	1 [B]	NA	238.92	
	NPS Agriculture – Cropland (LA)	123 acres of Cropland (1% of 12,349 acres in TMDL report) with reduced tillage practices		NA	609 [A]		
Strawberry Creek (Mill Creek)	Urban Storm Water (WLA)	TMDL report indicated 93 acres impervious pavement, treat 15% (14 acres) with porous pavement	72.07	NA	8 [A]	7.27	**Yes** (Total of 8 tons reduced from Urban sources exceeds the WLA reduction needed from the TMDL report of 7.27 tons)
	NPS Agriculture (LA)	Buffer strips (3 miles of stream identified in Figure 2 of TMDL report as unbuffered*0.01 miles contributing width = 0.03 sq.mi. = 19.2 acres)	31.53	NA	33 [A]	11.63	**Yes** (Total of 33 tons reduced from Agricultural sources exceeds the LA reductions needed from the TMDL report of 11.63 tons)

[1] ACOE Sediment Transport study estimate. (USACE, W.F. Baird & Associates Ltd., *Grand River Sediment Transport Modeling Study*, May 23, 2007)
[2] From NPS Inventory, See Table 3.3 [3] From Plaster Creek WMP, 2007
[A] Calculated from STEPL (See Appendix 6.4 for TMDL spreadsheets and calculations)
[B] Calculated from MDEQ Pollutant Reduction Calculation Manual, See Table 4.1b.

BMP Best Management Practices
MS4 Municipal Separate Storm Sewer System
NPS Nonpoint Source
SMU Subwatershed Management Unit
TMDL Total Maximum Daily Loads

Table 6.6 – TMDL Reduction Goals for Phosphorus

Subwatershed Management Unit (SMU)	P-LOAD Phosphorus Load	Source (Identified in TMDL Report)	BMPs	BMP Efficiency[1]	Estimated Reduction from BMPs on NPS Sites[2]	Estimated Reduction from BMPs Over Entire SMU	Reduction Needed[3]	TMDL Met
Deer Creek	3,600	Urban runoff	7 sites for buffers on urban stream, 2 SESC enforcement	80%	NA	unknown	TBD	TBD
		NPS Agriculture	9 sites of residue management, 2 streambank erosion, 4 tile outlet repair, 2 stream crossing stabilization	100%	2,880	NA	TBD	TBD
		NPS Animal Feeding Operations	9 sites of manure management, 4 livestock exclusion	100%				
Total:	**3,600**				2,880	0	0	

[1]See References in Appendix 6.1
[2]Using P-LOAD if no NPS calculated
[3]TMDL is scheduled for 2012 and the reduction needed will be determined at that time.

BMP Best Management Practice
NPS Nonpoint Source
SESC Soil Erosion and Sedimentation Control
SMU Subwatershed Management Unit
TBD To Be Determined
TMDL Total Maximum Daily Load

6.8 ACTION PLAN IMPLEMENTATION

The Action Plans outlined in Tables 6.1a and 6.1b present a long-term implementation strategy for LGRW to begin installing and adopting measures to restore, protect, and maintain the designated uses in the Watershed. The following steps outline the basic strategy and include references to specific sections, figures, or appendices of this WMP to assist in its user friendliness.

1. Select the high priority subwatershed management unit for restoration and areas for protection/preservation of interest. (Sections 4.4 and 4.5, Figures 4.1 and 4.2, Appendices).
2. Review the prioritized pollutants, sources, and causes for that subwatershed (Table 4.1).
3. Select the top priority pollutant to address.
4. Contact LGROW with assistance in establishing a Watershed organization for this subwatershed management unit if one does not exist.
5. Organize a meeting of a Steering Committee to review selection (Chapter 1, Appendix 1.1, and Chapter 9).
6. Review the BMPs identified for the selected subwatershed management unit (Tables 6.1a and 6.1b).
7. Consider which of these BMPs is the most feasible to implement based on pollutant removal efficiency, available funding, and public interests (Appendix 6.2).
8. Select a BMP or a system of BMPs to implement and evaluation measures (Table 6.3 and Table 8.1). Solicit participation from community partners for technical and financial assistance (Table 6.1a and Table 6.1b).
9. Apply for funding. (Table 6.1a, Table 6.1b, Chapter 9).

Chapter 7 – Information and Education Strategy

7.0 INFORMATION AND EDUCATION STRATEGY

OBJECTIVES

- Who needs to be kept up to date with Watershed information?
- What information needs to be distributed?
- How will the information be distributed?
- Was the education strategy effective?

7.1 DRIVING FORCES, GOALS, AND OBJECTIVES

The Information and Education (I&E) strategy includes the identification of goals, target audiences, messages, delivery mechanisms, and evaluation measures. The I&E strategy has been formulated into a working document that outlines major educational opportunities and actions needed to successfully maintain and improve water quality in the Watershed. The strategy was designed to build on previous efforts and activities that were found to be successful in the Lower Grand River Watershed (LGRW). Identification of driving forces, goals, and objectives will help determine the scope of the campaign and focus efforts on a purpose.

7.1.1 Driving Forces

There are several driving forces that prompted the creation of a Watershed Management Plan (WMP) for the LGRW. Because of increasing urban development, threats of combined sewer overflows (CSOs), and both past and current water pollution, the public has felt a need to protect and restore this resource. In 2002, the Grand Valley Metropolitan Council (GVMC), the Annis Water Resources Institute (AWRI) of Grand Valley State University (GVSU), and Fishbeck, Thompson, Carr & Huber, Inc. (FTC&H) became interested in initiating a project to address Watershed concerns by creating a WMP for the LGRW. The project was supported and promoted by numerous communities who pledged to attend meetings and provide available resource information. Many of these communities had been identified by the USEPA as having urbanized areas requiring a National Pollutant Discharge Elimination System (NPDES) storm water discharge permit. These communities saw the opportunity to use the Lower Grand River WMP as a guide to understanding water quality concerns in their community and developing their Storm Water Pollution Prevention Initiative (SWPPI) in accordance with NPDES Municipal Separate Storm Sewer System (MS4) Storm Water Regulations. A WMP was approved by the MDNRE in 2004, under the Clean Michigan Initiative guidelines, and then updated in 2007 to add information about urban water quality concerns to meet the NPDES MS4 permit requirements. GVMC received additional funding in 2007 to update the WMP to meet federal guidelines, by including information specific to the pollutant loadings and reductions expected with the implementation of the recommended BMPs. LGROW took this opportunity to revisit the entire WMP and update the components to meet the current needs of the Watershed.

7.1.2 I&E Goal

The I&E goal is to increase the involvement of the community in Watershed protection and restoration activities through the steps of awareness, education, and action. To assist in meeting this goal, this I&E Strategy recommends coordinating efforts with the Public Education Plan (PEP) being implemented by LGRW communities in accordance with NPDES MS4 Storm Water Regulations. The entire PEP is included in Appendix 7.1. By meeting the I&E goal, the I&E strategy will help fulfill the vision and mission statements established for the Watershed and LGROW, as stated in Chapter 1.

7.1.4 I&E Strategy Objectives

To reach the I&E goal, four major objectives must be met. These objectives will move target audiences through three phases of outreach: awareness, education, and action. The messages and delivery mechanisms used to achieve these outcomes will vary with each target audience. Under each objective, specific tasks and products will be developed to address how the objective will be achieved. The objectives are as follows:

- *Objective 1* (Awareness): Make the target audience aware that they live in a Watershed with unique resources and that their day-to-day activities affect the quality of those resources.

- *Objective 2* (Education): Educate target audiences on the link between urban development/rural practices and water quality impacts. Highlight what actions can be taken to reduce impacts.

- *Objective 3* (Action): Motivate the audience to adopt and implement practices that will result in water quality improvements.

- *Objective 4* (Action): Incorporate Watershed protection activities into land-use planning and land management decisions.

7.2 IDENTIFYING TARGET AUDIENCES

The target audiences include individuals or groups known to impact or be impacted by the project and whose support is needed to achieve the goals of the project. The following targeted audiences were identified by reviewing existing WMPs in the Watershed and the PEP as follows:

- Agricultural Producers
- Builders and Developers
- Businesses (industrial, non-industrial, and agricultural)
- Faith-based Organizations
- Golf Courses
- Homeowner's Associations
- Local Units of Government
- Outdoor Enthusiasts
- Residents of MS4 Communities
- Rural Residents
- Riparian Landowners (stream and lake)
- Teachers (K-12)
- Students (K-12)
- College and University Faculty and Professors
- College and University Students
- Urban Residents

Characterizing each target audience is an important part of implementing an I&E strategy. Collecting demographic information will help define the socio-economic structure of each target audience. Information on existing knowledge of Watershed issues, current attitudes and beliefs, and existing communications channels will also be relevant, and should be determined before initiating an education campaign. This information will ensure that appropriate messages are reaching the designated target audiences using effective formats and distribution methods.

To better understand target audiences, the Social Profile of the LGRW was determined by the Center for Environmental Study (CES) in 2010. This information helped characterize the target audiences identified in this I&E Strategy. Results of the social profile can be found in Appendix 7.2. In addition, information on population statistics and urban vs. rural land uses of the LGRW is included in Appendix 7.2. This 1990 and 2000 U.S. Census data were provided by the Michigan Department of Natural Resources and Environment (MDNRE).

An excerpt from the social profile indicating how to use the profile as follows:

The human dimensions of the LGRW have been addressed by this Social Profile. The techniques for using this information and designing outreach programs, as reflected in the I&E Strategy is summarized below, including the use of an example “48809 Belding ZIP Code Tabulation Area (ZCTA)”. In tailoring outreach for a specific impaired stream segment, a LGRW subwatershed, or community, consider these steps:

- Identify target audiences. Collect information to understand them. Create outreach focused on the characteristics of watershed stakeholders. Cultivate a constituency of stakeholders interested in the LGRW’s health. Tailor messages to reflect their interest and motivate change.
- Identify the ZIP codes associated with the subwatershed (see “Crosswalk” table below), the stream segment, or the community. Look up the specific ZIP Code Profile (Attachment 1).
- The data found in the ZIP Code Profiles will change as more up-to-date information becomes available, such as the 2010 Census data. Review the information in the ZIP Code Profile to determine whether more current information will be useful to the effort. Utilize the “American FactFinder”, the Census Bureau’s online tool for accessing a wide variety of demographic data organized by ZIP codes and by communities, including maps of the ZCTA with water features. http://factfinder.census.gov/home/saff/main.html?_lang=en
- In compiling demographic information, compare it with other watershed ZIP Codes, the county, state, or nation. Combine different population characteristics to see if a pattern emerges or to confirm a conclusion about the data.
- Used in a variety of ways for I&E outreach efforts that have not been described here

Example ZIP Code Profile - 48809 Belding
Land area: **86.7** sq. mi. Water area: **1.7** sq. mi. Average elevation: **798** feet above sea level

Sub-watersheds	Communities	School districts, etc.
Bear Creek, Bellemy Creek Deer Creek, Direct drainage to Grand River, Flat River Prairie Creek Wabasis/Beaver Dam Creeks	Ionia County Belding, City; Otisco Township Parts of Orleans, Keene, and Grattan (Kent County) Townships	Belding Area School District (2,371 6 schools) Grattan Academy (200) Faith Community Christian School (42 students) Alvah N. Belding Memorial Library (47,987 visits)

2000 population	Median age	Under 5 yrs old	Over 18 yrs old	Over 65 yrs old	Race White	Race Black/ African American	Origin Hispanic or Latino	Average household size	Total housing units	Education 4yr+ deg
11,192	**33.4**	**7.8%**	**69.5%**	**10.9%**	**96.7%**	**0.4%**	**2.7%**	**2.73**	**4,299**	**12.2%**

Language other than English	In labor force 16+ yrs old	Commute time (minutes)	Median House-hold Income	Families below poverty level	Work in county of residence	Businesses 2007	Employees 2007	Employed in manufacturing
3.6%	**68.1%**	**28.4**	**$40,275**	**9.2%**	**48.2%**	**194**	**2,074**	**31.8%**

Farm operations 2007	Farm operations with animals 2007	Government payment programs	Density persons per mi2	Urban population	K-12 Students 2000	Households 2000	Vehicles (estimated)	Dogs (estimated)
147	**61**	**62**	**125**	**52.8%**	**2,538**	**4,011**	**7,438**	**1,604**

ZIP Code Profile Information Summary

Land and Water Area	Average Elevation
The focus of the I&E effort may be on a smaller portion of the ZIP code area or on the entire ZIP code. The size of the ZIP code area in square miles for both land and water can be compared with other watershed areas or the watershed as a whole.	The average elevation in feet above sea level of the ZIP code can indicate whether the area contains drainage headwaters and delineates how upstream a community may be relative to other watershed communities. Such information can help connect the watershed residents to the larger watershed.
Watershed range 5.9 to 171.0 square miles	**Watershed range 600 to 1,006 feet above sea level**
*The land area of the 48809 Belding ZCTA is **86.7** square miles with a water area of **1.7** square miles.*	*The average elevation of the 48809 Belding ZCTA is **798** feet above sea level perhaps suggesting that the area is balanced between being both upstream and downstream of several other LGRW communities.*

Sub-watersheds	Communities	Schools
The LGRW crosses many boundaries, sometimes making it more challenging for outreach efforts. The focus of the I&E effort may be on an impaired stream segment or a subwatershed. It can be directed at the residents, farmers, businesses or officials of a county, township, village, city, or urban neighborhood. Outreach might be aimed at educators, students, and their families found at local schools and libraries. At the same time, the resources of communities, neighborhoods, school districts, and libraries may be tapped as ways to distribute information. In addition its use in mail and other types of I&E campaigns, ZIP codes are a tool for leveraging demographic information so that outreach can be tailored to target audiences in these geographic entities. The "crosswalk" table helps identifies what LGRW subwatersheds are contained within specific ZIP code areas. *The geographic resources of the 48809 Belding ZCTA include several LGRW tributaries and subwatersheds as well as a number of LGRW communities, public and private schools, and a local library.*		

Population	Median Age
The size of the population in the ZIP code indicates the possible magnitude of outreach efforts, such as suggesting numbers for the printing of I&E materials or for the distribution of surveys.	Outreach efforts can target audiences based on age. A population's median age, where half the population is older and half is younger, is influenced by the age composition of the population, e.g. the number of retirees, empty nesters, expanding families, and college students, among other factors.
Watershed Range 813 - 59,089 people	**Watershed Range 21.1 years to 40.4 years**
*The population in the 48809 Belding ZCTA for the 2000 Census was **11,192**.*	*The median age of the 48809 Belding ZCTA was **33.4** years, younger than the both the state's median age of 35.5 years and U.S. median age of 35.3 years.*

Under 5 years old	Over 18 years old	Over 65 years old
Community interests and participation varies across age groups and outreach should reflect these variations. A higher percentage of children under 5 years of age suggest more families with young children. These families are busy and focused on raising children. Outreach might focus on the family rather than the individual.	Those over 18 years of age represent the watershed's adult population, that is, the population that can vote and make other important decisions. Studies have shown that younger adults are more interested in active volunteering, informal socializing, and technology-based activities while their parents are engaged by current events, political activity, and giving while their grandparents are highly engaged in giving, church, and community affairs.	A higher proportion of residents over 65 years old may suggest a larger number of empty nest couples or retirees. Such age groups respond to different messages and approaches. For example, about half of this age group has indicated they could use assistance with yard work. Older adults are entering a time of life when work and family responsibilities decrease. They are looking for connection, growth, and meaning. Many will have the opportunity to keep contributing to the community in a variety of ways.
Watershed Range 5.4% -10.3%	**Watershed range 65.2% to 80.7%**	**Watershed range 4.3% to 14.9%**
*The portion of the 48809 Belding ZCTA population under 5 years old was **7.8%** in comparison with 6.8% of the state's population, suggesting a greater presence of younger families.*	*The portion of the population over 18 years of age in the 48809 Belding ZCTA was **69.5%.***	*The portion of the 48809 Belding ZCTA population over 65 years old was **10.9%** in comparison with 12.3% of the state's population and 10% of the U.S. population.*

Race White	Race Black/African American	Origin Hispanic or Latino
The 2000 Census indicates that the racial composition of the watershed is predominantly white. However, the presence of other races or ethnic origins in the LGRW, besides the Black/African American and Hispanic proportion, will need to be assessed. Over the past twenty years, diversity in the watershed has increased.	The proportional presence of Black/African American residents in the watershed suggests how outreach efforts might need to reflect the beliefs and values represented by this population.	Successful I&E will need to connect with all segments of an area's population to solicit their interest and participation, especially where language might need to be an element of effective outreach.
Watershed range 39.6% to 98.8%	**Watershed range 0.0% to 43.0%**	**Watershed range 0.3% to 23.2%**
*Similar to most watershed ZCTA's, the racial composition of the 48809 Belding ZCTA was **96.7%** white.*	*Slightly over 14% of the state's population was Black/African American in 2000 while nationally it was 12.3 % in contrast to **0.4%** in the 48809 Belding ZCTA.*	*For comparison, the state's Latino or Hispanic population was 3.3% and the Hispanic/Latino proportion of the U.S. population was 12.5 % while it was **2.7%** in the 48809 Belding ZCTA.*

Average Household Size	Total Housing Units
Household size is the average number of persons living in a household. Household size may indicate larger families in a ZCTA. Decreasing household size and increasing population suggests greater development impact in the watershed. I&E efforts can use average household size to estimate impact of outreach efforts to households, such as all members of a household being exposed to a media campaign.	Water quality is closely related to decisions made at the housing unit level. Based on various studies, housing units can be used to estimate, for example, how many septic systems are used (28% of Michigan housing units in rural/suburban areas - and growing) and the number of users that need to become aware of water quality issues. Lawn sizes and chemical application rates, as another example, can be estimated based on housing unit numbers.
Watershed range 2.05 to 3.09 persons per household	**Watershed range 317 to 23,410 housing units**
*In the 48809 Belding ZCTA, the household size of **2.73** was larger when compared with 2.56 in Michigan and 2.59 in the U.S population.*	*The number of housing units in the 48809 Belding ZCTA was **4,299**.*

Education	Language Other than English
The levels of education attained by watershed residents, such as the percentage of the population with a bachelor's degree or above, suggest a higher degree of community engagement and possibly a greater confidence in science, among other attributes. Outreach materials will need to anticipate the information and educational needs of the population based on educational characteristics.	Certain segments of the population may feel more comfortable receiving information about the watershed in a language they are much more conversant in than English. Outreach can be designed to reflect the probability of specific language needs in certain watershed communities.
Watershed range 6.3% to 49.3% with a bachelor's degree or higher	**Watershed range 1.0% to 23.3% speak a language other than English at home**
*The population in 48809 Belding ZCTA with a bachelor's degree or higher was **12.2%** compared to 21.8% of the state's population.*	*In the 48809 Belding ZCTA **3.6%** indicated that a language other than English is spoken in their home. Details on what specific language is spoken, whether Dutch, Spanish, or Slovakian, are available from the U.S. Census. (See also Origin Hispanic/Latino)*

