Rush Creek Watershed Management Plan

Submitted by Jamestown Township and Partners

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List of Acronyms

AUID	Assessment Unit Identitication
BMP	Best Management Practice
C	Federal Candidate
CA	Critical Area
CS	Critical Site
CAFO	Concentrated Animal Feeding Operation
CCA	Certified Crop Advisors
CFS	Cubic Feet Per Second
CFU	Colony Forming Unit
CDC	County Drain Commissioner
CMTESP	Certified Michigan Turfgrass Environmental Stewardship Program
CNMP	Comprehensive Nutrient Management Plan
CSO	Combined Sewer Overflow
DO	Dissolved Oxygen
E	Endangered
E. coli	*Escherichia coli*
F	Fahrenheit
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Maps
GAAMP	Generally Accepted Agricultural Management Practices
GIS	Geographic Information System
GVMC	Grand Valley Metro Council
GVSU AWRI	Grand Valley State University Annis Water Resources Institute
HIT	High Impact Targeting
HUC	Hydrologic Unit Code
I/E	Information and Education
k	Known
KCDC	Kent County Drain Commissioner
KCHD	Kent County Health Department
KCRC	Kent County Road Commission
LE	Federally Listed Endangered Species
LGROW	Lower Grand River Organization of Watersheds
LID	Low Impact Development
LLFWA	Landscape Level Wetland Functional Asssessment
LT	Federally Listed Threatened
MACC	Macatawa Area Coordinating Council
MAEAP	Michigan Agricultural Environmental Assurance Program
mg/L	Milligrams per Liter
MDARD	Michigan Department of Agriculture and Rural Development
MDEQ	Michigan Department of Environmental Quality
MDNR	Michigan Department of Natural Resources
mL	Milliliters
MLRA	Major Land Resource Area
MNFI	Michigan Natural Features Inventory
MS4	Municipal Separate Storm Sewer System

MST	Microbial Source Tracking
NH3-N	Ammonia
NO3-N	Nitrate
NO2	NItrite
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NRCS	Natural Resources Conservation Service
NREPA	Natural Resources Enviornmental Protection Act
NSA	Neighborhood Source Assessment
OCDPH	Ottawa County Department of Public Health
OCRC	Ottawa County Road Commission
OCWRC	Ottawa County Water Resources Commissioner
p	Potential
P	Preservation
PBC	Partial Body Contact
PEP	Public Education Plan
PS	Federal Species with Partial Status
QAPP	Quality Assurance Project Plan
RCW	Rush Creek Watershed
RUSLE	Revised Universal Soil Loss Equation
s	Suspected
SC	Special Concern
SEDMOD	Spatially Explicit Delivery Model
SES	Streamside Ecological Services, Inc.
SESC	Soil Erosion and Sedimentation Control
SIDMA	Social Indicators Data Management and Analysis
SMNIDP	Southern Michigan/Northern Indiana Drift Plains
SSO	Sanitary Sewer Overflow
STEPL	Spreadsheet Tool for Estimating Pollutant Loads
TBC	Total Body Contact
TES	Timmermans Environmental Services, LLC
TMDL	Total Maximum Daily Load
T	Threatened
TP	Total Phosphorus
TSS	Total Suspended Solids
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
US EPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WMP	Watershed Management Plan
WRC	Water Resources Commissioner
WQC	Water Quality Criteria
WQS	Water Quality Standards
WWTP	Wastewater Treatment Plant
X	Extirpated

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EXECUTIVE SUMMARY

The Rush Creek Watershed (RCW) drains an area approximately 59 square miles in Kent and Ottawa Counties in southwest Michigan. Rush Creek is a tributary to the Grand River and the watershed is a part of the larger Lower Grand River Watershed.

The land uses in the RCW range from urban and suburban to rural/agricultural. The area is experiencing severe development pressure due to its close proximity to the Cities of Grand Rapids and Holland. Land use has changed from approximately 16 percent developed in 1992 to 51 percent developed in 2011 (Vogelmann, J.E., S.M. Howard, L. Yang, C. R. Larson, B. K. Wylie, and J. N. Van Driel, 2001 and Homer et. al, 2011), and development has continued since 2011. The area has an agricultural history, and agricultural land uses make up approximately 35% of the watershed as of 2011, though, today, most agricultural land uses are in the East Branch Rush Creek subwatershed.

Summary of Watershed Pollution Reduction Goals:

- Reduce peak discharges to modeled values presented in the FEMA February 5, 1992 Flood Insurance Study prepared for the Charter Township of Georgetown, Michigan, which means reducing peak flows approximately 50% compared to current levels. As a short-term goal, peak discharges in the RCW should be reduced by 20% in ten years.

- Reduce *E. coli* concentrations to meet WQS.

- Reduce Total Suspended Sediment concentrations by 44%.

- Reduce water temperature in the East Branch subwatershed by two degrees (average July water temperature), to fall within the cold-transitional temperature range.

- Reduce nutrient loading for ammonia as nitrogen by 36%, reduce total phosphorus by 83%, and reduce nitrates and nitrites concentrations by 40%.

- Generally reduce pesticide concentrations reaching the surface waters, improve application practices, and investigate prevalence in usage and concentrations within the RCW surface water.

Summary of Implementation Recommendations:
Generally, across the watershed, the following pollutants and causes are prioritized.

Pollutants in Priority Order	Causes to Prevent in Priority Order
1. Hydrology	1a. Prevent new alterations to hydrology that increase peak discharge. 2b. Restore previously altered hydrology.
1. *E. coli* – Human sources	2a. Prevent human sources of *E. coli* from leaving designated treatment sites. 2b. Prevent human sources of *E. coli* from reaching surface waters.
3. *E. coli*- Agriculture sources	3a. Prevent agricultural sources of *E. coli* from leaving application sites. 3b. Prevent agricultural sources of *E. coli* from reaching surface waters.
4. Sediment	4a. Prevent soil erosion. 4b. Prevent eroded sediment sources from reaching surface waters.
5. Nutrients	6a. Prevent nutrients sources from leaving application sites. 6b. Prevent nutrient sources from reaching surface waters.
6. Increasing Water Temperature	5. Prevent increases in stream temperature, especially in East Branch subwatershed.
7. Herbicides and Pesticides	7a. Encourage proper and conservative use of herbicides and pesticides, including use within a safe distances from surface waters. 7b. Prevent herbicides and pesticides from reaching surface waters.

Though protection and improvement efforts should be implemented wherever necessary in the watershed, Chapter 10 outlines high priority areas for preservation, critical sites for restoration, and critical areas for restoration identified for each geographical area.

Generally, the following action items are prioritized for both Preservation and Restoration Activities, summarized below and detailed in Chapter 10. The first step recommended is to hire a Rush Creek Watershed Coordinator through a newly formed watershed organization or an existing partner organization. Since the management of non-point source pollution is primarily done through voluntary action, the watershed coordinator is vital in assisting and encouraging other partners to implement WMP recommendations through Information and Education recommendations summarized in Chapters 8 and 10.

Preservation

With the majority of RCW being developed or used for agriculture, little of the watershed remains in its more natural undeveloped state. Preservation is the most effective and cost efficient way to prevent the degradation of the water quality.

The following are the RCW priorities for preservation. Information and Education recommendations can also be used to help in addressing preservation recommendations.

1) Adopt Post Construction Controls Stormwater Ordinances and County development rules (standards manuals) in all urbanized and non-urbanized areas, and review them in context with this WMP to evaluate any possible remaining gaps.

2) Protect and preserve existing wetlands.

3) Restore historic wetlands and increase flood storage through other means such as two-stage ditches with wetland vegetation.

4) Encourage and install LID techniques, Green Infrastructure, native plants, and trees.

5) Review and adopt additional opportunities for RCW protective ordinances described in Chapter 9.3.

6) Manage Rush Creek to facilitate its use for kayaking.

Preservation activities are important in High Quality, Threatened, and Impaired areas to protect the areas from degradation. Due to the developed state of the RCW, any of the recommendations outlined for preservation are also considered priority recommendations for restoration of the RCW.

Restoration

Restoration activities are important to address Threatened and Impaired areas to reduce pollutant loading, improve water quality in impaired and Threatened areas and prevent degradation of water quality in high quality areas.

The following are the generalized and summarized RCW priorities for restoration. Information and Education recommendations can also be used to help in addressing restoration recommendations.

1) Adopt Post Construction Controls Stormwater Ordinances and County development rules (standards manuals) in all urbanized and non-urbanized areas, and review them in context with this WMP to evaluate any possible remaining gaps.

2) Protect and preserve existing wetlands.

3) Restore historic wetlands and increase flood storage through other means such as two-stage ditches with wetland vegetation.

4) Encourage and install the LID techniques, green infrastructure, native plants, and trees.

5) Require homes with access to sanitary sewer service to abandon septic systems and connect to sanitary sewer service.

6) Develop and implement septic system I/E campaign and include incentives for proper management.

7) Develop septic ordinance in Kent County.

8) Investigate sanitary sewer expansion in areas of high-density septic systems.

9) Hold one-on-one technical meetings with farmers, with a focus on those farming in priority areas identified, including the less common muck soils that are present in the RCW, to encourage BMP adoption.

10) Develop and implement an I/E campaign for improved management of developed land, including gutter disconnection from stormsewer and manicured lawn management.

11) Develop and implement an I/E campaign to reach hobby farmers to encourage BMP adoption.

12) Bank stabilization.

13) Provide technical and financial assistance for greenhouse operators to adopt BMPs.

14) Advertise an illicit discharge reporting system.

15) Develop and implement an I/E campaign to encourage riparian BMPS.

16) Road and Stream Crossing inventory and street sweeping BMPS.

17) Improve turfgrass management.

The recommended actions included for this WMP total $34,969,790 in NPS pollutant reduction BMP improvements and $2,269,600 in Information and Education (or technical assistance) measures over a ten-year time period, or a total installed cost of $53,095,683 if all recommendations are completed. Though it is noted that due to the voluntary nature of NPS pollution prevention the recommendations are comprehensive and sometimes redundant, understanding that they may not all be adopted. The assumption is built in that every stakeholder or landowner may not agree to adopt the exact recommendations included within.

1.0 INTRODUCTION

The Rush Creek Watershed (RCW) drains an area approximately 59 square miles in Kent and Ottawa Counties in southwest Michigan (Figure 1.1). Rush Creek is a tributary to the Grand River and the watershed is a part of the larger Lower Grand River Watershed. The Main Branch of Rush Creek, also called the Northwest Rush Drain, flows east from Blendon Township, through the City of Hudsonville and through Georgetown Township, to the confluence with the East Branch of Rush Creek. The East Branch of Rush Creek, also called the Rush Creek Jamestown Branch Drain, flows north from Jamestown Township, through the City of Grandville and Georgetown Township, to the confluence with the Main Branch of Rush Creek. Tributaries of the East Branch extend into Jamestown Township, Byron Township, and the City of Wyoming. The Main Branch and East Branch combine near Chicago Drive and discharge into the Grand River.

The land uses in the RCW range from urban and suburban to rural/agricultural. The area is experiencing severe development pressure due to its close proximity to the Cities of Grand Rapids and Holland. The area has an agricultural history, though, today, most agricultural land uses are in the East Branch Rush Creek subwatershed.

The surficial geology of the RCW was formed during the most recent continental glaciation event. Of note are the peat and muck soils that were formerly the bottom of a river channel and, now drained, are used for vegetable farming and sod production. Also of note are significant sand and gravel deposits that make the RCW home to gravel pits and associated residential lake developments.

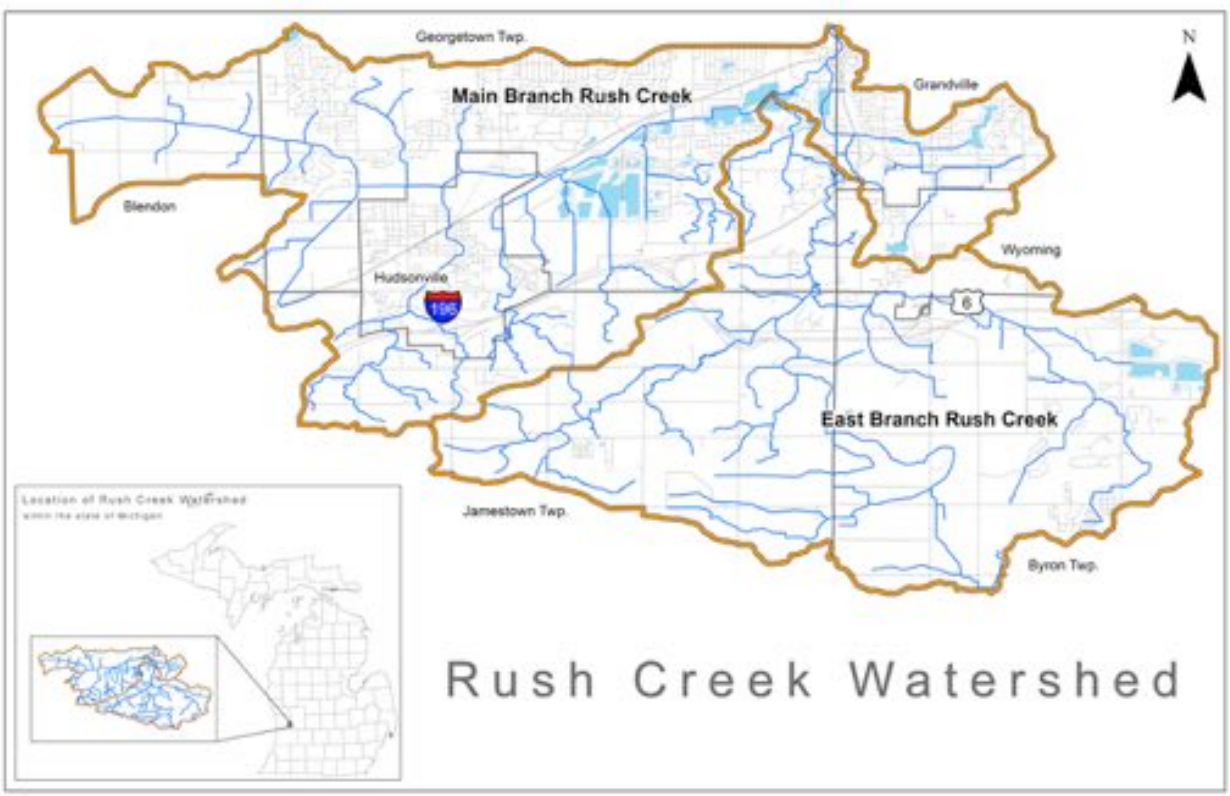

Figure 1.1 Rush Creek Watershed Locator Map

This Watershed Management Plan (WMP) was authored by the Rush Creek Management Team, comprised of representatives from Jamestown Township, Streamside Ecological Services, Inc. (SES) and Timmermans Environmental Services, LLC. (TES). The management team coordinated and guided all efforts related to the planning process and overall WMP development, including stakeholder engagement. Hudsonville High School Green Team and Trinity Christian Reformed Church were important partners in the development of the WMP, as well as several other community partners listed in Appendix A. In addition, community stakeholders provided input through a community meetings and one-on-one meetings.

1.1 Goal of Watershed Planning

The goal of this WMP is to assist the Rush Creek community in ensuring the long-term protection and improvement of the stream and surrounding lands, with focus on the designated uses of the RCW that are mandated by state and federal water quality programs. This WMP is intended, among other things, to provide a shared strategy for moving community jurisdictions and organizations forward with respect to water quality as affected by nonpoint source (NPS) pollutants.

1.2 Key Elements of Developing a Watershed Management Plan

Watershed planning and implementation is a process that includes building partnerships, characterizing the watershed, setting goals and identifying solutions, designing an implementation program, implementing the watershed plan, and measuring progress and making adjustments (United States Environmental Protection Agency [US EPA], 2008).

Watershed Management Plans are a resource to be used to prevent and improve water quality problems by understanding and addressing NPS pollution affecting a watershed. Nonpoint source pollution comes from diffuse sources, and is typically carried by stormwater across the land; it is in contrast to point source pollution that is discharged from an identifiable point such as a pipe (US EPA, 2008). These WMPs document impaired areas for improvement or restoration and high-quality areas for long-term protection. A WMP should outline an action-oriented approach for improving and protecting water quality. The United States Environmental Protection Agency (US EPA) recommends developing a WMP by following their defined planning and implementation process, which includes the following nine elements:

1. **Identification of the causes and sources** or groups of similar sources that will need to be controlled to achieve the load reductions estimated in the watershed-based plan.

2. **Estimate the load reductions** expected for the management measures described in element (3.) below.

3. Describe the **NPS management measures** that will need to be implemented to achieve the load reductions estimated in element (2.) above, and identify the critical areas in which those measures will be needed to implement the plan.

4. Estimate the amounts of **technical and financial assistance needed**, associated costs, and/or the sources and authorities that will be relied upon, to implement the plan.

5. Develop an **information/education component** that will be used to enhance public understanding of the project and encourage early and continued participation in selecting, designing, and implementing the NPS management measures.

6. Develop a **schedule for implementing the NPS management measures** identified in the plan that is reasonably expeditious.

7. Develop a description **of interim, measurable milestones** for determining whether NPS management measures or other control actions are being implemented.

8. Develop a **set of evaluation criteria** that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards (WQS) and, if not, the criteria for determining whether the watershed-based plan needs to be revised.

9. Develop a **monitoring component** to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under element (8.) above.

1.3 How to use this Watershed Management Plan

Watershed Management Plans are intended to be a guidebook to be used by individuals and organizations interested in protection, preservation and wise use of our lands and waters. Unfortunately, WMPs include a large amount of information and must meet many requirements to be approved by state and federal agencies. Experience suggests that a WMP can quickly become unmanageable to those interested in relatively simple, straightforward implementation of the recommendations set forth. As such, this WMP has been organized in a manner intended to promote short and long-term measures that can be easily identified and efficiently implemented. The WMP has been divided into the following chapters, which, to a degree, can be read and used collectively, or independently:

Chapter 2. Description of the Rush Creek Watershed provides a general overview of the RCW. This is background information that will be interesting to certain individuals, but does not include specific information to be used for any type of implementation projects. Most of the relevant information from this chapter will be explained in greater detail in Chapter 4.

Chapter 3. Water Quality in the Rush Creek Watershed – An Overview explains water quality standards in the State of Michigan, the protected designated uses that surface water bodies must attain and the pollutants that impair or threaten the designated uses of the RCW. This chapter is a must read.

Chapter 4. Rush Creek Watershed HUC 12 Subwatersheds includes detailed descriptions of the two subwatersheds that comprise the RCW. The descriptions provided for each subwatershed include summaries of existing information and a synopsis of all data collected during this planning process.

Chapter 5. Goals and Objectives for the Rush Creek Watershed were based upon the information that was collected, analyzed, and is currently known about the RCW and described in preceding chapters.

Chapter 6. Pollutants, Sources and Causes lists all of the NPS pollutants that have been identified within the RCW. For each pollutant, a loading estimate was calculated to determine overall contribution, and the source and cause of each pollutant was identified or speculated.

Chapter 7. Best Management Practices including general structural and managerial recommendations are listed to address each of the pollutants, sources, and causes.

Chapter 8. Social Survey Analysis and Information and Education Recommendations including results of a survey completed by farming and non-farming residents of the watershed and recommendations for what information and how to disseminate it to residents in order to prevent NPS pollution.

Chapter 9. Ordinance Review and Recommendations includes a summary of existing and recommended regulatory mechanisms.

Chapter 10. Summary of Watershed Management Recommendations is the chapter that provides users of this WMP with clear direction on what needs to be done in each jurisdiction to address NPS pollution to protect and/or improve the RCW. Each task includes information necessary to ensure success, including a description of “who, what, where, when and how much?”

Chapter 11. Evaluation and Monitoring Plan provides the information necessary for measuring the successfulness of implementing this WMP.

2.0 DESCRIPTION OF THE RUSH CREEK WATERSHED

2.1 Geographic Scope

The RCW is identified with ten-digit Hydrologic Unit Code (HUC) 0405000605 by the United States Geological Survey (USGS). The watershed, which encompasses approximately 59 square miles (37,760 acres), is located in portions of Kent and Ottawa Counties. The watershed contains two subwatersheds (12-digit HUC) with 60.8 miles of stream in the Rush Creek Main Branch and 59.7 miles of stream in the East Branch, totaling approximately 120.5 miles of stream. The East Branch and Main Branch subwatersheds are about 28 to 32 square miles in size, respectively (Michigan GIS Open Data, 2017). The main stem of Rush Creek originates in the southeastern portion of Blendon Township (Ottawa County) as a series of drainage ditches, in an area characterized by low to moderate density residential and forested land uses, although portions of all tributaries also flow through some agricultural areas. Most of the stream has been channelized to facilitate rapid drainage of the land and is managed as designated county drain. The cities of Hudsonville, Wyoming, and Grandville are urban areas located in the RCW.

Table 2.1: Subwatersheds

12 Digit HUC	Name	Subarea (sq. mi)	Total Drainage (sq. mi)	Length River (mi)	Length Tributaries (mi)
040500060511	Rush Creek	31.6	59.4	1.54	60.8
040500060509	East Branch Rush Creek	27.8	27.8	0	59.7

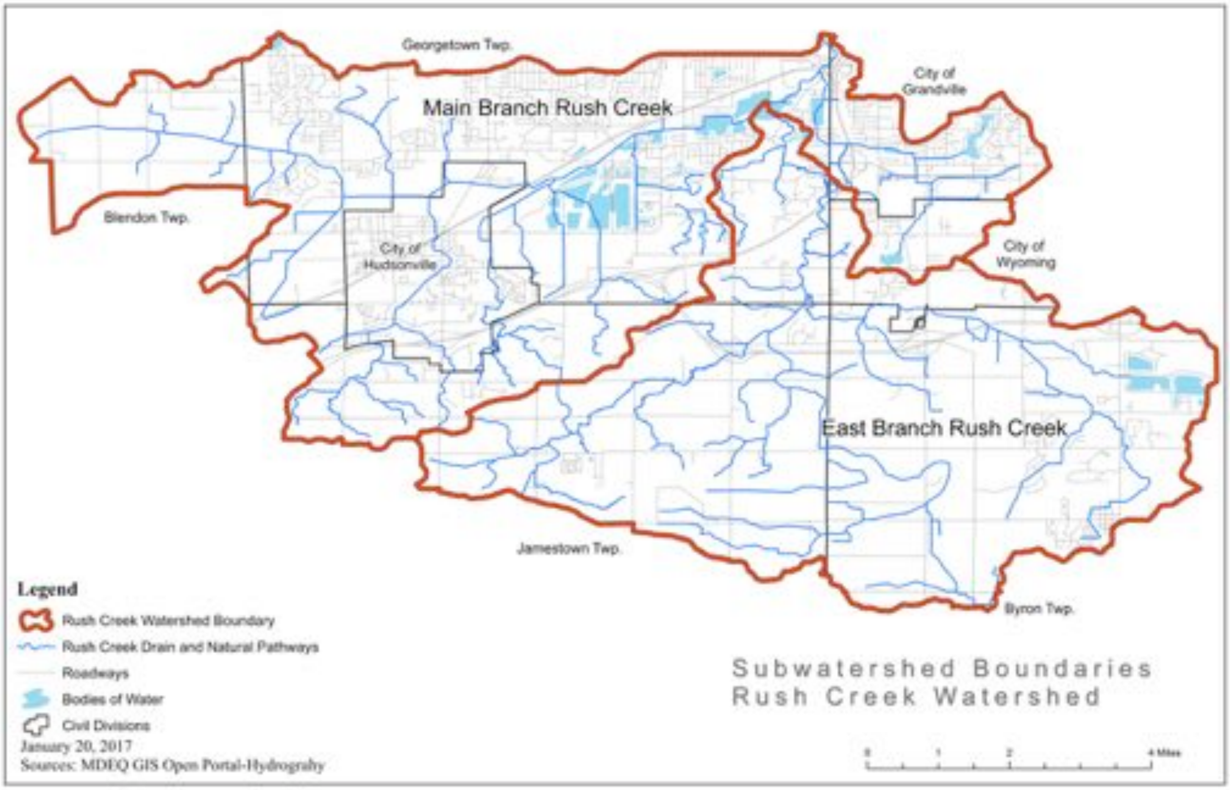

Figure 2.1 Subwatershed Boundaries

2.2 History

The RCW has a history rooted in agriculture, due in part to the muck soils of the former riverbed. Farming is still an important land use in the RCW, though due to an increase in development, much of the agricultural land has been developed. The area has been largely developed in the past twenty to thirty years, and it still undergoing development, due to its proximity to the larger Grand Rapids and Holland areas. Two major highways transect the watershed, I-196 constructed in 1971 and M-6 constructed in 2003. With the presence of glacial outwash, described in Chapter 2.4, there are many gravel pits in the RCW. Some have been converted into inland lakes for residential developments.

2.3 Land Use

Water quality is related to land use. “High amounts of modified land covers are related to lower water quality, while higher amounts of natural land cover have positive effects on water quality” (Michigan Department of Environmental Quality [DEQ], 2016). The land uses of the RCW are outlined in Table 2.2 and shown in Figure 2.2. The majority of the watershed is developed, and agriculture is the second largest land use type.

Table 2.2. Current Land Use in the Rush Creek Watershed (Homer et. al, 2015)

Land Cover Type (2011)	Area (sq. mi)	Area (%)
Open Water	0.9	2
Barren Land	0.6	1
Developed Land- All	30.6	51
Forest- All Types	4.7	8
Scrub	0.2	0
Herbaceous	0.3	0
Agricultural All Types	20.6	35
Wetlands	1.6	3
Total Area	**59.5**	**100**

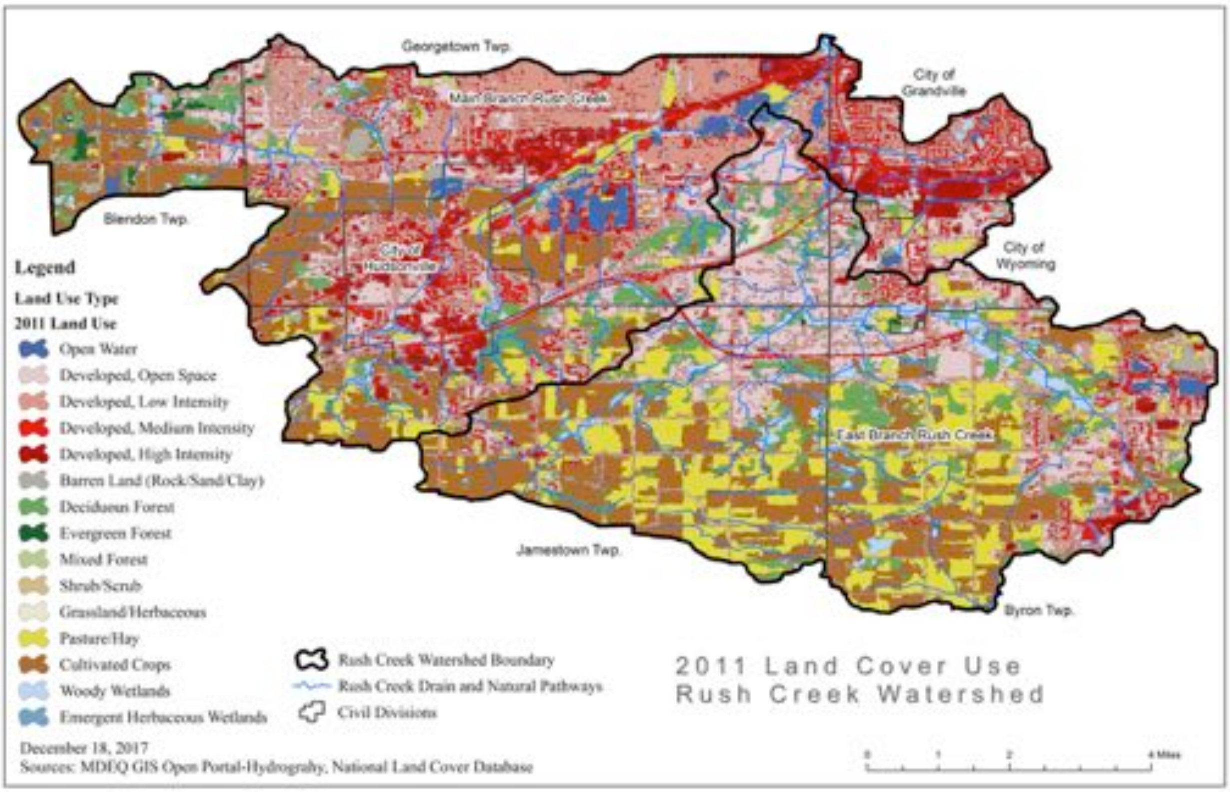

Figure 2.2 Current Land Use (2011)

2.3 Topography

Rush Creek originates in the southeastern portion of Blendon Township (elevation 657 feet above sea level) and drops to the Grand River (elevation 589 ft.) (Michigan Lower Peninsula DEM) (Figure 2.3). This drop of 68 feet over nearly 10.5 miles equates to an average slope of about 6.5 feet per mile, or 0.12%. The highest elevation in the RCW is 903 ft. and the lowest elevation is 581 ft. For the purpose of regional comparison, the average surface elevation of Lake Michigan is 577 ft., the elevation of Detroit is 646 ft. and the highest elevation in Lower Michigan is 1,705 ft. in the vicinity of Cadillac.

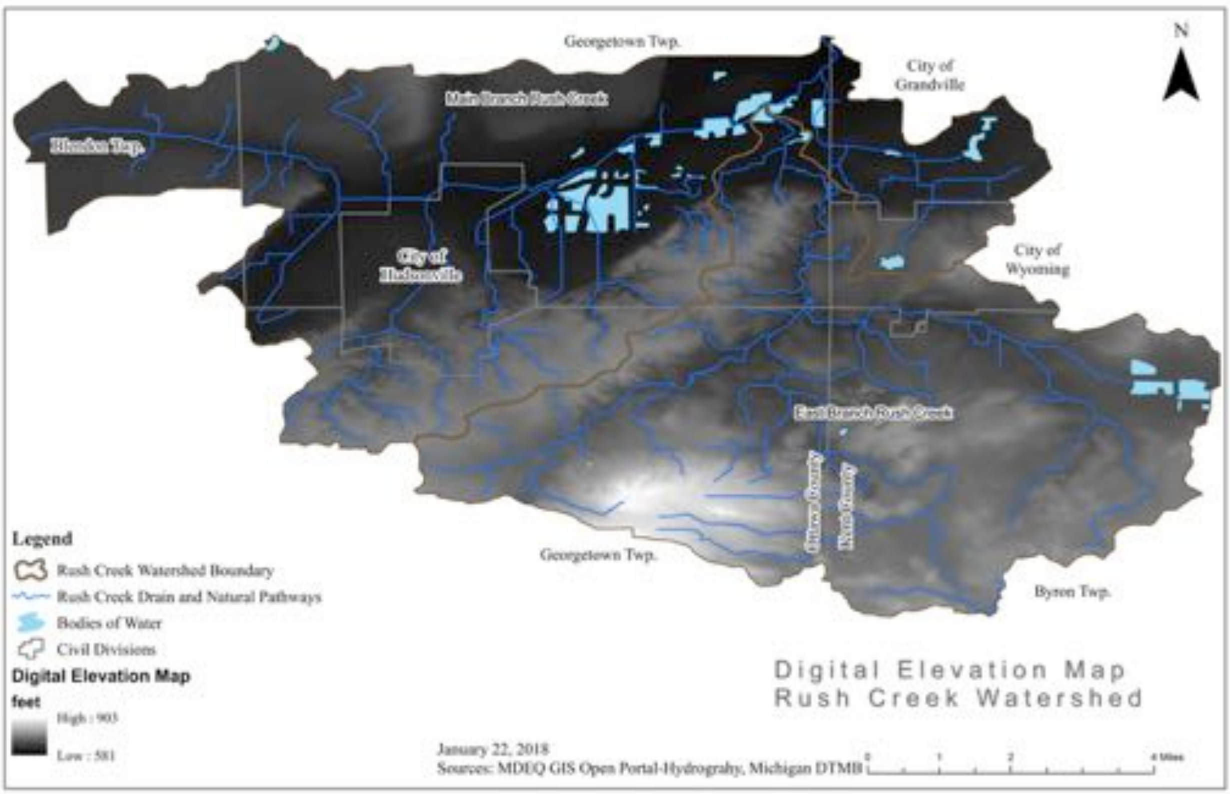

Figure 2.3 Topography

2.4 Geology

Bedrock in the RCW lies under approximately 10-300 feet of unconsolidated deposits left by the glaciers. Figure 2.4 shows that the bedrock present in the western two-thirds of the RCW is the Marshall Sandstone and the eastern one-third the Michigan Formation. In the RCW area, the Michigan Formation consists primarily of shale with an upper gypsum layer and other layers of limestone and sandstone. In places where the glacial sand and gravel deposits are relatively thin (mostly the Grandville and Jenison areas), gypsum can be found at or near the surface and has been encountered in various gravel pits.

The surficial geology of the RCW was formed during the most recent continental glaciation event, known as the Wisconsin, which covered the Great Lakes region and extended into central Indiana and Illinois. The ice sheet that covered all of Michigan began to retreat 35,000 years ago. During the retreat and subsequent melting, a variety of rock debris, known as glacial drift, was deposited. Glacial drift deposited directly by ice and never sorted is referred to as till. Till was deposited in the RCW (Figure 2.5) as end moraines, or ridges, and is either fine-textured (Hudsonville/Jamestown area) or medium-textured (Byron Center area). Fine-textured till contains mostly clay and some silt and sand while medium-textured till contains an even mix of clay, silt, and sand. This end moraine till material was deposited at the fringes of the ice sheet when the aerial extent of it was essentially stable for a period of time. Thus, till deposits can be quite thick (200-300 feet) and generally represent the higher elevations in the RCW (Figure 2.5).

Glacial drift that is sorted and stratified by glacial meltwater before deposition is called outwash and typically consists of sand and gravel deposits. Most of the northern part of the RCW contains glacial outwash sand and gravel. The small northwest portion of the RCW contains sand and gravel deposited near the former shoreline of Lake Michigan when it extended farther east then the present day location. The glacial outwash sand and gravel occur at lower topographic elevation (50-100 feet than the surrounding glacial till upland) and represent a former outlet of the Grand River that was abandoned around 12,000 years ago. Where these deposits occur in the Main Branch of Rush Creek, postglacial alluvium material including peat and muck were subsequently deposited. In the East Branch of Rush Creek, muck is absent except for a small area north of Byron Center. An aerial photograph of the RCW area (Figure 2.6) shows the extent of this former river channel (known as the Zeeland Channel) and the muck land, which has been drained and used primarily for vegetable farming during the past 100 years. There is approximately 3.02 square miles of muck fields. Other postglacial alluvial deposits include marl, which is an accumulation of clay mixed with calcium carbonate brought by groundwater from glacial till containing pulverized limestone. Marl deposits occur along Chicago Dr. east of Hudsonville in low water table areas.

Due to their higher hydraulic conductivity, glacial sand and gravel deposits allow for higher rates of groundwater movement and inflow into the channel of Rush Creek. They also serve as potable and non-potable sources of water for domestic water and irrigation purposes. Fine-textured till deposits may contain pockets of sand and gravel enough for domestic water well use, but generally are not considered good aquifers.

Ottawa County has seen a decline in static water levels and an increase in drawdown in Central Ottawa County, measured from 1970 to 2015. There has also been an increase in chloride contamination, correlated with the increased drawdown. Groundwater modeling predicts some potential low water areas in the RCW. This study was completed by Michigan State University in March 2018, and the Executive Summary is included in Appendix J. A plan for groundwater use, conservation, and education will be developed, including high priority groundwater areas, solutions, actions, and stakeholders (Ottawa County Planning and Performance Improvement, 2017).

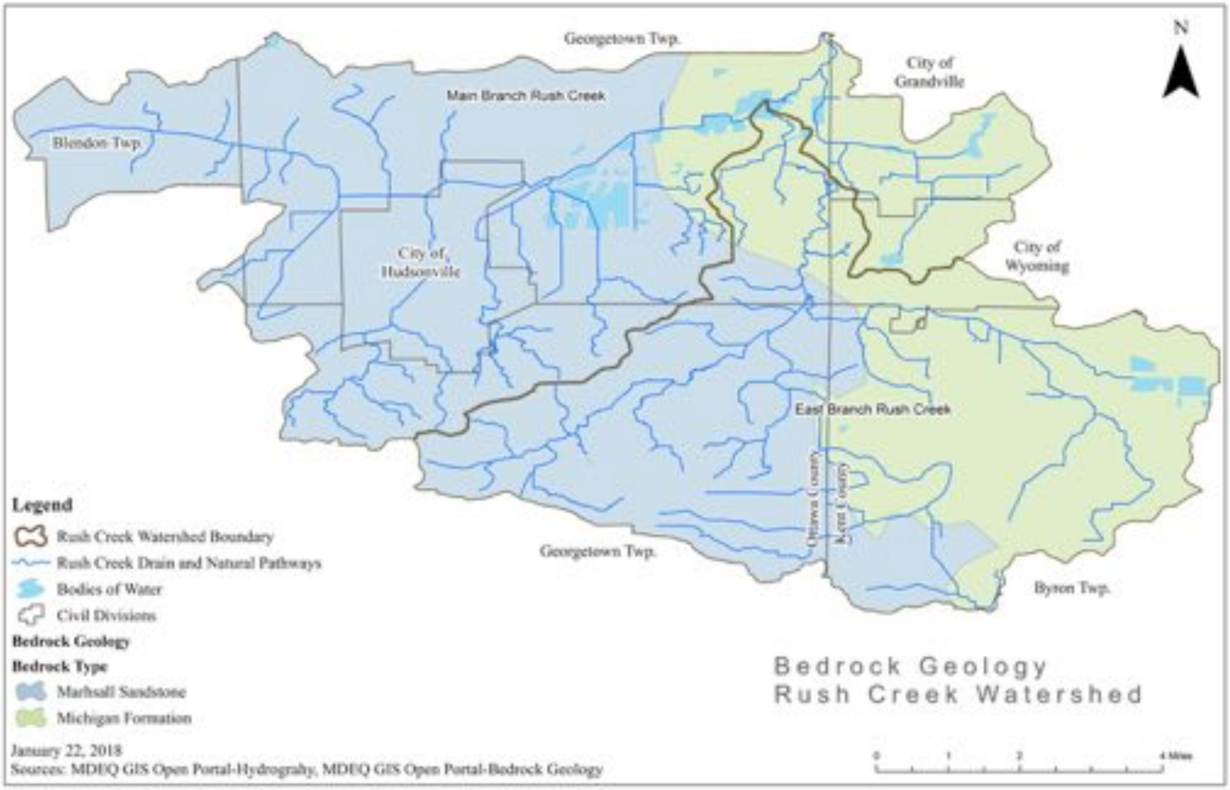

Figure 2.4 Bedrock Geology

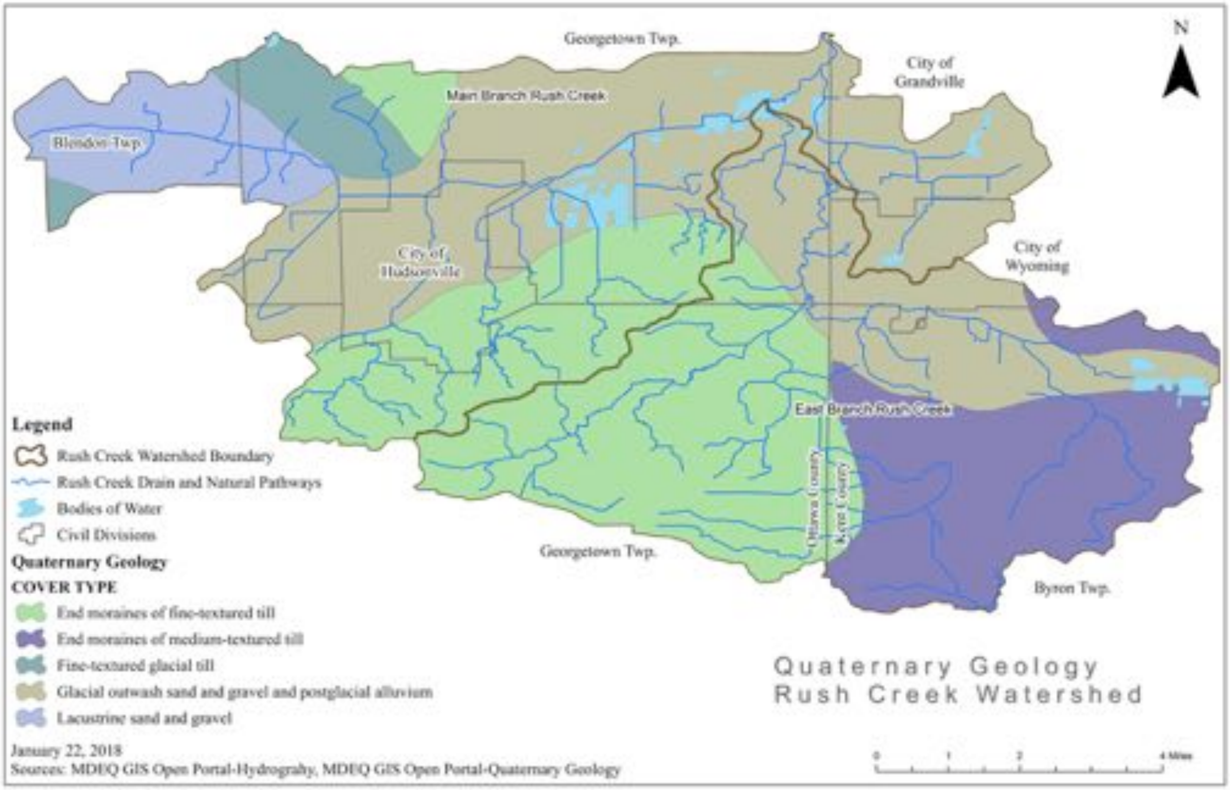

Figure 2.5 Quarterny Geology

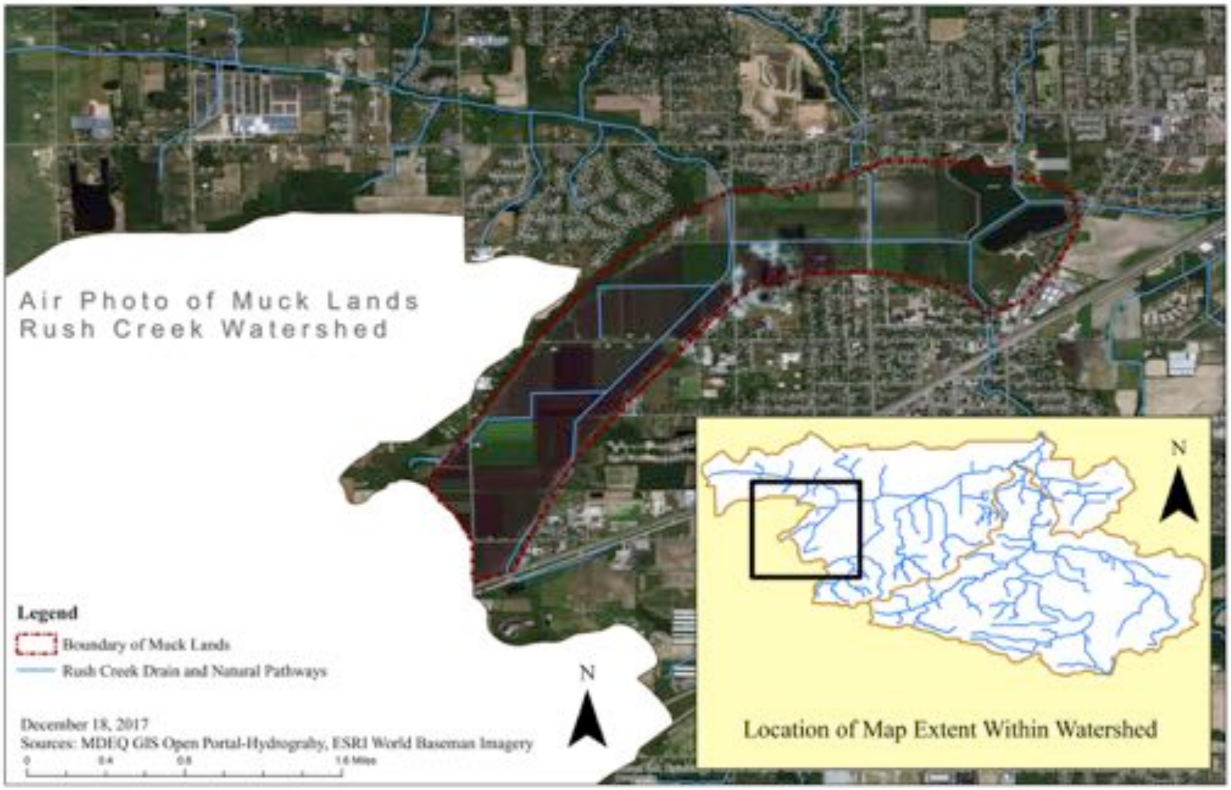

Figure 2.6 Aerial View Showing Muck Lands

2.5 Soils

The RCW is within Major Land Resource Area (MLRA) 98 – Southern Michigan and Northern Indiana Drift Plain (United States Department of Agriculture [USDA], Natural Resources Conservation Service, [NRCS], 2006). Soils are classified based on the characteristics and properties of the different horizons present in the soil profile. A soil profile is a vertical section that begins at the soil surface to a depth of 80 inches. In addition to the textural properties of the glacial derived parent material, the characteristics of the dominant soils in the RCW were influenced by native vegetation of forests and grasslands and deposits of peat and muck. The soils have profiles ranging from loamy sand to clay loam textures with well to very poorly internal drainage. Major soil series classified within the watershed include, but not limited to, Adrian, Blount, Capac, Carlisle, Edwards, Granby, Grattan, Hillsdale, Houghton, Marlette, Miami, Morley, Parkhill, Pewamo, and Spinks. Detailed descriptions of each soil series are available at: https://soilseries.sc.egov.usda.gov/osdnamequery.asp

Soil texture, the percent of sand, silt and clay within each soil horizon, and bulk density, the weight of solids within a measured volume of soil, both affect the rate and ability of water to infiltrate the soil. Low infiltration rates generally correlate with higher soil erosion rates. Soil properties ultimately affect how land applied nutrient and pollutants are absorbed, such as manure, septage or fertilizers, and transmitted over or through the soil. Soils are classified into hydrologic soil groups (A, B, C and D) to indicate the minimum rate of infiltration obtained for bare soil after prolonged wetting (Table 2.3) (USDA NRCS, 2007). The infiltration rate is the rate at which water enters the soil at the soil surface, and is controlled by surface conditions. The hydrologic soil group also indicates the transmission rate, or the rate at which water moves within the soil. This rate is controlled by the soil profile. Table 2.3 summarizes the differences in the four hydrologic soil groups.

Table 2.3: Hydrologic Soil Groups

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)

Each of these different soil types also has different erosive properties. Certain soils have greater potential for overland erosion, and other soils have greater potential for transmission. Understanding how soils respond to precipitation is critical in watershed management, especially considering negative impacts on water quality of the creeks and rivers that are directly related to eroded sediment. In addition, the functionality of a septic system is dependent on the ability of the soil to allow water to percolate through the soil. Unsuitable soil for septic systems is soil that is poorly to very poorly drained with a seasonal high water table of less than one foot below the ground surface or soil that is highly impermeable. It is important to know how land uses on different soil types will affect runoff, erosion, transmission, and, ultimately, how it will affect water quality of the receiving waters.

Table 2.4 highlights the percentage of hydrologic soil groups throughout the RCW, and Figure 2.7 shows their spatial distribution. The predominant soil types are A (21%) and C (25%), with high and medium infiltration rates, respectively. Some soils (40.2%) have a dual classification, where the first letter refers to the drained condition and the second letter refers to the undrained condition. The dual classification signifies the presence of a high water table that keeps the soils saturated, and therefore the soils with a dual classification have a very low infiltration rate in their natural saturated state.

Approximately 36% of the watershed contains soils with low infiltration rates, including groups C, C/D or D, which would have low infiltration rates, higher erosive properties and are more susceptible to contributing sediment, along with any associated land applied nutrients (e.g., manure and fertilizers), that may be transported to surface water bodies.

Table 2.4. Rush Creek Watershed Soils

Classification	Area (sq. mi)	Area (%)
A	12.30	20.7
A/D	7.92	13.3
B	4.06	6.8
B/D	10.94	18.4
C	14.99	25.2
C/D	5.06	8.5
D	1.27	2.1
Not Rated	2.93	5.0
Total	59.47	100

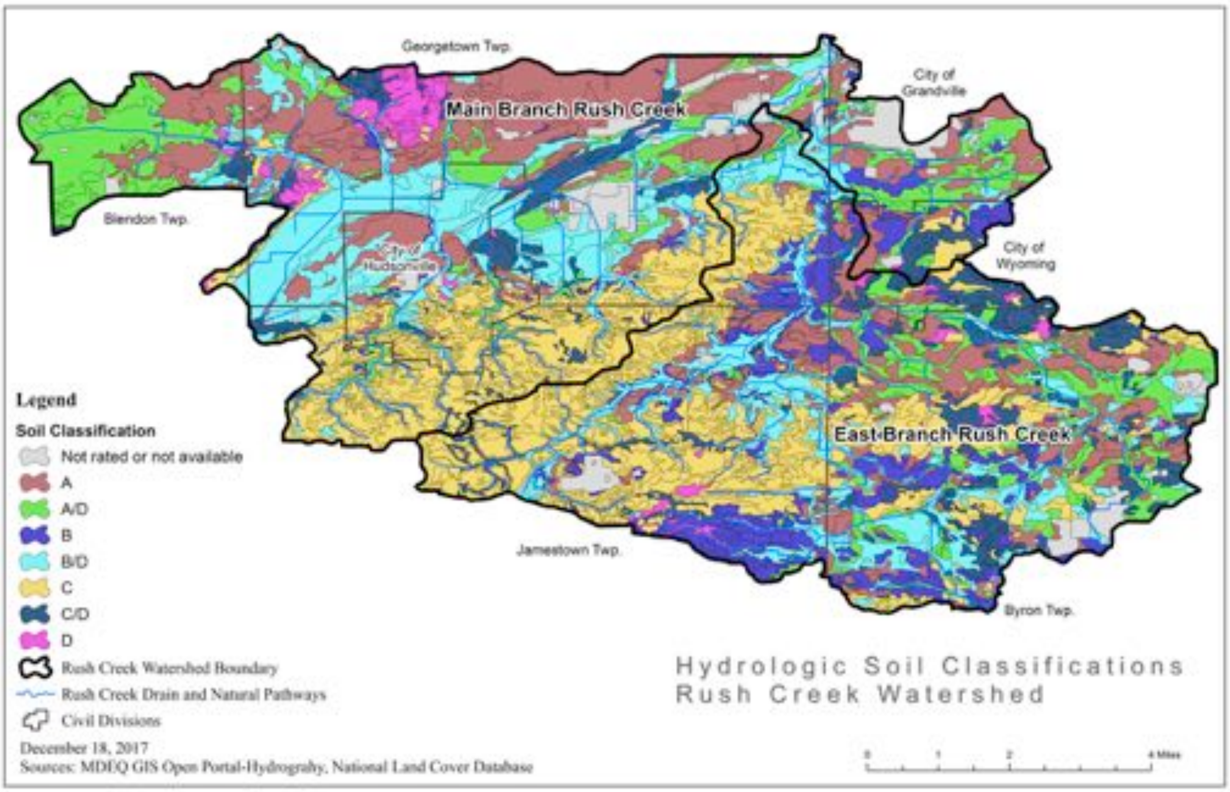

Figure 2.7 Hydrologic Soil Groups (2013 Kent County, 2014 Ottawa County)

2.6 Climate

The Rush Creek watershed has a modified continental climate. The prevailing westerly winds cross Lake Michigan and pick up warm, moist air in the winter and cool, moist air in the summer. The result is milder winters and cooler summers than regions located west of Lake Michigan. According to Intellicast (http://www.intellicast.com/Local/History.aspx?location=USMI0344, accessed July 28, 2017), the average high and low temperatures for January, which is the coldest month in the nearby City of Grand Rapids, are 29 degrees (°) Fahrenheit (F) and 16°F, respectively. The coldest day on record was in January of 1899, when the temperature reached -24°F. In July, the warmest month, the average high and low temperatures are 82°F and 61°F, respectively. The highest recorded temperature of 108°F occurred in July of 1936. Like temperature, precipitation is seasonally variable with February, the driest month, receiving an average of 1.54 inches of precipitation and September, the wettest month, receiving an average of 4.28 inches. The average annual rainfall is 37.13 inches. The dominant precipitation in the months of December through February is snowfall, with an annual average snowfall of 72 inches and the largest average snowfall occurring in January (21 inches).

2.7 Hydrology

Hydrology is a science dealing with the properties, distribution, and circulation of water on and below the earth's surface and in the atmosphere. Hydrology is heavily dependent on topography, geography, soils and climate, which were previously discussed in this document. Understanding how this science relates to, and is affected by, changes in land use and natural landscapes are the basis for developing successful WMPs.

A number of lakes, streams and wetlands are found throughout the RCW. There are approximately 120.5 miles of streams, 2,290 acres of wetlands and 346 acres of lakes and ponds (Michigan GIS Open Data, 2017). All but 13 of these lakes are smaller than five acres in size. There are three named lakes in the RCW, Georgetown Park (43 acres), Rushmore (41 acres), and Kenowa (27 acres).

In a natural state, water exists in these wetlands, lakes, ponds or other low areas for periods of time. These areas can provide groundwater filtering and recharge, recycling of waste products, flood control, spawning and mating grounds for fish and wildlife, and water for human use. Streams often originate from these locations or other small, undefined areas such as groundwater seeps that provide the water that flows downhill and maintains our river systems.

Changes to wetlands, lakes, ponds, floodplains, and other land uses affects the flashiness of a stream. The term flashiness reflects the frequency and rapidity of short-term changes in stream flow and is related to the availability of wetlands and other headwater water-storage areas in addition to other land characteristics like impervious surfaces. A stream described as flashy responds to rainfall by rising and falling quickly. Conversely, a stream that is not flashy would rise and fall less over a longer period of time for an equivalent rainfall and would typically derive more of its overall flow from groundwater. A less flashy stream is generally more desirable. The watershed does not contain an active USGS monitoring station.

<u>Floodplains</u>

Rivers, streams, lakes, and drains occasionally overflow their banks and onto adjacent land areas called floodplains. While often viewed in a negative light, the process of streams and rivers overtopping their banks and flooding adjacent lands is natural and important in a number of ways. Flooding transfers nutrients and soil transported by the stream to adjacent wetlands and floodplains. It provides critical access to certain fish species for spawning and nursery habitat, and it dissipates flow energy that otherwise erodes streambanks and streambeds.

In regulatory terms, the word floodplain is often used to describe the land that will be inundated by water resulting from a 100-year (1% annual chance) flood. However, lands lying between the normal river elevation and the 100-year floodplain elevation are inundated by flood water on a more frequent basis (e.g. two, five or ten-year floods). These areas are critically important for connectivity between land and water, and especially, for maintaining stream stability. Rivers that cannot utilize their floodplains are typically erosion-prone due to larger flows with higher energy being contained within the stream channel.

Riverine flooding often occurs in spring with snowmelt and heavy rain events and in summer with storms. Rivers, streams, and drains will overflow their banks and their floodplains will become partially or fully saturated. Urban flooding is typically caused by large amounts of impervious surfaces that can overwhelm the storm sewer systems with significant amounts of runoff. Flash floods, typically caused by fast-moving runoff, may occur during short but intense heavy rains in localized areas, but will dissipate in a relatively short amount of time. On the other hand, constant, less intense rain can cause “general flooding,” in which large areas are flooded for a relatively longer period of time than a flash flood. This type of flooding can also occur from large snowmelts. During these flooding events, the soil becomes completely saturated and water ponds in depressions or other low-lying areas.

Risks to structures and people located within the floodplain are calculated in accordance with Federal Emergency Management Agency (FEMA) requirements. If they are located within a floodplain, such as a 10 or 100-year floodplain, the inherent risks can impact insurance policies. The areas within the RCW have Flood Insurance Rate Maps (FIRM) in place that provide a planning tool for communities and land owners to help assess flood risk. These areas are shown in Figure 2.8. Floodplains in Kent County are still in draft form and have not yet been approved by FEMA.

An important component of the watershed planning process is identifying areas where flooding is acceptable; these areas can be protected or restored to ensure that natural headwater and stream functions are maintained to the greatest extent. If more of these “acceptable” areas are protected or restored, then flooding of developed or utilized lands will be reduced.

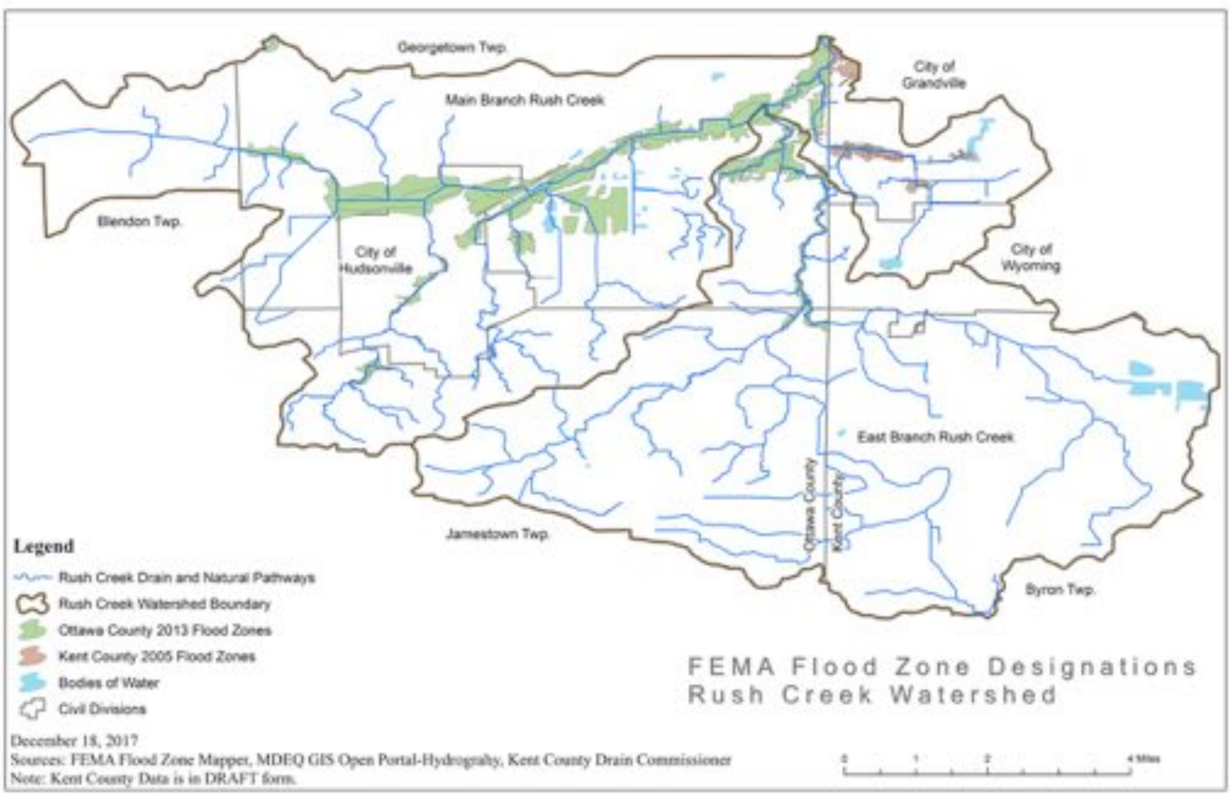

Figure 2.8 Flood Zone Designations

Wetlands

Cowardin et. al (1979) provided the following general definition of wetlands: “Wetlands are lands where saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface.” To many people, wetlands have long been considered “worthless” lands that are an impediment to development and farming or are a breeding ground for mosquitoes and other intolerable pests. It is true that we would not be inhabiting Michigan if not for the draining and filling of wetlands. This perception still prevails at times, but the importance of wetlands in the hydrologic process (including flood reduction) and as features in a complete ecosystem cannot be understated.

Wetlands are especially important for flood control, groundwater recharge and erosion control, and they play a critical role in attenuating pollutant loads. When a wetland is destroyed, or its ability to function naturally is impacted, the free services that it provides are lost and it often requires great expense to replace it. For example, the loss of wetlands in an upper tributary watershed reduces the ability of the land to attenuate floods and the ability of the stream channel to function properly. Instead of being captured in low-lying areas and being released slowly, precipitation makes its way directly to the stream channel. Due to these changes, the duration, magnitude or frequency of storm flows increase, resulting in velocity and flow increases in the streams, and ultimately streambank erosion. Flooding is exacerbated in downstream areas and can impact cropland or developed areas. The cost for lost crops, repairing streambanks and building floodwalls or levies to protect cities can be in the millions of dollars. Furthermore, the construction of floodwalls and levies typically exacerbate flooding further downstream of the structures.

Wetlands provide critical habitat for wildlife and fish; some species rely entirely on wetlands for reproduction or other phases of their life cycle. Wetlands provide habitat to many threatened and endangered species that are not found elsewhere; about 50 percent of Michigan’s threatened, endangered, rare or special concern plant species depend on wetlands (Cwiekal, 2003). Wetlands are diverse; there are different types of wetlands, such as forested, emergent, and shrub-scrub, and different functions served by wetlands such as flood storage, sediment retention, and habitat. Emergent wetlands and scrub-shrub wetlands with standing water are necessary for many fish species, such as northern pike, to lay their eggs. These wetlands must have an adequate connection to a river to allow fish to enter and exit them. They must also maintain their water levels during the hatching period, so that once the eggs hatch, the young can thrive until they return to the river.

The Michigan Department of Environmental Quality (MDEQ) has made a substantial effort to provide the tools and information necessary to understand the importance of wetlands, as well as to protect and restore them. The Landscape Level Wetland Functional Assessment (LLWFA) is one tool that has been designed for targeting wetland protection and restoration efforts in a watershed. The LLWFA analyzes a variety of data to prioritize wetlands for protection or restoration based on how well those wetlands serve specific functions.

There are approximately 2,290 acres of wetlands existing in the RCW today, with about 84% of historic wetlands having been lost to farming and development (LLWFA) (Figure 2.9).

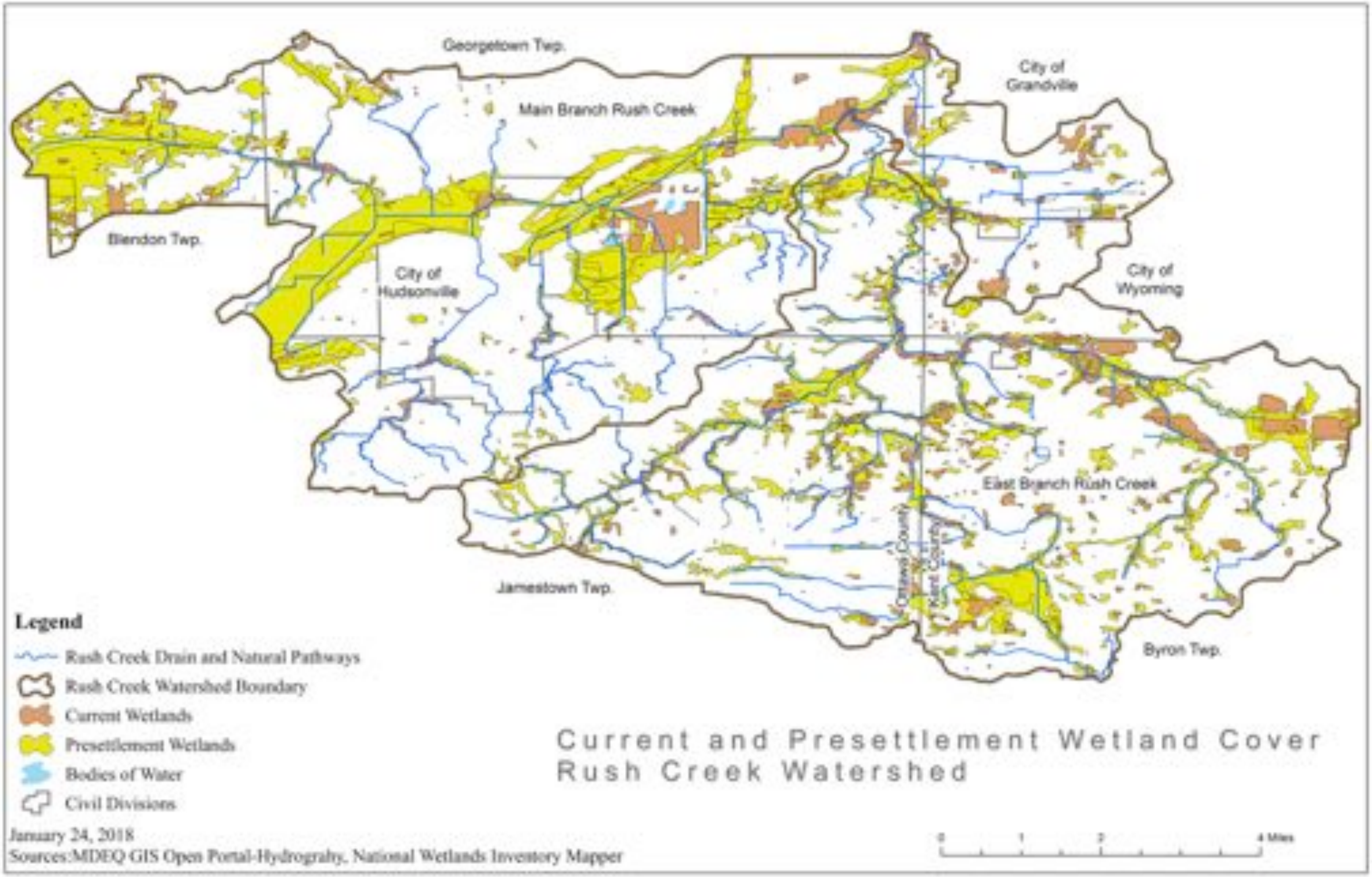

Figure 2.9 Existing and Presettlement Wetlands

Designated County Drains

The Michigan Drain Code (Public Act 40 of 1056, as amended) is the law that governs the responsibilities of County Drain Commissioners/Water Resources Commissioners (CDCs/WRCs). The commissioners oversee the construction, operation, and maintenance of established county drains. Most of Rush Creek and its tributaries are altered for efficient drainage and/or maintained as designated county drains; in fact about 52% (approximately 63 miles) of total stream miles of the watershed are considered to be county drains. As such, they may no longer provide some of their natural functions described in previous sections, but instead provide other important functions necessary for use of the land by humans. Because county drains are often created or maintained by dredging, understanding the difference between designated county drains and natural streams is an important component in identifying the potential for water quality, instream habitat and other stream functions.

Roadside ditches, agricultural field tile lines, roof gutters with downspouts connected to storm sewers, and curb and gutter systems, as examples, are all part of an efficient drainage system that has been designed to bypass the natural processes which might cause standing water and flooding. The ongoing demand for maintenance to provide efficient drainage from urban and agricultural lands, while balancing concerns of downstream riparians is often the responsibility of CDCs/WRCs, who are burdened with managing this demand for drainage, and consistently busy with maintaining designated county drains to convey stormwater runoff.

Unfortunately, the creation of drainage ways for agriculture, construction of storm sewers for development and filling or disconnection of floodplains have historically transferred problems such as flooding, streambank erosion and decreased water quality to downstream neighbors. Figure 2.10 shows which waterways in the RCW are designated county drains, and which are natural pathways.

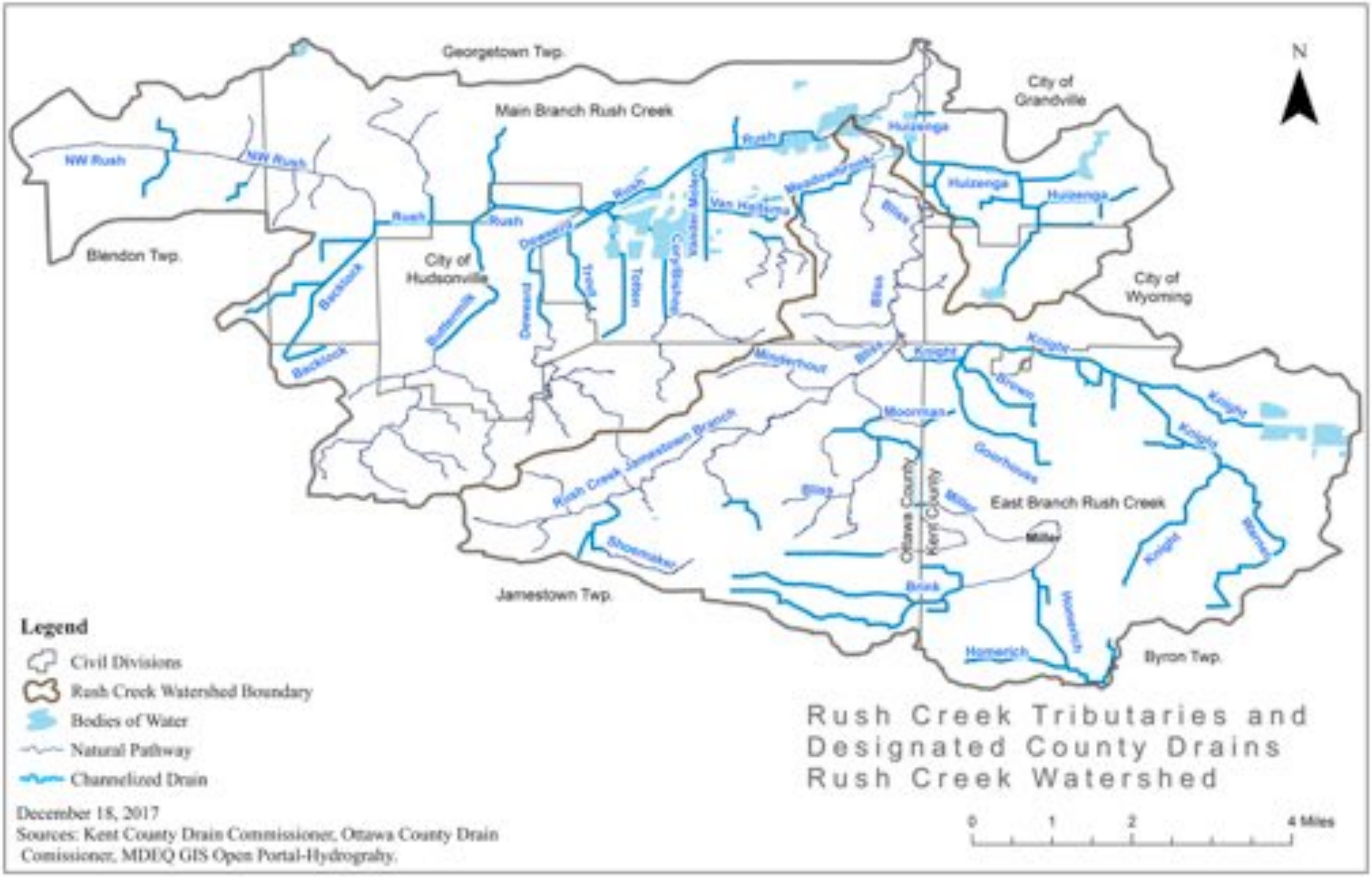

Figure 2.10 Designated County Drains and Natural Pathways

2.8 Dams

Dams are constructed for a variety of purposes, from mechanical power to electrical power generation, flood control, and recreation. Today, many of these dams are still in use for their intended purpose or provide alternative uses such as “lakefront” property or wildlife floodings.

The negative impacts associated with some dams, from interruption of natural water and sediment transport patterns to migration barriers for fish and other organisms, are well documented.