Labor Force	Commute Time
The labor force participation rate is the proportion of workers over 16 years employed or available for work. The differences in rates between communities might reflect the number of people enrolled full-time in school, withdrawn from the labor force after seasonal work, unable to find work, and not working for other reasons such as caring for their families. **Watershed range 43.6% to 81.8%** *In 2000, labor force participation in the 48809 Belding ZCTA was **68.1%** of the population. In Michigan, it was 64.6% and on the national level it was at 63.9%.*	Longer commute times reduce social connections, e.g. less attendance at watershed meetings or fewer evenings picking up litter from local streams. Additionally, communities experiencing a growing presence of commuters, often not committed to the area, may view watershed issues differently. **Watershed range 17.3 to 41.8 minutes** *The mean travel time in the 48809 Belding ZCTA was **28.4 minutes**, compared to state commuters with 24.1 minutes and the national mean of 25.5 minutes. (See also "Work in County of Residence".)*
Median Household Income	**Families Below Poverty Level**
The median household income is the point where half of an area's households would have income below that amount and half would have income above that amount. Median household income fairly represents a typical income level for the community. Studies have shown that as income rises, more of the population participates in community projects. Decreasing income may reflect levels of inequality, conditions of deprivation, or disinvestment and capital flight. **Watershed range $30,176 to $83,902** *The median household income in the 48809 Belding ZCTA was **$40,275** in 2000. The median household income for Michigan was $46,181 compared to the national median household income of $42,148.*	The percent of families below the poverty level represent families with income less than the poverty threshold for that family size. The percent of families who fall below the threshold is one way to represent the poverty situation for a community. Higher poverty rates indicate that there are not enough jobs paying wages sufficient to keep families above the poverty threshold. These jobs are less stable, have less predictable hours, often making it difficult for individuals to participate in community activities. **Watershed range 1.0% to 18.0% below poverty level** *In the 48809 Belding ZCTA, **9.2%** of families were estimated to be below the poverty level. The family poverty rate for Michigan was 9.7% compared to the national rate of 9.2%.*
Work in County of Residence	**Business Establishments**
When residents live and work in the same community, they have shorter commute times. Outreach can be designed to target individuals at home or at work, whichever becomes a more effective method. Determine whether the outflow of workers to worksites outside of their county of residence is a lifestyle preference or economic necessity. This daily outflow of workers to other areas can have negative impact on social resources and civic engagement. **Watershed range 18.5% to 94.6% work in county of residence** *In the 48809 Belding ZCTA, **48.2%** of the population works in the county where they live. For comparison, 70.9% of Michigan residents worked in their county of residence. (see also Commute Time)*	If I&E efforts will target businesses in a community, the number of business establishments in the ZCTA often represents employment centers in the watershed. The nature of these businesses will vary throughout the watershed, from large industrial complexes to convenience stores. These numbers provide a sense of economic activity and how outreach can target businesses and their employees. **Watershed range 7 to 1,604 business establishments** *There are **194** businesses in the 48809 Belding ZCTA.*

Employees	Employed in Manufacturing
With the participation of business establishments in a watershed, it may be possible to target employees. The number of employees in the ZCTA, who may or may not live in the ZCTA, provides an indicator of the magnitude of the outreach activities. **Watershed range 22 to 40,022 employees** *There were **2,074** employees in the 48809 Belding ZCTA.* *See also Business Establishments.*	The distribution and type of jobs by industry are indicators of economic diversification in the watershed. The economic recession had a negative effect in the watershed with substantial declines in the goods-producing sector. Higher reliance on manufacturing suggests a vulnerable economy. **Watershed range 5.0% to 38.5% of workforce employed in manufacturing** *In 2007, manufacturing employment was at **31.8%** of the workforce in the 48809 Belding ZCTA compared to 22.5% of the state's and 14.1% of the U.S. workforce.*

Farm Operations	Farm Operations with Animals	Conservation Programs
Based on the 2007 Census data, the number of farm operations was summarized by watershed ZCTA. These farm operations ranged from orchards to row crops to livestock operations. Eight watershed ZCTAs have no farm operations identified in 2007. **Watershed range 3 to 404 farm operations** *There were **147** farm operations identified in the 48809 Belding ZCTA.*	During the 2007 Agricultural Census, the total number of farm operations with animals was summarized by ZCTA. This data provides a sense of the number of farm operations that are managing animals in the ZCTA. The management of animals, whether livestock or poultry or another animal, can have an impact on water quality. More details on the types of animals can be found in the Census information. **Watershed range 5 to 141 farm operations with animals** *There were **61** farm operations out of 147 that managed animals in the 48809 Belding ZCTA.*	Farm operations that have participated in the following governmental programs that help farmers conserve natural resources suggest possible interest in other similar programs to improve the watershed: the Conservation Reserve Program, Wetlands Reserve Program, Farmable Wetlands Program, and Conservation Reserve Enhancement Program plus other federal, state, and local programs **Watershed range 2 to 220 participating farm operations** *There were **62** farm operations that participated in various programs in the 48809 Belding ZCTA.*

Population Density	Urban Population	K-12 Student Population
The number of persons per square mile often reflects the intensity of development and often distinguishes rural from urban areas. Studies have found that higher population densities adversely affect the quantity and quality of storm water runoff, suggesting that these impacts escalate with density but decline on a per capita basis.	The urban nature of an area suggests certain population characteristics important to outreach activities. Based on these population densities, the ZIP code profiles indicate the percentage of the population that is urban. Very highly urban: 75% or more urban Highly urban: 50% to 74.9% urban Moderately urban: 25% to 49.9% urban Moderately rural: 10% to 24.9% urban Highly rural: Less than 10% urban	The size of the student population in kindergarten to 12th grade provides an indication of the level of effort that may be required in reaching out to school age children. These students may be attending public or private schools or may be home schooled. They may or may not be attending schools located in the ZIP code or in the watershed.
Watershed range 45 to 6,563 persons per square mile *The population density of the 48809 Belding ZCTA was **125** persons per square mile while it was 175 in Michigan.*	**Watershed range 0% to 100%** *In the 48809 Belding ZCTA, **52.8%** of the population was considered urban. It can also be estimated that 47.2% of the population was rural.*	**Watershed range 283 to 12,152 K-12 students** *The number of K-12 students in the 48809 Belding ZCTA was **2,538**, suggesting the magnitude of outreach efforts targeting these students.*
Households	**Vehicles**	**Dogs**
A household includes all persons who occupy a housing unit (as defined above). Knowing the quantity of households within certain areas of the watershed may help to define other relevant parameters (250-350 gallons of wastewater are generated per household per day by Michigan residents). Estimates of total watershed households can be useful in planning for the distribution of outreach materials.	Vehicle ownership is associated with various nonpoint sources of pollution, such as fueling spills, leaks of automotive fluids, and driveway vehicle washing. The number of vehicles - cars, vans, and trucks - kept at home and available for use by household members were counted in the 2000 Census. Outreach can utilize these counts to illustrate how much vehicle wash water is discharged.	Managing pet waste may be a topic for improving water quality in a subwatershed. The number of dogs in a ZCTA can be estimated based on data from the U.S. Human Society and other organizations indicating that four in ten (40%) U.S. households include at least one dog.
Watershed range 503 to 58,843 households *In the 48809 Belding ZCTA there were **4,011** households generating, for example, between 100,275 and 140,385 gallons of wastewater per day.*	**Watershed range 600 to 37,092 vehicles** *In the 48809 Belding ZCTA there were **7,438** vehicles.*	**Watershed range 201 to 23,537 dogs** *There are about **1,604** dogs in the 48809 Belding ZCTA.*

Crosswalk – ZIP Codes Associated with LGRW Subwatersheds

	BASS RIVER	BEAR CREEK	BELLEMY CREEK	BUCK CREEK	CEDAR CREEK	COLDWATER RIVER	COOPERS CLEAR BLACK	CROCKERY CREEK	DEER CREEK	DIRECT DRAINAGE	FALL CREEK	GLASS CREEK	HIGH BANK CREEK	INDIAN MILL CREEK	LAKE CREEK	LIBHART C REEK	LOWER FLAT RIVER	LOWER ROGUE RIVER	LOWER THORNAPPLE IVE	MILL CREEK	MUD CREEK	PLASTER CREEK	PRAIRIE CREEK	RUSH CREEK	SAND CREEK	SPRING LAKE/NORRIS	UPPER FLAT RIVER	UPPER ROGUE RIVER	UPPER THORNAPPLE	WABASIS/BEAVER DAM
48809 Belding		•	•							•							•						•				•			•
48813 Charlotte																													•	
48815 Clarksville						•									•		•													
48829 Edmore																											•			
48834 Fenwick																	•						•							
48837 Grand Ledge																													•	
48838 Greenville							•																				•			•
48846 Ionia			•							•					•	•	•						•							
48849 Lake Odessa						•				•					•	•					•									
48851 Lyons										•						•														
48865 Orleans			•							•							•						•							
48875 Portland						•				•						•														
48876 Potterville																													•	
48881 Saranac			•			•				•					•		•													
48884 Sheridan																							•							
48885 Sydney																											•			
48886 Six Lakes																											•			
48888 Stanton																											•			
48890 Sunfield																					•									
48897 Woodland						•													•		•									
49046 Delton					•						•	•	•						•											
49050 Dowling					•								•																	
49058 Hastings					•	•					•	•	•						•											
49073 Nashville													•						•		•								•	
49096 Vermontville																					•								•	
49301 Ada		•								•							•		•			•								
49302 Alto						•													•											
49303 Bailey								•																				•		
49306 Belmont		•								•								•												
49315 Byron Center				•																		•		•						
49316 Caledonia				•															•			•								
49318 Casnovia								•										•										•		
49319 Cedar Springs							•											•										•		•
49321 Comstock										•				•				•		•					•					
49322 Coral							•																				•			
49325 Freeport						•																								
49326 Gowen							•																				•			

Crosswalk – ZIP Codes Associated with LGRW Subwatersheds

	BASS RIVER	BEAR CREEK	BELLEMY CREEK	BUCK CREEK	CEDAR CREEK	COLDWATER RIVER	COOPERS CLEAR BLACK	CROCKERY CREEK	DEER CREEK	DIRECT DRAINAGE	FALL CREEK	GLASS CREEK	HIGH BANK CREEK	INDIAN MILL CREEK	LAKE CREEK	LIBHART C REEK	LOWER FLAT RIVER	LOWER ROGUE RIVER	LOWER THORNAPPLE IVE	MILL CREEK	MUD CREEK	PLASTER CREEK	PRAIRIE CREEK	RUSH CREEK	SAND CREEK	SPRING LAKE/NORRIS	UPPER FLAT RIVER	UPPER ROGUE RIVER	UPPER THORNAPPLE	WABASIS/BEAVER DAM
49330 Kent City								•										•										•		
49331 Lowell		•				•				•					•		•		•											
49333 Middleville						•						•							•											
49339 Pierson							•																					•		
49341 Rockford		•					•			•							•	•												•
49343 Sand Lake							•											•									•	•		
49345 Sparta								•		•								•		•								•		
49347 Trufant							•																				•			
49401 Allendale	•									•																				
49403 Conklin								•	•									•		•					•					
49404 Coopersville								•	•	•															•					
49415 Fruitport								•		•																•				
49417 Grand Haven	•							•		•																				
49418 Grandville				•						•														•						
49426 Hudsonville	•									•														•						
49428 Jenison	•									•														•						
49435 Marne									•	•															•					
49448 Nunica								•		•																•				
49451 Ravenna								•	•																	•				
49456 Spring Lake										•																•				
49503 Grand Rapids										•												•								
49504 Grand Rapids										•				•																
49505 Grand Rapids										•																				
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49509 Grand Rapids				•						•												•								
49512 Grand Rapids				•															•			•								
49525 Grand Rapids										•								•		•		•								
49544 Grand Rapids										•				•				•		•					•					
49546 Grand Rapids										•									•			•								
49548 Grand Rapids				•																		•								

7.3 DEVELOPING MESSAGES

Each target audience must have a clear understanding of the problems being addressed by the project and how the project affects them before any behavioral changes are to take place. The known pollutants in the Watershed are pathogens and bacteria, sediment, nutrients, unstable hydrology, temperature, habitat fragmentation, and chemicals. Based on the Watershed pollutants and their sources, the following broad messages were developed, as noted in Tables 7.1A through 7.1H. Messages intended for target audiences will be based on this broad message but should be customized, using the Social Profile, to reflect the character of the audience.

- A Watershed is an area of land that drains to a common point. You live in the Lower Grand River Watershed. You impact the Watershed. Learn more about the Lower Grand River Watershed by visiting www.lowergrandriver.org.
- Human actions increase the chances of pathogen and bacterial contamination in waterbodies. Bacterial contamination from cropland, livestock, septic tanks, ducks and geese, and the sanitary sewer create unsafe water for human contact.
- Human actions increase sedimentation and adversely affect water quality. Sediment changes the flow capacity of the stream and impairs aquatic habitats.
- Human actions increase nutrients in waterbodies and adversely affect water quality. Nutrient-rich waters encourage excessive plant growth, deplete oxygen, and impair aquatic habitats.
- Changes in land use impact stream flows, creating water quality, stream stability, and flooding concerns.
- Human actions adversely impact the temperature of waterbodies. Lack of riparian vegetation and a dense drain network cause increased stream temperatures.
- Fragmented habitats result in the degradation of wildlife populations.
- Human actions increase the amount of toxic chemicals in waterbodies and adversely affect water quality. Do your part to keep you and your family safe and healthy.

7.4 SELECTING DELIVERY MECHANISMS

A mixture of activities and media formats are normally required to relay messages effectively to diverse audiences. The key is persistence. Repeating messages is the most effective way for people to remember the message.

Because the collective target audience is broad, multiple formats will be necessary to reach each audience and to reinforce messages over time. Formats should be phased in as each audience moves from awareness to education and finally to action. 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.

Formats should be distributed through a variety of delivery mechanisms (Tables 7.2A through 7.2H). One of the most effective means of distributing information is to piggyback 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. Some of the activities included in Tables 7.1A through 7.1H are as follows:

- Award Programs
- Banners
- Brochures
- Mailers
- Postcards
- Demonstration Projects
- Newspaper Inserts
- Newsletter Articles
- Public Meetings
- Workshops
- Professional Development Sessions
- Training Sessions
- River Cleanups
- Signage
- Social Media
- Website Updates

7.5 IMPLEMENTATION OF I&E STRATEGY

7.5.1 TASKS AND SCHEDULES

The implementation of the I&E strategy follows three steps: (1) awareness; (2) education; and (3) action.

Awareness
General information about what a Watershed is and providing examples of NPS pollution will increase awareness of target audiences about the issues. The public will be made aware that they live in a Watershed and that their day-to-day activities can affect water quality. They will learn about the impacts that land use activities have on water quality, and general approaches to minimize these impacts. Awareness will be raised, in part, through signage, postcards, and brochures.

Education
The public will have opportunities for more in-depth education through a variety of opportunities, including websites, brochures, workshops, 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
Actions occur when audiences change behaviors and develop programs and events that influence and improve water quality. Such actions include participation in stream cleanups, implementing best management practices (BMPs) to improve water quality, and making informed decisions on land use planning. Taking ownership for the solutions of water quality concerns provides a framework for sustainability and ensures the continuation of the project's objectives.

The I&E activities will be focused first on the critical areas in the Watershed, as identified in Table 4.3 - Critical Areas for Restoration and Table 4.4 - Priority Areas for Preservation and Protection. Sustainability for the I&E efforts will be developed throughout the project since the protection of the Watershed will be a long-term endeavor. The schedule for implementation is included in Tables 7.1A through 7.1H.

7.5.2 POTENTIAL PARTNERS

Many groups and organizations are active within the Watershed and will provide support and assistance in educational efforts. The Public Awareness and Marketing (PAM) Committee was formed to implement the original I&E Strategy developed for the LGRW. Tables 7.1A through 7.1H lists the potential partners associated with the different I&E messages and objectives.

Assistance for the I&E activities includes many potential partners. A sampling of those that have been involved are listed below:

- AWRI;
- Calvin College
- Center for Environmental Study
- County Conservation Districts;
- County Drain Commissioners;
- County Health Departments;
- County Planning Commissions;
- County Road Commissions;
- Home Builders Association;
- Land Conservancies;
- MDNRE;
- Michigan State University Extension (MSUE) Office;
- MS4 permittees
- NRCS;
- Nature Conservancies.
- Outdoor Recreation Organizations;
- Parks and Recreation Departments;
- PAM Committee;
- Subwatershed Organizations;
- West Michigan Environmental Action Council;
- West Michigan Sustainable Business Forum.

7.5.3 Evaluation Measures

Evaluation of the education campaign provides a feedback mechanism for continuous improvement of the I&E Strategy. Evaluation tools are built into the strategy at the beginning to ensure that accurate feedback is generated.

In regard to specific I&E tasks, the purpose, theme, and objective (learning, behavioral, and emotional) of each delivery mechanism should be defined prior to implementation. An I&E worksheet template developed for completing such an assessment is provided on the last page of this chapter. This worksheet will help define each activity during its initial development and result in a more fine-tuned product that can be easily evaluated based on its initial purpose and objectives. Tables 7.1A through 7.1H recommends evaluation methods to assess the success of each delivery mechanism, in accordance with the I&E worksheet.

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 support needed?
- Are additional activities needed?
- Do some activities need to be modified or eliminated?
- Are the resources allocated sufficient 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 BMP implementation activities correspond to the I&E strategy?

7.6 COORDINATION WITH NPDES MS4 STORM WATER REQUIREMENTS

To meet the NPDES MS4 Storm Water Regulations, communities in Kent and Ottawa Counties developed a PEP to address storm water pollution between 2010 and 2014 (Appendix 7.1). The PEP was specifically designed to: (1) promote, publicize, and facilitate Watershed education for the purpose of encouraging the public to reduce the discharge of pollutants in storm water to the maximum extent practicable; and (2) encourage prevention of pollution over treatment of pollution. The PEP defines target audiences, develops specific messages, and selects delivery mechanisms to promote the goals and objectives of reducing storm water runoff. The PEP also includes mechanisms for evaluating the success or effectiveness of the plan.

The LGRW I&E strategy will be coordinated with the PEP through the PAM Committee to share resources, convey similar messages, and encourage the reduction of Watershed pollution. The LGRW I&E strategy and PEP overlap in many ways, such as addressing similar pollutants and listing activities for meeting similar objectives. This presents challenges in coordinating efforts, but also presents opportunities for innovative ideas. For example, local governments are listed as a target audience and a potential partner in several areas of the LGRW I&E Strategy. The MS4 communities can be involved in any of these identified activities, and then choose how those activities apply either directly to requirements in the PEP or propose them as an alternative approach when submitting their progress report. These activities can also be reported to the MDNRE as efforts above and beyond their existing requirements.

INFORMATION AND EDUCATION ACTIVITY WORKSHEET TEMPLATE

Activity:

Purpose of Activity:

Target Audience:

Learning Objectives (What do you want the target audience to learn from this activity?):

Behavioral Objectives (What do you want the target audience to act on after this activity?):

Emotional Objectives (What do you want the target audience to feel from this activity?):

Distribution Method (e.g. workshop, flyer):

Date of Completion:

Budget:

Project Evaluation

Quantitative Evaluation:

Qualitative Evaluation:

Level of Success (After Implementation):

Table 7.1a – Information & Education Strategy to Raise Public Awareness

Focus: Public Awareness									
WMP Goal No. 12: Educate stakeholders about the Watershed and the impacts that stakeholders have on the Watershed.									
Objectives: Increase public knowledge and broaden awareness of the Watershed. Develop partnerships among stakeholders by sharing ideas, resources, and facilitating cooperative activities that increase public awareness of watershed management and impact land use policies.									
Messages: 1) A watershed is an area of land that drains to a common point. You live in the Lower Grand River Watershed. You impact the watershed. 2) Learn more about the Lower Grand River Watershed by visiting www.lowergrandriver.org.									
Critical Areas: Entire Watershed									
		Measurable Milestone							
Target Audience	Social Profile*	Awareness (within 1 year)	Education (within 3 years)	Action (within 5 years)	Potential Partners	Responsible for Implementation	Estimated Costs	Activity Specific Evaluation Method	Watershed-wide Evaluation Method
Urban and Rural Residents	See sections 2.0 (Who lives in the LGRW?), 5.0 (Zip code Profiles), and 6.1.3 (Survey Results - Survey Participants from Rural and Urban Zip Codes) of the Social Profile	Attend 4 festivals (e.g. Bear Creek Waterfest, Grand River Water Festival) or other public events to distribute 400 brochures about the state of the Lower Grand River Watershed.	Print second run (33,000) of existing multi-page newspaper insert with a map, watershed information, and LGROW/subwatershed organization contact information.	Hold one meeting in every subwatershed (31 locations) to report on activities to help build a sense of community within each subwatershed. Facilitate the Grand River Clean-up annually.	Center for Environmental Study, Subwatershed Organizations, Public Awareness and Marketing (PAM) Committee, West Michigan Environmental Action Council, Homeowner's Associations	LGROW	Brochure: $0.70/brochure x 400 plus 25 hours ($40/hr). Inserts: $0.03/insert x 33,000 plus 8 hours. Meetings: $300/meeting x 16 plus 95 hours. Grand River Clean-up: Cost covered through other programs. Total = $11,190	Website hits in response to brochure/inserts. Number of brochures/inserts distributed. Exit questionnaires and attendance at meetings. Number of participants in clean-ups.	Annual Website or Paper Questionnaire, Focus Group, and/or Telephone Survey

Table 7.1a – Information & Education Strategy to Raise Public Awareness

Focus: Public Awareness									
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Messages: 1) A watershed is an area of land that drains to a common point. You live in the Lower Grand River Watershed. You impact the watershed. 2) Learn more about the Lower Grand River Watershed by visiting www.lowergrandriver.org.									
Critical Areas: Entire Watershed									
Target Audience	Social Profile*	Measurable Milestone			Potential Partners	Responsible for Implementation	Estimated Costs	Activity Specific Evaluation Method	Watershed-wide Evaluation Method
		Awareness (within 1 year)	Education (within 3 years)	Action (within 5 years)					
		Display LGROW's pull-up banners at 4 public events, meetings, or workshops to raise awareness about the Lower Grand River Watershed and LGROW.	Publish quarterly website updates informing the public about activities, findings, and progress on the Lower Grand River Watershed projects.	Form Grand River Expedition (GRE) 2020 Committee to plan route and activities to address changes/ improvements to the Lower Grand River.	Annis Water Resources Institute, Grand Lady Riverboat Company, Public Awareness and Marketing (PAM) Committee, GRE Planning Committee, Homeowner's Associations	LGROW	Banners: 4 hours ($40/hr). Website updates: 8 hours. Committee meetings: $2,000. Total = $2,480	Exit questionnaires and attendance at meetings. Website hits. Number of participants in GRE Committee for Lower Grand River.	
Teachers and Professors	See sections 5.0 (Zip Code Profiles) and 7.4 (Schools Serving the Watershed) of the Social Profile	Facilitate 3 "Dinner and Dialogue" sessions where teachers begin developing partnerships with environmental partners in their community.	Facilitate 8 professional development training sessions for educators on environmental education related to the Grand River.	Coordinate with teachers to develop 10 proposals for school projects on place-based environmental education.	Local units of government, Blandford Nature Center, Kent ISD, Calvin College, Aquinas College, Kent Conservation District, GVSU	GVSU - College of Education, Groundswell	Funded by the Great Lakes Stewardship Initiative.	Number of partnerships formed. Attendance at sessions. Number of proposals developed and implemented.	

Table 7.1a – Information & Education Strategy to Raise Public Awareness

Focus: Public Awareness									
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Messages: 1) A watershed is an area of land that drains to a common point. You live in the Lower Grand River Watershed. You impact the watershed. 2) Learn more about the Lower Grand River Watershed by visiting www.lowergrandriver.org.									
Critical Areas: Entire Watershed									
		Measurable Milestone							
Target Audience	Social Profile*	Awareness (within 1 year)	Education (within 3 years)	Action (within 5 years)	Potential Partners	Responsible for Implementation	Estimated Costs	Activity Specific Evaluation Method	Watershed-wide Evaluation Method
Students	See sections 2.6 (Student Population: Kindergarten to Grade 12), 5.0 (Zip Code Profiles), and 7.4 (Schools Serving the Watershed) of the Social Profile	Purchase and/or utilize existing EnviroScape models for watershed education (KCDC and OCDC have models; 6 models for 6 remaining counties).	Coordinate with Groundswell to show the film, “Mysteries ofthe Great Lakes" to local students; film provides anintroduction to stewardship for young people (8 annual film viewings).	Write school newsletter articles to encourage students to participate in existing stream clean-ups: e.g., Coldwater River Watershed Council's Annual Clean Up and Mayor's Annual Grand River Clean Up (8 articles for 8 counties).	West Michigan Environmental Action Council, Coldwater River Watershed Council, OCDC, KCDC, GVSU - College of Education, Groundswell	LGROW	EnviroScape presentations: $250/model x 6 plus 25 hours ($40/hr). Film presentation: $23/DVD x 8 plus 16 hours. Newsletter articles: 16 hours. Total = $3,964.	Student attendance and exit questionnaire results.	Annual Website or Paper Questionnaire, Focus Group, and/or Telephone Survey

Table 7.1a – Information & Education Strategy to Raise Public Awareness

Focus: Public Awareness									
WMP Goal No. 12: Educate stakeholders about the Watershed and the impacts that stakeholders have on the Watershed.									
Objectives: Increase public knowledge and broaden awareness of the Watershed. Develop partnerships among stakeholders by sharing ideas, resources, and facilitating cooperative activities that increase public awareness of watershed management and impact land use policies.									
Messages: 1) A watershed is an area of land that drains to a common point. You live in the Lower Grand River Watershed. You impact the watershed. 2) Learn more about the Lower Grand River Watershed by visiting www.lowergrandriver.org.									
Critical Areas: Entire Watershed									
		Measurable Milestone							
Target Audience	Social Profile*	Awareness (within 1 year)	Education (within 3 years)	Action (within 5 years)	Potential Partners	Responsible for Implementation	Estimated Costs	Activity Specific Evaluation Method	Watershed-wide Evaluation Method
Faith-based Organizations	See section 7.7 (Watershed Congregations) of the Social Profile	Facilitate watershed education by updating and maintaining website quarterly (www.calvin.edu/admin/provost/pcw/).	Host 3 rain barrel parties and facilitate 3 stream clean-ups with church members in the Plaster Creek Watershed.	Coordinate with faith-based organization to construct 5 rain gardens in the Plaster Creek Watershed.	Calvin College, West Michigan Environmental Action Council, Christian Reformed Church in North America	Plaster Creek Working Group	Activities currently funded by existing programs.	Website hits. Attendance at stakeholder meetings/clean ups. Number of rain barrels installed. Number of rain gardens constructed.	

Table 7.1a – Information & Education Strategy to Raise Public Awareness

Focus: Public Awareness									
WMP Goal No. 12: Educate stakeholders about the Watershed and the impacts that stakeholders have on the Watershed.									
Objectives: Increase public knowledge and broaden awareness of the Watershed. Develop partnerships among stakeholders by sharing ideas, resources, and facilitating cooperative activities that increase public awareness of watershed management and impact land use policies.									
Messages: 1) A watershed is an area of land that drains to a common point. You live in the Lower Grand River Watershed. You impact the watershed. 2) Learn more about the Lower Grand River Watershed by visiting www.lowergrandriver.org.									
Critical Areas: Entire Watershed									
Target Audience	Social Profile*	Measurable Milestone			Potential Partners	Responsible for Implementation	Estimated Costs	Activity Specific Evaluation Method	Watershed-wide Evaluation Method
		Awareness (within 1 year)	Education (within 3 years)	Action (within 5 years)					
Businesses	See sections 3.6 (Business Establishments), 3.7 (Manufacturing Employment), 3.9 (Other Aspects of the Watershed's Economy), and 5.0 (Zip code Profiles) of the Social Profile	Since the business group is under represented in LGROW, mail 75 postcard invitations to business contacts inviting them to participate in the Grand River Forums.	Continue facilitating annual Grand River Forum meetings to educate stakeholders, including new business contacts.	Meet with 5 new business contacts to encourage them to become members of LGROW.	West Michigan Sustainable Business Forum	LGROW	Postcards: $0.85/postcard x 75 plus 8 hours ($40/hr). Grand River Forum Meetings: $400/meeting plus 40 hours. Meetings: 3 hours/meeting x 5. Total = $2,984	Number of new business members joining LGROW.	Annual Website or Paper Questionnaire, Focus Group, and/or Telephone Survey
* Gajewski, B. 2010. A Social Profile of the Lower Grand River Watershed. Center for Environmental Study, Grand Rapids, MI. 105 pp.									

Table 7.1b – Information & Education Strategy to Address Pathogens and Bacteria

Pollutant 1: Pathogens and Bacteria									
WMP Goal No. 1: Restore and maintain waterbodies for partial body contact recreational use. **WMP Goal No. 2:** Restore and maintain waterbodies for total body contact recreational use.									
Objectives: 1) Implement manure management planning and implementation, 2) Implement livestock management practices at access sites, 3) Implement vegetative buffering practices and manure management planning and implementation, 4) Encourage proper septic tank management, 5) Implement vegetative buffering practices, 6) Implement MDNRE population management practices, and 7) Implement sanitary sewer maintenance practices.									
Message: Human actions increase the chances of pathogen and bacterial contamination in waterbodies. Bacterial contamination from cropland, livestock, septic tanks, ducks and geese, and the sanitary sewer create unsafe water for human contact.									
Critical Areas: Impaired Uses: Bass River; Buck Creek; Direct Drainage to Lower Grand River; Plaster Creek; Coldwater River; Coopers, Clear, and Black Creeks; Crockery Creek, Deer Creek; Threatened Uses: Upper/Lower Rogue River; Spring Lake/Norris Creek; Sand Creek									
		Measurable Milestone							
Target Audience	Social Profile*	Awareness (within 1 year)	Education (within 3 years)	Action (within 5 years)	Potential Partners	Estimated Costs	Responsible for Implementation	Activity Specific Evaluation Method	Watershed-wide Evaluation Method
Rural Residents	See sections 2.0 (Who lives in the LGRW?), 4.7 (Wastewater), 5.0 (Zip Code profiles), and 6.1.3 (Survey Results - Survey Participants from Rural and Urban Zip Codes) of the Social Profile	Post online information on proper septic system maintenance using Facebook, YouTube, or watershed website. Link information to 8 county websites.	Distribute 1,600 copies of EPA's "A Homeowner's Guide to Septic Systems" brochure (200 per impaired critical area).	Complete and advertise 40 (5 per impaired critical area) septic system repairs.	Conservation Districts, MDNRE, Michigan State University Extension	Online information: 16 hours ($40/hr). Brochures: $0.50/copy x 1,600 plus 5 hours. Repair advertisements: $0.25/ad x 30 plus 16 hours; costs for repairs covered by existing programs. Total = $2,290	LGROW and Health Departments	Number of website hits. Number of phone calls/website hits in response to brochure. Number of additional septic system repairs completed.	Annual Website or Paper Questionnaire, Focus Group, and/or Telephone Survey
Outdoor Enthusiasts	See section 6.1.3 (Survey Results - Passive and Active Recreation) of the social profile	Develop and install 16 signs (2 per impaired critical area) with "Please don't feed waterfowl" advertisement, developed by the Watershed Center.	Develop and distribute 1,600 (200 per impaired critical area) brochures at state/local parks.	Advertise 1 population management demonstration project in LGRW in coordination with the MDNRE.	Health Departments, Parks and Recreation Departments, State Parks, Outdoor Recreation Organizations, MDNRE	Signs: $150/sign x 16 plus 80 hours ($40/hr). Brochures: $0.70/brochure x 1,600 plus 30 hours. Advertisements: $0.25/ad x 8 plus 8 hours. Total = $8,242	LGROW	Observation survey to determine reduction in the number of people who feed wildlife.	

Table 7.1b – Information & Education Strategy to Address Pathogens and Bacteria

Pollutant 1: Pathogens and Bacteria									
WMP Goal No. 1: Restore and maintain waterbodies for partial body contact recreational use. **WMP Goal No. 2:** Restore and maintain waterbodies for total body contact recreational use.									
Objectives: 1) Implement manure management planning and implementation, 2) Implement livestock management practices at access sites, 3) Implement vegetative buffering practices and manure management planning and implementation, 4) Encourage proper septic tank management, 5) Implement vegetative buffering practices, 6) Implement MDNRE population management practices, and 7) Implement sanitary sewer maintenance practices.									
Message: Human actions increase the chances of pathogen and bacterial contamination in waterbodies. Bacterial contamination from cropland, livestock, septic tanks, ducks and geese, and the sanitary sewer create unsafe water for human contact.									
Critical Areas: Impaired Uses: Bass River; Buck Creek; Direct Drainage to Lower Grand River; Plaster Creek; Coldwater River; Coopers, Clear, and Black Creeks; Crockery Creek, Deer Creek; Threatened Uses: Upper/Lower Rogue River; Spring Lake/Norris Creek; Sand Creek									
		Measurable Milestone							
Target Audience	Social Profile*	Awareness (within 1 year)	Education (within 3 years)	Action (within 5 years)	Potential Partners	Estimated Costs	Responsible for Implementation	Activity Specific Evaluation Method	Watershed-wide Evaluation Method
Agricultural Producers	See sections 3.8 (Farm Operations), 4.3 (Agriculture in the Watershed), and 5.0 (Zip Code Profiles) of the Social Profile	Develop and distribute 1,600 mailers (200 per impaired critical area) on proper manure application, livestock access issues, and benefits of vegetative buffers.	Distribute 1,600 (200 per impaired critical area) brochures on available incentive programs.	Develop sustainable farm award program with the MDA to acknowledge and promote farms with sound environmental practices.	Natural Resources Conservation Service, MDNRE, Conservation Districts, Michigan State University Extension	Mailers: $0.10/mailer x 1,600 plus 8 hours ($40/hr). Brochure: $0.70/brochure x 1,600 plus 20 hours. Coordination with MDA: 4 hours/ meeting x 6. Total = $3,360	LGROW and Michigan Department of Agriculture (MDA)	Number of contacts made as a result of mailers/brochures. Adoption of farm award program by the MDA.	Annual Website or Paper Questionnaire, Focus Group, and/or Telephone Survey
Local Units of Government	See attachment 1 (Zip Code Profiles) of the social profile	Develop and distribute 125 brochures (25 per targeted county) on septic system regulations and value of upgrading aging/leaking sanitary sewers.	Conduct 5 workshops on septic system regulations for Muskegon, Newaygo, Montcalm, Kent, and Ionia Counties.	Assist 5 counties with adoption of regulations or ordinances and finding needed funding for sewer upgrades.	Conservation Districts, Michigan State University Extension, MDNRE	Brochures: $0.70/copy x 125 plus 16 hours ($40/hr). $300/workshop x 5 plus 40 hours; $5,000/ordinance development x 5. Total = $28,828	LGROW and Health Departments	Number of phone calls in response to brochures. Attendance and exit questionnaires at workshops. Number of adopted regulations or ordinances. Number of upgraded sanitary sewer miles.	

* Gajewski, B. 2010. A Social Profile of the Lower Grand River Watershed. Center for Environmental Study, Grand Rapids, MI. 105 pp.

Table 7.1c – Information & Education Strategy to Address Sediment

Pollutant 2: Sediment									
WMP Goal No. 3: Restore and maintain waterbodies for other indigenous aquatic life and wildlife use. **WMP Goal No. 4:** Restore and maintain waterbodies for cold water fishery use. **WMP Goal No. 5:** Restore and maintain waterbodies for warmwater fishery use.									
Objectives: 1) Implement cropland management practices; 2) Implement vegetative buffering practices; 3) Implement watershed focused land-use planning; 4) Implement low impact development practices; 5) Implement watershed focused land-use planning; 6) Implement proper Soil Erosion and Sedimentation Control techniques; 7) Implement channel stabilization and erosion control techniques; 8) Implement livestock management practices at access sites; 9) Implement streambank stabilization, bio-engineering, and erosion control techniques; 10) Reduce and control gully erosion; 11) Implement streambank stabilization and erosion control techniques; and 12) Reduce and control lakeshore erosion.									
Message: Human actions increase sedimentation and adversely affect water quality. Sediment changes the flow capacity of the stream and impairs aquatic habitats.									
Critical Areas: Impaired Uses: Bass River; Direct Drainage to Lower Grand River (York Creek); Mill Creek (Strawberry Creek); Plaster Creek; Coldwater River; Indian Mill Creek; Mud Creek; Sand Creek; Threatened Uses: Deer Creek; Buck Creek; Upper/Lower Rogue River; Spring Lake/Norris Creek									
		Measurable Milestone							
Target Audience	Social Profile*	Awareness (within 1 year)	Education (within 3 years)	Action (within 5 years)	Potential Partners	Estimated Costs	Responsible for Implementation	Activity Specific Evaluation Method	Watershed-wide Evaluation Method
Agricultural Producers	See sections 3.8 (Farm Operations), 4.3 (Agriculture in the Watershed), and 5.0 (Zip Code Profiles) of the Social Profile	Develop and distribute 1,600 mailers (200 per impaired critical area) on how to reduce cropland, tile, and rill/gully erosion.	Distribute 1,600 (200 per impaired critical area) brochures on available incentive programs.	Develop sustainable farm award program with the MDA to acknowledge and promote farms with sound environmental practices.	Natural Resources Conservation Service, Michigan State University, Conservation Districts, MDNRE	Mailers: $0.10/mailer x 1,600 plus 8 hours ($40/hr). Brochure: $0.70/brochure x 1,600 plus 20 hours. Coordination with MDA: 4 hours/ meeting x 6. Total = $3,360	LGROW and Michigan Department of Agriculture	Number of contacts made as a result of mailers/brochures. Adoption of farm award program by the MDA.	Annual Website or Paper Questionnaire, Focus Group, and/or Telephone Survey

Table 7.1c – Information & Education Strategy to Address Sediment

Pollutant 2: Sediment									
WMP Goal No. 3: Restore and maintain waterbodies for other indigenous aquatic life and wildlife use. **WMP Goal No. 4:** Restore and maintain waterbodies for cold water fishery use. **WMP Goal No. 5:** Restore and maintain waterbodies for warmwater fishery use.									
Objectives: 1) Implement cropland management practices; 2) Implement vegetative buffering practices; 3) Implement watershed focused land-use planning; 4) Implement low impact development practices; 5) Implement watershed focused land-use planning; 6) Implement proper Soil Erosion and Sedimentation Control techniques; 7) Implement channel stabilization and erosion control techniques; 8) Implement livestock management practices at access sites; 9) Implement streambank stabilization, bio-engineering, and erosion control techniques; 10) Reduce and control gully erosion; 11) Implement streambank stabilization and erosion control techniques; and 12) Reduce and control lakeshore erosion.									
Message: Human actions increase sedimentation and adversely affect water quality. Sediment changes the flow capacity of the stream and impairs aquatic habitats.									
Critical Areas: Impaired Uses: Bass River; Direct Drainage to Lower Grand River (York Creek); Mill Creek (Strawberry Creek); Plaster Creek; Coldwater River; Indian Mill Creek; Mud Creek; Sand Creek; Threatened Uses: Deer Creek; Buck Creek; Upper/Lower Rogue River; Spring Lake/Norris Creek									
Target Audience	Social Profile*	Measurable Milestone			Potential Partners	Estimated Costs	Responsible for Implementation	Activity Specific Evaluation Method	Watershed-wide Evaluation Method
		Awareness (within 1 year)	Education (within 3 years)	Action (within 5 years)					
		Publish newsletter article in Conservation District newsletters on how to reduce cropland, tile, and rill/gully erosion (one article for 8 counties).	Conduct 3 workshops on the benefits of no till practices; workshops to be held on local farms currently implementing practices.	Meet with 24 local agricultural producers (3 per impaired critical area) using door to door talks to discuss no till practices and funding opportunities.	Michigan Department of Agriculture, Michigan State University Extension, Conservation Districts, MDNRE	Articles: 12 hours ($40/hr). Workshops: $300/workshop x 3 plus 30 hours. Meetings: $150 for materials plus 25 hours. Total = $3,730	LGROW and Natural Resources Conservation Service	Website hits in response to articles. Exit questionnaires at workshops and following meetings. Number of practices implemented.	