Seven dams or lake level control structures are known to exist in the RCW; including the lake level control structures for Kenowa Lake, Rushmore Lake, Crystal Springs Lake, and the Buttermilk Creek Detention Dam, the Johnson Estate Dam and the Rush Creek Detention Basin Dam (No. 2), (Figure 2.11) (MDEQ MiWaters, 2017). The Ottawa County Water Resources Commissioner (OCWRC) has completed projects to reduce the threat of flooding, including improvements along Bliss Creek in Georgetown Township that help to alleviate flooding near 44th Street and Kenowa (FEMA, 2013). Information about three dams under the jurisdiction of the Ottawa County Water Resources Commissioner that “serve to control stormwater during heavy rainfall, improve water quality by entrapping sediment and provide a habitat for wildlife” excerpt from a 2013 FEMA Flood Insurance Study (2013):

> Rush Creek Phase I Dam, which is also known as Georgetown Dam or Rush Creek Dam, is located at the upper end of Northwest Branch of Rush Creek in the Charter Township of Georgetown. This structure is an earthen dam constructed in 1978 measuring approximately 700 feet long and 17.9 feet tall at its crest. An area measuring 634.6 acres drains to this dam. A 54-inch diameter corrugated metal pipe (CMP) is located at the flow line of the channel and acts at the primary spillway. During periods of increased runoff, outflow through this orifice is regulated by an aluminum slide gate controlled by a motor-operated gearbox above the inlet. A 24-inch diameter CMP located 13 feet above the channel acts as a secondary spillway. An auxiliary spillway, in the form of an overflow weir, is located 14.6 feet above the channel. The dam was originally designed for the 2-percent-annual-chance flood event, but has since been modified to contain the 1- percent-annual-chance flood event (Reference 25).
>
> Rush Creek Phase II Dam, which is also known as DeWeerd Dam or Jamestown Dam, is located on DeWeerd Drain upstream of Interstate 196. This structure is an earthen dam constructed in 1982 measuring approximately 315 feet long and 18.3 feet tall at its crest. An area measuring approximately 700 acres drains to this dam. Rush Creek Phase III Dam, which is also known as Buttermilk Dam, is located on Buttermilk Creek upstream on Interstate 196. This structure is an earthen dam with a 60- inch CMP acting as the primary spillway. At the eastern side of the earthen berm is a concrete weir for high flow (Reference 21). (FEMA, p. 16-17).

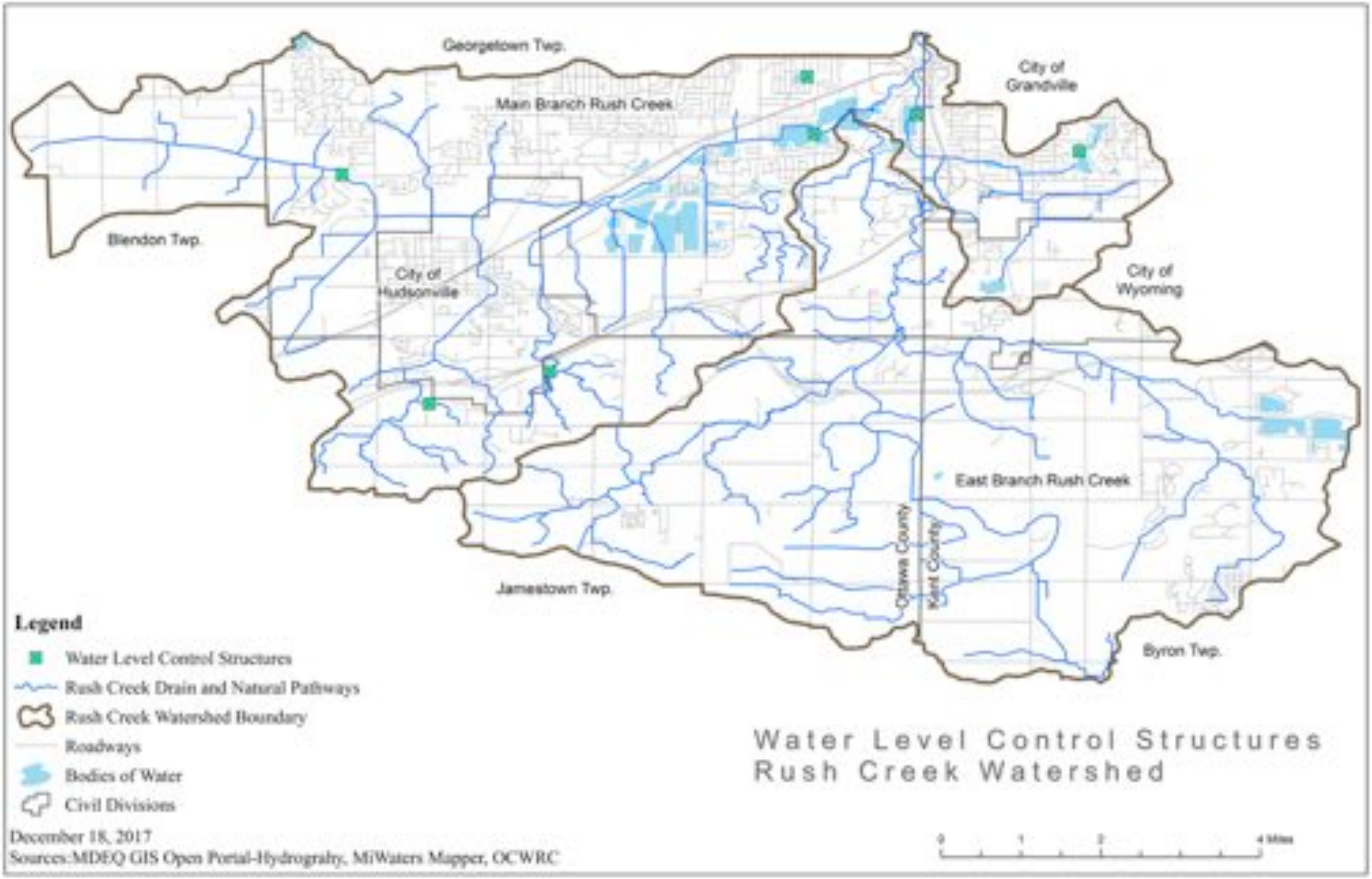

Figure 2.11 Water Level Control Structures in Watershed

2.9 Aquatic Life

Michigan Department of Natural Resources (MDNR) classifies the Rush Creek and East Branch Rush Creek as warmwater, and the biological communities are reflective of this temperature designation. Water temperature monitoring conducted in July 2016 suggests that some tributaries, especially in the East Branch of Rush Creek, have temperatures in the cool or coldwater designation range (Figure 2.12). Stream temperatures were also measured at three sites in July 2017, Site 1 RCT had an average temperature of 70.7 degrees F (warm), Site 3RCT had an average temperature of 68.6 degrees F (cool), and site 7 RCT had an average temperature of 71.1 degrees F (warm). Stream temperature data is included in Appendix B. Stream temperatures were cooler where wetlands or forested land is present. Generally, aquatic habitat is considered to be moderately impaired due to past channelization, but both the fish and macroinvertebrate communities have found to be "acceptable" by MDEQ at multiple locations in the watershed. The fish community contains as many as sixteen species of fish, with gamefish such as sunfish (bluegill, bass) and yellow perch present, but small in size (Figure 2.13). In 2016, a young-of-the-year rainbow trout (steelhead) and mottled sculpin, two coldwater dependent species, were captured in the East Branch. The macroinvertebrate community has been found to be quite diverse and well balanced.

Through the Michigan Clean Water Corps program, stream quality scores were calculated based on macroinvertebrates counts at three sites collected once a year from 2012 to 2017. Rush Creek was rated as Fair in 2012, 2013, 2014, and 2017 and Good in 2015 and 2016 at a site located at Rush Creek and Main Street in Georgetown Township. Two additional sites were rated in 2017. A site located at 428 Port Sheldon was rated Good, and a site at Rush Creek and 12th Ave. in Jenison was rated as Fair. This data is included in Appendix B.

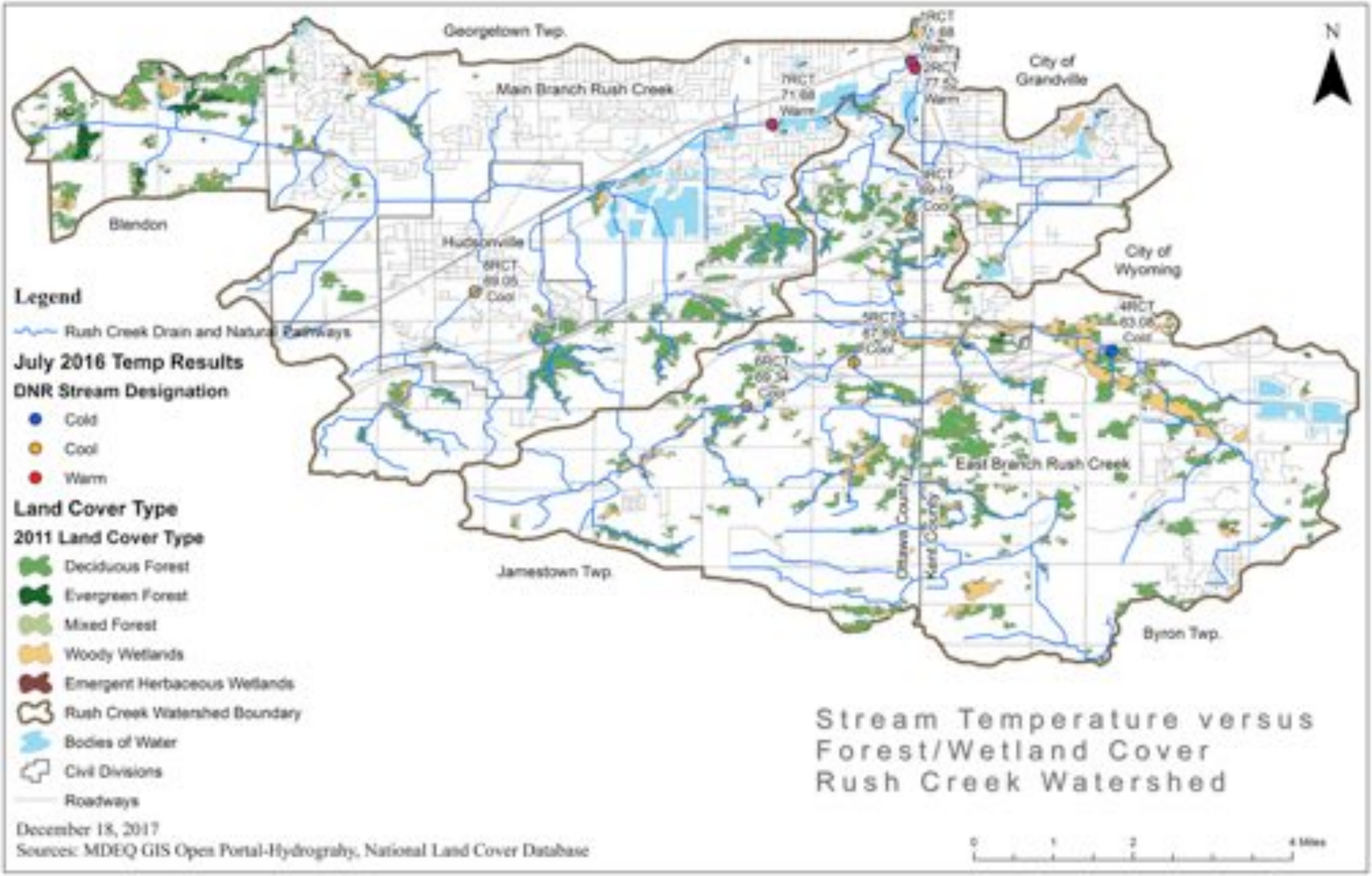

Figure 2.12 Stream Temperatures Vs. Forest and Wetland Cover

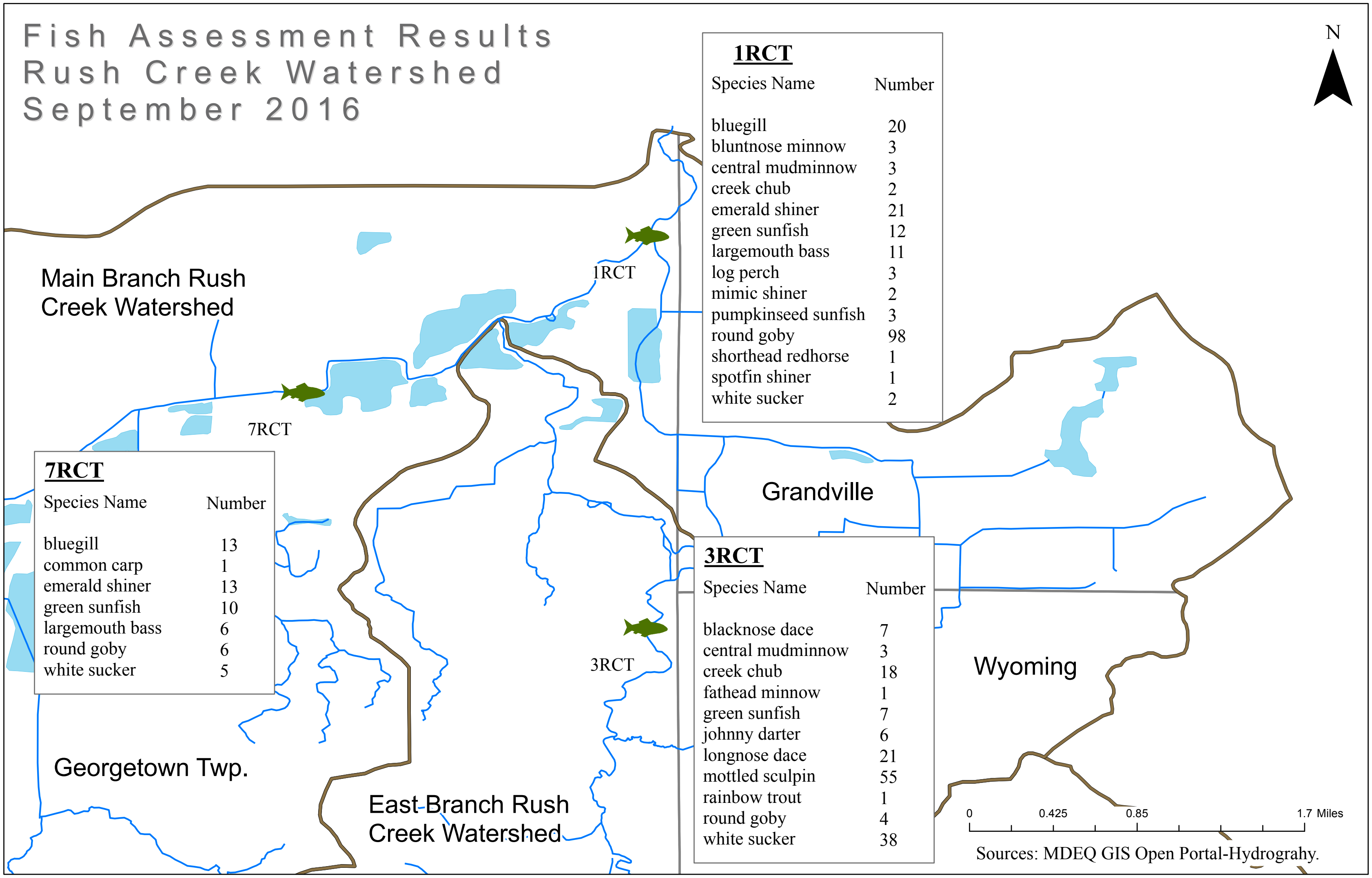

Figure 2.13 Fish Assessment Results

2.10 Protected Species

Under Part 365 of Public Act 451, people are not allowed to take or harm any endangered or threatened fish, plants or wildlife. The RCW spans Kent and Ottawa Counties. The Michigan Natural Features Inventory (MNFI) Rare Species Explorer lists fourteen state endangered (E), 43 state threatened (T) and 52 state special concern (SC) species in Kent County (Table 2.5) and nine state endangered, 29 state threatened and 33 state special concern in Ottawa County (Table 2.6). However, it is uncertain which of these species exists in the RCW. The tables also show species presumed to be Extirpated (X) in the State, Federally Listed Endangered Species (LE), Federally listed Threatened (LT), Federal Candidate (C), and Federal Species with Partial Status (PS). The MDNR defines these protected species as follows:

"*Endangered species*: Any species of fish, plant life, or wildlife that is in danger of extinction throughout all or a significant part of its range, other than a species of interest determined by the Department, or the Secretary, of the United States Department of the Interior to constitute a pest whose protection under this part would present an overwhelming and overriding risk to humans.

Threatened species: Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Special Concern: While not afforded legal protection under the Act, many of these species are of concern because of declining or relict populations in the state. Should these species continue to decline, they would be recommended for threatened or endangered status. Protection of Special Concern species now, before they reach dangerously low population levels, would prevent the need to list them in the future by maintaining adequate numbers of self-sustaining populations within Michigan. Some other potentially rare species are listed as of Special Concern pending more precise information on their status in the state; when such information becomes available, they could be moved to threatened or endangered status or deleted from the list" (MDNR, 2016).

Today, most rare species of plants and animals are threatened or endangered because of habitat destruction (including pollution), introduction of non-native organisms and direct killing. The loss of one species can affect many other species in the ecosystem, and the total impact of extinction is not always apparent. It is clear, however, that conserving biological diversity is essential for maintaining healthy, functioning ecosystems.

As previously stated, about 50 percent of Michigan's threatened, endangered, rare or special concern plant species depend on wetlands. An understanding of the presence or absence of threatened, endangered and special concern plant and animal species, and their habitats, can be used to help guide land conservation and management decisions in the watershed. Regional conservation efforts appear to have the greatest potential on private lands and through existing landowner habitat improvement or protections programs (Hyde et al., 2009).

Table 2.5 State Threatened, Endangered, and Special Concern Species Documented in Kent County (MNFI, 2017)

Common Name	Scientific Name	Taxonomic Group	State Status	Federal Status
Spindle lymnaea	*Acella haldemani*	Snails	SC	
Lake sturgeon	*Acipenser fulvescens*	Fish	T	
Blanchard's cricket frog	*Acris blanchardi*	Amphibians	T	
Climbing fumitory	*Adlumia fungosa*	Flowering Plants	SC	
Elktoe	*Alasmidonta marginata*	Mussels	SC	
Slippershell	*Alasmidonta viridis*	Mussels	T	
Grasshopper sparrow	*Ammodramus savannarum*	Birds	SC	PS
Leadplant	*Amorpha canescens*	Flowering Plants	SC	
Canadian milk vetch	*Astragalus canadensis*	Flowering Plants	T	
Cooper's milk vetch	*Astragalus neglectus*	Flowering Plants	SC	
White or prairie false indigo	*Baptisia lactea*	Flowering Plants	SC	
Cut-leaved water parsnip	*Berula erecta*	Flowering Plants	SC	
Kitten-tails	*Besseya bullii*	Flowering Plants	E	
Rock cress	*Boechera dentata*		T	
Missouri rock-cress	*Boechera missouriensis*	Flowering Plants	SC	
Rusty-patched bumble bee	*Bombus affinis*	Insects	SC	LE
Side-oats grama grass	*Bouteloua curtipendula*	Flowering Plants	E	
False boneset	*Brickellia eupatorioides*	Flowering Plants	SC	PS
Swamp metalmark	*Calephelis mutica*	Insects	SC	
Frosted elfin	*Callophrys irus*	Insects	T	
Davis's sedge	*Carex davisii*	Flowering Plants	SC	
Hairy-fruited sedge	*Carex trichocarpa*	Flowering Plants	SC	
Cattail sedge	*Carex typhina*	Flowering Plants	T	
Campeloma spire snail	*Cincinnatia cincinnatiensis*	Snails	SC	
Spotted turtle	*Clemmys guttata*	Reptiles	T	
Lake herring or Cisco	*Coregonus artedi*	Fish	T	
Purple wartyback	*Cyclonaias tuberculata*	Mussels	T	
White lady slipper	*Cypripedium candidum*	Flowering Plants	T	
Beak grass	*Diarrhena obovata*	Flowering Plants	SC	
Leafhopper	*Dorydiella kansana*	Insects	SC	
Creeping whitlow grass	*Draba reptans*	Flowering Plants	T	
Purple coneflower	*Echinacea purpurea*	Flowering Plants	X	
Flattened spike rush	*Eleocharis compressa*	Flowering Plants	T	
Engelmann's spike rush	*Eleocharis engelmannii*	Flowering Plants	SC	
Black-fruited spike-rush	*Eleocharis melanocarpa*	Flowering Plants	SC	
Blanding's turtle	*Emydoidea blandingii*	Reptiles	SC	

Virginia snakeroot	*Endodeca serpentaria*	Flowering Plants	T	
Snuffbox	*Epioblasma triquetra*	Mussels	E	LE
Persius dusky wing	*Erynnis persius persius*	Insects	T	
Wahoo	*Euonymus atropurpureus*	Flowering Plants	SC	
Tinted spurge	*Euphorbia commutata*	Flowering Plants	T	
Peregrine falcon	*Falco peregrinus*	Birds	E	PS:LE
Queen-of-the-prairie	*Filipendula rubra*	Flowering Plants	T	
Watercress snail	*Fontigens nickliniana*	Snails	SC	
Umbrella-grass	*Fuirena pumila*	Flowering Plants	T	
Showy orchis	*Galearis spectabilis*	Flowering Plants	T	
White gentian	*Gentiana alba*	Flowering Plants	E	
Downy gentian	*Gentiana puberulenta*	Flowering Plants	E	
Stiff gentian	*Gentianella quinquefolia*	Flowering Plants	T	
Prairie smoke	*Geum triflorum*	Flowering Plants	T	
Wood turtle	*Glyptemys insculpta*	Reptiles	SC	
Bald eagle	*Haliaeetus leucocephalus*	Birds	SC	
Whiskered sunflower	*Helianthus hirsutus*	Flowering Plants	SC	
Green violet	*Hybanthus concolor*	Flowering Plants	SC	
Goldenseal	*Hydrastis canadensis*	Flowering Plants	T	
Henry's elfin	*Incisalia henrici*	Insects	T	
Whorled pogonia	*Isotria verticillata*	Flowering Plants	T	
Twinleaf	*Jeffersonia diphylla*	Flowering Plants	SC	
Scaleshell	*Leptodea leptodon*	Mussels	E	LE
Black sandshell	*Ligumia recta*	Mussels	E	
Furrowed flax	*Linum sulcatum*	Flowering Plants	SC	
Virginia flax	*Linum virginianum*	Flowering Plants	T	
Dwarf-bulrush	*Lipocarpha micrantha*	Flowering Plants	SC	
Broad-leaved puccoon	*Lithospermum latifolium*	Flowering Plants	SC	
Karner blue	*Lycaeides melissa samuelis*	Insects	T	LE
Virginia bluebells	*Mertensia virginica*	Flowering Plants	E	
Copper button	*Mesomphix cupreus*	Snails	SC	
Red mulberry	*Morus rubra*	Flowering Plants	T	
River redhorse	*Moxostoma carinatum*	Fish	T	
Pugnose shiner	*Notropis anogenus*	Fish	E	
Bigmouth shiner	*Notropis dorsalis*	Fish	SC	
Poweshiek skipperling	*Oarisma poweshiek*	Insects	T	LE
Tamarack tree cricket	*Oecanthus laricis*	Insects	SC	
Depressed ambersnail	*Oxyloma peoriense*	Snails	SC	
Ginseng	*Panax quinquefolius*	Flowering Plants	T	
Louisiana waterthrush	*Parkesia motacilla*	Birds	T	
Beard tongue	*Penstemon calycosus*	Flowering Plants	T	

Carey's smartweed	*Persicaria careyi*	Flowering Plants	T	
Orange- or yellow-fringed orchid	*Platanthera ciliaris*	Flowering Plants	E	
Round pigtoe	*Pleurobema sintoxia*	Mussels	SC	
Brown walker	*Pomatiopsis cincinnatiensis*	Snails	SC	
Vasey's pondweed	*Potamogeton vaseyi*	Flowering Plants	T	
King rail	*Rallus elegans*	Birds	E	
Prairie buttercup	*Ranunculus rhomboideus*	Flowering Plants	T	
Tall beakrush	*Rhynchospora macrostachya*	Flowering Plants	SC	
Bald-rush	*Rhynchospora scirpoides*	Flowering Plants	SC	
Three-square bulrush	*Schoenoplectus americanus*	Flowering Plants	E	
Torrey's bulrush	*Schoenoplectus torreyi*	Flowering Plants	SC	
Cerulean warbler	*Setophaga cerulea*	Birds	T	
Hooded warbler	*Setophaga citrina*	Birds	SC	
Eastern massasauga	*Sistrurus catenatus*	Reptiles	SC	LT
Blue-eyed-grass	*Sisyrinchium strictum*	Flowering Plants	SC	
Yellow-flowered leafcup	*Smallanthus uvedalia*	Flowering Plants	T	
Missouri goldenrod	*Solidago missouriensis*	Flowering Plants	T	
River fingernail clam	*Sphaerium fabale*	Fingernail and Pea Clams	SC	
Trailing wild Bean	*Strophostyles helvula*	Flowering Plants	SC	
Drummond's aster	*Symphyotrichum drummondii*	Flowering Plants	T	
Western silvery aster	*Symphyotrichum sericeum*	Flowering Plants	T	
Eastern box turtle	*Terrapene carolina carolina*	Reptiles	SC	
Lilliput	*Toxolasma parvum*	Mussels	E	
Nodding pogonia or three birds orchid	*Triphora trianthophora*	Flowering Plants	T	
Sand grass	*Triplasis purpurea*	Flowering Plants	SC	
Deertoe	*Truncilla truncata*	Mussels	SC	
Paper pondshell	*Utterbackia imbecillis*	Mussels	SC	
Goosefoot corn salad	*Valerianella chenopodiifolia*	Flowering Plants	T	
Purplecap valvata	*Valvata perdepressa*	Snails	SC	
Pyramid dome	*Ventridens intertextus*	Snails	SC	
Ellipse	*Venustaconcha ellipsiformis*	Mussels	SC	
Rainbow	*Villosa iris*	Mussels	SC	
Prairie golden alexanders	*Zizia aptera*	Flowering Plants	T	

Table 2.6 State Threatened, Endangered, and Special Concern Species Documented in Ottawa County (MNFI, 2017)

Common Name	Scientific Name	Taxonomic Group	State Status	Federal Status
Blanchard's cricket frog	*Acris blanchardi*	Amphibians	T	
Climbing fumitory	*Adlumia fungosa*	Flowering Plants	SC	
Elktoe	*Alasmidonta marginata*	Mussels	SC	
Slippershell	*Alasmidonta viridis*	Mussels	T	
Rock cress	*Boechera dentata*		T	
Rusty-patched bumble bee	*Bombus affinis*	Insects	SC	LE
Red-shouldered hawk	*Buteo lineatus*	Birds	T	
Davis's sedge	*Carex davisii*	Flowering Plants	SC	
Sedge	*Carex seorsa*	Flowering Plants	T	
Campeloma spire snail	*Cincinnatia cincinnatiensis*	Snails	SC	
Pitcher's thistle	*Cirsium pitcheri*	Flowering Plants	T	LT
Marsh wren	*Cistothorus palustris*	Birds	SC	
Spotted turtle	*Clemmys guttata*	Reptiles	T	
Kirtland's snake	*Clonophis kirtlandii*	Reptiles	E	
Blue-eyed Mary	*Collinsia verna*	Flowering Plants	SC	
Lake herring or Cisco	*Coregonus artedi*	Fish	T	
Kiyi	*Coregonus kiyi*	Fish	SC	
Shortjaw cisco	*Coregonus zenithicus*	Fish	T	
Pallas' bugseed	*Corispermum pallasii*	Flowering Plants	SC	
Purple wartyback	*Cyclonaias tuberculata*	Mussels	T	
Three-ribbed spike rush	*Eleocharis tricostata*	Flowering Plants	T	
Blanding's turtle	*Emydoidea blandingii*	Reptiles	SC	
Wahoo	*Euonymus atropurpureus*	Flowering Plants	SC	
Tinted spurge	*Euphorbia commutata*	Flowering Plants	T	
Dune cutworm	*Euxoa aurulenta*	Insects	SC	
Peregrine falcon	*Falco peregrinus*	Birds	E	PS:LE
Watercress snail	*Fontigens nickliniana*	Snails	SC	
Showy orchis	*Galearis spectabilis*	Flowering Plants	T	
Bald eagle	*Haliaeetus leucocephalus*	Birds	SC	
Green violet	*Hybanthus concolor*	Flowering Plants	SC	
Gentian-leaved St. John's-wort	*Hypericum gentianoides*	Flowering Plants	SC	
Twinleaf	*Jeffersonia diphylla*	Flowering Plants	SC	
Short-fruited rush	*Juncus brachycarpus*	Flowering Plants	T	
Black sandshell	*Ligumia recta*	Mussels	E	

Broad-leaved puccoon	*Lithospermum latifolium*	Flowering Plants	SC	
Northern appressed clubmoss	*Lycopodiella subappressa*	Ferns and Fern Allies	SC	
Virginia bluebells	*Mertensia virginica*	Flowering Plants	E	
Red mulberry	*Morus rubra*	Flowering Plants	T	
River redhorse	*Moxostoma carinatum*	Fish	T	
American lotus	*Nelumbo lutea*	Flowering Plants	SC	
Bigmouth shiner	*Notropis dorsalis*	Fish	SC	
Weed shiner	*Notropis texanus*	Fish	X	
Threehorn wartyback	*Obliquaria reflexa*	Mussels	E	
Hickorynut	*Obovaria olivaria*	Mussels	E	
Ginseng	*Panax quinquefolius*	Flowering Plants	T	
Eastern pipistrelle	*Perimyotis subflavus*	Mammals	SC	
Ornamanted peaclam	*Pisidium cruciatum*	Fingernail and Pea Clams	SC	
A fingernail clam	*Pisidium simplex*	Fingernail and Pea Clams	SC	
Round pigtoe	*Pleurobema sintoxia*	Mussels	SC	
Bog bluegrass	*Poa paludigena*	Flowering Plants	T	
Pink papershell	*Potamilus ohiensis*	Mussels	T	
Mermaid-weed	*Proserpinaca pectinata*	Flowering Plants	E	
Pine-drops	*Pterospora andromedea*	Flowering Plants	T	
Whorled mountain mint	*Pycnanthemum verticillatum*	Flowering Plants	SC	
Round lake floater	*Pyganodon subgibbosa*	Mussels	T	
King rail	*Rallus elegans*	Birds	E	
Spearwort	*Ranunculus ambigens*	Flowering Plants	T	
Maryland meadow beauty	*Rhexia mariana*	Flowering Plants	T	
Meadow beauty	*Rhexia virginica*	Flowering Plants	SC	
Sauger	*Sander canadensis*	Fish	T	
Hooded warbler	*Setophaga citrina*	Birds	SC	
Yellow-throated warbler	*Setophaga dominica*	Birds	T	
Atlantic blue-eyed-grass	*Sisyrinchium atlanticum*	Flowering Plants	T	
Trailing wild Bean	*Strophostyles helvula*	Flowering Plants	SC	
Eastern box turtle	*Terrapene carolina carolina*	Reptiles	SC	
Lilliput	*Toxolasma parvum*	Mussels	E	
Snow trillium	*Trillium nivale*	Flowering Plants	T	
Fawnsfoot	*Truncilla donaciformis*	Mussels	T	
Deertoe	*Truncilla truncata*	Mussels	SC	
Paper pondshell	*Utterbackia imbecillis*	Mussels	SC	
Rainbow	*Villosa iris*	Mussels	SC	
Wild rice	*Zizania aquatica*		T	

2.11 Invasive Species

"Invasive species" refers to a species whose introduction does, or is likely to, cause economic or environmental harm or harm to human health. Like most areas, the RCW contains many invasive species. Some of the more pervasive include Eurasian water milfoil, purple loosestrife, Japanese knotweed, round goby, zebra mussel and garlic mustard. Perhaps the most visibly destructive of late is the emerald ash borer, which has caused most ash trees to die. The subsequent fall of each tree can take cause multiple healthy trees to fall, and leave stream banks unstable and left open to erosion. Some invasive species especially affect wetlands. For example, buckthorn grows in wetlands and impacts frog embryo development and they can grow so thick as to make wetlands impassable. European frog-bit is a free-floating aquatic plant that is affecting shorelines and wetlands.

Under a contract with the MDNR Wildlife Division, MNFI evaluated the occurrence of invasive plants throughout the state and created a strategy to manage their harmful effects on wildlife (Higman and Campbell, 2009). It was found that southern Lower Michigan is especially susceptible to invasive plants given the area's human population density. Priority invasive species for Kent Conservation District are European Frog-bit, Non-native Phragmites, Giant and Japanese Knotweed, Pale or Black Swallow-wort, Oriental bittersweet, Chinese silver-grass, Japanese Barberry, Glossy and Common buckthorn. Priority invasive species of the Ottawa County Conservation District are Oriental bittersweet, Phragmites, Japanese Knotweed, Pale or Black Swallow wort, Japanese Barberry, Glossy/common buckthorn, Japanese Honeysuckle, Autumn Olive and Black Locust. The Kent and Ottawa County Conservation Districts as well as the West Michigan Conservation Network provide outreach, information, and assistance on invasive species in the area.

2.12 Recreational Uses and Government Protected Lands

There are township, city, and county owned parks in the RCW, but no state owned lands. Figure 2.14 shows Government Protected Lands and Parks, excluding golf courses and cemeteries. Some watershed municipalities, including the City of Hudsonville, have prioritized connectivity in their community master planning. More specifically, the Hudsonville prioritizes using waterways as recreational corridors, and connecting these non-motorized corridors where they are disconnected. The OCWRC also would like to see Rush Creek available for use as a recreational corridor.

There are six golf courses in the watershed: Railside, Ironwood, Maple Hill in Kent County and Glen Eagle, Sunnybrook Country Club, Rolling Hills, in Ottawa County. Of those golf courses, the Sunnybrook Country Club, located in the East Branch subwatershed, has participated in the Certified Michigan Turfgrass Environmental Stewardship Program (CMTESP). The CMTESP is a voluntary program covering environmental stewardship related laws, regulations, and Best Management Practices (BMPs), such as wellhead protection, buffer strips, and pesticide and fertilizer storage (Michigan Turfgrass Environmental Stewardship Program, accessed July 29, 2017 https://www.mtesp.org/about). The program is available for any managed turfgrass areas including golf course, schools, parks, and universities.

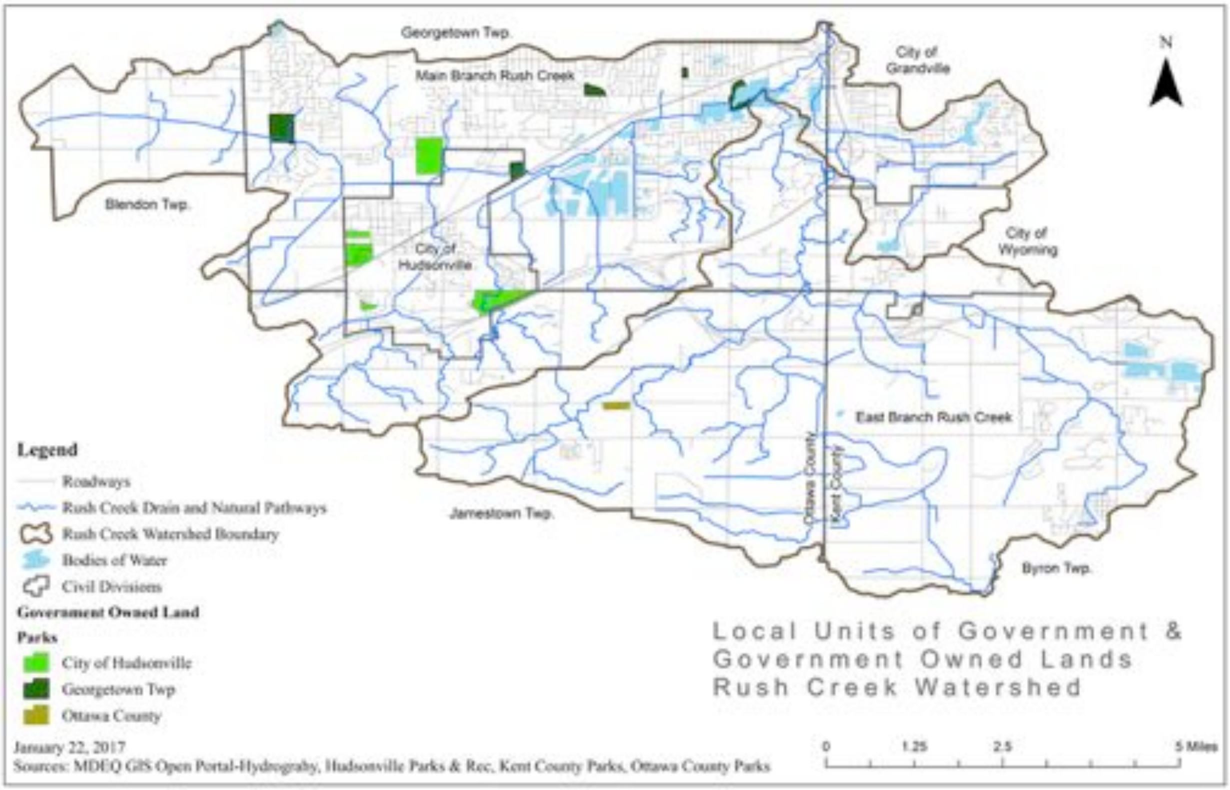

Figure 2.14 Government Protected Land

2.13 Political Jurisdictions

The local government entities located within the RCW are listed in Table 2.7 and shown in Figure 2.15. Policies of local governments are further reviewed in Chapter 9.

In addition to the local county, city, and township governments, state agencies with regulatory oversight include the MDEQ and MNDR. MDEQ works to enforce federal and state environmental protection laws. The MDEQ is the state's permitting authority for inland lakes and streams (NREPA, 1994 PA 451, Part 301), wetlands (NREPA, 1994 PA 451, Part 303), National Pollutant Discharge Elimination System (NPDES), concentrated animal feeding operation (CAFOs), Soil Erosion and Sedimentation Control (SESC), and storm water management. In addition, the MDEQ is the permitting authority for the federal Clean Water Act (Part 404). The MDNR manages the state's fish and wildlife resources, as well as state parks and game areas.

Local Health Departments manage permitting programs for well and septic system installation, affecting groundwater resources. The Kent County Health Department (KCHD) and Ottawa County Department of Public Health (OCDPH) are the oversight agencies responsible for permitting onsite well and septic system installations. The OCDPH has a Real Estate Transfer Evaluation Program that includes a mandatory evaluation of septic systems at a home or business before the time of sale. The program identifies septic systems requiring maintenance, repair or replacement, which is beneficial for the RCW. Additional details of the program are included in Chapter 9.2.2.

County Road and Drain/Water Resources Commissions also exercise authority over watershed resources. Road commissions plan and execute road development and maintenance projects. Road installation may impact drainage patterns. Roads crossing over surface waters and wetlands may require culverts or bridges. Design parameters of bridges and culverts, including size, depth and debris impaction, may affect stream hydrology or wetland function. Likewise, operations and maintenance methods for road grading, repairs, and snow and ice removal can vary in their impact on water quality. Drain commissioners have authority to maintain or alter a large percentage of the watershed's tributaries to minimize flooding on agricultural and developed lands. Management and maintenance methods used by drain commissioners can have a large impact on water quality. It is important for both road and drain commissions to keep current regarding BMPs for water quality.

Part 91 of Natural Resources Enviornmental Protection Act (NREPA) soil erosion and sedimentation control is administered and enforced by MDEQ through various county and local government units. Counties have a designated County Enforcing Agency, and municipalities are able to designate Municipal Enforcing Agencies. County Enforcing Agencies and Municipal Enforcing Agencies are responsible for reviewing soil erosion and sediment control plans, issuing permits and reviewing compliance with Part 91, and taking enforcement actions when necessary (MDEQ, 2016c) retrieved from https://www.michigan.gov/documents/deq/wrd-sesc-agency-list_539870_7.pdf).

In the RCW, County Enforcing Agencies include the Kent County Road Commission (KCRC) and the OCWRC.

The installation of some BMPs recommended within this WMP, such as wetland restoration, streambank stabilization, and green infrastructure, may require permits from MDEQ and/or other local regulatory agencies through the appropriate permitting program. MDEQ administers permits for wetlands, inland lakes and streams through the MDEQ/United States Army Corps of Engineers (USACE) Joint Permit Application (https://www.michigan.gov/deq/0,4561,7-135-3313_71520_24403---,00.html).

Table 2.7. Political Jurisdictions in the RCW (Michigan GIS Open Data, 2017)

Cities by County		Townships by County	
Kent	**Ottawa**	**Kent**	**Ottawa**
Grandville	Hudsonville	Byron	Blendon
Wyoming			Georgetown
			Jamestown

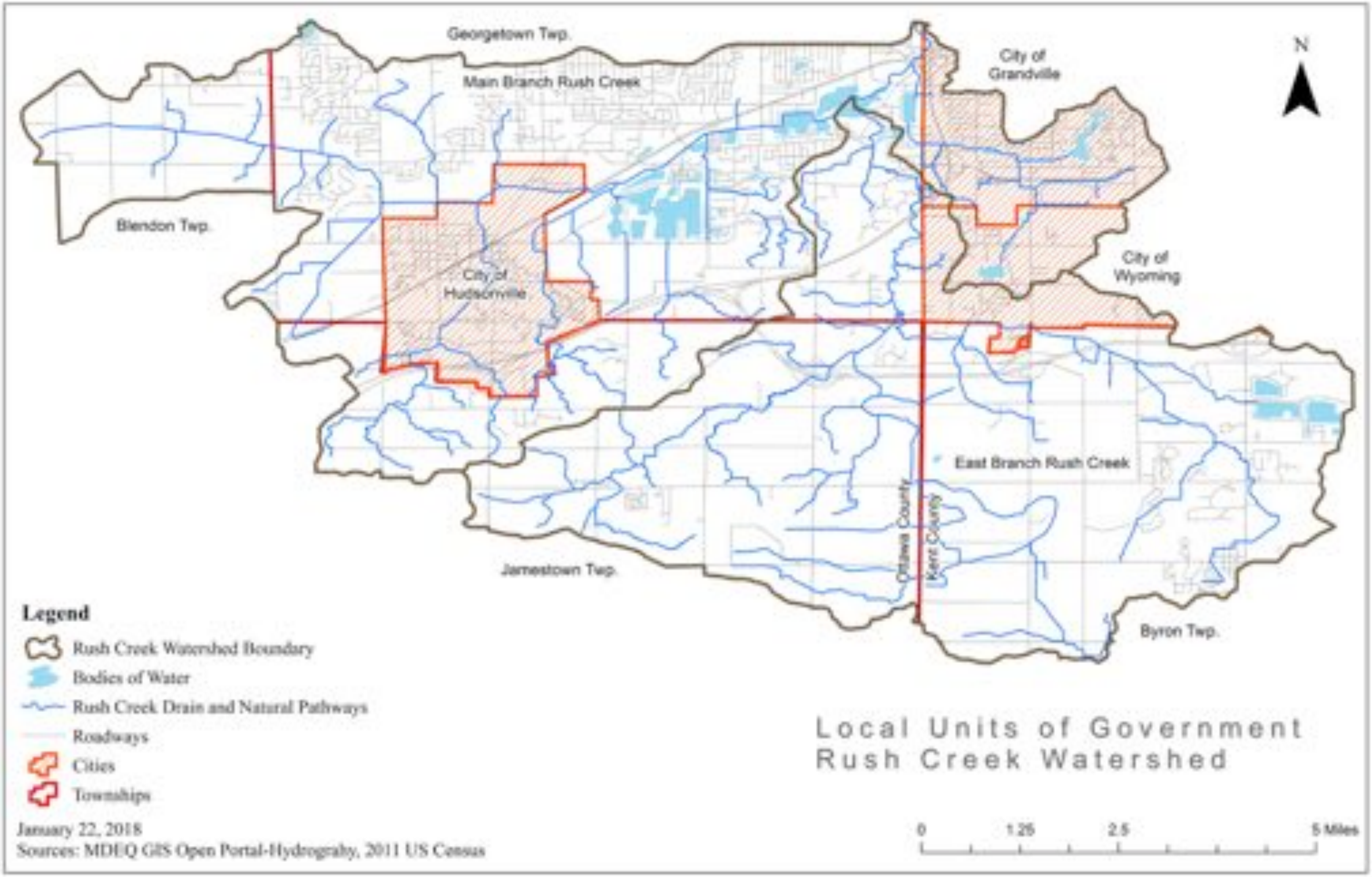

Figure 2.15 Local Units of Government

2.14 Demographics

There are 59,547 people within the 59 square mile RCW. As a result, the population density is 1,000 people per square mile. There are over twice as many people living in the Main Branch of Rush Creek watershed (1,337 people per square mile) than in the East Branch subwatershed watershed (546 people per square mile) (US EPA, 2016). The 2011 population density by census Tract is shown in Figure 2.16.

There are 21,027 households, with 85% of the housing units owner occupied and 15% renter occupied. Per capita income is $25,976, with 39% of the households earning >$75,000, 24% earning $50,000-$75,000, 25% earning $25,000-$50,000, and 12% earning <$25,000. The RCW had 20% of the people considered low income compared to the state average of 35%. The East Branch Rush Creek watershed population has a slightly higher percentage (46%) of >$75,000 household income earners (US EPA, 2016).

The percentage of people with less than a high school education (6%) in Rush Creek watershed is slightly lower than state (11%) and national (14%) averages. High school graduates make up 31% of the population, those with some college 32%, those with an associate's degree 10%, and those with a bachelor's degree or higher 31%.

The percentage of minority population is 7%, although it has grown from 4% in the 2000 Census. Average minority population in the state is 24% and nationwide 36%. The largest minority in the RCW is Hispanic at 3% or 2,023 people. The age breakdown of people in the watershed are 0-4 years 7%, 0-17 years 28%, 18+ 72%, 65+ 12%. These compare well with state and national values.

Historically, the population of the Rush Creek watershed has grown from 50,089 recorded at the 2000 Census where population density was 833 people per square mile. As might be expected, the percentage of people earning >$75,000 was lower (31%), and those earning $50,000-$75,000 was higher (29%). Also, the percentage of people with no high school diploma was higher (10%) and those with some sort of college degree was lower. Percentages of the population by age did not change appreciably from 2000 to 2010 (US EPA, 2016).

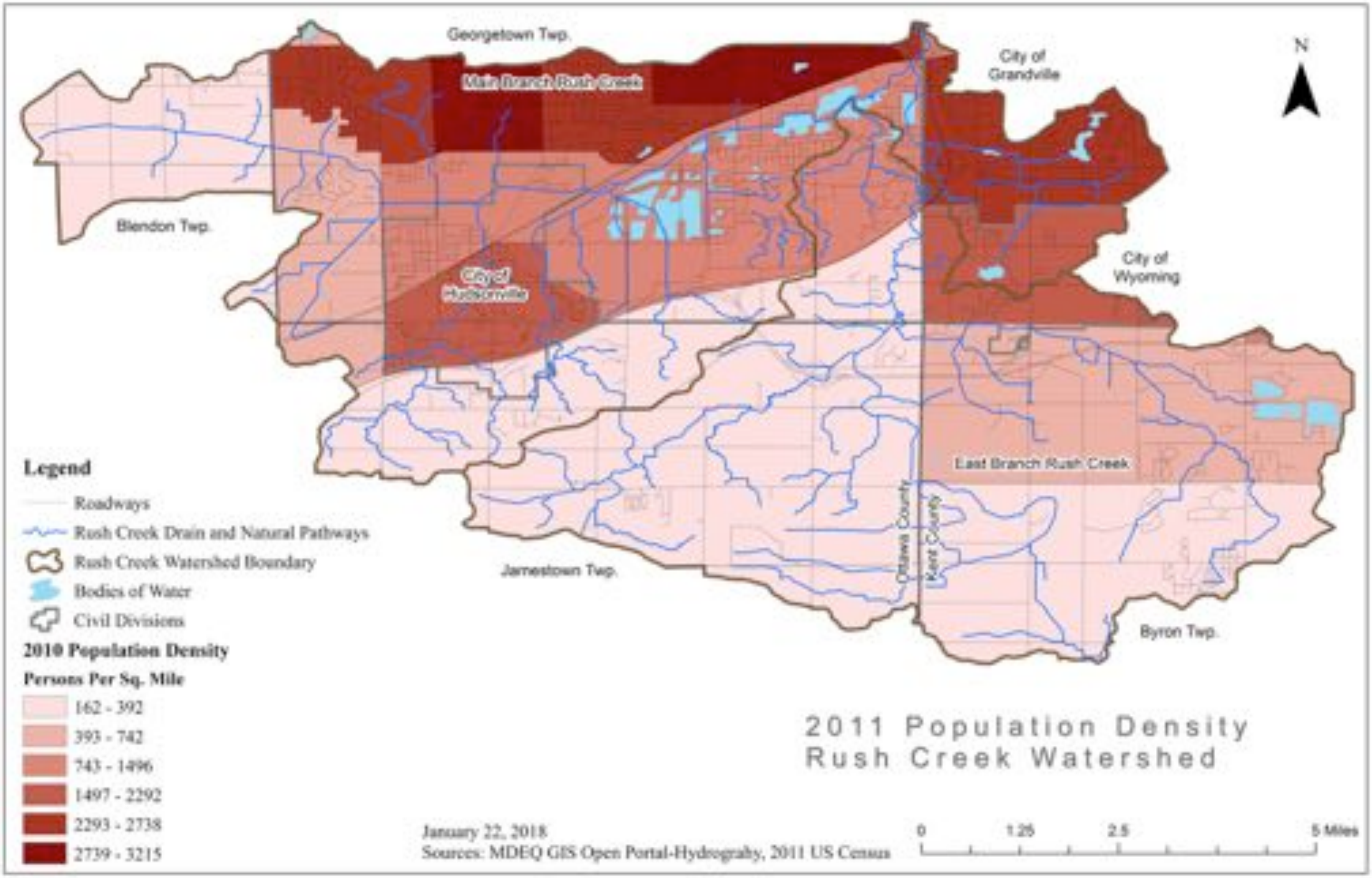

Figure 2.16 Population Density by US Census Tract

3.0 WATER QUALITY IN THE RUSH CREEK WATERSHED – AN OVERVIEW

The State of Michigan has a system for determining if surface waters meet established standards. These standards are described in this chapter, along with discussion on how the RCW measures up to these standards and the variety of NPS pollutants that have been identified in the RCW, including *Escherichia coli* (*E. coli)*, sediment, nutrients, temperature, and altered flow regimes.

3.1 Designated Uses and Water Quality Standards in Michigan

All surface waters of Michigan (i.e. The Great Lakes and their connecting waters, all inland lakes, rivers, streams, impoundments, open drains, wetlands, other surface bodies of water within the confines of the state) are expected to provide eight designated uses. These **designated uses**, specified in Part 4 Rules issued in accordance with Part 31 of the Natural Resources and Environmental Protection Act (1994 PA 451, as amended), **are protected, by law,** and include:

- *Agriculture* – Surface water must be of the quality that it can be used for livestock watering, irrigation and other agricultural activities.
- *Industrial water supply* – Surface waters must meet quality standards for use in commercial or industrial applications.
- *Public water supply* - After conventional treatment methods, surface waters must provide a source of water that is safe for human consumption, food processing, and cooking.
- *Navigation* – Surface waters must be of the quality sufficient for passage of boat traffic; for purposes of this WMP, the USACE definition of navigation is used (eg. Commercial shipping) and, thus, was not considered to be a designated or desired use of the RCW.
- *Warmwater/coldwater fishery* – Water bodies designated as warmwater fisheries should be able to sustain populations of fish species such as panfish. Water bodies designated as coldwater fisheries should be able to sustain populations of fish species such as trout.
- *Habitat for other indigenous aquatic life and wildlife* – Surface waters must support fish, other aquatic life and wildlife that use the water for any stage of their life cycle.
- *Partial body contact recreation* – Residents of the state should be able to use surface waters for activities that involve direct contact with the water but does not involve the immersion of the head, such as fishing and kayaking.
- *Total body contact recreation between May 1 and October 31* – The waters of the state should allow for activities that involve complete submersion of the head such as swimming.

Surface waters are periodically assessed by the MDEQ and must meet certain WQS to determine if a water body is attaining its designated uses. If a surface water is not attaining any of the eight designated uses, due to violation of WQS, it is defined as an impaired waterbody by the State of Michigan, and in this WMP. Once waterways are listed as impaired, the MDEQ is required to develop a Total Maximum Daily Load (TMDL) for the corresponding waterway(s) and its watersheds, or apply a state-wide TMDL to the non-complying watershed. A TMDL is the maximum amount of a particular pollutant a water body can assimilate without violating numerical and/or narrative Water Quality Criteria (WQC). Each TMDL reach identified by MDEQ is identified by a unique Assessment Unit Identification (AUID) number. It is important to note that not all subwatersheds or waterbodies are assessed by MDEQ on a regular basis; thus, if a waterbody is not listed as impaired, it does not mean that it is meeting all WQS, but it may not have been assessed.

The WQC for pollutants measured and/or present in this watershed are listed in Table 3.1, including *E. coli*, water temperature, and DO. In addition, comparable standards are listed in this table for pollutants that may not have a WQC including, Ammonia, Nitrite and Nitrate as Nitrogen, TP, and TSS.

3.2 Impaired and Threatened Designated Uses in the Rush Creek Watershed

The Impaired and Threatened Designated Uses are outlined below. A discussion of apparent sediment pollution, possible nutrient enrichment and altered hydrology of Rush Creek documented in MDEQ studies and recent assessment activities are discussed in other chapters of the WMP.

3.2.1 Impaired Designated Uses

Partial Body Contact and Total Body Contact Recreation
E. coli is identified as a primary pollutant of concern in the RCW. *E. coli* is a type of bacteria associated with warm-blooded animal waste, and is used as an indicator of other disease-causing organisms in the water that are more difficult to measure. Illnesses, such as gastroenteritis, are associated with contacting contaminated water and the severity of illness depends on the amount of exposure and the type of pathogen a person encounters. The presence of bacteria in quantities greater than the WQC may impair the designated use of partial and total body contact (TBC) water recreation.

Michigan's WQS (established by Part 4 Rules issued in accordance with Part 31 of NREPA) set limits on the concentration of microorganisms allowed in surface waters of the state and surface water discharges. Waters of the state must meet a limit of 130 *E. coli* colony forming units (cfu) present in 100 milliliters (mL) of water as a 30-day geometric mean of five sampling events (3 samples per event) and 300 *E. coli* per 100 mL of water for any single sampling event during the May 1 through October 31 period in order to meet the TBC recreation standard (Table 3.1). The limit for the Partial Body Contact (PBC) recreation standard is a geometric mean of 1,000 *E. coli* per 100 mL water for any single sampling event (3 samples per event) at any time of the year (2006).

The designated use of TBC recreation is impaired due to high *E. coli* levels in about 35 miles of Rush Creek (AUID: 040500060511-02) (Figure 3.1). Michigan's Statewide *E. coli* Total Maximum Daily Load (MDEQ, 2017a), and Michigan's 2016 Integrated Report (MDEQ, 2016 revised 2017) lists the AUID 040500060511-02 as not attaining the TBC designated use in 2016. East Branch Rush Creek is listed in Michigan's 2016 Integrated Report as "Not Assessed" for TBC and PBC.

In Rush Creek, PBC recreation is considered a fully supported use; however, results of 2016 and 2017 data collection dispute this conclusion. For the purpose of this watershed management planning process, nearly all of the RCW are considered to be Impaired for TBC and/or PBC (Figure 3.1).

Fish Consumption

Like all surface waters in Michigan the 2016 Integrated Report indicates that the entirety of the stream (AUID's 040500060509-01, -02, and 040500060511-01, -02, -04) is not meeting its designated use for fish consumption due to mercury in fish tissue and PCBs in fish tissue and the water column. The mercury and PCBs issues will be addressed with statewide TMDLs, that are under development by the MDEQ. Due to the ubiquitous nature of these contaminants and their propensity to overlap watershed boundaries, these pollutants are not addressed in this WMP.

3.2.2 Threatened Designated Uses

The term "Threatened" is not used by state or federal agencies to describe impacts to water quality; however, for the purpose of this WMP, a surface waterbody that trends towards exceeding any WQS is considered Threatened. Through literature review, site investigations and stakeholder input, a variety of NPS pollutants have been identified that may threaten water quality within the RCW. These are discussed below.

Partial Body Contact and Total Body Contact Recreation

Based upon data collected as part of this watershed planning process, it appears that nearly the entire RCW should be included in the statewide TMDL for *E. coli*, due to exceedance of the WQC. This violation of WQC indicates that the amount of *E. coli* is excessive and needs to be addressed to protect the PBC and TBC designated uses. The findings of WQC exceedences at additional sample sites beyond those in the statewide TMDL indicate the water is currently impaired.

Warmwater/Coldwater Fishery and Habitat for Indigenous Aquatic Life and Wildlife

The designated uses for warmwater and coldwater fishery were classified as "not assessed" in the 2016 Integrated Report for both Rush Creek and East Branch Rush Creek. While the designated uses for Other Indigenous Aquatic Life and Wildlife ranged from "not assessed," "fully supporting, " and "insufficient information" (MDEQ, 2016 revised 2017). Rush Creek had previously been listed in the Clean Water Act Section 303(d) list of water bodies not attaining the "other indigenous aquatic life and wildlife" designated use due to stream modifications (Category 4c); however, two sites sampled in Rush Creek (AUID 040500060511-02) by MDEQ in 2009 were found to be supporting the designated use with acceptable macroinvertebrate communities (MDEQ, 2011).

Though the RCW is designated as a warmwater stream (MDNR, 2017), temperature data collected in 2016 indicate tributaries in East Branch Rush Creek subwatershed may be cool-transitional or coldwater streams. In addition, during 2016 fish sampling, one trout and several mottled sculpin were collected. Scientific literature supports that temperature is the most critical factor affecting trout distribution in a stream. According to the MDNR, cold-transitional streams fall at the warmer edge of the acceptable range for trout, and the temperatures often promote rapid growth in trout; these streams are defined as having July mean water temperatures between 63.5ºF and 67.1ºF. Mean July 2016 temperatures in the East Branch of the RCW ranged from 63.1ºF to 69.3ºF, indicating that the stream could be capable of supporting trout or other coldwater species if managed properly. Mean July 2017 stream temperatures at site 3RCT had an average temperature of 68.6 degrees F (cool).

Data also indicate that the designated uses of warmwater/coldwater fishery and habitat for other indigenous aquatic life and wildlife are Threatened by excessive sediment and nutrients in many locations. Excessive sediment in a stream can degrade fish and macroinvertebrate habitat by lowering DO levels as well as burying potential habitat for fish and aquatic macroinvertebrates. In addition, sediment can carry other pollutants to the watershed such as phosphate and *E. coli* bacteria.

Although Michigan's WQS do not include numerical limits for sediment, they do require that waters not have any of these physical properties: unnatural turbidity, unnatural color, oil films, floating solids, foam, settleable solids, suspended solids, and deposits (Rule 323.1050). They also state that in no instance shall total dissolved solids in the waters of the state exceed a concentration of 500 milligrams per liter (mg/L) as a monthly average nor more than 750 mg/L at any time, as a result of controllable point sources (Rule 323.1051). Though there is no WQC set for Total Suspended Solids, a TMDL for biota set in nearby

Plaster Creek had a total suspended solids (TSS) goal of 30 mg/L (MDEQ, 2002), and thus is used as a target value for TSS in RCW.

When available, Michigan Part 4 WQS Rules were used to understand where nutrient concentrations were excessive throughout the RCW. If a WQS does not exist, sampling results were compared to those collected across US EPA Ecoregion VII, or the Southern Michigan/Northern Indiana Drift Plains Ecoregion (SMNIDP) sites. Table 3.1 summarizes the target values used to assess pollutants of concern within the watershed.

Excess nutrients can also have a negative impact on water quality, increasing aquatic plant life and the oxygen demand. Nutrient data collected throughout the watershed as part of this planning process generally found nutrient concentrations in the surface water were higher following wet weather events, and locations with fine-grained soils, hills and agricultural land uses showing the largest concentrations of nutrient pollution when compared to MDEQ and USEPA median values and mean ecoregion values.

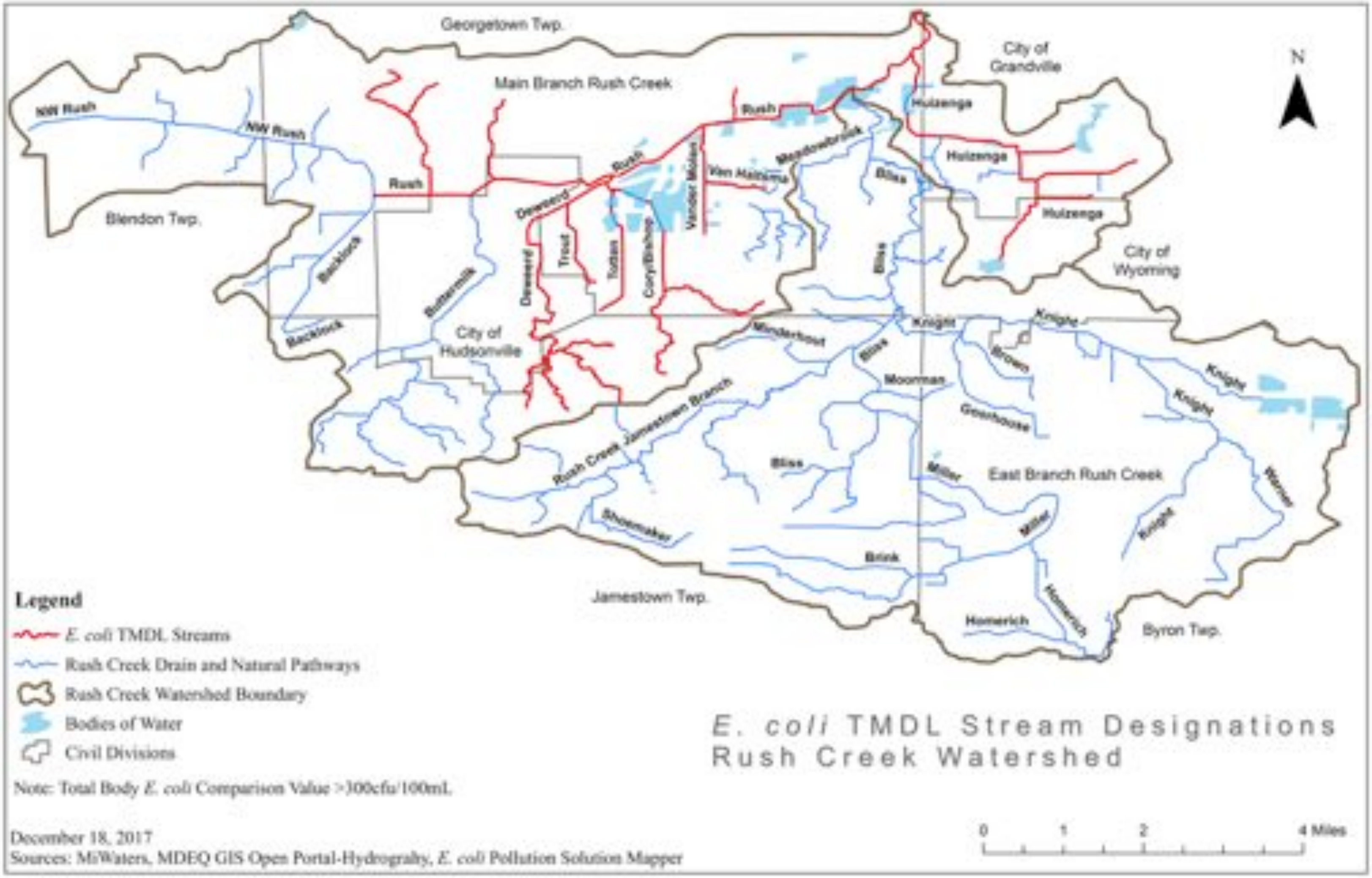

Figure 3.1 *E. coli* Total Maximum Daily Load

Table 3.1. Target Values Used to Assess Pollutants of Concern

Parameter	Target Value	Units	WQC or Comparable	Type	Source
E. coli	130	cfu/100 mL	WQC	Total Body Contact Recreation in all waters of the state. Calculated as a 30-day geometric mean from 5 or more sampling events.	Michigan Department of Environmental Quality Water Bureau Water Resources Protection. (2006, January 13). Part 4 Water Quality Standards
E. coli	300	cfu/100 mL	WQC	Total Body Contact in all waters of the state	Michigan Department of Environmental Quality Water Bureau Water Resources Protection. (2006, January 13). Part 4 Water Quality Standards
E. coli	1,000	cfu/100 mL	WQC	Partial Body Contact in all waters of the state	Michigan Department of Environmental Quality Water Bureau Water Resources Protection. (2006, January 13). Part 4 Water Quality Standards
Water Temperature	67.1	Deg F July mean	WQC	Coldwater Fishery	Michigan Department of Natural Resources Water Withdrawal Assessment Tool.
Dissolved Oxygen	7	mg/L	WQC	Waters connected to Great Lakes	Michigan Department of Environmental Quality Water Bureau Water Resources Protection. (2006, January 13). Part 4 Water Quality Standards.
Dissolved Oxygen	5	mg/L	WQC	All other waters	Michigan Department of Environmental Quality Water Bureau Water Resources Protection. (2006, January 13). Part 4 Water Quality Standards.
Ammonia (NH3-N)	0.042	mg/L	C	Mean concentration calculated from SMNIDP ecoregion sites	Lundgren, R. 1994. Reference Site Monitoring Report 1992-1993. Michigan Department of Natural Resources, Surface Water Quality Division, Lansing, Michigan. Report No. MI/DNR/SWQ-94-048.
Total Phosphorus (TP)	0.03125	mg/L	C	Ambient WQ criteria recommendations; 25th percentile of ecoregion stream population	Ambient Water Quality Criteria Recommendations: Information Supporting the Development of State and Tribal Nutrient Criteria: Rivers and Streams in Nutrient Ecoregion VII. US EPA 822-B-00-018). Washington D.C.
Total Suspended Solids	30	mg/L	C	Informal target	Michigan Department of Environmental Quality Surface Water Quality Division. (2002, July). Total Maximum Daily Load for Biota for Plaster Creek Kent County, Michigan
Nitrite and Nitrate- as Nitrogen (measured only NO3-N)	0.41	mg/L	C	Ambient WQ criteria recommendations; 25th percentile of ecoregion stream population	Ambient Water Quality Criteria Recommendations: Information Supporting the Development of State and Tribal Nutrient Criteria: Rivers and Streams in Nutrient Ecoregion VII. (US EPA, 2000 822-B-00-018). Washington D.C.

3.3 Desired Uses

Stakeholders report concern about erosion and the amount of sediment in the surface waters following rain events (September, 18, 2017). Furthermore, stakeholders on bodies of water within the watershed, including Georgetown Shores, Rushmore Lake, and near the Pinnacle Center, have complained of turbid waters. Rushmore Lake has since been separated from Rush Creek, while solutions are still under investigation for Georgetown Shores and The Pinnacle Center.

Additionally, stakeholders report interest in using the watershed for aesthetic and recreational enjoyment, including for fishing, kayaking, watering gardens, and visual enjoyment. Concern of *E. coli* was also reported (September 18, 2017).

3.4 Pollutants That May Impair Designated and Desired Uses

Based upon what is currently known about the RCW, NPS pollutants that can be managed to meet the WMP Designated and Desired Uses include:

- Modified hydrology such as drains, floodplain and wetland loss;
- Pathogens, as measured through *E. coli* concentrations;
- Sediment, as measured through TSS;
- Nutrients, as measured through Ammonia as nitrogen, Nitrates and Nitrites, and Total Phosphorus;
- Pesticides and herbicides;
- Mercury and PCBs; and
- High water temperatures.

Of great concern to residents and stakeholders in the RCW is flooding, or modified hydrology. Flooding has been a concern since the mid 1970s (MDNR, 1989). Land use changes have filled in floodplains and wetlands and, consequently, reduced the amount of floodplain storage that is available and increasing the volume of floodwaters. Though modified hydrology may not be a measureable water quality pollutant, it contributes excess sediment to the water, which is a known pollutant and has a targeted water quality standard. In addition modified hydrology affects the habitat for other indigenous aquatic life and wildlife designated use. Therefore, by USEPA definitions, sediment is the known pollutant, and altered flow regime/modified hydrology is the cause. However, throughout this WMP, altered flow regime/modified hydrology is listed as the pollutant due to the perceived severity of this particular pollutant cause. In addition, other known, suspected, or potential causes of sediment pollution in the RCW are typically resulting from overland flow sediment pollutant loading, whereas the sediment from the altered flow regime also includes sediment from sources such as bank scour resulting from the flashiness of the flow. The flashy flows may result in other impacts to the stream beyond sediment loading. Later in the WMP, recommendations are made for modified hydrology to be measured through flow/discharge measurements. Land use changes, such as a loss of wetlands or an increase in pervious surfaces, can also be used as indicators of modified hydrology. Sediment monitoring may also be used as a measure.

3.5 Summary of Select Previous Studies of Rush Creek Watershed

The branches of Rush Creek originate from a series of designated county drains in Ottawa and Kent Counties. A large part of the watershed is channelized to facilitate rapid drainage (MDEQ, 2003)

In 1989, the MDNR completed a study of the potential effects of reducing floodplain storage in Rush Creek. Modeling results indicated that a reduction in floodplain storage would result in increased flood stages and discharges. However, perhaps more importantly, even if floodplain storage was not reduced, urbanization of the watershed could result in increased runoff potential, greater flood flows and higher flood elevations.

In 1999, MDEQ assessed water chemistry and surveyed the fish and macroinvertebrate communities. The fish community was found to be acceptable, containing sixteen taxa of warmwater species. The macroinvertebrate community was also rated as acceptable and contained a diverse assemblage of organisms. Physical habitat was noted as fair, but impaired by the flashy nature of the stream, leading to sedimentation of the stream bottom. Results of water chemistry sampling indicated that, when compared to reference sites in the same ecoregion, the levels of ammonia, TP and TSS exceeded average values.

In 2003, the DEQ conducted a road/stream crossing visual assessment and directly measured water temperature, DO, and pH. Based on the field observations, potential sources of non-point source pollution were identified at each location. The potential sources were primarily crop and transportation related, channelization, streambank erosion and urban/residential runoff. The water temperatures were relatively cool at most locations since the survey was conducted in the fall. The DO and pH data were not summarized in response to unstable readings and unreliable calibrations of the field meters.

In 2005, DEQ found the macroinvertebrate community to be poor in the Main Branch of Rush Creek at 12th Avenue. The habitat was described as marginal due to historic dredging, a homogenous channel and very limited stable habitat. Substrate was dominated by sand and silt, and bank scour was evident and indicative of great variation in flows. The East Branch of Rush Creek continued to support an acceptable macroinvertebrate community and better aquatic habitat than the Main Branch (QAPP, p. 2, 2016).

3.6 2016/2017 Water Chemistry Data Collection and Analysis Summary

The following data were collected specifically for this Watershed Management Planning Process, between 2016 and 2017 following methods described in the Quality Assurance Project Plans (QAPP) in Appendix C.

- Continuous sampling of dissolved oxygen (DO) and water level at three sample locations;
- Continuous sampling of temperature at 9 sample locations;
- Water sampling at six sample locations during two wet weather and two dry weather events for *E. coli* and nutrient analyses (A sampling event was considered wet weather when there was at least 0.25 inches of precipitation within a 24-hour period prior to sample collection);
- Water sampling at three sample locations on five occasions during a 30-day period for *E. coli* and nutrient analyses;
- Additional water sampling at four sample locations in the watershed for *E. coli* and source tracking analyses.
- Gauge plate installations at six sample locations, water level loggers installations at three sample locations, and discharge measurements during two to four distinct runoff events;
- Loading calculations using the discharge measurements and water chemistry sampling data;
- Social Indicators Data Management and Analysis (SIDMA) survey to establish the baseline public knowledge and perceptions of residences within the watershed;
- High Impact Targeting (HIT) modeling of sediment
- LLWFA
- Tillage survey
- Windshield survey
- Fish surveys at three sample locations within the watershed;
- Macroinvertebrate Survey at three sampling locations
- Microbial Source Tracking for human, bovine, canine, equine, duck, geese, sources
- Canine scent tracking and confirmation laboratory analysis to assess potential sources of human waste;
- Municipal ordinance review;
- Stakeholder input; and
- Geographic information system (GIS)/Database review of land use.