Table 7.1c – Information & Education Strategy to Address Sediment

Pollutant 2: Sediment									
WMP Goal No. 3: Restore and maintain waterbodies for other indigenous aquatic life and wildlife use. **WMP Goal No. 4:** Restore and maintain waterbodies for cold water fishery use. **WMP Goal No. 5:** Restore and maintain waterbodies for warmwater fishery use.									
Objectives: 1) Implement cropland management practices; 2) Implement vegetative buffering practices; 3) Implement watershed focused land-use planning; 4) Implement low impact development practices; 5) Implement watershed focused land-use planning; 6) Implement proper Soil Erosion and Sedimentation Control techniques; 7) Implement channel stabilization and erosion control techniques; 8) Implement livestock management practices at access sites; 9) Implement streambank stabilization, bio-engineering, and erosion control techniques; 10) Reduce and control gully erosion; 11) Implement streambank stabilization and erosion control techniques; and 12) Reduce and control lakeshore erosion.									
Message: Human actions increase sedimentation and adversely affect water quality. Sediment changes the flow capacity of the stream and impairs aquatic habitats.									
Critical Areas: Impaired Uses: Bass River; Direct Drainage to Lower Grand River (York Creek); Mill Creek (Strawberry Creek); Plaster Creek; Coldwater River; Indian Mill Creek; Mud Creek; Sand Creek; Threatened Uses: Deer Creek; Buck Creek; Upper/Lower Rogue River; Spring Lake/Norris Creek									
		Measurable Milestone							
Target Audience	Social Profile*	Awareness (within 1 year)	Education (within 3 years)	Action (within 5 years)	Potential Partners	Estimated Costs	Responsible for Implementation	Activity Specific Evaluation Method	Watershed-wide Evaluation Method
Riparian Landowners	Social profile to be determined	Develop and advertise a program for riparian tree/vegetation planting in local newspapers and conservation districts' tree sale notices (800 notices per 8 impaired critical areas).	Conduct 2 workshops about importance of riparian habitats and tree sales in coordination with Arbor Day.	Assist 10 riparian landowners with planting trees and riparian vegetation for runoff filtration.	County Planning Commissions, County Drain Commissioners, Conservation Districts, Natural Resources Conservation Service	Riparian planting program: $3,000 to develop program, $0.10/notice x 800 plus 16 hours ($40/hr). Workshops: $300/workshop plus 18 hours. Riparian plantings: $1,000/buffer x 10 plus 40 hours. Total = $16,730	LGROW	Number of contacts resulting from notices. Results of exit questionnaires following workshops. Number of feet of vegetation planted in the riparian zone.	Annual Website or Paper Questionnaire, Focus Group, and/or Telephone Survey

Table 7.1c – Information & Education Strategy to Address Sediment

Pollutant 2: Sediment									
WMP Goal No. 3: Restore and maintain waterbodies for other indigenous aquatic life and wildlife use. **WMP Goal No. 4:** Restore and maintain waterbodies for cold water fishery use. **WMP Goal No. 5:** Restore and maintain waterbodies for warmwater fishery use.									
Objectives: 1) Implement cropland management practices; 2) Implement vegetative buffering practices; 3) Implement watershed focused land-use planning; 4) Implement low impact development practices; 5) Implement watershed focused land-use planning; 6) Implement proper Soil Erosion and Sedimentation Control techniques; 7) Implement channel stabilization and erosion control techniques; 8) Implement livestock management practices at access sites; 9) Implement streambank stabilization, bio-engineering, and erosion control techniques; 10) Reduce and control gully erosion; 11) Implement streambank stabilization and erosion control techniques; and 12) Reduce and control lakeshore erosion.									
Message: Human actions increase sedimentation and adversely affect water quality. Sediment changes the flow capacity of the stream and impairs aquatic habitats.									
Critical Areas: Impaired Uses: Bass River; Direct Drainage to Lower Grand River (York Creek); Mill Creek (Strawberry Creek); Plaster Creek; Coldwater River; Indian Mill Creek; Mud Creek; Sand Creek; Threatened Uses: Deer Creek; Buck Creek; Upper/Lower Rogue River; Spring Lake/Norris Creek									
		Measurable Milestone							
Target Audience	Social Profile*	Awareness (within 1 year)	Education (within 3 years)	Action (within 5 years)	Potential Partners	Estimated Costs	Responsible for Implementation	Activity Specific Evaluation Method	Watershed-wide Evaluation Method
Local Units of Government, Builders and Developers, Homeowner's Associations	See attachment 1 (Zip Code Profiles) of the social profile	Develop and distribute 1,600 (200 per impaired critical area) posters on good housekeeping practices to reduce sediment transport from impervious surfaces, drainage networks, and construction sites.	Distribute 1,600 (200 per impaired critical area) brochures.	Facilitate 8 training sessions for government staff on good housekeeping practices to reduce sediment transport from impervious surfaces, drainage networks, and construction sites.	SESC Enforcing Agents, Road Commissions, MDNRE	Posters: $1.25/poster x 1,600 plus 16 hours ($40/hr). Brochure: $0.70/brochure x 1,600 plus 20 hours. Training Sessions: $75/ meeting x 8 plus 50 hours. Total = $7,160	LGROW	Number of contacts made as a result of posters/brochures. Exit questionnaire following training sessions.	

* Gajewski, B. 2010. A Social Profile of the Lower Grand River Watershed. Center for Environmental Study, Grand Rapids, MI. 105 pp.

Table 7.1d – Information & Education Strategy to Address Nutrients

Pollutant 3: Nutrients									
WMP Goal No. 3: Restore and maintain waterbodies for other indigenous aquatic life and wildlife use. **WMP Goal No. 4:** Restore and maintain waterbodies for cold water fishery use. **WMP Goal No. 5:** Restore and maintain waterbodies for warmwater fishery use.									
Objectives: 1) Implement manure management planning and implementation, 2) Implement livestock management practices at access sites, 3) Implement vegetative buffering practices and manure management planning and implementation, 4) Encourage proper septic tank management, 5) Implement proper fertilizer application practices, 6) Implement vegetative buffering practices, 7) Implement MDNRE population management practices, and 8) Implement sanitary sewer maintenance practices.									
Message: Human actions increase nutrients in waterbodies and adversely affect water quality. Nutrient rich waters encourage excessive plant growth, deplete oxygen, and impair aquatic habitats.									
Critical Areas: Impaired Uses: Lake Creek; Deer Creek; Upper Thornapple River (Low DO); Threatened Uses: Bass River; Buck Creek; Coldwater River; Plaster Creek; Upper/Lower Rogue River; Spring Lake/Norris Creek; Sand Creek									
		Measurable Milestone							
Target Audience	Social Profile*	Awareness (within 1 year)	Education (within 3 years)	Action (within 5 years)	Potential Partners	Estimated Costs	Responsible for Implementation	Activity Specific Evaluation Method	Watershed-wide Evaluation Method
Urban and Rural Residents, Golf Courses	See sections 2.0 (Who lives in the LGRW?), 5.0 (Zip code Profiles), and 6.1.3 (Survey Results - Survey Participants from Rural and Urban Zip Codes) of the Social Profile	Post online information on proper use and application of non-phosphorus fertilizers using Facebook, YouTube, or watershed websites. Link information to 8 county websites. Use information from the "Healthy Beaches" series, developed by the Watershed Center.	Distribute 1,600 brochures on the proper use and application of non-phosphorus fertilizers (160 per critical area).	Assist 3 golf courses in switching to non-phosphorus fertilizers. Develop and distribute flyer at golf course to advertise demonstration projects to encourage residents to use non-phosphorus fertilizers.	Michigan State University Extension, Conservation Districts	Online information: 16 hours ($40/hr). Brochures: $0.70/copy x 1,600 plus 5 hours. Golf course assistance: 40 hours. Brochure: $0.70/brochure x 300 plus 30 hours. Total = $4,970	LGROW	Number of website hits. Number of phone calls/website hits in response to brochures. Number of golf courses changing fertilizer practices.	Annual Website or Paper Questionnaire, Focus Group, and/or Telephone Survey

Table 7.1d – Information & Education Strategy to Address Nutrients

Pollutant 3: Nutrients									
WMP Goal No. 3: Restore and maintain waterbodies for other indigenous aquatic life and wildlife use. **WMP Goal No. 4:** Restore and maintain waterbodies for cold water fishery use. **WMP Goal No. 5:** Restore and maintain waterbodies for warmwater fishery use.									
Objectives: 1) Implement manure management planning and implementation, 2) Implement livestock management practices at access sites, 3) Implement vegetative buffering practices and manure management planning and implementation, 4) Encourage proper septic tank management, 5) Implement proper fertilizer application practices, 6) Implement vegetative buffering practices, 7) Implement MDNRE population management practices, and 8) Implement sanitary sewer maintenance practices.									
Message: Human actions increase nutrients in waterbodies and adversely affect water quality. Nutrient rich waters encourage excessive plant growth, deplete oxygen, and impair aquatic habitats.									
Critical Areas: Impaired Uses: Lake Creek; Deer Creek; Upper Thornapple River (Low DO); Threatened Uses: Bass River; Buck Creek; Coldwater River; Plaster Creek; Upper/Lower Rogue River; Spring Lake/Norris Creek; Sand Creek									
		Measurable Milestone							
Target Audience	Social Profile*	Awareness (within 1 year)	Education (within 3 years)	Action (within 5 years)	Potential Partners	Estimated Costs	Responsible for Implementation	Activity Specific Evaluation Method	Watershed-wide Evaluation Method
Agricultural Producers	See sections 3.8 (Farm Operations), 4.3 (Agriculture in the Watershed), and 5.0 (Zip Code Profiles) of the Social Profile	Mail postcards on proper use and application of fertilizers; information compiled by Michigan State University Extension (400 notices for 8 counties).	Write articles for conservation district/county newsletters about proper use and application of fertilizers (8 articles for 8 counties).	Assist 5 farms in developing Comprehensive Nutrient Management Plans (CNMP).	Michigan Department of Agriculture, Groundwater Stewardship Program, Conservation Districts	Postcards: $0.85/postcard x 400 plus 20 hours. Articles: 16 hours ($40/hr). CNMP assistance: 40 hours. Total = $3,380	LGROW and Michigan State University Extension	Number of contacts resulting from mailers and articles. Number of farms with completed CNMPs.	
		Develop and distribute 1,600 mailers (160 per critical area) on proper manure application, livestock access issues, and benefits of vegetative buffers.	Distribute 1,600 (160 per critical area) brochures on available incentive programs.	Develop sustainable farm award program with the MDA to acknowledge and promote farms with sound environmental practices.	Natural Resources Conservation Service, Conservation Districts, Michigan State University Extension, MDNRE	Mailers: $0.10/mailer x 1,600 plus 8 hours ($40/hr). Brochure: $0.70/brochure x 1,600 plus 20 hours. Coordination with MDA: 4 hours/ meeting x 6. Total = $3,360	LGROW and Michigan Department of Agriculture	Number of contacts made as a result of mailers/brochures. Adoption of farm award program by the MDA.	Annual Website or Paper Questionnaire, Focus Group, and/or Telephone Survey

Table 7.1d – Information & Education Strategy to Address Nutrients

Pollutant 3: Nutrients									
WMP Goal No. 3: Restore and maintain waterbodies for other indigenous aquatic life and wildlife use. **WMP Goal No. 4:** Restore and maintain waterbodies for cold water fishery use. **WMP Goal No. 5:** Restore and maintain waterbodies for warmwater fishery use.									
Objectives: 1) Implement manure management planning and implementation, 2) Implement livestock management practices at access sites, 3) Implement vegetative buffering practices and manure management planning and implementation, 4) Encourage proper septic tank management, 5) Implement proper fertilizer application practices, 6) Implement vegetative buffering practices, 7) Implement MDNRE population management practices, and 8) Implement sanitary sewer maintenance practices.									
Message: Human actions increase nutrients in waterbodies and adversely affect water quality. Nutrient rich waters encourage excessive plant growth, deplete oxygen, and impair aquatic habitats.									
Critical Areas: Impaired Uses: Lake Creek; Deer Creek; Upper Thornapple River (Low DO); Threatened Uses: Bass River; Buck Creek; Coldwater River; Plaster Creek; Upper/Lower Rogue River; Spring Lake/Norris Creek; Sand Creek									
		Measurable Milestone							
Target Audience	Social Profile*	Awareness (within 1 year)	Education (within 3 years)	Action (within 5 years)	Potential Partners	Estimated Costs	Responsible for Implementation	Activity Specific Evaluation Method	Watershed-wide Evaluation Method
Riparian Landowners	Social profile to be determined	Develop and advertise a program for riparian tree/vegetn planting in local newspapers & conservation districts' tree sale notices (300 notices for 3 impaired critical areas).	Conduct 2 workshops about importance of riparian habitats and tree sales in coordination with Arbor Day.	Assist 10 riparian landowners with planting trees and riparian vegetation for runoff filtration.	County Planning Commissions, County Drain Comsners, Conservation Districts, Natural Resources Conservation Service, Homeowner's Associations	Riparian planting program: $3,000 to dvlp. program, $0.10/notice x 300 plus 16 hrs ($40/hr). Workshops: $300/workshop plus 18 hrs. Riparian plantings: $1,000/buffer x 10 plus 40 hrs. Total = $16,680	LGROW	Number of contacts resulting from notices. Results of exit questionnaires following workshops. Number of feet of vegetation planted in the riparian zone.	
Rural Residents	See sections 2.0 (Who lives in the LGRW?), 4.7 (WW), 5.0 (Zip Code profiles), and 6.1.3 (Survey Results - Survey Participants from Rural and Urban Zip Codes) of the Social Profile	Post online info. on proper septic system maintenance using Facebook, YouTube, or watershed websites. Link information to 8 county websites.	Distribute 1,600 copies of EPA's "A Homeowner's Guide to Septic Systems" brochure (160 per critical area).	Complete and advertise 40 (4 per critical area) septic system repairs.	MDNRE, Michigan State University Extension Conservation Districts	Online info.: 16 hours ($40/hr). Brochures: $0.50/copy x 1,600 plus 5 hrs. Repair advrtsmnts: $0.25/ad x 30 plus 16 hrs; costs for repairs covered by existing programs. Total = $2,290	LGROW and Health Departments	Number of website hits. Number of phone calls/website hits in response to brochure. Number of additional septic system repairs completed.	Annual Website or Paper Questionnaire, Focus Group, and/or Telephone Survey

Table 7.1d – Information & Education Strategy to Address Nutrients

Pollutant 3: Nutrients									
WMP Goal No. 3: Restore and maintain waterbodies for other indigenous aquatic life and wildlife use. **WMP Goal No. 4:** Restore and maintain waterbodies for cold water fishery use. **WMP Goal No. 5:** Restore and maintain waterbodies for warmwater fishery use.									
Objectives: 1) Implement manure management planning and implementation, 2) Implement livestock management practices at access sites, 3) Implement vegetative buffering practices and manure management planning and implementation, 4) Encourage proper septic tank management, 5) Implement proper fertilizer application practices, 6) Implement vegetative buffering practices, 7) Implement MDNRE population management practices, and 8) Implement sanitary sewer maintenance practices.									
Message: Human actions increase nutrients in waterbodies and adversely affect water quality. Nutrient rich waters encourage excessive plant growth, deplete oxygen, and impair aquatic habitats.									
Critical Areas: Impaired Uses: Lake Creek; Deer Creek; Upper Thornapple River (Low DO); Threatened Uses: Bass River; Buck Creek; Coldwater River; Plaster Creek; Upper/Lower Rogue River; Spring Lake/Norris Creek; Sand Creek									
		Measurable Milestone							
Target Audience	Social Profile*	Awareness (within 1 year)	Education (within 3 years)	Action (within 5 years)	Potential Partners	Estimated Costs	Responsible for Implementation	Activity Specific Evaluation Method	Watershed-wide Evaluation Method
Outdoor Enthusiasts	See section 6.1.3 (Survey Results - Passive and Active Recreation) of the social profile	Develop and install 16 signs (1-2 per critical area) with "Please don't feed waterfowl" advertisement, developed by the Watershed Center.	Develop and distribute 1,600 (160 per critical area) brochures at state/local parks.	Advertise 1 population management demonstration project in LGRW in coordination with the MDNRE.	Health Departments, Parks and Recreation Departments, State Parks, Outdoor Recreation Organizations, MDNRE	Signs: $150/sign x 16 plus 80 hours ($40/hr). Brochures: $0.70/brochure x 1,600 plus 30 hours. Advertisements: $0.25/ad x 8 plus 8 hours. Total = $8,242	LGROW	Observation survey to determine reduction in the number of people who feed wildlife.	
Local Units of Government	See attachment 1 (Zip Code Profiles) of the social profile	Develop and distribute 125 brochures (25 per targeted county) on septic system regulations and value of upgrading aging/leaking sanitary sewers.	Conduct 5 workshops on septic system regulations for Muskegon, Newaygo, Montcalm, Kent, and Ionia Counties.	Assist counties with adoption of regulations or ordinances and finding needed funding for sewer upgrades.	Health Departments, Conservation Districts, Michigan State University Extension, MDNRE	Brochures: $0.70/copy x 125 plus 16 hours ($40/hr). $300/workshop x 5 plus 40 hours; $5,000/ordinance development x 5. Total = $28,828	LGROW and Health Departments	Number of phone calls in response to brochures. Attendance and exit questionnaires at workshops. Number of adopted regulations or ordinances. Number of upgraded sanitary sewer miles.	Annual Website or Paper Questionnaire, Focus Group, and/or Telephone Survey