A variety of information was gathered to complete subwatershed inventories, including existing reports and data collected (2016-2017), as part of this watershed planning process. A synopsis of methods used for data collected in 2016 and 2017 are included in the QAPP provided in Appendix C, and additional information on the data collection methods is below. A summary of watershed data is included in Appendix D. A unique set of management recommendations based upon the pollutants, sources and causes that are known, suspected or potentially occurring in the RCW are outlined in Chapter 10.

Sediment Modeling

Sediment modeling was completed for the RCW using the HIT model (MSU IWR, 2009). The model accounts for sheet erosion and associated sediment loading that originates from agricultural lands (O'Neil, 2010). HIT modeling combines two GIS based models to prioritize areas at risk for sediment loading: the Revised Universal Soil Loss Equation (RUSLE) to estimate soil erosion and the Spatially Explicit Delivery Model (SEDMOD) to estimate the delivery of eroded soil to the stream network. Model inputs include: digital elevation model, soil survey (1:100K), rainfall, and land use (with tillage information incorporated if available).

Using the HIT model, sedimentation loading in tons per acre per year by subwatershed was estimated following methods developed by the MSU Institute of Water Research (Ouyang, Bartholic, & Selegean, 2005). A map of the modeling results, showing estimated tons of sediment loading originating from agricultural lands by way of sheet erosion is shown in Figure 3.8. The HIT model is likely underestimating sediment loading from agricultural fields as it does not include gully erosion or site-specific loading from other sources described below such as livestock access to streams. Also, the HIT model does not include urban sources of sediment.

Windshield Survey

The watershed was surveyed by driving and collecting data about land use practices and conditions (the methodology is included in Appendix C). In the rural areas, each road was driven, land management practices were observed and estimates and general locations of the number of large farm animals in each subwatershed were recorded. Numbers of smaller livestock, such as chickens, were not estimated, as their relative contributions of waste and ultimately *E. coli* to the watershed are considered to be smaller than that of larger livestock. In the urban areas, due to high density and the large number of roads, a general overview was conducted by driving a random pattern of roads within the various types of neighborhoods and land use patterns. Each basic "type" of neighborhood, based upon age and size of the homes, size of the parcels, etc. was identified for further inspection using the Unified Subwatershed and Site Reconnaissance guidance, specific to the neighborhood source assessment field sheets and methodology (Center for Watershed Protection, 2005).

The windshield survey found mixed uses of land, from older residential neighborhoods, to newer residential subdivisions, and high-density residential areas, agricultural fields, muck farming, and mostly smaller animal farm operations, with the exception of a few larger animal farm operations. Many new subdivisions have been built surrounding gravel pits and manmade lakes; homes in these subdivisions typically have well-manicured lawns that extend to the edge of the water. Newer developments appear much more likely to have intensive lawn and landscape management, including use of herbicides, pesticides and fertilizers. These chemicals also appear to be used precipitously on agricultural land within the watershed. In more than one instance, use of herbicides directly adjacent and within drains and other waterways was observed.

E. coli

E. coli data were collected in three tributaries in the Main Branch Rush Creek Subwatershed and three tributaries in the East Branch Rush Creek Subwatershed in 2016 and 2017 (Tables 3.2 and 3.3). The Huizenga Drain, the eastern most part of the Rush Creek Subwatershed (2RCT), was the only location sampled that did not exceed the 300 or 1,000 CFU/100 mL WQC. The remaining five sites typically exceeded the TBC WQC following dry weather event and exceeded the PBC WQC following wet weather events. Figures 3.2 and 3.3 shows *E. coli* geomeans from 2016 sampling, and Figures 3.4 and 3.5 shows *E. coli* loading from 2016 sampling.

Thirty-day geometric means were calculated at three sites (Table 4.2). The site nearest the confluence of the Grand River, Rush Creek at Main Street (Site 1RCT), had a value of 640 CFU/100 mL. The site located on the Main Branch of Rush Creek, Blair Street (Site 7RCT), had a 30-day geomean of 780 CFU/100 mL. The East Branch Rush Creek Subwatershed (Bliss Drain), sampled at Kenowa Ave. (Site 3RCT), had the highest 30-day *E. coli* geomean of 1,178 CFU/100 mL. All are well above the 130 CFU/100 mL TBC WQC.

E. coli concentrations following wet weather events were significantly higher statistically than *E. coli* concentrations following dry weather events.

Source tracking by canines and Microbial Source Tracking (MST) indicate that humans, horses, cattle, dogs, ducks, geese, and turkeys are all contributing to the bacterial water pollution (Figure 3.7 and Table 3.4). Additional detail about source tracking is included later in each subwatershed. Water chemistry and MST data are included in Appendix D.

Nutrient Analysis

A statistical analysis was completed on the RCW nutrient concentrations, using comparison values from Table 3.1 and more detailed summer sampling comparison values for phosphate and nitrates (US EPA, 2000). This detailed analysis is included in Appendix E. As a general trend, nutrient concentrations in the surface water were higher following wet weather events, and locations with fine-grained soils, hills and agricultural land uses showing the largest concentrations of nutrient pollution.

Phosphate is generally carried to surface waters attached to sediment. TSS concentrations as well as phosphate concentrations following wet weather events were significantly higher than the TSS and phosphate concentrations following dry weather events. Phosphate concentrations were higher at sample sites 5RCT, 6RCT and 8RCT, which drain land that is primarily agricultural and consists of fine-textured till/clay loam soil, whereas all other areas are medium-textured till to coarse-grained deposits. In addition, this part of the watershed is hillier than the rest of the watershed. Fine-grained soil retains more phosphate than coarse-grained soil and hilly topography leads to an increase of soil erosion during rain events. It is likely that the high phosphate concentrations during wet weather are a result of the addition of phosphate to soils in this agricultural area coupled with fine-grained soils and high susceptibility to erosion. Phosphate concentrations at sample sites 4RCT and 9RCT are lower than sites 5RCT, 6RCT, and 8RCT likely because this agricultural area drains land that consists of muck underlain by sand and gravel deposits and loamy sand underlain by medium-textured till and is generally flat. Sample Sites 1RCT, 2RCT, 3RCT, and 7RCT are located in urban areas and in glacial outwash sand and gravel/alluvium, but are influenced by the sediment and attached phosphate flowing down from upstream sites. The load of phosphate is high at 5RCT and 6RCT in the East Branch, but both 3RCT (downstream East Branch) and 7RCT (downstream Main Branch) and 1RCT (mouth of Rush Creek) have comparable loads of phosphate. Phosphate concentrations measured in 2016 and 2017 as compared against the water quality comparison value listed in Table 3.1 are displayed in Figure 3.10.

The Main Branch of Rush Creek was higher in ammonia, especially during wet weather, where ammonia concentrations were even increased at the mouth of Rush Creek. There was not a significant difference in ammonia concentrations between wet and dry weather events, although wet weather events did result in higher ammonia concentrations. The ammonia concentrations in the Main Branch were significantly higher than those in the East Branch. Ammonia concentrations measured in 2016 and 2017 as compared against the water quality comparison value listed in Table 3.1 are displayed in Figure 3.12.

Nitrate/nitrite concentrations were not significantly different between wet and dry rain events when compared at all sampling sites; however, at the low discharge sites 5RCT, 6RCT, and 8RCT they were higher following wet weather events versus dry weather events. The nitrate/nitrite concentrations were not significantly different between the Main Branch and the East Branch. Nitrate/nitrite concentrations measured in 2016 and 2017 as compared against the water quality comparison value listed in Table 3.1 are displayed in Figure 3.11.

Sediment can carry other pollutants, including phosphate and *E. coli* to the surface waters. TSS concentrations following wet weather events were significantly higher than the TSS concentrations following dry weather events. Sample sites 5RCT, 6RCT, and 8RCT drain land that is agricultural, fine-textured till and hilly. These locations had the highest wet weather TSS concentrations. These results validate HIT modeling results, Figure 3.8, that shows the areas with the greatest erosion being in the south central and eastern portions of the RCW. TSS concentrations measured in 2016 and 2017 as compared against the water quality comparison value listed in Table 3.1 are displayed in Figure 3.9.

<u>Discharge Analysis</u>

Discharge was measured at nine sites on multiple occasions. The gauge plate water elevation or transducer level logger elevation were also recorded during each discharge measurement. Subsequently, the discharge and water elevation data were plotted to generate a rating curve for each site. When comparing the lowest to highest flow rates, approximately one foot of water level rise was measured at most sampling locations, and two feet of rise was recorded at two sampling locations. The discharge rates were up to 34 times greater following rain events when compared to the same flows during dry weather. Discharge data is included in Appendix D.

The surface water analytical data, discharge rating curves and gauge heights at the time of surface water sampling were used to calculate loading estimates for ammonia, *E. coli*, nitrate and nitrite, phosphorous, and TSS. *E. coli* loading information is displayed in Figures 3.4 and 3.5. They were also used in the nutrient analysis.

Flood insurance studies that included portions of the RCW were published in 1992 (FEMA, February 5, 1992) and 2013 (FEMA, May 16, 2013). The studies cited flooding problems from high runoff events. In particular, flooding problems exist along Bliss Creek at the intersection of Kenowa and 44th St. The Bliss Creek Intercounty Drain, Huizenga Intercounty Drain, Northwest Branch of Rush Creek, and DeWeerd Drain were analyzed. Peak discharges for subbasins in Rush Creek were calculated as was a final peak discharge for Rush Creek. The study included a hydrologic analyses to establish a peak discharge-frequency using HEC computer models. The precipitation values were 3.75, 4.7, 5.1, and 6.0 inches for 10-, 2-, 1-, and 0.2-perecent-annual-chance precipitation events. In general, the modeled peak discharge values presented in the 2013 report are about twice the values modeled in 1992 (FEMA, 2013). For example, the one-percent-chance (100-year storm) peak discharge modeled at the mouth of

Huizenga Drain in the 1992 was 465 cubic feet per second (cfs) and modeled as 950 cfs in the 2013 study. This increase in peak discharge is likely a result of significant land use changes, and was predicted in the study completed by MDNR is 1989 (MDNR, 1989). The flood stage elevation also increased from 1992 to 2013. The modeling results demonstrate that flood discharges have approximately doubled since the 1992 insurance study, while flood stages have increased.

RCW discharge data collected as a part of the RCW management planning process were found to fit within the modeled FEMA discharge values. For example, the measured discharge at the monitoring station near 12th Avenue 10 hours after a two-inch rainfall event (24-hour duration), which is located approximately one third of a mile downstream of the FEMA HEC modeled discharge location, was 198 cfs. A peak discharge of 275 cfs for the two-inch rainfall event was determined from the monitoring station discharge rating curve since the storm event peak water level elevation was approximately 0.78 feet higher than the field measured value. For comparison, the 2013 FEMA flood study included the following modeled discharge values at a location 1/3 mile upstream of monitoring station near 12th Avenue, 881 cfs for 3.75 inches of rainfall in 24 hours, 2,185 cfs for 4.7 inches of rainfall in 24 hours, 2,751 cfs for 5.1 inches of rainfall in 24 hours, and 976 cfs for 6.0 inches of rainfall in 24 hours. Our discharge rating curve value is consistent with an exponential curve applied to the modeled rainfall discharges presented in the 2013 report.

Typically, restoring the natural hydrologic response to presettlement conditions would represent the watershed long-tem goal when an official targeted flow reduction has not been established by EPA or MDEQ, as is the case for the RCW. However, a presettlement goal for the RCW is not realistic, or attainable, due to significant land use development and reclassification of over 50% of the watershed channels as county drains. Therefore, the modeled peak discharges presented in the 1992 Flood Insurance Study presents the current long-term goal for the RCW, or approximately a 50% reduction in peak flows compared to current levels. As a short-term goal, peak discharges in the RCW should be reduced by 20% in ten years.

This hydraulic analysis validates the importance of the proposed stormwater ordinances and standard designs described in detail in Chapter 9. In addition, to meet this goal, where possible sites should be retrofitted with green infrastructure and low impact development (LID) features to intercept runoff in order to reduce the flow, sedimentation, and pollution into RCW. Each BMP may vary in design storm year values, and benefits or runoff volumes reduced can be calculated using the Rainwater Rewards calculator (www.rainwaterrewards.com) developed by West Michigan Environmental Action Council, Grand Valley State University (GVSU), and Michigan Tech Research Institute or other design calculations.

Dissolved Oxygen

DO concentrations were measured at three locations (1RCT, 3 RCT, 7RCT). Temperature and DO concentrations from location 3RCT on the East Branch were graphed in Figure 3.13. DO concentrations ranged from just above 6 mg/L to nearly 12 mg/L. There was about a pretty consistent and expected 12-hour lag between the temperature and DO, likely to due biologic action. The July DO average for 1 RCT on the Main Branch is 6.57 mg/L, ranging from approximately 4 to 10.3 mg/L. Data collected from the station at 7RCT appeared to be impacted by excessive sediment. The WQC for DO is 5 mg/L for warmwater and 7 mg/L for coldwater.

Tillage Survey

The MDEQ conducted a tillage survey during the Spring of 2018 (April), capturing fall 2017 tillage practices in the Main Branch Rush Creek subwaterhed. The inventory was conducted to identify fields that were likely contributing the highest amount of agricultural NPS pollution based on an assessment of the crop type, tillage practices, and proximity to surface water. Data collection included identification of crops planted in each field and tillage practices for each field. MDEQ also conducted a spring tillage survey in June 2018 of the Main Branch Rush Creek subwatershed in order to identify, spring tillage practice used. This tillage survey can be used to further identify priority agriculture areas and corresponding recommended BMPs. The completed tillage survey is included in Appendix F.

Table 3.2 Summary of 2016/2017 *E. coli*, Nutrient, and Sediment Concentrations in the Rush Creek Watershed

Monitoring Location	Sample Date	Weather Condition	*E. coli* Geomean TBC 300 PBC 1,000	NH3 mg/L 0.042	NO3 + NO2 mg/L 0.41	P mg/L 0.03125	TSS mg/L 30
1RCT	7/27/16	Dry	560	0.073	1.1	0.099	20
	8/12/16	Wet		0.057	0.94	0.076	14
	8/16/16	Wet		0.067	0.48	0.43	160
	8/23/16	Dry		0.085	1.0	0.13	27
	8/30/16	Dry		0.049	0.92	0.082	8.0
2RCT	7/27/16	Dry	320	0.059	0.36	0.069	5.0
	8/16/16	Wet	280	0.013	0.069	0.06	18
	9/13/16	Dry	280	0.027	0.34	0.056	9.5
	5/1/17	Wet	300	0.028	0.43	0.046	18
3RCT	7/27/16	Dry	480	0.034	0.88	0.091	9.5
	8/12/16	Wet		<0.005	0.78	0.057	2.5
	8/16/16	Wet		0.049	0.64	0.38	130
	8/23/16	Dry		0.015	1.2	0.071	8.5
	8/30/16	Dry		<0.005	1.0	0.077	6.5
4RCT	7/27/16	Dry	630	0.033	0.74	0.094	4.5
	8/16/16	Wet	4300	0.015	0.33	0.19	58
	9/13/16	Dry	530	0.011	1.0	0.062	4.5
	5/1/17	Wet	2100	0.055	0.45	0.15	45
5RCT	7/27/16	Dry	1400	0.024	0.55	0.13	9.0
	8/16/16	Wet	7500	0.037	2.7	0.28	60
	9/13/16	Dry	940	<0.005	0.84	0.076	<2.3
	5/1/17	Wet	4600	0.14	1.5	0.46	160
6RCT	7/27/16	Dry	530	0.051	1.5	0.13	10
	8/16/16	Wet	7200	0.059	2.4	0.47	180
	9/13/16	Dry	540	<0.005	1.3	0.071	<2.3
	5/1/17	Wet	4800	0.1	1.4	0.75	120
7RCT	7/27/16	Dry	580	0.13	1.1	0.085	10
	8/12/16	Wet		0.13	1.4	0.12	20
	8/16/16	Wet		0.084	0.81	0.33	100
	8/23/16	Dry		0.13	1.0	0.093	19
	8/30/16	Dry		0.11	0.92	0.097	7.5
8RCT	7/27/16	Dry	500	0.074	0.71	0.099	16
	8/16/16	Wet	24000	0.067	2.4	0.26	61
	9/13/16	Dry	520	<0.005	0.79	0.062	<2.3
	5/1/17	Wet	14000	0.2	0.41	0.39	180
9RCT	7/27/16	Dry	600	0.25	1.7	0.098	16
	8/16/16	Wet	11000	0.17	1.2	0.37	20
	9/13/16	Dry	560	0.053	2.2	0.079	4.5
	5/1/17	Wet	4100	0.097	0.73	0.18	120

Table 3.2 Summary of 2016/2017 *E. coli*, Nutrient, and Sediment Concentrations in the Rush Creek Watershed (continued)

Monitoring Location	Sample Date	Weather Condition	*E. coli* Geomean TBC *WQC* 300 PBC *WQC* 1,000	NH3 mg/L *Target Value 0.042*	NO3 + NO2 mg/L *Target Value 0.41*	P mg/L *Target Value 0.03125*	TSS mg/L *Target Value 30*
RC-100	7/17/17	Dry	**170**	NA	NA	NA	NA
RC-101	7/17/17	Dry	**10**	NA	NA	NA	NA
RC-102	7/17/17	Dry	<10	NA	NA	NA	NA
RC-103	7/17/17	Dry	**640**	NA	NA	NA	NA
RC-103 Dup	7/17/17	Dry	**500**	NA	NA	NA	NA
9RCT Dup	7/27/16	Dry	**1300**	**0.28**	**1.7**	**0.2**	**20**
1RCT Dup	8/12/16	Wet	NA	**0.047**	**0.95**	**0.073**	**14**
4RCT Dup	8/16/16	Wet	NA	NA	NA	NA	NA
6RCT Dup	8/16/16	Wet	**6300**	NA	NA	NA	NA
8RCT Dup	8/16/16	Wet	NA	**0.077**	**2.4**	**0.27**	NA
1RCT Dup	8/23/16	Dry	NA	**0.1**	**1.0**	**0.1**	NA
3RCT Dup	8/23/16	Dry	NA	NA	NA	NA	**8.5**
7RCT Dup	8/23/16	Dry	**280**	NA	NA	NA	NA
3RCT Dup	8/30/16	Dry	NA	**0.14**	**1.0**	**0.076**	**6.5**
8RCT Dup	9/13/16	Dry	**540**	**0.0093**	**0.78**	**0.084**	**4.5**
8RCT Dup	5/1/17	Wet	**14000**	**0.072**	**0.42**	**0.4**	**210**

Blue	*E. coli* value exceeds TBC WQC
Red	*E. coli* value exceeds PBC WQC or nutrient data exceeds comparison value listed
NA	Not assessed. Parameter not collected

Table 3.3 Summary of 2016/2017 30-day *E. coli* Geomean Concentrations in the Rush Creek Watershed

Sample Number	**Date**	**Weather**	***E. coli* Left** *Target Value 130*	***E. coli* Center** *Target Value 130*	***E. coli* Right** *Target Value 130*	**Geomean** *Target Value 130*	**30-day Geomean** *Target Value 130*
1RCT	8/2/16	Dry	**450**	**610**	**500**	**516**	**640**
	8/9/16	Dry	**320**	**320**	**470**	**364**	
	8/12/16	Wet	**4200**	**7700**	**6000**	**5789**	
	8/23/16	Dry	**490**	**320**	**780**	**496**	
	8/30/16	Dry	**180**	**200**	**220**	**199**	
3RCT	8/2/16	Dry	**660**	**640**	**590**	**629**	**1178**
	8/9/16	Dry	**610**	**680**	**530**	**604**	
	8/12/16	Wet	**16000**	**16000**	**18000**	**16641**	
	8/23/16	Dry	**790**	**820**	**810**	**807**	
	8/30/16	Dry	**450**	**400**	**490**	**445**	
7RCT	8/2/16	Dry	**620**	**740**	**630**	**661**	**780**
	8/9/16	Dry	**690**	**610**	**700**	**665**	
	8/12/16	Wet	**9000**	**9200**	**10000**	**9390**	
	8/23/16	Dry	**450**	**340**	**300**	**358**	
	8/30/16	Dry	**220**	**170**	**200**	**196**	

Table 3.4 Summary of 2016 Human Source Tracking in the Rush Creek Watershed

Sample ID	Canine			*E. Coli*	DNA	
	Abby	Kenna	Sable	cfu/100 ml	Human	General Bacteroids
EB-3	Y	Y	Y	1,100	pos.	pos.
EB-5	N	Y	Y	560	pos.	pos.
EB-6	N	Y	N	--	--	--
EB-8	N	Y	N	6,700	pos.	pos.
EB-8 Dup	N	Y	N	--	--	--
EB-9	N	N	N	--	--	--
EB-10	Y	N	--	130	--	--
EB-11	N	N	N	--	--	--
EB-12	N	N	N	--	--	--
EB-13	N	Y	N	6,600	pos.	pos.
EB-14	N	N	N	--	--	--
EB-15	N	N	Y	3,200	pos.	pos.
EB-16	N	N	N	--	--	--
EB-18	N	N	N	--	--	--
EB-19	N	N	N	--	--	--
EB-20	N	Y	Y	8,200	pos.	pos.
EB-21	N	Y	N	19,000	pos.	pos.
EB-22	N	N	--	--	--	--
EB-23	N	N	--	--	--	--
EB-25	Y	Y	--	640	pos.	pos.
EB-26	--	N	--	--	--	--
EB-27	--	N	--	--	--	--
EB-28	Y	Y	--	6,000	pos.	pos.
EB-29	--	N	--	--	--	--
EB-29	--	N	--	--	--	--
EB-30	N	Y	--	600	pos.	pos.
EB-31	N	N	--	--	--	--
EB-32	Y	Y	--	490	pos.	pos.
EB-33	N	N	--	--	--	--
EB-34	Y	N	--	2,300	pos.	pos.
EB-34	Y	N	--	--	pos.	pos.
EB-35	--	Y	--	290	--	--
RC-2	Y	Y	Y	370	pos.	pos.
RC-5	Y	N	--	--	--	--
RC-5 Dup	Y	N	--	--	--	--
RC-8	Y	Y	N	70	--	--
RC-11	Y	N	N	--	--	--
RC-12	N	N	Y	--	--	--
RC-14	Y	Y	Y	2,900	pos.	pos.
RC-15	N	N	N	--	--	--
RC-16	N	Y	N	2,500	pos.	pos.
RC-17	Y	Y	Y	5,600	pos.	pos.
RC-18	N	Y	N	--	--	--
RC-19	Y	N	Y	3,300	pos.	pos.
RC-20	Y	Y	Y	3,400	pos.	pos.
RC-22	Y	Y	Y	450	pos.	pos.
RC-23	N	Y	Y	2,300	pos.	pos.
RC-25	Y	Y	N	--	--	--
RC-100 (7/19/17)	--	--	--	--	pos.	--
RC-101 (7/19/17)	--	--	--	--	pos.	--

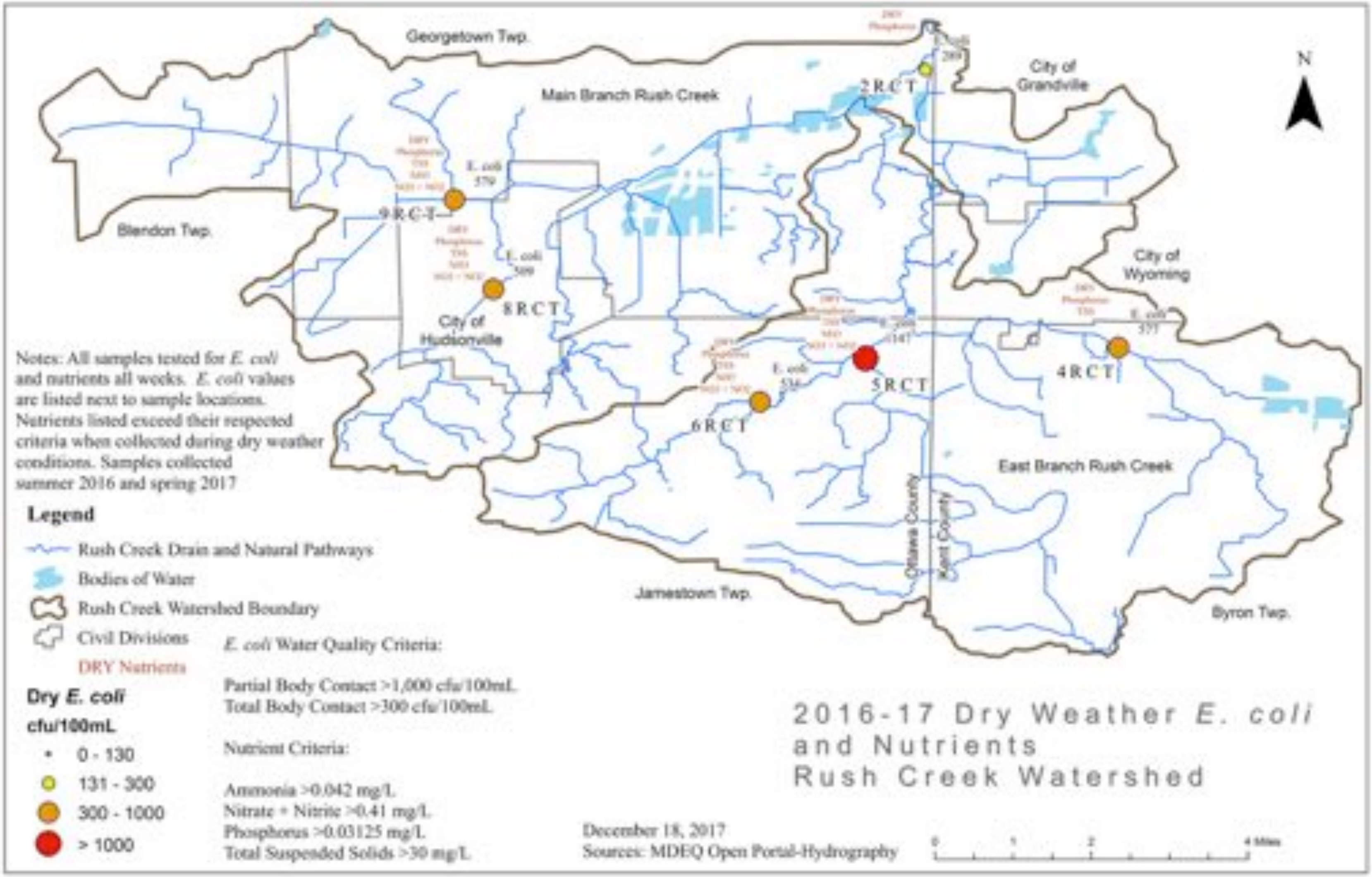

Figure 3.2 2016 Dry Weather *E. coli* and Nutrient Concentrations

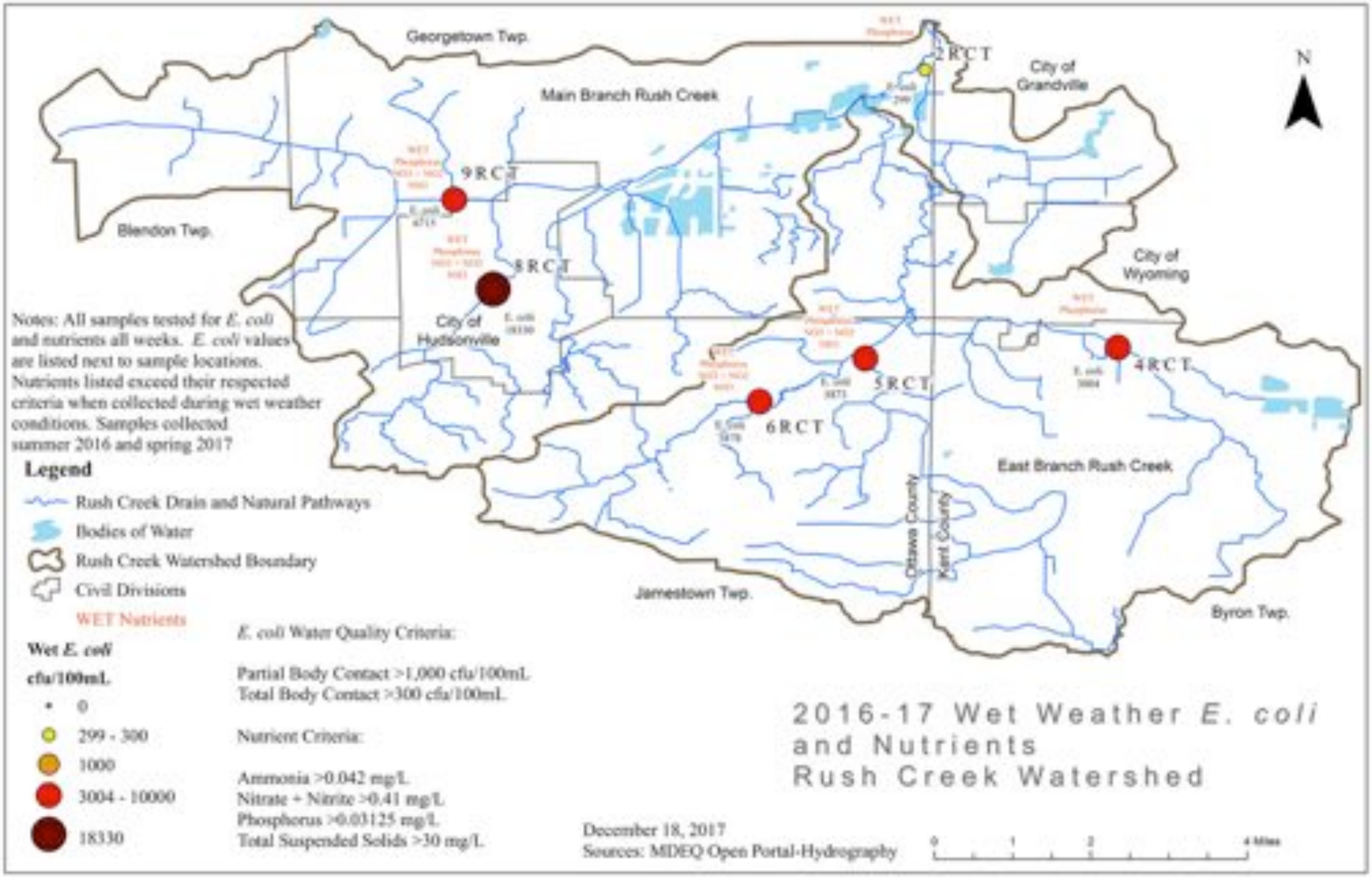

Figure 3.3 2016 Wet Weather *E. coli* and Nutrient Concentrations

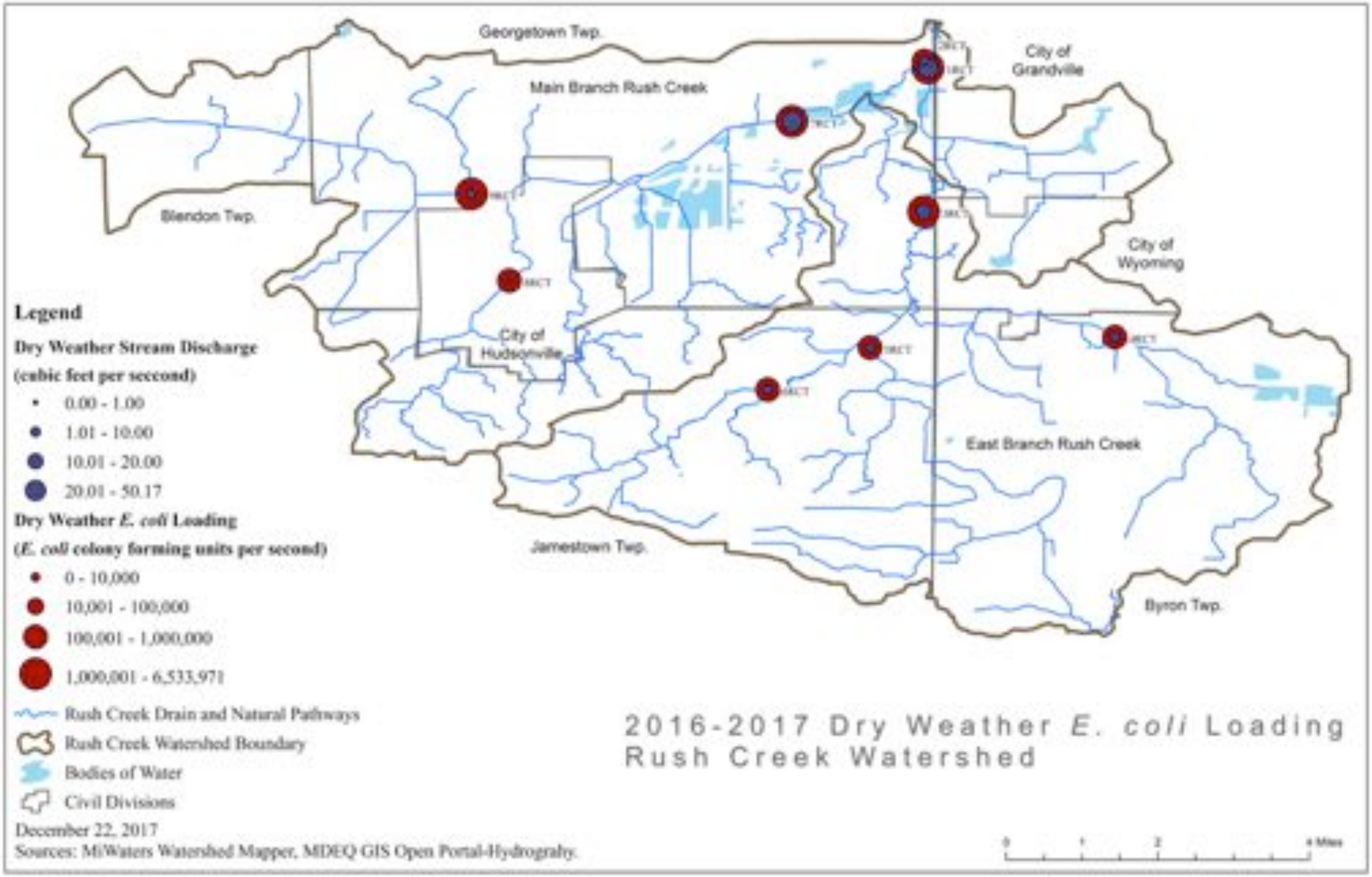

Figure 3.4 2016 Dry Weather *E. coli* Loading

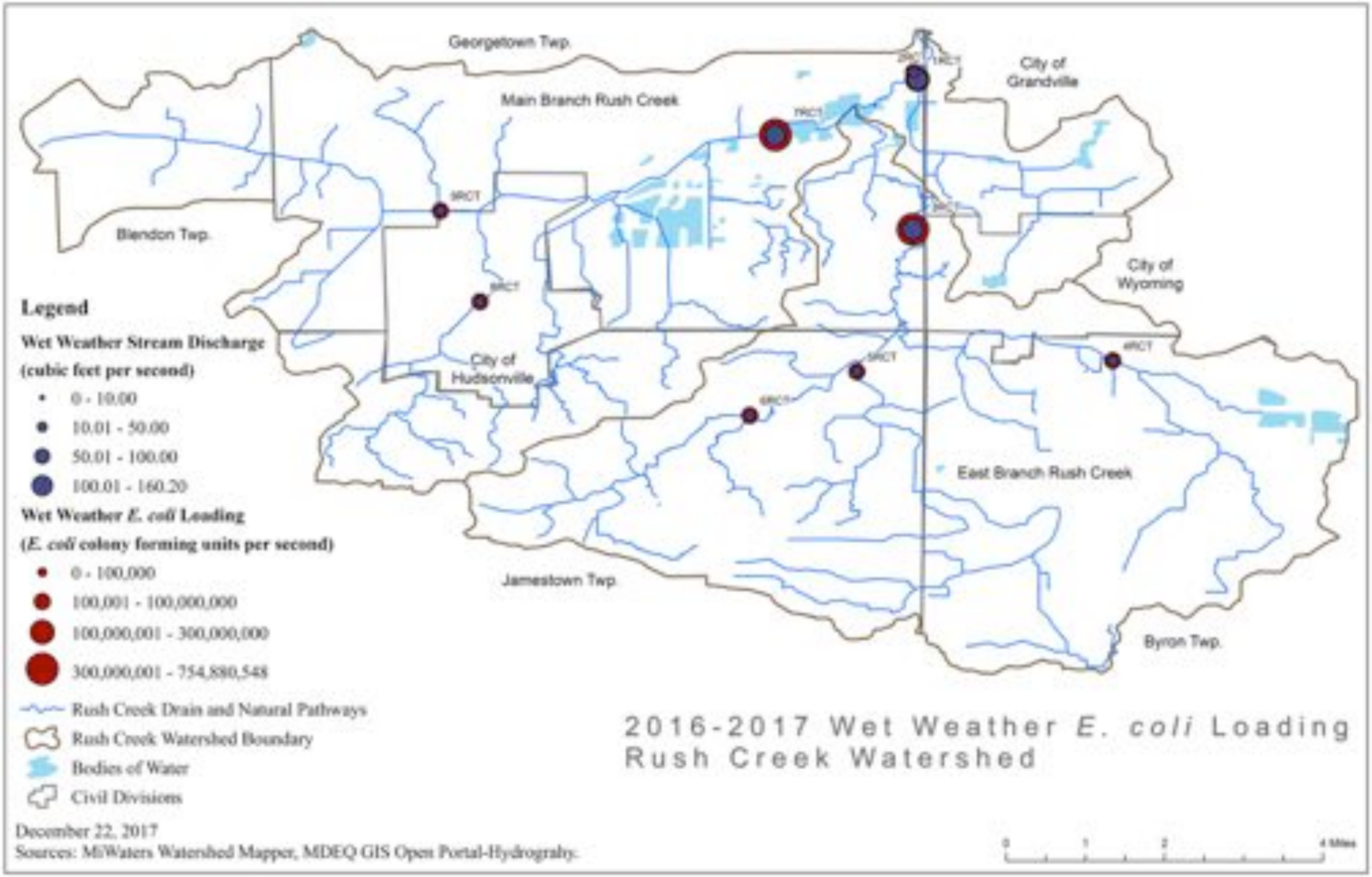

Figure 3.5 2016 Wet Weather *E. coli* Loading

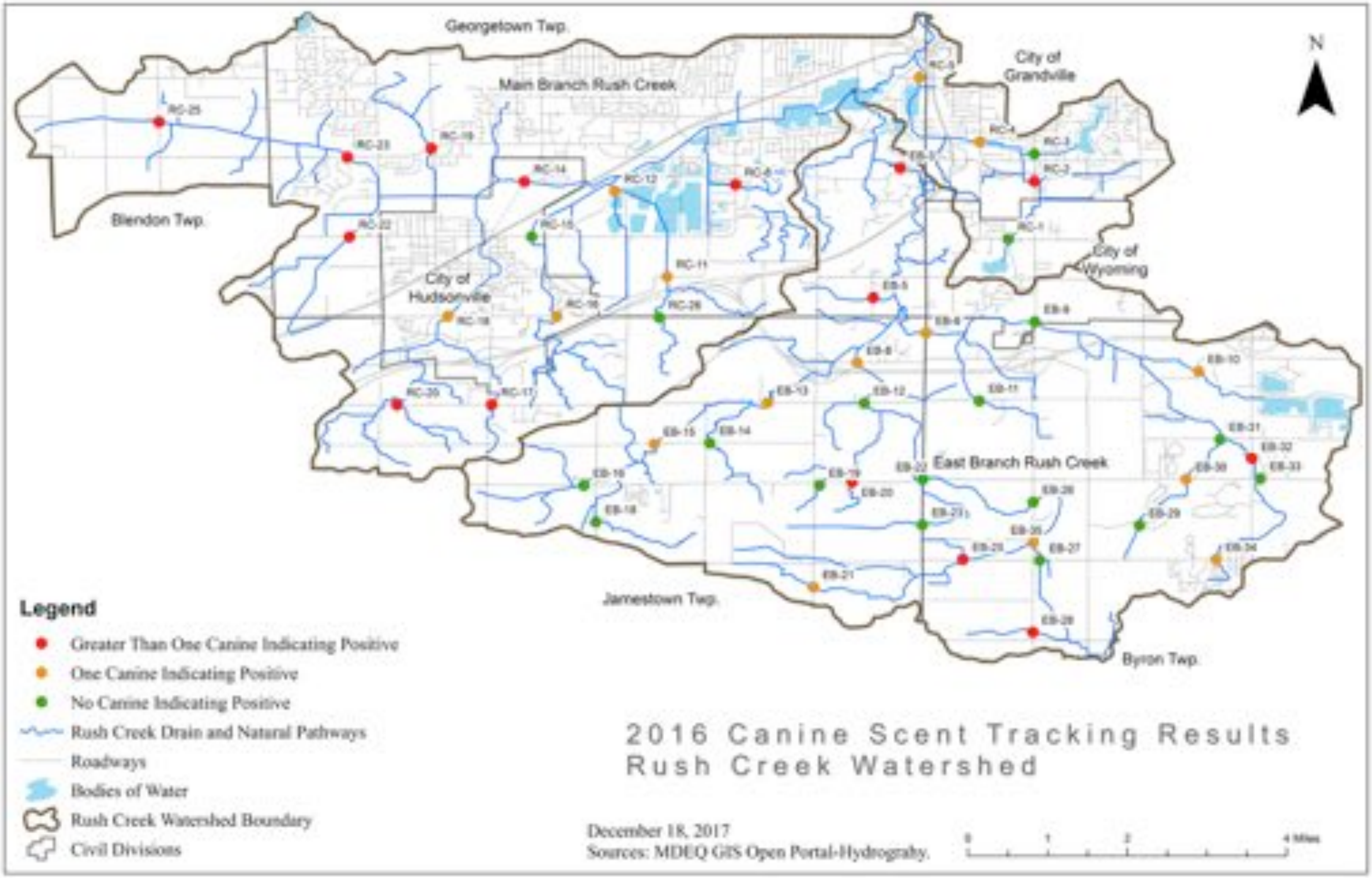

Figure 3.6 2016 Canine Scent Tracking Results

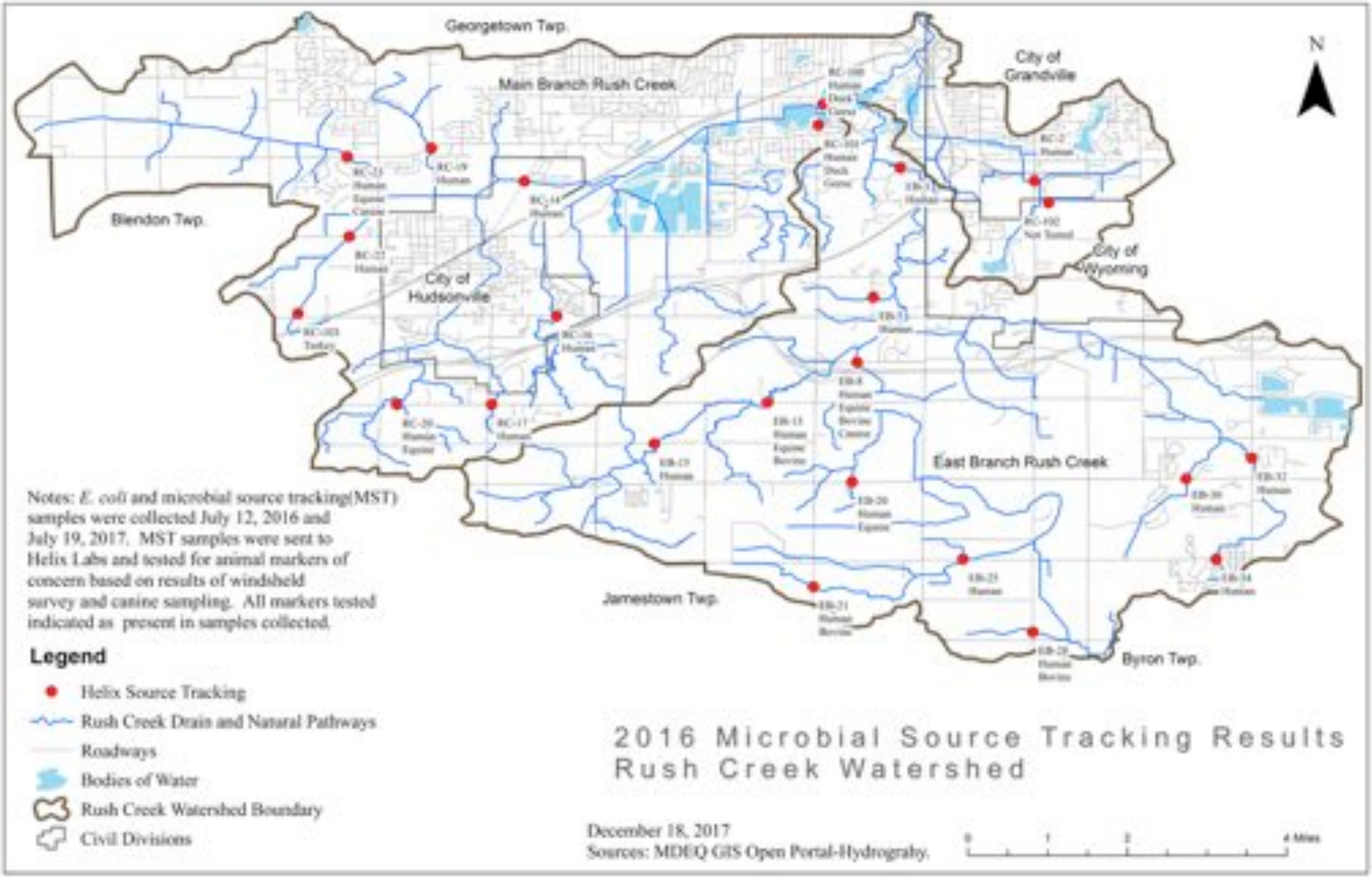

Figure 3.7 2016 Microbial Source Tracking Results

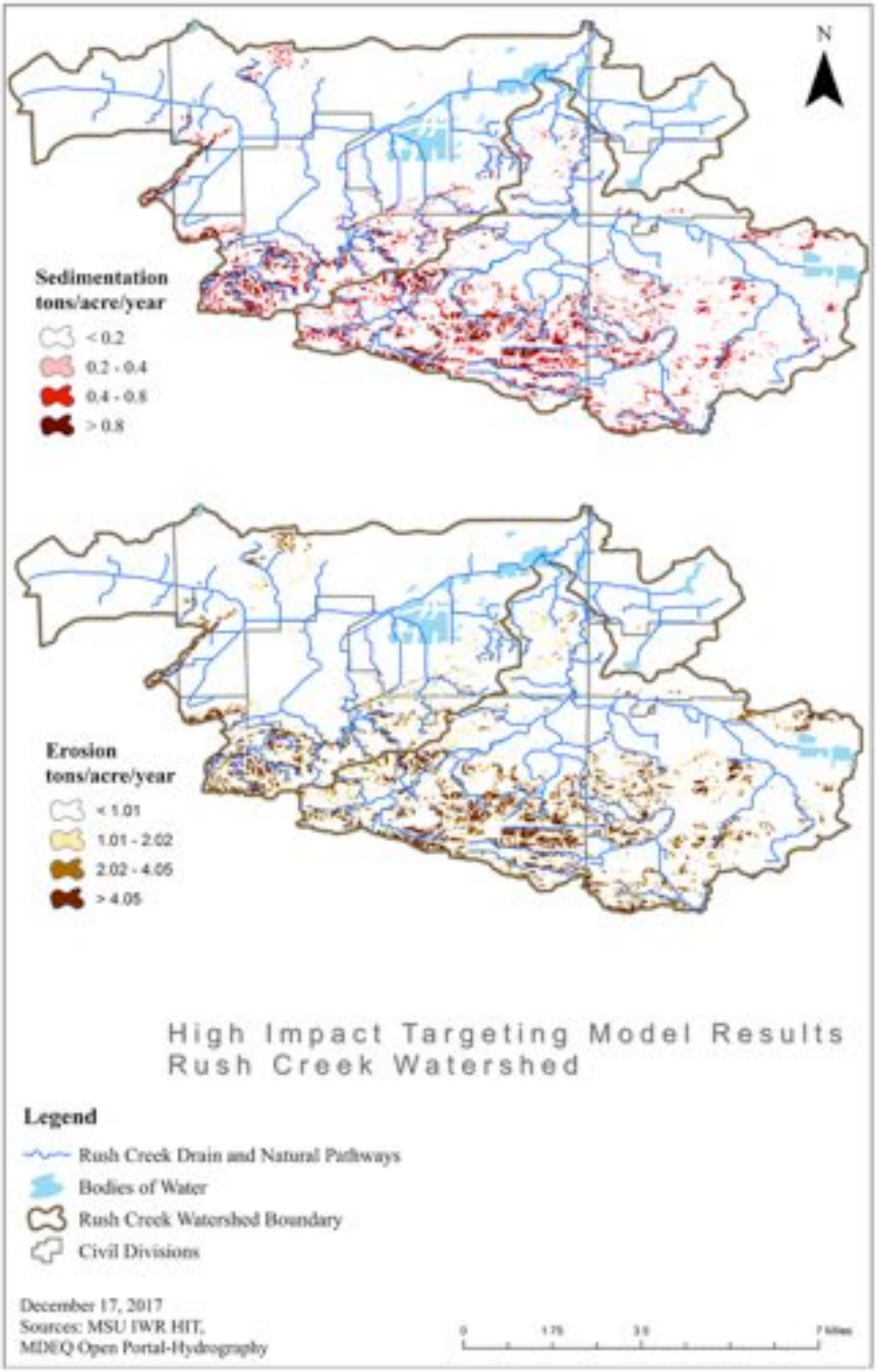

Figure 3.8 High Impact Targeting Model Results

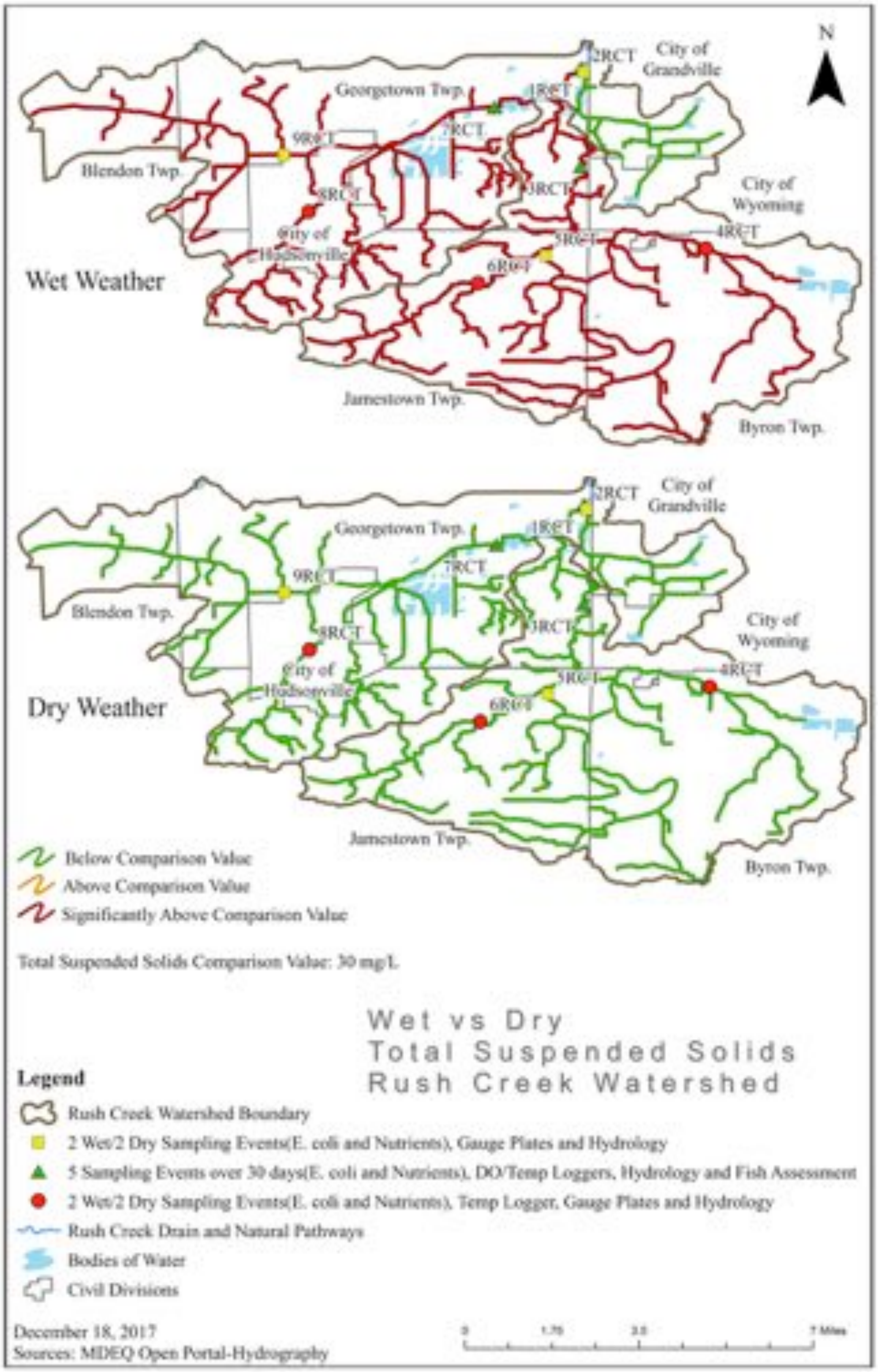

Figure 3.9 Total Suspended Solids Concentrations Wet and Dry Weather

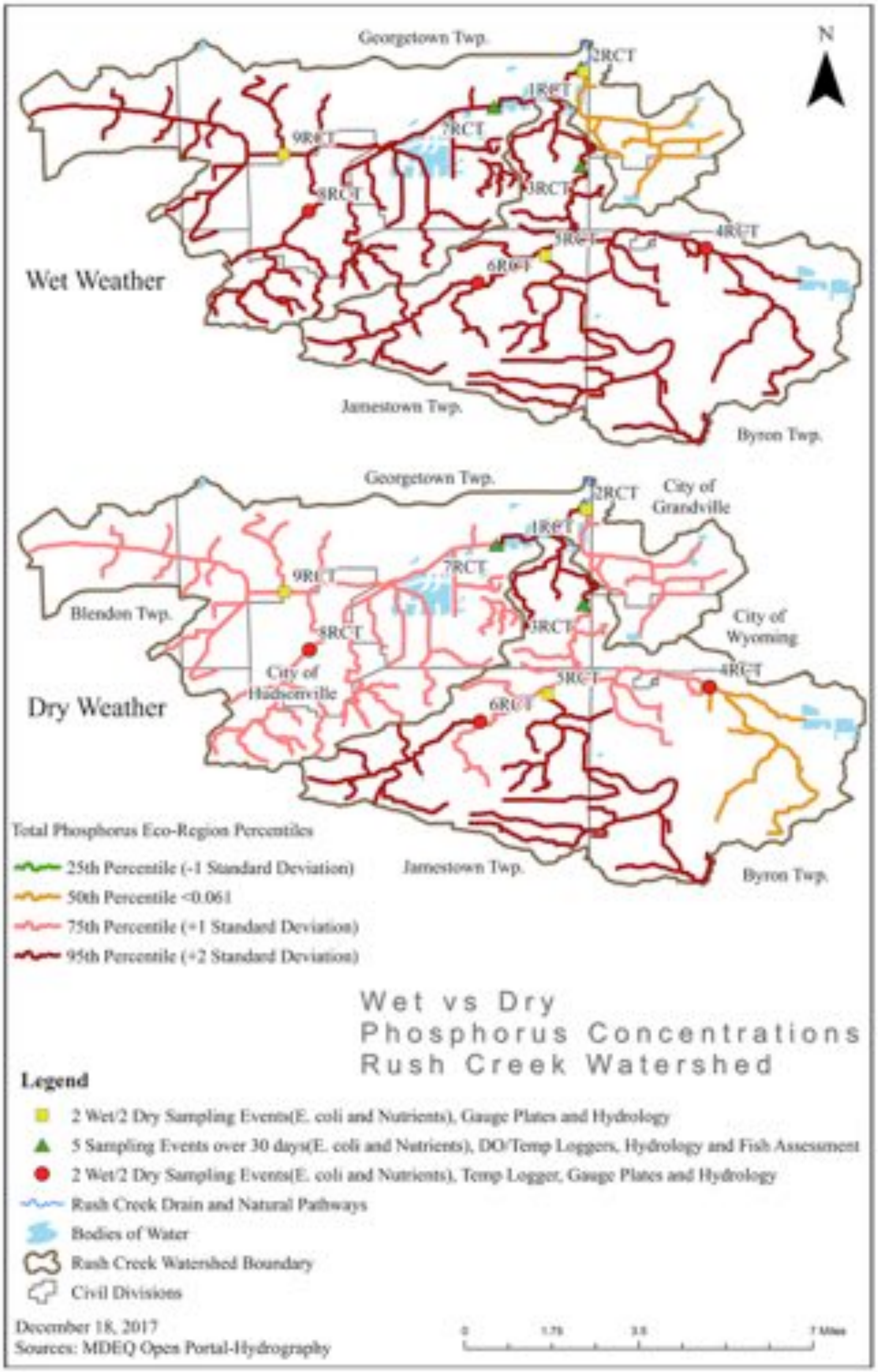

Figure 3.10 Phosphorus Concentrations Wet and Dry Weather

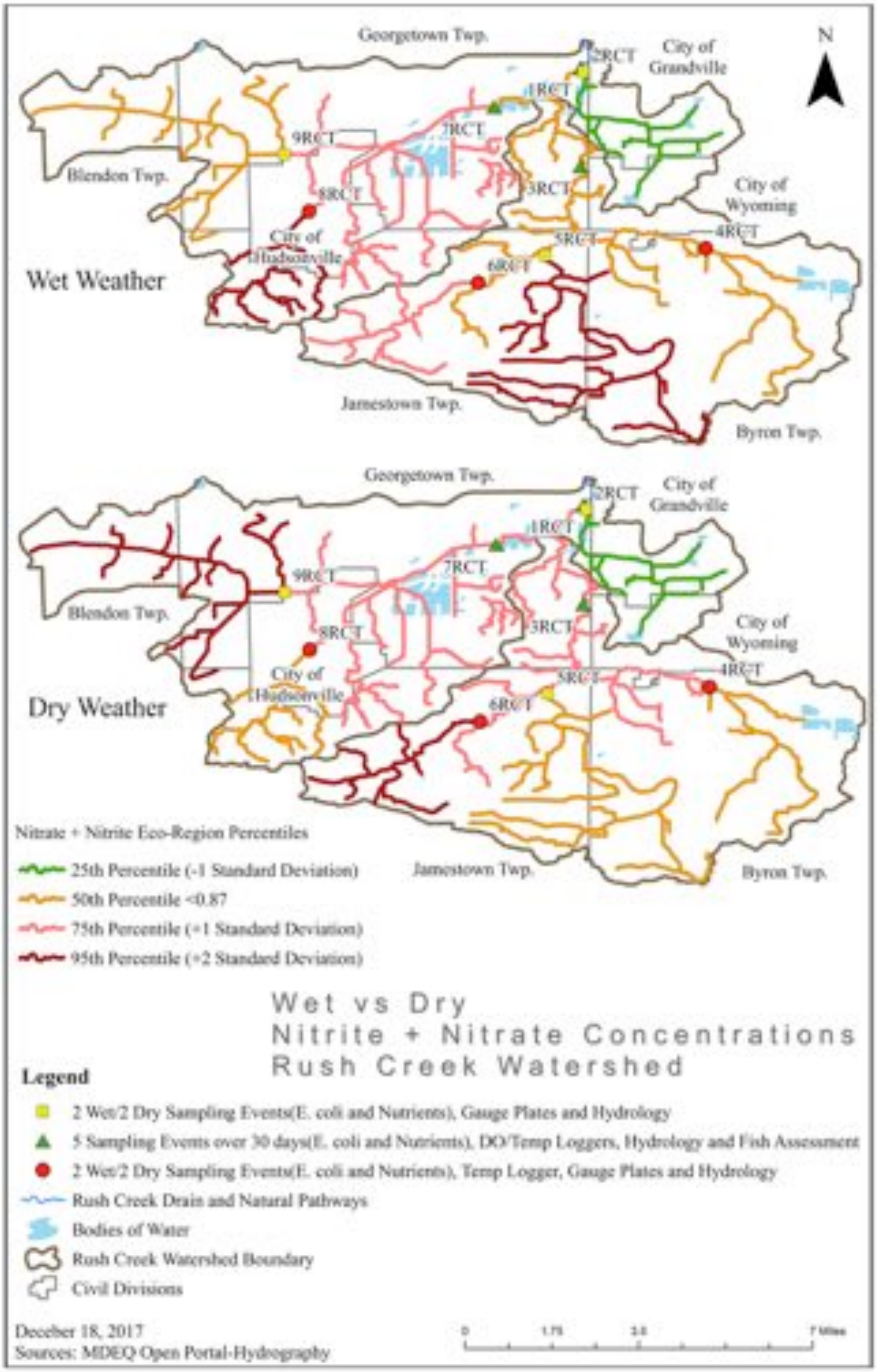

Figure 3.11 Nitrate and Nitrite Concentrations Wet and Dry Weather

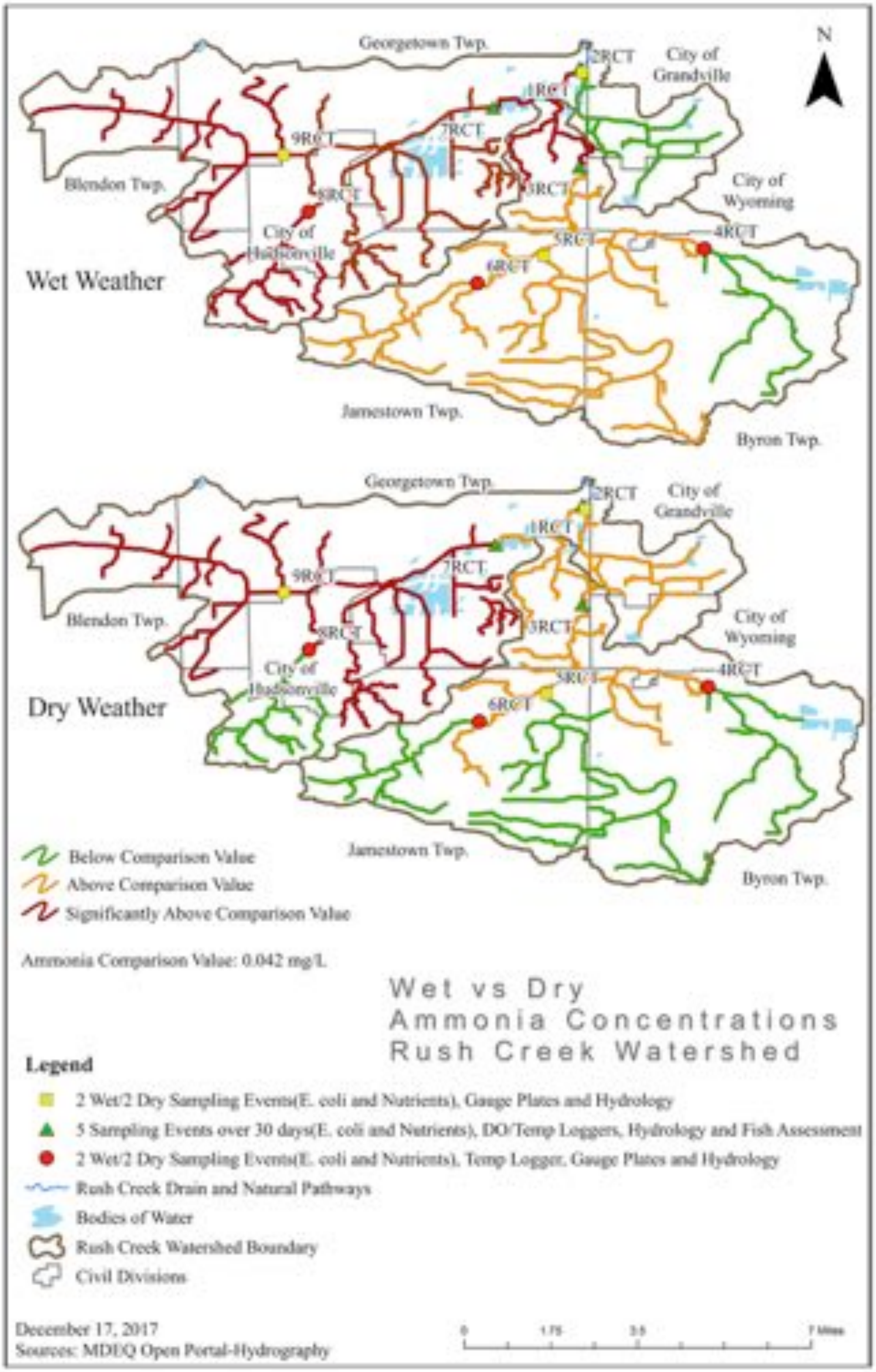

Figure 3.12 Ammonia Concentrations Wet and Dry Weather

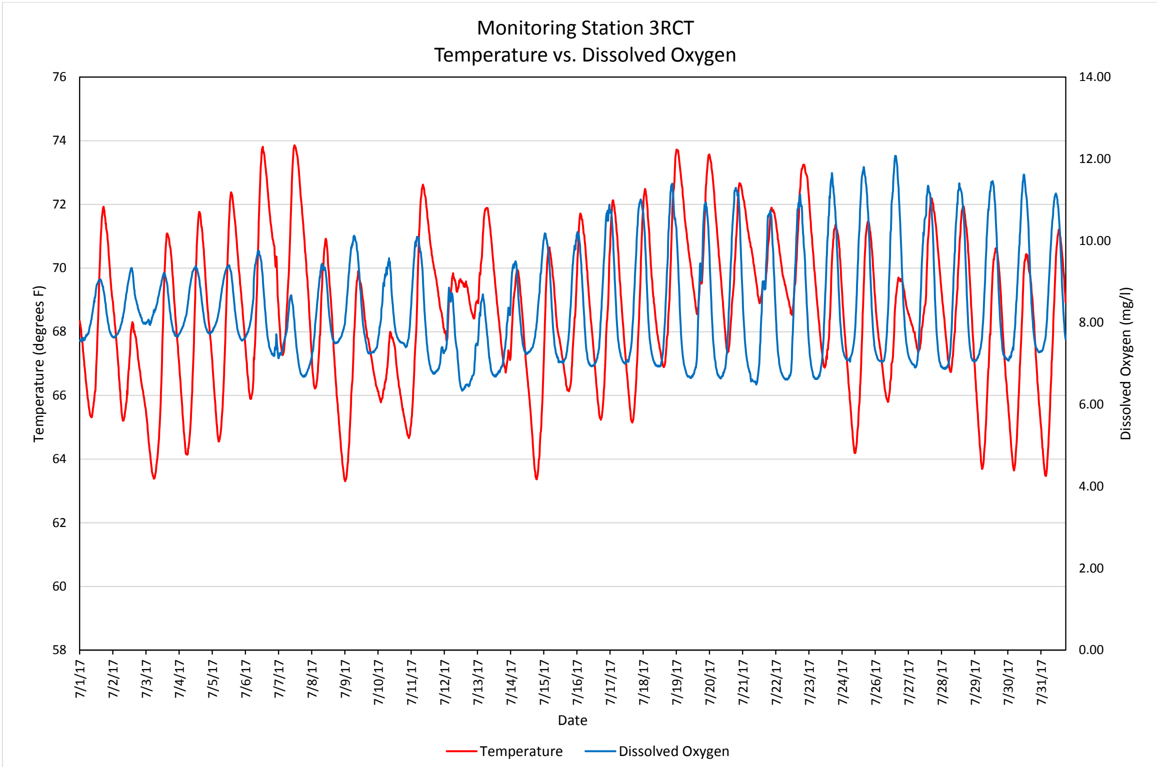

Figure 3.13 Monitoring Station 3 RCT Temperature Vs. Dissolved Oxygen

4.0 RUSH CREEK WATERSHED HUC 12 SUBWATERSHEDS

4.1 Rush Creek Subwatershed (Main Branch)

<u>Biology</u>

Rush Creek and its tributaries are designated warmwater (MDEQ, 2003). MDEQ (2003) found the fish community in Rush Creek, at 12th Avenue, to be acceptable based upon Procedure 51. Sixteen species of fish were captured, with creek chubs and bluegill making up about 49% of the sample. Invasive round gobies were not reported in the stream at this time. The macroinvertebrate community was also rated as acceptable, with a well-balanced and diverse assemblage of organisms. Habitat was rated as fair and impacted by flashy hydrology and fine sediment. The riparian zone was reported to be very narrow.

From 2012 to 2017, the Trinity Christian Reformed Church conducted MiCorps macroinvertebrate sampling on Rush Creek at Main Street in Jenison. Scores have fluctuated between fair and good. Mayflies and caddisflies have been commonly represented in the macroinvertebrate community. A site at Bursley Elementary on Rush Creek, upstream of Rushmore Lake, was monitored in 2017 and scored fair in quality.

At Quincy Road, MDEQ 2003a) found the macroinvertebrate community to be acceptable, with several families of caddisflies present. Habitat was rated as fair at this station, with impairments related to historic dredging.

In 2004, MDEQ conducted macroinvertebrate community surveys at 45 stations in the Lower Grand River (MDEQ, 2005), which included two locations within the RCW. Four of the sites contained excellent communities, thirty-seven were rated as acceptable and only four sites, including Rush Creek at 12th Ave., were rated as poor. Historic Rush Creek dredging has caused a homogenous channel, with sand and silt the predominant substrate (MDEQ, 2005). The Rush Creek biologic communities were suspected to be limited by the flashiness of the creek, and bank scour in excess of 20 inches was reported (MDEQ, 2005).

Based on historic data, Rush Creek was listed in the Clean Water Act Section 303(d) list of water bodies not attaining the “other indigenous aquatic life and wildlife” designated use due to stream modifications (Category 4c) in 2010. However, two sites sampled in Rush Creek (AUID 040500060511-02) by MDEQ in 2009 were found to be supporting the designated use with acceptable macroinvertebrate communities (MDEQ, 2011).

Fish sampling conducted in 2016, as part of this planning project, resulted in the capture of only six species and 54 total fish at 12th Avenue. Common carp and round goby, both considered to be invasive, accounted for two of the species. Bluegill, emerald shiner and green sunfish dominated the catch. It should be noted, according to P51 procedures, 50 fish are needed to determine if a waterway is meeting its coldwater or warmwater designation, so this sampling event narrowly meets the P51 procedure requirements. At Main Street, near Chicago Drive, 182 fish, representing 14 species, were documented. About 54% of the catch consisted of round gobies. Most fish species collected during the survey are considered to be tolerant of degraded conditions

<u>Road/Stream Crossing Survey</u>

A formal road stream-crossing inventory was not completed in the development of this WMP. An inventory is recommended in Chapter 10.

A survey of road/stream crossings was conducted by MDEQ in 2003 (MDEQ, 2003). The findings are included here since a formal road/stream crossing inventory was not completed as a part of this watershed management planning process.

The following text was copied from the 2003 survey, with minor modifications:

Rush Creek originates in southeastern Blendon Township and is joined by an unnamed tributary from southwestern Georgetown Township. Seven survey locations were evaluated on this portion of Rush Creek from the headwaters to the crossing at Balsam Drive. The land use in this area is a mix of agriculture, commercial areas and low to high density residential. The majority of the impacts to the stream in this area seem to result from transportation erosion or erosion due to the road stream crossing as well as runoff from adjacent croplands and residential lawns. Very little in stream habitat was observed in these reaches mainly due to channelization and very little riparian vegetation. Several sites, near the sod farms, appear to be a critical area for nutrient and sediment runoff.

- *64th north of Port Sheldon - No in-stream cover was observed for this site. No aquatic plants, floating algae, filamentous algae, turbidity, bacterial sheen/slime, oil sheen, foam or trash were observed. Riparian vegetation was variable and ranged from less than 10 feet (ft.) on the banks of the downstream side to more than 100 ft. on the upstream side and consisted of shrubs and small trees. Adjacent land uses included cropland, impervious surfaces, forest and an animal feeding operation. Potential non point source pollution (NPS) was categorized as moderate for crop related activities and slight for urban residential runoff and transportation.*
- *56th north of Port Sheldon - Silt, detritus and muck accounted for 100% of the substrate on the upstream side while both silt and sand appeared to dominate the substrate on the downstream side. Some overhanging vegetation and woody debris (upstream side) was available for in-stream cover. No aquatic plants, floating algae, filamentous algae, turbidity, bacterial sheen/slime, oil sheen, foam or trash were observed. Little riparian vegetation (less than 10 feet) was observed downstream which consisted of grasses. A moderate amount of riparian vegetation (10 to 30 ft.) was observed upstream which consisted of shrubs and trees. Adjacent land uses included forest, maintained lawn, and disturbed ground. Potential NPS pollution was categorized as moderate for urban residential runoff and slight for transportation. Comments were: Maintained lawns on downstream side with little riparian buffer, construction ongoing within 500ft of upstream side.*
- *48th north of Port Sheldon - Silt, sand and gravel appeared in almost equal amounts on the upstream side. Substrate observations were inadvertently omitted for the downstream side. Some overhanging vegetation and woody debris (upstream side) was available for in-stream cover. Some aquatic plants were observed on the downstream side. In general, abundant riparian vegetation (30 to more than 100 ft.) was observed both upstream and downstream, with the exception of the upstream right bank which had less than 10 ft. Vegetation generally consisted of small trees and shrubs. Adjacent land uses included shrub/old field, an animal feeding operation and maintained lawns. Potential NPS pollution was categorized as moderate for urban residential runoff, animal feeding operations and transportation. Comments were: Potential impacts from animal feeding operation.*
- *40th south of Port Sheldon - Silt and sand comprised equal parts of the upstream substrate while observations were prohibited on the downstream side due to abundant turbidity. Only overhanging vegetation (downstream side) was available for in-stream cover. Some aquatic plants and abundant turbidity were observed on the downstream side, while only some turbidity was observed upstream. Little riparian vegetation (less than 10 feet) was observed both upstream and downstream, and consisted of grasses. Adjacent land uses consisted of cropland.*

Potential NPS pollution was categorized as high for crop related activities and slight for transportation and channelization. Comments were: Adjacent sod farm/turfgrass-no riparian buffer.

- *Van Buren west of 40th - Silt, detritus and muck accounted for 100% of the substrate on both the upstream and downstream sides. Only overhanging vegetation (upstream and downstream) was available for instream cover. Aquatic plants were observed both upstream and downstream while some filamentous algae were observed downstream. Little riparian vegetation (less than 10 feet) was observed both upstream and downstream, and consisted of grasses. Adjacent land use consisted of cropland. Potential NPS pollution was categorized as high for crop related activities and slight for transportation. Comments were: Railroad ties in stream, hardly any buffer from adjacent sod farm, which has bare exposed soil.*
- *36th north of Van Buren - Due to level of turbidity, substrate observations were prohibited for the upstream side. However, silt, sand and gravel appeared on the downstream side. Only overhanging vegetation (downstream side) was available for in-stream cover. Aquatic plants and turbidity were observed both upstream and downstream. Little riparian vegetation (less than 10 feet) was observed both upstream and downstream, and consisted of grasses. Adjacent land use consisted of cropland. Potential NPS pollution was categorized as high for crop related activities, moderate for transportation and slight for channelization. Comments were: 1 of 3 culverts is partially obstructed, very turbid water on upstream side, field underdrains outlet here.*
- *Balsam south of Port Sheldon - Silt, sand and gravel appeared on both the upstream and downstream sides. Some overhanging vegetation and woody debris (downstream side) was available for in-stream cover. Abundant aquatic plants were observed upstream while trash was observed downstream. In general, little riparian vegetation (less than 10 ft.) was observed both upstream and downstream, and consisted of grasses and shrubs. Adjacent land uses included shrub/old field and maintained lawns. Potential NPS pollution was categorized as slight to high for urban residential runoff and slight for transportation and mining (gravel sand operation). Comments were: Gravel sand operation within 100 ft. of stream, adjacent landowner mowing right up to the edge.*

The west central area of the subwatershed consists of an unnamed tributary that flows from the area near the small village of Zutphen (south of I-196) north through Hudsonville to Rush Creek. It drains heavily agricultural areas in its headwaters to moderately urban areas where it converges with Rush Creek just west of Balsam Drive. The majority of the impacts to the stream in this area seem to result from inadequate riparian buffers, urban residential runoff, and transportation non point source pollution. Turbidity was commonly noted at survey locations in this subwatershed indicating sediment runoff from adjacent land uses and excessively silty and sandy substrates. Also common to this watershed were highly channelized reaches armored by concrete which disrupts the natural stream flow and meandering pattern.

- *Quincy east of 40th - Silt, detritus and muck, appeared to dominate both the upstream and downstream substrates. Some overhanging vegetation and woody debris was available for in-stream cover. Some turbidity was observed both upstream and downstream. Riparian vegetation was variable and ranged from more than 100 ft (upstream banks) to less than 10 ft on the downstream right bank. Vegetation was dominated by shrubs and trees. Adjacent land uses included forest and maintained lawns. Potential NPS pollution was categorized as moderate to high for transportation, moderate for streambank erosion and slight for urban residential runoff. Comments were: Some erosion occurring near culvert due to steep banks and gully forming flow from road runoff.*

- *Quincy east of 32nd - Silt, detritus and muck, appeared to dominate both the upstream and downstream substrates. Some overhanging vegetation and woody debris (upstream side) was available for in-stream cover. Some filamentous algae (upstream and downstream) and some turbidity (downstream) was observed. A moderate amount of riparian vegetation, 10 to 30 ft (upstream) and 30-100 ft (downstream) was observed, and consisted of grasses, shrubs and trees. Adjacent land uses included shrub/old field, forest and impervious surfaces. Potential NPS pollution was categorized as slight for transportation. Comments were: Looks like a surface water drive trib, with no flow currently.*
- *New Holland west of 32nd - Silt and sand made up equal parts of the upstream substrate while observations were prohibited on the downstream side due to turbidity. Some overhanging vegetation and woody debris (upstream side) was available for in-stream cover. A bacterial sheen was observed both upstream and downstream while some turbidity was also noted downstream. In general little riparian vegetation (less than 10 feet) was observed which consisted of trees and shrubs. Adjacent land uses included forest and maintained lawn. Potential NPS pollution was categorized as high for urban residential runoff and slight for transportation. Comments were: Lots of lawn clippings deposited in this area, no riparian vegetation further downstream.*
- *32nd north of Barry - Silt and sand appeared in almost equal amounts on both the upstream and downstream sides. Overhanging vegetation, undercut banks and woody debris were available both upstream and downstream. Some turbidity and trash was observed upstream and downstream. Little riparian vegetation (less than 10 feet) was observed on the right bank while a moderate amount of riparian vegetation (10 to 30 ft) was observed on the left bank. Vegetation was dominated by shrubs and trees. Adjacent land uses included impervious surfaces and maintained lawn. Potential NPS pollution was categorized as moderate for transportation and urban residential runoff, and slight for recreational activities. Comments were: Both culverts creating plunge pools, left side of downstream reach armored with concrete slabs, Hudsonville High School just upstream, this site is just downstream from the former golf course.*
- *Oak west of Balsam - Silt and sand appeared in almost equal amounts on both the upstream and downstream sides. Some overhanging vegetation and woody debris (upstream side) was available for in-stream cover. Some turbidity was observed upstream and foam downstream. Little riparian vegetation (less than 10 feet) was observed both upstream and downstream, and consisted of grasses. Adjacent land uses included impervious surfaces and maintained lawn. Potential NPS pollution was categorized as moderate for channelization and debris in water, slight to moderate for urban residential runoff, and slight for transportation, streambank erosion, hydrology and sources unknown. Comments were: Lots of trash in stream including small propane canister, 4 dead fish on downstream side, right side of downstream reach completely concrete, no vegetation at all. Upstream looks more natural.*

The lower subwatershed includes the final reaches of Rush Creek as it flows northeast from the City of Jenison to its convergence with the Grand River. The majority of the land use in this area is commercial and urban land use. The lower reaches of Rush Creek were extremely turbid which could have been the result of previous rains in the area but could partially be the result of large amount of sediment being carried from storm water runoff and agricultural and residential land uses throughout the watershed. Overall the amount of impervious surface cover and little riparian vegetation in some areas of lower Rush Creek could lead to high flows with greater erosive power in the future.

- *Port Sheldon east of Chicago Drive - Due to level of turbidity, substrate observations were prohibited. Only overhanging vegetation and woody debris were available for the upstream side only. Some aquatic plants, floating algae and turbidity were observed. In general a moderate* *amount of riparian vegetation (10 to 30 ft) was observed which consisted of grasses, shrubs and trees. Adjacent land uses included shrub/old field, cropland and maintained lawn. Potential NPS pollution was categorized as slight for crop related activities and transportation. Comments were: Some erosion evident from road ditch drainage although some work has been done, silt fences and grass seed.*

- *12th north of Port Sheldon - Due to level of turbidity on the upstream side substrate observations were prohibited. Sand appeared to dominate the downstream substrate with lesser amounts of silt and gravel also present. Overhanging vegetation and undercut banks were available both upstream and downstream. Abundant turbidity and some trash was observed on the upstream side while only turbidity was observed downstream. In general a moderate amount of riparian vegetation (10 to 30 ft) was observed which consisted of shrubs and trees. Adjacent land uses consist of maintained lawns. Potential NPS pollution was categorized as slight to moderate for urban residential runoff and slight for transportation and recreational. Comments were: looks like adjacent landowners might be raking leaves into stream, needs more riparian buffer.*
- *Cottonwood northwest of Port Sheldon - Due to level of turbidity on the upstream side substrate observations were prohibited. Sand appeared to dominate the downstream substrate with lesser amounts of gravel also present. Some overhanging vegetation and woody debris (downstream side) was available for in-stream cover. Some turbidity, foam and trash were observed. Little riparian vegetation (less than 10 feet) was observed on the right bank while a moderate amount of riparian vegetation (10 to 30 ft) was observed on the left bank. Vegetation consisted of grasses, shrubs and trees. Adjacent land uses included shrub/old field and maintained lawns. Potential NPS pollution was categorized as moderate for urban residential runoff and slight for transportation and channelization. Comments were: The channel on the upstream side has a diverted engineered channel so that the stream is forced to flow through and around a residential property.*
- *Old M-21 - Due to level of turbidity substrate observations were prohibited. Overhanging vegetation, undercut banks, and boulders (downstream only) were available for in-stream cover. Some turbidity and trash were observed. A moderate amount of riparian vegetation (10 to 30 ft) was observed both upstream and downstream and consisted of shrubs and trees. Adjacent land uses included impervious surfaces, forest, and maintained lawn. Potential NPS pollution was categorized as slight for transportation and urban residential runoff. Comments were: Boulders are creating adequate aeration, need some runoff control from road crossing erosion.*

A designated drain [Huizenga Drain] flows from the City of Grandville to Rush Creek with its headwaters originating south of 44th street near the Rivertown Crossing Mall. It drains residential areas as well as heavily commercialized, urban areas where it converges with Rush Creek north of Tyler Street. Although this is a designated drain water quality should still be a concern as it flows into Rush Creek and ultimately the Grand River. Most of the impacts to the drain result from channelization and urban residential runoff.

- *44th west of Wilson - Silt and sand were observed in equal amounts on the upstream side while silt, sand, and gravel appeared on the downstream side. Overhanging vegetation (upstream and downstream) and undercut banks and woody debris (only downstream) were available for in-stream cover. Some trash was observed upstream. Little riparian vegetation (less than 10 feet) was observed upstream while a moderate amount of riparian vegetation (10 to 30 ft) was observed downstream. Vegetation was dominated by trees both upstream and downstream. Adjacent land uses included cropland and impervious surfaces. Potential NPS pollution was categorized as slight for urban residential runoff and channelization. Comments were: Buffer looks pretty good on downstream side, looks pretty natural.*

- *Canal east of I-196 (north of Barry Street) - Sand and gravel were observed for both the upstream and downstream sides with lesser amounts of silt, detritus and muck also present. Only overhanging vegetation (upstream and downstream) was available for in-stream cover. Some turbidity (downstream) and some trash (upstream) were observed. In general little riparian vegetation (less than 10 feet) was observed which consisted of grasses and shrubs. Adjacent land uses consist of maintained lawns. Potential NPS pollution was categorized as moderate for urban residential runoff. Comments were: Water is somewhat impounded on downstream side, channel is much wider.*
- *Kenowa north of 44th - An equal amount of sand and gravel was observed for both the upstream and downstream sides. Only overhanging vegetation (upstream and downstream) was available for in-stream cover. Some trash was observed downstream. Little riparian vegetation (less than 10 feet) was observed downstream while a moderate amount of riparian vegetation (10 to 100 ft) was observed upstream. Vegetation was dominated by grasses both upstream and downstream. Adjacent land uses included shrub/old field, impervious surfaces, and maintained lawns. Potential NPS pollution was categorized as slight to moderate for urban residential runoff and slight for transportation and channelization.*
- *Tyler Street west of Kenowa - Due to level of turbidity substrate observations were prohibited. Only undercut banks were available for in-stream cover. In general a moderate amount of riparian vegetation (10 to 30 ft) was observed which consisted of shrubs and trees. Adjacent land uses included shrub/old field, impervious surfaces, and maintained lawn. Potential pollution NPS was categorized as slight transportation and urban residential runoff.*

The eastern central subwatershed consists of an unnamed tributary that flows north from the Angling Road area (south of I-196) through Hudsonville to Rush Creek. It drains heavily agricultural areas in its headwaters to moderately urban areas where it converges with Rush Creek before Rush Creek crosses Port Sheldon. The majority of the impacts to the stream in this area seem to result from inadequate riparian buffers, urban residential and cropland runoff, and transportation non point source pollution. Turbidity was commonly noted at survey locations in this subwatershed although most of the turbidity could probably be attributed to previous rain events in the area. Also common to this watershed were highly channelized reaches with little in stream habitat. The most notable site within this subwatershed was at Jackson east of 32nd which showed evidence of high flows and moderate to severe streambank erosion although the stream was dry at the time of the survey. Conversations with the adjacent residential landowner revealed that the stream had been relocated from its natural location to accommodate the residential property. Observed erosion and intermittent high flows could partially be a result of previous relocation of the stream channel. This areas is recommended for further study.

- *Jackson east of 32nd - Due to dry conditions, water temperature and substrate observations were prohibited at this site. No in-stream cover was observed for this site. No aquatic plants, floating algae, filamentous algae, turbidity, bacterial sheen/slime, oil sheen, foam or trash were observed. Abundant riparian vegetation (more than 100 ft) was observed downstream while a little (less than 10 ft) to a moderate (10 to 30 ft) amount of riparian vegetation was observed upstream. In general the upstream vegetation was dominated by grasses while the downstream vegetation was dominated by trees. Adjacent land uses included shrub/old field, pasture, impervious surfaces, forest and maintained lawn. Potential NPS pollution was categorized as high for streambank erosion and hydrology, and slight for transportation, channelization and sources unknown. Comments were: Dry at time of survey although perched culvert and streambank erosion evident, can't figure out the reason for such high flows that are indicated by this amount of erosion. Talked to adjacent landowner who said that stream channel was redirected 20 to 25 years ago as part of home development.*

- *Barry east of 32nd - Silt, sand and gravel were observed on the upstream side while equal amounts of sand and gravel were noted for the downstream side. Overhanging vegetation and woody debris were available both upstream and downstream for in-stream cover. Some foam and trash were observed downstream. Little riparian vegetation (less than 10 feet) was observed downstream while a moderate amount of riparian vegetation (10 to 30 ft) was observed upstream. In general downstream vegetation was dominated by shrubs while upstream vegetation was dominated by trees. Adjacent land uses included cropland and maintained lawn. Potential NPS pollution was categorized as slight for crop related activities and urban residential runoff. Comments were: Water looks way down, many sump drainage pipes exposed.*
- *Van Buren west of Edson - Sand appeared to dominate the upstream and downstream substrate with lesser amounts of silt also present. Only overhanging vegetation (upstream and downstream) was available for instream cover. Abundant turbidity was observed upstream, while some turbidity and foam were observed downstream. Little riparian vegetation (less than 10 feet) was observed upstream while a moderate amount of riparian vegetation (10 to 30 ft) was observed downstream. Vegetation was dominated by grasses both upstream and downstream. Adjacent land uses included shrub/old field and cropland. Potential NPS pollution was categorized as moderate to high for crop related activities, and slight for transportation and channelization. Comments were: Water turbid from previous rains, pictures show comparison in water depth.*
- *Van Buren east of Edson - Silt, detritus and muck, appeared to dominate both the upstream and downstream substrates. Only overhanging vegetation (upstream and downstream) was available for in-stream cover. Some turbidity was observed both upstream and downstream. Little riparian vegetation (less than 10 feet) was observed both upstream and downstream, and consisted of grasses and shrubs. Adjacent land uses included cropland and maintained lawn. Potential NPS pollution was categorized as moderate for crop related activities, and slight for transportation. Comments were: No specific comments were recorded for this site.*

Farm Animal Survey

Results of the windshield survey conducted in this subwatershed indicate that there are at least 13 locations that house large animals including cattle and horses. Because several of these facilities house animals indoors, an accurate count was not possible. Still, a total of only 30 large animals were visibly counted, at a density of approximately one animal per square mile. The largest farms appeared to be two equestrian centers with unknown numbers of horses. The largest herd of animals visible was only six cattle. One turkey farm was noted that appeared to house a large number of turkeys, though the farm is not a known CAFO. Microbial Source Tracking testing indicated horse, canine, duck, geese, and turkey DNA markers were in the water (RCW, 2016). Social survey results indicated there are actually more than 1,252 animals in the entire RCW, excluding homes with one to three horses on less than ten acres. Farmers reported owning anywhere from 2-359 livestock animals. Details of the results of the survey are included in Chapter 8.

Problem sites were identified including a location with three cows in the stream and runoff from two adjacent sites causing gully erosion on a pasture with two horses.

Buffer strips between agricultural fields and drains were not prevalent during the windshield survey and are reportedly not a popular BMP.

Figure 4.1 displays wet weather *E. coli* data, agricultural land use, MST data, animal farm operation data collected during the windshield survey, and CAFO locations.

Neighborhood Source Assessment

As part of the planning process, two Neighborhood Source Assessments (NSA) were conducted to characterize residential areas and to identify pollutants of concern in these areas. Data were collected from an older neighborhood with single family homes in the City of Hudsonville, near Vanburen and Madison Streets, and the newer "Spring Meadow" neighborhood with both single and multi-family units, near Quincy Street and 32nd Avenue, using a methodology developed by the Center for Watershed Protection (2005). The single-family neighborhood in the City of Hudsonville is older and well established with small lots. Lawns are well maintained, but do not appear to receive excessive fertilizer and no permanent irrigation systems were noted. The neighborhood has paved roads and driveways, some sidewalks, but no curb and gutter. Some downspouts appeared to be directly connected to storm or sanitary sewer, while some discharged to pervious surfaces. Storm drain inlets lined the street and some were stenciled to indicate their connection to the stream. They were clean and not covered with debris. There was open space in the neighborhood, but no stormwater pond visible. Water quantity, nutrients and sediment were the likeliest NPS pollutants. There appeared to be potential for rain gardens, rain barrels, and disconnecting gutters from the stormsewer.

The more recently developed "Spring Meadow" neighborhood had well-maintained lawns that were likely receiving excess fertilizer, herbicide and pesticide treatments. The majority of the lawns appeared to receive permanent "non-target" irrigation, and some systems irrigated pervious surfaces, including sidewalks. The neighborhood has paved roads and driveways, sidewalks on both sides of the street, spaced approximately 15 feet from the road, and curb and gutter. Impervious surfaces were clear of debris and yard clippings. Approximately half of the downspouts appeared to be directly connected to storm or sanitary sewer, while some discharged to pervious surfaces and others to nonpervious surfaces. Storm drain inlets lined the street and some were stenciled to indicate their connection to the stream. They were generally clean. There was open space in the neighborhood, but no stormwater pond or floodplain visible. Water quantity, nutrients, pesticides and herbicides were the likeliest NPS pollutants. There appeared to be potential for improved lawn/landscaping practices, rain barrels, and disconnecting gutters from the stormsewer.

A site with bare soil undergoing new home construction was noted during the windshield survey. Soil was leaving the site and entering the drainageway. While this site has since been stabilized, it highlights the need for diligence by SESC inspectors at construction sites.

Sediment/HIT

MDEQ (2003) reported the flashy nature of the stream tended to produce fine sediment and/or silt, which often settled out on areas of stable habitat. According to the HIT model, agricultural lands in the Rush Creek subwatershed contribute 0.063 tons of sediment/acre/year (MSU IWR, 2009). An estimated 1,264 tons of sediment enters the waterways each year from overland sources in this subwatershed. The HIT model estimates of sediment being contributed to the RCW from overland erosion are shown in Figure 3.8. The HIT model displays most agricultural erosion in this subwatershed coming from the southeastern part of the subwatershed, south and east of the I-196 expressway. The model also predicts areas of significant erosion to the north and west of the Backlock Drain, and near the watershed boundary north of I-196.

The OCWRCs office has not completed a large-scale dredging project, rather obstructions are removed as they are reported problematic (OCWRC Linda Brown, personal communication, July 18, 2017). Common obstructions include fallen trees in the streambed, and beaver dams.

The Main Rush Creek branch has reported sediment problems (OCWR Linda Brown, personal communication, July 18, 2017).

There are complaints of excessive sediment in the Georgetown Shores neighborhood and lakes, south of 44th Ave. and Chicago Drive. A study of the Corey Bishop Drain is underway to understand the sources of erosion and sediment load contributions. The study found it probable that the high sediment load being carried into the manmade lakes was caused by extensive erosion in the drain, and that there had been significant change in the elevation of the drain since the construction of I-196 (Eng. Engineering and Surveying, 2017, Appendix J).

To help settle out excess sediment and for flood storage, detention or retention ponds, wetlands and/or two-stage ditches with adjacent wetland plants for flood storage are recommended along Buttermilk Creek (OCWR Linda Brown, personal communication, July 18, 2017).

Rushmore Lake was disconnected from Rush Creek in the 1970's to alleviate resident concerns of fluctuating water levels and excessive sediment contributions to the lake from Rush Creek (OCWRC, personal communication, July 18, 2017).

A resident at the stakeholder meeting also reported land sinking, excessive erosion and an increase in water flow in Rush Creek, upstream of Rushmore Lake, near 12th Ave. due to recent wetland destruction and development (September 18, 2017).

<u>Water Chemistry/*E. coli*</u>

MDEQ (2003) analyzed water samples from Rush Creek at 12th Avenue and at Balsam Road. Levels of ammonia, TP and TSS were found to exceed average regional comparison values. However, the levels were within reported comparison ranges.

As a part of a biological survey completed in the Lower Grand River Watershed in 2004, water chemistry samples were collected at one site in Rush Creek, and the collective results were compared to the reference ranges for each parameter for the Southern Michigan/Northern Indiana Till Plain (SMNITP) ecoregion compiled by Lundgren (1994) and Michigan's WQS and WQC. The range of total phosphorus was similar to that found in the 2004 survey of the Lower Grand River Watershed (Rockafellow, 2005) and within the range found in 1994 at the nearest reference site by Lundgren (1984) (0.033 to 0.17 mg/L in the Thornapple River at McKeown and Barger Roads). The concentrations of other parameters at all sites were within the expected range for the SMNITP ecoregion (Lundgren, 1994) and below Michigan WQS.

Water temperature monitoring (2016) found Rush Creek to be a "cool" water stream at site 8RCT, with an average July water temperature of 69.1°F. At 2RCT, the average July water temperature of a small tributary was 77.5°F, which is considered to be "warm". Two other sites on Rush Creek 1RCT and 7RCT had average July temperatures of 71.7 degrees. In July 2017, Site 1RCT had an average temperature of 70.7 degrees F (warm) and site 7RCT had an average temperature of 71.2 degrees F (warm).

Rush Creek at Main Street (Site 1RCT) was sampled for the 30 day *E. coli* geomean, and had a value of 640 CFU/100 mL, which is above the 130 CFU/100 mL TBC WQC. This site is nearest the confluence of the Grand River. Weekly geomeans at this site ranged from 199 to 5,789 CFU/100 mL, exceeding the PBC WQC one of five weeks, exceeding the TBC WQC four of five weeks, and meeting the weekly WQC one week (2016).

Rush Creek at Blair Street (Site 7RCT) had a 30-day *E. coli* geomean of 780 CFU/100 mL, which is also above the 130 CFU/100 mL TBC WQC. The weekly geomeans ranged from 196 to 9,390 CFU/100 mL (2016). The PBC WQC was exceeded one week and the TBC WQC was exceeded four of five weeks, and WQC was met one week,

The Huizenga Drain was sampled at Port Sheldon (Site 2RCT) after two wet weather and two dry weather events in 2016-2017. Dry weather geomeans were 280 and 320 CFU/100 mL, just below and above the TBC WQC, respectively. Wet weather geomeans were 280 and 300 CFU/100 mL, below or just at the TBC WQC.

The Buttermilk Drain was sampled at 32nd Ave. (Site 8RCT) after two wet weather and two dry weather events in 2016-2017. Dry weather geomeans were 500 and 520 CFU/100 mL, both above the TBC WQC. Wet weather geomeans were 24,000 and 14,000 CFU/100 mL, well above the PBC WQC.

Rush Creek was sampled at 36th Ave. (Site 9RCT) after two wet weather and two dry weather events in 2016-2017. Dry weather geomeans were 560 and 600 CFU/100 mL, both above the TBC WQC. Wet weather geomeans were 11,000 and 4,100 CFU/100 mL, well above the PBC WQC.

Qualitative DNA source tracking at locations in the RCW found equine markers present at the sampling site RC-20, located on the unnamed tributary south of Hudsonville, and both canine and equine markers present at the sampling site RC-23 on the Main Rush Creek branch. At these sites, testing for other host sources was not completed. These positive results indicate that the host sources contributed to fecal contamination at the time of the sample collection (Helix, 2017), and are assumed to be a consistent source of fecal contamination to the watershed.

Source tracking for the turkey marker indicated that turkey fecal matter is also a contributing source, though no quantitative testing was done (Helix, 2017).

Additional quantitative and qualitative DNA source tracking was completed at a sample site in Rushmore Lake and at 8th Avenue Park (Georgetown Community Park). Human, duck, and geese sources were detected at both sites. Human sources of fecal contamination were the predominant source on Rushmore Lake, where the human marker was detected in quantities 95.01 times greater than the geese marker, and the duck marker was detected in quantities 33.13 times greater than the geese marker. At the sample site located in 8th Avenue Park, duck was the predominant source, where the duck marker was detected in quantities 526.39 times greater than the geese source, and the human marker was detected in quantities 31.56 times greater than the geese marker (Helix, 2017).

Canine scent tracking was used to screen samples collected from 14 sample sites for the presence of human wastewater contamination on two sampling dates in 2016. Three canines were used in the testing. Where no canines alert to the presence of human wastewater, it is unlikely that human wastewater is present; where one or two canines alerted to the presence of human wastewater indicating human *E. coli* may be a probable contributing source if high concentrations of *E. coli* are present and; where three canines alerted to the presence of human wastewater, and high *E. coli* concentrations were measures, it is most likely that the presence of human wastewater is a significant source. Results are shown in Table 3.4 and Appendix D. Canines did not alert to the presence of human wastewater contamination at one site, one canine alerted to the presence of human wastewater contamination at four sites, two canines alerted to the presence of human wastewater contamination at four sites, and three canines alerted to the presence of human wastewater contamination at five sites.

Qualitative DNA source tracking at eight sample locations tested on one date in 2016 found human markers present at all sites tested, which include sample numbers: RC-2, RC-14, RC-16, RC-17, RC-19, RC-20, RC-22, RC-23, and two sites in 2017 including RC-100 and RC-101, shown in Figure 3.7. One to three canines alerted to the presence of human wastewater contamination at all of these sites.

A resident at the stakeholder meeting reported a gap in access to sanitary service for approximately 50 homes on Blair Street and Shady Oak Ct. in Georgetown Township, in an area that otherwise appears sewered (September 18, 2017).

TSS were measured below the target value of 30 mg/L at all sites after dry weather sampling events, but three of five sampling locations were above the comparison values after wet weather sampling events. The samples on Rush Creek (Site 2RCT), draining the western portion of the subwatershed, were below the target value for TSS after one of the wet weather events, and the samples on the Huizenga Drain (Site 9RCT), draining the northeastern portion of the subwatershed, were below the target value for TSS after both of the wet weather events. However, the samples from Buttermilk Drain, draining the south central part of the subwatershed (Site 8RCT), from Rush Creek (Site 7RCT) and from all of Rush Creek and East Branch Rush Creek subwatersheds (Site 1RCT) exceeded TSS comparison values following the wet weather events (2016-2017). TSS concentrations were highest at Site 8RCT on the Buttermilk Drain and at Site 6 in the East Branch subwatershed.

Figure 4.2 displays *E. coli* data, human canine and MST data, biosolids spreading locations, land use and sanitary sewer system boundaries.

<u>Wetlands/Floodplains</u>

Flooding has been a concern in the RCW since the mid-1970's when proposed subdivision permits were denied due to their building plans as compared to the 100-year floodplains. Analysis by MDNR in 1989 showed that filling more than ten percent of the floodplain storage volume, upstream of 12th Avenue, would result in a measureable increase in the 100-year flood elevation. Filling the entire floodway fringe was estimated to raise the 100-year flood state 0.5 to 2.5 feet, with the greatest projected increase near the mouth of the watershed. The report concludes "even if floodplain storage is not reduced, future urbanization could result in increased runoff potential, greater flood flows, and higher flood elevations. The need to develop and implement a basin-wide stormwater management plan for Rush Creek is evident" (MDNR, p 9).

There are approximately 983 acres of wetlands in the Main Branch subwatershed. This subwatershed has lost 90% of its historic wetlands. Within the RCW, 44% of the remaining wetlands are in the Main Branch subwatershed.

<u>Potential Conservation Areas</u>

A WMP was prepared for the Lower Grand River Watershed in 2011, which includes the Rush Creek subwatershed. The Lower Grand River Watershed envisions a corridor along Rush Creek as a potential natural corridor (GVSU Annis Water Resources Institute [AWRI], 2010).

The City of Hudsonville also has an Imagine 2030 visioning plan, which includes enhancing and connecting the city, including the use of waterways as recreational corridors.

<u>Protected Lands</u>

Georgetown Township and the City of Hudsonville both have parks in this subwatershed, displayed on Figure 2.14. Many parks are adjacent Rush Creek or a drain or tributary.

There are four golf courses in the subwatershed: Maple Hill, Glen Eagle, Sunnybrook Country Club, and Rolling Hills. Of those golf courses, the Sunnybrook Country Club, located in the East Branch subwatershed, has participated in CMTESP.

Government Jurisdictions

Georgetown, Blendon, and Jamestown Townships, as well as the cities of Grandville, Wyoming and Hudsonville, are located in this subwatershed. Most of the Rush Creek subwatershed is in Ottawa County, and a small portion is in Kent County.

Nonpoint Source Assessment

Unnaturally high concentrations of geese and ducks were noted at 8th Avenue Park on 8th Ave. Lake in Georgetown Township and near Rivertown Mall in Grandville. MST sampling completed at on date in 2017 indicated duck was the predominant contributing bacterial pollutant source, though the E. coli concentration measured was <10 CFU/100 mL.

Several years ago, residents of Rushmore Lake, in Georgetown Township, reported a suspected broken sanitary sewer pipeline adjacent to Rushmore Lake, as evidenced by water with very high concentrations of *E. coli* seeping into Rushmore Lake along the southern shoreline (Rushmore Lake Stakeholder Meeting, May 8, 2017). Residents reported the Township did not conduct follow-up assessment or corrective action. The Township was not familiar with a leaking pipe in the area, but did report a sewer back-up in the area due to a heavy rain event in 2005 (Georgetown Township communication, January 11, 2018).

A community of approximately 12-15 homes located just outside of the RCW at 40th and Rylie St was reported as being suspected of having problems with sewage disposal due to the lot size and soil type of the area. Though the majority of this community is located outside of the RCW, some homes in this community may near the border or just inside the RCW.

The RCW is a tributary of the Grand River. However, at high flow times, the Grand River water level also increases significantly and backs up into the RCW, which further exacerbates flooding along the lower reaches of Rush Creek. Though the City of Grand Rapids has eliminated their combined sewers and the associated risk of overflows, there may be other sources of *E. coli* affecting the Grand River that may occasionally contribute bacteria to the RCW during occasional backups.

Of note in this watershed are 21 greenhouses (Figure 4.3), one sod farming operation, and farming in muck fields. Greenhouses that discharge over 10,000 gallons per day need a groundwater permit from MDEQ, and greenhouses that have their site tied to a tile drain or pipe may need a permit from MDEQ.

There is reportedly good acceptance of LID practices by contractors in the watershed (OCWRC personal communication, July 18, 2017).

Dams

Six flood control structures are located in this subwatershed. The Buttermilk Creek Detention Dam on Buttermilk Drain, Rush Creek Detention Basin Number Two on the Deweerd Drain, and one on the Main Branch of Rush Creek were constructed in the 1970's to reduce impacts from flooding. These are not permanent impoundments. They also help to control sediment. In addition there are the Crystal Springs Lake Level Control Structure, Rushmore Lake Level Control Structure, Kenowa Lake Level Control Structure, and the Johnson Estate Dam.

4.2 East Branch of Rush Creek Subwatershed

This section of stream has a history of localized flooding during heavy rain events, and as a result, East Branch Rush Creek was shortened by a diversion channel upstream, near Kenowa Avenue, in the early 1990s. The diversion channel and what was formerly named East Branch Rush Creek are managed as the Bliss Creek Intercounty Drain. The greater surrounding area consists of suburban residential land use and some forested areas.

The East Branch of Rush Creek is less populated and has more natural areas and agricultural activities as compared to Rush Creek (MDEQ, 2005).

Biology

In 2017, the Trinity Christian Reformed Church conducted MiCorps macroinvertebrate sampling Bliss Creek at Port Sheldon, near the confluence of Rush Creek. The site scored a good rating.

MDEQ (2003) reported fair (moderately impaired) habitat and an acceptable macroinvertebrate community at Barry Road. Three families of mayflies were noted.

MDEQ (2016b) sampled the East Branch Rush Creek/Bliss Creek Intercounty Drain at 44th Street in Georgetown Township. The macroinvertebrate community scored acceptable and habitat scored marginal. The macroinvertebrate community was dominated by Amphipoda and Hydropsychidae, both facultative taxa that tend to dominate moderately disturbed environments (Voshell, 2002). Sand was the dominant sediment type (80% visual estimate). Undercut banks, overhanging vegetation, large woody debris, and rootwads were all sparse. The streambed showed moderate amounts of sediment deposition and flashiness was evident by bank scour 9-18 inches above the water surface. Two large apartment complexes were noted on both sides of the stream.

Fish sampling conducted in 2016 near Kenowa Avenue resulted in the capture of 161 fish, representing 11 species. Of note were three cool/coldwater species: rainbow trout, mottled sculpin (dominant) and longnose dace. Each of these three species is also very sensitive to environmental degradation. Only four round gobies were collected at this site.

Road/Stream Crossing Survey

A formal road stream-crossing inventory was not completed in the development of this WMP. An inventory is recommended in Chapter 10.

Farm Animal Survey

Results of the windshield survey conducted in this subwatershed indicate that there are at least 40 locations that house large animals including cattle and horses. A total of 385 large animals were counted, but, because several of these facilities house animals indoors, an accurate count was not possible. The largest farm appeared to be a dairy with approximately 100 head. The average number of animals per farm, excluding this one farm, is just over seven. MST testing indicated equine, bovine, and canine DNA markers were in the water (2016). Social survey results indicated there are actually more than 1,252 animals in the entire RCW, excluding homes with one to three horses on less than ten acres. Farmers reported owning anywhere from 2-359 livestock animals. Details of the results of the survey are included in Chapter 8.

A few sites were noted that appear to be sources of pollution, including a horse manure pile located on a slope near a drain, a site with bank erosion, and an eroded gully running through a pasture. Details about these sites are included in Chapter 10.

Figure 4.1 displays wet weather *E. coli* data, agricultural land use, MST data, animal farm operation data collected during the windshield survey, and CAFO locations.

Neighborhood Source Assessment

Four NSAs were conducted to characterize residential areas and to identify pollutants of concern in these areas. Data were collected from downtown Byron Center, near Merton SW and 84th St. SW, Amber Creek Neighborhood, Byron Shores Neighborhood, and Pleasant Valley using a methodology developed by the Center for Watershed Protection (2005).

The single-family neighborhood in Byron Center is older and well established. Approximately half of the lot was impervious, and just less than half of the lot was covered with grass. Lawns do not appear to receive excessive fertilizer and no permanent irrigation systems were noted. There is junk or trash in the yards and the majority of driveways are paved, but are in mixed condition. Some are clean, some dirty and stained, and some are breaking up. The neighborhood has paved roads but no curb and gutter and no sidewalks in the residential neighborhood. The majority of downspouts appeared to be directed towards impervious surfaces, some appeared to discharge to pervious areas, and few appeared to be connected to storm or sanitary sewer. One rain barrel was spotted in this neighborhood. The area had stormsewers, though the inlets were not stenciled to indicate their connection to the stream. Approximately 80% of the storm drains appeared clean and the other 20% appeared dirty. There was no open space or stormwater pond visible. Oil and grease and sediment were the likeliest NPS pollutants. There appeared to be potential for rain barrels and street sweeping.

The “Amber Creek” neighborhood, near downtown Byron Center, has multifamily units that appear to be around 20 years old. The neighborhood appears to have a Homeowners Association. A majority of the lots are impervious surfaces, and approximately a quarter of the lot surface is grass/lawn. The driveways and streets are impervious surfaces, and appeared clean. The neighborhood does not have curb and gutter, but is serviced by stormsewer. Inlets are not stenciled to indicate their connection to the streams. The neighborhood had open space and a stormwater pond. Downspouts in the neighborhood connect to a mix of stormdrains, impervious surfaces, and pervious surfaces. Dog waste bags were available in the community. Nutrients, sediment, and excess runoff appear to be the likeliest major pollutants in the neighborhood. One company likely manages the lawn care. There appears to be potential for improvements in lawn maintenance practices and reducing and slowing down the stormwater runoff. There was an active development site north of Amber Creek that had inadequate erosion control practices.

The “Byron Shores” neighborhood is a newer neighborhood with single-family homes on small lots. Approximately half of each of the lots is impervious, and the remainder is grassy lawns, trees, and landscaped areas. The lawns appear highly maintained and likely receiving fertilizer, herbicide, and pesticide treatments. The streets and driveways are paved, and there are sidewalks on both sides of the street approximately ten feet from the street. These surfaces are generally clean, with some lawn clippings on them and the storm drain inlets, and some nonpervious surfaces receiving non-target irrigation. Curb and gutter line the streets, and some of the storm drains are stenciled to indicate their connection with the stream. Some downspouts appear to be connected to the storm or sanitary sewer, while others are directed onto nonpervious surfaces. The neighborhood includes a lake, though no buffers were present along the lake. Nutrients, herbicide and pesticides appear to be the most likely pollutants. Recommended BMPs include buffers or native plants along the lake, the addition of trees, rain gardens or rain barrels, improved lawn maintenance and irrigation practices and the disconnection of storm sewers from the stormsewer. With the exception of the lake, many neighborhoods similar to this neighborhood were noted during the windshield survey, including Georgetown Shores, Railside West, Meadows, North, and Indian Rails. Similar BMPs are recommended in these neighborhoods.

Nearby “Byron Shores”, the “Pleasant Valley” neighborhood of single-family homes on approximately half-acre lots was also surveyed. The majority of each of the lots was highly maintained grass lawn receiving irrigation. The streets and driveways were paved and sidewalks were on both sides of the street, approximately 12 feet from the road. Though the surfaces were generally clean, they did receive some non-targeted irrigation and had lawn clippings left on them. About half of the downspouts appeared to be connected to the storm sewer, most others appeared to drain onto pervious surfaces, and some drained onto pervious surfaces. Storm drain inlets were not stenciled to indicate their connection to the creek, and some were dirty. The neighborhood encircles Pleasant Pond or Vansingel Lake Drive. No riparian buffer surrounds the lake. The most likely pollutants appear to be nutrients, herbicides, and pesticides, and excessive stormwater entering the stormsewer system from connected gutters. Recommended BMPs include buffers or native plants along the lake, the addition of trees, rain gardens or rain barrels, improved lawn maintenance and irrigation practices, including proper placement of lawn clippings, and the disconnection of storm sewers from the stormsewer.

Sediment/HIT

According to the HIT model, the East Branch Rush Creek subwatershed contributes 0.121 tons of sediment/acre/year (MSU IWR, 2009). An estimated 2,194 tons of sediment enters the waterways each year from overland sources in this subwatershed. The HIT model estimates of sediment being contributed to the RCW from overland erosion are shown in Figure 3.8. The HIT model displays most sedimentation originating from agricultural fields in the headwaters of the southwestern portion of the subwatershed.

The natural channel of Rush Creek was modified during the construction of I-196. Culverts beneath I-196 were installed essentially perpendicular to the expressway, which required creek dredging and lining of the banks with concrete to facilitate, in some cases, a 90-degree change in direction of the Rush Creek channel. The result of the altered channel over time is readily apparent along I-196 near Kenowa Avenue where three, 12-foot diameter culverts were installed beneath the expressway. One of the three culverts is only functional during extreme high flows (i.e. 5+ feet higher than normal base flow) due to natural deposition of sediment along the inside bend of the altered channel. The culvert is essentially blocked with over four feet of sediment and trees that have grown in the deposited sediment. The decrease in culvert capacity has led to flood events and sediment deposition upstream of the I-196 crossing near Kenowa, as confirmed by an observed 50% reduction in the channel width and a over three foot increase in the surrounding floodplain elevation since I-196 construction. This location is near the most downstream part of East Branch Subwatershed, and sediment deposited in this location has eroded from land further upstream. The OCWRC recommended storage and sediment reduction improvements upstream of this location to fix the problem, including two stage ditches and remediating erosion contributions from fallen ash trees (OCWRC, personal communication, January 5, 2018).

No large-scale dredging projects have been completed by the OCWRCs office, rather obstructions are removed as they are reported problematic (OCWRC Linda Brown, personal communication July 18, 2017).

Water Chemistry/*E. coli*

MDEQ (2003) analyzed water samples from the East Branch at Barry Road. Water quality parameters were found to be below the average regional values and no exceedances of WQC were found. It was speculated that the better water quality in the East Branch (as compared to Rush Creek) was a reflection of differences in land use.

Water temperature monitoring conducted in 2016 found average July temperatures ranging from 63.1 to 69.3 degrees (cool to coldwater range). The average July 2017 water temperature collected at one site (3 RCT) was 68.61 degrees F (cool).

The best tree cover remains along waterways in East Branch Subwatershed, Kent County (Kent County Drain Commissioner (KCDC), personal communication, December 7, 2017).

The Bliss Drain was sampled at Kenowa Ave. (Site 3RCT), and had a 30-day *E. coli* geomean of 1,178 CFU/100 mL, which is well above the 130 CFU/100 mL TBC WQC. Weekly geomeans exceeded the TBC WQC all five weeks sampled and exceeded the PBC WQC one week. Geomeans ranged from 445 to 16,641 CFU/100 mL (2016).

The Knight Drain was sampled at 64th St. (Site 4RCT) after two wet weather and two dry weather events in 2016-2017. The highest *E. coli* geomeans were measured following wet weather events. Wet weather geomeans were well above the PBC WQC (4,300 and 2,100 CFU/100 mL). Dry weather geomeans exceeded the TBC WQC (530 and 630 CFU/100 mL).

The Bliss Drain of the East Branch Rush Creek subwatershed was sampled at Ransom Street (Site 5RCT) after two wet weather and two dry weather events in 2016-2017. The highest *E. coli* geomeans were measured following wet weather events. Both wet weather geomeans were well above the PBC WQC (7,500 and 4,600 CFU/100 mL). Dry weather geomeans exceeded the PBC WQC on one date and exceeded the TBC WQC on both dates (940 and 1,400 CFU/100 mL).

The Rush Creek Jamestown Branch was sampled at Quincy Street (Site 6RCT) after two wet weather and two dry weather events in 2016-2017. Both wet weather geomeans were well above the PBC WQC (7,200 and 4,800 CFU/100 mL). Dry weather geomeans both exceeded the TBC WQC (530 and 540 CFU/100 mL).

Qualitative DNA source tracking at five locations in the East Branch RCW found bovine, canine, and equine markers present at sampling site EB-8 located on Bliss Creek; bovine and equine markers present at site EB-13 located on Rush Creek-Jamestown Branch; an equine marker present at site EB-20 located on an unnamed tributary; and bovine markers present at sites EB-21 on an unnamed tributary and EB-28 on Homerich Drain. At these sites, testing was not conducted for other host sources. These positive results indicate that the host sources contributed to fecal contamination at the time of the sample collection (Helix, 2017), and are assumed to be a prevalent source of fecal contamination to the watershed.

Quantitative comparative DNA source tracking was analyzed at two sample sites. At sample site EB-8 on Bliss Creek, the canine host source was detected in the lowest quantities and bovine host sources were detected in the highest quantities. There was approximately 2,106 times more of the bovine DNA source detected as compared to the canine source. There was approximately 25 times more of the human DNA source detected as compared to the canine source, and approximately five times more of the equine source detected as compared to the canine source. At sample site EB-21 on an unnamed tributary, the human host source was detected in lower quantities as compared to the bovine source.

There was approximately 179 times more of the bovine source detected as compared to the human source. Though it should be noted that the human source water sample was collected on a different date than the water samples measuring the other host sources.

Canine scent tracking was used to screen samples collected from 14 sites for the presence of human wastewater contamination on two sampling dates in 2016. Three canines were used in the testing. Where no canines alert to the presence of human wastewater, it is unlikely that human wastewater is present, where one or two canines alerted to the presence of human wastewater, indicating human *E. coli* may be a probable contributing source if high concentrations of *E. coli* are present and; where three canines alerted to the presence of human wastewater, and high *E. coli* concentrations were measures, it is most likely that the presence of human wastewater is a significant source. Results are shown in Table 3.4. Canines did not alert to the presence of human wastewater contamination at seven sites, one canine alerted to the presence of human wastewater contamination at six sites, two canines alerted to the presence of human wastewater contamination at two sites, and three canines alerted to the presence of human wastewater contamination at one site.

Qualitative DNA source tracking at 12 sample locations tested on two dates in 2016 found human markers present at all sites tested, which include sample numbers: EB-3, EB-5, EB-8, EB-13, EB-15, EB-20, EB-21, EB-25, EB-28, EB-30, EB-32, EB-34 shown in Figure 4.2.

The bathroom near the road at Railside Golf Course should be investigated. Canine scent screening did not identify the presence of human source bacteria upstream, but did identify the presence of human source immediately downstream of the restroom building.

One resident suspected unpermitted bathrooms are contributing bacteria to the watershed at a business located on the south side of Ransom St. and west of Prices Place (September 18, 2017).

TSS values were below the target value of 30 mg/L at all sites after dry weather sampling events, but the majority of sampling locations were above the comparison values after the two wet weather sampling events. The Rush Creek Jamestown Branch was sampled at Kenowa Ave (Site 6) and was tied for the highest TSS concentration within both of the subwatersheds after a wet weather event. The Bliss Drain within the East Branch of the Rush Creek subwatershed sampled at Ivanrest (Site 5), measuring the sediment from the south central portion of the East Branch Rush Creek subwatershed, had the second highest TSS concentration of the subwatershed.

Figure 4.2 displays *E. coli* data, human canine and MST data, biosolids spreading locations, land use and sanitary sewer system boundaries.

<u>Wetlands/Floodplains</u>

Where significant flooding has occurred on Bliss Creek, at 44th Ave. and Kenowa, the Intercounty Drain Board has installed sediment basins and evaluated a regional detention facility. The regional detention facility is again under evaluation by the Intercounty Drain Board. A Preliminary Engineering Report was completed to evaluate “hydraulic conditions and alternatives to reduce depth, duration, and frequency of flooding along a portion of the Bliss Creek Intercounty Drain between 84th Street and 1,500 feet downstream of the southerly Wilson Road crossing” in December 2016 (Spicer Group, p. 16, 2016).

There are approximately 1,277 acres of wetlands in the East Branch subwatershed. Approximately 65% of the historic wetlands have been lost in this subwatershed. The majority (56%) of the wetlands existing in the RCW are in the East Branch subwatershed.

Potential Conservation Areas

Most of the wetlands remaining in the RCW are in the East Branch subwatershed. Due to the magnitude of wetland loss across the RCW to date, any existing wetlands should be considered a priority for preservation.

Protected Lands

Ottawa County has one protected park in this subwatershed, displayed on Figure 2.14 There are two golf courses in the subwatershed, Railside and Ironwood.

Government Jurisdictions

Georgetown, Jamestown, and Byron Townships and the Cities of Grandville and Wyoming are located in the East Branch of Rush Creek subwatershed. The subwatershed is located in both Kent and Ottawa Counties.

Nonpoint Source Assessment

Of note in this watershed are four greenhouses (Figure 4.3), and a small area of muck farming north of Byron Center.

One stakeholder reported that homes in the heart of Jamestown Township being connected to on-site septic tanks for the disposal of solids, and the sanitary sewer system for the treatment of sewage liquids (meeting, August 22, 2017).

Dams

No flood control structures are located in this subwatershed.

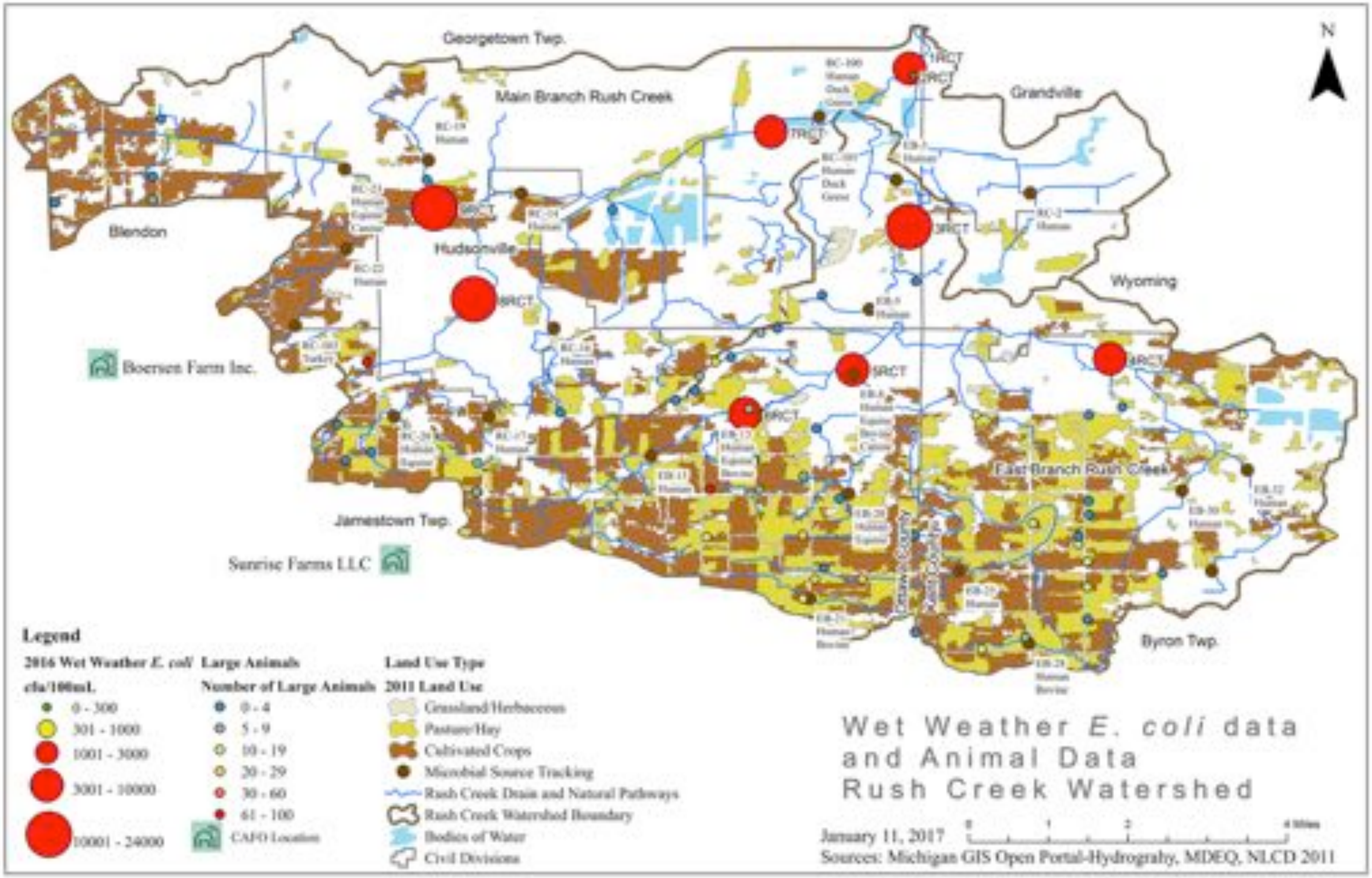

Figure 4.1 Wet Weather *E. coli* and Animal Data

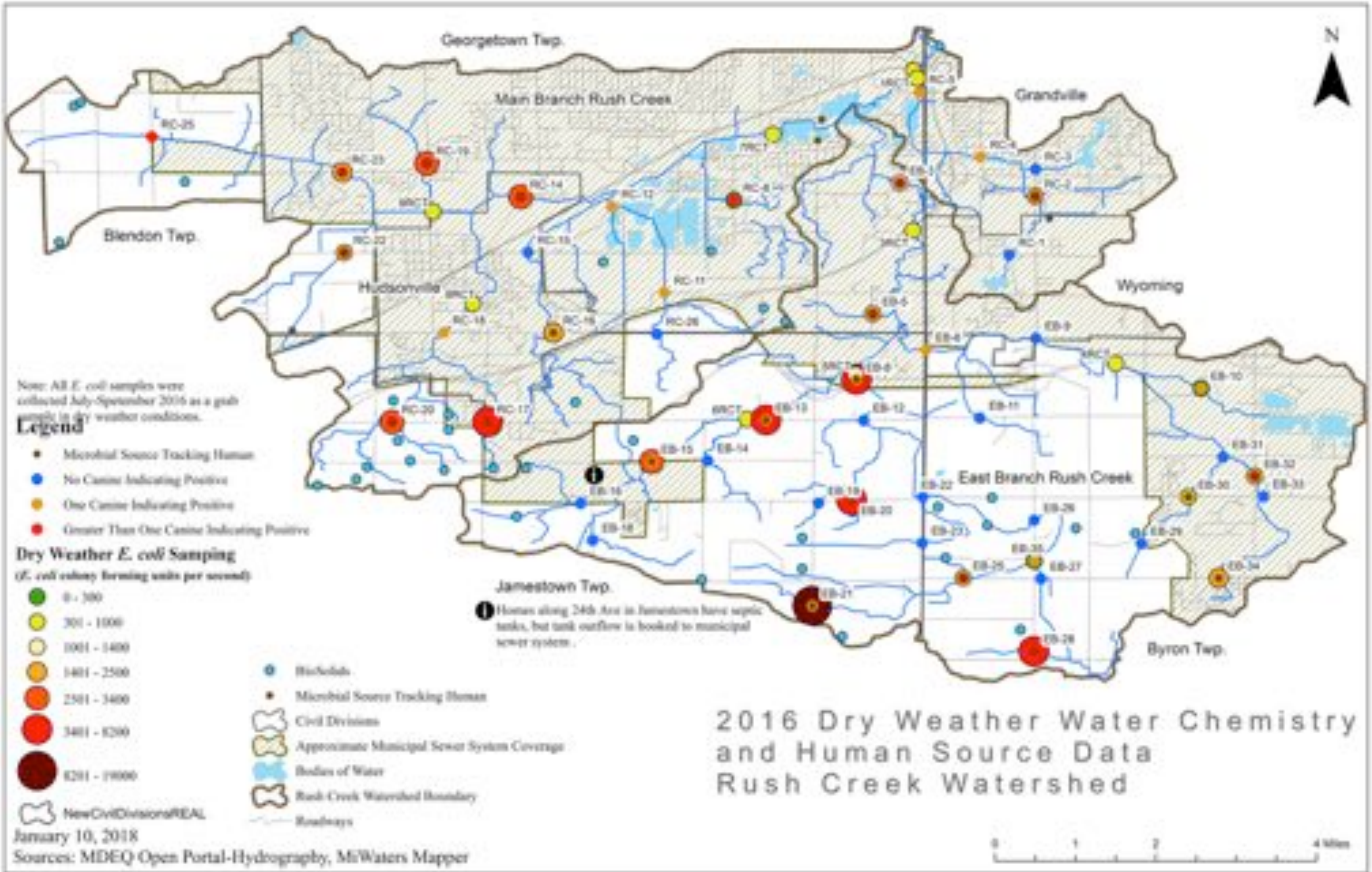

Figure 4.2 Dry Weather Water Chemistry and Human Source Data

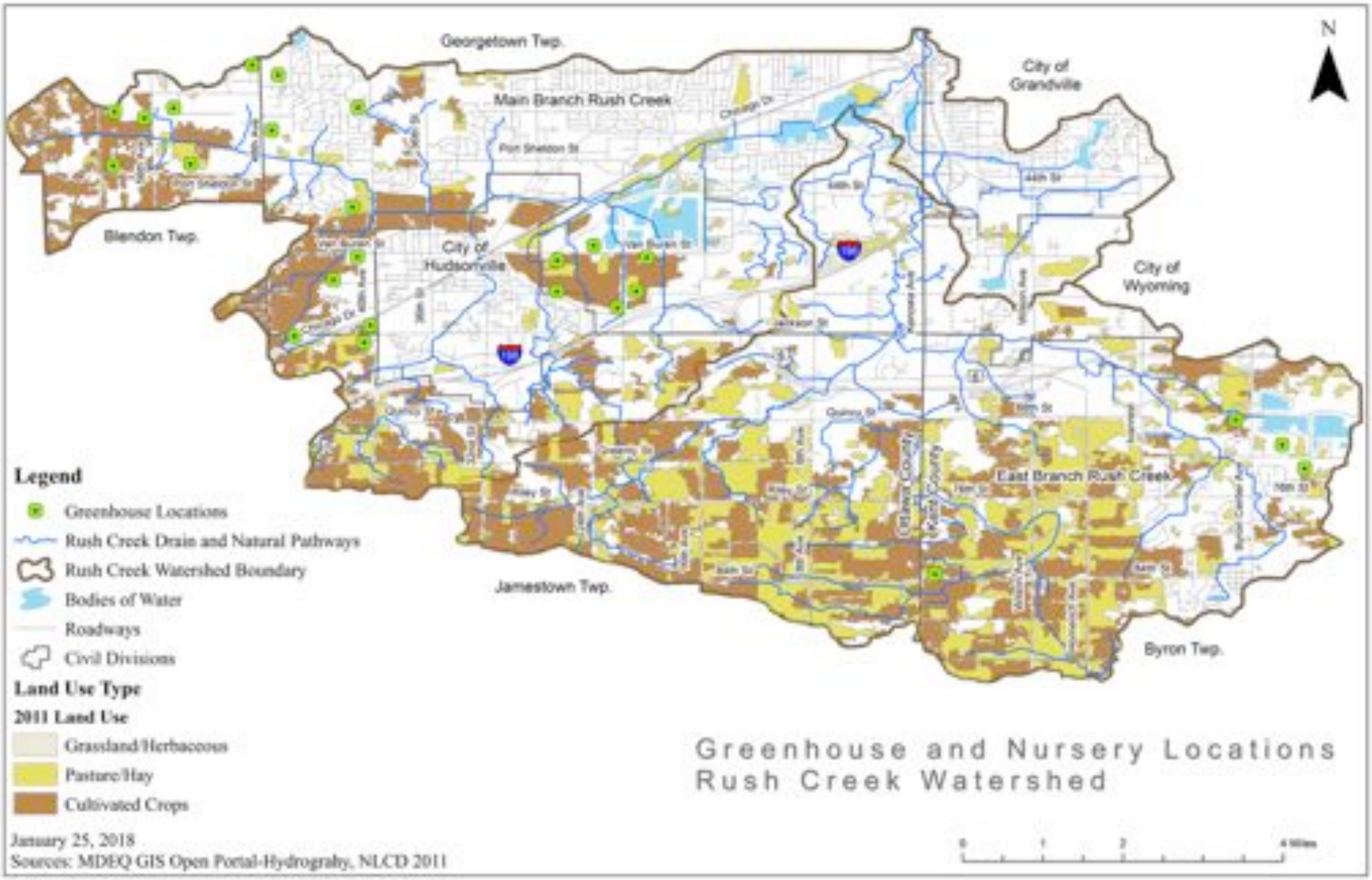

Figure 4.3 Greenhouse and Nursery Locations

5.0 GOALS AND OBJECTIVES

5.1 Goals for the Rush Creek Watershed

The RCW Management Team set out to develop a WMP that is readable, understandable and useful for local municipalities, organizations and communities to work individually or through collaborative efforts toward protection and improvement of the RCW. This chapter describes the goals and objectives of this WMP, based upon what we currently know about the RCW including the information obtained, collected, analyzed and described in Chapters 1 through 4.

The goals of this WMP are to:

1. Provide the direction necessary to restore water quality in impaired waters, so that the designated uses of total and partial body contact recreation are being met.
2. Maintain designated uses that are currently being met by identifying the sources and causes of pollution that have potential to degrade water quality and threaten the designated uses; make recommendations for managing these pollutants.
3. Develop a plan that maximizes the water quality, natural ecosystem functions, habitat, and aesthetics of the watershed.
4. Manage the watershed to minimize the impact of flashiness and other pollutants caused by development and land use practices while supporting the desired land use activities.
5. Implement targeted education and action plans for the watershed's residents related to the pollutants, sources, and causes of the watershed that lead to land management changes resulting in improved water quality.
6. Strengthen partnerships with local municipalities and organizations.

5.2 Objectives to Meet the Watershed Goals

The following objectives are presented as steps to help achieve the WMP goals. Recommendations in Chapter 10 and Tables in Chapter 8, and in Appendix G directly address the actions needed to make progress towards the goals and objectives listed. Monitoring and evaluating progress towards the goals and objectives is an important component that is described in Chapter 11.

Goal 1: Provide the direction necessary to restore water quality in impaired waters, so that the designated uses of total and partial body contact recreation are being met.

Goal 1 corresponding objectives:

a. Prioritize the sources and causes of pollutant impairments to the RCW *(completed as a part of this WMP)*.
b. Recommend BMPs to reduce the concentration and volume of pollutant inputs to Rush Creek and its tributaries *(completed as a part of this WMP)*.
c. Encourage use of existing technical support to increase BMP implementation in key areas *(included as a recommendation in this WMP, and requires implementation).*
d. Provide clear direction on priorities and action items necessary to improve water quality *(completed as a part of this WMP)*.
e. Identify partnering municipalities, organizations and stakeholders; encourage communication and collaboration *(begun as a part of this WMP, and requires continued implementation).*

f. Develop and implement an Information and Education (I/E) campaign to target audiences, including landowners, agricultural producers, local governments, riparians and other stakeholders *(included as a recommendation in this WMP, and requires implementation).*
g. Manage Rush Creek so that it is accessible to kayakers *(included as a recommendation in this WMP, and requires implementation).*

Goal 2: Maintain designated uses that are currently being met by identifying the sources and causes of pollution that have potential to degrade water quality and threaten the designated uses; make recommendations for managing these pollutants.

Goal 2 corresponding objectives:

a. Complete a WMP that includes the "nine elements", as required by the US EPA *(completed as a part of this WMP)*.
b. Conduct watershed wide data collection of *E. coli*, flow, nutrient, and biological monitoring to determine extent of problem *(completed as a part of this WMP)*.
c. Complete a detailed inventory of land use and sediment pollution of both HUC-12 subwatersheds within RCW *(completed as a part of this WMP)*.
d. Complete a WMP that provides a level of detail sufficient for protection and improvement goals by local municipalities and other local organizations and citizens *(completed as a part of this WMP)*.
e. Prioritize the NPS pollutants of concern, along with their sources and causes *(completed as a part of this WMP)*.
f. Recommend BMPs for specific locations that will lead to pollutant reduction *(included as a recommendation in this WMP, and requires implementation)*.
g. Develop and implement an I/E campaign to target audiences, including landowners, agriculture, local governments, and other stakeholders *(included as a recommendation in this WMP, and requires implementation)*.
h. Identify key partnering organizations and stakeholders; encourage communication and collaboration *(begun as a part of this WMP, and requires continued implementation).*
h. Encourage use of existing technical support to increase BMP implementation *(included as a recommendation in this WMP, and requires implementation)*.
i. Increase the amount of properly managed, permanently protected land *(included as a recommendation in this WMP, and requires implementation)*.
j. Work with local governments to ensure that existing ordinances are being implemented properly and to develop sensible protection ordinances *(included as a recommendation in this WMP, and requires implementation)*.

Goal 3: Develop a plan that maximizes the water quality, natural ecosystem functions, habitat, and aesthetics of the watershed.

Goal 3 corresponding objectives:

a. Identify especially high quality areas in the watershed for protection *(completed as a part of this WMP)*.
b. Explore the potential for managing the East Branch as a coldwater fishery *(included as a recommendation in this WMP, and requires implementation)*.
c. Identify existing policies and policy gaps that support improved water quality and diverse native species, including policies of local municipalities *(completed as a part of this WMP)*.

d. Identify BMPs for the residential, agricultural, and municipal land uses of the watershed that improve water quality and help to achieve this goal *(included as a recommendation in this WMP, and requires implementation)*.
e. Identify partnering municipalities, organizations and stakeholders; encourage communication and collaboration *(begun as a part of this WMP, and requires continued implementation)*.
f. Complete a WMP with protection and improvement goals that local municipalities can use *(completed as a part of this WMP)*.

Goal 4 Manage the watershed to minimize the impact of flashiness and other pollutants caused by development and land use practices while supporting the desired land use activities.

Goal 4 corresponding objectives:

a. Encourage local governments to establish sustainable land use planning and management techniques for water quality protection *(included as a recommendation in this WMP, and requires implementation)*.
b. Include recommendations that will reduce the flashiness and related sediment loading of the watershed through the restoration of wetlands, buffers, and floodplains as well as the construction of rain gardens *(included as a recommendation in this WMP, and requires implementation)*.
c. Use the SIDMA survey results to develop and implement an I/E campaign to target audiences, including landowners, agriculture, local governments, and other stakeholders *(included as a recommendation in this WMP, and requires implementation)*.
d. Encourage use of existing technical support to increase BMP implementation in key areas *(included as a recommendation in this WMP, and requires implementation)*.

Goal 5 Implement targeted education and action plans for the watershed's residents related to the pollutants, sources, and causes of the watershed that lead to land management changes resulting in improved water quality.

Goal 5 corresponding objectives:

a. Identify target audiences for watershed messaging *(completed as a part of this WMP).*
b. Develop a plan that local organizations can use to make the target audience aware of the resources in their watershed, aware of the pollutants and causes of pollution in the watershed, and that their day-to-day activities can affect the quality of those resources. Develop a plan that local organizations can use to inform the target audiences of what actions and BMPs are recommended for them to adopted to reduce impacts *(included as a recommendation in this WMP, and requires implementation)*.
c. Further motivate the target audience to adopt and implement practices that will result in water quality improvements, with more detailed instruction, and further incentives *(included as a recommendation in this WMP, and requires implementation)*.
d. Incorporate watershed protection activities into local regulatory mechanisms, policies, land-use planning and land management decisions *(included as a recommendation in this WMP, and requires implementation)*.

Goal 6 Strengthen partnerships with local municipalities and organizations.

Goal 6 corresponding objectives:

a. Work with local municipalities on policy reviews *(begun as a part of this WMP, and requires continued implementation)*.
b. Work with local interested religious and educational organizations, including schools and churches *(begun as a part of this WMP, and requires continued implementation)*.
c. Write a WMP that is readable, understandable and useful for local municipalities, organizations and communities to work individually or through collaborative efforts toward protection and improvement of the RCW *(completed as a part of this WMP)*.

6.0 POLLUTANTS, SOURCES AND CAUSES

Based upon detailed information reviewed, collected and analyzed for this WMP, this chapter details the NPS pollutants of concern identified within the RCW, along with their sources and causes. The source of pollution is a general description of the original site or living organism discharging the pollution, while the cause describes the behavior at a particular location that allows the pollution to be discharged into the waterways.

The pollutants were categorized as to whether the pollutant was known, that is, confirmed and measured through laboratory data or field assessment; suspected, meaning observed or reported by a stakeholder but not measured; or potential, where conditions are suitable for the pollutant to exist. The causes of pollution were generally ranked in priority order, with known (k) causes taking priority, followed by suspected (s) and potential (p) causes. Altered flow regime (6.1.1) and *E. coli* (6.1.2) are both the number one priority pollutants. Within the suspected and potential causes of pollution rankings, the largest amounts of pollution the source was estimated to be contributing were ranked as the highest priority.

With knowledge of the sources and causes of the pollutants, a suite of BMPs is suggested to minimize each pollutant's impact on the watershed. BMPs are recommended at sites known, suspected, or potentially causing pollution. Pollutants, sources, and causes are tabulated in Appendix G.

6.1 Pollutants

6.1.1 Altered Flow Regime

An altered flow regime is ranked as the highest priority pollutant. A stream is a part of a river system. One function of the ditches, drains and streams is to carry stormwater runoff from the land. The various sizes, flows, and locations of a stream, its floodplains, wetlands, and river system also create diverse habitats and impact water quality. A diverse number of species live in aquatic environments, and aquatic species live in different parts of a river system at different parts of their life cycles. Changes to the natural flow regime affect the nutrients, habitat, temperature, natural flood cycle, and floodplain storage. An altered flow regime is, pointedly, destroying the natural function and ecosystem of the RCW, and for purposes of this WMP, is considered a Threat to water quality.

Source: Altered Hydrology (k)

Modifications to the RCW hydrology have increased the speed of water through the watershed, and have effectively increased the frequency, magnitude and duration of "flood" events. The RCW hydrology has been altered through various ways, including wetland loss, efficient agricultural drainage, impervious surfaces, and stormwater pipes, increasing the flashiness of the stream system. A flashy stream responds to rainfall by rising and falling quickly. Conversely, a stream that is not flashy would rise and fall less over a longer period of time for an equivalent rainfall and would typically derive more of its overall flow from groundwater.

Wetlands are especially important for flood control, groundwater recharge and erosion control, and they play a critical role in attenuating pollutant loads. When a wetland is destroyed, or its ability to function naturally is impacted, the free services that it provides are lost and it often requires great expense to replace it. For example, the loss of wetlands in an upper tributary of the watershed reduces the ability of the land to attenuate floods and the ability of the stream channel to function properly. Instead of being captured in low-lying areas and being released slowly, precipitation makes its way directly to the stream channel. Due to these changes, the duration, magnitude or frequency of storm flows increase, resulting in velocity and flow increases in the streams, and ultimately leads to increased streambank erosion and flood potential. Similar effects can be had when land uses change from a pervious use to an impervious use, thus altering the path of precipitation from percolation into to runoff. Flooding is exacerbated in downstream areas and can impact cropland or developed areas. The cost for lost crops, repairing streambanks and building floodwalls to protect cities can be in the millions of dollars. The RCW has lost approximately 84% of its historic wetlands. There are 2,290 acres of wetlands in the RCW, representing only 3% of the land surface.