Table 7.1e – Information & Education Strategy to Address Unstable Hydrology

Pollutant 4: Unstable Hydrology									
WMP Goal No. 3: Restore and maintain waterbodies for other indigenous aquatic life and wildlife use. **WMP Goal No. 4:** Restore and maintain waterbodies for cold water fishery use. **WMP Goal No. 5:** Restore and maintain waterbodies for warmwater fishery use.									
Objectives: 1) Restore and protect wetlands, 2) Minimize the impact of tiles and drainage networks on hydrology, 3) Restore and protect floodplains, and 4) Use alternative techniques and stream restoration practices (e.g. two-stage channel design, in-stream structures) when drain maintenance is necessary.									
Message: Changes in land use impact stream flows, creating water quality, stream stability, and flooding concerns.									
Critical Areas: Threatened Uses: Coldwater River; Crockery Creek; Direct Drainage to Lower Grand River; Lower/Upper Thornapple River; Plaster Creek; Upper/Lower Rogue River; Rush Creek; Sand Creek									
Target Audience	Social Profile*	Measurable Milestone			Potential Partners	Estimated Costs	Responsible for Implementation	Activity Specific Evaluation Method	Watershed-wide Evaluation Method
		Awareness (within 1 year)	Education (within 3 years)	Action (within 5 years)					
Agricultural producers	See sections 3.8 (Farm Operations), 4.3 (Agriculture in the Watershed), and 5.0 (Zip Code Profiles) of the Social Profile	Publish newsletter article in Conservation District newsletters on the value of wetland/floodplain restoration, the impacts of tiles and channelization, and available incentive programs (one article for 8 counties).	Distribute 1,600 brochures (200 per impaired critical area) on available incentive programs to address the sources/causes of unstable hydrology issues.	Develop sustainable farm award program with the MDA to acknowledge and promote farms with sound environmental practices.	Natural Resources Conservation Service, Michigan State University, Conservation Districts, MDNRE	Articles: 12 hours ($40/hr). Brochure: $0.70/brochure x 1,600 plus 20 hours. Coordination with MDA: 4 hours/ meeting x 6. Total = $3,360	LGROW and Michigan Department of Agriculture	Number of contacts made as a result of articles/brochures. Adoption of farm award program by the MDA.	Annual Website or Paper Questionnaire, Focus Group, and/or Telephone Survey
Builders and Developers	See section 3.6 (Business Establishments) and Attachment 1 of the social profile	Post online information on watershed focused land use planning to reduce wetland, floodplain, and stream impacts using Facebook, YouTube, or watershed website. Email web links to contacts.	Facilitate 3 workshops on the use and value of the Landscape-Level Wetland Functional Assessment Tool.	Involve builders and developers in organizing 3 initiatives similar to the "Rein in the Runoff" campaign implemented in Spring Lake.	West Michigan Sustainable Business Forum, MDNRE, SEMCOG, Spring Lake, Annis Water Resources Institute, Home Builders Association	Online information: 16 hours ($40/hr). Workshops: $300/workshop plus 20 hours. Campaign initiative: $25,000. Total = $26,740	LGROW	Number of website hits. Exit questionnaires following workshops/ campaign meetings. Success at meeting campaign goals.	

Table 7.1e – Information & Education Strategy to Address Unstable Hydrology

Pollutant 4: Unstable Hydrology									
WMP Goal No. 3: Restore and maintain waterbodies for other indigenous aquatic life and wildlife use. **WMP Goal No. 4:** Restore and maintain waterbodies for cold water fishery use. **WMP Goal No. 5:** Restore and maintain waterbodies for warmwater fishery use.									
Objectives: 1) Restore and protect wetlands, 2) Minimize the impact of tiles and drainage networks on hydrology, 3) Restore and protect floodplains, and 4) Use alternative techniques and stream restoration practices (e.g. two-stage channel design, in-stream structures) when drain maintenance is necessary.									
Message: Changes in land use impact stream flows, creating water quality, stream stability, and flooding concerns.									
Critical Areas: Threatened Uses: Coldwater River; Crockery Creek; Direct Drainage to Lower Grand River; Lower/Upper Thornapple River; Plaster Creek; Upper/Lower Rogue River; Rush Creek; Sand Creek									
Target Audience	Social Profile*	Measurable Milestone			Potential Partners	Estimated Costs	Responsible for Implementation	Activity Specific Evaluation Method	Watershed-wide Evaluation Method
		Awareness (within 1 year)	Education (within 3 years)	Action (within 5 years)					
Local Units of Government	See attachment 1 (Zip Code Profiles) of the social profile	Post online information on 1) watershed focused land use planning to reduce wetland, floodplain, and stream impacts, and 2) alternative techniques to drain maintenance using Facebook, YouTube, or watershed website. Link information to 8 county websites.	Facilitate 3 workshops on the use and value of the Landscape-Level Wetland Functional Assessment Tool.	Develop 3 initiatives similar to the "Rein in the Runoff" campaign implemented in Spring Lake.	SEMCOG, MDNRE, Spring Lake, Annis Water Resources Institute	Online information: 16 hours ($40/hr). Workshops: $300/workshop plus 20 hours. Campaign initiative: $25,000. Total = $26,740	LGROW	Number of website hits. Exit questionnaires following workshops/ campaign meetings. Success at meeting campaign goals.	

* Gajewski, B. 2010. A Social Profile of the Lower Grand River Watershed. Center for Environmental Study, Grand Rapids, MI. 105 pp.

Table 7.1f – Information & Education Strategy to Address High Temperature

Pollutant 5: High Temperature									
WMP Goal No. 3: Restore and maintain waterbodies for other indigenous aquatic life and wildlife use. **WMP Goal No. 4:** Restore and maintain waterbodies for cold water fishery use. **WMP Goal No. 5:** Restore and maintain waterbodies for warmwater fishery use.									
Objective: 1) Restore and protect the stream buffer and canopy.									
Message: Human actions adversely impact the temperature of waterbodies. Lack of riparian vegetation and a dense drain network cause increased stream temperatures.									
Critical Areas: Threatened Uses: Coldwater River; Plaster Creek; Sand Creek, Upper/Lower Rogue River									
		Measurable Milestone							
Target Audience	Social Profile*	Awareness (within 1 year)	Education (within 3 years)	Action (within 5 years)	Potential Partners	Estimated Costs	Responsible for Implementation	Activity Specific Evaluation Method	Watershed-wide Evaluation Method
Riparian Landowners	Social profile to be determined	Develop and advertise a program for riparian tree planting in local newspapers and conservation districts' tree sale notices (400 notices for 4 threatened critical areas).	Conduct 2 workshops about importance of riparian habitats and tree sales in coordination with Arbor Day.	Assist 10 riparian landowners with planting trees.	County Planning Commissions, County Drain Commissioners, Conservation Districts, Natural Resources Conservation Service	Tree planting program: $3,000 to develop program, $0.10/notice x 400 plus 16 hours ($40/hr). Workshops: $300/workshop plus 18 hours. Tree plantings: $1,000/buffer x 10 plus 40 hours. Total = $16,690	LGROW	Number of contacts resulting from notices. Results of exit questionnaires following workshops. Number of trees planted in the riparian zone.	Annual Website or Paper Questionnaire, Focus Group, and/or Telephone Survey
Local Units of Government	See attachment 1 (Zip Code Profiles) of the social profile	Develop and distribute fact sheet on Low Impact Development (LID) practices to reduce impervious surfaces (125 copies for 5 counties).	Conduct one workshop for each of the 5 counties that need LID storm water criteria (Kent, Ottawa, and Montcalm Counties are adopting LID criteria).	Adopt LID ordinance in the 5 counties that need LID storm water criteria.	County and Local Planning Commissions, County Drain Commissioners, Conservation Districts, Economic Development Committees	Fact Sheet: $0.25/fact sheet x 125 plus 12 hours ($40/hr). Workshop: $300/workshop x 5 plus 25 hours. Ordinance: $5,000/ordinance assistance x 5. Total = $28,010	LGROW	Website hits in response to fact sheets. Exit questionnaires following workshops. Number of LID ordinances adopted.	

* Gajewski, B. 2010. A Social Profile of the Lower Grand River Watershed. Center for Environmental Study, Grand Rapids, MI. 105 pp.

Table 7.1g – Information & Education Strategy to Address Habitat Fragmentation

Pollutant 6: Habitat Fragmentation									
WMP Goal No. 3: Restore and maintain waterbodies for other indigenous aquatic life and wildlife use. **WMP Goal No. 4:** Restore and maintain waterbodies for cold water fishery use. **WMP Goal No. 5:** Restore and maintain waterbodies for warmwater fishery use.									
Objective: 1) Implement watershed focused land use planning.									
Message: Fragmented habitats result in the degradation of wildlife populations.									
Critical Areas: Impaired Uses: Direct Drainage to Lower Grand River (York Creek); Threatened Uses: Entire Watershed									
		Measurable Milestone							
Target Audience	Social Profile*	Awareness (within 1 year)	Education (within 3 years)	Action (within 5 years)	Potential Partners	Estimated Costs	Responsible for Implementation	Activity Specific Evaluation Method	Watershed-wide Evaluation Method
Local Units of Government	See section 4.4 (Parks, Recreation and Tourism) and Attachment 1 (Zip Code Profiles) of the Social Profile	Develop and distribute 200 mailers on the benefits of green corridors/natural connections (200 for 8 counties).	Develop and distribute 200 booklets on the green corridor/natural connections plan for the LGRW (200 for 8 counties).	Provide 4 presentations for county governments on land use planning methods to preserve/restore green corridors/natural connections.	Parks and Recreation Departments, Land Conservancies, Nature Conservancies	Mailers: $0.10/copy x 200 plus 8 hours ($40/hr). Booklets: $1.00/copy x 200 plus 40 hours. Presentations: $300/presentation x 4 plus 25 hours. Total = $ 4,340	LGROW and Annis Water Resources Institute	Number of phone calls/website hits in response to mailers/booklets. Attendance at presentations. Implementation status of green corridor/natural connections plan.	Annual Website or Paper Questionnaire, Focus Group, and/or Telephone Survey

* Gajewski, B. 2010. A Social Profile of the Lower Grand River Watershed. Center for Environmental Study, Grand Rapids, MI. 105 pp.

Table 7.1h – Information & Education Strategy to Address Chemicals

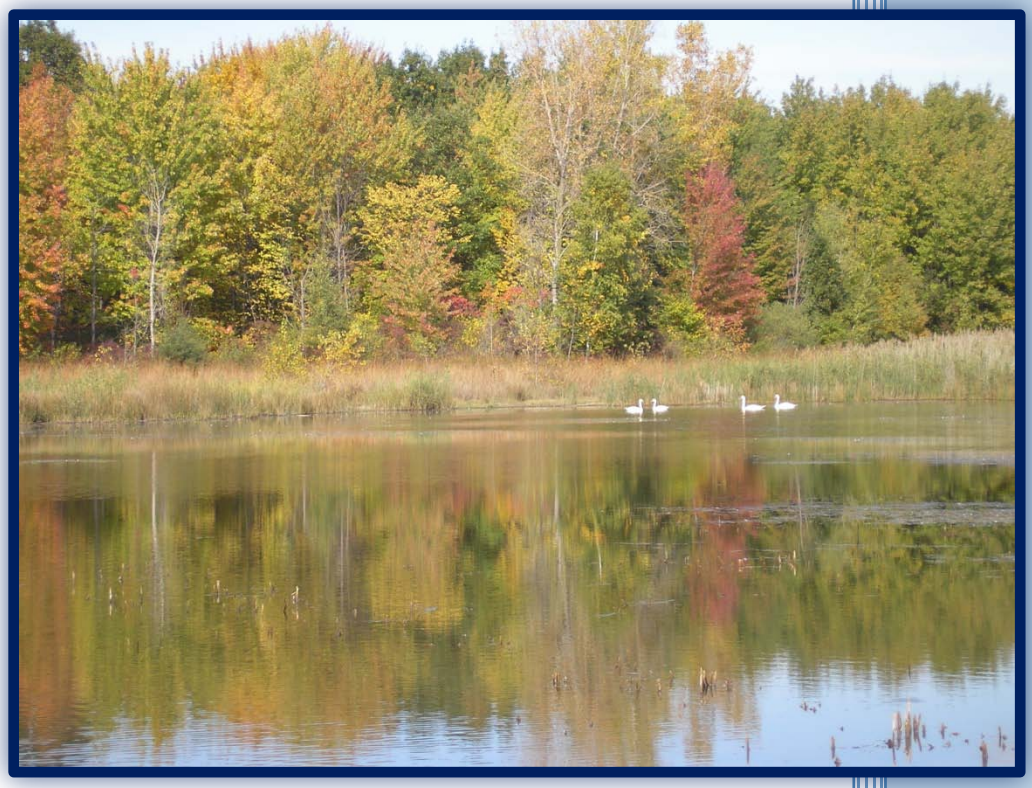
Pollutant 7: Chemicals									
WMP Goal No. 3: Restore and maintain waterbodies for other indigenous aquatic life and wildlife use. **WMP Goal No. 4:** Restore and maintain waterbodies for cold water fishery use. **WMP Goal No. 5:** Restore and maintain waterbodies for warmwater fishery use.									
Objectives: 1) Implement turf management practices, 2) implement turf management practices, 3) restore and protect the stream buffer and canopy, and 4) implement watershed focused land-use planning.									
Message: Human actions increase the amount of toxic chemicals in waterbodies and adversely affect water quality. Do your part to keep you and your family safe and healthy.									
Critical Areas: Entire Watershed									
Target Audience	Social Profile*	Measurable Milestone			Potential Partners	Estimated Costs	Responsible for Implementation	Activity Specific Evaluation Method	Watershed-wide Evaluation Method
		Awareness (within 1 year)	Education (within 3 years)	Action (within 5 years)					
Agricultural Producers	See sections 3.8 (Farm Operations), 4.3 (Agriculture in the Watershed), 4.5 (Solid Waste Management and Recycling), and 5.0 (Zip Code Profiles), of the Social Profile	Mail postcards on 1) the availability of Integrated Pest Management (IPM) Resources, developed by Michigan State University Extension, and 2) EQIP funding opportunities (400 for 8 counties).	Write articles for conservation district/county newsletters about proper IPM resources and EQIP funding opportunities (8 articles for 8 counties).	Assist 5 farms in applying for incentive payments through EQIP to implement IPM practices.	Michigan Department of Agriculture, Groundwater Stewardship Program, Conservation Districts, MDNRE	Postcards: $0.85/postcard x 400 plus 20 hours. Articles: 16 hours ($40/hr). EQIP assistance: 40 hours. Total = $3,380	LGROW and Michigan State University Extension	Number of contacts resulting from notices and articles. Number of farms enrolled in EQIP program.	Annual Website or Paper Questionnaire, Focus Group, and/or Telephone Survey

Table 7.1h – Information & Education Strategy to Address Chemicals

Pollutant 7: Chemicals									
WMP Goal No. 3: Restore and maintain waterbodies for other indigenous aquatic life and wildlife use. **WMP Goal No. 4:** Restore and maintain waterbodies for cold water fishery use. **WMP Goal No. 5:** Restore and maintain waterbodies for warmwater fishery use.									
Objectives: 1) Implement turf management practices, 2) implement turf management practices, 3) restore and protect the stream buffer and canopy, and 4) implement watershed focused land-use planning.									
Message: Human actions increase the amount of toxic chemicals in waterbodies and adversely affect water quality. Do your part to keep you and your family safe and healthy.									
Critical Areas: Entire Watershed									
Target Audience	Social Profile*	Measurable Milestone			Potential Partners	Estimated Costs	Responsible for Implementation	Activity Specific Evaluation Method	Watershed-wide Evaluation Method
		Awareness (within 1 year)	Education (within 3 years)	Action (within 5 years)					
Riparian Landowners	See section 4.5 (Solid Waste Management and Recycling) of the social profile	Develop and advertise a program for riparian tree/vegetation planting in local newspapers and conservation districts' tree sale notices.	Conduct 2 workshops about importance of riparian habitats and tree sales in coordination with Arbor Day.	Assist 10 riparian landowners/golf courses with planting trees and riparian vegetation for runoff filtration.	County Planning Commissions, County Drain Commissioners, Conservation Districts, Natural Resources Conservation Service, Homeowner's Associations	Riparian planting program: $3,000 to develop program, $0.10/notice x 100 plus 16 hours ($40/hr). Workshops: $300/workshop plus 18 hours. Riparian plantings: $1,000/buffer x 10 plus 40 hours. Total = $16,660	LGROW	Number of contacts resulting from notices. Results of exit questionnaires following workshops. Number of feet of vegetation planted in the riparian zone.	

Annual Website or Paper Questionnaire, Focus Group, and/or Telephone Survey

Chapter 8 – Methods of Measuring Progress



8.0 METHODS OF MEASURING PROGRESS

OBJECTIVES

- How will the Watershed's progress be quantified?
- What conditions need to be monitored in order to gauge progress?
- How will these conditions be monitored?
- How will the WMP be evaluated?

8.1 MEASURES OF SUCCESS

Measures of success are essential to any project to evaluate and assess the achievements of the project, and determine the benefits to water quality and the quality of life resulting from the implementation of the Best Management Practices (BMPs). The success of the project toward meeting its goals of improving water quality and restoring the designated uses of the Lower Grand River Watershed (Watershed) depends on many factors, all of which need to be continuously evaluated.

Various groups are currently monitoring several parameters in the Watershed, as described in Table 8.1. Some are conducted at a local level, such as the City of East Grand Rapids monitoring Reeds Lake, while others are administered at the county and state levels, such as the beach monitoring program. Establishing monitoring targets, against which observed measurements are compared, helps the Steering Committee determine whether progress is being made toward targets and ultimately the Watershed goals. The targets set are not enforceable, just a measure for the Steering Committee to use to gauge the implementation efforts. Section 8.2 describes measurements that can be taken to indicate overall water quality. Section 8.3 describes ongoing Watershed monitoring efforts. Section 8.4 outlines Watershed monitoring components to evaluate overall changes in Watershed conditions. Section 8.5 describes the Volunteer Monitoring Toolbox and its application to subwatershed evaluation. Section 8.6 provides the evaluation framework to assess the success of the WMP implementation efforts.

8.2 INDICATORS OF OVERALL WATER QUALITY

8.2.1 Measurements

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

Measurements are defined by categories of indirect indicators 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 would be measuring 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.

Measurements will be used to determine whether the pollutant load reduction goals are being met, as calculated in Tables 6.3 through 6.6. Pollutant reduction criteria have been established for the known and suspected pollutants of the Watershed as described below.

Pathogens and Bacteria

Pathogen monitoring programs should be designed to determine whether surface waters meet WQS for partial and total body contact recreation between May 1 and October 31. R 323.1062 State of Michigan Part 4 Water Quality Standards requires that all waters of the state shall be protected for total body contact recreation and shall not contain more than 130 *E. coli* (*Escherichia Coli*) per 100 milliliter (mL) as a 30-day geometric mean. In addition, at no time shall the waters of the state protected for total body contact contain more than 300 *E. coli* per 100 mL, as a geometric mean of at least three samples collected during the same sampling event.