Dams can alter the flow regime and are constructed for a variety of reasons including, farming, industry, wildlife, power, recreation, flood control and lake control. The dams typically have both benefits and drawbacks. Most dams in the RCW were constructed for flood and lake control. Road crossings over a stream can also alter the flow regime by forcing the flow to constrict through a culvert or multiple culverts.

Cause: Loss of Flood Storage

<u>Altered morphology and hydrology including loss of wetlands and floodplain and increased drainage (k) -</u> Modifications to the courses of waterways made for farming, residential, and commercial uses of land are common in the RCW. These modifications can cause the waterways to lose natural functions, to increase in flashy flows, change the nutrient cycling, or to change course through erosion. Hydrologic modifications that eliminate or disconnect floodplains or wetlands remove floodplain storage areas and collectively can ultimately change the floodplain elevation.

The loss of wetlands and floodplains can also cause an increase in sediment, *E. coli*, and nutrient loading within the stream since wetlands filter pollutants (i.e. sediment, *E. coli*, and nutrients). The LLWFA (MDEQ, 2013) identified a loss of 84% of wetlands in the RCW. The RCW is reported to have experienced flooding problems since the mid 1970s (MDNR, Menerey and Croskey, 1989). An analysis on the effects of reduced floodplain storage completed in 1989 determined "that the reduction in floodplain storage will result in increased flood stages and flood discharges", and more specifically that "on Rush Creek, upstream of 12th Avenue, compensating excavation will be required for fills that exceed 10 per cent of the storage volume available within the floodplain. Filling more than 10 per cent of the storage volume will result in measureable increase in the 100-year flood elevation, and could not be permitted under the State Floodplain Regulatory Authority (MDNR, Menerey and Croskey, p. 9, 1989)." Furthermore, the 100-year flood stages could rise between 0.5 and 2.5 feet due to increased flood discharges if the entire floodway fringe was filled without compensation (MDNR, Menerey and Croskey, 1989). Floodplain and wetlands restoration, ordinances, and conservation practices can be adopted in the RCW to prevent altered morphology and hydrology from causing watershed-wide impacts. Approximately 52%, approximately 63 stream miles of 120.5 total stream miles of the watershed are considered to be county drains.

Cause: Loss of Pervious surfaces

Rainwater that falls on the native landscape is absorbed by plants, infiltrates into the soil and groundwater, while the remaining fraction runs off the land and discharges directly into creeks and streams. The precipitation in native landscapes has a slower path to the watershed's creeks and uses natural systems to filter pollutants. However, a majority of rainwater that falls on impervious surfaces runs off of the surface, is less likely to infiltrate the soil or be absorbed by plants and trees, and reaches the creeks at a faster rate and in larger volume than rainwater that falls on native landscape. This runoff carries more pollutants.

Commercial and Residential Development (k)

Much of the RCW is a developing suburban area, with increased impervious areas. Beyond floodplain storage analysis, the 1989 floodplain storage report concluded “even if floodplain storage is not reduced, future urbanization could result in increased runoff potential, greater flood flows, and higher flood elevations (MDNR, Menerey and Croskey, p. 9, 1989).” Land use has changed from approximately 16 percent developed in 1992 to 51 percent developed in 2011 (Vogelmann, J.E., S.M. Howard, L. Yang, C. R. Larson, B. K. Wylie, and J. N. Van Driel, 2001 and Homer et. al, 2011). Agricultural land use changed from approximately 69 percent to 35 percent over that timespan. There was also a loss in wetland and forest land use from 1992 to 2011 (Vogelmann et. al., 2001, and Homer et. al., 2011). It should be noted that these land use changes only serve as estimates as they are derived from two different datasets and utilize different mapping technologies.

Ash tree disease, removal of trees and tree rows (k) – Trees intercept and infiltrate stormwater, curb soil erosion from wind, filter pollutants, and help to cool the surface water. A deciduous tree can intercept 500-760 gallons of water per year, while a mature evergreen can intercept more than 4,000 gallons per year (Cotrone, 2017). The removal of trees and tree-fence rows increases the amount of precipitation running off the land as opposed to being intercepted, increasing flashy flows and surface water temperatures. It also increases the exposure to erosion from the wind previously protected by the windbreak. Trees along road corridors also help snow and ice from impairing roadway conditions.

Trees have been cleared from many areas of the RCW for agriculture and land development, which make up 86% of the current land use (Homer et. al, 2015). Additionally, many ash trees have died recently from the emerald ash borer and other diseases. The best tree cover remains along waterways in East Branch Subwatershed, Kent County (KCDC, personal communication, December 7, 2017).

Direct connection of gutters to stormsewer (k) – The NSA found the direct connection of gutters to stormsewer is a common practice in the watershed. This direct connection of runoff from roofs to the stormsewer diverts stormwater from infiltrating into the soil and instead into stormdrains, increasing the flashiness of the creeks. There are an estimated 21,027 households in the RCW. During the NSA, downspouts were not connected to the storm sewer at all in some neighborhoods, and in other neighborhoods were connected to the storm sewer in up to half of the homes. We estimate that 25% of the homes in the RCW, or 5,257 homes, could be connected directly to the stormsewer.

Cause: Stream channel alterations

Perched or undersized culverts at Road/Stream Crossings (k, s)- Stream and road crossings force drains, creeks, streams, and rivers to flow under a constructed road or driveway and through a culvert, set of culverts, or a bridge. The streambanks, streambed, and velocity can be altered in the process. Culverts that are not sized appropriately or are installed at an incorrect slope or elevation alter the hydrology of the stream. Modifications to the natural channel path to facilitate the installation of road crossings will also alter the stream hydrology even when the culverts are properly designed and installed. This altered hydrology can cause sediment build-up, erosion, pools, or can serve as an impediment to fish passage.

Several undersized and/or perched culverts were noted as a problem throughout the RCW, at public road crossings and private driveways, though not all were inventoried in this study. A more detailed inventory is recommended.

The natural channel of Rush Creek was modified during the construction of I-196. Culverts beneath I-196 were installed essentially perpendicular to the expressway, which required creek dredging and lining of the banks with concrete to facilitate, in some cases, a 90-degree change in direction of the Rush Creek channel. The result of the altered channel over time is readily apparent along I-196 near Kenowa Avenue where three, 12-foot diameter culverts were installed beneath the expressway. One of the three culverts is only functional during extreme high flows (i.e. 5+ feet higher than normal base flow) due to natural deposition of sediment along the inside bend of the altered channel. The culvert is essentially blocked with over four feet of sediment and trees that have grown in the deposited sediment. The decrease in culvert capacity has also lead to flood events and sediment deposition upstream of the I-196 crossing near Kenowa, as confirmed by an observed 50% reduction in the channel width and at least a three foot increase in the surrounding floodplain elevation since I-196 construction. This site is frequently dredged by the OCWRC. Sediment reductions upstream, and a two-stage ditch with adjacent wetland plants, are recommended to help to alleviate this situation (OCWRC phone conversation, January 5, 2018).

<u>Beavers (k)-</u> Following the 2013 flood, there has been a large increase in the beaver population of the RCW, contributing to localized flooding. Reported beaver dams are managed by the OCWRC (telephone conversation January 5, 2018).

6.1.2 *E. coli*

E. coli pollution is a significant and widespread problem in the RCW, and is ranked as the second highest priority pollutant. Due to high *E. coli* concentrations the TBC and PBC designated uses are not being attained, human health is at risk when in contact with the surface water, and the Rush Creek- Main Branch and East Branch subwatersheds have been included in the proposed statewide TMDL (MDEQ, 2017a). Sampling data associated with this planning process is summarized in Tables 3.2, 3.3, and 3.4. The *E. coli* TBC WQC was exceeded in at least one sample at each sampling location tested. Michigan's 2016 Integrated Report (MDEQ, 2016 revised 2017) lists the AUID 040500060511 as not attaining the TBC designated use in 2016. East Branch Rush Creek is listed in Michigan's 2016 Integrated Report as "Not Assessed" for TBC and PBC. Information collected during this planning process clearly indicates that the entire RCW is contaminated with *E. coli* and should be considered Impaired.

Using bacterial source tracking and canine scent tracking, human bacterial sources were confirmed during this planning project and appears to be widespread in both the East Branch and Rush Creek subwatersheds. DNA markers for cattle (bovine), horses (equine), dogs (canine), were detected in the East Branch Rush Creek subwatershed, and duck, geese, canine and equine were detected in the Rush Creek subwatershed.

In the Draft State-wide TMDL, MDEQ found "exceedances of the *E. coli* WQS that occur during high flows are generally linked with rainfall events, such as surface runoff contaminated with fecal material, a flush of accumulated wildlife feces in runoff or storm sewers (regulated and unregulated), trash from the storm sewers or septic tank failures involving failing drainage fields that no longer percolate properly (surface failures). Exceedances that occur during low flows or dry conditions can generally be attributed to a constant source that is independent of the weather. Examples of constant sources include illicit connections (either directly to surface waters or to storm sewers), some types of on-site septic system failures, continuous NPDES discharges, groundwater contamination, and pasture animals with direct stream access. Groundwater contamination of surface water with *E. coli* can occur in areas where a high groundwater table overlaps with septic systems, or in areas where livestock or animal waste is allowed to accumulate in groundwater recharge areas (MDEQ, p. 21, 2017a)."

RCW data suggests that *E. coli* contamination is of concern during both dry and wet weather events. The highest levels of *E. coli* were measured after wet weather events, where TBC WQC were typically exceeded. The less stringent PBC WQC was typically exceeded during dry weather (the absence of rain events). As described above, pollution presence during certain weather can be indicative of the source of the pollution.

Source: Humans

Watersheds in Michigan with higher population density generally have higher *E. coli* in surface waters" (MDEQ, 2017a). Human sewage contains *E. coli* and was detected in both subwatersheds tested through canine scent tracking (Figure 4.2). Furthermore, human sources were confirmed through MST testing, where all locations tested positive. Twelve different locations in the East Branch, sampled on one of two different dates, tested positive for human bacterial sources, and ten locations in the Rush Creek subwatershed, sampled on one of two dates, tested positive for human bacterial sources. The way human waste is managed and treated can affect the chances of *E. coli* reaching surface water. Suspected and potential NPS causes of human *E. coli* contributions are listed below and ranked by the estimated relative size of the contribution.

Causes: Human E. coli Contributions

<u>Aging septic systems, improper installation and/or improper maintenance (k, s</u>) - Homes and businesses that are not connected to a private or municipal sewer are required to use on-site septic systems. These systems typically consist of underground tanks that lead to a drainage field, where wastewater percolates down through the soil. If these systems are not installed, maintained, or replaced properly, waste can leak or overflow into the surface water without proper treatment. Septic systems may fail if they are installed without proper consideration of their drainage abilities. Of specific concern are the systems installed at a high density and those located in poorly drained soils near surface waters. Natural Resource Conservation Service (NRCS) Septic Tank Absorption Fields Soil Survey maps for Kent and Ottawa Counties indicate that a majority of soils in the RCW are rated as having very limited suitability for septic fields (USDA NRCS, 2017). There is a higher groundwater table in Byron Center. Installation of traditional septic systems in these soils could result in human septage reaching the groundwater and surface water prior to treatment. In addition, of concern are sanitary connections that do not currently meet code, illicit septic connections to agricultural tile drains or illicit discharges directly to surface water. Historically, septic systems for several homes along a residential street in Jamestown Township were not equipped with drain fields. Instead, each residential septic tank was manifolded to a four-inch pipe that discharged directly to the Jamestown Branch of Rush Creek. Those septic tanks now connect to the sanitary sewer system. Similar illicit discharges may be ongoing given the general rural nature and relatively old age of some home in the East Branch subwatershed.

Recent research on Lower Michigan watersheds identifies septic systems as the primary driver of human sources of *E. coli* in watersheds. More specifically, the study found watersheds with more than 1,621 septic systems had significantly higher concentrations of human sources under baseflow conditions (Verhougstraete, Martin, Kendall, Hyndman, and Rose, 2015). When examined statewide, low-density development had a stronger correlation with high *E. coli* levels than higher density development (2017a, MDEQ). From these studies and RCW data, we can deduce that septic systems are contributing to *E. coli* concentrations in the surface water.

For this project we estimated the number of septic systems in the RCW using information collected from RCW municipalities. Sanitary sewer services much of the more developed areas of the RCW, though some individual homes and groups or neighborhoods of homes within the sanitary service areas utilize septic systems. Illicitly connected septic systems may be located in any area within the watershed, but are considered a point source of pollution.

Local knowledge at KCHD roughly estimates there are 400-450 homes with septic systems not connected to sanitary sewer service within the RCW in Kent County. Most homes in Kent County using septic systems are in low-density areas, west of Byron Center and South of M-6 (email communication, December 20, 2017).

Municipal sewer services are available to all of the City of Wyoming located within the RCW. However, it is unknown if every facility is connected to the sewer. It is estimated that few homes in the City of Wyoming within the RCW may still have a septic system. Due to their age, older homes on 52nd Street may potentially not be connected to the municipal sewer (City of Wyoming Communication, November 16, 2017).

The City of Grandville estimates there are no more than 15 homes with septic systems located within the RCW (City of Grandville communication, January 16, 2018).

Local governments in Ottawa County shared their estimates on the number of septic systems in their cities or townships, and many were not able to quantify how many are located in their boundaries.

Georgetown Township (which extends beyond the RCW) does not know how many properties in their townships utilize septic systems. However, they have over 300 properties with septic systems that are already being required to connect to nearby municipal sewer due to their proximity to sanitary service. There are some RCW neighborhoods in Georgetown Township without sanitary service access, including approximately 100 homes near Blair St. and Shady Oak. Georgetown Township has studied sanitary service installation and has adopted a plan to infill areas without sanitary service when road re-surfacing projects are due (Georgetown Township communication, January 9, 2018).

There are an estimated 10-15 homes with septic systems and access to sanitary sewer service in Hudsonville. Approximately half of those homes are expected to be connected to sanitary sewer as a part of a road and trail construction project planned for 2018-2019 (City of Hudsonville, personal communication, January 5, 2018).

Jamestown Township (which extends beyond the RCW) has 1,669 facilities with septic systems (tanks and drainfields). There are 164 homes with in the RCW that have a septic tank and also discharge to the sanitary sewer.

Blendon Township does not know how many septic systems are operating in their Township.

A community of approximately 12-15 homes located just outside of the RCW at 40th and Rylie St was reported as being suspected of having problems with sewage disposal due to the lot size and soil type of the area. Though the majority of this community is located outside of the RCW, some homes of this community may be on the border or just inside the RCW.

OCDPH requires a mandatory evaluation of septic systems at a home or business before the time of sale. Across all of Ottawa County (which extends far beyond the RCW), there are approximately 1,300 real estate inspections per year, approximately 25% of the well or septic systems inspected require a correction, and approximately 80-100 sites require a new septic system because the current septic system was determined to be failing (OCDPH personal communication, December 12, 2017). Failing septic systems that are identified through this program are required to be replaced. Septic systems that do not meet the current code do not have to be brought up to the current septic system code. Septic systems on small lots and installed in clay soils often fail (OCPHD Matt Allen, personal communication, December 12, 2017). A 10% failure rate is used in estimating septic failures for the RCW, which is estimated by MDEQ to be the statewide failure rate (MDEQ, 2017d). More developments in Ottawa County have water service but not sewer service (phone communication, December 8, 2017).

E. coli, canine, and MST data is further detailed in Chapters 4 and 10.

Combined Sewage Overflow (s)- Uncontrolled Combined sewage overflow (CSO), a combination of untreated or partially treated municipal sewage and stormwater, have historically impacted the Grand River from some upstream municipalities, such as the Cities of Lansing and Grand Rapids. The City of Grand Rapids has recently separated their storm sewer from sanitary sewer system, greatly reducing the risk of partially or untreated sewer being discharged into the Grand River. The upstream city of Lansing has not yet separated their sewer systems. The RCW is a tributary of the Grand River, discharging into the Grand River. However, at high flow times the Grand River water level also rises and temporarily flows into a portion of Rush Creek resulting in any CSO impacts from the Grand River impacting Rush Creek. These CSO impacts should be reduced, though specific recommendations for these sources are not addressed in this WMP.

Sanitary Sewer Overflow (k)- There are two permitted wastewater treatment plants located in the watershed, operated by the City of Grandville and Rush Creek Mobile Home Parks. There was one recent reported sanitary sewer overflow (SSO) (discharge of raw or inadequately treated sewage from municipal systems) to Rush Creek. There were many more reported SSOs upstream of Rush Creek in the Grand River Watershed (MDEQ, 2017c, accessed http://www.deq.state.mi.us/csosso/).

Municipal Stormwater (s)- Stormsewer pipes collect runoff from many of the developed areas in the RCW. Most of the stormsewer systems are regulated as point sources and subject to a Municipal Separate Storm Sewer Systems (MS4) Permit through the NPDES Program. Pollutants from NPSs, such as dog waste and illicit discharge, still enter the stormwater and ultimately the watershed. Pollutant sources contributing to MS4 discharges are individually and specifically identified in this WMP. More detail of the MS4 program is included in Chapter 9.

Over or improper application of biosolids (p) – Treated biosolids from wastewater treatment plants (WWTPs) is applied on land as fertilizer at approximately 33 sites, 20 sites in the Main Branch subwatershed, and 13 sites in the East Branch subwatershed. Biosolid applications are regulated by Residuals Management Programs; pathogens in biosolids are required to be significantly reduced, prior to land application (R 323.2418 of Part 24, Land Application of Biosolids, of the NREPA, 1994 PA 451, as amended. However, they remain a potential a source of *E. coli* in this watershed.

Aging Infrastructure (s)- Residents of Rushmore Lake, in Georgetown Township, reported a suspected broken sanitary sewer pipeline adjacent Rushmore Lake, as evidenced by water with high concentrations of *E. coli* seeping into Rushmore Lake along the southern shoreline. (Rushmore Lake Stakeholder Meeting, May 8, 2017). Other aging infrastructure has the potential to impact surface waters if not repaired and maintained. For example, canine scent screening did not identify the presence of human source bacteria upstream of the Railside Golf Course. However, positive canine responses were noted immediately downstream of a small building with restrooms at the golf course.

Source: Livestock

Livestock manure is a known source of *E. coli* and the way that it is managed can affect the chances of contaminating surface water. There are approximately 20.6 square miles, or 13,184 acres of agriculture land in the RCW. The RCW contains at least 53 large animal facilities with over 420 large animals seen during a survey of the watershed (Figure 4.1). Approximately 30 of these facilities had horses. Other animal facilities, including a turkey farm with fowl housed inside, were evident. These locations all require some degree of manure management and have the potential for improper storage and land application of manure.

Livestock data were also collected from the SIDMA survey. Of the approximately 60 farmers who responded to the survey, approximately 42 respondents (of approximately 60) have a total of 1,252 animals. The respondents collectively reported to have 303 dairy cattle (four farms), 679 beef cattle (18 farms), six longhorn cattle (one farm), four hogs (one farm), 50 poultry (five farms), 20 sheep (one farm), 13 goats (two farms) and 86 horses (ten farms). This survey did not include farms that have only a few horses (the windshield survey estimated that there are approximately 16 farms with one to three horses).

Two CAFOs are located outside and in close proximity of the watershed boundary, housing hogs and chickens. In 2016, the nearby chicken CAFO housed 2,053,500 (average) to 2,054,000 (maximum) chickens for laying eggs, and an additional an additional 525,000 (average) to 526,000 (maximum) pullets. An estimated 24,239 tons of solid waste was generated from the CAFO in 2016, all of which was transferred off-site. The solid waste is stored on-site in roofed storage buildings with a capacity of 3,527,400 cubic feet. A portion of the generated waste may be periodically applied as fertilizer to the chicken CAFO's 1,459 acres of land. It is likely that much of the waste from this facility was transported and spread on other agricultural properties within the RCW. The hog CAFO near the watershed boundary reported an average of 10,000 hogs and a maximum of 10,180 hogs, producing an estimated 1,733,000 gallons of waste. In 2015, none of this waste was manifested for off-site disposal, but instead was reportedly applied to a portion of the 1,874 acres are available at the farm for land application (MDEQ, 2016a).

It is assumed that these facilities represent a broad spectrum of practices, ranging from protective of water quality to egregious and negatively impacting water quality. It cannot be overstated that many of these farms abide by acceptable standards or have approved manure management plans. However, MST in the RCW has confirmed the presence of bacteria from cattle and horses in the surface water through microbial source testing, thus, all farms are considered to be, at least, a potential source. Further, because so many programs are available for technical or financial assistance, it is becoming more and more difficult to justify poor practices.

Livestock causes of *E. coli* contributions are listed below and ranked by the relative estimated size of the contribution.

When statistically examined statewide, the amount of agriculture in a watershed had a stronger correlation with *E. coli* than the amount of developed land (MDEQ, 2017a).

Causes: Livestock E. coli Contributions

<u>Improper application of manure (s)</u> - Livestock manure is typically spread on cropland for use as fertilizer. The soil conditions, spreading rate, weather, proximity to surface water, buffer, tile and overland drainage all affect the runoff path of manure and associated *E. coli*. Based on the prevalence of cropland in the watershed and land use observations noted during the windshield survey, it is suspected

that the over or improper application of manure is a major contributing cause of *E. coli* contamination in the RCW. Figure 4.1 displays agriculture land use and thus where manure spreading may likely occur.

Livestock holding facilities and washwater (k and s) - Holding facilities concentrate livestock feed and manure, and therefore *E. coli*, in an area. When the facilities are adjacent to a waterway, these nutrients can enter the waterway through runoff. This is a potential source since many holding facilities inventoried in the watershed during the windshield survey are proximate to surface waters. The RCW contains an estimated 53 large animal facilities. Each location houses at least one large animal, with a total of approximately 269 cattle, 144 horses and seven other large animals seen during a survey of the watershed (Figures 4.1). A few animal facilities were evident, but animals were not visible outside during the survey. One turkey farm with fowl housed inside was also noted in the Rush Creek Main Branch subwatershed.

Unrestricted livestock access to stream (k)– Using streams as a source of drinking water for livestock was, once, a common practice. However, unrestricted livestock access to a stream results in livestock waste being directly discharged into water, trampled streambanks, and ultimately streambank erosion and sediment input. Today, with several alternatives available for watering livestock and/or excluding them from surface water, many of which can be at least partially funded by government sources, direct stream access is much less common and unnecessary. A farming operation was observed in the RCW that appeared to allow livestock access to a stream or surface water with connection to a stream, while two other farming operations were noted where pastures ran adjacent to a drainage ditch or headwater streams. The specific location with noted unrestricted livestock access is listed in Chapter 10.

Improper storage of manure (k, s, p) – Whether it is left in place or stored and spread, livestock manure requires proper handling and management. For example, Michigan's generally accepted agricultural management practices (GAAMPs) specify manure storage at least 50 feet from a property line, at least 150 feet from a non-farm home, at least 150 feet from surface water, and in such a way that runoff from the manure storage does not enter into surface water or neighboring properties. An appropriate coverage and barrier beneath the manure is also a requirement (Michigan Department of Agriculture and Rural Development [MDARD], 2014). Improper storage and handling of manure poses a risk of impacting both surface and ground water. At least one site was noted during the windshield survey of improper storage of manure, shown in Chapter 10.

Manifested CAFO-manure land spreading resulting in over or improper application of manure (s) - CAFOs are home to a large number of livestock, and, thus, produce a large volume of manure.

Waste from CAFOs is managed and spread on the property of the CAFOs, who are permitted and managed under NPDES permits, and are addressed as point sources through the permit, rather than as non-point sources. As previously mentioned, there are no CAFOs within the RCW. However, CAFO waste can also be manifested to other facilities within the RCW to be spread as fertilizer. The use of that waste by non-CAFO operations is not regulated. Due to the cost of transportation, we assume the majority of it is land applied in the vicinity of the CAFO. However, the exact location where this waste is applied, or if it is stored and applied using acceptable practices, is unknown. Due to the mass of waste from CAFOs manifested near the RCW (over 24,000 tons of chicken waste reported manifested in 2016, [MDEQ, 2016a]) it is suspected that the over or improper application of manure manifested from CAFOs is a contributing cause of *E. coli* contamination, though poultry MST was not completed as a part of this process.

Source: Pets

Pet waste is a source of *E. coli*. Dogs and cats are the most common "household" pets. Household and feral populations of cats and dogs were not estimated. However, the American Veterinary Medical Association data estimate that 36.5 percent of households have 1.6 dogs each (AVMA, 2012). Assuming these estimates, there would be approximately 12,112 dogs in the RCW. The way the dog waste is managed can affect the chances of *E. coli* from the waste reaching the surface water. Domesticated cat waste is more typically disposed of in litter boxes and ultimately in landfills.

Causes: Pet E. coli Contributions

<u>Dog waste not picked up (s)</u> - Dog waste is often left in place on the ground or collected. It is not treated nor spread and used as fertilizer. Collection of dog waste from the ground can help prevent runoff from transporting *E. coli* bacteria present in the waste to the surface water. Picking up dog waste is considered particularly important in the more developed portions of the watershed where the concentration of dogs is expected to be higher and the drainage systems are denser, resulting in a reduced likelihood of the dog waste filtering through vegetation.

One canine boarding facility was noted during the windshield survey, though their waste management practices are unknown.

Source: Wildlife (k)

Wildlife is considered a source of *E. coli* in this watershed and was confirmed through bacterial source tracking. DNA markers for ducks and geese were confirmed in the Rush Creek Main Branch subwatershed and would be expected throughout the RCW. In both sites tested, there was quantitatively more duck waste than geese waste. At one site of the two sites there was more human waste than duck waste, and at the second site, there was more duck waste than human waste. Populations were not counted or estimated as they tend to be ubiquitous among land uses, and are managed by the MDNR and are less manageable through a WMP. However, causes of wildlife *E. coli* contributions that watershed management could help reduce *E. coli* concentrations and are reviewed here.

Causes: Wildlife E. coli Contributions

<u>Riparian management practices that encourage or attract wildlife (k)</u> - Manicured grass in the riparian zone and sandy beaches can attract waterfowl. The populated lakes in the RCW typically maintain landscapes or sandy beaches to the edge of water, to some degree. The accumulation of waterfowl and the amount of fecal waste reaching the surface water can be controlled. Though no specific locations were noted where waterfowl were being fed, it is a practice often seen in suburban areas. The feeding of waterfowl and other wildlife leads to unnaturally high concentrations of animals and should be discouraged

High habitation rates of Canada geese and other waterfowl were noted at three locations in the watershed (Rushmore Lake [RC-101], Georgetown Community Park [RC-100], Ponds near Rivertown Mall [RC-102]), listed in Chapter 10. Measured proportionally to human waste, Georgetown Park had higher concentrations of waterfowl waste, with duck, human, and geese contributions measured in that order. *E. coli* concentrations at this location, measured on only one date was 170 CFU/100 mL. In the sample collected at Rushmore Lake, measured proportionally to each other, the largest contributing source of bacteria was human, followed by duck and geese. *E. coli* concentrations at this location, measured on only one date was 10 CFU/100 mL. Other sources, such as farm animals and other wildlife were not measured at these sites. Though other residential lakes in the RCW were not sampled for *E. coli* and its sources, we can expect *E. coli* concentrations and sources them to be similar to the Rushmore Lake. Though many geese were spotted at the ponds near Rivertown Mall, the *E. coli* concentrations were measured at less than 10 CFU/100 mL, so no additional source tracking sampling was done at that site. Some local municipalities including KCDC and MDNR, operate programs to reduce waterfowl populations.

Municipal Stormwater- Stormsewer pipes collect runoff from many of the developed areas in the RCW. The stormsewer system can collect wildlife droppings from animals such as raccoon and coyote droppings. More detail of the MS4 program is included in Chapter 9, though these sources are not addressed in this WMP as they are considered less manageable than the other sources covered within the WMP.

6.1.3 Sediment

Sediment is ranked as the third highest priority pollutant. Many MDEQ and other biological reports attribute the degraded aquatic habitat to excess sedimentation of the streambed. Excessive fine sediment in a stream covers more desirable substrates that provide habitat values such as spawning areas for fish and attachment sites for aquatic insects. It can also lead to increased streambank erosion and altered morphology. TSS data were collected and most sites exceeded the TSS comparison value following the wet weather sampling events.

TSS concentrations following wet weather events were significantly higher than the TSS concentrations following dry weather events.

Source: Cropland

Cropland often has exposed soil that is at a higher risk of erosion. Most cropland goes through periods of time where vegetation is either not planted, not yet established, or not dense enough to prevent erosion. Eroded soils travel through runoff or wind to streams and rivers. Cropland causes of sediment contributions are listed below and ranked by the size of the contribution. There are approximately 20.6 square miles of cultivated land in the watershed (Homer et. al, 2015). Sample sites that drain land that is agricultural, fine-textured till and hilly had the highest wet weather TSS concentrations, validating the HIT model results. Figure 2.2 and 4.1 shows agricultural land in the RCW. Figure 3.8 displays results of HIT model, which estimates that nearly 3,458 tons of sediment per year is eroding into waterways from crop and agricultural land from sheet erosion. Areas with the greatest erosion are located in the south central and eastern portions of the RCW Figure 10.3.

There are an estimated 90 landowners in the RCW who are involved with farming or lease their properties for farming. These farms range in size from hobby farm to very large farming operations. This estimate includes horse farms greater than ten acres in size.

Causes: Cropland Sediment

Tillage practices (k) - Different tillage practices disturb the soils to different extents. Some practices leave the ground more susceptible to erosion through runoff by leaving bare soil or little crop residue in the soil. The NRCS recommends conservation tillage practices including no-till, mulch-till, and ridge-till (USDA NRCS, 2010).

Agriculture makes up 35% of the RCW's land use, and results of a tillage survey completed by the MDEQ in 2018 are included in Appendix F.

Cultivation of steep slopes or drainage ways (k) – Steep slopes have high soil erosion rates, and have increased velocity rates of runoff water on the slopes. Cultivation on these steep slopes, or likewise in drainage ways that have a intermittent or constant flow of water, disturbs the stability of these soils and become more susceptible to soil erosion. The NRCS recommends grassed waterways instead of cultivated waterways and contour farming on hillsides to stabilize the soils. Cultivation on steep slopes was prevalent in the southern headwaters of the East Branch Rush Creek subwatershed. Sample sites that drain land that is agricultural, fine-textured till and hilly had the highest wet weather TSS concentrations, validating the HIT model results.

Muck farming (k)- A ribbon of nutrient rich organic muck soil within the RCW that represents an ancient Grand River tributary floodplain has been converted into farmland (Figure 2.6). The groundwater table is especially high in areas with muck soils, thereby creating a faster connection between stormwater, groundwater and ultimately surface water if not drained properly. Muck soils are typically higher in nitrogen as compared to mineral soil. Windbreaks and ground cover are also needed to protect the nutrient rich soil from wind erosion (Silva, MSU-E, 2012). In the RCW, winter cover crops are less common for muck soils, and soil loss has become a large problem for the muck fields

Draining or filling of wetlands and floodplains (k)- There has been a loss of 84% of wetlands in the RCW. Many of these wetlands were lost to agricultural uses, where the affects are two-fold, first the loss of the ability for the wetlands to store sediment, and second additional sediment and increased runoff rates from the agricultural land use.

The practice of draining or filling wetlands was a widespread practice in the RCW, among other watersheds in Lower Michigan, and it contributes sediment to the surface waters.

Ash tree disease, removal of trees and tree rows (k, s) – Trees and tree rows act as a windbreak, and curb soil erosion from wind. The removal of the tree and fence rows allows soil erosion from wind to increase across the fields previously protected by the wind break. Trees also contribute to other watershed benefits, they help intercept rainwater, slowing its pathway to storm sewers, ditches, and natural cannels, ultimately, reducing flashy flows (Cotrone, 2017). Trees along road corridors also help snow and ice from impairing roadway conditions.

In addition, a large number of ash trees have died in the RCW, and across the eastern United States.

Source: Public and Private Roads

Historically, roads were built adjacent to streams (Anderson and Gesford, 2006), and can negatively impact the water quality of the streams. Most roads in the RCW are paved, nonpervious surfaces that collect sediment from nearby land erosion and vehicular traffic. Road/stream crossings, steep banks, and steep roadways near wetlands and waterways can be significant public road-related sources of sediment. Proper construction and maintenance of both paved and gravel roads can also reduce the rate of road-related sediment.

Causes: Paved/Gravel Road Sediment

Erosion by wind, rain, or traffic (k) - Sediment from roads is carried by wind, water, and traffic into roadside ditches, drains, wetlands, and ultimately into streams and rivers. The transport of road sediments into the drainage network is readily apparent during any precipitation event or snowmelt period. BMPs, such as well-timed street sweeping can minimize the impacts from erosion. Ottawa County Road Commission (OCRC) sweeps primary, local, and MDOT roads that have curb and gutter and enclosed storm sewer about once every year in the spring. In 2017, 210 miles of road were swept and 1,391 tons of materials were removed from the curb line (OCRC Jerry Olman, email communication, October 27, 2017). Major highways that traverse the RCW include I-196, M-6, and M-121 and often have their own MS4 permit.

A formal road and stream crossing survey was not conducted during this watershed management planning process, but some sites were noted to be carrying excessive sediment to the water include, and are listed but by no means limited to the locations listed in Chapter 10. Results of a 2003 survey were included in Chapter 4.1.

<u>Multiple Culvert or Perched or undersized culverts at Road/Stream Crossings (k)</u>- Stream and road crossings force drains, creeks, streams, and rivers to flow under a constructed road or driveway and through a culvert, set of culverts, or a bridge. The streambanks, streambed, and velocity can be altered in the process. Culverts that are not sized appropriately or are installed at an incorrect slope or elevation alter the hydrology of the stream. Modifications to the natural channel path to facilitate the installation of road crossings will also alter the stream hydrology even when the culverts are properly designed and installed. This altered hydrology can cause sediment build-up, erosion, pools, or can serve as an impediment to fish passage.

Several undersized culverts were noted as a problem throughout the RCW, at public road crossings and private driveways, though not all were inventoried in this study.

The natural channel of Rush Creek was modified during the construction of I-196. Culverts beneath I-196 were installed essentially perpendicular to the expressway, which required creek dredging and lining of the banks with concrete to facilitate, in some cases, a 90-degree change in direction of the Rush Creek channel. The result of the altered channel over time is readily apparent along I-196 near Kenowa Avenue where three, 12-foot diameter culverts were installed beneath the expressway. One of the three culverts is only functional during extreme high flows (i.e. five plus feet higher than normal base flow) due to natural deposition of sediment along the inside bend of the altered channel. The culvert is essentially blocked with four plus feet of sediment and trees that have grown in the deposited sediment. The decrease in culvert capacity has also lead to flood events and sediment deposition upstream of the I-196 crossing near Kenowa, as confirmed by an observed 50% reduction in the channel width and a three plus foot increase in the surrounding floodplain elevation since I-196 construction. The OCWRC recommended storage and sediment reduction improvements upstream of this location to fix the problem, including two stage ditches and remediating erosion contributions from fallen ash trees (OCWRC, personal communication, January 5, 2018). A study of the Corey Bishop Drain that there had been significant change in the elevation of the drain since the construction of I-196 (Eng. Engineering and Surveying, 2017).

Source: Developed Areas

Developed land allows sediment to collect and be conveyed into stormwater systems and into waterways at a quicker rate when compared to that of undeveloped land in its natural state. Approximately 51% of the RCW is developed land. The impervious surfaces and lack of vegetation that is associated with developed land causes flashy flows of runoff entering rivers. The majority of the watershed, including the cities of Hudsonville, Grandville, Wyoming and Jamestown, South Blendon, and Georgetown Townships is subject to MS4 permit requirements for the discharge of untreated stormwater into the RCW.

Causes: Sediment from Developed Land

Urban/Commercial/Industrial (s)- Sediment that collects on impervious surfaces in urban areas gets carried with runoff into roadside ditches and stormwater drains and ultimately streams, and rivers, without the benefit of filtration through pervious soils. Most of these areas are covered under municipal MS4 permits, and some industrial sites are covered under their own MS4 permit. A majority of the urban development in the watershed is concentrated in the Rush Creek Main Branch subwatershed.

Bare soil on construction sites (k)- The NSA identified a few construction sites with bare soil. These sites are sources of sediment, and are of concern due to the rapid development of the RCW.

Neighborhood (s)- Similar to urban areas, sediment collects on impervious surfaces in neighborhoods, adjacent paved driveways, sidewalks and roadways. Again, this sediment gets carried with runoff into roadside ditches, stormwater drains, streams and rivers without the benefit of filtration through pervious soils. This is of most concern in neighborhoods where stormwater is collected in storm drains and piped directly to the creeks. Most of the neighborhood developments in the watershed are also concentrated in the Rush Creek Main Branch subwatershed.

Source: Streambanks

Unstable streambanks, undercut streambanks, streambanks with steep slopes, and streambanks lacking vegetation can contribute sediment to creeks and rivers. Streambank causes of sediment contributions are listed below and prioritized by the estimated relative amount of sediment contributions to the creeks and rivers.

Causes: Streambank Sediment

Altered morphology and hydrology including loss of floodplain (k and s) - Modifications to the courses of waterways made for road crossings, farming, residential, and commercial uses of land are common in the RCW. These modifications can cause streambanks to erode and the waterways to lose natural functions, to increase in flashy flows, or to change course through erosion, increasing the amount of sediment in the waterways. Hydrologic modifications that eliminate or disconnect floodplains remove areas from the system that filter sediment from runoff causing an increase in sediment load within the stream. As a result of these modifications, some channels have become incised (KCDC, personal communication, December 7, 2017), including the Corey Bishop Drain among others (Eng. Engineering and Surveying, 2017).

Removal of vegetation and ash tree disease (k) - Areas adjacent to waterways that lack vegetation are not protected from erosive streamflows. This flow of water can directly contribute to the erosion of the streambank or over widening of a channel.

Recently, many ash tresses have died as a result of the invasive emerald ash borer and other diseases. As the trees along the streambanks die, they fall into the stream, often taking down other trees and their root system with them as they fall. As a result, much of the streambank becomes unstable and a source of sediment.

Source: Livestock

Livestock can trample fields and holding facilities wearing down vegetation and resulting in soil exposure susceptible to erosion.

Unrestricted livestock access to stream (k and s) – Using streams as a source of drinking water for livestock was, once, a common practice. However, unrestricted livestock access to a stream results in livestock waste being directly discharged into water, trampled streambanks, and ultimately streambank erosion and sediment input. Today, with several alternatives available for watering livestock and/or excluding them from surface water, many of which can be at least partially funded by government sources, direct stream access by livestock is much less common and unnecessary. At least one location was noted where livestock was in the stream.

6.1.4 Nutrients

Nutrients are ranked as the fifth priority pollutant as concentrations of nitrates and nitrites, ammonia as nitrogen, and phosphate were measured above regional comparison concentrations (RCW, 2016-2017). Nutrient pollution is often associated with agricultural practices, lawn maintenance, and leaking septic systems. Excessive nutrient loading can also be the cause of reduced DO concentrations. Overland nutrient sources of pollution can be transported by sediment through runoff. Similar to *E. coli*, dry weather sources of nutrients can be attributed to such things as leaking or failing septic systems. Wet weather sources of nutrients are carried with overland runoff, such as fertilizer and manure spread on lawns and crops. Nutrients are considered a Threat to water quality in the RCW.

Source: Plant and Crop Cultivation

Cropland receives periodic inputs of nutrients through chemical fertilizers and manure. Most cropland also goes through periods of time where vegetation is either not planted, not yet established, or not dense enough to prevent erosion, leaving the soil more susceptible to erosion. The eroded soils, and thus the nutrients attached to the soils, are often carried with runoff to streams and rivers. Cropland causes of nutrient contributions are listed below and ranked by the size of the contribution. Thirty-five percent of the RCW is agricultural land, or approximately 20.6 square miles of cropland in the watershed (Homer et. al, 2015).

Causes: Cropland Nutrient Contributions

Improper application of manure/fertilizers (k) - Livestock manure and fertilizers are frequently spread on crops for use in promoting plant growth. The soil conditions, slope, spreading rate, weather, proximity to surface water, groundwater, and drainage all affect the path of manure and fertilizer. Due to the conditions recorded during the windshield survey, and data collected, it is suspected that the over or improper application of livestock manure and fertilizers is a major contributing cause of nutrient contributions to the watershed. Approximately 35% of the land in the RCW is used for agriculture (Figure 2.2).

Figures 4.1 displays agricultural land uses in the watershed, and thus where the majority of manure spreading would likely occur.

Specific Locations noted in the windshield survey of improper application of manure are listed in Chapter 10.

Tillage practices (k) – Different tillage practices disturb the soils to different extents. Some practices leave the ground more susceptible to erosion through runoff by leaving bare soil or little crop residue in the soil. Soil that erodes from cropland through runoff can carry nutrients to streams and rivers. The NRCS recommends conservation tillage practices including no-till, mulch-till, and ridge-till (USDA NRCS, 2010). Agriculture makes up 35% of the RCW's land use, and results of a tillage survey completed by the MDEQ in 2018 are included in Appendix F.

Muck farming (k)- A ribbon of nutrient rich organic muck soil within the RCW that represents an ancient Grand River tributary floodplain has been converted into farmland (Figure 2.6). There is approximately 3.02 square miles of muck fields in the RCW. The groundwater table is especially high in areas with muck soils, thereby creating a faster connection between stormwater, groundwater and ultimately surface water if not drained properly. Muck soils are typically higher in nitrogen as compared to mineral soil. Windbreaks and ground cover are also needed to protect the nutrient rich soil from wind erosion (Silva, MSU-E, 2012). In the RCW, winter cover crops are less common for muck soils, and soil loss has become a large problem for the muck fields

Causes: Greenhouse Nutrient Applications

Fertilizer application in plant cultivation (s, p)- At least 25 different properties with greenhouses were inventoried during the windshield survey. Though the nutrient application and stormwater management practices at these greenhouses are not known, it is likely that they all utilize fertilizers for their production. Fertilizers can enter the surface water runoff if they are not fully absorbed by the plants. Under some circumstances, greenhouses require a permit to discharge their runoff.

Source: Livestock

Livestock food and waste contain nutrients. If the food and waste are not properly stored and managed, nutrients may be transported into waterways.

Causes: Livestock Nutrient Contributions

Holding facilities (k) - Holding facilities concentrate the nutrients from livestock feed and manure in an area and when the facilities are adjacent to a waterway or drain tile, nutrients can enter waterways through runoff.

Improper storage of manure (k, s, p) - Livestock manure that is left in place or collected, stored, and spread has the potential to leach nutrients. It requires proper handling to prevent nutrients from the manure from reaching groundwater or surface water. At least one site was noted during the windshield survey of improper storage of manure.

Unrestricted livestock access to stream (k) - Areas where livestock have direct access to a stream have the potential to contribute manure, sediment and associated nutrients to the stream. As discussed in the *E. coli* section of this chapter, there are nine sites that have been identified as having known or suspected livestock access areas. A farming operation was observed in the RCW that appeared to allow livestock access to a stream or surface water with connection to a stream, while two other farming operations were noted where pastures ran adjacent to a drainage ditch or headwater streams.

Source: Manicured Landscapes (k)

Manicured landscapes often require the application of fertilizers to remain healthy and green through all seasons. Fertilizer from these landscapes can enter groundwater and surface waters if they are not fully absorbed by the landscaping.

Causes: Nutrient Contributions of Manicured Landscapes

Over or improper application of fertilizers to residential, commercial, and municipal lawns (s) - The soil conditions, spreading rate, weather, proximity to surface water, groundwater, and drainage all affect the path and uptake of fertilizer.

Over or improper application of fertilizers was apparent during the NSA in neighborhoods with highly maintained lawns. There are an estimated 21,027 homes in the RCW, with additional municipal and commercial properties that are commonly known to use a lot of fertilizers and pesticides.

Over or improper application of fertilizers to golf courses (s) - Golf courses apply fertilizers and pesticides to maintain their greens. Six golf courses are located in the RCW. Though generally golf courses contribute less fertilizers and pesticides than residential, strip development, and agricultural land uses they still are contributors of pollutants that can be managed.

Source: Human

Human waste, including grey water (water that is used for laundering, bathing, or washing) and black water (water from flushed toilets) contains nutrients from soaps a*nd human wastes. If this water is not properly treated it can contribute nutrients to waterways. Canine scent tracking detected human waste in both subwatersheds tested. Raw wastewater contains approximately 10.4 mg/L of phosphorus and 60 mg/L of nitrogen (Lowe et. al, 2009).* Raw wastewater contains approximately 232 mg/L of TSS (Lowe et. al, 2009).

Causes: Human Nutrient Contributions

Aging septic systems and/or improper maintenance (k) – Septic systems concentrate waste and wastewater nutrients. They may fail if they are installed without proper consideration of their drainage abilities. Of specific concern are the systems located in poorly drained soils near surface waters. Canine source tracking and MST confirmed the presence of human septage in the watershed. See description discussed in the *E. coli* section of this chapter for more details. Leaking and illicit septic systems may be a major contributing source of ammonia and nitrate. These concentrations were significantly higher in the Main Branch than the East Branch.

Over or improper application of biosolids (p) – Treated biosolids from WWTPs are applied on land as fertilizer at approximately 33 sites, 20 sites in the Main Branch subwatershed, and 13 sites in the East Branch subwatershed. Biosolid applications are regulated by Residuals Management Programs; pathogens in biosolids are required to be significantly reduced, prior to land application (R 323.2418 of Part 24, Land Application of Biosolids, of the NREPA, 1994 PA 451, as amended. However, they remain a potential a source of *E. coli* in this watershed.

Source: Waterfowl

Waterfowl waste contains nutrients and is often concentrated near surface water. Waterfowl are considered a source of nutrients in this watershed.

Causes: Waterfowl Waste

Overpopulation of waterfowl (k) - Waterfowl, including Canada geese, often congregate near surface water. Their waste is flushed into the surface water through runoff.

Manicured lawns and park spaces adjacent to waterways are suspected locations for where the waterfowl are residing. High habitation rates of Canada geese and other waterfowl were noted at three locations in the watershed (Rushmore Lake, Georgetown Community Park, Rivertown Mall), listed in Chapter 10. Measured proportionally to human waste, Georgetown Park had higher concentrations of waterfowl waste. Some local municipalities including KCDC and MDNR, operate programs to reduce waterfowl populations.

6.1.5 Increasing Water Temperature

Stream water temperatures affect the types of aquatic life that can be sustained, as well as the solubility of oxygen. High water temperatures contain lower levels of DO. Water bodies are designated as warmwater or coldwater fisheries, and should be able to sustain their respective populations of fish species. Coldwater habitats, which support trout and other cold water-dependent species, are less prevalent in Lower Michigan than are warmwater habitats. Coldwater habitats are important to protect and preserve, as they are high quality and sensitive. The East Branch of Rush Creek is not currently a designated coldwater stream (MDNR, 2017). The following MDNR criteria were used to categorize the streams by water temperature:

- Cold = July mean water temperature ≤63.5° F (17.5°C)
- Cold-transitional = July mean water temperature >63.5° F (17.5°C) and ≤67° F (19.5°C)
- Cool (or warm transitional) = July mean water temperature >67° F (19.5°C) and ≤70° F (21°C)
- Warm = July mean water temperature >70° F (21°C).

It is important for a stream to stay within the same temperature category, since when a stream changes temperature category, an associated change to the biological community can be expected. Considering the existing land use practices and the watershed's proximity to a growing urban area, the cool and coldwater temperature in the East Branch Rush Creek subwatershed should be considered Threatened.

Source: Direct Sunlight

Waters of a coldwater or warmwater streams can increase through exposure to the sun.

Cause: Increased sun exposure

Loss of riparian canopy (k)- Trees and shrubs in the riparian zone help to provide shading to the stream and help streams maintain their coldwater temperatures. Loss of trees and shrubs in the buffer zone adjacent to the stream can increase the streams exposure to the sun, and therefore cause an increase in water temperature. Trees are commonly removed for agriculture, development and to maintain flow in county drains. Figure 2.12 shows that in places of the watershed with more tree cover, stream temperatures are lower.

Source: Development

Developed land alters the natural flow of a river system. The intensity and duration of rain events, as experienced by the river system, are increased by impervious surfaces, altered vegetation, and altered drainage. Development, impervious surfaces, stormwater ditches and systems, and agricultural drains convey stormwater into waterways at a quicker rate when compared to that of undeveloped land in its natural state. The water is often warmer than if it had followed its natural route to the stream. Developed land causes of thermal contributions are listed below. Fifty-one percent of the RCW is developed, and 35% is used for agriculture.

Cause: Impervious Surfaces and Flashy Flow

Altered morphology and hydrology including loss of floodplain and wetlands (k and s) - Modifications to the courses of waterways are often made for road construction, farming, residential, and commercial uses of land. Agricultural drains are a common source of the altered morphology. Through these modifications, wetlands, floodplains, riparian areas, and the watershed lose some natural functions, which include a decreased ability to infiltrate rainwater. The stormwater reaches the stream faster than it would have without the development, and the water is often warmer and full of more sediment and other pollutants.

Alerted morphology and hydrology, including the loss of floodplains and wetlands, was a widespread practice in the RCW.

Commercial and Residential Development (k)

Much of the RCW is a developing suburban area, with increased impervious areas. Beyond floodplain storage analysis, the 1989 floodplain storage report concluded urbanization could increase runoff potential, and increase flood flows and change flood elevations (MDNR, Menerey and Croskey, p. 9, 1989)." Land use has changed from approximately 16 percent developed in 1992 to 51 percent developed in 2011 (Vogelmann, J.E., S.M. Howard, L. Yang, C. R. Larson, B. K. Wylie, and J. N. Van Driel, 2001 and Homer et. al, 2011). It should be noted that these land use changes only serve as estimates as they are derived from two different datasets and utilize different mapping technologies, but even as estimates help to show general trends in land use changes.

6.1.6 Pesticides and Herbicides

Pesticides and herbicides are often associated with agricultural practices and lawn maintenance. Their use observed at one location in the RCW killed the buffer strip adjacent to a designated drain. Their use also can have unintended consequences to insects and water quality. They are not commonly tested as a part of WMP development, but are a growing water quality and environmental concern across the country, especially in agricultural areas. Due to their observed use adjacent to a county drain in the RCW, pesticides and herbicides are considered a Threat to water quality in the RCW.

Source: Plant and Crop Cultivation

Cropland receives periodic application of pesticides and herbicides. Thirty-five percent of the RCW is agricultural land, or approximately 20.6 square miles of cropland in the watershed (Homer et. al, 2015).

Causes: Application to Cropland

Improper application of herbicides and pesticides (s) - Due to the conditions recorded during the windshield survey, it is suspected that the use of herbicides and pesticides in the RCW is contributing to watershed pollution. At several sites, it was apparent that herbicide treatments had killed vegetation along and within county drains and road ditches.

Figures 4.1 display agricultural land uses in the watershed, and thus where the majority of manure spreading would likely occur.

Source: Manicured Landscapes (s)

Highly manicured landscapes, such as those in residential and commercial development, are often managed with pesticides and herbicides. Herbicides and pesticides from these landscapes can enter groundwater and surface waters if they are not fully absorbed by the landscaping.

Causes: Nutrient Contributions of Manicured Landscapes

Over or improper application of herbicides and pesticides to commercial and residential, commercial and municipal lawns (s) - The soil conditions, application rate, weather, proximity to surface water, groundwater, and drainage all affect the path and uptake of herbicides and pesticides.

Highly maintained lawns were apparent during the NSA. There are an estimated 21,027 homes in the RCW, with additional municipal and commercial properties that are commonly known to use a lot of fertilizers and pesticides.

Land use is displayed in Figure 2.2.

Over or improper application of herbicides and pesticides to golf courses (s)- Golf courses often apply herbicides and pesticides to maintain their greens free of weeds. Six golf courses are located in the RCW. Though generally golf courses contribute less fertilizers and pesticides than residential, strip development, and agricultural land uses they still are contributors of pollutants that can be managed.

6.2 Pollutant Loadings and Reduction Goals to Meet TMDL Goals

Michigan's Statewide *E. coli* Total Maximum Daily Load (MDEQ, 2017a), and Michigan's 2016 Integrated Report (MDEQ, 2016 revised 2017) lists the AUID 040500060511 as not attaining the TBC designated use in 2016. East Branch Rush Creek is listed in Michigan's 2016 Integrated Report as "Not Assessed" for TBC and PBC. Rush Creek and other tributaries within the RCW were also found to be exceeding the TBC and/or PBC WQC during this Watershed Management Planning process.

Because an *E. coli* TMDL is concentration-based rather than load-based, the goal is also equal to 130 *E. coli* per 100 mL as a 30-day geometric mean; 300 *E. coli* per 100 mL as a daily maximum for TBC; and 1,000 *E. coli* per 100 mL as a daily maximum for PBC recreation. As such, reduction goals for this project are based upon the relationship between existing *E. coli* concentrations and the WQC. The goal is to ultimately have all water bodies meet the WQC for *E. coli.*

Previous studies of agricultural watersheds suggest that significant reductions in *E. coli* concentrations are possible through implementation of physical BMPs. Horizon (2010) reports 58% reductions as a result of site-specific wetland restoration in the Tyler Creek watershed in Kent County, MI. It is appropriate then, to assume that if enough BMPs are installed on a watershed scale, that large-scale reductions in *E. coli* concentrations are feasible.

To meet these goals, a set of recommendations including preservation practices, BMPs, I/E, and regulatory mechanisms is included in this WMP. It is difficult to determine exactly how many BMPs are needed to meet the load reduction goals as the specific design and implementation of each of these tools and BMPs will affect its pollutant loading reduction efficacy. Estimates provided within this WMP are intended to be reasonable, but should be monitored and modified as needed, as discussed in Chapter 11.

The feasible and attainable goals for BMP implementation were determined to be approximately 10% of the practices in three years and 20% in ten years. The pollutant loadings should be monitored after BMP implementation so progress toward reduction goals can be evaluated. Implementation schedules and practices should then be adjusted to ensure that the TMDL goals will be met.

6.3 Pollutant Loading and Reduction Goals for Other Pollutants

Even though TMDLs have not been established to address the other pollutants of concern in the RCW, targeted reduction values for altered hydrology, sediment, nutrients, pesticides and water temperature are established.

Typically, restoring the natural hydrologic response to presettlement conditions would represent the watershed long-tem goal when an official targeted flow reduction has not been established by EPA or MDEQ, as is the case for the RCW. However, a presettlement goal for the RCW is not realistic nor attainable due to significant land use development and reclassification of over 50% of the watershed channels as county drains. Therefore, the modeled peak discharges presented in the 1992 Flood Insurance Study presents the current long-term goal for the RCW, or approximately a 50% reduction in peak flows compared to current levels. As a short-term goal, peak discharges in the RCW should be reduced by 20% in ten years.

A reduction in discharge will also ultimately help to reduce pollutant concentrations. Nutrient reduction goal concentrations are listed in Table 3.1. Nutrient goals include: ammonia as nitrogen below 0.042 mg/L; total phosphorous, less than 0.03125 mg/L; nitrate less than 0.41 mg/L. The goal is to meet these concentrations for nitrates, ammonia, and total phosphorus.

The goal TSS sediment concentration is 30 mg/L as listed in Table 3.1, a nearby TMDL for biota set in Plaster Creek had a total suspended solids (TSS) goal of 30 mg/L (MDEQ, 2002).

Using these target nutrient and sediment concentrations values (Table 3.1) and the discharge measurements collected as a part of this planning process, loading reductions values were calculated. To achieve the target concentrations, ammonia as nitrogen would need to be reduced by 36%, total phosphorus would need to be reduced by 83%, TSS would need to be reduced by 44%, and nitrates and nitrites would need to be reduced by 40%. The results are tabulated in Appendix D.

The water temperature goals are to reduce the water temperature in the East Branch subwatershed by two degrees (average July water temperature), to fall within the cold-transitional temperature range of the stream water temperature categories outlined by MDNR, listed above in Section 6.1.5.

Pesticide concentrations were not measured during this watershed management planning process, but pesticide application practices of concern to water quality were observed. Therefore, no numerical measureable goals are outlined here, and instead general reductions and additional investigations are recommended.

7.0 BEST MANAGEMENT PRACTICES

Often more than one BMP is a feasible alternative to address a particular pollutant, source, and cause. In the priority and critical areas, an agricultural BMP should be selected on a field-by-field and subfield basis. Individual site conditions, the preference of the agricultural producer, and the recommendations of the agricultural technician or expert should all be considered when selecting an agricultural BMP Below a non-exhaustive list of BMP options is categorized by source and pollutant. Watershed, cost, site conditions, removal efficiency, and preference of the party installing the BMP should all be taken into consideration when selecting the BMP for each individual site.

BMPs recommended for the RCW are outlined in Appendix G.

7.1 Altered Flow Regime BMPs

BMPs to address Altered Hydrology Pollutant Contributions

Structural/Vegetative
Wetland Restoration
Floodplain Restoration
LID Infrastructure (new and retrofit)
Rain Barrels
Rain Gardens
Native Plants
Trees
Culvert Replacement
Culvert Maintenance
Stream Restoration
Disconnect gutters from storm sewer system

Management
Coordination with Road and Drain Commissions
Wetland Preservation
Floodplain Preservation
Preservation Practices
Information and Education
Regulatory Mechanism- LID and Stormwater Ordinance

7.2 *E. coli*, Nutrient, Pesticide and Herbicide BMPs

BMPs to address **Livestock *E. coli* and Crop Land Nutrient, Pesticide and Herbicide** Contributions

Edge of Field Practices
Wetland Restoration
Buffers
Saturated buffers
Controlled drainage for tile drained fields

In field Practices
Landowners should develop a winter manure management strategy to prevent land-applied wastes from leaving the site.
Do not apply manure to sites with a slope of greater than 6% and within 150 feet of surface water, including drainage ditches and streams.
Inject liquid manure
Cover Crop
Gypsum
Sample and test manure for nitrogen and phosphorus content prior to application
Provide credit for nitrogen and phosphorus in manure to offset commercial fertilizer rates
Implement nutrient stewardship practices that focus on 1) sources 2) rate, 3) timing, and 4) placement
Use MSU Extension guidelines for N application rates
Use nitrification inhibitor for fall N applications if soil temperatures are > 50 degrees F at 4-inch depth
Minimize fall application of N application compared to spring applicatio**n**
Split application of N to include sidedress N after corn emergence
Soil sample and test for phosphorus and apply P at crop removable rate (Generally considered by laboratories as “Optimum” rate. Do not exceed the upper range of optimum.
Band P application in lieu of broadcast

Structural/Vegetative
Alternative Water Sources
Wetland Restoration
Filter and Buffer Strips with Maintenance
Capture and/or Redirect Runoff
Contained Manure Storage Areas
Rotating Manure Storage
Cover Crops and gypsum
Tile Line Control Structures
Exclusion Fencing or Controlled Access for livestock

Management
Information and Education
Regulatory Mechanism
Modify Application Rates and Timing
Agricultural Management Practices
Incentives
Preservation Practices
Field Tile Management
Comprehensive nutrient management plans
Crop Residue Management
Michigan Agriculture Environmental Assurance Program
Engage and Use Certified Crop Advisors (CCA)
Preservation Practices
Track or regulate CAFO manifested manure

BMPs to address **Human *E. coli* and Nutrient** Contributions

Structural/Vegetative	**Management**
Septic Maintenance, Repairs or Replacement Implement alternative absorption field technologies	Connect homes with septic systems with access to sanitary sewer to sanitary sewer service Information and Education Repair improperly connected systems Follow recommended guidance below for septic system installations Regulatory Mechanism Incentives Modify Biosolid Application Rates Septic System Database Development Risk-based Ordinance Soil and Nutrient testing

Septic System Installation Guidance

Follow Health Department regulations. Do not install conventional absorption fields in the following situations: 1) floodplains, 2) slopes >5% unless drop boxes are installed, 3) soils with limited and high permeability rates described below, 4) bedrock within 6 feet of ground surface, 5) soils with seasonal high water tables, or where otherwise not suitable.

Do not install conventional absorption fields on soils having the following properties: 1). moderately slow, slow, and very slow permeability ratings; 2). Internal drainage classes of rapid, moderately rapid, somewhat poor, poor, or very poor.

Install perimeter tile drainage at a depth below the conventional absorption field for soils with moderate and/or moderately slow permeability and somewhat poorly and/or poorly drained.

BMPs to address **Manicured Landscape Nutrient, Pesticide, and Herbicide** Contributions

Structural/Vegetative	**Management**
LID Infrastructure Native Plants Buffers Natural Shorelines Wetland Restoration	Information and Education Regulatory Mechanism Preservation Practices

BMPs to address **Greenhouse Nutrient** Contributions

Structural/Vegetative	**Management**
Rainwater harvesting Retention pond/constructed wetlands	Soil and Nutrient management Control runoff volumes, temperatures, nutrient loading Information and Education Integrated pest management

BMPs to address **Pet *E. coli* and Nutrient** Contributions

Structural/Vegetative	**Management**
Buffers	Regulatory Mechanism
Natural Shorelines	Information and Education
	Signs
	Preservation Practices

BMPs to address **Wildlife *E. coli* and Nutrient** Contributions

Structural/Vegetative	**Management**
Shoreline Buffers	Information and Education
Wetland Restoration	Regulatory Mechanism
Natural Shorelines	Preservation Practices
Native Plants	Egg Destruction
	Goose relocation

7.3 Sediment BMPs

BMPs to address Cropland Sediment Contributions

Structural/Vegetative	**Management**
Contour crop strips for slopes > 5% gradient	No-till and/or Strip Tillage
Contour prairie strips for slopes >5% gradient	Crop rotation to include small grain and forage crop
Terraces for slopes >5% gradient	Inter-seed in growing annual crop (C, Sb) for fall cover
	Double crop with soybeans in small grain stubble after harvest
Cover Crops and gypsum	Preservation Practices
Wetland Restoration	Conservation Tillage with >50% residue after planting
Filter and Buffer Strips with Maintenance	Agricultural Management Practices
Windbreaks	Agricultural Outreach
Contour/Terrace farming	Information and Education
Redirecting stormwater flow	Regulatory Mechanism
Grass on most erosive areas	Incentives
	Michigan Agriculture Environmental Assurance Program or similar

BMPs to address Developed Areas Sediment Contributions

Structural/Vegetative	**Management**
Install sediment fences during construction	
Floodplain Restoration	Floodplain Protection
Low impact development practices	Street Sweeping
Detention or Retention Ponds	Incentives
Wetland Restoration	Preservation Practices
	Information and Education
Shoreline Buffers	
Stormwater system devices with pollutant separation capabilities	Regulatory Mechanism- LID and Stormwater Ordinance
Improved driveway/stream crossings	

Reduce impervious surfaces

BMPs to address Streambank Sediment Contributions

Structural/Vegetative	**Management**
Floodplain Restoration	Floodplain Protection
Wetland Restoration	Preservation Practices
Streambank stabilization	Drain Maintenance
Filter and Buffer Strips with Maintenance	Incentives
Stream Restoration	Information and Education
Exclusion Fencing or Controlled Access for livestock	Regulatory Mechanism
Alternative Water Sources	Coordination with Road Commission and Drain Commissions
LID Infrastructure	
Erosion Control	
Vegetation	

7.4 Temperature BMPs

BMPs to address Increasing Water Temperatures

Structural/Vegetative	**Management**
Riparian buffer tree canopy and buffer	Incentives
Filter and Buffer Strips with Maintenance	Preservation Practices
Wetland Restoration	Riparian zone preservation
Floodplain connection	Information and Education
LID Infrastructure	Regulatory Mechanism
Rain Gardens	

7.6 Wetland Restoration for Flood Storage and *E. coli*, Nutrient, and Sediment Removal

As previously discussed, the RCW has lost 84 percent of its historic wetlands. The restoration, or recreation, of historic wetlands is an important BMP to help water quality. Wetland restoration is recommended for areas that were historically wetlands but have since been drained. It should be noted however, in comparison to restoration, the protection of existing wetlands is the more efficient, important and effective way to protect water quality in the RCW and is discussed in Chapter 9. The most critical wetlands to restore are those with flood storage capacity. The second most important wetlands to restore are those with *E. coli,* sediment, and nutrient pollution removal functions and groundwater recharge functions. Another important consideration in the restoration of wetlands is landowner approval. Considering the RCW is 51% developed, some sites may be harder to restore as wetlands than others due to their current land uses of locations (for example, highly developed areas).

Wetlands that met the following criteria are prioritized as historical wetlands to restore, for the purpose of storing floodwaters, filtering *E. coli*, sediment, and nutrient pollutants, and protecting groundwater recharge.

A review of the LLWFA (MDEQ, 2013) as it related to the RCW pollutants of concern, wetland proximity to stream channel, and a *Geospatial Prioritization of Historic Wetland Restoration: A Multi-model*

Watershed Scale Approach in the Lower Grand River Watershed of Michigan (Zuber, 2015) were used to identify priority wetlands to restore in the RCW.

Through this review, nine major historic wetland areas, including 1,716 acres, are considered priority to restore. These areas are shown in Figure 10.2. Landowner permissions have not been confirmed for these proposed sites. Due to the high levels of development in this watershed, and continued pressures from land development, landowner interest is a very important consideration. Landowner interest in wetland restoration of sites that are not prioritized here should be considered, and prioritized if their property contained historic wetlands, and prioritized higher if their property contained historic wetlands that perform any of the priority pollutant reduction functions needed for the RCW (flood storage, *E. coli,* sediment, and nutrient pollution removal functions and groundwater recharge functions).

The critical areas to restore historic wetlands are shown later in the Chapter 10 in Figures 10.2.

In addition, the OCWRC and KCDC have completed smaller-scale studies on individual drains in the RCW and efforts to reduce flooding and sedimentation in the RCW. Current studies, including recommendations, for flood storage and sediment reduction are included in Appendix J. Recommendations in these studies are generally applicable to this WMP, with recommendations related to flood storage and sediment reduction.

8.0 SOCIAL SURVEY ANALYSIS AND INFORMATION AND EDUCATION RECOMMENDATIONS

Watershed management and the reduction of NPS pollution are largely dependent upon the participation of the community within the watershed. The opinions, characteristics, behaviors, and demographics of the RCW community were first assessed. Using the social survey data collected in conjunction with water quality data and input from partners, specific I/E messages were developed for specific audiences related to the RCW priority pollutants, sources, and causes.

The RCW team held a public meeting to present project findings and recommendations. Over 40 partners and residents attended and provided input and feedback. The project findings were also presented to the Georgetown Township Trustees since a majority of the RCW is located within the township. A meeting was also held with the Rushmore Lake Association, where approximately 25 people attended.

Two different social surveys were mailed to residents of the RCW: one for residents who do not farm and another for residents who potentially or do farm. RCW landowner data was obtained from the Ottawa County Water Resources Commissioner and the Kent County accessKent Geographic Information System Data Library. Landowners were randomly selected from this list and any repeat, municipal/state, or commercial landowners were not included in the non-farmer survey. The mailing list did not include those renting from large apartment complexes but did include those owning condos. From the RCW landowner list, several methods were used to identify potential farmers for the farmer survey. These included commercial listings of farms, a windshield survey of farm animals, and identification of large cultivated/pastured parcels (>7 acres) from aerial photos. The number of potential farmers identified was then cross checked with the randomly selected non-farmer survey list and any potential farmers who appeared on this list were taken off.

The non-farmer survey was sent out to 1,300 households. The first 1,050 households had surveys sent out to them as many as three times, with the third mailing giving recipients the choice of checking the box to “opt out” of completing the survey. The survey was sent, just once, to an additional 250 households. Overall, thirty-one percent of households responded to the survey by answering the survey or returning the survey with the “opt-out” response completed. To ensure the results are statistically valid, the survey was designed to achieve a 95% confidence interval (5% error). There were 357 surveys returned, and considering there are an estimated 21,027 households in the RCW, the calculated error rate is 5.15%.

The second survey, for farmers, was sent out to 381 households, as many as three times, with the third survey giving recipients the choice of “opting out”. There was a 25% response rate, taking into account surveys that were returned from recipients who indicated they were not involved in farming. To ensure the results are statistically valid, a 95% confidence interval was the goal (5% error). There were 64 surveys returned (completed or with the “opt-out” option selected). Using methods described in Appendix H, this response rate is within the 95% confidence interval, with an error rate of 6.5%. APPENDIX H includes a detailed summary of the SIDMA survey response information, analysis and Information and Education References.

8.1 Social Survey and Watershed Demographics

Watershed demographics are outlined in Chapter 2.14. In summary there are 59,547 people within the 59 square mile RCW (US EPA, 2016).

There are 21,027 households (US EPA, 2016) and 494 people completed either a non-farmer or farmer survey. A summary of information about the survey respondents as compared to other known watershed demographic information is included in Table 8.1. Residents of the RCW are more educated than average, where approximately 11% have less than a high school education. Residents who responded to the survey were generally older and better educated than the average RCW resident. Residents with more education may be more familiar with and thus more willing to participate in research surveys. Older residents may also have more time available to complete a survey as opposed to younger residents who may be busy raising families. More than 80% of non-farmers live on a lot <1 acre, indicating that most of the RCW is not a rural watershed.

Table 8.1: Demographics of RCW residents and survey respondents

Information Category	RCW (US EPA, 2016)	Non-Farmer Survey	Farmer Survey
Households (or number of surveys sent out)	21,027	1,300	381
Number of survey respondents	494	357	137
Under 18	28	--	--
18-65	60	--	--
Over 65	12	--	--
Mean age	--	56	63
Male (%)	50	72	83
Female (%)	50	38	17
Less than high school ed. (%)	6	2	3
High school education. (%)	31	18	39
Some college education (%)	32	15	20
College (Assoc. or Bach. or more)	41	65	38
Owner occupied (%)	85	100	97
Lot size: <1/4 acre (%)	--	35	1.5
Lot Size: 1/4 to 1 acre (%)	--	45	10
Lot Size: 1- 5 acres (%)	--	15	13.8
Lot Size: > 5 acres (%)	--	5	74.6
Average length of residency (years)	--	17	28
Place of residence: town, village or city (%)	--	55	8.4
Place of residence: rural subdivision of development (%)	--	32	16.8
Place of residence: isolated rural residence or farm (%)	--	13	32.8
Place of residence: farm (%)	--	0	42
Renter occupied (%)	15	--	--

To understand the land use of the watershed, it is important to know that agriculture is a large and important industry in the State of Michigan, the RCW not excluded.

Based on 2013 cash receipts, Michigan's top ten agricultural products are:

1) Milk- $1.7 billion in sales, ranking number 7 in the Nation in milk production.
2) Corn- $1.57 billion in sales from 2.6 million acres.
3) Soybeans- $1.31 billion in sales.
4) Greenhouses and nurseries- $617 million in sales.
5) Cattle and calves- $541.16 million in sales.
6) Hogs- $48.8 million in sales from raising over 1 million hogs.
7) Sugar beets- $389.12 million in sales and ranked fourth in the Nation for production.
8) Wheat- $279.9 million in sales from approximately 60,000 acres.
9) Chicken eggs- $268.54 in sales producing 3.7 billion eggs.
10) Apples- $245.81 in sales and ranked second in the Nation for apple production (MDARD, 2015).

Other notable facts about Michigan's agricultural industry, are that Michigan ranks eighth in the nation for potato production, ranks fifth in the nation for wholesale horticulture with $459 million in sales, in 2008 Michigan ranked 11th in the nation with 461 organic farms covering over 68,000 acres and producing $71.1 million in sales (MDARD, 2015). Kent County ranked third in the state in 2007, with wholesale and retail agricultural sales over $63,000,000. Greater than one third of Michigan farms are 10 - 49 acres in size, approximately one third are 50 – 179 acres, approximately 20% are greater than 180 acres, and approximately 8% are less than ten acres. The average organic farm is 148 acres (MDARD, 2015).

8.2 Social Survey Results

8.2.1 Summary of Non-farmer Survey Responses

Residents of the RCW who responded to the SIDMA survey care about their water quality and have an awareness of their impact on water quality. Non-farming residents most commonly selected scenic beauty and picnicking/family activities as their most important and highest quality uses. However, residents are generally unfamiliar with specific information about the RCW water quality, pollutants, sources of pollution, and consequences of pollution. More, they are constrained in their willingness to take action to improve water quality, mostly due to cost.

Results of the survey indicate information is also a limiting factor for residents. The majority of residents had not been made aware of water quality issues within RCW over the past year, and the majority of residents (>60%) answered that they did not know the severity of various RCW pollutants or their causes. Approximately 50% of respondents do not know if the water quality or flooding of Rush Creek is getting better or worse. Approximately 30% believe it to be staying the same, while the rest (less than 20%) believe it to be getting better or worse. Residents indicated that phosphorous and nitrogen are the most problematic pollutants of the RCW and correspondingly, excessive aquatic plants or algae is the most problematic consequence of poor water quality. Respondents indicated the second and third most problematic pollutants were bacteria and sedimentation. Residents did not perceive contaminated drinking water, odor, or lower property values as much of a problem. Residents indicated the largest sources of pollution are related to land development, such as excessive nutrients and stormwater runoff. Respondents perceive geese to be a larger source of pollution than septic tanks. This is opposite of what the data collected during the development of the WMP found.

The most commonly selected BMPs reported in use were lawn clipping care and proper fertilizer usage. Residents were not very familiar with riparian buffers, native plants, or wetland restoration; although annual MS4 reports from the Kent County Drain Commissioner, Kent County Road Commission, and the

City of Hudsonville indicate that residents are most interested in learning about native plants, rain gardens, and buffers (GVMC, 2016b,e,f).

Of the residents with septic systems, 60-70% report properly maintaining their systems, though this number is often reported high in surveys of this nature. Nearly 9% of septic systems appear to have major problems. Respondents indicated cost as the most limiting factor to proper septic maintenance. The majority of residents did not want a reminder from local government about required maintenance nor did they want government involved in inspections.

Management decisions on a resident's property are mostly affected by cost and the lack of information or equipment. Just less than half of respondents use a professional lawn care company for some part of their lawn care.

Respondents indicated that they receive most of their information about water quality from the newspaper, and they trust government sources the most, followed by local environmental groups. However, approximately half of respondents were not familiar with active local groups such as the Lower Grand River Organization of Watersheds (LGROW) and West Michigan Environmental Action Council (WMEAC).

As compared to farming residents, residents indicated more willingness to change their practices and pay more to better influence water quality.

8.2.1.1 Indicator Scores

Using the SIDMA tool, key questions from the survey were selected related to sediment, *E. coli*, nitrogen, phosphorus, bacteria and viruses, and flow alteration, which are identified as the primary pollutants affecting the RCW. Indicator scores for awareness, attitudes, constraints, capacity, and behavior were developed by the SIDMA tool and are included in Appendix H. Of note, non-farming residents have a more positive score and attitude related to water quality, but a less positive score relating to their willingness to take action to improve water quality. Indicator scores calculated from the survey suggest that residents experience constraints to behavior change and adopting key practices. Twenty-seven percent of the target audience are considered to be implementing practices in critical areas.

As compared to farming residents, non-farmer residents are more aware of types of pollutants impairing the waterways, source of pollutants, and consequences of pollution, though farmers are more aware of appropriate practices to improve water quality. Non-farming resident attitudes about water-quality were better than farmers, and both groups had a similar willingness to take action to improve water quality. Non-farmers and farmers alike reported constraints to their behavior change, though non-farmers indicated more constraints than farmers.

8.2.1.2 Rating of Water Quality

When residents were asked which of five activities were most important to them (canoeing/kayaking/other boating, eating locally caught fish, picnicking and family activities, fish habitat, or scenic beauty), over 80% of the non-farming residents rated scenic beauty and picnicking activities as most important relative to other categories. Likewise, when asked to rate the quality of water in the area for those same uses, picnicking and scenic beauty were rated by respondents as the highest quality. Although more people (74%) answered for the swimming category, they rated it relatively the poorest water quality.

8.2.1.3 Your Water Resources

When asked if residents knew where the rainwater went when it left their property, nearly 60% of respondents responded yes and approximately 40% of respondents reported they did not know where the rainwater went when it left their property.

The survey asked residents to answer eight questions about their level of responsibility and willingness to take action to improve water quality. Respondents found it easy to agree that farmers should follow recommended practices to improve water quality, and approximately 90% agreed that it was their personal responsibility to improve water quality and that their actions can influence water quality. These results show that those willing to participate in the survey have a sense of environmental responsibility. In the second highest ranked set of activities, the respondents were slightly less likely to agree, but still generally agreed that the quality of life in their community depends on good surface water quality, that it is important to protect water quality even if it slows economic development, and that they would be willing to change the way they care for their lawn or yard to improve water quality. However, there were more people who disagreed or were neutral with these statements. The respondents appear to be environmentally responsible when asked about their thoughts as opposed to their actions. When people are asked if they are willing to pay more to protect water quality, 28% disagree/strongly disagree, 36% are neutral, and 36% agree/strongly agree. Thus, respondents of the survey appear to be environmentally conscious but report being less likely to take action if the action will increase costs.

8.2.1.4 Water Impairments, Sources of Pollution, and Consequences of Water Quality

Residents were given a list of eight water pollutants that are generally present in the local water bodies and asked their opinions on how much of a problem each pollutant is to the water. The majority of respondents (50-67%) indicated that they did not know if the pollutant was a problem for the RCW, with the exception of sedimentation where only 39% of respondents did not know about the scale of the sediment pollution problem. Respondents indicated that phosphorus and nitrogen were the most problematic pollutants to the RCW, followed by bacteria and viruses and sedimentation.

Non-farming residents were asked their opinions about how much of a problem twelve different sources of pollution are to the RCW. Residents responded about 32-66% of the time that they did not know how much of a problem certain pollutants are. Answers to this survey question indicate that non-farming respondents generally do not know what specific sources are polluting the RCW, but for those who do know they perceive land development sources of pollution from excessive nutrients and stormwater runoff (land development/stormwater runoff, stormwater runoff from streets and/or highways) to be the biggest source of pollution.

Non-farming residents were asked their opinions about how problematic eight various consequences of poor water quality were. The overall range of means was lower (people thought it was less of a problem) than the range of means for pollution sources. This indicates that the sources of pollution are considered a larger problem than the consequences of water pollution or that the consequences of water pollution are not well understood. The highest ranked consequence of pollution is excessive aquatic plants or algae (seen as a slight to moderate problem). This fits well with the question where respondents ranked excessive nutrients as a slight to moderate problem.

8.2.1.5 Adopting Practices to Improve Water Quality

Non-farming residents were asked their level of experience with seven different BMPs that can improve water quality. Figures 8.1-8.3 display the willingness of respondents to adopt select BMPs considered important for the RCW.

Figure 8.1 Non-farming Resident Survey Respondent's Willingness to Follow Manufacturer's Instructions when Fertilizing Lawn or Garden

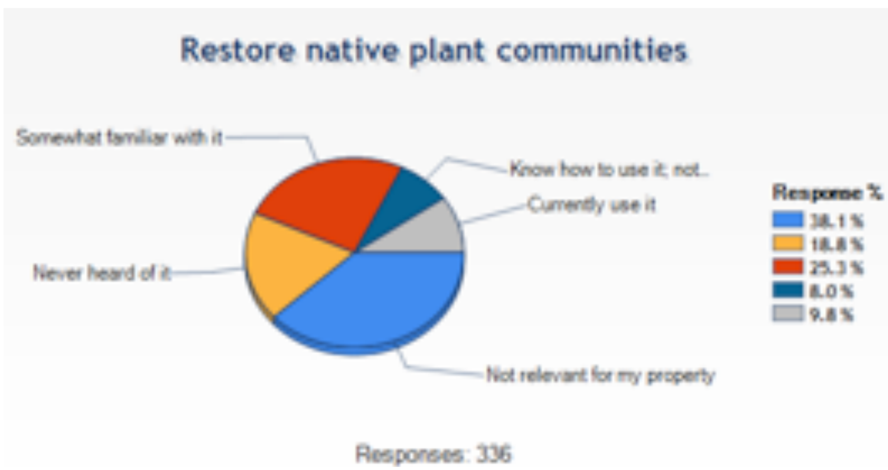

Figure 8.2 Non-farming Resident Survey Respondent's Willingness to Restore Native Plant Communities

Figure 8.3 Non-farming Resident Survey Respondent's Willingness to Maintain Riparian Buffer

The majority of respondents indicated that they follow the manufacturer's instructions when fertilizing their lawn, but very few respondents are working to restore native plant communities or riparian buffers, and many did not think restoring native plants was a relevant practice for their property.

Residents were asked questions about establishing herbaceous plants as a riparian buffer and their willingness to try the BMP (Figure 8.4). Though few residents were familiar with the practice, over half are or are maybe willing to try this practice. The limiting factors to this BMP are a lack of understanding about the practice and cost.

Figure 8.4 Non-farming Resident Survey Respondent's Willingness to Try Riparian Buffer

Non-farming residents were asked about their familiarity with and willingness to try regular septic maintenance and results are displayed in Figures 8.5 and 8.6. Respondents reported septic system installation dates ranging from 1948-2016 with a mean of 1989 (29 years old). There was a clumping of septic systems noted by properties with similar parcel numbers. However, when asked if they were willing to use the septic cleaning BMP, only 66% reported yes or that they already do. Nearly 13% of people with septic systems did not answer this question and 21% of people answered maybe. Respondents who answered no were zero. Considering the slight difference in answers between the questions, we can estimate that septic systems in at least 30% of homes are not properly maintained.

Figure 8.5 Non-farming Resident Survey Respondent's Familiarity with Regularly Maintaining Septic System BMP

When people who report owning a septic system were asked what factors affect their ability to maintain their septic systems, cost was the reason most frequently cited for limiting their ability to implement the septic cleaning BMP.

When residents with septic systems were asked if they had experienced problems with their septic systems, 80% reported no problems and 11% reported slow drains as the most common problem. Nearly 9% of respondents with septic systems reported having more serious problems such as sewage backup in the house, bad smells near the tank or field, or sewage on the surface. This indicates that there is likely a 10% failure rate or septic systems at the minimum, as used in other calculations in this WMP.

Two-thirds of respondents with septic systems did not want to be reminded of septic system maintenance or inspections by their local health department (Figure 8.6)

Figure 8.6 Non-farming Resident Survey Respondent's Willingness to Regularly Maintain Septic System

Residents were asked if they wanted a local government agency to handle inspections of septic systems, and results are displayed in Figure 8.7. Residents with septic systems, as compared to those without septic systems, were less likely to agree that a local government should handle septic system inspections (16% vs. 31%).

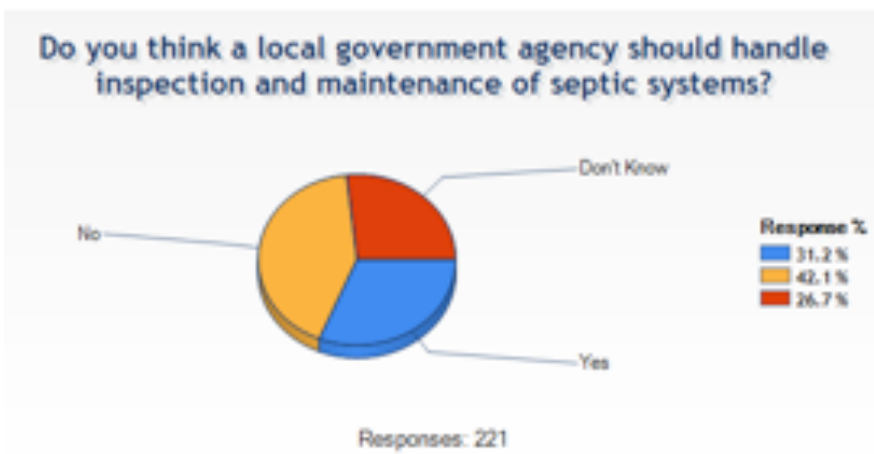

Figure 8.7 Non-farming Resident Survey Respondent's Opinion on Septic System Inspection and Maintenance Responsibilities

When asked about what issues limited the ability of non-farming residents to change their management practices, there was a wide range of mean values, indicating a wider range of opinions. The top issues included personal out-of-pocket expenses and a lack of information or equipment.

8.2.1.6 Information Sources

Most people (62%) had not been made aware of water quality issues in the RCW in the last year though 23% did not answer this question. Of those who answered that they had learned of water quality issues in the RCW, (37%) had learned of the issue from the newspaper (mainly the Advance), their own observation or research was the second most common answer (21%), followed by TV (19%), city/township (12%), and neighbors (11%).

Non-farming residents reported that they had the most trust in government sources of information including MDNR, MDEQ, local Township or City governments, and Kent/Ottawa Drain Commissioners in that order. Residents reporting trusting environmental groups next, including WMEAC and LGROW, although approximately half of the respondents were not familiar with these organizations. Family, friends, and neighbors were the next most trusted source of information, followed by the local garden center. Although government is listed as the most trusted resource, people did not indicate that they have received information from the government.

8.2.2 Summary of Farmer Survey Responses

Farming residents of the RCW who responded to the SIDMA survey understand that they are responsible for improving the water quality of Rush Creek and report a higher willingness than non-farmers to sacrifice economic development for protecting good water quality. Farmers report a willingness to change their management practices to improve water quality, though are less willing to pay more for improved water quality. Farming residents most commonly selected scenic beauty as their most important and highest quality uses.

Results of the survey indicate information is a limiting factor for non-farmers as well. The majority of residents had not been made aware of water quality issues within RCW over the past year, and 23-55% of the residents answered that they didn't know the severity of various RCW pollutants. Approximately 80% of farmers think the water quality and flooding problems of Rush Creek are either staying the same or that they do not know. As compared to non-farmers, farmers indicated they were more aware of the sources and consequences of water pollution. They indicated that sedimentation is the most problematic pollutant of the RCW, and correspondingly, that the biggest sources of water pollution are stormwater runoff from streets and/or highways, excessive use of lawn fertilizers and/or pesticides, and land development or redevelopment. While land development is a major source of water pollution in the RCW, respondents do not think that some of the other large RCW pollutants were much more than a slight problem, including improperly maintained septic systems and soil erosion from farm fields.

Based on survey responses, it appears approximately 60 of the survey respondents actively farm in the RCW. This survey represents answers from a large percentage of the RCW farmers as there are an estimated 90 total farmers who farm in the RCW. The most commonly used BMPs selected are regular septic maintenance, grassed waterways to reduce soil erosion and soil loss, and use of cover crop for erosion protection and soil improvement. Most respondents were not familiar with the two-stage ditch BMP that is a priority to the local OCWRC.

Although 16 to 42% of farming respondents reported using Comprehensive Nutrient Management Plan (CNMP), a grazing plan, or residue retention BMPs, farmers indicated that cost, lack of equipment, lack of government cost share, interference with land use, the desire to keep things the way they are, and the features of their property make it difficult, as constraining reasons for adopting specific BMPs. Respondents were not concerned with reduced farm yields or not being able to see a demonstration site.

Most farms are family operations, and the average farmer has been farming for 30 years. Fifty-five farmers indicated they have tillable acreage, ranging from 4-650 acres, with an average of 70 tillable acres. Corn, vegetables, soybeans, cover crop, and pasture were the most common crops grown.

Just short of half of the survey respondents have property that touches a stream, river, lake or wetland, indicating there may be increased potential for pollutants to reach the surface water at these sites, or increased potential locations for BMPs. More farmers than non-farmers have an understanding of where their rainwater goes after it runs off their property.

More farmers had septic systems than non-farmers. Although the average age of septic systems was 28 years old, few problems were reported. Most farmers do not want to be reminded of septic maintenance needs by the local government, nor do they want local government involved in inspections.

Farmers report that the sources they trust the most are the Farm Bureau, the Soil and Water Conservation District, and the University Extension.

8.2.2.1 Indicator Scores

Using the SIDMA tool, key questions from the survey were selected related to sediment, *E. coli*, nitrogen, phosphorus, bacteria and viruses, and flow alteration, which are identified as the primary pollutants affecting the RCW. Indicator scores for awareness, attitudes, constraints, capacity, and behavior were developed by the SIDMA tool, and are included in Appendix H. Of note, farming residents were less aware of the consequences of pollutants to water quality as compared to non-farming residents, but they were more aware of appropriate practices to improve water quality. Similar to non-farming residents, calculated scores indicate that farmers have a more positive attitude related to water quality, but a less positive attitude relating to their willingness to take action to improve water quality. In addition, similar to the non-farming residents, indicator scores calculated from the survey suggest that farmers experience constraints to behavior change and adopting key practices. Forty-seven percent of the target audience are considered to be implementing practices in critical areas.

8.2.2.2 Property Management

Farmers answered specific questions about their farming operation, including what types of crop they grow, how many acres they manage, and how many livestock they raise. Responses are summarized in Tables 8.2 and 8.3 below. This information can be used to understand what types of crops and livestock are in the RCW and at what scale. Of the approximately 60 farmers who responded to the survey, approximately 42 respondents have a range of 2-359 livestock animals, totaling 1,252 animals. In comparison, the windshield survey visually identified 53 animal farming operations (cattle, horses, or other medium sized animals) and approximately 420 animals within the watershed. According to the survey, 23 farmers own cattle and 10 farmers own horses. Farmer surveys were not sent to properties that were 7.5 acres or smaller, or to properties with only one or two horses (the windshield survey estimated that there are approximately 16 farms with one to three horses). Livestock ownership is concentrated to relatively few farms in the RCW.

Table 8.2: Survey Respondent Summary of Crop Farming in RCW

Type of crop	Number Respondents	Number with acreage	Range of acreage (those with acreage)	Mean of acreage (those with acreage)	Standard deviation of acreage (those with acreage)
Total tillable	59	55	4-650	70	132
Corn	54	22	2-405	64	108
Soybeans	54	9	7.5-100	33	30
Small grains	52	5	2-100	34	40
Cover/alfalfa	55	20	5-80	23	19
Pasture	56	23	2-70	13	15
Conservation	52	1	15	15	NA
Other*	55	16	1-350**	107	133

*Other crops mentioned include melons, pumpkins, flowers, vegetables, corn, hay, berries, squash, sod, orchard, celery, onions
**A large farming operation reported 6,800 acres of other (corn, beans, woodlots)-this was not included in the statistical calculation.

Table 8.3: Survey Respondent Summary of Livestock Farming in RCW

Type (acreage)	Number Respondents	Number with animals	Range of animals (those with animals)	Mean of animals (those with animals)	Standard deviation of animals (those with animals)
Dairy cattle	54	4	48-100	76	24
Beef cattle	53	18	2-359	38	82
Hogs	51	1	4	4	NA
Poultry	50	5	7-50	28	20
Other livestock*	55	13	2-20	10	7

*Other livestock mentioned: 10 people own horses, 1 person owns longhorn cattle for breeding, 2 people own goats, 1 person owns sheep.

8.2.2.3 Rating of Water Quality

When farming residents were asked about how they would rate the quality of water for six different activities in their areas, by far the most people answered scenic beauty as the most important use (53%) and highest quality (61% rated it as good quality). Swimming, eating fish, and boating were ranked as having okay quality. Responses to this question are similar to those collected from non-farming residents.

When farming residents were asked their opinions on water quality and flooding, most farming residents (approximately 50%) responded that they did not know if the water quality of Rush Creek is getting better or worse, and nearly 40% of respondents said they do not know if the flooding of Rush Creek is getting better or worse, though the majority, over 40%, believe it to be staying the same.

When farming residents were asked their opinions about eight different types of pollution, they most often reported being unfamiliar with the various pollutants, and generally ranked pollutants as less of a problem than non-farmers. Farmers were most confident in their knowledge of sedimentation (only 23% answered that they did not know), and for those who responded, it was ranked as the most problematic pollutant (though they only considered it a slight problem). In comparison, more farmers rated the water quality as poor for many activities as compared to the non-farmers. There is a general lack of understanding of the water quality and quantity conditions of the RCW.

8.2.2.4 Your Water Resources

Farmers were asked nine questions related to their opinions on their affect and relationship to the local water resources. The majority of farming respondents agree that they have a personal responsibility for protecting water quality, that their actions impact water quality, and that using recommended practices improves water quality. The majority of respondents agree that the quality of life depends on good water quality and that they are willing to sacrifice economic development for good water quality. While the majority of respondents agree that they are willing to change their management and lawn practices to improve water quality, there are still just over 40% of the respondents who indicate they are neutral or opposed to changing their practices.

However, when asked if farmers were willing to pay more to improve water quality (through local taxes or fees for example), the respondents were split, and nearly half of the respondents were not willing to pay more, and nearly one third were neutral.

8.2.2.5 Water Impairments, Sources of Pollution, and Consequences of Water Quality

Farmers were asked their opinions about 12 different sources of water pollution in the RCW. The three highest ranked sources of pollution are: stormwater runoff, lawn fertilizer, and land development, which farming respondents categorized as between a slight and moderate problem. The rest of the sources of pollution are considered a slight problem, including sources of water pollution from farming practices (droppings from geese, streambank or shoreline modification, removal of riparian vegetation, excessive use of fertilizers for crop production, improperly maintained septic systems, soil erosion from farm fields, manure from farm animals, turf management). Respondents view erosion from fields or septic systems as nothing more than a slight problem, though these sources of pollution were identified as priority sources of pollutants in this WMP. Famers perceive excessive use of lawn fertilizer to be a bigger problem than excessive use of fertilizers for crop production. Respondents answered “don’t know” to sources of pollution pertaining to riparian vegetation and streambank stabilization.

When farming residents were asked their opinions about eight different consequences of poor water quality, the overall range of means was lower than those in the question asked about sources of pollution, indicating that the sources of pollution were considered a larger problem than the consequences of water pollution. The highest ranked consequence of pollution is excessive aquatic plants or algae (seen as a slight to moderate problem), followed by polluted swimming areas. The farmers' rankings of the consequences of poor water quality were roughly the same as the rankings of non-farmers, but farmers perceived the consequences to be less problematic.

8.2.2.6 Adopting Practices to Improve Water Quality

When recipients of the farming survey were asked more specific questions about ten different BMPs that improve water quality, the survey responses went from roughly 120 to 60, indicating that only approximately 60 respondents of the farmer survey were farmers. Those roughly 60 farmer responses are summarized here. The majority of respondents say that the following BMPs are relevant and that they are using them: regular servicing of septic systems, using a grassed waterway to reduce erosion and soil loss, and using cover crops for erosion protection and soil improvement. The next most reportedly used BMPs are a field border to trap sediment below a critical area and/or establishing vegetation to stabilize streambanks and/or shorelines, where approximately 30-35% of farming residents say they are using these BMPs, and 40-650% of respondents indicate the BMPs are not relevant to their property. Approximately half of respondents indicated the following BMPs as relevant to their properties, and of those who indicated the BMPs were relevant to their property, approximately 45-65% are using them: using field windbreaks to reduce soil loss, using fences to exclude livestock from riparian areas, restore/enhance wetlands, and regulate the water levels in tile lines. Approximately 70% of respondents indicate that a two-stage ditch is not relevant to their property or that they have never heard of it. Only approximately 9% of respondents are using this BMP.

Farmers were asked about their familiarity with, willingness to try, and specific constraints of three BMPs: CNMP, residue retention, and grazing plan. Surveyed farmer responses about the CNMP BMP are displayed below in Figures 8.8 and 8.9. Of those who indicated that this BMP was not relevant for their property, most indicated that they did not have any livestock, or they had limited livestock or manure. Respondents were split into approximate thirds on their willingness to try the BMP (yes, no, maybe responses). The top three constraints indicated from all respondents were the desire to keep things the way they are, cost, and the features of their property make it difficult.

Figure 8.8 Farming Resident Survey Familiarity with CNMP

Figure 8.9 Farming Resident Survey Willingness to Try CNMP

Surveyed farmer responses about the residue retention BMP are displayed below in Figures 8.10 and 8.11. Some respondents shared that this practice is not relevant because they grow hay or because they do not grow crops, use cover crops, use no till, or have small or have no acreage. Nearly 80% of respondents indicated that they are willing or may be willing to try this BMP. The farmers' top constraints of adopting this BMP are the desire to keep things the way they are, the features of their property make it difficult, or the lack of equipment.

Figure 8.10 Farming Resident Survey Familiarity with the Residue Retention BMP

Figure 8.11 Farming Resident Survey Willingness to Try the Residue Retention BMP

Surveyed farmer responses about the use of a grazing plan BMP are displayed below in Figures 8.12 and 8.13. Approximately 46% of respondents report this BMP as not being relevant to their property since most report they do not have livestock, do not have grazing animals, or have few livestock. Just less than 60% of respondents already use this BMP or are willing to try the BMP. The top reported constraints of adopting a grazing plan BMP are cost, the time required or the lack of equipment (though responses from people who report that this BMP is not relevant to their property may be included in the constraints data).

Figure 8.12 Farming Resident Survey Familiarity with Grazing Plan BMP

Figure 8.13 Farming Resident Survey Willingness to Try Grazing Plan BMP

Forty farmers responded to a question asking what is included in their nutrient management plans and results are displayed in Figure 8.14. Livestock manure and commercial nutrients are each covered in approximately 40% of the nutrient management plans.

Figure 8.14 Farming Resident Survey Sources Included in Nutrient Management Plans

Farming residents were asked questions about their septic systems and nearly 70% of farmers (~60) indicated that they regularly service their septic systems, while 15% indicated it is not relevant to their property, and 15% indicated they have not heard of, are somewhat familiar with, or are not practicing septic system servicing. Over 80% of respondents with septic systems did not want to be reminded of septic system maintenance or inspections by the local health department, though one respondent noted they receive reminders from the company who pumps their septic tank. When asked if people wanted a local government agency to handle inspections of septic systems, approximately 80% of respondents with septic systems answered no, which is much greater than the 42% of all non-farming respondents with septic systems that also answered no.

Most farmers (80%) reported they do not use a professional lawn care service and approximately 17% use a lawn care service for fertilizing and pest control, in contrast to the 46% of non-farmers who indicate they use a professional lawn care services for either mowing, fertilizing and/or pest control.

Farmers were asked how much 13 different issues limited the ability of farming residents to change their management practices, and there was a wide range of mean values, indicating a wide range of opinions. The issue most commonly reported as affecting their ability to change management practices was personal out-of-pocket expense. Respondents also reported that a lack of information, cost-share opportunities, physical ability or equipment as well as possible interference with land use practice flexibility, are reasons limiting their ability to change management practices. Respondents are not concerned about reduced yields or not being able to see a demonstration. Cost continues to be the primary constraint to BMP adoption.

8.2.2.7 Information Sources

Approximately half of the respondents (51%) had not been made aware of water quality issues in the RCW in the last year, 40% did not answer this question, and of the 9% of people who answered that they had learned of water quality issues in the RCW, most people (50%) had learned of the issue from the newspaper (mainly the Advance), their own observation or research was the second most common answer (17%), followed by Jamestown Township Board (2%), the mail or other sources not reported.

The survey asked farmers how much they trusted ten different organizations as sources of information. Farmer residents reported that they had the most trust in the Farm Bureau, followed by Soil and Water Conservation District, and University Extension. Farming respondents ranked government sources of information lower. There were fewer responses to questions about trusting other landowners/friends and the state environmental agency as compared to other sources. The lack of response to this question could be due to distrust in government. A fairly even distribution of responses indicates that some people are very trusting while others are not very trusting in information sources.

8.3 Goals and Objectives of the Information and Education Strategy

The goals and corresponding objectives of this Watershed Management Plan related to I/E, are outlined in Chapter 5 and included here.

Goal 1: Provide the direction necessary to restore water quality in impaired waters, so that the designated uses of total and partial body contact recreation are being met.

Goal 1 corresponding objectives:

c. Encourage use of existing technical support to increase BMP implementation in key areas *(included as a recommendation in this WMP, and requires implementation).*

d. Identify partnering municipalities, organizations and stakeholders; encourage communication and collaboration *(begun as a part of this WMP, and requires continued implementation).*

e. Develop and implement an Information and Education (I/E) campaign to target audiences, including landowners, agricultural producers, local governments, riparians and other stakeholders *(included as a recommendation in this WMP, and requires implementation).*

f. Manage Rush Creek so that it is accessible to kayakers *(included as a recommendation in this WMP, and requires implementation).*

Goal 2: Maintain designated uses that are currently being met by identifying the sources and causes of pollution that have potential to degrade water quality and threaten the designated uses; make recommendations for managing these pollutants.

Goal 2 corresponding objectives:

f. Recommend BMPs for specific locations that will lead to pollutant reduction *(included as a recommendation in this WMP, and requires implementation)*.
g. Develop and implement an I/E campaign to target audiences, including landowners, agriculture, local governments, and other stakeholders *(included as a recommendation in this WMP, and requires implementation)*.
h. Identify key partnering organizations and stakeholders; encourage communication and collaboration *(begun as a part of this WMP, and requires continued implementation).*
i. Encourage use of existing technical support to increase BMP implementation *(included as a recommendation in this WMP, and requires implementation)*.
j. Increase the amount of properly managed, permanently protected land *(included as a recommendation in this WMP, and requires implementation)*.
k. Work with local governments to ensure that existing ordinances are being implemented properly and to develop sensible protection ordinances *(included as a recommendation in this WMP, and requires implementation)*.

Goal 3: Develop a plan that maximizes the water quality, natural ecosystem functions, habitat, and aesthetics of the watershed.

Goal 3 corresponding objectives:

d. Identify BMPs for the residential, agricultural, and municipal land uses of the watershed that improve water quality and help to achieve this goal *(included as a recommendation in this WMP, and requires implementation)*.

e. Identify partnering municipalities, organizations and stakeholders; encourage communication and collaboration *(begun as a part of this WMP, and requires continued implementation)*.

Goal 4 Manage the watershed to minimize the impact of flashiness and other pollutants caused by development and land use practices while supporting the desired land use activities.

Goal 4 corresponding objectives:

a. Encourage local governments to establish sustainable land use planning and management techniques for water quality protection *(included as a recommendation in this WMP, and requires implementation)*.
b. Include recommendations that will reduce the flashiness and related sediment loading of the watershed through the restoration of wetlands, buffers, and floodplains as well as the construction of rain gardens *(included as a recommendation in this WMP, and requires implementation)*.
c. Use the SIDMA survey results to develop and implement an I/E campaign to target audiences, including landowners, agriculture, local governments, and other stakeholders *(included as a recommendation in this WMP, and requires implementation)*.
d. Encourage use of existing technical support to increase BMP implementation in key areas *(included as a recommendation in this WMP, and requires implementation)*.

Goal 5 Implement targeted education and action plans for the watershed's residents related to the pollutants, sources, and causes of the watershed that lead to land management changes resulting in improved water quality.

Goal 5 corresponding objectives:

b. Develop a plan that local organizations can use to make the target audience aware of the resources in their watershed, aware of the pollutants and causes of pollution in the watershed, and that their day-to-day activities can affect the quality of those resources. Develop a plan that local organizations can use to inform the target audiences of what actions and BMPs are recommended for them to adopted to reduce impacts *(included as a recommendation in this WMP, and requires implementation)*.
c. Further motivate the target audience to adopt and implement practices that will result in water quality improvements, with more detailed instruction, and further incentives *(included as a recommendation in this WMP, and requires implementation)*.
d. Incorporate watershed protection activities into local regulatory mechanisms, policies, land-use planning and land management decisions *(included as a recommendation in this WMP, and requires implementation)*.

Goal 6 Strengthen partnerships with local municipalities and organizations.

Goal 6 corresponding objectives:

a. Work with local municipalities on policy reviews *(begun as a part of this WMP, and requires continued implementation)*.
b. Work with local interested religious and educational organizations, including schools and churches *(begun as a part of this WMP, and requires continued implementation)*.

More specifically, the overall goal of the I/E strategy is to implement targeted education and action plans for the watershed's residents related to the pollutants, sources, and causes of the watersheds that lead to land management changes resulting in improved water quality.

There are two general phases of outreach: awareness/education and action. A different message and delivery mechanism is proposed to achieve these outcomes for various target audiences and various pollutants. The awareness/education phase emphasizes that residents or stakeholders must have a clear understanding of water quality problems, consequences, and the proposed solutions prior to any likely behavioral changes, while the action phase lists the action items needed to change behaviors to improve water quality. The objectives are as follows:

Awareness/Education Objective: Make the target audience aware of the unique resources in their watershed, aware of the pollutants and causes of pollution in the watershed, and that their day-to-day activities can affect the quality of those resources. Michigan's economy depends on clean water and clean water drives Michigan's economy. Our quality of life and ability to use the RCW and Michigan's water resources depends on good water quality. Inform the target audiences of what actions and BMPs are recommended for them to be adopted to reduce impacts. Inform the target audience about cost savings available, cost share programs, and incentives. Provide information, assistance, equipment resources and demonstration for recommended BMPs. Minor incentives can be included.

Action Objective: Further motivate the target audience to adopt and implement practices that will result in water quality improvements, with more detailed instruction, and further incentives. Inform the target audience about cost savings available, cost share programs, and incentives. Provide information, assistance, equipment resources and demonstration for recommended BMPs.

Action Objective: Incorporate watershed protection activities into local regulatory mechanisms, policies, land-use planning and land management decisions.

Specific tasks and methods are recommended in Tables 8.4 through 8.7 to achieve these objectives, and were developed by taking into account social survey information and watershed pollutants, sources, and causes.

8.4 Target Audiences

The most efficient I/E messages reach the audience members within the watershed community who can affect the most change to land management practices that are causing the pollution. The target audience for the I/E campaign is the watershed community. The target audiences are summarized below:

- Homeowners/ Residents (59,547 people/ 21,027 homes)
- Riparian land/home owners (two major neighborhoods with Lake Associations)

- Residents in rural areas without sanitary service (mainly Blendon, Jamestown, Byron Townships, and part of Georgetown Township)
- KCHD
- Municipalities- All (Cities of Grandville, Wyoming, and Hudsonville, and Blendon, Byron Center, Jamestown, and Georgetown Township)
- Municipalities outside urbanized area (Blendon, Byron Center, Jamestown Township)
- Road Commissions
- School Children
- Pet Owners
- Local landscaping companies
- Golf courses, schools, parks managers other turf managers

General watershed messages were developed in Chapter 8.6 and Tables 8.4 through 8.7 based on what is known about the residents and watershed from watershed demographics, social survey information, and watershed and water chemistry data.

8.5 Regional Collaboration and Partnerships

Partnerships are an effective and recommended way to reach the target watershed audience. Residents are connected with and trust different organizations. The implementation of the I/E Plan in the WMP should enhance and strengthen existing efforts through increased partnerships, funding and evaluation of outreach activities, and build new partnerships where needed.

<u>Proposed Rush Creek Watershed Council</u>

There is not currently a RCW watershed council, though there are community partners working within the RCW. The development of a RCW and the subsequent hiring of a watershed coordinator would be beneficial in the implementation of this RCW WMP.

<u>Hudsonville High School Green Team, and Trinity Christian Reformed Church</u>

Hudsonville High School's Green Team and Trinity Christian Reformed Church have been active organizations in RCW water monitoring and the watershed management planning process. As rooted organizations in the RCW, their continued involvement and partnerships will be an asset to implementing the RCW WMP. A continuation of these partnerships and an expansion of partnerships with other churches and schools are a recommended way to reach residents of the RCW.

<u>Lower Grand River Organization of Watersheds</u>

The RCW is in the Lower Grand River Watershed where the Grand Valley Metro Council (GVMC) houses LGROW, which coordinates the cooperation of watersheds and MS4 communities. Communities work both individually and collaboratively at the watershed level to manage their stormwater and to satisfy the requirements of the MS4 program, described in more detail in Chapter 9. As a part of their MS4 permits, communities share a Public Education Plan (PEP) since there is regional overlap in audiences, pollutants, messages, calls to action, events, cleanups, etc. This cooperative approach strengthens community partnerships.

Through LGROW, the GVMC coordinates the MS4 permits within the RCW for the Cities of Wyoming, Grandville, Hudsonville, Georgetown Township, KCRC, and the KCDC. In addition, GVMC's LGROW also oversees the PEP for OCRC, and OCWRC. The remaining municipalities within the RCW do not participate in the regional public education.

Education is coordinated through both LGROW and the local government agency. LGROW was rated as a slight to moderately trusted source of information, though many respondents were not familiar with the organization.

Though public education is a required component of the MS4 permitting for MS4 communities, there is room to expand the public education messaging and methods to better account for the RCW specific pollutants, sources, causes and target audience. Also, non-MS4 communities could partner with LGROW and MS4 communities to be included in regional I/E resources, and/or RCW I/E efforts could be expanded to include messages developed with RCW specific information collected as a part of this watershed management planning process.

<u>MDNR and MDEQ</u>
Respondents of the residential (non-farmer) survey reported their most trusted source of information as the MDNR and MDEQ. Information from these agencies should be used when possible.

<u>Local Township or City Governments</u>
Respondents of the residential (non-farmer) survey reported their second most trusted source of information as local townships or city governments. These government agencies should be used to help distribute RCW I/E messages when possible.

<u>Kent and Ottawa Drain Commissioners</u>
Respondents of the residential (non-farmer) survey reported their third most trusted source of information are the local drain commissioners. These government agencies should be used to help distribute RCW I/E messages when possible.

<u>Farm Bureau</u>
Respondents of the farmer survey reported their most trusted source of information as the Farm Bureau. The Farm Bureau should be used to help distribute RCW I/E messages and technical resources related to agriculture when possible.

<u>Conservation Districts</u>
Respondents of the farmer survey reported their second most trusted source of information as the Soil and Water Conservation Districts. The Conservation Districts should be used to help distribute RCW I/E messages and technical resources related to agriculture when possible.

<u>MSU-E</u>
Respondents of the farmer survey reported their third most trusted source of information as University Extension. Since the RCW contains specialized agriculture, including muck farming and greenhouses, specialized technical resources from MSU-E should be used for these fields when possible.

Other Potential Partners

There are several other programs, organizations and agencies that will be important partners in the implementation of the I/E Strategy. A non-exhaustive list of potential partner organizations have been identified that have an overlapping interest or use of the local water resources, or are a local community organization with a vested interest in the local community. These organizations are recommended as partners in implementing the Watershed Management Plan, and more specifically, parts of the I/E plan.

- Local businesses/industry

- Local church communities
- Ducks Unlimited
- FFA
- Friends of Buck Creek
- Groundswell
- Health Departments (Kent, Ottawa)
- West Michigan Land Conservancy
- Lake Associations
- Local Media
- Local Schools
- Macatawa Area Coordinating Council (MACC)
- MDARD
- Michigan Natural Shoreline Partnership
- NRCS
- Plaster Creek Stewards
- River City Wild Ones
- Road Commission
- Schrems West Michigan Trout Unlimited
- Veterinary Offices
- West Michigan Environmental Action Council
- West Michigan Sustainable Business Forum

The roles of these partners is further described in the I/E Tables 8.4 through 8.7 and Chapter 10.

Many of these organizations have existing programs that promote improved water quality through NPS pollution control or preservation, and these existing programs should be advertised, leveraged and utilized through this process as well. Examples include the Michigan Agricultural Environmental Assurance Program (MAEAP) Program, NRCS Farm Bill Programs, MDNR- Private Lands Programs, USFWS Partners for Fish and Wildlife, and Conservation Easements, to name a few.

Many partnerships were formed through the development of this WMP. Jamestown Township lead the Watershed Management Plan Grant Process. The Hudsonville High School Green Team helped present data at the public presentation. Display boards were subsequently posted at the Jamestown Township library for display. Trinity Christian Reformed Church provided macronivertebrate data they have collected for multiple years and other input for the WMP. Many municipalities contributed to the plan through meetings, email, and phone conversation. LGROW, MACC, Deer Creek and Bass River Watersheds shared information about successful programs in their nearby watersheds that can be expanded on for the RCW. These partners expressed much interest related to the implementation of the WMP.

8.6 Information and Education Messages

Generally, RCW residents and agricultural producers understand some of the RCW pollutants, though they don't fully understand the scale of pollution. Some residents understand nutrients, bacteria, and sediments are pollutants in the RCW, but most report they do not know what pollutants are problems. RCW residents would benefit from a better understanding of what pollutants are problems in the RCW. Residents and farmers believe that stormwater runoff from streets and highways, excessive use of lawn fertilizers and/or pesticides, and land development/redevelopment are the most problematic sources of pollution in the RCW. While these are sources of pollution in the RCW of concern, this list is not complete, and they do not understand the scale of the RCW's impairment or condition.

RCW residents and farmers generally understand their actions affect the water quality and report willingness to take action to improve water quality. However, fewer reported willingness to pay for changes to their behavior, and cost was the most common constraint to adopting BMPs.

Residents generally responded with a willingness to try various BMPs. However, the survey results also indicate there are some constraints to changing residents' and producers' behaviors. Limiting factors include money, equipment, and knowledge as some of the top reasons reported. Over half of residents (non-farmers) report that they include keeping grass clippings and leaves out of the roads, ditches and gutters, and following the manufacturer's instructions when fertilizing lawns and gardens. However, they also report lawns as a major pollution source. Many more BMPs are available for residents to adopt to improve the RCW. Nearly 70% of famers report regularly servicing their septic tanks, using grassed waterways to reduce erosion and soil loss, and use of cover crops. Windshield surveys and water chemistry data indicate additional BMPs are needed in the RCW at residential, commercial, and agriculture properties.

In addition to message information, technical and financial resources or incentives are also recommended. Furthermore, cost savings that can be achieved by BMP adoption should be emphasized in I/E messaging.

The known pollutants in the RCW are altered hydrology, pathogens and bacteria, sediment, nutrients, and increasing water temperatures. Using the social survey results, watershed pollutants and their causes, the following key general messages were developed. For each pollutant, more detailed messages are listed in Tables 8.4 through 8.7. Messages intended for target audiences will be based on these broad messages but should be customized and targeted for delivery.

Altered Flow Regime: Stormwater leaves your property and enters stormsewer pipes, drains, wetlands, creeks, and eventually reaches the local Rush Creek Watershed, the Grand River and Lake Michigan. Stormwater is not treated. Residential, commercial, and other land developments change the natural flows of rainwater, groundwater, and surface water. Changes to the hydrology affect water quality health, stream flows, stream stability, stream temperatures, flooding, and habitats. Rainwater runoff carries pollutants including sediment, nutrients, and bacteria so the goal is to slow the path of water to the drain. Rain barrels can capture rainwater that can be used for watering, saving money on water costs. Planting tree, native plants, and riparian vegetation can reduce runoff and improve water quality. Two-stage ditches can help reduce flooding. Stormwater that falls on developed areas is warmer and can affect fish habitat. Conserve money and water wisely.

Bacteria: Bacteria and pathogens pollute the Rush Creek Watershed, and failing and aging septic systems as well as farm animals and waterfowl are a known contributing sources of pollution. Bacteria and pathogen contamination affects our ability to swim and boat in the water. Michigan's economy depends on clean water and clean water helps to drive Michigan's economy. Our quality of life and ability to use the RCW and Michigan's water resources depends on good water quality. Following recommended septic system maintenance and management practices can reduce bacteria in the watershed.

Bacteria and viruses pollute the Rush Creek Watershed. Pick up your pet waste to protect our water quality.

Lawns and Turf: Stormwater leaves your property and enters storm sewer pipes, drains, wetlands, creeks, and eventually reaches the local Rush Creek Watershed, the Grand River and Lake Michigan. Stormwater is not treated. Michigan's economy depends on clean water and clean water drives Michigan's economy. Our quality of life and ability to use the RCW and Michigan's water resources depends on good water quality. Phosphorus and nitrogen from lawn care practices are pollutants of the RCW. An excess of nutrients can impair the scenic beauty of the RCW, lead to excessive aquatic plants, and also affect our drinking water. You can help to improve the RCW water quality with improved lawn care practices. Riparian vegetation in our lawns is important to water quality. Water wisely.

Agriculture Audience: Sediment, nutrients, and bacteria pollute the Rush Creek Watershed. These pollutants can impair the beauty of the RCW. Urban and agricultural sources of pollution are the cause. There are technical and financial resources available to help farmers with Best Management Practice adoption. Best Management Practices can be a financial benefit to your farm and water resources. Include specific information on BMPs such as: riparian vegetation, windbreaks, two-stage ditches, CNMP, tile line water level control, sediment control, nutrient management, waste management, and wetland restoration opportunities.

Table 8.4: I/E Altered Hydrology]

Focus: Altered Hydrology							
Messages: Stormwater leaves your property and enters stormsewer pipes, drains, wetlands, creeks, and eventually reaches the local Rush Creek Watershed, the Grand River and Lake Michigan. Stormwater is not treated. Residential, commercial, and other land developments change the natural flows of rainwater, groundwater, and surface water. Changes to the hydrology affect water quality health, stream flows, stream stability, stream temperatures, flooding, and habitats. Rainwater runoff carries pollutants including sediment, nutrients, and bacteria so the goal is to Slow the path of water to the drain. Rain barrels can capture rainwater that can be used for watering, saving money on water costs. Planting tree, native plants, and riparian vegetation can reduce runoff and improve water quality. Two-stage ditches can help reduce flooding. Stormwater that falls on developed areas is warmer and can affect fish habitat. Conserve money and water wisely.							
Critical Areas: Entire RCW, most important include developed areas of the RCW.							
Focus: Altered Hydrology			**Measureable Milestones**				
Target Audience	**Justified Need (SIDMA/Water Chemistry)**	**Source, Cause**	**Awareness/Education (within 3 years)**	**Action (3 or more years)**	**Potential Partners**	**Estimated Costs**	**Evaluation Method**
Municipalities outside urbanized area (Blendon, Byron Center, Jamestown Twp.)	Land use has changed from ~16-51% developed (Vogelmann, J.E., S.M. Howard, L. Yang, C. R. Larson, B. K. Wylie, and J. N. Van Driel, 2001 and Homer et. al, 2011): 84% of RCW wetlands have been lost; Modeled peak flow has doubled from 1992-2013 (FEMA)	Altered hydrology due to loss of wetlands; Non-pervious surfaces; Development	Meet with each local government and discuss ways they can implement the proposed Stormwater ordinances and design standards	Municipalities adopt county stormwater ordinances and design standards	LGROW, OCWRC, KCDC	$20,000/ municipality ($60,000 total)	Number of participating nonurbanized municipalities

Table 8.4: I/E Altered Hydrology (cont.)

Focus: Altered Hydrology			Measureable Milestones				
Target Audience	Justified Need (SIDMA/Water Chemistry)	Source, Cause	Awareness/Education (within 3 years)	Action (3 or more years)	Potential Partners	Estimated Costs	Evaluation Method
Residents	Land use has changed from ~16-51% developed (Vogelmann, J.E., S.M. Howard, L. Yang, C. R. Larson, B. K. Wylie, and J. N. Van Driel, 2001 and Homer et. al, 2011): 84% of RCW wetlands have been lost; modeled peak flow has doubled from 1992-2013 (FEMA); NSA found up to 50% of homes may have their gutters connected to the stormsewer; The majority of nonfarming surveyed residents do not know what the water quality and flooding trends of Rush Creek are and the majority of residents have not been made aware of any water quality or flooding trends from any source in the last year. Surveyed residents already believe land development and excessive use of fertilizers and/or pesticides are slight to moderate sources of pollution, and they report willingness to change the way they care for their lawn or yard. Environmental groups are ranked as a trusted source of information (following government sources), though approximately half of nonfarmer survey respondents indicated they are not familiar with local WMEAC and LGROW organizations. These organizations have existing applicable programs in the Grand Rapids Area. Local schools and churches have already participated in RCW activities. Conservation Districts are a trusted partner ranked by surveyed farmers and are a source of native plants. Surveys within Master Planning Documents (Hudsonville) showed that planting trees is important to residents. Surveyed residents do not understand much about fish and water quality implications. Annual MS4 Reports from Kent County and Hudsonville indicate that residents are most interested in learning about native plants, rain gardens, and buffers (GVMC, 2016b,e,f)	Altered hydrology due to loss of wetlands, tree removal; Non-pervious surfaces; Development; Direct connect of gutters to stormsewer	RCW watershed coordinator shares RCW water quality and water quantity information through a general education campaign shared through newspaper, TV, local government (websites, newsletters, and mailers to residents, possibly through their tax or utility bills), environmental groups, and other partners; Begin partnership and introduction of local environmental groups that are already working on rainscaping, rain barrel, native plants, trees, and similar BMPs (WMEAC Rain barrels, LGROW Grand River Rainscaping); Watershed-wide campaign about capturing rainwater though rain barrels, rain gardens, native plants, trees, streamside buffers, and disconnecting gutters from stormsewer. Hold informative workshops; Hold on-site meetings to complete site assessments; Contact landowners who own wetlands identified as priority preservation wetlands with information about wetland preservation programs.	Develop a Green Team with local students to help install LID and GI. Partners work with home and landowners to design and install rainscaping practices (rain gardens, rain barrels, trees, native plants, curb cut rain gardens, disconnect gutters from storm sewer) with cost shared design and installation services. Hold workshops about BMPs; Make demonstration sties available for homeowners to learn from.	Newly developed watershed council and Green Team; WMEAC, LGROW, Municipalities, Schools, Local watershed organization, Churches; Conservation Districts	watershed coordinator for I/E: \$60,000/yr. (10 yrs.).; \$2,000/ workshop (10); Fund incentives for infrastructure installation (see BMP table for costs); Flyers (\$10,000); Green Team (\$125,000/yr. for 5 years)	Workshop statistics (number of workshops held, number in attendance at workshops, social survey data collected from workshop participants); Number of BMPs adopted as measured by survey or count of BMPs installed

Table 8.4: I/E Altered Hydrology (cont.)

Focus: Altered Hydrology			Measureable Milestones				
Target Audience	**Justified Need (SIDMA/Water Chemistry)**	**Source, Cause**	**Awareness/Education (within 3 years)**	**Action (3 or more years)**	**Potential Partners**	**Estimated Costs**	**Evaluation Method**
Residents who own priority wetlands to protect	Land use has changed from ~16-51% developed (Vogelmann, J.E., S.M. Howard, L. Yang, C. R. Larson, B. K. Wylie, and J. N. Van Driel, 2001 and Homer et. al, 2011): 84% of RCW wetlands have been lost; Peak flow has doubled from 1992-2013 (FEMA); Environmental groups are ranked as a trusted source of information (following government sources), though approximately half of non-farmer survey respondents indicated they are not familiar with local WMEAC and LGROW organizations. Conservation Districts are a trusted partner ranked by surveyed farmers and are a source of native plants.	Altered hydrology due to loss of wetlands,	Through aerial photo and/or parcel review, identify properties with the largest quantity of and highest quality wetlands identified as priority preservation wetlands. Contact landowners who own wetlands identified as priority preservation wetlands with information about wetland preservation programs through flyers, door hanger, letters, or phone call. Share information about wetland protection programs.	Secure wetland protection	KCDC, OCWRC, Conservation Districts, Land Conservancy of West Michigan, Ducks Unlimited,	watershed coordinator for I/E: $60,000/yr. (10 yrs.); Fund incentives for infrastructure installation (see BMP table for costs); Flyers ($10,000)	Number of acres of wetlands protected
Homeowners-Riparian	NSA found that many lakes did not have a riparian buffer and there was an opportunity for trees in those neighborhoods. Land use map shows tree coverage lacking along creeks and drains, especially in the Main Branch; Riparian properties can have a larger impact on surface water quality due to their proximity; Surveys within Master Planning Documents (Hudsonville) showed that planting trees was important to residents. KCRC reported that native vegetation/ rain gardens/ riparian buffers were an I/E topic of great interest to their residents (GVMC, 2016f).	Manicured landscapes, over or improper application of fertilizers to residential, commercial, and municipal lawns; Altered hydrology due to loss of wetlands, tree removal; Non-pervious surfaces; Development; Direct connect of gutters to stormsewer	Through Lake Association newsletters, local governments, social media, and meetings share information about riparian buffers, trees, Natural Shorelines, native plants, and proper fertilizer, pesticide, and herbicide use; Host Water Quality summit; Share information outlined for residents above, in nutrients, and bacteria sections.	Cost shared design and Installation services; Hold informative workshops like a "Water Quality Summit" for Lake Associations and larger riparian neighborhoods; Create demonstration sites	Lake Associations, Local governments, Conservation Districts, Local watershed organization(s),	watershed coordinator for I/E: $60,000/yr. (10 yrs.); $1,000/water quality summit (4)	Summary of how residents were reached with information; Workshop statistics (number of workshops held, number in attendance at workshops, social survey data collected from workshop participants); Number of BMPs adopted as measured by survey or count of BMPs installed

Table 8.4: I/E Altered Hydrology (cont.)

Focus: Altered Hydrology			Measureable Milestones				
Target Audience	**Justified Need (SIDMA/Water Chemistry)**	**Source, Cause**	**Awareness/Education (within 3 years)**	**Action (3 or more years)**	**Potential Partners**	**Estimated Costs**	**Evaluation Method**
Road Commissions	Culvert inventory not completed as a part of RCW watershed management planning process but culverts are often a source of sediment in watersheds. Ottawa County Road Commission already participates in this program with nearby MACC as the program provides good information for their records.	Undersized or Multiple Culverts;		Expand road crossing inventory program (similar to that within the Macatawa Watershed) into Rush Creek Watershed; Begin road crossing inventory and share data with road commission while looking for opportunities to improve road/stream crossings for road commission and water quality benefits: Adopt and implement coordinated maintenance program for drain maintenance, culvert replacements, stream and road crossing maintenance	Local watershed organization(s), Road Commissions (Kent, Ottawa), Micorps, volunteers, churches	$7,000/ County Maintenance inventory Program development + cost of needed culvert replacements	Road/Stream crossing inventory percent completed; Percent of culverts replaced or improved based on data collected
SESC	NSA found two sites with bare soil exposed. Rapid development of the RCW.	Development	Communicate with SESC about need for diligent management	Increased oversight	Local watershed organization(s)	watershed coordinator for I/E: $60,000/yr. (10 yrs.)	Response from SESC; Observed new development sites

Table 8.4: I/E Altered Hydrology (cont.)

Focus: Altered Hydrology			Measureable Milestones				
Target Audience	**Justified Need (SIDMA/Water Chemistry)**	**Source, Cause**	**Awareness/Education (within 3 years)**	**Action (3 or more years)**	**Potential Partners**	**Estimated Costs**	**Evaluation Method**
Students	Reaching students In educational settings can help build foundations of water quality knowledge for long term benefits, reaching younger students and their parents. Education level related to watershed knowledge in SIDMA survey.	Altered hydrology due to loss of wetlands, tree removal; Non-pervious surfaces; Development; Direct connect of gutters to stormsewer; *E. coli* sources, agriculture sources, maintained landscape	RCW watershed coordinator or other educational programs share RCW water quality and water quantity information with teachers and students	Students participate in watershed projects such as stenciling storm drains, sharing information with parents and other community members through educational events, Green Team development and participation in watershed projects (rain gardens, native plantings, tree plantings, etc.) at their school sites or other locations	Hudsonville High School Green Team, Trinity Christian Reformed Church, LGROW, WMEAC, Groundswell	watershed coordinator for I/E: $60,000/yr. (10 yrs.); $5,000 materials	Student surveys taken after lessons; Student project participation
				Ten Year Total	**$1,338,000**	**+costs in Table G2**	

Table 8.5 I/E Pathogen and Bacteria (Humans and Dogs)

<table>
<tr><td colspan="8">Focus Pathogens and Bacteria</td></tr>
<tr><td colspan="8">Messages: Bacteria and pathogens pollute the Rush Creek Watershed, and failing and aging septic systems are a known contributing source of pollution. Bacteria and pathogen contamination affects our ability to swim and boat in the water. Following recommended septic system maintenance and management practices can reduce bacteria in the watershed. Bacteria and viruses pollute the Rush Creek Watershed. Pick up your pet waste to protect our water quality.</td></tr>
<tr><td colspan="8">Septic Critical Areas: Rural areas located outside of sanitary service coverage area, primarily Blendon, Jamestown, and Byron Townships, and some of Georgetown Township. Homes with septic systems within urbanized areas (<15 Grandville, 10-15 Hudsonville, <5 Wyoming)</td></tr>
<tr><td colspan="8">Pet Waste Critical Areas: Medium to highly developed areas, especially Georgetown Township, Hudsonville, Wyoming, Grandville, and more densely developed neighborhoods</td></tr>
<tr><td colspan="3">Focus: Pathogens and Bacteria</td><td colspan="2">Measureable Milestones</td><td></td><td></td><td></td></tr>
<tr><td>Target Audience</td><td>Justified Need (SIDMA/Water Chemistry)</td><td>Source, Cause</td><td>Awareness/Education (within 3 years)</td><td>Action (3 or more years)</td><td>Potential Partners</td><td>Estimated Costs</td><td>Evaluation Method</td></tr>
<tr><td>Residents (Rural Areas located outside of Sanitary Service Coverage Area, primarily Blendon, Jamestown, Byron Townships, and part of Georgetown Township; specific homes in Wyoming, Grandville, and Hudsonville)</td><td>Survey results indicate majority (over 60%) of households with septic systems are maintaining their systems, however soil survey maps indicate soil types and groundwater depth may be unsuitable for traditional septic systems. Surveyed residents report bacteria and viruses as their second (farmer) or third (non-farmer) priority pollutant and consider it a slight problem. Surveyed residents think improperly maintained septic systems are a slight to moderate source of pollution, ranked as the second (farmer) or third (non-farmer) priority source. In contrast, data show failing septic systems are a critical source of pollution impairing water quality. Septic systems in RCW are an average of 28 years old. Surveyed residents don't have full understanding of what a septic system does or how to tell if it is failing. Cost, desire to keep things the way they are, and insufficient proof of water quality benefit are the reasons preventing people from septic maintenance. The majority of surveyed residents do not want reminders from the local health department. Local partners advise including more than flyers in Information and education campaign.</td><td>Septic Systems</td><td>Hold general I/E campaign about bacteria and virus pollution presence and septic system sources in RCW through Newspaper, TV, Local Governments (Township), Conservation District, and Environmental group partners: Publicize WMP findings and septic maintenance recommendations in newspaper and TV; Information should include that septic systems are a source of water pollution (bacteria and nutrient) and related impacts to swimming and boating, septic maintenance guidance. Seek septic tank pumping/inspection coupons and information distribution from local companies. Distribute info. through Townships and/or tax bills; Determine homes using septic systems (Byron and Blendon Townships) and send targeted mailers; Send targeted mailers to households with septic systems (Jamestown, Georgetown) to households with septic systems within urbanized areas (Wyoming. Grandville, Hudsonville)</td><td>Since cost was listed as the number 1 constraint to BMP adoption: Develop and implement incentives for homeowners through cost share program to inspect/ repair/ replace septic failures/ problems, especially in Ottawa County which is currently eligible for 319 grant funding because they have a septic ordinance; Continuation of outreach and education campaign; Priority homes should be closest to creeks and drains; Reach homeowners with targeted mailers sent directly to their homes.</td><td>Trusted Sources of Info. for Farmers: Conservation Districts; Farm Bureau; University Extension: Trusted Sources of Information for non-farmers: MDEQ, Local Government, WMEAC/ LGROW</td><td>$1.00/ mailer (1,000); watershed coordinator for I/E: $60,000/yr. (10 yrs.).; $40,000 to develop campaign materials; Monetary incentives to pump, maintain, and repair septic systems in Ottawa County.</td><td>Increase in homes maintaining septic systems measured through social survey or septic coupon redemption; Increase in inspection, repair and replacement measured through cost share program.</td></tr>
</table>

Table 8.5 I/E Pathogen and Bacteria (Humans and Dogs) (cont.)

Focus: Pathogens and Bacteria			**Measureable Milestones**				
Target Audience	**Justified Need (SIDMA/Water Chemistry)**	**Source, Cause**	**Awareness/Education (within 3 years)**	**Action (3 or more years)**	**Potential Partners**	**Estimated Costs**	**Evaluation Method**
Residents	Requested by Health Department Partner; Reportings of illicit discharge at watershed public meeting	Septic Systems, Septage, biosolids, manure haulers	Advertise Illicit Discharge Citizen reporting methods	Advertise Illicit Discharge Citizen reporting methods	LGROW, Health Departments, Drain Commissioners, Municipalities, Watershed Council	watershed coordinator for I/E: $60,000/yr. (10 yrs.); $10,000 I/E materials	Record of advertisement
KCHD	No sanitary service maintenance ordinance exists	Septic Systems	Organize and facilitate Septic Systems Work Groups to outline tasks needed to develop and adopt risk-based septic system policies; Coordinate partnerships between municipalities and health departments; Presentations to municipalities.	Continue Septic Systems Work Group if needed; Adopt and implement coordinated risk based septic system ordinances; Seek sustainable funding.	KCHD; MDEQ; Real Estate Industry	work group facilitation and reporting $100,000/ Health Department (1); $1,000/ public meeting (10)	Implemented septic policy and enforcement review
Municipalities (Byron/ Blendon)	Septic systems are a known source of pollution in the RCW. Septic systems installed at higher densities are known sources of pollution. Many municipalities and the State of Michigan have policies to require or encourage connection of sanitary sewer service where it is available within a certain distance. Septic systems in the RCW are a reported average of 28 years old.	Septic Systems	Meet Byron and Blendon Townships about *E. coli* pollution in RCW and septic system sources	Municipalities require homes to connect to sanitary service that is accessible within set distance, and abandon septic systems.	Municipalities	watershed coordinator for I/E: $60,000/yr. (10 yrs.)	Summary of meetings with Municipalities

Table 8.5 I/E Pathogen and Bacteria (Humans and Dogs) (cont.)

Focus: Pathogens and Bacteria			**Measureable Milestones**				
Target Audience	**Justified Need (SIDMA/Water Chemistry)**	**Source, Cause**	**Awareness/Education (within 3 years)**	**Action (3 or more years)**	**Potential Partners**	**Estimated Costs**	**Evaluation Method**
Pet Owners (especially in more developed areas, Wyoming, Grandville, Georgetown Township, Hudsonville, Jamestown Twp. and other areas with more concentrated housing) and municipalities	NSA found dog waste bags were not available in all subdivision type neighborhoods assessed. There may be around 12,112 dogs in the RCW if residents have average number of dogs according to AVMA. Source tracking indicates that canines were a contributing source of bacteria.	Dog waste not picked up	Pick up your pet waste campaign through signage, newspapers, TV, local government; Install pick up your pet waste signs/stations and bags; Expand pet waste pledge campaign (LGROW)	Maintain filling of pet waste stations with bags; Municipal ordinance adoption	Municipalities; LGROW, WMEAC, Lake and Neighborhood Associations; Veterinarian Offices;	watershed coordinator for I/E: $60,000/yr. (10 yrs.); Pet waste bags $500/yr. (10); Pet waste stations $300/each (100); up to $10,000 per ordinance (up to 7)	Increase of installed pet waste stations and need for bag refills; Ordinance adoption: record of pet waste pledge numbers
Homeowner Associations	NSA found dog waste bags were not available in all subdivision type neighborhoods assessed. There may be around 12,112 dogs in the RCW if residents have average number of dogs according to AVMA. Source tracking indicates that canines were a contributing source of bacteria.	Dog waste not picked up	Encourage homeowner associations to include pet waste pickup requirements in their association rules/bylaws	Adoption of pet waste rules in neighborhood association rules/bylaws.	Neighbor-hood Associations	watershed coordinator for I/E: $60,000/yr. (10 yrs.)	Increase of pet waste rules adopted.

Estimated 10 year Costs $256,000 **+costs in Tables 8.4 & G2**

Table 8.6: I/E Messages for Agriculture Audience

Focus: altered hydrology, sediment, pathogens and bacteria, nutrients, pesticides, herbicides							
Messages: Sediment, nutrients, and bacteria pollute the Rush Creek Watershed. These pollutants can impair the beauty of the RCW. Urban and agricultural sources of pollution are one cause of pollution. There are technical and financial resources available to help farmers with Best Management Practice adoption. Best Management Practices can be a financial benefit to your farm and water resources. Include specific information on BMPs to include: riparian vegetation, windbreaks, two-stage ditches, CNMP, tile line water level control, sediment control, nutrient management, waste management, and wetland restoration opportunities.							
Critical Areas: Agriculture land use areas modeled in HIT (Figure 4.7), Farms with livestock animals (Figure 4.13), Farms identified in Critical Areas (Figure 10.3)							
Focus: altered hydrology, sediment, pathogens and bacteria, nutrients, pesticides, herbicides			**Measureable Milestones**				
Target Audience	**Justified Need (SIDMA/Water Chemistry)**	**Source, Cause**	**Awareness/Education (within 3 years)**	**Action (3 or more years)**	**Potential Partners**	**Estimated Costs**	**Evaluation Method**
Agricultural Producers with tillable acreage	HIT Model; Nutrient concentrations over WQC; Impaired water from bacteria; Surveyed farmers understand their actions affect water quality and understand good water quality affects our quality of life and report a willingness to change their management practices to improve water quality, though fewer report willingness to pay more for these practices. Surveyed farmers believe sediment, bacteria, and nutrients are a slight problem, though nearly half of surveyed farmers do not know what pollutants are problematic to the RCW. Surveyed farmers rank agricultural sources of pollution as only slight problems behind more urban type sources. Nearly half of farmers do not know if removal of riparian vegetation is a source of pollution. Surveyed farmers think consequences of water quality pollution are less problematic than residents. Nearly 30% of surveyed farmers had not heard of two-stage ditches and over half of surveyed farmers don't think tile water level regulation is applicable to their property, when it most likely is relevant; Over 30% of surveyed farmers are not familiar with CNMP or residue retention and majority report they are or may be willing to try; Cost, lack of equipment, desire to keep things they way they are, physical abilities, and lack of equipment were some of the top reasons cited for limiting management practices; Half of farmer survey respondents say their property touches a stream, river, lake, or wetland. Most trusted sources cited as: Farm Bureau, Conservation District, and University Extension. Farm service agencies and crop consultants are listed as the next most trusted sources of information, have been successful partners in neighboring Macatawa watershed, and expand the resource and audience. 40-50% of surveyed farmers don't know if the flooding or water quality of Rush Creek is getting better or worse, nor have they heard reports about it in the last year. Equine, bovine, turkey sources identified through MST.	Cropland: Tillage Practices, Cultivation of steep slopes or drainage ways; Removal of Trees and Fence Rows; Improper application of manure and fertilizers	Ag. technical resource connects with and establishes relationship with the estimated 90 farmers in the RCW through one-on-one meetings; Share information about existing agricultural technical and cost share programs available; Provide BMP information; Provide cost share incentives; Perform farm assessments and share information about relevant BMPs for each farmer (nutrient and waste management, sediment reduction, tillage practices, buffers); Report WMP findings, sources, and causes of pollution in local newspapers, through local Conservation District, through local government agencies; Include information on BMPs for proper CAFO waste use	Continue one-on-one meetings; Increased adoption of Ag BMPs; Additional NRCS and MAEAP Program outreach; Provide Incentive/Cost-Share opportunities; Focus group about buffers	Farm Bureau, Conservation Districts, MSU-E, Agronomic service providers	watershed coordinator for I/E: $60,000/yr. (10 yrs.); full time technical resource $70,000/yr. (6) hired in coord. with a trusted source of information; $1,500/ focus group (3)	Participation in one-on-one meetings with Ag. Technical resource.; Increase of partner or other incentives redeemed; MAEAP Program data on risk reductions and verified practices; Focus group meeting results; Increase in partnerships; Increase in BMP adoption

Table 8.6: I/E Messages for Agriculture Audience (cont.)

Focus: altered hydrology, sediment, pathogens and bacteria, nutrients, pesticides, herbicides			Measureable Milestones				
Target Audience	**Justified Need (SIDMA/Water Chemistry)**	**Source, Cause**	**Awareness/Education (within 3 years)**	**Action (3 or more years)**	**Potential Partners**	**Estimated Costs**	**Evaluation Method**
Agricultural Producers and hobby farmers with livestock	Survey indicates farms have 1-359 animals (cattle, hogs, poultry, horses, goat, sheep); Approximately 53-70 farms with animals; 16-50 homes with 1-3 horses on less than ten acres; See 'Agricultural producers with tillable acreage' above	Livestock holding facilities	Ag. technical resource connects with and establishes relationship with the estimated 53 farmers in the RCW through one-on-one meetings; Share information about existing agricultural technical and cost share programs available; Provide BMP information; Provide cost share incentives; Perform farm assessments and share information about relevant BMPs for each farmer (nutrient and waste management, sediment reduction, tillage practices, buffers); Report WMP findings, sources, and causes of pollution in local newspapers, through local Conservation District, through local government agencies	Continue one-on-one meetings; Increased adoption of Ag. BMPs; Additional NRCS and MAEAP Program outreach; Provide Incentive/Cost-Share opportunities; Focus group about buffers	Farm Bureau, Conservation Districts, MSU-E, Agronomic service providers	watershed coordinator for I/E: $60,000/yr. (10 yrs.); full time technical resource $70,000/yr. hired in coord. with a trusted source of information	Participation in one-on-one meetings with Ag. Technical resource.; Increase of partner or other incentives redeemed; MAEAP Program data on risk reductions and verified practices; Focus group meeting results; Increase in partnerships; Increase in BMP adoption

Table 8.6: I/E Messages for Agriculture Audience (cont.)

Focus: altered hydrology, sediment, pathogens and bacteria, nutrients, pesticides, herbicides			Measureable Milestones				
Target Audience	**Justified Need (SIDMA/Water Chemistry)**	**Source, Cause**	**Awareness/Education (within 3 years)**	**Action (3 or more years)**	**Potential Partners**	**Estimated Costs**	**Evaluation Method**
Green-houses managers/ owners	25 properties with greenhouses were identified.	Fertilizer application in plant cultivation	Provide one-on-one technical resource information for greenhouses (MSU-E may have resources); Share information about existing agricultural technical and cost share programs available; Provide BMP information; Provide cost share incentives; Report WMP findings, sources, and causes of pollution in local newspapers, through local Conservation District, through local government agencies	Continue one-on-one meetings; Increased adoption of BMPs; Provide Incentive/Cost-Share opportunities	Farm Bureau, Conservation Districts, MSU-E, Agronomic service providers	MSU-E technical resource $10,000: watershed coordinator for I/E: $60,000/yr. (10 yrs.); full time technical resource $70,000/yr. (6) hired in coord. with a trusted source of information; BMP cost shares (see BMP table)	Measure of one-on-one meetings held; Measure of BMPs adopted

Table 8.6: I/E Messages for Agriculture Audience (cont.)