The criteria for evaluating *E. coli* will be based on water samples collected and tested for levels of *E. coli.* Results will be analyzed for exceedances of Water Quality Standards (WQS) for partial and total body contact recreation. Recommendations for monitoring include *E. coli* monitoring by the MDNRE as part of the Watershed-wide biological survey every 5 years, and the subsequent monitoring of reaches with pending or approved TMDLs (Figure 3.1 B).

Another recommendation is to monitor the status of BMP implementation to eliminate identified *E. coli* contributing sources, such as failing septic systems. Municipalities and county health departments can track implementation where septic system failures are suspected. Permitted waste dischargers currently monitor for coliform bacteria as specified in their permits.

Sediment

The criteria for sediment evaluation would be reaching a goal of WQS for 80 mg/L (milligrams per liter) for total suspended solids (TSS) measured by a certified laboratory; more sites having sedimentation consistent with the soil types as rated through the pebble count; implementation of BMPs on all identified nonpoint source (NPS) sites of sediment loading; and a measurable increase in the water quality and macroinvertebrate rating, as rated through the Great Lakes and Environmental Assessment Section (GLEAS) Procedure No. 51 (P51) survey for macroinvertebrates. The measurements for sediment reduction will use the following: (1) before and after TSS measurements, (2) pebble count survey data, (3) P51 survey data, (4) number of BMPs implemented, and (5) before and after photos of BMPs. Plaster Creek is the one exception in the Watershed related to its criteria for sediment evaluation. The Plaster Creek TMDL has a goal for TSS of 30 mg/L instead of 80 mg/L. Other monitoring recommended includes an evaluation of streambank erosion.

Nutrients

According to the Michigan Department of Natural Resources and Environment (MDNRE), nutrients shall be limited to the extent necessary to prevent stimulation of growth of aquatic rooted, attached, suspended, and floating plants, fungi, or bacteria which are or may become injurious to the designated

uses of the surface waters of the state. Nutrient reduction goals should align with the total maximum daily loads (TMDLs) that have been established for the Watershed. For Morrison Lake, the spring turnover period must meet the target value of 0.030 mg/L over a sustained period of time and under various flow regimes. The measurements for nutrient reduction will include before and after water quality data (DO, chlorophyll a, phosphorus, and other parameters listed in Table 8.1), number of BMPs implemented, and photos of the site before and after implementation of BMPs.

Water grab samples should be collected from surface waters with elevated nutrient concentrations. These waterways may experience occasional algal blooms with the input of phosphorus and nitrogen from surface water runoff. Livestock, septic tanks, cropland and urban landscapes, ducks and geese, and sanitary sewer leaks are all known or suspected sources of nutrients in the Watershed. Nutrient monitoring is recommended for stream reaches and lakes on the State's 303(d) list for organic enrichment (Figure 3.1D), phosphorus (Figure 3.1C), and dissolved oxygen (Figure 3.1A).

High Temperature

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 coldwater and warmwater streams.

To support a coldwater fishery, heat load cannot cause exceedance of monthly limits (maximum 68°F in June, July, and August). To support a warmwater fishery, heat load cannot cause exceedance of monthly limits (maximum 77°F in July and August [Creal and Wuycheck 2002]). Measurements for temperature impacts include before and after water quality data (DO, temperature), P51 fisheries and macroinvertebrate data, number of BMPs implemented, and photos of the site before and after implementation of BMPs.

Continuously recording data loggers (such as HOBO Pro v2, http://www.onsetcomp.com/products/data-loggers/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.

Sites currently monitored for temperature are included in Table 8.1.

Schrems West Michigan Trout Unlimited (TU) completed temperature studies in the spring and summer of 2009. They are trying to identify the impact of agriculture practices on coldwater streams. Temperature data was collected at the following locations:

- Prairie Creek, Ionia County: Charles Road and Prairie Creek Road
- Rogue River, Kent County: Packer Road below and above the Rockford Dam on Stegman Creek; the Rogue River below and above Stegman Creek's outlet to the Rogue River; on Cedar Creek; and the Rogue River below and above Cedar Creek's outlet to the Rogue River.
- Tyler Creek, Kent County: At Pratt Lake Drain, on Bear Creek, and on Tyler Creek on the Dolan property near the confluence with the Coldwater River.

Additional sites should be identified in coordination with TU current temperature monitoring program. Baseline information in other subwatersheds will be useful and necessary for measuring improvements related to the installation of BMPs.

Chemicals

The criteria for chemical evaluation will be based on implementing BMPs on areas where chemical containment facilities are constructed or chemicals are applied to the land. Chemicals will be prevented from reaching surface water by using proper application methods and amounts, and the use of filter and

buffer strips where appropriate. Measurements for reduction of chemicals include before and after water quality data (chemical analysis), P51 fisheries and macroinvertebrate data, number of BMPs implemented, and photos of the site before and after implementation of BMPs.

8.3 ONGOING WATERSHED MONITORING EFFORTS

Monitoring activities within the Watershed have been conducted by many partners, as described in Table 8.1. This table serves as the basis for developing the environmental monitoring component for this WMP. Particular attention to future monitoring will be given to stream reaches identified on the State's 303(d) list in the Integrated Report. (Figures 3.1 A-D). Table 8.1 lists significant previous and current water quality monitoring programs in the Watershed, sorted by the organization conducting the monitoring.

Table 8.1 – Water Quality Monitoring and Evaluation for the Watershed

Monitoring Site(s)	Parameter Target	Type of Analysis	Protocol	Status	Frequency	Test Agent
Organization(s) – MDNRE						
Grand River and its tributaries (including Libhart, Tibbets, Crooked Creek & Deer Creek)	Water Chemistry	TDS, Total Phosphorus, Nitrogen	MDNRE Protocol	Conducted in 2003	Once every 5 years (scheduled for 2013)	MDNRE
Flat River	Macroinvertebrate community and stream habitat	Biological survey	GLEAS P51	Conducted, most recently, in July & August 2008.	Once every 5 years (2013)	MDNRE
Rogue River	Macroinvertebrate community and stream habitat	Biological survey	GLEAS P51	Conducted, most recently, in July 2008.	Once every 5 years (2013)	MDNRE
Thornapple River	Macroinvertebrate community and stream habitat	Biological survey	GLEAS P51	Conducted, most recently, in July 2008.	Once every 5 years (2013)	MDNRE
Lower Grand River	Macroinvertebrate community and stream habitat	Biological survey	GLEAS P51	Conducted, most recently, in June, July & August 2004.	Once every 5 years (2014)	MDNRE
Lower Grand River	Water Chemistry	TDS, Total Phosphorus, Nitrogen	MDNRE Protocol	Conducted, most recently, in July & August 2009.	Once every 5 years (2014)	MDNRE
Coldwater River	Macroinvertebrate community	Macroinvertebrate Survey	MDNRE Protocol/ GLEAS P51	Conducted in 2008	Once every 5 years (2013)	MDNRE
Entire Watershed	Hydrologic assessment to evaluate the impact of urban development on the stability of stream channels in the Watershed; and compare the erosion potential of several common storm water management approaches for stream protection, to ensure that effective controls are being requested by local units of government within the Watershed.	Hydrology	MDNRE Protocol	Conducted in 2009	Not currently monitored	Consultants, MDNRE

Table 8.1 – Water Quality Monitoring and Evaluation for the Watershed

Monitoring Site(s)	Parameter Target	Type of Analysis	Protocol	Status	Frequency	Test Agent
Bear Creek	Hydrologic assessment to help determine the effect of land use changes in the Watershed on Bear Creek's flow regime, evaluate what effect potential urbanization will have on peak stream flows, and to provide design flows for streambank stabilization BMPs.	Hydrology	MDNRE Protocol	Conducted in 2003	Not currently monitored	MDNRE
Cedar Creek	Hydrologic assessment to help determine the effect of land use changes in the Watershed on Cedar Creek's flow regime, and to provide design flows for streambank stabilization BMPs.	Hydrology	MDNRE Protocol	Conducted in 2004	Not currently monitored	MDNRE
Coldwater River	Hydrologic assessment to help determine the effect of drainage system alterations and land use changes on the Coldwater River's flow regime, and to provide design flows for streambank stabilization BMPs.	Hydrology	MDNRE Protocol	Conducted in 2003	Not currently monitored	MDNRE
Hager Creek	Hydrologic analysis of Hager Creek Reference Reaches, including a comparison of the physical characteristics of the Watersheds and calculation of surface runoff volumes and peak flows.	Hydrology	MDNRE Protocol	Conducted in 2002	Not currently monitored	MDNRE
Sand Creek	Hydrologic assessment to help determine the effect of land use changes in the Watershed on Sand Creek's flow regime, and to provide design flows for streambank stabilization BMPs.	Hydrology	MDNRE Protocol	Conducted in 2003	Not currently monitored	MDNRE

Table 8.1 – Water Quality Monitoring and Evaluation for the Watershed

Monitoring Site(s)	Parameter Target	Type of Analysis	Protocol	Status	Frequency	Test Agent
Thornapple River	Hydrology	Volume and velocity measurements	MDNRE Protocol	Conducted in 2008	Not currently monitored	MDNRE
Plaster Creek Watershed: Plaster Creek at Market Street; Godfrey Street; 28th Street; Schaffer Street; 44th Street; 60th Street; 68th Street tributary at 28th Street; 60th Street	Pathogens	(*E. coli* count/100 mL)	MDNRE Protocol	Conducted in 2002	Once/5 Years	MDNRE
Organization(s) – West Michigan Environmental Action Council (WMEAC)						
Rogue River Watershed: Barkley, Rum, Shaw, and Stegman Creeks on Northland Drive; Becker Creek on Lyons Property; Rogue River at Rector and Jericho; Cedar Creek at Friske; Duke Creek at Division	Macroinvertebrate community, Sediment, and Temperature	Stream Habitat Assessment; Benthic Macroinvertebrates	MDNRE Protocol/GLEAS P51	2009 – 2019	2 times/year (spring and fall)	WMEAC
Rush Creek	Macroinvertebrate/Habitat Analysis	Benthic Macroinvertebrates/Habitat Analysis	MiCorps Volunteer Stream Monitoring Procedure/MiCorps Habitat Analysis	2009-Present	1 time/year (fall)	WMEAC volunteers
Plaster Creek at Division; Plaster Creek Family Park	Macroinvertebrate community	Macroinvertebrate Survey	MDNRE Protocol/GLEAS P51	2000 – Present	Once/Year	WMEAC Volunteers
Organization(s) – Michigan Lakes and Stream Association Members						
Rogue River Watershed: Bills Lake, Freska Lake, Big Pine Island Lake, High Lake	Temperature and Nutrients	Total Phosphorus	Cooperative Lakes Monitoring Program	2009 – 2019	2 times/year (spring/late summer)	Michigan Lakes and Stream Association Members
		Chlorophyll a			1/month (May – September)	
		DO			Every 2 weeks (May – September)	
		Water Temperature			Every 2 weeks (May – September)	
		Carlson's Trophic State Index (Transparency)			18 weekly measurements (May – September)	

Table 8.1 – Water Quality Monitoring and Evaluation for the Watershed

Monitoring Site(s)	Parameter Target	Type of Analysis	Protocol	Status	Frequency	Test Agent
Organization(s) – Kent County Health Department						
Rogue River Watershed: Long Lake and Myers Lake	Pathogens	*E. coli*	MDNRE Protocol	2009 – 2019	1 time/year: summer	Kent County Health Department
Organization(s) – City of Grand Rapids		***sent to Ed V. to revise 9-21-10, sent to Kurt Anderson for review.***				
Plaster Creek at Burton Street; Silver Creek at Croften	Temperature	Temperature (°C)	Hand-held Temperature probe	1985 – Present	Quarterly	City of Grand Rapids
	DO	DO (%)	Standard Methods 18th Ed., SM, 4500G			
	pH	pH	SM 4500B			
	BOD	BOD (mg/L)	SM 5210B			
	TSS	TSS (mg/L)	SM 2540D			
	Pathogens	Fecal Coliform	SM 9222D			
	Sodium Chloride	Sodium Chloride (mg/L)	SM 4500E			
	Phosphorus	Phosphorus (mg/L)	SM 4500E B5			
	Nitrate	Nitrate (mg/L)	SM 4500E			
	Nitrite	Nitrite (mg/L)	SM 4500B			
Organization(s) – City of East Grand Rapids						
Two established stations on Reeds Lake	Phosphorus	Phosphorus (mg/L)	MDNRE Protocol	Conducted in 2008	Every other year (next is 2010)	City of East Grand Rapids
	Chloride	Chloride (mg/l)	MDNRE Protocol			
	Temperature	Temperature (°C)	MDNRE Protocol			
	Dissolved Oxygen	DO (%)	MDNRE Protocol			
	pH	pH	MDNRE Protocol			
	Conductivity	Conductivity (Microsemens)	MDNRE Protocol			
	Dissolved Solids		MDNRE Protocol			
	Transparency		MDNRE Protocol			

Table 8.1 – Water Quality Monitoring and Evaluation for the Watershed

Monitoring Site(s)	Parameter Target	Type of Analysis	Protocol	Status	Frequency	Test Agent
Organization(s) – MS4 Permitees						
Outfalls throughout urbanized areas of Watershed (see NPDES MS4 IDEP program)	Temperature	Temperature (°C)	Hand-held Temperature probe	Conducted in 2004	Once/5 Years	MS4 Communities/FTC&H
	Conductivity	Conductivity (Microsemens)	Hand-held Conductivity probe			
	pH	pH	Hand-held pH probe			
	Ammonia	Ammonia (mg/L)	Test Strips			
	Copper	Copper (mg/L)	Test Strips			
	Nitrate	Nitrate (mg/L)	Test Strips			
	Nitrite	Nitrite (mg/L)	Test Strips			
	Phosphorus	Phosphorus (mg/L)	Test strips/HACH kit			
	Surfactants	Surfactants (presence/absence)	Jar/glass			
Organization(s) – Plaster Creek Steering Committee						
Plaster Creek at Market Street, Godfrey Street, 28th Street, Schaffer Street, 44th Street, 60th Street, and 68th Street Tributary at 28th Street and 60th Street	Pathogens	*E. coli* count/100 mL	MDNRE Protocol	Unknown	Monthly wet and dry weather sampling	Kent County Health Department and Grand Rapids Clean Water Plant
Plaster Creek at Godfrey Ave., Eastern Ave., 68th Street, and East Paris Avenue.	TSS	TSS (mg/L)	MDNRE Protocol	Unknown	Monthly	Grand Rapids Clean Water Plant

Table 8.1 – Water Quality Monitoring and Evaluation for the Watershed

Monitoring Site(s)	Parameter Target	Type of Analysis	Protocol	Status	Frequency	Test Agent
Organization(s) –CRWC and MDNRE						
Coldwater River - 8 sites	Pathogens, Sediment, Nutrients, DO, Temperature	*E. coli* MPN/100 mL	IDEXX method	Conducted from 2004 to 2009, MDNRE assessment in 2009	4x/yr Rain Event; 6x/yr - Summer (Not currently monitored)	Kent County Health Department, CRWC, Volunteers, MDNRE
		TSS (mg/L)	MDNRE Protocol	MDNRE assessment in 2009	6x/yr - Summer (Not currently monitored)	Kent County Health Department, CRWC, Volunteers, MDNRE
		Total Phosphorus/ Ortho phosphorus (mg/L)	MDNRE Protocol	MDNRE assessment in 2009	6x/yr - Summer (Not currently monitored)	Kent County Health Department, CRWC, Volunteers, MDNRE
		Nitrate/Nitrite (mg/L)	MDNRE Protocol	MDNRE assessment in 2009	6x/yr - Summer (Not currently monitored)	Kent County Health Department, CRWC, Volunteers, MDNRE
		DO	Handheld Specific Conductance/DO Meter	MDNRE assessment in 2009	6x/yr - Summer (Not currently monitored)	CRWC, Volunteers, MDNRE
		Temperature (°C)	Handheld Temperature Probe	MDNRE assessment in 2009	6x/yr - Summer (Not currently monitored)	CRWC, Volunteers, MDNRE
		Stream embeddedness	MDNRE Protocol	MDNRE assessment in 2009	6x/yr - Summer (Not currently monitored)	Kent County Health Department, CRWC, Volunteers, MDNRE

Table 8.1 – Water Quality Monitoring and Evaluation for the Watershed

Monitoring Site(s)	Parameter Target	Type of Analysis	Protocol	Status	Frequency	Test Agent
Organization(s) – Michigan State University – Water Quality & Health Laboratory						
Coldwater River (4 sites)	Pathogens, pH, Turbidity, Temperature	Bacterial source tracking	USEPA Method 1601/1602, mTec (APHA standard method 9222), PCR Human source marker, qPCR Bovine/human source marker, qPCR Human source marker	Assessed in 2007 – 2008. Reassess in 2011	3x/yr (dry) – Summer 3x/yr (wet) – Summer	MSU Water Quality & Health Laboratory
		pH	Handheld pH Probe			
		Turbidity	MDNRE Protocol			
		Temperature (°C)	Handheld Temperature Probe			
Buck Creek (2 sites)	Pathogens, pH, Turbidity, Temperature	Bacterial source tracking	USEPA Method 1601/1602, mTec (APHA standard method 9222), PCR Human source marker, qPCR Bovine/human source marker, qPCR Human source marker	Assessed in 2008	Weekly for 6 weeks in Summer	MSU Water Quality & Health Laboratory
Organization(s) – Bear Creek Watershed Council						
Bear Creek	Macroinvertebrate/Habitat Analysis	Benthic Macroinvertebrates/Habitat Analysis	MiCorps Volunteer Stream Monitoring Procedure/MiCorps Habitat Analysis	2010	1 time/year (fall)	Bear Creek Watershed Council, volunteers

Table 8.1 – Water Quality Monitoring and Evaluation for the Watershed

Monitoring Site(s)	Parameter Target	Type of Analysis	Protocol	Status	Frequency	Test Agent
Organization(s) – CRWC						
Coldwater River, Duck Creek, and Tyler Creek	Habitat, Nutrients, DO	Stream Habitat Assessment	USEPA Rapid Bioassessment	Ongoing	4x/yr	Lakewood Schools, Hastings Schools, Thornapple Kellogg Schools, Caledonia Schools, and the Lamps Home School Group, CRWC
		Nitrate/Nitrite (mg/L)	MDNRE Protocol	Ongoing	4x/yr	Lamps Home School Group, CRWC
		DO	Handheld Specific Conductance/ DO Meter	Ongoing	4x/yr	Lamps Home School Group, CRWC
		Total Phosphorus (mg/L)	MDNRE Protocol	Ongoing	4x/yr	Lamps Home School Group, CRWC
Coldwater River Watershed - Brown Road and Hastings Road	Macroinvertebrate community	Macroinvertebrate Survey	MDNRE Protocol/GLEAS P51	Ongoing	4x/yr	Thornapple Kellogg Schools, Lowell High School, and Home School Groups, CRWC
Coldwater River Watershed - Coldwater River and Tyler Creek	Number of Brown Trout	Electroshocking	MDNRE Protocol	2004, 2005, reassess in 2009	1x/yr	GVSU, CRWC
Coldwater River Watershed, 7 wells	Groundwater well monitoring for *E. coli*	*E. coli* MPN/100 mL	IDEX Method EPA	Scheduled for summer 2009	6x/yr – Summer	CRWC, MDNRE
Coldwater River Watershed: Baker, Morin, and Versluys	Rainfall	Rain gauge	Standard protocol	Ongoing, data from 2003 available	Continuous	CRWC
	Hydrology	Velocity (ft/sec)	Pygmy Flow Meter	Assessed in 2009	4x/year during wet and dry weather	CRWC, MDNRE, GVSU
Organization(s) – Schrems West Michigan Trout Unlimited						
Prairie Creek, Rogue River, and Tyler Creek	Temperature	Temperature (°C)	Handheld Temperature Probe	Assessed in 2009 (Spring and Summer)	Hourly (May through October)	Schrems West Michigan Trout Unlimited, Volunteers

Table 8.1 – Water Quality Monitoring and Evaluation for the Watershed

Monitoring Site(s)	Parameter Target	Type of Analysis	Protocol	Status	Frequency	Test Agent
Organization(s) – LGROW Partners/FTC&H						
Buck Creek (12 sites), Plaster Creek (13 sites), Coldwater River (17 sites)	Pathogens	*E. coli* count/100 mL	MDNRE Protocol	Sampling data collected as part of the LGRW *E. coli* Implementation Project (May 17, 2005 – October 31, 2007)	Monthly dry weather sampling; 3 wet weather sampling events; one-time microbial source tracking (6 sites only)	Kent County Health Department, Barry Eaton District Health Department
Organization(s) – Wastewater Treatment Plants						
Buck Creek, Plaster Creek	Temperature	Temperature (°C)	Hand-held Temperature probe	No sites yet identified	Not yet determined	Wyoming Clean Water Plant
	DO	DO (%)	Standard Methods 18th Ed., SM, 4500G			
	pH	pH	SM 4500B			
	BOD	BOD (mg/L)	SM 5210B			
	TSS	TSS (mg/L)	SM 2540D			
	Pathogens	Fecal Coliform	SM 9222D			
	Sodium Chloride	Sodium Chloride (mg/L)	SM 4500E			
	Phosphorus	Phosphorus (mg/L)	SM 4500E B5			
	Nitrate	Nitrate (mg/L)	SM 4500E			
	Nitrite	Nitrite (mg/L)	SM 4500B			
Organization(s) – MiCorps						
Thornapple River Watershed (46 sites)	Macroinvertebrate community	Macroinvertebrate Survey	MDNRE Protocol/GLEAS P51	May 23, 2007 – October 29, 2007	2x/year	Volunteers
	Temperature	Temperature (°C)	Handheld Temperature Probe	May 23, 2007 – October 29, 2007	2x/year	Volunteers
	DO	DO	Handheld Specific Conductance/DO Meter	May 23, 2007 – October 29, 2007	2x/year	Volunteers
	pH	pH	Handheld pH Probe	May 23, 2007 – October 29, 2007	2x/year	Volunteers

Table 8.1 – Water Quality Monitoring and Evaluation for the Watershed

Monitoring Site(s)	Parameter Target	Type of Analysis	Protocol	Status	Frequency	Test Agent
Lower Grand River Watershed (11 sites)	Macroinvertebrate community	Macroinvertebrate Survey	MDNRE Protocol/GLEAS P51	June 21, 2008 and October 4, 2008	2x/year	Volunteers
	Temperature	Temperature (°C)	Handheld Temperature Probe	June 21, 2008, October 4, 2008, and May 25, 2009	2x/year	Volunteers
	DO	DO	Handheld Specific Conductance/ DO Meter	June 21, 2008, October 4, 2008, and May 25, 2009	2x/year	Volunteers
	pH	pH	Handheld pH Probe	June 21, 2008, October 4, 2008, and May 25, 2009	2x/year	Volunteers

BMP best management practice
CRWC Coldwater River Watershed Council
DO dissolved oxygen
GVSU Grand Valley State University
GLEAS P51 Great Lakes and Environmental Assessment Section Procedure 51
IDEP Illicit Discharge Elimination Plan
MDNRE Michigan Department of Natural Resources and Environment
mg/L milligrams per liter
mL milliliter
MS4 Municipal Separate Storm Sewer System
MSU Michigan State University
NPDES National Pollutant Discharge Elimination System
TDS total dissolved solids
TSS total suspended solids
USEPA U.S. Environmental Protection Agency
WMEAC West Michigan Environmental Action Council

8.4 ENVIRONMENTAL ASSESSMENTS

8.4.1 Erosion Assessments

The purpose of conducting a Bank Erosion Hazard Index (BEHI) Assessment is: to increase the understanding of the Watershed's characteristics and the impact of changes on stream stability; to provide a basis for water quality recommendations; and to help determine critical areas. Bank erosion rates are quantified to develop sediment loading calculations and prioritize critical erosion sites.

Erosion monitoring, using "bank pins" or a similar method, should be conducted at a representative sample of erosion sites. One of the best ways to quantify bank erosion is to measure it directly in the field. A 4-foot rod is driven horizontally into an eroded streambank, flush with the surface, and the amount of exposed pin is measured over time. Results are useful for making accurate predictions of annual erosion and, when combined with other measurements, annual sediment loading. These results can be used for a number of purposes, including inclusion in grant applications for funding of implementation projects. A detailed description of the use of bank pins can be found on the internet at: http://www.dnr.state.wi.us/waterways/factsheets/Bank_pin_form.pdf

It is recommended to conduct erosion assessments using BEHI or bank pins, whatever method is most appropriate, along reaches with established TMDLs for siltation (Figure 3.1D), if streambank erosion is a concern. Monitoring efforts should be undertaken as soon as possible to establish baseline conditions. This baseline information will provide detailed measures of bank erosion prior to project implementation, which can later be used to calculate load reductions from installed BMPs.

8.4.2 Biological and Physical Habitat Monitoring

Metrics from the P51 physical habitat methods should be used to assess the amount of sediment present in the stream and the condition of the riparian corridor. Specifically, Metric 2 – Embeddedness and Metric 4 – Sediment Deposition are good measures of the amount of fine sediment present on the stream bottom. Care should be taken, however, to note the difference between a coarse bed stream covered with fine sediment, and a sand bed stream which is inherently composed of fine sediment. Another simple method useful for quantifying substrate composition, and degree of sedimentation, is the Wolman (1954) pebble count (http://relicensing.pcwa.net/documents/Library/PCWA-L-161.pdf). Relative to the riparian corridor, P51 Metrics 9 – Vegetative Protection and 10 – Riparian Vegetative Zone Width should be estimated.

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. Biological sampling is especially useful to document community changes following installation of BMPs. The MDNRE currently conducts this monitoring in various watersheds on somewhat regular cycles, so all additional efforts should be coordinated with the MDNRE to avoid duplicate sampling.

Biological and physical habitat monitoring should begin immediately on stream reaches with approved and pending TMDLs for siltation (Figure 3.1D). Baseline information will be useful and necessary for measuring improvements related to installation of BMPs.

8.4.3 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 should be conducted by a professional. Hydrologic monitoring is recommended for reaches impaired by anthropogenic flow alterations (Figure 3.1C) to establish trends over time.

8.4.4 Subwatershed Monitoring

sMonitoring stations should be established near the outlet of each of the 31 subwatershed management units as an initial screening and to obtain records of water quality over time. Pathogens, TSS, embeddedness, macroinvertebrate communities, nutrient parameters, and water temperature would be useful measures for monitoring larger-scale improvements to water quality on a subwatershed scale. Data could be collected by regular site visits by trained individuals. Potential sites for monitoring should also include the downstream ends of TMDL reaches (Figures 3.1A to 3.1D), and sites where NPS pollutants will be reduced due to installation of BMPs (Appendix 4.1). Additional monitoring sites have been identified in previously approved WMP for Buck Creek, Plaster Creek, and Coldwater River.

The MDNRE provides a monitoring request form for stakeholders to submit information about potential monitoring sites that follow surface water quality monitoring recommendations, to support implementation of the Watershed-specific component of the MDNRE's Strategic Environmental Quality Monitoring Program for Michigan 's Surface Waters (Strategy). More information and the request form can be found at: http://www.michigan.gov/deq/0,1607,7-135-3313_3686_3728-12735--,00.html

The Data, Information, and Procedures (DIP) Subcommittee has the responsibility to oversee future monitoring efforts in the LGRW. Table 8.2 outlines the strategy that the Committee will take to implement the assessment necessary to document improvements in the Watershed.

Table 8.2 – Assessment Strategy for the LGRW

Strategy Steps	Action Items	Potential Responsible Partners	Milestone
1. Review Existing Information	1. Review LGRW Management Plan's Monitoring Strategy (Chapter 8). 2. Review list of impaired waterways (reaches requiring TMDLs). 3. Review the MS4 storm water monitoring requirements.	1. LGROW/DIP Committee, WMEAC	Year 1 Qtr 1
		2. LGROW/DIP Committee, MDEQ, Subwatershed Groups with TMDL water bodies, County Drain Commissioners, Health Departments	Year 1 Qtr 1
		3. LGROW/DIP Committee, MS4 Communities, MDEQ	Year 1 Qtr 2
2. Determine Priorities	1. Select priority pollutant/impairment based on Step 1. 2. Select target subwatershed(s) based on Step 1.	1. LGROW/DIP Committee, WMEAC	Year 1 Qtr 3
		2. LGROW/DIP Committee. WMEAC	Year 1 Qtr 3
3. Gather Pertinent Resources	1. Identify organizations/projects with relevant data. 2. Send requests for this additional information. 3. Enter new data into the data repository.	1. LGROW/DIP Committee, MDEQ, WMEAC, GVSU	Year 2 Qtr 1
		2. GVSU	Year 2 Qtr 1
		3. GVSU	Year 2 Qtr 1
4. Identify Information Gaps	1. Identify data gaps for selected subwatersheds based on priorities.	1. LGROW/DIP Committee	Year 2 Qtr 2
5. Develop Assessment Strategy	1. Identify existing partners and programs (e.g., volunteer monitoring toolbox). 2. Identify tasks to build on existing efforts.	1. LGROW/DIP Committee, WMEAC	Year 2 Qtr 3
		2. LGROW/DIP Committee, WMEAC	Year 2 Qtr 3
6. Implement Assessment Strategy	1. Apply and secure funding. 2. Complete assessment strategy. 3. Implement project.	1. LGROW/Subwatershed groups	Year 2 Qtr 4
		2. LGROW, MS4 Communities	Year 3 Qtr 1
		3. LGROW/DIP Committee, WMEAC, MS4 Communities	Year 3 Qtr 1

DIP	Data, Information, and Procedures	MDEQ	Michigan Department of Environmental Quality
GVSU	Grand Valley State University	MS4	Municipal Separate Storm Sewer System
LGROW	Lower Grand River Organization of Watersheds	TMDL	total maximum daily loads
LGRW	Lower Grand River Watershed	WMEAC	West Michigan Environmental Action Council

8.5 VOLUNTEER MONITORING TOOLBOX

As part of the LGROW initiative, a volunteer stream monitoring toolbox (toolbox) was developed by the West Michigan Environmental Action Council (WMEAC). The purpose of this toolbox was to assist volunteer monitoring groups in implementing water quality monitoring programs in the LGRW. It is instrumental as a capacity-building tool, and is intended to simplify the process of Watershed protection by providing advice in determining which water quality parameters to sample, sampling frequency, sampling site selection, and appropriate methodology. An outline of the toolbox's approach is included in Appendix 8.1. The toolbox will be of value to Watershed residents for implementation at all levels of organization; from individually concerned citizens and Watershed councils, who seek to protect the water quality of the Grand River, to Municipal Planning units, who seek direction in complying with regulation mandates.

The toolbox took its shape following review and critique from various Watershed partners, including: the Grand Valley Metropolitan Council (GVMC), the MDNRE, Fishbeck, Thompson, Carr & Huber, Inc. (FTC&H), and the Annis Water Resources Institute (AWRI). Additionally, two training sessions were conducted with: (1) Calvin College, an institution that monitors Plaster Creek Watershed, and (2) Trinity Christian Reformed Church, a faith-based group that monitors the Rush Creek Watershed. During these training sessions, feedback forms were used to evaluate the toolbox for the purpose of enhancing its capabilities and user friendliness. The completed feedback forms are included in Appendix 8.1

Presently, the toolbox is embedded (http://148.61.56.211/ISCWEBDocuments/Stream%20Monitoring%20Toolbox.ppt) in an online PowerPoint format. The PowerPoint platform imposes inherent, but negotiable, limitations. As one navigates through the decision tree, the user can use the "previous slide" button to return to the previously viewed slide. However, the program will not allow the user to view a succession of previously viewed slides. Additionally, at various points, the toolbox takes the user into a separate internet browser, at which point the user cannot use the browser's "back" button to navigate back into the toolbox. These limitations can be overcome by simply returning to the first slide and running through the progression of slides iteratively. Future funding is being explored to create an internet platform that will overcome these limitations.

8.6 EVALUATION FRAMEWORK

8.6.1 Evaluation of Future Accomplishments

Measuring progress is critical to both meeting the long-term goals of protecting and restoring water quality in the LGRW and the West Michigan Regional goals to be a great place to live, learn, work, and play. Historically, measuring progress has not been done in a strategic, systemic way. Goals for BMP implementation were incorporated in the 2004 WMP, but many were contingent on receiving grant support for implementation. There was little ownership by the various stakeholder groups ensuring this kind of assessment received the necessary priority. There was no integrated system in place within the framework of LGROW partners to collect, use, and distribute assessment information. However, as the WMP was updated, a strategy was developed regarding the measurement of expected accomplishments.

The following vision and mission statements were developed:

Vision:

LGROW measures of success and accomplishments will be used to celebrate achievements, evaluate progress, make appropriate adjustments in approaches, and provide education and awareness about what is being done. Providing stakeholders with access to assessment data will help to leverage resources and encourage a high level of engagement by everyone involved.

Mission:

LGROW will use measures of success and an accomplishment assessment to give direction, provide encouragement, and help prioritize future actions for all Watershed stakeholders.

The following benefits for measuring progress and tracking accomplishments were identified:

1. It is important to see the progress and celebrate what has been accomplished. It encourages those doing the work to keep focused on the goals and not give up.
2. It helps to evaluate what is working, what is not, and make adjustments to actions plans, keeping work effective and efficient.
3. It provides opportunity for networking, sharing ideas, and assistance for stakeholders within the Watershed.
4. It promotes cutting edge thinking and encourages a “can do” attitude among all stakeholders.
5. It keeps Watershed residents educated and informed about what is going on.
6. It makes grant proposals more marketable.

The following barriers to tracking accomplishments were identified:

1. Measures of success are not currently well defined.
2. No one has identified what is being collected
3. Only the MS4 permit measures are correlated to the Lower Grand River 2004 and 2007 WMPs.
4. LGROW partners do not have an integrated system in place to collect, analyze, and distribute accomplishment data.
5. There are no resources in place to identify measures or institutionalize data collection by various stakeholder groups.
6. There is no coordinated plan to record data so that it can be retrieved easily.
7. There is no plan in place to acknowledge and celebrate the successes.

The following goals were developed:

- Goal 1: Identify, collect, analyze, and summarize what accomplishments have been made from 2004-2009 regarding the implementation of the 2004 LGRW Management Plan.

- Goal 2: Develop a plan that will define measures of success and the system necessary to measure progress and track accomplishments. This system should meet the data management criteria listed in the Lower Grand Vision Outline (Appendix 8.2).

- Goal 3: Implement the plan, so that in 3 years there is an integrated system in place to measure progress and make adjustments, track accomplishments, distribute results, and celebrate accomplishments.

In November 2009, the MDNRE, GVMC, and a Florida intern teamed up to tackle Goal 1. The following strategy was created in order to accomplish this goal.

Strategy steps:

1. Divide stakeholders into manageable categories or groups for the purpose of distributing an assessment questionnaire.

2. Review the Lower Grand River WMP and MS4 permits to determine the type of accomplishments that are expected and should be measured.
3. Using the Lower Grand River WMP and MS4 permits as a basis, develop the draft questionnaires.
4. Get feedback from representatives of the various stakeholder groups regarding the draft questionnaires on how to improve them.
5. Revise questionnaires by incorporating the comments from the representative stakeholder groups.
6. Distribute questionnaires using online survey system.
7. Analyze the return rate.
8. Make follow-up telephone calls and e-mails to find out why questionnaires are not being returned and record responses.
9. Encourage targeted stakeholders to fill out the questionnaire.
10. Analyze responses.
11. Analyze and modify strategy to develop a better approach.
12. Report on the findings in the 2010 Lower Grand River WMP Update.

Due to limited resources and time constraints, only four counties in the Watershed were selected in a pilot study of accomplishments: Barry, Ionia, Kent, and Ottawa Counties. The Watershed stakeholders were divided into groups. The groups were: (1) Natural Resource Conservation Service (NRCS)/Farm Service Agency, (2) Conservation Districts, (3) Land Conservancies, (4) County Drain Commissioners, (5) County Road Commissions, (6) County Health Departments, (7) County Parks and Recreation Departments, (8) Subwatershed Groups, and (9) Local Governments/Counties.

Recommended activities from the 2004 Lower Grand River WMP were combined with BMP implementation measurement goals offered by local MS4 projects to develop initial draft questionnaires for each stakeholder group. These Lower Grand River WMP activities and BMP implementation measurement goals ranged from a wide array of reporting topics including:

- Various BMPs,
- Illicit connection counts,
- Enforcement actions,
- Earth change projects,
- Sanitary and storm system repairs,
- Spill incidents,
- Street sweeping,
- Streambank erosion measures,
- Storm inlet stenciling,
- Newly dedicated open lands,
- Adopted rules related to protecting water quality,
- Septic system manifests and records,
- Development restrictions or riparian easements,
- The adoption of storm water or Low Impact Development (LID) ordinances,
- Yard waste management,

- Drainage retrofits,
- Public education efforts,
- River cleanups,
- Watershed monitoring,
- Stakeholder outreach,
- Grant awards, and
- Construction site and soil and erosion permits.

A draft questionnaire was developed for each stakeholder group keyed on their various goals, activities, and the type of work they performed. The questionnaire also included open-ended questions for each of the stakeholder groups, giving them the opportunity to report their respective success and failures and their overall reaction to the online questionnaire.

MDNRE staff and their intern met with several stakeholders representing several stakeholder groups to obtain feedback regarding the draft questionnaires. Based on the feedback from those meetings, the questionnaires were revised, downloaded into an online survey tool, and a notice sent to the selected stakeholder groups. The MDNRE made telephone calls to many of the recipients who received the questionnaire but had not yet responded, in an attempt to encourage their participation. Returns varied depending on the stakeholder group.

Worth particular mention are the efforts of the NRCS and the Farm Service Agency. Through a meeting and telephone conversations with NRCS and the Farm Service Agency, it was discovered that implemented agricultural structural BMPs are regularly reported as part of ongoing database development for each Watershed. A questionnaire was not required for the NRCS or Farm Service Agency, in that they were able to deliver an Excel spreadsheet (Appendix 8.3) listing the agricultural BMPs that have been implemented in the LGRW from 2004 to 2009. Result summaries from the remaining stakeholder groups are also included in Appendix 8.3.