Focus: altered hydrology, sediment, pathogens and bacteria, nutrients, pesticides, herbicides			Measureable Milestones				
Target Audience	**Justified Need (SIDMA/Water Chemistry)**	**Source, Cause**	**Awareness/Education (within 3 years)**	**Action (3 or more years)**	**Potential Partners**	**Estimated Costs**	**Evaluation Method**
Muck farmers	Nutrient rich organic muck soil (ancient Grand River tributary floodplain) has been converted into farmland. The groundwater table is especially high in areas with muck soils. Muck soils are typically higher in nitrogen. Windbreaks and ground cover are also needed to protect the nutrient rich soil from wind erosion (Silva, MSU-E, 2012). In the RCW, winter cover crops are less common for muck soils, and soil loss has become a large problem for the muck fields; Muck soils are less common soils and thus require more specialized knowledge for BMP adoption	Muck farming	Provide one-on-one technical resource information for muck farmers (MSU-E may have resoruces); Share information about existing agricultural technical and cost share programs available; Provide BMP information; Provide cost share incentives; Report WMP findings, sources, and causes of pollution in local newspapers, through local Conservation District, through local government agencies	Provide cost incentives for windbreaks, cover crops, and other BMPs	MSU-E	MSU-E technical resource $10,000: watershed coordinator for I/E: $60,000/yr. (10 yrs.); full time technical resource $70,000/yr. (6) hired in coord.with a trusted source of information; BMP cost shares (see BMP table)	Measure of one-on-one meetings held. Measure of BMPs adopted
Agricultural Producers	Buffer strips are not commonly used in the RCW, and are reportedly not a popular BMP in the agricultural community. Often buffer strips are not popular because they reduce productivity of some land adjacent to a drain or creek that may otherwise be farmed; ~45% of farmers who responded to survey have property adjacent to stream, river, lake, or wetland	Cropland, Livestock	Hold a series of focus groups with farmers to understand their opinions about buffer strips, and how to increase the adoption of buffer strips, or an equally effective BMP, in the RCW. Discuss ideas on how to successfully incentivize buffer and filter strips that are now unpopular and uncommon	Provide innovative financial assistance programs to encourage installation of buffer/filter strips	Conservation Districts, Farm Bureau, MSU-E	$1500/ focus group meeting (3)	Focus group participation and input
			Estimated 10 year Costs	**$444,500**	**costs in Tables 8.4, 8.5 & G2**		

Table 8.7: I/E Lawns and Turf

Focus: Nutrients, herbicides, pesticides							
Messages: Stormwater leaves your property and enters storm sewer pipes, drains, wetlands, creeks, and eventually reaches the local Rush Creek Watershed, the Grand River and Lake Michigan. Stormwater is not treated. Michigan's economy depends on clean water and clean water drives Michigan's economy. Our quality of life and ability to use the RCW and Michigan's water resources depends on good water quality. Phosphorus and nitrogen from lawn care practices are pollutants of the RCW. An excess of nutrients can impair the scenic beauty of the RCW, lead to excessive aquatic plants, and also affect our drinking water. You can help to improve the RCW water quality with improved lawn care practices. Riparian vegetation in our lawns is important to water quality. Water wisely.							
Critical Areas: Developed areas							
Focus: Nutrients, herbicides, pesticides			**Measureable Milestones**				
Target Audience	**Justified Need (SIDMA/Water Chemistry)**	**Source, Cause**	**Awareness/Education (within 3 years)**	**Action (3 or more years)**	**Potential Partners**	**Estimated Costs**	**Evaluation Method**
Local landscaping companies	Approximately half of non-farming residents report using a professional landscaping company for part or all of their lawn maintenance needs. Approximately 20% of farming residents use a professional landscaping company for part of their lawn landscaping needs. Some neighborhoods in NSA appeared to be managed by one landscaping company. The nearby Macatawa Watershed operates a successful Lawn Care Seal of Approval program to encourage BMP use by landscaping companies.	Maintained landscapes		Watershed coordinator connect with local landscaping companies; Set up RCW Lawn Care Seal of Approval Program or expand MACC program by connecting with local landscaping companies, annually seeking their commitment to BMP use, advertising Lawn Care Seal of Approval companies; Seek municipal support in hiring only approved companies.; Continue annual seal of approval commitments;	MACC; Conservation Districts, Municipalities; Landscaping companies; Local watershed organization; Homeowner and Lake Associations	watershed coordinator for I/E: $60,000/yr. (10 yrs.); Program set up and advertising $5,000 annually; Training module $20,000	Number of landscaping companies committing to program and the amount of customers they service in the RCW.

Table 8.7: I/E Lawns and Turf (cont.)

Critical Areas: Developed areas							
Focus: Nutrients, herbicides, pesticides			**Measureable Milestones**				
Homeowners & Businesses with maintained lawns	Surveyed residents agree that it is their responsibility to help protect water quality and are willing to change the way they care for their lawn to improve water quality. Less residents report willingness to pay more to change their practices, indicating a cost share may be necessary or information helping residents how water quality protective behavior changes may help them save money. Surveyed residents believe that phosphorus and nitrogen are the RCW's biggest pollutants and are slight to moderate problems. Surveyed residents believe that excess lawn fertilizers and/or pesticides and land development are moderate sources of pollution, though one third of respondents, don't know. Surveyed residents have the least amount of knowledge about riparian vegetation. The issues limiting surveyed residents management practices generally include: cost, information and equipment. Most residents have not been made aware of any water quality issues in the RCW, and of those who have, most said they heard about them through the newspaper, TV, or on their own. Government sources were the most trusted source of information, followed by environmental groups, though nearly half of residents were not familiar with local environmental groups. Cost is a common reported constraint to adopting BMPs by surveyed residents, so highlight ways Michigan's economy is helped and not hindered by improved water quality. Land use has changed from ~16-51% developed (Vogelmann, J.E., S.M. Howard, L. Yang, C. R. Larson, B. K. Wylie, and J. N. Van Driel, 2001 and Homer et. al, 2011). NSA identified potential for improved lawn/landscaping and irrigation practices, rain gardens or rain barrels, buffers or native plants, and trees. Annual MS4 Reports from Kent County indicate that residents are very interested in learning about proper use of pesticides/fertilizers/herbicides (GVMC, 2016f)	Maintained landscapes	RCW part-time watershed coordinator shares RCW water quality information through a general education campaign shared through newspaper, TV, local government (websites, newsletters, and mailers to resident, possibly through their tax or utility bill), environmental groups; Improved lawn care practices can help improve the RCW water quality and its scenic beauty. Lawn care BMPs protective of water quality can reduce costs (optimized fertilizer, pesticide, and herbicide applications, proper grass mowing height, proper watering procedures, clean grass clippings and fertilizer from surfaces); Encourage native plants and trees; Encourage and soil testing;	Hold workshops on proper lawn care; Make demonstration sties available for homeowners to learn from; Incentives for soil tests	Municipalities; Conservation Districts; Local Watershed organization; WMEAC; LGROW, church's, schools, Neighborhood Associations, MSU-E	watershed coordinator for I/E: $60,000/yr. (10 yrs.); $20,000 to develop campaign materials; Flyers ($10,000); Soil tests ($25/test, 21,027 households, assume up to 25% soil test, $132,000)	Increase in participating homeowners as measured through social survey; Attendance at workshops and survey questions following workshops; Number of soil tests performed

Table 8.7: I/E Lawns and Turf (cont.)

Critical Areas: Developed areas							
Focus: Nutrients, herbicides, pesticides			**Measureable Milestones**				
Golf Courses, Schools, Parks managers other turf managers	Golf courses apply fertilizers and pesticides to maintain their greens. Six golf courses are located in the RCW. Though generally golf courses contribute less fertilizers and pesticides than residential, strip development, and agricultural land uses they still are contributors of pollutants that can be managed.	Maintained Turf		Connect with 6 golf courses in the RCW; Provide information about CMTESP ; Golf courses and other turf managers complete and adopt 12 module environmental stewardship certification program, including pesticide, fertilizer, and buffer strip BMPs	CMTESP Program	watershed coordinator for I/E: $60,000/yr. (10 yrs.); $350/ certification cost plus additional costs ranging from $100-$30,000 each site.	Number of CMTESP certified facilities
		Estimated 10 year Costs	**$231,100**	**+costs in Tables 8.4, 8.5, 8.6 &G2**			

8.7 Informational Resources

A number of resources are available that contain messages applicable to the RCW. These resources should be utilized in developing exact content and materials for I/E sharing with the community. Residents reported in the survey that the two most highly trusted sources of information were state and local governments and local environmental groups. Farmers reported the most trusted sources of information include the Farm Bureau, the Soil and Water Conservation District, and the University Extension.

- EPA (https://www.epa.gov/hwp/tools-and-resources-protect-watersheds)
  - Resources available related to all relevant watershed topics
- MDEQ (https://www.michigan.gov/deq/0,4561,7-135-3313_71618_3682_3714---,00.html)
  - Resources available related to all relevant watershed topics
- MDNR (https://www.michigan.gov/dnr/0,4570,7-350-79136_79236---,00.html)
  - Resources available related to aquatic life, stream habitat, coldwater streams
- MSU-Extension and other University Extension Resources (https://www.canr.msu.edu/water_quality/ and http://www.iwr.msu.edu and http://www.canr.msu.edu/outreach/)
  - Listed as the third trusted source of information in the farmer SIDMA survey
  - Resources available related to riparian fencing, septic systems, BMP practices, plants, forests, etc.
- Conservation Districts (http://kentconservation.org and http://www.ottawacd.org)
  - Listed as the second trusted source of information in the farmer SIDMA survey
  - Resources available related to agricultural programs including MAEAP, technical assistance, BMPs, and forest management.
- LGROW (https://www.lgrow.org)
  - Resources available related to Lower Grand River Watershed specific information, rainscaping, BMPs.
- WMEAC (https://wmeac.org)
  - Resources available related to rain barrels and green infrastructure benefits and calculations
- NRCS (https://www.nrcs.usda.gov/wps/portal/nrcs/site/national/home/)
  - Resources available related to agricultural programs, technical and financial assistance, and BMPs
- Michigan Natural Shoreline Partnership (http://www.mishorelinepartnership.org)
  - Resources available related to land management adjacent riparian areas
- Groundswell (https://www.gvsu.edu/coe/cep/groundswell-6.htm)
  - Resources available related to watershed education in the schools

8.8 Implementation

While partners can implement a majority of the I/E messaging, a watershed coordinator is recommended to help coordinate partners, grants, resources, and recommended programs.

The estimated costs for implementing all components of the I/E plan are $762,000 for a ten year time period. The costs associated with some proposed tasks in the I/E plan are included in the BMP table in Appendix G, and thus are not included in the total calculated I/E cost. These tasks could be considered BMPs or technical assistance and are not just I/E.

More than one pollutant may be addressed with the I/E Campaign at a time, as some BMPs may address more than one pollutant.

The majority of surveyed residents, both farmers and non-farmers, report they have not been made aware of water quality issues in the RCW. Those who have been made aware of water quality issues learned of them through the newspaper (mainly the Advance) and TV. These media sources should continue to be used to reach the RCW residents and target audiences. In addition, social media, including Facebook, should be used to reach local residents.

Local Events

There are several recurring, local events that focus on responsible watershed management. Many of these events are hosted through LGROW or local government agencies as a part of MS4 permit requirements. Other events, such as the Trinity Christian Reformed Church Volunteer Stream Monitoring program is not a part of the MS4 program but still supports the health of the RCW. The volunteer team monitors the macroinvertebrate communities annually in Rush Creek. This is a hands-on activity for volunteers and an opportunity to educate them about indicators of water quality. Many other local events, such as the Hudsonville Fair held annually in August are excellent ways to reach members of the RCW.

This I/E strategy recognizes the importance of these events and encourages the continuation of them.

8.9 Evaluation

Evaluation of the education campaign provides feedback to understand the effectiveness of the I/E Strategy, and allow for adaption where needed. Social survey information collected during this planning process provides a baseline comparison prior to the I/E Activity.

After several components of the I/E strategy have been implemented, a follow-up SIDMA survey of watershed residents will be considered to assess additional changes in knowledge and behavior. The follow-up survey would again target two audiences: residential and agriculture.

Additionally, surveys will be used following workshops and/or hands-on events to assess knowledge gain, and to develop a level of understanding and interest among participants pertaining to different topics. These evaluation techniques allow the project team to assess the effectiveness of outreach programs and change them as needed to more adequately address topics of concern. Conversations and/or focus group discussions with outreach partners will also be used to assess the effectiveness of programs and identify gaps in programming across the watershed.

Tables 8.4-8.7 recommend an evaluation method for each targeted audience, pollutant, and message to assess the success of each delivery mechanism. In addition to the evaluations in the I/E table, continued monitoring of the water quality (described in Chapter 11) will indicate signs of improvement, degradation or no change. The following questions should be considered during implementation of the I/E Strategy, as also recommended in the Lower Grand River Organization of Watersheds I/E plan (2011):

- 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? (p. 7-14)

These evaluation methods will be used to help provide an understanding of the effectiveness and challenges of the I/E activities, and allow for adaptations as needed.

8.10 Funding Acknowledgement

It is important to acknowledge Partners and Funders on outreach materials developed.

9.0 ORDINANCE REVIEW AND RECOMMENDATIONS

Local governments have opportunities to protect RCW water quality through adoption and enforcement of regulatory mechanisms, such as local zoning, resolutions, and policies. The adoption of regulatory mechanisms is in alignment with the WMP goals, as they help to protect water quality and minimize the impact of development, while supporting the desired land uses.

Potential regulatory mechanisms related to stormwater vary by government agency in the RCW. Much of the land within the RCW is within the Grand Rapids urbanized area, as defined by the 2016 US Census (https://www.epa.gov/npdes/urbanized-area-maps-npdes-ms4-phase-ii-stormwater-permits) and is subject to different regulation than non-urbanized land through a NPDES MS4 Permit. Many local government agencies rely on their MS4 permitting requirements, with assistance from LGROW or MACC, for their stormwater management.

Of note, Kent County and Ottawa County municipalities within the RCW have drafted new Stormwater Ordinances and County development rules (standards manuals) that have been submitted to the MDEQ for review and approval with their MS4 permit documents. For consistency, there are many similarities between the two county ordinances. The proposed development rules relate to post construction control activities and outline infiltration and stormwater management requirements for proposed development, and are enforced through the stormwater ordinance. In both counties, a model ordinance, a standards manual, and a stormwater design calculator tool for MS4 permittees were developed to utilize in their implementation of the new post-construction stormwater control requirements outlined in the 2016 NPDES Permit Application (GVMC, p. 4-5, 2016). The municipalities are expected to adopt versions of the ordinances after permit issuance by MDEQ. The adoption of post construction control ordinances is very important for addressing some of the NPS pollutants identified in this WMP, including water quantity and sediment. Recommendations included in this WMP assume that these ordinances will be approved and adopted. The draft or final stormwater ordinances should be reviewed in context with this WMP to evaluate any possible remaining gaps.

Though many of the local government agencies within the RCW are a part of the MS4 permitted areas, some local governments are only partially included in the urbanized area and some are not included in the urbanized area, and thus are not required to participate in stormwater management through the MS4 program. For better watershed protection, it is recommended that the local jurisdictions within the RCW participate in the applicable components of the MS4 stormwater management program.

A review of the MS4 program, current activities under the MS4 program, existing stormwater related local policies, and additional regulatory mechanism related recommendations are included below.

9.1 Municipal Separate Storm Sewer

The focus of this WMP is on NPS pollution. In urban areas, NPS pollution is actually considered a point source and is regulated as such. As a large part of the RCW is regulated under the MS4 program, a full understanding of it is useful as recommendations beyond those that are being addressed in the MS4 program can help to reduce NPS stormwater pollution. The MDEQ discusses the significance of the MS4 program to protect and improve water quality in the Draft Michigan's Statewide *E. coli* Total Maximum Daily Load:

> Storm water is runoff from rain or snow-melt. In urban communities, storm water often enters into pipes and roadside ditches or flows directly across roads and parking lots before entering surface water. An urban landscape prevents much of the storm water runoff from soaking into the ground due to impervious surfaces like building roofs and pavement, leaving pollutants to be carried untreated to surface waters. As storm water flows across the developed landscape and through

pipes and drains, it becomes contaminated by pet and wildlife waste, trash, and other pollutants. Sometimes sewage from homes and businesses comes into contact with the storm water because the plumbing is improperly connected to the storm sewer, rather than entering the sanitary sewer. This situation is called an illicit connection to storm sewers, and they are illegal under all circumstances.

Municipalities with a regulated MS4 (e.g., separated storm sewer pipes, parking lots, public roads, and roadside ditches) located within an urbanized area with a discharge to surface waters are required to have the MS4 permit. These permits are generally issued to counties, cities, townships, universities, public school systems, airports with public areas, and state agencies. Urbanized areas are defined by the U.S. Census Bureau and updated after each major population census, every ten years. When new census results are released, the new urbanized area is added to the previous area. This means that as urbanized areas grow over time, new MS4 permittees are identified and issued permits in accordance with MDEQ regulations, but the regulated areas never shrink. Some areas within the MS4 permitted municipality may not be subject to permit requirements; for example, townships often own or operate a regulated MS4 on small parcels of property (e.g., township hall or library), and are only regulated if that property is part of the urbanized area. If a municipality is located in an urbanized area, but is found to have no storm sewer outfalls that enter surface water, a permit may not be issued.

Cities, villages, and townships are required to have their own MS4 permit. Other municipal entities may have their own MS4 permit, or they may be included (“nested”) in the MS4 permit of another municipal entity (such as a school district that is nested within an MS4 permitted city).

Like other types of storm water, potential sources of *E. coli* from these MS4s include: illicit sanitary connections to storm sewers, and contaminated runoff during storm events. Contamination of runoff can be from pets, feral animals, nuisance wildlife (especially those that are attracted to human habitation, such as raccoons), improper garbage disposal (such as diapers or cat litter), and failing septic systems (such as failures that result in seepage to the storm sewer). (p. 29, 2017a, Referenced Figures and Sections removed)

Under the MS4 individual permit, all permittees are required to reduce the discharge of pollutants (including *E. coli*) from their MS4 to the maximum extent practicable through the development and implementation of a Public Involvement and Participation Program, a storm water-related Public Education Program, an Illicit Discharge Elimination Program (IDEP), a post-construction Storm Water Control Program for new development and redevelopment projects, a Construction Storm Water Runoff Control Program, and a Pollution Prevention/Good Housekeeping Program for municipal operations.

The IDEP requirements of the permits have great potential to reduce *E. coli* levels in impaired water bodies. The IDEP requires permittees to develop a program to find and eliminate illicit connections and discharges to their MS4. This includes a plan to conduct dry-weather screening of each MS4 outfall and point of discharge at least once every five years (unless an alternative schedule or approach is approved by the MDEQ). If an *E. coli* TMDL is identified in the notice letter to apply for permit coverage, the applicant must submit a TMDL Implementation Plan as part of the application. Upon issuance of an MS4 individual permit, the permittee is required to implement the approved TMDL Implementation Plan with the goal of reducing the discharge of *E. coli*. The permittee is required to demonstrate that they are making progress in meeting WQS as part of the TMDL Implementation Plan. Requirements in future MS4 permit revisions may be different, but must be consistent with the goals of this TMDL.

> The individual MS4 permits discharging to a USEPA-approved *E. coli* TMDL area, are required to implement prioritized BMPs to be consistent with the requirements and assumptions of the TMDL and TMDL Implementation Plan. By prioritizing BMPs, permittees are able to focus their efforts, which will help to make progress towards meeting Michigan's WQS. To demonstrate progress, permittees are required to monitor the effectiveness of the BMPs during the permit term. MS4 permittees may choose to work collaboratively on the TMDL Implementation Plan to address an *E. coli* impairment. Collaborative efforts may provide an opportunity to work with watershed or regional partners in a cost-effective manner.
>
> The Michigan Department of Transportation statewide MS4 is not an expected source of *E. coli* due to the nature of their operations; however, their permit requires the reduction of the discharge of pollutants to the maximum extent practicable and employment of BMPs to protect water quality. In their current permit (as of 2015), the Michigan Department of Transportation has electively chosen to apply their MS4 permit requirements to their MS4 statewide (including state roads, rights of way, and facilities), regardless of the urbanized area delineation. (p. 30, 2017a)

Areas that are considered urbanized by the U.S. Census Bureau are shown in Figure 9.1. Communities that own and/or operate a storm sewer system, within the urbanized area are required to have an MS4 permit. Of note, only portions of Blendon, Jamestown, and Byron Townships are considered urbanized, but they do not have MS4 permits since they do not own or operate a storm sewer system. The urbanized areas in those townships are subject to the MS4 rules, covered by the Road Commissioner or Drain/Water Resources Commissioners. MDEQ determined that Georgetown does own and operate enough of a storm sewer system on township-owned property that they are required to have an MS4 permit. The public education and stormwater ordinance will apply to the entire township even though not all of it is in the urbanized area. The Cities of Grandville, Wyoming, and Hudsonville are entirely included in the urbanized area and, thus have MS4 permits.

In the RCW, communities work both individually and collaboratively at the watershed level to manage their stormwater and to satisfy the requirements of the MS4 program. In areas where there is a TMDL, the permittees identify and prioritize actions to "identify and prioritize actions to reduce pollutants in storm water discharges from the MS4 to make progress in meeting WQS. These prioritized actions shall be reported to the Department as indicated in their Certificates of Coverage" (LGROW, p. 6-29, 2011).

Through LGROW, the GVMC coordinates the MS4 permits within the RCW for the Cities of Wyoming, Grandville, Hudsonville, Georgetown Township, and KCRC and the KCDC. In addition, GVMC's LGROW also oversees the PEP for OCRC, and OCWRC. MACC assists the RC and OCWRC in their permit management and compliance.

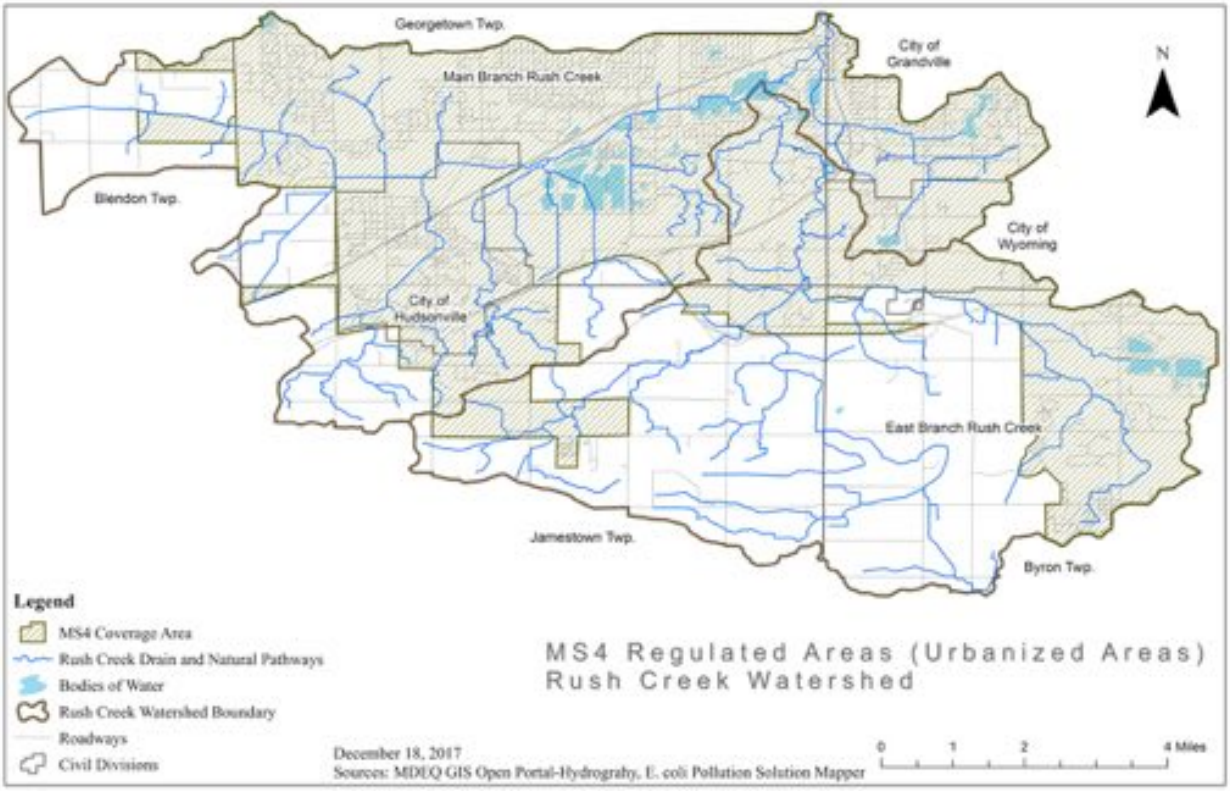

Figure 9.1 MS4 Regulated Areas

9.2 MS4 and Local Ordinance Review

Though much of the RCW is managed under the MS4 program, there are opportunities to further reduce NPS pollution by exceeding the requirements of the MS4 permit. The current MS4 activities and existing ordinances were assessed through a review of recent Progress Reports and Local Government Ordinance Review Checklists completed by Byron and Jamestown Townships and the Cities of Hudsonville and Wyoming (included in Appendix G). Current reported practices and ordinances are included below by jurisdiction. For consistent water quality management, the entirety of the RCW should follow applicable MS4 management and educational practices outlined in the permit requirements. Currently, only designated urbanized areas are required to follow MS4 permit requirements.

A resource that is not included here, but one that will be useful for making land use decisions is the Single Source Project under development by GVMC, via Regis. The project will map zoning maps, transportation information, and environmental data (GVMC, p. 12-13, 2016). This resource may be useful in the implementation of the Rush Creek WMP.

Recommendations on how to address NPS pollution in the RCW beyond the measures taken in the MS4 permit are detailed in this chapter and in Chapters 8 and 10.

9.2.1 Kent County

Some programs and management operate at a county government level, or have been adopted by multiple township or city governments, as described below.

“Permitted communities within the Lower Grand River Watershed have developed procedures for managing vegetation and using fertilizers on Permittee owned properties. A brochure updated in 2014 allows for permitted MS4s to customize and distribute it to their staff, contractors, and local landscaping businesses (GVMC, p. 15 2016).”

Health Department

Kent County does not have an ordinance requiring point-of-sale septic system inspections. “The permitted entities within Kent County rely on implementation of their stormwater MS4 Illicit Discharge Elimination Program and the Health Department’s follow up on failing or failed septic systems. Where failed septic systems are found, a connection to sanitary is typically required if a sanitary sewer connection is available within 250 feet” (GVMC, p. 11, 2006). The Health Department does not have jurisdiction to require homes to connect to sanitary service that have not been reported and confirmed to be failing (Steve Petrides, personal communication, December 14, 2017). Suspected failed septic systems or other illicit discharges can be reported to the Health Department general number 616-632-6900.

The health department is in the process of converting their septic files to an electronic database that will be made available to the public when completed (Steve Petrides, personal communication, December 14, 2017).

Drain Commissioner

KCDC is working with MDNR and other communities to control Canada goose populations through egg destruction, goose relocation, and nest destruction (GVMC, p. 11 2016e).

The current Post Construction Control Activity requirements are detailed below from the MS4 2016 Annual Report:

> All new plat developments reviewed by the Kent County Drain Commissioner within Kent County are required to be equipped with detention facilities for stormwater. This requirement may be waived if it can be demonstrated to the Drain Commissioner’s satisfaction that the off-site drainage facilities exist and are adequate. This is provided that easements and water quality issues have been addressed.
>
> The stormwater detention facility shall be designed in accordance with criteria established by the County Drain Commissioner. The Commissioner may determine the need to incorporate more stringent design requirements into the stormwater drainage system for either water quantity control or water quality control in response to local need.
>
> The purpose of stormwater management is to prevent flooding, minimize property damage, prevent erosion, eliminate nuisance conditions, lower overall costs, and improve overall water quality.
>
> Stormwater management is required to provide protection from flooding by limiting the post-developed peak rate of discharge (volume, velocity, & concentration shall also be considered); recharge groundwater where possible by allowing for retention of runoff where soils are compatible; and pollution abatement by retention with percolation or detention without infiltration (wet detention).
>
> The design storm serves as the basis for design. The selection of the storm duration and distribution affects the resulting runoff volume and peak discharge rate.

> The basin discharge controls shall be based on the peak release rate of 0.13 cfs/acre or at times 0.05 cfs/acre and the first 0.5” of runoff shall be held for not less than 12 hours or more than 24 hours.
>
> If deemed necessary to insure adequate maintenance of the proposed stormwater facilities, the Commissioner may require the Proprietor to establish, in whole or in part, the proposed storm water facilities as a county drain upon their completion.
>
> The county does not have planning and zoning authority and therefore relies upon the local unit of government to direct growth to identified areas, to protect sensitive areas such as wetlands and riparian areas, to maintain and/or increase open spaces, and to encourage infill development in higher density urban areas and areas with existing infrastructure. (GVMC, p 21, 2016e)

The KCDC participates in public education required through the MS4 permit process. Their 2016 educational activities included flyer distribution in their office and at Grand Rapids Public Schools elementary schools, and distributing information on the Drain Commissioner and County websites. They identified the native plants/rain gardens/buffers and septic system maintenance were the topics of most interest to residents. They also noted observing a higher number of residents picking up dog waste in their 2016 progress report (GVMC, 2016e).

The KCDC performed dry weather screening for illicit discharge and “inspected 543 outfalls and found 131 with dry weather flow. From the 131 only 7 were flagged from testing results as being a possible illicit discharge. 4 out of the 7 are illicit discharges; 2 of which are from Landfills under the jurisdiction of the Department of Public works which is working towards a solution, the leaking garbage compressor is still being addressed by local township and the other was an illicit discharge from a sanitary connection from a single family home. Through all the inspections and testing only 7 potential illicit discharges were identified out of the 543, resulting in a 1.3% return“ (GVMC, p. 54, 2016e).

In 2012 KCDC adopted a number of Operating and Maintenance procedures for items including the management of their streets, vegetation, use of fertilizers, and TSS reduction efforts.

Road Commission

Many of the KCRC operating procedures were adopted as a part of the MS4 permit requirements. The most recent procedures for street sweeping, dust control, snow removal, roadway and bridge maintenance, roadside vegetation management, etc. were adopted in 2012. A new draft stormwater policy for KCRC was developed in December 2016, including a Good Housekeeping and Pollution Prevention Best Management Practices Manual for Structural and Operational Stormwater Controls. Staff and contractors also complete biennial training on pollution prevention topic areas (GVMC, 2016f).

The KCRC works to reduce the amount of chlorides used in winter deicing operations by spreading them in the center of the road and allowing traffic to spread it across the roadway instead of applying materials to the entire width of the roadway (GVMC, 2016f).

The reported information and education topics of greatest interest to the public that the KCRC interfaces with are native vegetation/rain gardens/riparian buffers, proposed use of pesticides/fertilizers/herbicides, and proper hazardous waste management (GVMC, 2016f).

9.2.1.1 Grandville

The southern portion of the City of Grandville is located within the RCW, while the remainder and majority of the City is located in the Buck Creek Watershed. The City is required to have an MS4 permit. The City shares newsletter articles on their website and in a bi-monthly web-based newsletter. They report that their residents are most interested in information and education topics including reporting stormwater pollution, proper yard waste disposal, proper pet disposal, and household hazardous waste management. Residents reported a few illicit discharges in 2016.

Approximately 60 storm drains located across the city (not all necessarily in the RCW) are marked to discourage dumping in the storm drain. A storm drain awareness activity took place in the Whispering Springs neighborhood in 2015. The City of Grandville participates in river cleanups for Buck Creek and the Grand River. The City has provided 32,000 pet waste bags at various locations in 2015-2016.

In 2010, Grandville adopted a number of Operating and Maintenance procedures for their streets, vegetation, use of fertilizers, and TSS reduction efforts.

Sanitary sewer service is provided by the City of Grandville to its residents, the City of Hudsonville and portions of Georgetown Charter Township, reducing the number of residents on septic systems (GVMC, p. 11-12, 2016a).

Grandville Public Schools are nested in the city’s MS4 permit.

The City of Grandville is pursuing a Tree City USA Designation through the Arbor Day Foundation. A Grandville Tree Committee has been appointed by the Grandville City Council to work on this designation (City of Grandville Ken Krombeen, personal communication, January 16, 2018). The Grandville Community Tree Project Strategic Plan is included in Appendix J (Tornga, 2017). This designation provides a framework for managing their public trees. Trees provide a multitude of NPS pollution benefits and should be encouraged. Trees can reduce Total Nitrogen and Total Phosphorus pollutant loading by 23.8% and TSS 5.8% when compared to pollutant loading from turfgrass land uses, and 8.5%, 11.0%, and 7.0% respectively when compared to pollutant loading from impervious cover land uses (Hynicka and Divers, 2016 found in Cappiella et al., 2016).

The City of Grandville is active and interested in the protection and restoration of the adjacent Buck Creek Watershed with the Friends of Buck Creek watershed group. The Buck Creek Watershed and the RCW share many similarities, and opportunities to partner efforts between the watersheds to further amplify NPS pollution reduction efforts should be pursued.

Ordinance Review

A completed ordinance review was not provided for inclusion in this WMP. The City of Grandville anticipates updating their ordinances as they relate to stormwater after the new Stormwater Ordinances and County development rules have been approved by the MDEQ (City of Grandville Ken Krombeen, personal communication, January 16, 2018).

The City requires homes within 100 feet from sanitary service lines to connect to the service.

9.2.1.2 Wyoming

The southwest corner of the City of Wyoming is located in the RCW. The City is required to have an MS4 permit.

The City adopted the Good Housekeeping and Pollution Prevention Best Management Practices Manual submitted to the MDEQ for review in 2015.

The current Post Construction Control Activity requirements are detailed below from the MS4 2016 Annual Report:

> The City of Wyoming has a Post-Construction Storm Water Ordinance, Number 28-96, adopted on January 6, 1997 that controls stormwater in areas of development. It ensures that the owner of the development site is responsible for maintenance of the stormwater controls or the City will provide maintenance as necessary and at the expense of the property owner. During site development plan review, a drainage plan must be prepared that specifies ownership and maintenance responsibility (Sec. 86-381).
>
> This ordinance works in conjunction with other internal ordinances to ensure stormwater quality. Chapter 38 of the City Code regulates construction in floodways, and prohibits, among other things, sewage disposal systems and storage of hazardous materials. Chapter 90 (Zoning) requires site plan review for specific developments (Sec. 90-48(1)). This site plan must include topographic information, surfacing materials and a grading plan, and must consider surface water drainage. The City's Land Use Plan 2020, adopted in 2006, recognizes that increased residential densities are necessary. To that end, the Land Use Plan recommends a re-evaluation of the zoning ordinance. As part of WMP objectives, the City commits to reviewing the current ordinance and existing LID measures and potentially incorporating such measures into its regulatory structure. The City's sanitary sewer code mandates connection to its sanitary sewer system if the structure is within 200 feet of the sanitary sewer (Sec. 86-136).
>
> City ordinances allow for the usage of BMPs to control stormwater quality, and may verbally recommend such BMPs to a developer. As previously mentioned, maintenance of these BMPs must be clearly defined as part of the site plan submittal (Sec. 86-358). (GVMC, p. 24, 2016c).

The City educates their residents about stormwater at an annual Public Works Open House, where over 1,700 people attended in 2016. They report the most popular information and education topics pertain to the proper use of pesticides/fertilizers/herbicides and household hazardous waste. The City of Wyoming produces a web-based newsletter and posts stormwater related articles on their website. The general stormwater webpage has received nearly 5,000 visits. (GVMC, 2016c).

The City of Wyoming participates in the Buck Creek Cleanup and was a major partner in the recently completed Buck Creek Monitoring Project, funded, in large part, by a Clean Michigan Initiative grant.

Storm drain markers are applied to the City of Wyoming storm drains in response to dumping complaints.

<u>Ordinance Review</u>

The City of Wyoming follows WMP recommendations from LGROW. Significant management and MS4 stormwater permit changes are expected soon, updating the current 2003 permit and subsequent management. A new stormwater ordinance is expected to be adopted following the reissuance of the MDEQ stormwater permit.

The City has a Stormwater Master Plan from 1996, but the plan does not include inventories and/or recommendations regarding overall local or regional green infrastructure. The City has set BMPs for new impervious surfaces. The existing Master Plan references needs for a comprehensive system of stormwater collection, storage, diversion or movements. There are existing stormwater ordinances set for developments that are either greater than or less than one acre, among others (Section 86). Standard design criteria for stormwater management, as published by the KCDC applies. Stormwater review is required with every site plan review. A form-based code has been adopted for certain areas within the City, though not in the area of the City located within the RCW.

As per Section 86 of the City of Wyoming's Ordinances, failing or illicit septic systems located within a set distance (200 feet) of a sanitary main must connect to adjacent sanitary service, or be repaired if located greater than the sanitary main set distance. (Section 86-133-141, https://library.municode.com/mi/wyoming/codes/code_of_ordinances?nodeId=PTIICOOR_CH86UT_ARTIIISASESY_DIV1GE_S86-133ABWAPO, June 8, 2017, accessed November 9, 2017).

The City posts information on their website to help answer general questions about the municipality. Information to help with stormwater permitting can be found at: https://www.wyomingmi.gov/About-Wyoming/City-Departments/Public-Works/Engineering/Construction-Requirements. Stormwater conveyance proposed in new subdivision (plats) is reviewed as a part of the site plan and planning commission review. The Engineering Department and Planning Department help with building permits, land or land use changes, building occupancies, and general code enforcement. Pre-application conferences are conducted with design professionals and city staff to discuss stormwater issues and priorities involving site development. The Planning Commission reviews Site Plans and discusses stormwater concepts. A local engineering review of the plans is also completed. County, state, and federal land use change rules also apply. While a final site plan review is required by the City of Wyoming, there are currently no monitoring requirements. Monitoring requirements are anticipated to be a requirement under a future ordinance.

9.2.1.3 Byron Township

Byron Township does not have MS4 permit requirements.

<u>Ordinance Review</u>

The Master Plan is periodically updated, with the last major update undergone in January 2017. The Master Plan includes inventories and/or recommendations regarding overall local or regional green infrastructure. However, the Master Plan does not make recommendations regarding comprehensive water quality or protection or a comprehensive system of stormwater collection or storage. It does incorporate strategies or BMPs from an approved WMP. The Master Plan uses a rational or normative basis for determining population levels and concentrations, and types and locations of land use, incorporating mixed-use and village center land uses. The Master Plan includes guidelines for complete streets. It also uses public opinions to help develop goals, objectives, and action items.

Subdivisions (i.e. land divisions) and condominiums are regulated in the ordinances. Water quality and management is spread throughout existing zoning ordinances, including requirements for managing stormwater on land development sites.

General information about Byron Township is on their website www.byrontownship.org. Building officials, the Township Clerk, and planning personnel from consultant Williams and Works are the main contacts for land use, building, and code enforcement. Pre-application meetings with various Township departments are conducted prior to development, though no initial planning commission reviews are required regarding use or development. Proposed developments require a local engineer's review. A final review is required, as well as monitoring by the Planner, Inspection Office, and Clerk.

Public water and sewer are services are offered in the township, administered by Byron Township in coordination with the Charter Township of Gaines and with water and sewer services provided by the City of Wyoming. However, connection of existing structures is only required under certain instances, including failure of an existing private sewage disposal facility, or if the Township determines it is a necessity based on public health and welfare.

The Byron Township Water and Sewer Ordinance (2008) requires a stormwater application and permit, including a drainage plan, Kent County approved Erosion and Sedimentation Control Permit, and signed maintenance agreement, for new developments. Private sewage waste is not allowed to be land applied in the Township and must be transported to public septage water treatment facilities.

The KCRC and/or KCDC manage the storm sewer system.

The Byron Township website has links for educational materials related to water use, stormwater, and septage, including links to LGROW.

9.2.2 Ottawa County

Department of Public Health

Of note in Ottawa County is the OCDPH Real Estate Transfer Evaluation Program that includes a mandatory evaluation of septic systems at a home or business before the time of sale. The program identifies septic systems requiring maintenance, repair or replacement, which is beneficial for the RCW. It does not prevent the sale of the property nor does it specify who is responsible for correcting any problems found during the inspection (Ottawa Department of Public Health). Failing septic systems that are identified through this program are required to be replaced. Septic systems that do not meet the current code do not have to be brought up to the current septic system code. Through this program, approximately 1,300 septic systems are inspected each year across Ottawa County (which extends beyond the boundary of the RCW), and of those systems approximately 25% of properties require a correction to either their well or septic system, and approximately 80-100 properties require a new septic system. Septic systems on small lots and installed in clay soils often fail (Matt Allen, personal communication, December 12, 2017). A 10% failure rate is used in estimating septic failures for the RCW.

Ottawa County, and other municipalities with point of sale inspection programs, are eligible to apply for federal grants to voluntarily inspect and or improve septic systems.

Water Resources Commissioner

The OCWRC works with MACC on achieving their MS4 permit compliance. In addition, they help to extend the reach of the educational efforts of LGROW and MACC, through efforts including information dissemination to the public, events, committee involvement, and storm drain stenciling.

The OCWRC houses stormwater educational information on their website.

In the neighboring Macatawa Watershed, the OCWRC constructed the Park West Drain as a system of bioswales to help improve the quality of the stormwater. A similar practice may help improve the water quality of the RCW.

Road Commissioner

The OCRC works with MACC on achieving their MS4 related requirements. OCRC helps to extend the reach of the educational efforts of LGROW and MACC, through efforts including information dissemination to the public, committee involvement, and storm drain stenciling.

A new Illicit Discharge Elimination Program plan has been adopted for the OCRC that will be implemented starting in the 2018 Fiscal Year, including improved datasheets and Road Soft Software. No outfalls, of the 51 inspected by the OCRC in 2016-2017, required further investigation (MACC, 2017b).

As a part of the MS4 program, they have established a catch basin inspection and street sweeping schedule. Streets in the urbanized area, and some streets in the non-urbanized area, are scheduled to be swept annually in the spring.

The following information about Pollution Prevention and Good Housekeeping is excerpt from the MACC OCRC October 2015-2017 MS4 Storm Water Progress Report and provides information on OCRC BMPs that extend into the RCW:

> In 2016, the OCRC removed 105 tons of material from catch basins. Street sweeping resulted in the removal and proper disposal of 1,078 tons of material
>
> The OCRC engages with the agricultural community in the maintenance of roadside ditches in rural areas of the county. They also encourage the use of agricultural best management practices adjacent to roadside ditches to protect water quality.
>
> Snow plow trucks are equipped with GPS units to track in real time the use of salt, sand and de-icing agents. This helps to reduce and minimize salt usage. The OCRC is also in the process of constructing new salt storage facilities for the Coopersville and Hudsonville garages. Once construction is complete, the county will have 4 enclosed buildings and containment for salt storage. (MACC, p. 13, 2017b)
>
> The OCRC swept 210 miles of county road that removed 1,391 tons of material. There were no changes to the parking lot/street sweeping schedule and no changes in sweeping priorities. (MACC, p. 16, 2017b)

The OCRC is an Authorized Public Agency, which enables them to administer the SESC program on their own projects.

The OCRC recently replaced large culverts in the county at the end of their life expectancy. In comparison to the old culverts, the newly installed culverts are sized to improve stream hydrology. In the neighboring Macatawa Watershed, the OCRC is helping the MACC to evaluate road-stream crossings as a source of sediment in order to prioritize stream crossing repair and replacement.

9.2.2.1 Georgetown Township

Portions of Georgetown Charter Township collaborate with the City of Grandville for sanitary sewer service (GVMC, p. 11-12, 2016d). Jenison Public Schools is a nested jurisdiction under the Georgetown Township's MS4 permit.

The following text is excerpt from the Georgetown Township 2016 MS4 Annual Report regarding the current stormwater ordinance:

> Georgetown Township has a Storm Water Ordinance, Ord. No. 2002-01, §§ 1.01--9.01, Chapter 48 as amended, revised 3-1-06, that controls stormwater in areas of new development and

significant redevelopment. It includes various levels of control depending on zones established based on the sensitivity of the receiving waters. The ordinance also ensures that the owners of facilities constructed to meet the stormwater requirements properly operate and maintain the facilities.

The Township requires specific practices for water quality and stream protection as follows: Sec. 48-43. Stormwater discharge rates and volumes.

The township and/or OCDC is authorized to establish minimum design standards for stormwater discharge release rates and to require dischargers to implement on-site retention, detention or other methods necessary to control the rate and volume of surface water runoff discharged into the stormwater drainage system, in the following circumstances:

(1) A parcel of land is being developed in a manner that increases the impervious surface area of the parcel; or

(2) The discharge exceeds the OCDC and/or township's calculated predevelopment discharge characteristics for the subject property, and the OCDC and/or township determines that the discharge is a violation of the drainage, flooding or soil erosion regulations of this chapter. (Ord. No. 2002-01, § 3.03, 2-11-02)

As described in Article VIII of the Ordinance, the Township requires Low Impact Development practices through its storm water management standards at sites of new development and significant redevelopment if located in Zone A of the Township.

The Storm Water Ordinance includes regulations that adhere to the Floodplain Ordinance and the Soil Erosion and Sedimentation Control program of the Township.

Storm water retention/detention issues and all inspection maintenance issues are complaint driven.

When issues are brought to our attention they are referred to the Public Works Department. At that time they are visited and categorized depending on who has possession or jurisdiction over the said area.

- Ottawa County Drain Commission - Call Drain Commission with issue
- RC- Call Road Commission with issue
- Private Ownership- Call owner with issue and corrective measures to pursue. If not completed in timely manner Township will make corrections and charge to owner or place on tax rolls. Issues are almost always corrected under Code Enforcement if not under storm water ordinance.
- Georgetown Charter Township property- Corrective measures taken. (GVMC, p. 21-22, 2016d)

The Township distributes educational materials for the MS4 program in their office and with their printed winter tax bills. In addition a stormwater poster board display was set up at the Georgetown Township Office building. They also have stenciled storm drains, and hung doorknob flyers about storm drains (GVMC, 2016d).

Of particular success in 2016 was the MS4 Illicit Discharge Elimination Program, where 16 failing septic systems were connected to sanitary sewer (GVMC, 2016d).

In the Annual Report, Georgetown Township reported working with OCWRC to rebuild and enclose the Chicago Drive Drain and clean a floodplain shelf on Rush Creek (GVMC, 2016d).

Ordinance Review

The Township does not have a lot of ordinances pertaining to stormwater runoff, but does require an approved drain permit from the OCWRC before a building permit is issued (Rod Weersing, email communication, June 20, 2017).

9.2.2.2 The City of Hudsonville

The entire City of Hudsonville is located in the main branch subwatershed of the RCW. Though the City celebrates its agricultural roots from the 1800's to present, the entire City is classified as an urbanized area that requires MS4 stormwater permitting.

The City is included in the LGROW MS4 permit. Information included in the 2016 Annual Report is included here to help better understand current stormwater management, and how and where improvements can be made.

The City has buffer provisions within their zoning ordinances. A portal is available on the City website for residents to report nuisance wildlife. The City of Hudsonville's sewage is treated at the Grandville Cleanwater Treatment Plant (GVMC, p. 11, 2016b).

Green infrastructure and LID are emphasized at the municipal level, and I&E efforts about rain gardens, buffer strips, and native plantings are also targeted directly to homeowners.

There are no gravel roads in the City of Hudsonville. Therefore, RCW sedimentation from gravel roads is not a concern.

The City has adopted the Kent County Model Storm Water Ordinance for Storm Water Controls with some minor adjustments to manage post-construction stormwater, as copied below.

ARTICLE IV. STORMWATER CONTROL

***Editor's note:** Ordinance No. 04-249, adopted 12-14-04, amended Art. IV in its entirety to read as herein setout. Former Art. IV pertained to similar subject matter and derived from Ord. No. 92, Arts. I-- XI, adopted 7-13-82.

> **Cross references:** Plumbing code, § 6-51 et seq.; drainage improvements and subdivisions, § 21-42. The City requires specific practices for water quality and stream protection as follows: **Sec. 23-142. Stormwater discharge rates and volumes.**
>
> The city shall utilize the drain commissioner's minimum design standards for stormwater discharge release rates. However, if the city commission makes a specific finding that the drain commissioner's standards are insufficient, the city may establish minimum design standards for stormwater discharge release rates and require dischargers to implement on-site retention, detention or other methods necessary to control the rate and volume of surface water runoff discharged into a stormwater drainage system.
>
> As described in Section 8 of the Ordinance, the City requires Low Impact Development practices through its storm water management standards at sites of new development and significant redevelopment if located in Zone A of the Township.

> The Storm Water Ordinance includes regulations that adhere to the Floodplain Ordinance and the Soil Erosion and Sedimentation Control program of the City. When a site plan approval is requested, we require the following pieces of information in relation to Storm Water Controls found in our Zoning Ordinance as referenced:
> 15-9.B.9
> The description of measures to be taken to control soil erosion and sedimentation during and after completion of grading and construction operations. This description shall include the location of proposed retaining walls, dimension and materials of same, fill materials, typical vertical sections, and plans for restoration of adjacent properties, where applicable;
>
> 15-9.B.11
> The location and elevations of existing water courses and water bodies, including county drains, and manmade surface drainage ways, 100-year floodplains, and all wetlands;
>
> 15-13.C
> Standards for Site Plan Review Regarding Drainage provisions. Special attention shall be given to proper site drainage so that removal of storm waters will not adversely affect neighboring properties or overload watercourses in the area.
>
> The City of Hudsonville's current Storm Water Ordinance (Chapter 23, IV, sections 110-203) requires a developer to provide the City with a "Maintenance Plan" that addresses long term maintenance on the drain or retention/detention pond. This Maintenance Plan must address who is responsible for the maintenance, what kind of maintenance will be required and how often. The engineers then determine if the Maintenance Plan is adequate and either approve or approve with corrections at the site plan approval phase. (GVMC, p. 23-24, 2016b)

The City of Hudsonville has participated in a number of stormwater public education events for their MS4 permit, including a well-attended Department of Public Works Open House. They also distribute a newsletter to every resident, and frequently include stormwater related articles. In addition, Hudsonville distributes stormwater related information through their government offices, the library and community events. They report native vegetation/rain gardens/riparian buffers of being of greatest interest to their community. Native plants have been used in the city, and a presentation was given at a rain garden in Sunrise Park, with about 40 people present.

<u>Ordinance Review</u>

The City adopted an "Imagine Hudsonville 2030" Master Plan in May 2015 (City of Hudsonville and Nederveld, Inc., 2015). The Plan envisions "A Distinctive City: A City that embraces its rural agricultural heritage and balances the past with endearing civic spaces, iconic public art, buildings that respond to a rural small town character, and infrastructure that encourages sustainable design" (p. 7, 2015).

The Master Plan includes an inventory of water bodies, floodplains, soil types, emergent, forested, and scrub-shrub areas. The Master Plan also includes some recommendations regarding green infrastructure and recommendations to promote water quality. Development in floodplains, wetlands, and forested areas is discouraged (p. 46), while planting and maintaining trees is recommended under Livable City Implementation Item Number Four (City of Hudsonville and Nederveld, Inc., p. 50, 2015).

Implementation strategies included within the Master Plan include, building sustainable buildings landscapes and streetscapes, including stormwater infrastructure, and stormwater as art, and “one way to do this is to create a City-wide policy that all street improvements include sustainable and aesthetically pleasing stormwater solutions” (City of Hudsonville and Nederveld, Inc., p. 11, 2015). Implementation of these items requires the adoption of LID standards and building new city infrastructure to meet LID standards (City of Hudsonville and Nederveld, Inc., p. 50, 2015).

Use of existing stormwater infrastructure is encouraged in the Master Plan. Adopting LID standards, and building city streets and infrastructure that follows LID standards is a Distinctive City Implementation item in the Master Plan. Complete street guidelines were adopted as a part of the Master Plan. Complete Streets include transportation for a variety of transit and sustainable stormwater management practices (City of Hudsonville and Nederveld, Inc. p. 16, 2015).

The City’s Master Plan does not incorporate strategies or BMPs from any approved WMP. However, the Downtown Zoning and City ordinances have an article on environmental sustainability standards. The Downtown Zoning Ordinance has a stormwater management matrix for stormwater treatment that promotes BMP and LID. The current stormwater requirements are for designing new sites for a 100-year storm. Through GVMC and the most recent MS4 permit application to MDEQ; the City recently submitted a more environmentally stringent stormwater ordinance that has an emphasis on stormwater infiltration.

The Master Plan does include public opinion survey data and associated action items related to planning and recreation. Visions within the Master Plan include a connected city, connecting neighborhoods and parks with green infrastructure and bicycle and pedestrian access. The use of existing infrastructure is encouraged in the Master Plan, emphasizing “density done well” and helping land to meet its highest and best use. The Master Plan envisions using waterways as recreational corridors (City of Hudsonville and Nederveld, Inc. p. 17, 2015).

One implementation strategy in the Master Plan is to plant trees for their multitude of benefits, including stormwater management benefits, and to coordinate with Consumers Power where needed (City of Hudsonville and Nederveld, Inc. p. 12, 2015). Planting trees was considered important, very important, or somewhat important to 89% of the public who participated in the Master Plan community input (City of Hudsonville and Nederveld, Inc. p. 34, 2015), and is primarily listed to be the responsibility of the City of Hudsonville and the DDA.

As related to land planning, there is a newly created area proposed for Traditional Neighborhood Development. Planning for public transportation is an implementation item. Density done well is an implementation strategy, and the downtown area consists of three mixed-use districts. Downtown Hudsonville has form-based zoning. Hudsonville also has separate plat and land division regulations.

A former golf course along New Holland and 36th Ave is slated for redevelopment and is bisected by Buttermilk Creek. The Master Plan envisions a non-motorized path running through the City, including along the creek with this redevelopment (p. 41). A village green is envisioned for Downtown Hudsonville (p. 41).

For general questions related to the municipality, City staff interface with the public through a Facebook page, a website, and staff and commissioner email addresses linked to the City webpage. For review and approval of development plans, the planning and zoning assistant process applications and the planning/zoning director reviews the applications. A consultant (PCI) is contracted by the City to process building construction related permits. The Planning/Zoning Director answers stormwater rule related questions. The Department of Public Works is responsible for helping residents where alterations are needed. The City also contracts with an engineering firm (Fleis & Vandenbrink), and they assist and review submitted plans when needed. When building applications are submitted, applicants are encouraged through the zoning ordinance to meet with the Planning/Zoning Director. Each applicable City Department reviews the proposed development plans, and informal meetings are available to applicants to better understand City regulations. Where required, the Planning Commission, City Commission, staff and building consultants review final plans. Monitoring is required by the Planning Department, and the draft stormwater ordinance includes additional monitoring requirements. County, State and Federal regulations also apply to land use changes within the City of Hudsonville, and require external review.

9.2.2.3 Blendon Township

A small portion of Blendon Township is located in the urbanized MS4 permitted area, but since they do not own or operate a storm sewer system, they are not required to have an MS4 permit.

<u>Ordinance Review</u>

A completed ordinance review was not provided for inclusion in this WMP.

9.2.2.4 Jamestown Township

A small portion of Jamestown Township is located in the urbanized MS4 permitted area, but since they do not own or operate a storm sewer system, they are not required to have an MS4 permit.

<u>Ordinance Review</u>

The Jamestown Township Master Plan is updated every five years and was last updated with minor updates in 2014. The Master Plan does not include an inventory or recommendations related to local green infrastructure, a map of protected lands and water bodies, or comprehensive water quality or water protection recommendations. The Master Plan suggests the Planning Commission defer to the appropriate agencies, e.g. MDEQ for wetlands, when a development is proposed. Jamestown Township requires that stormwater management adhere to the requirements of the OCWRC.

A WMP is not referenced in the Master Plan nor are WMP strategies or BMPs. The Master Plan does not use a rational or normative basis for determining population levels and concentrations, nor does it mention guidelines for neighborhood groupings. The Master Plan does include guidelines for new connections of streets and public utilities. The Master Plan includes public opinions and related recommendations, including public survey results that address parks and recreation opinions. There are no sections in the ordinances specifically addressing stormwater quality, management, and special uses, rather recommendations are spread throughout the regulations. Though they do require connection to the sanitary sewer if a structure is within 200 feet.

A site plan review process, including stormwater and drainage evaluations, is required in the ordinances. While there are land division regulations, there are no specific requirements for handling and conveying water. Special zones are not outlined in the ordinances that relate to the areas water bodies. Likewise, no form-based, smartcodes, or hybrid codes are included in the ordinances. Jamestown Township defers stormwater management at newly proposed sites to the OCWRC. Three municipal employees are available and serve as the main point of contact for building permits and land use changes. The Township requires that developers meet with the Site Plan Review Committee, and recommendations from the committee are shared with the Planning Commission. The Township engineers must approve proposed developments before proceeding to the Planning Commission. Likewise, applicable regulatory agencies outside of the Township must also approve developments prior to approval by the Planning Commission.

The Planning and/or Zoning Administrator and Township Engineer must give the final approval of proposed developments. Monitoring of the proposed project is required.

Jamestown Township has a website that includes general information about the municipality.

9.2.3 Summary of Recommendations

Recommendations to improve the RCW through regulatory mechanisms are summarized below.

Recommended Action: Adopt the draft or final Post Construction Controls Stormwater Ordinances and County Development Rules (standards manuals) and review the ordinances and development rules in context with this WMP to evaluate any possible remaining gaps.

As previously mentioned, draft Post Construction Controls Stormwater Ordinances are under review by MDEQ for both Kent and Ottawa County. Recommendations included in this WMP assume that these ordinances will be approved and adopted. A review of existing MS4 progress reports and local ordinances of RCW municipalities shows that there are varying degrees of stormwater management, and consequently, inconsistent watershed protection within the RCW. For example, Cities and Townships in the RCW do not have consistent monitoring requirements of stormwater infrastructure. Monitoring requirements are anticipated to be a requirement under a future ordinance. The ordinances and development rules are expected to allow more protective and consistent management of stormwater management in the RCW. Since a final draft was not available for review during the development of the RCW Management Plan, this text should be reviewed in context with this WMP to evaluate any possible remaining gaps.

Recommended Action: For consistent RCW water quality management, Blendon, Byron, and Jamestown Townships should follow the Kent or Ottawa Stormwater Ordinances and design standards. Currently, only designated communities in urbanized areas that own or operate a storm sewer system are required to follow MS4 permit requirements.

In addition, Townships should consider participation in the urbanized area I/E campaign managed through LGROW.

Recommended Action: Protect and preserve existing wetlands using regulatory mechanisms and other wetland protection programs. While some areas in the RCW are already largely developed (i.e. Hudsonville, Grandville, Wyoming, Georgetown Township), other areas are experiencing pressure from development. Varying levels of ordinances have been developed to manage the stormwater. In general, more stormwater ordinances have been enacted in the areas that are more developed. While these stormwater ordinances are very useful, the ordinances do not address a main component of this WMP, which is the protection and preservation existing wetlands.

In areas that are experiencing development pressure (i.e. East Branch Subwatershed, Blendon Township, Jamestown Township, Byron Township), regulatory mechanisms to protect the remaining undisturbed natural areas and wetlands are especially important. While Ottawa County often reviews the new development plans in these areas, “the county does not have planning and zoning authority and therefore relies upon the local unit of government to direct growth to identified areas, to protect sensitive areas such as wetlands and riparian areas, to maintain and/or increase open spaces, and to encourage infill development in higher density urban areas and areas with existing infrastructure” (GVMC, p 21, 2016e). Regulatory mechanisms to protect the environmentally sensitive areas and direct growth are described in Chapter 9.3 of this WMP.

There are 2,290 acres of wetlands remaining in the RCW. There are 1,127 acres of high priority flood storage capacity wetlands for preservation and 472 acres of pathogen removal wetlands for preservation. Of these wetlands, there are approximately 112 wetland features or 219 acres of wetlands that are the highest priority to preserve as the wetlands have both flood storage function and pathogen removal functions. These wetlands are shown in Figure 10.1. Preservation is typically considered to be the least expensive way to maintain water quality. In addition, incentives are available for landowners preserving high priority areas, including tax-incentives, conservation easement-purchase, and other programs such as the NRCS Wetlands Reserve Program.

Recommended Action: The use of LID and Green Infrastructure should remain a priority in the proposed Stormwater Ordinances, and in any other feasible methods. LID and Green Infrastructure is reportedly well accepted in the RCW by contractors (OCWRC, personal communication). Native vegetation, rain gardens, riparian buffers are all reportedly topics are of interest to residents in Kent County and the City of Hudsonville (GVMC, 2016e,f). Their use is encouraged in the City of Hudsonville Master Plan.

The City of Hudsonville Master Plan includes many site-specific opportunities to incorporate LID practices, native plants, and buffers protective of the RCW, including “density done well” a non-motorized path along Buttermilk Creek, using waterways as recreational corridors, and a village green envisioned in Downtown Hudsonville (p. 41, 2015). New or re-developments in the RCW should incorporate LID, Green infrastructure, and native plants whenever possible.

Recommended Action: Review and adopt additional regulatory mechanisms that are protective of the RCW, described in Chapter 9.3. Local governments have the authority to adopt environmentally protective ordinances, described in more detail in Chapter 9.3. For example, the City of Hudsonville has adopted buffer provisions within their zoning ordinances and Georgetown Township’s Storm Water Ordinance includes regulations that adhere to the Floodplain Ordinance and the SESC program of the Township. These ordinances are of benefit to the RCW. Additional opportunities for RCW protective ordinances related to environmentally sensitive development, soil erosion and sedimentation control, mature tree protection, among others discussed in detail in Chapter 9 and if adopted will further protect water quality.

Recommended Action: Trees can help to reduce flashiness and provide a multitude of NPS pollution benefits and should be encouraged in Hudsonville, the City of Grandville, Wyoming, Georgetown Township, Jamestown Township, Byron Township and in other RCW communities. The City of Grandville is pursuing a Tree City USA Designation through the Arbor Day Foundation. A Tree Board has been appointed and they have prioritized creating an Urban Forestry Strategic Plan and Urban Forestry Management Plan. A Strategic Plan will serve as a “Foundation for administration and management” and a Management Plan will include a tree inventory and identify and prioritize site-specific tree planting, maintenance and removal activities” (Tornga, p. 1, 2017). A tree City USA Designation provides a framework for managing their public trees. Approximately 35% of the City of Grandville is currently canopied by trees, and a goal of 50% tree canopy is currently included in their strategic plan (Tornga, 2017). Recommendations included in the Grandville Tree Project Strategic Plan (2017) and subsequent efforts by the Tree Board related to an increase in tree canopy will be of benefit to the RCW. The Strategic Plan is included in Appendix J.

Additional communities may benefit from Tree City Designations or additional tree plantings.

Likewise, the City of Hudsonville Master Plan recommends planting trees for their multitude of benefits, including stormwater management benefits, (City of Hudsonville and Nederveld, Inc. p. 12, 2015), and is considered of some importance to 89% of the public who participated in the Master Plan community input (City of Hudsonville and Nederveld, Inc. p. 34, 2015). Though tree planting is primarily listed to be the responsibility of the City of Hudsonville and the DDA, many other RCW partners could participate in this effort.

The loss of ash trees from disease has resulted in the loss of tree canopy on both sides of a stream in some places of the RCW, including on Bliss Creek in Georgetown Township, Grandville, and Wyoming. Restoration of the tree canopy on at least one side (preferably the south and/or west) of the creek is recommended, especially in residential areas.

Trees have a multitude of watershed benefits. A deciduous tree can intercept 500-760 gallons of water per year, while a mature evergreen can intercept more than 4,000 gallons per year (Cotrone, 2017). Trees can reduce Total Nitrogen and Total Phosphorus pollutant loading by 23.8% and TSS 5.8% when compared to pollutant loading from turfgrass land uses, and 8.5%, 11.0%, and 7.0% respectively when compared to pollutant loading from impervious cover land uses (Hynicka and Divers, 2016 found in Cappiella et al., 2016). Trees along the riparian corridor can help protect water temperatures from rising, which is especially important in the East Branch that has temperatures in the cool or cold-transitional range. In addition, replacing trees throughout the watershed will counter the recent loss of ash trees from disease. However, as commonly stated, it is difficult to manage what you can't measure. Additional tools may help communities to select, measure, and manage the watershed's trees and affect on water quality, including i-Tree (itreetools.org), a cooperative initiative with the U.S. Forest Service and others that helps to quantify the ecosystem services benefits of trees, including water quantity and quality.

Recommended Action- Priority municipalities: Byron, Blendon Townships. Encourage or require home and business owners who are using septic systems but who are located within sanitary service boundaries to connect to the sanitary sewer and properly abandon their septic systems.

Within sanitary service boundaries, ordinances can be adopted to reduce pollution loading from failing septic systems.

The Cities of Wyoming and Grandville and Jamestown and Georgetown Townships require connection to the sanitary sewer system if the structure is within a certain distance from sanitary sewer (typically around 200 feet). Municipal sewer services are available to all of the City of Wyoming located within the RCW. However, it is unknown if every facility is connected to the sewer. It is estimated that few homes in the City of Wyoming within the RCW may still have a septic system. Due to their age, a few older homes on 52nd Street may potentially not be connected to the municipal sewer (City of Wyoming Communication, November 16, 2017). Within Georgetown Township (which extends beyond the RCW) over 300 properties with septic systems are already being required to connect to nearby municipal sewer, and thus are considered a lower priority since this action is already underway. There are an estimated 10-15 homes with septic systems and access to sanitary sewer service in Hudsonville. Approximately half of those homes are expected to be connected to sanitary sewer as a part of a road and trail construction project planned for 2018-2019 (City of Hudsonville, personal communication, January 5, 2018). There are up to 15 properties outside of sanitary sewer service areas in the City of Grandville (City of Grandville, Ken Krombeen, personal communication, January 16, 2018).

Byron Township only requires the connection of a septic system under certain instances, including failure of an existing private sewage disposal facility, or a public health and welfare concern.

A review of gaps in municipal water and sewer bills or a review of Health Department records could be used methods to help identify operating septic systems. Health Departments do not have jurisdiction to require homes to connect to available sanitary service (sanitary service is within 200 feet of the roofline), unless a septic system has been reported to the Health Department and is determined to be failing.

Recommended Action: Adopt a risk-based septic system maintenance policy in Kent County and the State of Michigan. While OCDPH requires inspection of septic systems for a Real Estate Transfer, the State of Michigan and KCHD do not have similar ordinances, and instead only regulate septic systems at the time of installation. A risk-based septic system policy in Kent County would further protect the RCW from failing and leaking septic systems, and qualify county residents to receive federal grant money to voluntarily address failing septic system issues.

RCW partners should participate in a Septic Systems Work Group with the KCHD with the goal of outlining and implementing the tasks needed to develop and adopt risk-based septic system policies for addressing failing or malfunctioning systems at the level of governance determined by the work group (health department, County, or Township). The work group could include Septic Partners, such as the health department, conservation districts, municipalities, and the local and neighboring watershed groups. The work groups should take the necessary steps to implement policies that reduce the health and environmental risks of on-site septic systems. This task was outlined in the development of the Flat River Watershed Management Plan, and a similar workgroup is underway in the Maple River Watershed.

Once a risk-based septic system maintenance policy is adopted in Kent County, encourage and provide funding assistance for voluntary septic system inspection, maintenance and replacements, where warranted, in Kent County. Priority areas include the estimated 400-450 homes with septic systems in Kent County, located South of M-6 and west of Byron Center. Homes with septic systems that are in the closest proximity to creek and drains are the highest priority.

Recommended Action: Encourage and provide funding assistance for voluntary septic system inspection, maintenance and replacements, where warranted, in Ottawa County. Priority areas include the septic systems in Ottawa County. Jamestown Township (which extends beyond the RCW) has 1,669 facilities with septic systems (tanks and drainfields). It is unknown how many homes have septic systems in Georgetown Township or Blendon Township.

Homes with septic systems that are in the closest proximity to creek and drains are the highest priority.

9.3 Additional Local Policy Recommendations

Beyond the initial ordinance review completed as a part of this watershed management planning process, it is recommended that each local unit of government in the RCW review opportunities to better protect the RCW. Stormwater management and corresponding regulatory mechanisms can be difficult to understand and properly implement, especially for smaller government agencies. Community guidebooks and the assistance of knowledgeable stormwater personnel can help local government staff and commissioners to better understand, adopt and implement their community's regulatory mechanisms.

A community stormwater guidebook should be used or developed, similar to that of the Rogue River Watershed: A Stormwater Guidebook, Filling the Gaps: Environmental Protection Options for Local Governments 2nd Edition (Ardizone and Wyckoff, 2010), Tip of the Mitt Watershed Council's "Protecting Michigan's Wetlands: A guide for Local Governments" or guidebooks developed by the Center for Watershed Protection as guidance for RCW municipalities. The guidebook should be used as a resource by the local municipalities for the review, audit of existing regulations, proposal of new regulatory language, and adoption of watershed protective zoning and policies, with the assistance of appropriate knowledgeable partners.

A list of relevant policies that can be used by local governments to help protect water quality in the RCW have been selected from Filling the Gaps: Environmental Protection Options for Local Governments 2nd Edition (Ardizone and Wyckoff, 2010). Local governments have the authority to adopt environmentally protective ordinances under NREPA and/or through Planning and Zoning Enabling Acts. The resource guidebooks listed above can help describe the extent of and the difference between these two authorities.

Wetland Protection Recommended through Local Policy (Part 303, PA 451 of 1994)

Of particular importance is the protection of wetlands. Not all wetlands are currently protected under Part 303, Wetland Protection, of the NREPA, 1994 PA 451. Generally, if a wetland is smaller than five acres in size, is not contiguous to a larger wetland, or is not located within 500 feet of an inland lake or stream, it is not regulated or protected. Local governments have the authority to regulate wetlands smaller than five acres in size. Considering that only 16% of the RCW historic wetlands remain, all wetlands, regardless of size, should be protected to minimize further RCW water quality impacts. Local governments should adopt regulatory mechanisms to protect wetlands smaller than five acres in size that are not otherwise regulated by the MDEQ. Approximately 30% of the existing wetlands (nearly 700 acres) in the RCW have no protection under the existing law. Local governments have the opportunity to protect these wetlands through local policy. Michigan communities with wetland ordinances include Meridian Charter Township in Ingham County, Clyde Township in Allegan County, Cannon and Grattan Townships in Kent County, and Spring Lake Township in Ottawa County.

These wetlands are shown in Figure 10.1. Alternatively, MDEQ can regulate wetlands less than five acres in size that are noncontiguous if they have notified the landowner and MDEQ has determined the site essential to preservation of natural resources of the state from pollution, impairment, or destruction.

Septic System/Illicit Discharge Policy

Local governments have the authority to adopt policies to better protect the water from bacteria and nutrient contamination from septic systems through policies related to the permitting of new construction, their minimal required condition and function, and required maintenance. In addition, local governments can require older septic systems to be converted to sanitary sewer hook-ups. Illicit discharge prohibitions and exceptions are included in the model stormwater ordinance. Septic system policies are discussed in more detail in Chapter 10.

Sewage Sludge Policy (part 31, PA 451 of 1994)

Local governments may adopt regulations to protect groundwater and regulate the land application of sewage sludge (Ardizone & Wyckoff, 2010).

Environmentally Sensitive Development (Part 31, PA 451 of 1994; Part 323, PA 451 of 1994)

Permits can be required to develop land in, or setback from, environmentally sensitive areas, including from steep slopes, highly erodible areas, floodplains (Part 31), or on un-regulated wetlands. Development density, vegetated buffers, and native vegetation are some of the tools local governments can use to protect these sensitive areas. In addition, using the 100-year floodplain as a baseline, local governments can use local ordinances and building codes to regulate construction within floodplains (Ardizone & Wyckoff, 2010).

Soil Erosion and Sedimentation Control (Part 91, PA 451 of 1994)

SESC is authorized under NREPA PA 451 of 1994, Part 91 and administered by Authorized Public Agencies, which are state, county, and local governments. Each county has a County Enforcing Agency responsible for ensuring compliance, and some local governments have a Municipal Enforcing Agency to ensure compliance. County and local governments can expand protections above and beyond Part 91 requirements, and can allow requirements for permits for earth change activities adjacent to wetlands, storm drains, and other sensitive environmental features. County and local governments can also adopt zoning related to stormwater control ordinances requiring on-site stormwater retention and treatment, impervious surface limitations, and routine street vacuuming or sweeping.

Stormwater Management Low-Impact Development Practices

LID techniques that help to filter or treat stormwater and/or minimize the impacts of altered morphology and flashy flows are recommended for new developments, with an emphasis in areas with more concentrated development, and parks adjacent to rivers and streams. As already discussed, a draft stormwater management policy is under review. Municipalities should review and consider adopting policies that require LID and green infrastructure. Policy incentives could be used as ways to encourage LID and green infrastructure use.

Street Sweeping Policy

The adoption, timing, and implementation of street sweeping/road maintenance policies by municipalities can help to reduce the amount of sediment entering the watershed from impervious surfaces through stormwater systems, or directly into rivers and streams from roadways and shoulders.

Mature Tree Protection

With Planning and Zoning Enabling Acts, local governments can protect mature trees. Mature trees keep land and water temperatures from rising, and retain water preventing flashy flows.

Farmland and Open Space Preservation

Beyond Part 361 of NREPA, Farmland and Open Space Preservation, PA 451 of 1994, local governments have authorities to encourage the preservation of Farmland and Open Space within their jurisdictions.

Inland Lakes and Streams (PA 451, Part 301, 1994)

Local governments have jurisdiction to adopt water quality protection planning, zoning, and policies. They may regulate keyhole developments, require vegetated buffers around lakes and streams, limit amount of pervious surfaces near lakes and streams, limit lot splits and control frontage requirements for docks, adopt setbacks from lakes and streams regarding buildings, tree-cutting, and mowing to protect natural shorelines.

Pervious Surface Development

In the more developed areas of the watershed and in groundwater recharge areas, policies for maintaining groundwater recharge can be adopted.

Pet Waste Ordinance

Ordinances requiring residents to pick up their pet waste can help to protect the watershed from *E. coli*.

Land Division/ Greenways/Greenbelts

Through a variety of tools, such as land division and subdivision or plat ordinances, development on sensitive environmental areas can be managed to protect open spaces, greenways or greenbelts.