Initially, the following challenges were encountered:

1. Attention given to what tasks get done and how success is measured varies considerably between and within stakeholder groups.
2. Many of the stakeholders were unfamiliar with the 2004 Lower Grand River WMP and, as such, there is little correlation between what was being measured and what the WMP proposes to measure.
3. Measurements do not necessarily focus on water quality and, therefore, do not always address water pollutants, sources, or causes.
4. What is measured is mostly quantitative data and does not address behavior change or show improvement trends in water quality.
5. Some of the data collected were not tied to a specific Watershed, which makes retrieval of accomplishments from a specific Watershed difficult.
6. The online survey system used, Zoomerang.com, has limited format capability and does not easily accommodate complex, multi-answer questions. Certain groups, such as Local Governments and County Road Commissioners, have more reporting categories than the others. Due to the length of these questionnaires and effort required to retrieve records, many stakeholders were frustrated by the process and simply did not respond. Out of 76 invitations to local governments, 26 opened the request and only 7 replied. Other groups appeared to have a better response rate; however, it is difficult to compare, given that local governments was such a large group.
7. Not all the recipients of the survey notice were able to read the e-mail that contained the survey link due to a formatting issue, so they just ignore it.

8. MDNRE staff followed up by contacting several key stakeholders that did not reply. The follow-up included an e-mail with the link to the survey questionnaire. Recipients were encouraged to fill out the questionnaire. The survey system was not able to record which organization filled out the questionnaire when they used the link provided by the MDNRE staff person.
9. The data being reported by stakeholders were in a form that must be reorganized into spreadsheets or some other data management software program, a function that is very labor intensive.
10. Communications regarding the questionnaires and promoting involvement in the survey needed to be expanded. Direct telephone calling and one-on-one interviews were done this time to encourage the completion of the survey. This proved a successful approach for most of the stakeholder groups. However, this was very labor intensive and not reasonable as part of a long-term sustainable process.

During the development of this WMP, information was collected that helped address these challenges. Table 6.2 – Measureable Milestones was the first step in addressing many of these challenges, and future work will reduce the inconsistencies of what evaluation methods are recommended and how information is collected.

Chapter 9 - Sustainability

9.0 SUSTAINABILITY

OBJECTIVES

- How was interest in the Lower Grand River Watershed initiated?
- What is LGROW?
- How is LGROW going to assist in implementing this WMP?
- How are Watershed accomplishments going to be measured?

9.1 INTRODUCTION

The recommendations of the Watershed Management Plan (WMP or Plan) are options that can be voluntarily implemented to achieve water quality goals. It will be important to sustain the voluntary implementation of the Plan's recommendations to ensure that the conditions in the Lower Grand River Watershed (Watershed) improve, thereby reducing the need for state regulations and mandates. Success of the WMP depends on consistent support from local governments, citizens, and businesses. Each of these communities has distinct needs that will require different strategies. However, to remain committed to a common water quality goal will require ongoing coordination of the intentions and actions of all these groups.

9.2 A STRATEGIC BEGINNING

The initial WMP, adopted in 2004, anticipated the need to sustain the collaboration and partnerships, and to advance the mission, vision, goals, and objectives established in that process. The intent was to place the Lower Grand River WMP initiative in a much larger context of long-term success founded on a wide base of support from all parts of the Watershed community. At that time, a mission statement, vision statement, core values, and other strategic components were developed through facilitated input from an assembly of Watershed stakeholders (informally known as the Grand River Forum).

Organizational Mission: *Discover and restore all water resources and celebrate our shared water legacy throughout our entire Grand River Watershed community.*

Watershed Vision: *Swimming, drinking, fishing, and enjoying our Grand River Watershed: Connecting water with life.*

Core Values of Our Watershed Work:

- Watershed activities are diverse, inclusive, and collaborative.
- Watershed efforts are sustainable and of high quality.
- Watershed images and messages create a widely shared sense of legacy and heritage.
- Watershed methods and products are holistic and employ a systems approach.
- Watershed organization and program evaluate progress and reward success.

Lower Grand River Watershed Strategic Components: The Vision Committee, established in the initial 2004 WMP, conducted focus group sessions with various Watershed stakeholders, to establish strategic goals and broad accomplishments to meet the vision. These components are included in Appendix 8.2. They include considerations for public awareness, information management, organization and finance, and general actions that are needed to establish and maintain a new watershed entity for the Lower Grand River Watershed.

9.3 A NEW WATERSHED ORGANIZATION

In determining what kind of organization was needed to support a large complex area such the Lower Grand River, Grand Valley State University's Seidman School of Business facilitated a strategic session

in 2005 with various stakeholders from throughout the Watershed. That process identified the need for an ongoing coordinating group of local officials, agency representatives, and leaders from local organizations. The provisional steering committee set up for this process undertook months of research, deliberation, and consideration of alternatives for creating the Lower Grand River Organization of Watersheds (LGROW). To meet its strategic needs, including providing basin-wide oversight, implementing watershed-wide initiatives, and prioritizing water quality concerns, LGROW was designed as a new kind of "hybrid" organization reflecting attributes of both Watershed Alliances (emphasizing the municipal and agency work required under Clean Water Act permit requirements) and Watershed Councils (supporting a wide array of input and interests from the wider community). It was very important that the new organization fit in with our strategic objectives and the components outlined in our previous Watershed planning efforts.

The purposes and primary responsibilities of LGROW are included in their bylaws (Appendix 9.1) and are summarized as follows:

- Maintain a widely recognized center to provide Watershed-related services.
- Ensure that there is effective coordination with other organizations, governmental bodies, agencies, and other entities, in order to meet the needs of the public, governmental bodies, sub-basin entities, and others concerning Watershed matters.
- Ensure public awareness of the need for effective Watershed protection and management.
- Devise and promote programs available to the public; and prepare materials for distribution to residents of the Watershed, emphasizing the importance of a healthy, usable, and sustainable lower Grand River.
- Receive, evaluate, organize, and distribute Watershed data and information to residents of the Watershed, regulatory bodies, and research organizations.
- Convene periodic assemblies of the persons and entities having interests in the Watershed.
- Formulate a WMP and implement the Plan in ways that will improve the quality of waters within the Watershed and encourage local efforts to protect and improve rivers, streams, and other waters.
- Review and comment upon sub-basin WMPs.
- Recommend priorities in the implementing of improvement projects affecting the Watershed.
- Review and comment upon local land use plans, capital improvement plans, and other proposals as they may relate to or affect the Watershed or any of its component waters.
- Prepare and disseminate reports on its activities, and address other water-related issues of interest to LGROW participants and the general public.
- Serve as a forum in which to coordinate Watershed and natural resource planning among local and regional land use agencies and programs.
- Promote sustainable development and smart growth in accordance with the principles adopted by Grand Valley Metro Council (GVMC) and other regional authorities.

9.4 ORGANIZATIONAL SUSTAINABILITY

To be sustainable, the provisional steering committee determined the need for a sound business footing, strong leadership from a wide cross section of the region, and an effective communications plan to reach out and continually involve the public at large in organizational activities.

Initial Business Plan

While LGROW is in the process of producing a new business plan to support the new organization, the steering committee had reviewed draft business plans and made several key findings during its organizational development.

Key Findings from 2006 Draft Business Plan

1. Need for Organization. Water quality and usage is an emerging concern for many communities, and government mandates for storm water management are under legislative and enforcement purview as communities are working to solve these potential impacts. In addition, the Grand River also serves as a source of entertainment, water for manufacturing, electricity, wildlife, and is a part of every citizen's daily life. Maintaining the river and educating the public regarding water preservation issues is a top priority for any organization representing the Lower Grand River. A new organization will endeavor, as stated in the mission, to help government, businesses, and residents to appreciate our natural resource and its value for future generations.

2. Competition and Coordination. There are several organizations working to improve the environmental quality in West Michigan. Every one is concerned about land usage, air quality, development patterns, economic potential, traffic patterns, and many other community development issues. These organizations include: West Michigan Strategic Alliance and its Green Infrastructure Initiative, West Michigan Sustainability Alliance, the West Michigan Sustainable Business Forum, Trails and Greenways Coalition, West Michigan Environmental Action Council, and others. All these groups are pursuing funding, educating the populace, and working to improve the environment. The opportunity for confusion amongst the communities is immense, but collaboration opportunities also exist. A Lower Grand River Watershed organization will establish its niche in the usage and protection of water resources with respect to the basin for the Grand River. This impacts all areas along the Grand River from its many tributaries to Lake Michigan. An association with GVMC will also leverage linking and encouraging collaborative efforts between municipalities as well as the above organizations. Coordination and collaboration will also be encouraged for existing and evolving watershed councils within the Lower Grand basin, such as the Rogue River Watershed Council.

3. Marketing and Communications. A new Watershed organization will need to establish its primary products or services as applied to various target audiences. They will further need to produce a communications mechanism to make future stakeholders and potential members aware of these services and the value made available to them by engaging with the organization. Target audiences, service offerings, promotional methods, and benchmarking to evaluate progress are all necessary components of ensuring the new organization will succeed.

4. Operations. GVMC will provide staff and fiduciary support as well as management oversight. A new organization may opt to acquire services through GVMC. Another option is to hire a director and staff through GVMC which in turn will be the employer of record and be required to meet all employee requirements. At this time, data on the quality of the Grand River is sketchy, fragmented, and reliability is inconsistent. Initial operations for this organization will include developing a program to train water monitoring volunteers to gather data consistently and be disseminated effectively. This will help establish benchmarks for water quality and usage. This baseline will evaluate effectiveness for water environmental programs, pollution control, water runoff, and also structures. These data can be used to establish priorities, design new programs, search for new resources, and help educate corporations and citizens on how to protect, improve, and maintain water quality.

Board Membership

Several of the key findings cited above led to a series of "next steps" for the organization, the result of which led directly to the establishment of its current committee structure and the following Board of Directors membership structure:

- Water Management Members. Municipal or regional public entities with water management responsibilities under the Clean Water Act.
- Watershed Sub-Basin Members. Representatives from those Watershed sub-basins of the Lower Grand with WMPs and functioning organizations working on key issues.
- Grand River Forum Members. Representatives selected at the Annual Meeting from one of the following forum groups: partnering municipalities, businesses/institutions, community organizations, private National Pollutant Discharge Elimination System (NPDES) permitees, and the public at large.

The balance of voting on the Board restricts the number of sub-basin and Grand River Forum members add up to no more than the total number of Water Management Members. This ensures that a near majority is always possible for the Water Management Members on the LGROW Board of Directors. The Board organizational chart can be seen in Figure 9.1.

Services Review Committee and Communications Plan

Another key element of the initial business plan led to a committee established to determine stakeholders and their service needs. Further need for a communications plan is vital to successfully promoting LGROW awareness; maintaining a regional presence; and educating stakeholders, constituents, and the West Michigan public on the purpose and accomplishments of the organization.

Sustaining Organizational Resources

LGROW operations can only be sustained through maintaining its membership base and engaging its partners at all levels. Above all else, LGROW must establish a strong effort to determine the needs of members and its partners' constituency, and report on its successes in meeting these needs.

9.5 MEASURING WATERSHED ACCOMPLISHMENTS

As suggested above in key findings from LGROW's draft business plan, the organization will need to establish a method of benchmarking and evaluating its progress.

Watershed Accomplishments Inventory

LGROW conducted a Watershed-wide inventory of accomplishments from many of its stakeholders (including local governments, county health departments, county parks departments, county road commissions, conservation districts, land conservancies, and Watershed sub-basin organizations). Each were asked in both personal interviews and an online inventory questionnaire to report on a wide array accomplishments including various best management practices (BMPs), illicit connection counts, enforcement actions, earth change projects, sanitary and storm system repairs, spill incidents, street sweeping, streambank erosion measures, storm inlet stenciling, dedicated open lands, adopted rules related to projecting water quality, septic system manifests and records, development restrictions or riparian easements, storm water or Low Impact Development (LID) ordinance adoptions, yard waste management, drainage retrofits, public education efforts, river cleanups, Watershed monitoring, stakeholder outreach, grant awards, and construction site and soil and erosion permits. The questionnaire also included open-ended questions for each of the stakeholder groups about their respective successes and failures and their overall reaction to the process.

Unfortunately, the process did not produce consistency in data, nor a thorough response, from stakeholders. This is due to several factors clearly implying changes for future efforts. First, a generic subscription based on-line system was used for generating and collecting answers for the inventory. The design of such surveys is far too simple to allow for the multiplicity of responses, the number of categories, and the detail in the response required in this process. This led respondents to a high degree of frustration and eventually abandoning the questionnaire. For local governments, for example, out of 76 invitations to report, 26 followed the link and only 7 replied. Other groups had better response rates, but these tended to have fewer questions to answer and fewer organizations throughout the Watershed (thus making personal contact easier and more effective).

The second issue with the questionnaire was that the data being reported is in a form that must be reorganized into spreadsheets or some other data management program, a function which is very labor intensive for stakeholders. Data has been collected and reorganized, but analyzing in a consistent fashion is yet to be done.

Finally, communications surrounding the questionnaire and promoting involvement needs to be expanded. Direct phone calling and one-on-one interviews were performed this time to encourage the completion of the questionnaire. This was successful for most stakeholder groups.

Though this initial effort did not produce enough consistent data for inclusion into a database of Watershed accomplishments, LGROW intentions for this effort are still to create a widely used, routinely

conducted, and easily interpreted reporting method. LGROW and its Data, Information, and Procedures (DIP) committee are currently reviewing the process and considering it for subsequent efforts.

Ongoing Measures for Success

At a time when resources are limited, it becomes critical that there is an integrated system in place that will help evaluate how successful an organization is in meeting their mission, vision, and goals for both the organization and Watershed resources. Through lessons learned from the disappointing results of the Watershed accomplishments inventory cited above, LGROW has realized the need for a focused effort and complete strategy to develop and implement an effective evaluation process. As a key finding in the draft business plan, LGROW is committed to continuing with this effort.

To accomplish this, LGROW is proposing measures of success and accomplishments that will be used to celebrate achievements, evaluate progress, make appropriate adjustments in approaches, and provide education and awareness. Stakeholders will be able to access assessment data thus helping to leverage resources and encourage a high level of engagement. To meet this outcome, LGROW intends to:

1. Continue to identify, collect, analyze, and summarize the recent Watershed accomplishments (2004-2009) regarding the implementation of the WMP.
    a. This goal was accomplished during the updating of the 2010 LGR Watershed Plan.

2. Develop a plan that will define measures of success and a system necessary to track progress and accomplishments. This system should meet the data management criteria listed in the Lower Grand Vision Outline (Appendix 8.2).
    a. Establish an Evaluation Subcommittee of the LGROW DIP to develop key water quality indicators and organizational evaluation measures.
    b. Enlist stakeholder group representatives to tracking indicators pertaining to their respective stakeholder groups.
    c. Report to the LGROW WMP Committee for considering appropriate adjustments, approaches, and priorities.
    d. Request LGROW Board to direct staff to seek funding for this program.
    e. LGROW would develop proposals to seek additional funding to implement the plan. Each of these components would have an implementation strategy, milestones and timeline. The time frame to complete Goal 2 will be January 2011 through Dec 2011

3. Implement the plan in a 3-year timeframe and integrate the process with ongoing work of LGROW, including routine updates to the WMP.
    a. Continue to have designated meetings throughout this time period with the various identified committees to address challenges and fine tune the system. The time frame to complete Goal 3 would be from Jan 2012 – Dec 2014.

If this proposal is achieved, it will help ensure that efforts by LGROW partners are effective, efficient, and sustainable. It will also help ensure that the Lower Grand River region remains a great place to live, work, and play, as well as provide a model for other watersheds in West Michigan.

9.6 ENVIRONMENTAL AND COMMUNITY SUSTAINABILITY

As an organization which aspires to affect all potentially polluting or destructive activities conducted throughout the entire Lower Grand River Watershed, LGROW is in a unique position to join with other large-scale initiatives throughout West Michigan, and bring a greater sense of water stewardship and improved quality to the entire region. Important initiatives of similar scale are now forming throughout the area to ensure that our environmental values are sustained for future generations, and that our population centers are built (or rebuilt) to grow and prosper without damaging the water, air, land, and life resources with which Michigan has been abundantly blessed.

To meet this end, LGROW already partners with many local organizations through its diverse membership and Board of Directors structure. However, due to their equally large geographies or expansive missions, many organizations and agencies have not seen themselves as part of LGROW's organizational membership. Such organizations and initiatives should be considered for ongoing partnerships surrounding the need for coordinating long-term sustainability in West Michigan.

Grand Valley Metropolitan Council and Metropolitan Planning Organizations

GVMC is currently the host organization, but may not always perform that role. LGROW should be involved in all efforts associated with region-wide planning of all types, especially those involving transportation, land use, housing, energy and other similar planning efforts.

Other Regional Planning Agencies

In addition to GVMC, the Macatawa Area Coordinating Council (MACC), West Michigan Regional Shoreline Development Commission, and the Southwest Michigan Regional Planning Commission all conduct similar activities to GVMC and should be valued partners for planning activities as well.

West Michigan Strategic Alliance – Green Infrastructure Leadership Council (GILC)

There is currently a Watershed focus-area within the GILC scope of activities. LGROW has already established a presence in this organization and should continue to do so.

Other Watershed Organizations

The Muskegon Watershed Assembly, the Macatawa Watershed Project of the MACC, the Kalamazoo River Watershed Council, upper reaches of the Grand River, and other watersheds in West Michigan, are all important regional efforts in West Michigan which LGROW should partner with, learn from, and assist wherever possible.

Other Regional Conservation Organizations

An array of large regional conservation related organizations with missions that match closely those of LGROW are often working on similar projects. LGROW should find ways to ensure their future efforts are compatible with these organizations.

Unique Educational Events, Gatherings, or Activities

Oftentimes there are unique and important events or forums that are conducted in the LGROW Watershed. The Ottawa County Water Quality Forum, Green Grand Rapids, the Community Sustainability Partnership, and the decennial Grand River Expedition are just a few of these. LGROW should participate in these efforts as well.

9.7 THE FUTURE OF WATERSHED MANAGEMENT IN THE LOWER GRAND

The ongoing success of a new LGROW is vital not only to improving water quality in the Grand River, but also improving the quality of all lives throughout the Great Lakes Basin. Through their continued use of this WMP in the Lower Grand River, LGROW can play a significant part in improving the quality and availability of waters throughout the entire state and region. By joining with other watersheds, including those in upper reaches of the Grand River, and with efforts to improve water resources below ground, in the atmosphere, and in our surrounding Great Lakes, LGROW can broaden its reach, share its knowledge, and learn from others as we tackle the most significant issues facing us today. Among these are: finding effective ways to moderate the negative affects of human activities, restoring balance to large-scale disturbances in global ecosystems including climate and energy, to improve the quality of life for all social classes, and to more efficiently invest in a future built upon sustained natural ecosystem services.

A WMP and its supporting organization can only go so far in accomplishing such wide-scaled change. While LGROW's mission is related specifically and directly to improving the waters in their charge, real change will only be through involvement with collaborations and partners dedicated to making long-term

successful lives from our homes, local towns, and subwatersheds, all the way up to our cities, regions, states, and nation. It is in this spirit, that of connecting the improvements in each of the hundreds of local rivers throughout our Watershed with the larger needs of our entire community and citizenry at large, that we have created this WMP.

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