Invasive Species Management

Exotic or invasive species can be discouraged in landscaping.

Municipalities should be invited to review the recommended regulatory mechanisms, and amend their policies and zoning, with the assistance of watershed management partners.

9.4 Priority Preservation and Restoration

In addition to improving municipal zoning to be more protective of the water quality, wetland protection and restoration is recommended. Though wetland restoration and protection efforts are encouraged wherever possible throughout the watershed, priority wetlands for preservation and critical wetlands for restoration have been identified and are described in this WMP. Wetland preservation and restoration can be helpful for both preserving and restoring the RCW. Land protection is often an opportunistic venture in that it can be assumed that the highest priority lands for protection may not be what is available for preservation. The protection of all wetlands, natural areas, and forests are beneficial to water quality, but wetlands are the highest priority in the RCW due to the need for stormwater management.

Land protection can be accomplished through incentives available to landowners, such tax-incentives, conservation easement-purchase, or other programs such as the NRCS Wetlands Reserve Program.

9.4.1 Pollution Reduction Wetlands for Preservation

Preservation of high quality lands and features, or lands that serve a particular function in protecting water quality, is an important component of watershed management. Such lands may not contribute pollutants due to their relatively undisturbed nature, but instead may store floodwaters or may provide areas for filtering pollutants from surrounding lands. Preservation is typically considered to be the least expensive way to maintain water quality. In addition, some financial incentives are available for landowners preserving high priority areas through conservation easement-purchase, or other programs such as the NRCS Wetlands Reserve Program.

For the multitude of positive benefits and water quality functions that they provide to a watershed, all natural areas and wetlands are important, collectively play a role in maintaining water quality and, therefore, should be protected. However, wetland protection is the highest priority in the RCW since financial resources for watershed management are limited.

Under state law, wetlands greater than five acres in size or contiguous to or within 500 feet of regulated bodies of water are generally protected from development and draining through a permitting process. However, there are exceptions to this permitting process that allow wetlands to be diminished or mitigated in alternate locations. For example, agriculture and lumbering do not always require a permit to drain or impact wetlands, and applications to fill a wetland are often approved. Though a mitigation process requires a subset of permitted wetland impacts to be offset elsewhere through construction of new wetlands, the replacement wetlands may not be as high of quality as those that were replaced. Because of the important functions of wetlands to water quality already discussed, and because the RCW has lost such a large percentage of its historic wetlands (84%), it is important to protect all wetlands, and more importantly wetlands that have functions that reduce the pollutants that have been identified in the RCW.

There are 2,290 acres of wetlands remaining in the RCW, with approximately 1,277 of those acres located in the East Branch Subwatershed and 983 acres in the Main Branch subwatershed.

Existing wetlands with flood storage and/or bacteria reducing functions are the highest priority wetlands to protect. GIS and the following criteria were used to identify wetlands within the RCW that may be especially worthy of protection. It should be reiterated, though, that the information used is computer based and has not been field verified. Using GIS and data in the MDEQ LLWFA (2013), the following wetlands are prioritized:

- Existing wetlands rated with a high flood storage capacity function; OR
- Existing wetlands with a pathogen removal function.

These wetlands will have the greatest impact in reducing the RCW priority pollutants, altered hydrology and pathogens.

Using these criteria, there are 1,127 acres of high priority flood storage capacity wetlands for preservation, 472 acres pathogen removal wetlands for preservation, and 112 wetland features or 219 acres of high priority wetlands with both flood storage function and pathogen removal functions. Only about eight percent of the wetland features (or 94 acres) are greater than five acres and, thus, currently protected.

9.4.2 Pollution Reduction Wetlands for Restoration

Wetland restoration recommendations are outlined in Chapter 7.6. Nine major historic wetland areas, including 1,716 acres, are considered priority to restore. These areas are shown in Figure 10.2.

9.4.3 Long and Short-term Goals

Wetland preservation and restoration helps to restore the water quality of watershed from pollutants, with targeted efforts on the two largest pollutants, altered hydrology and *E. coli*.

Considering that only 16% of historic wetlands remain in RCW, and the water quality is impaired from NPS pollutants, the following restoration goals have been developed:

1) Prevent any additional existing wetlands from being drained. All 2,290 acres existing wetlands in the RCW should remain. Adopt wetland protection regulatory ordinances at all seven local municipalities in the RCW within ten years. Utilize available incentives for landowners preserving high priority areas, including tax-incentives, conservation easement-purchase, or other programs such as the NRCS Wetlands Reserve Program. Protect 50 acres in the next three years and 500 acres in the next ten years.

2) Restore 100 acres of wetlands in the next three years and 500 acres of wetland in the next ten years.

3) Reduce peak discharge to 1992 Flood Insurance Study levels which equates to a reduction by approximately 50%. Reduce peak discharge by 20% in ten years.

10.0 SUMMARY OF WATERSHED MANAGEMENT RECOMMENDATIONS

This chapter is intended to provide specific implementation recommendations at a level of detail sufficient for preservation and restoration of the RCW. The chapter integrates the results of data collected throughout the watershed management planning process to develop infrastructure, management, information, and education recommendations that will serve as an Action Plan for Watershed Management of the RCW.

Additional detail and supporting information is found in previous chapters. More specifically: detailed information about land use is found in Chapter 2; detailed information about water chemistry is found in Chapter 4; information about the pollutants, sources and causes are discussed in Chapters 3, 4 and 6; BMPs are described in Chapter 7; and Information and Educational recommendations are described in detail in Chapter 8; while policy related recommendations are described in Chapter 9. Specific details for this chapter are provided in the Pollution, Source, Cause and BMP tables in Appendix G. Due to the voluntary nature of NPS pollution prevention, and the frequent need for cost share, the recommendations are comprehensive, understanding that they may not all be adopted. The assumption is built in that every stakeholder or landowner may not agree to adopt the exact recommendations included within. Therefore, some BMPs may be redundant, and the appropriate BMP for the RCW is the site-specific solution that is preferred by the landowner. This is especially true for the agriculture related BMPs, where a number of BMPs are listed as possible options, and not all BMPs listed may need to be implemented. Likewise, a number of recommended agricultural BMPs have an annual cost to them. Other costs have not been fully developed, including those associated with the Urban Forestry Management Plans and the Ottawa County Groundwater Study, which as recommendations under management by partner organizations. The recommended actions included for this WMP total $34,969,790 in NPS pollutant reduction BMP improvements and $2,269,600 in I/E (or technical assistance) measures over a ten-year time period, or a total installed cost of $53,095,683 if all recommendations are completed.

In order to maximize resources and efforts in reducing NPS pollutants and protecting and improving the RCW, priorities across the RCW are made within the following categories: priority pollutants, preservation areas, critical sites, critical areas, and Information/Education, described below.

- **Priority Pollutants**: A summary of the non-point source pollutants of greatest concern. The pollutant may currently be causing water quality impairments (exceeding a WQS), or these pollutants may threaten the water quality (trending toward impaired).
- **Preserving or Protecting Priority Areas:** High quality wetland areas are identified using specific criteria. Management recommendations to protect these areas are outlined. Protection of these areas was determined to best protect the water quality from further degradation.
- **Restoring Critical Sites**: Specific sites that are contributing priority pollutants to the water were identified. Infrastructure and/or management recommendations are outlined for each site to restore the water quality.
- **Restoring Critical Areas**: Widespread practices that are contributing priority pollutants to the watershed are identified, management recommendations for restoring the water quality from the pollutant are provided, and general locations are prioritized for improvements.
- **I/E:** Behavior changes by RCW residents are critical to the success of the reduction of NPS pollutants. Water quality information and recommended practices and behaviors are included. I/E recommendations are either integrated in the above categories or included on its own.

BMPs, preservation practices and restorative actions across the watershed are recommended wherever feasible to prevent further degradation and to maintain a high quality watershed. However, in an attempt to focus and optimize efforts and resources, various rankings and priorities are noted.

Though the noted prioritization is important, lower ranked recommendations should also be emphasized when applicable stakeholders are willing to implement one or more recommended practices, despite its ranking in the prioritization process below.

10.1 Summary Watershed Management Plan Goals

These implementation recommendations were developed to satisfy the goals of the WMP including:

- Provide the direction necessary to **restore water quality** so that the designated uses of total and partial body contact recreation are being met.

- **Maintain designated uses that are currently being met** by identifying the sources and causes of pollution that have potential to degrade water quality and Threaten the designated uses; and make recommendations for managing these pollutants.

- Develop a plan that **maximizes the water quality, natural ecosystem functions, habitat, and aesthetics** of the watershed.

- Manage the watershed to **minimize the impact of flashiness and other pollutants caused by development** while supporting the desired land use activities.

- Implement **targeted education and action plans** for the watershed's residents related to the pollutants, sources, and causes of the watershed **that lead to land management changes,** and result in improved water quality.

- **Strengthen partnerships** with local municipalities and organizations.

More specifically, the following pollution reduction goals have been established:

- Reduce peak discharges to modeled values presented in the FEMA February 5, 1992 Flood Insurance Study prepared for the Charter Township of Georgetown, Michigan, which means reducing peak flows approximately 50% compared to current levels. As a short-term goal, peak discharges in the RCW should be reduced by 20% in ten years.

- Reduce *E. coli* concentrations to meet WQS.

- Though there is no WQC set for Total Suspended Solids, a nearby TMDL for biota set in Plaster Creek had a Total suspended solids (TSS) goal of 30 mg/L (MDEQ, 2002), and thus is used as a target value for TSS in RCW. Using this target sediment concentrations and the discharge measurements collected as a part of this planning process, the loading reductions values for TSS is 44%.

- Reduce water temperature in the East Branch subwatershed by two degrees (average July water temperature), to fall within the cold-transitional temperature range.

- Reduce nutrient loading to meet comparison concentrations listed in Table 3.1. Using the target nutrient concentrations and the discharge measurements collected as a part of this planning process, the nutrient loading reductions values are as follows: ammonia as nitrogen: 36%; total phosphorus: 83%, and nitrates and nitrites: 40%.

- Generally reduce pesticide concentrations reaching the surface waters, improve application practices, and investigate prevalence in usage and concentrations within the RCW surface water.

To meet these goals, a set of recommendations including preservation practices, BMPs, I/E, and regulatory mechanisms is included herein. Estimated quantities of these BMPs needed are included in Appendix G. It is difficult to determine exactly how many BMPs are needed to meet the load reduction goals as the specific design and implementation of each of these tools and BMPs will affect its pollutant loading reduction efficacy. Estimates provided within this WMP are intended to be reasonable, but should be monitored and modified as needed, as discussed in Chapter 11.

The first step recommended is to hire a Rush Creek Watershed Coordinator through a newly formed watershed organization or an existing partner organization. Since the management of non-point source pollution is primarily done through voluntary action, the watershed coordinator is vital in assisting and encouraging other partners to implement WMP recommendations. A RCW Coordinator should begin or complete the following recommendations, related to the identified Preservation (P), Critical Sites (CS), Critical Area (CA), and I/E recommended actions items below in Sections 10.5-10.8 below. I/E recommendations are included in detail in Chapter 8.0 and Tables 8.4-8.7, and are generally integrated into the recommendations in Chapter 10.5-10.8, as I/E and technical assistance can be used to address Critical Areas, Preservation, and Critical Sites.

Years one through three (and beyond):

- Apply for grant funding to implement further WMP recommendations;
- Meet with partners identified in the WMP to encourage their partnerships, participation, and adoption of WMP recommendations;
- Work with partners to adopt policy and/or ordinance recommendations (Recommended Actions: P1, P2, P3, P11, CA10);
- Reach out to identified audiences to share targeted I/E, encourage BMP adoption, develop a green team to operate in the RCW for approximately five years, and assist with funding mechanism opportunities (Recommended Actions: P4/CA1, P5, PA6/CA2, P7/CA3, P8/CA4, P9/CA5, P10/CA6, P12, CA7, CA8, CA9, CA18, CA19);
- Coordinate inspection, I/E, and/or restoration efforts and funding mechanism options with identified partners at critical sites identified, working with the assistance of the recommended agricultural technician when funded (Recommended Actions: CS1-CS11);
- Encourage municipalities to develop sanitary sewer infrastructure plans (Recommended Actions: CA11)
- Coordinate the additional resources to hire recommended agricultural technical resources who will coordinate with agricultural landowners for approximately six years, apply for grant funding for recommended agricultural BMPs and technical assistance (Recommended Actions: CA12, CA13, CA14, CA15, CA16, CA17); and
- Implement I/E recommendations for years one through three outlined in Tables 8.4 to 8.7.

Years three through ten:

- Continue following work begun in years one through three. A Watershed Coordinator is recommended for at least ten years, and an agricultural technician is recommended for at least six years;
- Work with partners to manage a portion of Rush Creek for kayaking (Recommended Actions: P13);
- Coordinate a Water Quality Summit with Lake Associations (Recommended Action: CA20);
- Implement I/E recommendations for years three through ten outlined in Tables 8.4 to 8.7 (and Chapter 10.9);
- Implement additional recommended actions as prioritized in WMP (Chapter 10.4-10.8); and
- Further investigate “Additional Investigations” recommendations in Chapter 10.11.

An estimated timeline is included above, though an adaptive management approach is recommended. Some activates should be completed when the opportunity arrives (e.g. funding, partner participation, efficiency in coordinated efforts, etc.) without regard to whether or not it is the next priority task, and other recommendations may not be feasible to address in the recommended timeline if the necessary resources are not obtained. Likewise, some recommendations and/or BMPs may be duplicative, and the appropriate BMP for the RCW is the one preferred by each individual landowner that fits their particular site. This is especially true for the agriculture related BMPs, where a number of BMPs are listed as possible options, and not all BMPs listed may need to be implemented.

10.2 Pollutant, Source, and Cause Prioritization

There are many recommendations made in this plan to reduce NPS pollution in the surface water. In order to make the most effective use of resources, general watershed-wide recommendations pollutant reduction recommendations are prioritized and summarized in Table 10.1.

Table 10.1 Pollutant and Source Prioritization

Pollutants in Priority Order	Causes to Prevent in Priority Order
1. Hydrology	1a. Prevent new alterations to hydrology that increase peak discharge. 2b. Restore previously altered hydrology.
1. *E. coli* – Human sources	2a. Prevent human sources of *E. coli* from leaving designated treatment sites. 2b. Prevent human sources of *E. coli* from reaching surface waters.
3. *E. coli*- Agriculture sources	3a. Prevent agricultural sources of *E. coli* from leaving application sites. 3b. Prevent agricultural sources of *E. coli* from reaching surface waters.
4. Sediment	4a. Prevent soil erosion. 4b. Prevent eroded sediment sources from reaching surface waters.
5. Nutrients	6a. Prevent nutrients sources from leaving application sites. 6b. Prevent nutrient sources from reaching surface waters.
6. Increasing Water Temperature	5. Prevent increases in stream temperature, especially in East Branch subwatershed.
7. Herbicides and Pesticides	7a. Encourage proper and conservative use of herbicides and pesticides, including use within a safe distances from surface waters. 7b. Prevent herbicides and pesticides from reaching surface waters.

Recommended Actions from the categories (Preservation, Critical Sites, Critical Areas, Additional Investigations, and I/E) are listed below, generally in priority order. Some recommendations can be used to both restore and preserve the RCW. For example, though preservation is not prioritized in Table 10.1 above, certain preservation practices may be recommended to prevent human sources of *E. coli* from leaving designated treatment sites, or to prevent agricultural sources of *E. coli* from leaving the application sites.

10.3 Priority Pollutants

The pollutants of greatest concern in the RCW are altered hydrology and *E. coli* (bacteria). Followed by, in priority order, sediment, increasing water temperatures, nutrients, and herbicides and pesticides.

Altered Hydrology

Data collected for this WMP indicate that altered hydrology is the pollutant of greatest concern to the health of the RCW and is considered a top priority to address. However, in cases where the primary goal is to remove an impairment from the Integrated Report, *E. coli* is the pollutant of greatest concern.

The RCW has lost 84% of its historic wetlands from development and drain construction. Only 2,290 acres of wetlands remains in the RCW. Of the remaining wetlands, most are located in the East Branch subwatershed. An increase of impervious surfaces from land use changes has a great impact on hydrology. Land use has changed from approximately 16 percent developed in 1992 to 51 percent developed in 2011 (Vogelmann, J.E., S.M. Howard, L. Yang, C. R. Larson, B. K. Wylie, and J. N. Van Driel, 2001 and Homer et. al, 2011). Agricultural land use changed from approximately 69 percent to 35 percent over that time span, where the remaining agricultural land is effectively drained. There was also a loss in wetland and forestland from 1992 to 2011 (Vogelmann et. al., 2001, and Homer et. al., 2011). It should be noted that these land use changes only serve as estimates as they are derived from two different datasets and utilize different mapping technologies, but even as estimates help to show general trends in land use changes.

Approximately 63 stream miles of 120.5 total stream miles of the watershed are considered to be county drains.

Peak discharge in the RCW has approximately doubled from 1992 to 2017 as evidenced from modeled peak discharge values presented in both a 1992 and 2013 FEMA report (FEMA, 1992 and FEMA, 2013).

These hydrological changes increase intensity, duration and magnitude of flood events causing flashy stream conditions.

E. coli

Michigan's 2016 Integrated Report (MDEQ, 2016 revised 2017) lists the AUID 040500060511 as not attaining the TBC designated use in 2016. East Branch Rush Creek is listed in Michigan's 2016 Integrated Report as "Not Assessed" for TBC and PBC, and the Rush Creek Main Branch and East Branch subwatersheds have been included in the Proposed Statewide TMDL (MDEQ, 2017a). Because *E. coli* is formally recorded as a pollutant impairing the RCW in the Integrated Report and because *E. coli* impairments affect human health, *E. coli* is also considered a priority pollutant.

Based upon data collection and WQS established by the State of Michigan, contact with the surface waters, including swimming, wading, fishing, etc., should be avoided in large portions of the RCW during certain periods.

Using bacterial source tracking and canine scent tracking, human bacterial sources were confirmed during this planning project and appear to be widespread in both the East Branch and Rush Creek subwatersheds. DNA markers for cattle (bovine), horses (equine), and dogs (canine), were detected in the East Branch Rush Creek subwatershed, while duck, geese, canine and equine were detected in the Rush Creek subwatershed. Human septage is considered to be of higher risk to human health than livestock or wildlife waste, and thus is not considered acceptable, even at low concentrations, in this WMP.

RCW data suggests that *E. coli* contamination is of concern during both dry and wet weather events. The highest levels of *E. coli* were measured after wet weather events, where PBC WQC were typically exceeded. *E. coli* concentrations following wet weather events were significantly higher statistically than *E. coli* concentrations following dry weather events. The more stringent TBC WQC was typically exceeded during dry weather (the absence of rain events), and the PBC WQC was typically exceeded following wet weather events. The Huizenga Drain, located in the eastern most part of the Rush Creek Subwatershed (Grandville and Wyoming), was the only location sampled that did not exceed the 300 or 1,000 CFU/100 mL WQC.

Because of the higher *E. coli* concentrations following wet weather events, the majority of the *E. coli* is likely being transported from agricultural sources through overland runoff, agricultural drains, and livestock direct access into the waterways, from sources such as manure from farms and fields (Figure

4.1). Areas that are most vulnerable to erosion are identified as hilly areas with clay soils and agricultural land uses.

However, an assessment of human source tracking, *E. coli* concentrations, (Figure 4.2), land uses, and nutrient concentrations indicates that septic systems are a source of *E. coli* in the RCW. Illicitly connected septic systems, failing septic systems, and septic systems installed at a high density, septic systems installed in areas with relatively shallow depths to groundwater, and in poor soils are considered a priority source due to the risk presented to human health. High *E. coli* concentrations and human sources of *E. coli* were present within and outside of areas serviced by sanitary sewer. Septic systems are also located within and outside areas serviced by sanitary sewer.

Sediment

The HIT model estimates 2,194 tons per year of sediment entering Rush Creek from overland erosion in the East Branch Subwatershed and 1,264 tons per year of sediment entering Rush Creek from overland erosion in the Main Branch subwatershed (MSU IWR, 2009). The HIT model estimates are consistent with TSS data, which confirmed that TSS concentrations were significantly higher following wet weather events than the TSS concentrations following dry weather events.

Sediment can carry other pollutants, including phosphate and *E. coli* to the surface waters. Sample sites 5RCT, 6RCT, and 8RCT drain land that is primarily agricultural and consists of fine-textured till with significant topographic relief. These locations had the highest wet weather TSS concentrations. These results validate HIT modeling results, which shows the areas with the greatest erosion being in the south central and eastern portions of the RCW (Figure 3.8). TSS concentrations measured in 2016 and 2017 as compared against the water quality comparison value listed in Table 3.1 are displayed in Figure 3.8.

Table 10.2 and Table 10.3 list HIT modeling results showing estimated tons of sediment loading originating from agricultural lands by way of sheet erosion, and an estimated reduction in sediment loading, cost, and cost benefit for various types and amounts of BMPs adopted for both the East Branch and Main Branch of the RCW. Areas that are most vulnerable to erosion are identified as hilly areas with clay soils and agricultural land uses.

Table 10.2 East Branch Rush Creek HIT Model Sediment Loading and Potential Reductions from Selected BMPs

	BMP: Mulch Till on Worst 5% of Area			
Total (tons/year)	Total Reduction (tons/year)	Reduction (%)	BMP Cost ($10/acre)	BMP Cost Benefit ($/ton reduced)
2,194	283	13%	$9,050	$32
	BMP: Mulch Till on Worst 10% of Area			
Total (tons/year)	Total Reduction (tons/year)	Reduction (%)	BMP Cost ($10/acre)	BMP Cost Benefit ($/ton reduced)
2,194	351	16%	$18,099	$52
	BMP: No Till on Worst 5% of Area			
Total (tons/year)	Total Reduction (tons/year)	Reduction (%)	BMP Cost ($14/acre)	BMP Cost Benefit ($/ton reduced)
2,194	572	26%	$12,670	$22
	BMP: No Till on Worst 10% of Area			
Total (tons/year)	Total Reduction (tons/year)	Reduction (%)	BMP Cost ($14/acre)	BMP Cost Benefit ($/ton reduced)
2,194	729	33%	$25,339	$35
	BMP: Grass on Worst 5% of Area			
Total (tons/year)	Total Reduction (tons/year)	Reduction (%)	BMP Cost ($44/acre)	BMP Cost Benefit ($/ton reduced)
2,194	922	42%	$39,819	$43
	BMP: Grass on Worst 10% of Area			
Total (tons/year)	Total Reduction (tons/year)	Reduction (%)	BMP Cost ($44/acre)	BMP Cost Benefit ($/ton reduced)
2,194	1,171	53%	$79,638	$68
	BMP: Grass Buffer of Ag on all streams			
Total (tons/year)	Total Reduction (tons/year)	Reduction (%)	BMP Cost ($44/acre)	BMP Cost Benefit ($/ton reduced)
2,194	219	10%	$12,896	$59

Table 10.3 Rush Creek HIT Model Sediment Loading and Potential Reductions from Selected BMPs

	BMP: Mulch Till on Worst 5% of Area			
Total (tons/year)	Total Reduction (tons/year)	Reduction (%)	BMP Cost ($10/acre)	BMP Cost Benefit ($/ton reduced)
1,264	243	19%	$9,976	$41
	BMP: Mulch Till on Worst 10% of Area			
Total (tons/year)	Total Reduction (tons/year)	Reduction (%)	BMP Cost ($10/acre)	BMP Cost Benefit ($/ton reduced)
1,264	260	21%	$19,952	$77
	BMP: No Till on Worst 5% of Area			
Total (tons/year)	Total Reduction (tons/year)	Reduction (%)	BMP Cost ($14/acre)	BMP Cost Benefit ($/ton reduced)
1,264	447	35%	$13,966	$31
	BMP: No Till on Worst 10% of Area			
Total (tons/year)	Total Reduction (tons/year)	Reduction (%)	BMP Cost ($14/acre)	BMP Cost Benefit ($/ton reduced)
1,264	477	38%	$27,933	$59
	BMP: Grass on Worst 5% of Area			
Total (tons/year)	Total Reduction (tons/year)	Reduction (%)	BMP Cost ($44/acre)	BMP Cost Benefit ($/ton reduced)
1,264	728	58%	$43,894	$60
	BMP: Grass on Worst 10% of Area			
Total (tons/year)	Total Reduction (tons/year)	Reduction (%)	BMP Cost ($44/acre)	BMP Cost Benefit ($/ton reduced)
1,264	778	62%	$87,789	$113
	BMP: Grass Buffer of Ag on all streams			
Total (tons/year)	Total Reduction (tons/year)	Reduction (%)	BMP Cost ($44/acre)	BMP Cost Benefit ($/ton reduced)
1,264	115	9%	$8,642	$75

Increasing Water Temperatures

While the East Branch Rush Creek subwatershed had cool and coldwater temperatures, the subwatershed's land uses and growing suburban development threaten these temperatures. Ideal stream temperatures for the East Branch Rush Creek subwatershed are within the following MDNR ranges:

- Cold-transitional = July mean water temperature >63.5° F (17.5°C) and ≤67° F (19.5°C)
- Cool (or warm transitional) = July mean water temperature >67° F (19.5°C) and ≤70° F (21°C)

Most sampling locations in the East Branch subwatershed had temperatures in the Cool (warm transitional) range, and coldwater stream habitat would benefit by falling in the cold transitional range ≤67° F.

Nutrients

As a general trend, nutrient concentrations in the surface water were higher following wet weather events, and locations with fine-grained soils, hills and agricultural land uses showing the largest concentrations of nutrient pollution.

Phosphate concentrations are directly related to TSS, so addressing TSS pollutant sources will help to reduce phosphate loading. Agricultural sediment sources of NPS were identified as the priority source of phosphate pollution in both subwatersheds. In the Main Branch, this land is in the south and east portions of the Main Branch subwatershed, as shown in the HIT model results. Septic systems are the second highest priority contributing sources of phosphate.

There was not a significant difference in ammonia concentrations between wet and dry weather events, although wet weather events did result in higher ammonia concentrations. The ammonia concentrations in the Main branch were significantly higher than those in the East Branch. Nitrate/nitrite concentrations were not significantly different between wet and dry rain events when compared at all sampling sites, though the actual pollutant loading is higher due to the increased discharge. Leaking and illicit septic systems may be a major contributing source of ammonia and nitrate. Agriculture land uses are also a contributing source of nitrate and ammonia.

Nutrient contributions to the RCW can be reduced by removing leaking, failing, and illicitly connected septic systems and reducing erosion and stream flooding especially in the areas that are most vulnerable to erosion identified as hilly areas with clay soils and agricultural land uses.

Herbicides and Pesticides

Though no water sampling data were collected for herbicides and pesticides during this watershed management planning process, herbicides and pesticides are commonly applied on the types of land uses found in the RCW, including agriculture and urban and suburban developments. Additionally, evidence of misuse adjacent to an agriculture drain was noted during the windshield survey.

10.4 Priorities for Preservation

With the majority of RCW being developed or used for agriculture, little of the watershed remains in its more natural undeveloped state. Preservation is the most effective and cost efficient way to prevent the degradation of the water quality.

The following are the RCW priorities for preservation, described in detail in Chapter 10.4. I/E recommendations can be used to help in addressing preservation recommendations.

1) Adopt Post Construction Controls Stormwater Ordinances and County development rules (standards manuals) in all urbanized and non-urbanized areas, and review them in context with this WMP to evaluate any possible remaining gaps.

2) Protect and preserve existing wetlands.

3) Restore historic wetlands and increase flood storage through other means such as two-stage ditches with wetland vegetation.

4) Encourage and install LID techniques, Green Infrastructure, native plants, and trees.

5) Review and adopt additional opportunities for RCW protective ordinances described in Chapter 9.3.

6) Manage Rush Creek to facilitate its use for kayaking.

Preservation activities are important in High Quality, Threatened, and Impaired areas to protect the areas from degradation. Due to the developed state of the RCW, any of the recommendations outlined for preservation are also considered priority recommendations for restoration of the RCW.

10.5 Priorities for Restoration

Restoration activities are important to address Threatened and Impaired areas to reduce pollutant loading, improve water quality in impaired and Threatened areas and prevent degradation of water quality in high quality areas.

The following are the generalized and summarized RCW priorities for restoration, described in detail in Chapter 10.5. I/E recommendations can be used to help in addressing restoration recommendations.

1) Adopt Post Construction Controls Stormwater Ordinances and County development rules (standards manuals) in all urbanized and non-urbanized areas, and review them in context with this WMP to evaluate any possible remaining gaps.

2) Protect and preserve existing wetlands.

3) Restore historic wetlands and increase flood storage through other means such as two-stage ditches with wetland vegetation.

4) Encourage and install the LID techniques, green infrastructure, native plants, and trees.

5) Require homes with access to sanitary sewer service to abandon septic systems and connect to sanitary sewer service.

6) Develop and implement septic system I/E campaign and include incentives for proper management.

7) Develop septic ordinance in Kent County.

8) Investigate sanitary sewer expansion in areas of high-density septic systems.

9) Hold one-on-one technical meetings with farmers, with a focus on those farming in priority areas identified, including the less common muck soils that are present in the RCW, to encourage BMP adoption.

10) Develop and implement an I/E campaign for improved management of developed land, including gutter disconnection from stormsewer and manicured lawn management.

11) Develop and implement an I/E campaign to reach hobby farmers to encourage BMP adoption.

12) Bank stabilization.

13) Provide technical and financial assistance for greenhouse operators to adopt BMPs.

14) Advertise an illicit discharge reporting system.

15) Develop and implement an I/E campaign to encourage riparian BMPS.

16) Road and Stream Crossing inventory and street sweeping BMPS.

17) Improve turfgrass management.

10.6 Recommended Actions for Preserving or Protecting Priority Areas

Protection of land and water resources from degradation is a goal of this WMP. Generally, implementing preservation or protection measures in a watershed before it is polluted is more cost and time effective than subsequent restoration efforts. Preservation activities are recommended both as tools for protection and toward the restoration of designated uses. Some recommendations listed below are categorized as a recommendation for both preservation and restoration. Wetlands are particularly important to protect and restore as they are instrumental in maintaining optimal discharges and reducing pollutant loading.

Recommended actions for Preservation are listed below and numbered in priority order.

P1) Recommended Action: Adopt the draft or final Post Construction Controls Stormwater Ordinances and County development rules (standards manuals) and review the ordinances and development rules in context with this WMP to evaluate any possible remaining gaps.

As previously mentioned, draft Post Construction Controls Stormwater Ordinances are under review by MDEQ for both Kent and Ottawa County. Recommendations included in this WMP assume that these ordinances will be approved and adopted. A review of existing MS4 progress reports and local ordinances of RCW municipalities shows that there are varying degrees of stormwater management, and consequently, inconsistent watershed protection within the RCW. For example, Cities and Townships in the RCW do not have consistent monitoring requirements of stormwater infrastructure. Monitoring requirements are anticipated to be a requirement under a future ordinance. The ordinances and development rules are expected to allow more protective and consistent management of stormwater management in the RCW. Since a final draft was not available for review during the development of the RCW Management Plan, this text should be reviewed in context with this WMP to evaluate any possible remaining gaps.

Policy Partners are most important for implementing the Post Construction Controls Stormwater Ordinances.

P2) Recommended Action- (Blendon, Byron, Jamestown Townships): **For consistent RCW water quality management, Blendon, Byron, and Jamestown Townships should follow the Kent or Ottawa Stormwater Ordinances and design standards.** Currently, only designated communities in urbanized areas that own or operate a storm sewer system are required to follow MS4 permit requirements.

In addition, Townships should consider participation in the urbanized area I/E campaign managed through LGROW.

Policy Partners, especially the listed local municipalities, are most important for implementing the County Stormwater Ordinances and design standards. Assistance from the County Drain Commissioners may be especially useful.

P3) Recommended Action: Protect and preserve existing wetlands using regulatory mechanisms and other wetland protection programs. While some areas in the RCW are already largely developed (i.e. Hudsonville, Grandville, Wyoming, Georgetown Township), other areas are experiencing pressure from development. Varying levels of ordinances have been developed to manage the stormwater. In general, more stormwater ordinances have been enacted in the areas that are more developed. While these stormwater ordinances are very useful, the ordinances do not address a main component of this WMP, which is the protection and preservation existing wetlands.

In areas that are experiencing development pressure (i.e. East Branch Subwatershed, Blendon Township, Jamestown Township, Byron Township), regulatory mechanisms to protect the remaining undisturbed natural areas and wetlands are especially important. While Ottawa County often reviews the new development plans in these areas, "the county does not have planning and zoning authority and therefore relies upon the local unit of government to direct growth to identified areas, to protect sensitive areas such as wetlands and riparian areas, to maintain and/or increase open spaces, and to encourage infill development in higher density urban areas and areas with existing infrastructure" (GVMC, p 21, 2016e). Regulatory mechanisms to protect the environmentally sensitive areas and direct growth are described in Chapter 9.3 of this WMP.

There are 2,290 acres of wetlands remaining in the RCW. There are 1,127 acres of high priority flood storage capacity wetlands for preservation and 472 acres of pathogen removal wetlands for preservation. Of these wetlands, there are approximately 112 wetland features or 219 acres of wetlands that are the highest priority to preserve as the wetlands have both flood storage function and pathogen removal functions. These wetlands are shown in Figure 10.1. Preservation is typically considered to be the least expensive way to maintain water quality. In addition, incentives are available for landowners preserving high priority areas, including tax-incentives, conservation easement-purchase, and other programs such as the NRCS Wetlands Reserve Program.

Policy Partners, especially local municipalities, are most important for implementing wetland regulatory and preservation programs.

P4/CA1 Recommended Action- (All municipalities): Increase flood storage by restoring lost critical wetlands creating detention or retention ponds, bioswales, and two-stage ditches with wetland vegetation. RCW has lost 84% of its historic wetlands. The significant loss of wetlands reduces flood storage and contributes to RCW flashy flows. In addition, it is suspected that the loss of wetlands, especially those with pollution reduction functions, contributes to pollutant loading. As such, lost historic wetlands with flood storage functions and as well as groundwater recharge and *E. coli*, sediment, and nutrient removal functions, in proximity to pollutant sources and streams, are recommended for wetland restoration. Figure 10.2 shows priority areas that are recommended for restoration of critical wetlands following the process described in Chapter 7.6.

Detention and retention ponds help to store floodwaters and should be considered when wetlands cannot be restored. When no opportunities for wetlands, detention or retention ponds exist, two-stage ditches with adjacent wetland vegetation should be installed where possible.

Stream Restoration and Preservation Partners are most important for implementing wetland restoration efforts.

Nine major historic wetland areas, including 1,716 acres, are considered priority to restore, storing floodwaters and reducing *E. coli*, sediment and pollutant loading. These areas are shown in Figure 10.2.

P5 Recommended Action: The use of LID and Green Infrastructure should remain a priority in the proposed Stormwater Ordinances, and in any other feasible methods. LID and Green Infrastructure is reportedly well accepted in the RCW by contractors (OCWRC, personal communication). Native vegetation, rain gardens, riparian buffers are all reportedly topics are of interest to residents in Kent County and the City of Hudsonville (GVMC, 2016e,f). Their use is encouraged in the City of Hudsonville Master Plan.

The City of Hudsonville Master Plan includes many site-specific opportunities to incorporate LID practices, native plants, and buffers protective of the RCW, including "density done well" a non-motorized path along Buttermilk Creek, using waterways as recreational corridors, and a village green envisioned in Downtown Hudsonville (p. 41, 2015). New or re-developments in the RCW should incorporate LID, Green infrastructure, and native plants whenever possible.

Policy Partners are most important for facilitating LID and Green Infrastructure recommendations. The Plaster Creek Stewards watershed organization may be a helpful resource as they are successfully installing Green Infrastructure in a nearby watershed. In addition, expansion and utilization of the newly developed LGROW Rainscaping program may be an opportunity to increase LID and Green Infrastructure (https://www.lgrow.org/rainscaping/).

P6/CA2) Recommended Action: Trees can help to reduce flashiness and provide a multitude of NPS pollution benefits and should be encouraged in Hudsonville, the City of Grandville, Wyoming, Georgetown Township, Jamestown Township, Byron Township and in other RCW communities. The City of Grandville is pursuing a Tree City USA Designation through the Arbor Day Foundation. A Tree Board has been appointed and they have prioritized creating an Urban Forestry Strategic Plan and Urban Forestry Management Plan. A Strategic Plan will serve as a "Foundation for administration and management" and a Management Plan will include a tree inventory and identify and prioritize site-specific tree planting, maintenance and removal activities" (Tornga, p. 1, 2017). A tree City USA Designation provides a framework for managing their public trees. Approximately 35% of the City of Grandville is currently canopied by trees, and a goal of 50% tree canopy is currently included in their strategic plan (Tornga, 2017). Recommendations included in the Grandville Tree Project Strategic Plan (2017) and subsequent efforts by the Tree Board related to an increase in tree canopy will be of benefit to the RCW. The Strategic Plan is included in Appendix J.

Additional communities may benefit from Tree City Designations or additional tree plantings.

Likewise, the City of Hudsonville Master Plan recommends planting trees for their multitude of benefits, including stormwater management benefits, (City of Hudsonville and Nederveld, Inc. p. 12, 2015), and is considered of some importance to 89% of the public who participated in the Master Plan community input

(City of Hudsonville and Nederveld, Inc. p. 34, 2015). Though tree planting is primarily listed to be the responsibility of the City of Hudsonville and the DDA, many other RCW partners could participate in this effort.

The loss of ash trees from disease has resulted in the loss of tree canopy on both sides of a stream in some places of the RCW, including on Bliss Creek in Georgetown Township, Grandville, and Wyoming. Restoration of the tree canopy on at least one side (preferably the south and/or west) of the creek is recommended, especially in residential areas.

Trees have a multitude of watershed benefits. A deciduous tree can intercept 500-760 gallons of water per year, while a mature evergreen can intercept more than 4,000 gallons per year (Cotrone, 2017). Trees can reduce Total Nitrogen and Total Phosphorus pollutant loading by 23.8% and TSS 5.8% when compared to pollutant loading from turfgrass land uses, and 8.5%, 11.0%, and 7.0% respectively when compared to pollutant loading from impervious cover land uses (Hynicka and Divers, 2016 found in Cappiella et al., 2016). Trees along the riparian corridor can help protect water temperatures from rising, which is especially important in the East Branch that has temperatures in the cool or cold-transitional range. In addition, replacing trees throughout the watershed will counter the recent loss of ash trees from disease. However, as commonly stated, it is difficult to manage what you can't measure. Additional tools may help communities select, measure, and manage the watershed's trees and affect on water quality, including i-Tree (itreetools.org), a cooperative initiative with the U.S. Forest Service and others that helps to quantify the ecosystem services benefits of trees, including water quantity and quality.

Preservation partners and neighborhood and lake associations are most important for helping to increase tree coverage in the RCW.

P7/CA3) Recommended Action- (All Municipalities): Construct LID stormwater infrastructure in existing developments, including rain gardens, bioswales, retention or detention ponds by modifying the existing infrastructure, to alleviate flow entering stormsewer systems.

Each BMP may vary in design storm year values, and benefits or runoff volumes reduced can be calculated using the Rainwater Rewards calculator (www.rainwaterrewards.com) developed by West Michigan Environmental Action Council, Grand Valley State University (GVSU), and Michigan Tech Research Institute or other design calculations.

Municipalities are the most important partners to help install LID and Green Infrastructure.

P8/CA4) Recommended Action: Incorporate buffers, LID practices, and native plantings adjacent to the stream and in other municipal projects. The Hudsonville Master Plan envisions a non-motorized path along the creek as well as a village green in the city-center. Both projects, and others not listed here, are opportunities to incorporate LID and green infrastructure. Riparian areas are especially important areas to manage to support stream health. Proper management can filter pollutants, reduce bank erosion, and reduce stream temperatures.

Municipalities are important partners for implementing this recommendation.

P9/CA5) Recommended Action- (Entire RCW): Provide I/E and/or technical and financial incentives for rain gardens, rain barrels, proper fertilization, native plants, and trees to protect the waters from lawn fertilizer, herbicide and pesticide pollution contributions and runoff that contributes to flashy flows.

Annual MS4 reports from Kent County Drain Commissioner, Kent County Road Commission, and the City of Hudsonville indicate that residents are most interested in learning about native plants, rain gardens, and buffers (GVMC, 2016b,e,f).

The NSA identified potential for improved lawn/landscaping and irrigation practices, rain gardens or rain barrels, buffers or native plants, the addition of trees, rain gardens or rain barrels. Include I/E on the proper management of lawn clippings. More specific neighborhood information is found in Chapter 4.

Through a hired RCW watershed coordinator and developed local watershed council, share RCW water quality and water quantity information through a general education campaign including newspaper, TV, local government (websites, newsletters, and mailers to residents, possibly through their tax or utility bills), environmental groups, and other partners. A watershed coordinator should be hired for the full ten years estimated in this WMP.

Develop and implement a watershed-wide campaign about capturing rainwater though rain barrels, rain gardens, native plants, trees, streamside buffers, and disconnecting gutters from stormsewer.

Develop and implement a watershed-wide campaign about improved lawn care practices to improve the RCW water quality and its scenic beauty, including proper fertilizer, pesticide, and herbicide use, proper watering schedule, and optimized mowing height. Provide information on soil testing, native plants, and trees.

Hold informative workshops to help homeowners better understand how to adopt BMPs on their properties. Make demonstrations sties available. Provide technical and financial incentives for adopting BMPs.

Develop a Green Team with local students to help homeowners install LID and GI, including rain gardens. A Green Team should work in the RCW for a minimum of five years, and the need of the Green Team should be reevaluated partially through their operation.

Begin partnership and introduction of local environmental groups that are already working on rainscaping, rain barrel, native plants, trees, and similar BMPs (LGROW, WMEAC, etc.). For example, LGROW, and pilot subwatersheds Plaster Creek, Indian Creek, and Rogue River, have recently begun a Grand River Rainscaping Program, promoting GI information and adoption to homeowners, landscapers, and contractors. While the current project is available in the Lower Grand River Watershed, additional support could be used in the RCW to advertise this program and further incentive rainscaping BMP adoption.

Neighboring watersheds including the Macatawa manage a Lawn Care Seal of Approval Program soliciting participation for lawn care and landscaping companies to learn and practice BMPs in their operations, helping to reduce nutrient and NPS pollutant inputs. In return, the companies can advertise their participation in the program, and their earned watershed seal. A similar program, or an extension of the MACC program could be implemented in the RCW.

WMEAC holds rain barrel workshops and has a Rainwater Rewards tool that can be helpful in showing the financial benefits of LID and GI.

I/E and residential partners, including homeowners' associations, are most important for implementing.

P10/CA6) Recommended Action: Disconnect gutters from Storm Sewer. The Neighborhood Source Assessment identified many homes with gutters directly connected to the storm sewer. Extrapolations of the NSA were used to estimate that approximately 5,257 homes may have gutters directly connected to the stormsewer. Disconnecting the gutters from the storm sewers slows the speed at which runoff reaches the creek system, and allows the opportunity for some rainwater to infiltrate.

I/E about the benefits of disconnecting their gutters from the storm sewer should be shared with residents (as a part of the larger watershed I/E campaign described here), along with technical and financial resources to facilitate the gutter modification.

Residential partners, local environmental groups, and a Rush Creek Watershed Council, including homeowners' associations, are most important for implementing a gutter disconnection program. A Green Team could also be useful to implement this action.

P11) Recommended Action: Review and adopt additional regulatory mechanisms that are protective of the RCW, described in Chapter 9.3. Local governments have the authority to adopt environmentally protective ordinances, described in more detail in Chapter 9.3. For example, the City of Hudsonville has adopted buffer provisions within their zoning ordinances and Georgetown Township's Storm Water Ordinance includes regulations that adhere to the Floodplain Ordinance and the SESC program of the Township. These ordinances are of benefit to the RCW. Additional opportunities for RCW protective ordinances related to environmentally sensitive development, soil erosion and sedimentation control, mature tree protection, among others discussed in detail in Chapter 9 and if adopted will further protect water quality.

Policy Partners, especially local municipalities, are most important for adopting additional RCW regulatory mechanisms.

P12) Recommended Action: Identify landowners with priority wetlands for preservation on their land and share information about wetland protection through I/E. Use tools such as aerial photograph and/or parcel/address review and directly contact landowners with wetland protection information and other information described in Chapter 8. Receptive landowners should be connected with incentives and existing related wetland protection programs.

Preservation Partners are most important for developing and implementing a wetland preservation public outreach program and helping to secure the protection of wetlands.

P13) Recommended Action: Manage Rush Creek to facilitate its use for kayaking. Investigate the possibility of a Water Trail designation for a portion of the creek. Install signs and trash receptacles to better manage waste disposal, access, and parking.

Local municipalities, environmental and kayaking groups are most important for implementing

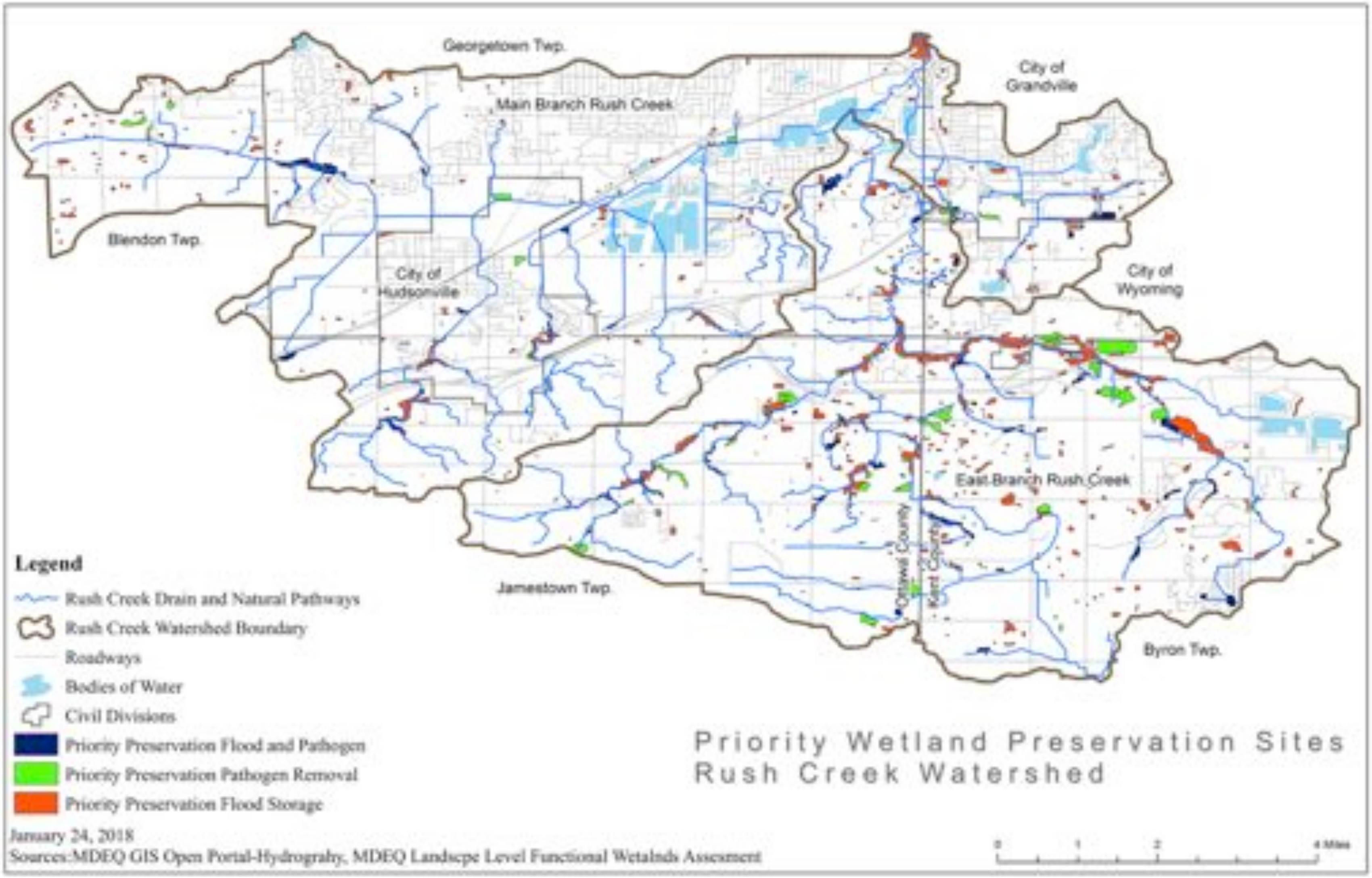

Figure 10.1 Priority Wetland Preservation Areas

10.7 Recommended Actions for Restoring Critical Areas

Some NPS pollutant contributions can be attributed to widespread practices. BMP recommendations follow on improving the practices that are known, suspected, or potentially contributing to surface water pollution problems.

Recommended actions for restoring critical areas are listed below. The pollutant categories are listed in priority order, and the overall recommended tasks are numbered in priority order across pollutant categories. It is important to remember that the recommended preservation activities are also important tools for the restoration of designated uses.

Recommended actions for Restoration of Critical Areas (CA) are listed below generally in priority order and the top 20 recommendations are numbered.

Altered Hydrology

CA1/P4) Recommended Action- (All municipalities): Increase flood storage by restoring lost critical wetlands creating detention or retention ponds, bioswales, and two-stage ditches with wetland vegetation. RCW has lost 84% of its historic wetlands. The significant loss of wetlands reduces flood storage and contributes to RCW flashy flows. In addition, it is suspected that the loss of wetlands, especially those with pollution reduction functions, contributes to pollutant loading. As such, lost historic wetlands with flood storage functions and as well as groundwater recharge and *E. coli*, sediment, and nutrient removal functions, in proximity to pollutant sources and streams, are recommended for wetland restoration. Figure 10.2 shows priority areas that are recommended for restoration of critical wetlands following the process described in Chapter 7.6.

Detention and retention ponds help to store floodwaters and should be considered when wetlands cannot be restored. When no opportunities for wetlands, detention or retention ponds exist, two-stage ditches with adjacent wetland vegetation should be installed where possible.

Stream Restoration and Preservation Partners are most important for implementing wetland restoration efforts.

Nine major historic wetland areas, including 1,716 acres, are considered priority to restore, storing floodwaters and reducing *E. coli*, sediment and pollutant loading. These areas are shown in Figure 10.2.

CA2/P6) Recommended Action: Trees can help to reduce flashiness and provide a multitude of NPS pollution benefits and should be encouraged in Hudsonville, the City of Grandville, Wyoming, Georgetown Township, Jamestown Township, Byron Township and in other RCW communities. The City of Grandville is pursuing a Tree City USA Designation through the Arbor Day Foundation. A Tree Board has been appointed and they have prioritized creating an Urban Forestry Strategic Plan and Urban Forestry Management Plan. A Strategic Plan will serve as a "Foundation for administration and management" and a Management Plan will include a tree inventory and identify and prioritize site-specific tree planting, maintenance and removal activities" (Tornga, p. 1, 2017). A tree City USA Designation provides a framework for managing their public trees. Approximately 35% of the City of Grandville is currently canopied by trees, and a goal of 50% tree canopy is currently included in their strategic plan (Tornga, 2017). Recommendations included in the Grandville Tree Project Strategic Plan (2017) and subsequent efforts by the Tree Board related to an increase in tree canopy will be of benefit to the RCW, and should be implemented.

Additional communities may benefit from Tree City Designations or additional tree plantings.

Likewise, the City of Hudsonville Master Plan recommends planting trees for their multitude of benefits, including stormwater management benefits, (City of Hudsonville and Nederveld, Inc. p. 12, 2015), and is considered of some importance to 89% of the public who participated in the Master Plan community input (City of Hudsonville and Nederveld, Inc. p. 34, 2015). Though tree planting is primarily listed to be the responsibility of the City of Hudsonville and the DDA, many other RCW partners could participate in this effort.

The loss of ash trees from disease has resulted in the loss of tree canopy on both sides of a stream in some places of the RCW, including on Bliss Creek in Georgetown Township, Grandville, and Wyoming. Restoration of the tree canopy on at least one side (preferably the south and/or west) of the creek is recommended, especially in residential areas.

Trees have a multitude of watershed benefits. A deciduous tree can intercept 500-760 gallons of water per year, while a mature evergreen can intercept more than 4,000 gallons per year (Cotrone, 2017). Trees can reduce Total Nitrogen and Total Phosphorus pollutant loading by 23.8% and TSS 5.8% when compared to pollutant loading from turfgrass land uses, and 8.5%, 11.0%, and 7.0% respectively when compared to pollutant loading from impervious cover land uses (Hynicka and Divers, 2016 found in Cappiella et al., 2016). Trees along the riparian corridor can help protect water temperatures from rising, which is especially important in the East Branch that has temperatures in the cool or cold-transitional range. In addition, replacing trees throughout the watershed will counter the recent loss of ash trees from disease. However, as commonly stated, it is difficult to manage what you can’t measure. Additional tools may help to measure and manage the watershed’s trees and affect on water quality, including i-Tree (itreetools.org), a cooperative initiative with the U.S. Forest Service and others that helps to quantify the ecosystem services benefits of trees, including water quantity and quality.

Preservation partners and neighborhood and lake associations are most important for helping to increase tree coverage in the RCW.

CA3/PA7) Recommended Action- (All Municipalities): Construct LID stormwater infrastructure in existing developments, including rain gardens, bioswales, retention or detention ponds by modifying the existing infrastructure, to alleviate flow entering stormsewer systems.

Each BMP may vary in design storm year values, and benefits or runoff volumes reduced can be calculated using the Rainwater Rewards calculator (www.rainwaterrewards.com) developed by West Michigan Environmental Action Council, Grand Valley State University (GVSU), and Michigan Tech Research Institute or other design calculations.

Municipalities are the most important partners to help install LID and Green Infrastructure.

CA4/PA8) Recommended Action: Incorporate buffers, LID practices, and native plantings adjacent to the stream and in other municipal projects. The Hudsonville Master Plan envisions a non-motorized path along the creek as well as a village green in the city-center. Both projects, and others not listed here, are opportunities to incorporate LID and green infrastructure. Riparian areas are especially important areas to manage to support stream health. Proper management can filter pollutants, reduce bank erosion, and reduce stream temperatures.

Municipalities are important partners for implementing this recommendation.

Recommended Action: Manage Rush Creek to facilitate its use for kayaking. Manage fallen ash trees, stabilize banks, and perform minor drain clearing to clear a path for recreational kayak use. Provide kayak launches.

OCWRC and County and City Parks Departments are recommended partners.

Recommended Action- (Ottawa County): Review recommendations of the Ottawa County groundwater and chloride study in context of this WMP and adopt applicable recommended actions. Ottawa County has seen a decline in static water levels and an increase in drawdown in central Ottawa County, measured from 1970 to 2015. Groundwater modeling predicts some potential low water areas in the RCW. There has also been an increase in chloride contamination, correlated with the increased drawdown. The Executive Summary of the study is included in Appendix J (Ottawa County Planning and Performance Improvement, 2017).

Urban/Residential

CA5/PA9) Recommended Action- (Entire RCW): Provide I/E and/or technical and financial incentives for rain gardens, rain barrels, proper fertilization, native plants, and trees to protect the waters from lawn fertilizer, herbicide and pesticide pollution contributions and runoff that contributes to flashy flows.

Annual MS4 reports from Kent County Drain Commissioner, Kent County Road Commission, and the City of Hudsonville indicate that residents are most interested in learning about native plants, rain gardens, and buffers (GVMC, 2016b,e,f).

The NSA identified potential for improved lawn/landscaping and irrigation practices, rain gardens or rain barrels, buffers or native plants, the addition of trees, rain gardens or rain barrels. Include I/E on the proper management of lawn clippings. More specific neighborhood information is found in Chapter 4.

Through a hired RCW watershed coordinator (~10 years) and developed local watershed council, share RCW water quality and water quantity information through a general education campaign including newspaper, TV, local government (websites, newsletters, and mailers to residents, possibly through their tax or utility bills), environmental groups, and other partners.

Develop and implement a watershed-wide campaign about capturing rainwater though rain barrels, rain gardens, native plants, trees, streamside buffers, and disconnecting gutters from stormsewer.

Develop and implement a watershed-wide campaign about improved lawn care practices to improve the RCW water quality and its scenic beauty, including proper fertilizer, pesticide, and herbicide use, proper watering schedule, and optimized mowing height. Provide information on soil testing, native plants, and trees.

Hold informative workshops to help homeowners better understand how to adopt BMPs on their properties. Make demonstrations sties available. Provide technical and financial incentives for adopting BMPs.

Develop a Green Team with local students to help homeowners install LID and GI, including rain gardens.

Begin partnership and introduction of local environmental groups that are already working on rainscaping, rain barrel, native plants, trees, and similar BMPs (LGROW, WMEAC, etc.). For example, LGROW, and pilot subwatersheds Plaster Creek, Indian Creek, and Rogue River, have recently begun a Grand River

Rainscaping Program, promoting GI information and adoption to homeowners, landscapers, and contractors. While the current project is available in the Lower Grand River Watershed, additional support could be used in the RCW to advertise this program and further incentive rainscaping BMP adoption.

Neighboring watersheds including the Macatawa manage a Lawn Care Seal of Approval Program soliciting participation for lawn care and landscaping companies to learn and practice BMPs in their operations, helping to reduce nutrient and NPS pollutant inputs. In return, the companies can advertise their participation in the program, and their earned watershed seal. A similar program, or an extension of the MACC program could be implemented in the RCW.

WMEAC holds rain barrel workshops and has a Rainwater Rewards tool that can be helpful in showing the financial benefits of LID and GI.

I/E and residential partners, including homeowners' associations, are most important for implementing.

CA6/PA10) Recommended Action: Disconnect gutters from Storm Sewer. The Neighborhood Source Assessment identified many homes with gutters directly connected to the storm sewer. Extrapolations of the NSA were used to estimate that approximately 5,257 homes may have gutters directly connected to the stormsewer. Disconnecting the gutters from the storm sewers slows the speed at which runoff reaches the creek system, and allows the opportunity for some rainwater to infiltrate.

I/E about the benefits of disconnecting their gutters from the storm sewer should be shared with residents (as a part of the larger watershed I/E campaign described here), along with technical and financial resources to facilitate the gutter modification.

Residential partners, local environmental groups, and a Rush Creek Watershed Council, including homeowners' associations, are most important for implementing a gutter disconnection program. A Green Team could also be useful to implement this action.

CA7) Recommended Action- (Priority municipalities: Byron, Blendon Townships): Encourage or require home and business owners who are using septic systems but who are located within sanitary service boundaries to connect to the sanitary sewer and properly abandon their septic systems.

Within sanitary service boundaries, ordinances can be adopted to reduce pollution loading from failing septic systems.

The Cities of Wyoming and Grandville and Jamestown and Georgetown Townships require connection to the sanitary sewer system if the structure is within a certain distance from sanitary sewer (typically around 200 feet). Municipal sewer services are available to all of the City of Wyoming located within the RCW. However, it is unknown if every facility is connected to the sewer. It is estimated that few homes in the City of Wyoming within the RCW may still have a septic system. Due to their age, a few older homes on 52nd Street may potentially not be connected to the municipal sewer (City of Wyoming Communication, November 16, 2017). Within Georgetown Township (which extends beyond the RCW) over 300 properties with septic systems are already being required to connect to nearby municipal sewer, and thus are considered a lower priority since this action is already underway. There are an estimated 10-15 homes with septic systems and access to sanitary sewer service in Hudsonville. Approximately half of those homes are expected to be connected to sanitary sewer as a part of a road and trail construction project planned for 2018-2019 (City of Hudsonville, personal communication, January 5, 2018). There are up to 15 properties outside of sanitary sewer service areas in the City of Grandville (City of Grandville, Ken Krombeen, personal communication, January 16, 2018).

Byron Township only requires the connection of a septic system under certain instances, including failure of an existing private sewage disposal facility, or a public health and welfare concern.

A review of gaps in municipal water and sewer bills or a review of Health Department records could be used methods to help identify operating septic systems. Health Departments do not have jurisdiction to require homes to connect to available sanitary service (sanitary service is within 200 feet of the roofline), unless a septic system has been reported to the Health Department and is determined to be failing.

Septic partners, especially municipalities, are most important for implementing.

CA8) Recommended Action- (Priority municipalities: Jamestown, Byron, and Blendon). In areas and to homes not serviced by municipal sewer, septic system outreach and improvement programs should be developed and implemented to inform residents about proper septic system maintenance repairs, and/or replacement practices.

Municipal sewer does not service large portions of Byron, Jamestown, and Blendon Townships, and many new septic systems being installed in these areas are advanced systems such as mound or deep cut systems.

Develop and distribute an I/E campaign about bacteria and virus pollution presence and septic system sources in RCW through Newspaper, TV, Local Government, Conservation District, and Environmental group partners.

Efforts should focus on the most problematic areas, including locations with traditional septic systems in the highest density areas not serviced by sanitary sewer and in soils unsuitable for traditional septic system due to soil type or the shallow depths to groundwater, and in locations where human source tracking results were positive (Figure 4.2).

There are an estimated 400-450 homes with septic systems outside of the sewer service area in Kent County, or assuming a 10% failure rate, there are approximately 40-45 failing septics.

Of the municipalities in Ottawa County, Jamestown Township (which extends beyond the RCW) has 1,669 facilities with septic systems (tanks and drainfields). It is assumed that approximately half of those homes are in the RCW (835). Also in Jamestown Township there are 164 homes with in the RCW that have a septic tank and also discharge to the sanitary sewer (see this listed in Critical Site). Blendon Township does not know how many septic systems are located in their Township.

Georgetown Township (which extends beyond the RCW) does not know how many properties in their townships utilize septic systems. Determine which homes are using septic systems in Georgetown Township that are not going to be connecting to sanitary sewer service. Georgetown Township has over 300 properties with septic systems that are already being required to connect to nearby municipal sewer due to their proximity to sanitary service. It is assumed that approximately half of those homes are in the RCW (169).

I/E should be shared with residents, including instructions for proper maintenance, repairs, and/or replacements. In the highest density areas, municipal septic collection and treatment should be evaluated with stakeholders. Residential properties adjacent to surface water have a large impact on water quality.

Septic Partners, listed below, with the cooperation of homeowners are most important for successful implementation. Coordination between local governments, lake associations and a regulating body such as the health department is important.

In addition to I/E efforts for homeowners with septic systems outside the urbanized area, residents with septic systems within urbanized areas and/or within sanitary service boundaries should also be targeted with septic system information. LGROW is an important partner to help reach residents with septic systems within urbanized areas. Though targeted I/E efforts, such as mailers, to homeowners known to have septic systems within LGROW's I/E urbanized area (Wyoming, Grandville, Hudsonville) may be warranted if those areas are not included in the general septic system I/E campaign area.

CA9) Recommended Action- (Ottawa County): Encourage and provide funding assistance for voluntary septic system inspection, maintenance and replacements, where warranted, in Ottawa County. Priority areas include the homes with septic systems in Ottawa County. Jamestown Township (which extends beyond the RCW) has 1,669 facilities with septic systems (tanks and drainfields). It is unknown how many homes have septic systems in Georgetown Township or Blendon Township.

Homes with septic systems that are in the closest proximity to creek and drains are the highest priority.

Septic Partners are most important for implementing this recommendation.

CA10) Recommended Action- (Kent County, State of Michigan): Adopt a risk-based septic system maintenance policy in Kent County and the State of Michigan. While OCDPH requires inspection of septic systems for a Real Estate Transfer, the State of Michigan and KCHD do not have similar ordinances, and instead only regulate septic systems at the time of installation. A risk-based septic system policy in Kent County would further protect the RCW from failing and leaking septic systems, and qualify County residents to receive federal grant money to voluntarily address failing septic system issues.

RCW partners should participate in a Septic Systems Work Group with the KCHD with the goal of outlining and implementing the tasks needed to develop and adopt risk-based septic system policies for addressing failing or malfunctioning systems at the level of governance determined by the work group (health department, County, or Township). The work group could include Septic Partners, such as the health department, conservation districts, municipalities, and the local and neighboring watershed groups. The work groups should take the necessary steps to implement policies that reduce the health and environmental risks of on-site septic systems. This task was outlined in the development of the Flat River Watershed Management Plan, and a similar workgroup is underway in the Maple River Watershed.

Once a risk-based septic system maintenance policy is adopted in Kent County, encourage and provide funding assistance for voluntary septic system inspection, maintenance and replacements, where warranted, in Kent County. Priority areas include the estimated 400-450 homes with septic systems in Kent County, located South of M-6 and west of Byron Center. Homes with septic systems that are in the closest proximity to creek and drains are the highest priority.

KCHD and the State of Michigan are most important for implementing this recommendation.

CA11) Recommended Action- (Priority order of municipalities: Georgetown, Blendon, Jamestown, and Byron Townships): Investigate extension of sanitary service or community systems in areas with a high density of septic systems. In the areas of the highest septic system density that are outside of the current municipal coverage areas, complete feasibility studies to assess cost estimates of community systems and/or sanitary service extension.

There are reportedly 100+ homes in the Blair St. and Shady Oak Ct. neighborhood in Georgetown Township that do not have sanitary sewer service available. Georgetown Township plans to install sanitary sewer service to areas not currently connected when road re-surfacing is due. Blendon Township expressed concern of water quantity and seeking connection to municipal water and sanitary sewer service (Bill VandenBerg phone conversation, May 1, 2018). The SIDMA survey found that over 80% of non-farming residents live on a lot smaller than one acre, indicating that other communities may have high-density septic systems that could benefit from sanitary sewer service also.

CA18) Recommended Action: Advertise a citizen reporting system for illicit discharge. At the stakeholder meeting, a resident reported a truck pumping waste into a creek, while another resident reported a business possibly discharging their bathroom waste illicitly. Residents can call the KCHD general number 616-632-6900, Kent County Drain Commissioner 616-336-3688, Ottawa County Water Resources 616-994-4530, Ottawa County Department of Public Health 616-393-5645, or Georgetown Township 616-994-4530 to report these complaints, but often residents are not aware of this. A citizen reporting system should be advertised and further developed if needed to encourage community report of suspected sewage problems. Additional methods of reporting complaints include MDEQ's Pollution Emergency Alerting System (PEAS) hotline 1-800292-4706 and online via MiWaters (https://miwaters.deq.state.mi.us).

Health Departments, Drain Commissioners, LGROW, and municipalities are important partners for this task.

Recommended Action- (Priority order of municipalities: Byron and Blendon Townships, City of Wyoming): Perform a water and sewer bill comparison within the areas covered by municipal water and sewer to identify which homes or buildings are still utilizing septic systems where there is municipal sewer coverage. Use this information to reach out to homeowners and encourage proper septic maintenance with I/E material and encourage connection to sanitary sewer service, if not required under the respective township or city ordinances.

CA19) Recommended Action- (Entire RCW): Provide I/E about the benefits and practices of shoreline buffers and proper fertilization to those who live adjacent lakes and streams with manicured lawns, including Lake Associations, to protect the waters from pollutants including lawn fertilizers, pesticides and herbicides.

NSA found that many lakes did not have a riparian buffer and there was an opportunity for trees in those neighborhoods. Land use map shows tree coverage lacking along creeks and drains, especially in the Main Branch. Riparian properties can have a larger impact on surface water quality due to their proximity.

Include information related to septic systems in riparian areas without sanitary sewer.

Provide cost shared design and installation services and access to demonstration sites as described above.

Provide information through flyers, newsletters, partner programs, demonstration sites and workshops.

I/E and Residential partners are most important for implementing this recommendation.

CA20) Recommended Action- (Entire RCW. Rushmore Lake, Georgetown Shores, and other RCW lakes and riparian neighborhoods): Provide more in depth I/E through Lake Association "Water Quality Summit" to share information on riparian BMPs, buffers, native plants, and fertilizer, pesticide and herbicide BMPs. Provide information, resources, and access to demonstration sites. Many lake neighborhoods assessed in the NSA lacked a riparian buffer. Opportunities for trees plantings were also identified.

I/E and Residential partners are most important for implementing this recommendation.

Recommended Action: Encourage proper pet waste management and provide dog waste bags in neighborhoods with highest density. The NSA found that dog waste bags are not provided in all high and medium density developments. Dog waste bags could be provided. Additional signs and bag stations could be installed.

Through I/E encourage residents to pick up their pet waste.

Expand pet waste pledge campaign that LGROW operates or other successful MS4 related pet waste programs.

Residential and I/E partners are most important for implementing, including neighborhood associations, veterinarian offices.

Recommended Action: To reduce fertilizer and pesticide loading, turf areas such as golf courses, parks and schools should utilize resources from, participate and gain certification in the MTESP program. One golf course in the RCW is MTESP certified and five others in the RCW are not certified.

Golf courses and others who manage turf grasses (e.g. municipalities, schools) are most important for implementing.

Agricultural

For all recommendations related to agricultural BMPs, it is emphasized that an agricultural BMP should be selected on a field-by-field and subfield basis. Individual site conditions, the preference of the agricultural producer, and the recommendations of the agricultural technician or expert should all be considered when selecting an agricultural BMP.

Critical agriculture areas are outlined in Figure 10.4 and animal farm operations are displayed on Figure 4.1.

CA12) Recommended Action- (Priority order: Sites within Jamestown, Byron, and Georgetown Townships): Hold one-on-one technical assistance meetings with RCW farmers. Share information about existing technical and financial assistance programs (MAEAP, EQUIP, etc.) with landowners and partners.

There are an estimated 90 landowners who are involved in farming operations whether as a business or a hobby, excluding homes with one or two horses on few acres. Though there may be fewer landowners who actively farm since many may lease their operations to others. Due to the relatively small number of farmers in the RCW, one-on-one technical assistance meetings are recommended with the RCW farmers. Priority farms include those identified in the tillage survey (Appendix F), critical sites identified in Figure 10.4, and those that own land in areas identified as critical areas for sediment reduction (Figure 10.3), and animal farms (Figure 4.1). Figure 10.3 identifies areas most susceptible to sediment erosion, as identified by the HIT model, topography, soil type most susceptible to erosion (fine grained soils and muck soils). As discussed, curbing erosion will help reduce *E. coli,* sediment, phosphorus, herbicide, and pesticide pollutants.

There are estimated to be 53-70 large animal facilities in the RCW. There were 53 large animal facilities with over 420 large animals seen throughout the watershed during the survey, in addition to a turkey farm with fowl housed inside. The majority of these animal farms (40) are located in the East Branch. Of the approximately 60 farmers who responded to the SIDMA survey, approximately 42 respondents (of approximately 60) have a total of 1,252 animals. The respondents collectively reported to have 303 dairy cattle (four farms), 679 beef cattle (18 farms), six longhorn cattle (one farm), four hogs (one farm), 50 poultry (five farms), 20 sheep (one farm), 13 goats (two farms), 86 horses (ten farms). The SIDMA survey did not include farms that have only a few horses (the windshield survey estimated that there are approximately 16 farms with one to three horses). Farmers manage tillable land ranging from four to 650 acres. Farms in the RCW contain corn (1,414 acres), soybeans (337 acres), small grains (172 acres), cover crop/alfalfa (450 acres), pasture (305 acres), conservation areas (15 acres), melons (1 acres), berries/pumpkins (15 acres), flowers (1 acres), vegetables (805 acres), trees (6300 acres), pasture (305 acres), corn/beans (350 acres), corn/grass (50 acres), sod (180 acres), grass/orchard (250 acres).

The most trusted resources identified in the SIDMA survey are the Farm Bureau, Conservation Districts, and University Extension. Partnerships with these organizations should be established to solicit their help in implementing the recommendations of this WMP. A technical resource should be hired in coordination with the trusted resources for an estimated six years, and should connect directly with the farmers to assess the farms, share a menu of appropriate BMPs, understanding that each farmer may need to implement a BMP specifically needed for their individual farm, and information on resources available. Technical assistance and financial incentives should be provided to the farmers for the implementation of the BMPs.

Encourage livestock owners who own large animals to adopt agricultural BMPs to reduce *E. coli*, sediment, and nutrient pollutant contributions, such as a grazing plan (~16% of farmer survey respondents report using this BMP and ~58%, report a willingness to try this BMP), filter and buffer strips, stormwater runoff management, proper manure management and other BMPs listed in Chapter 7 and in Appendix G. Landowners should develop a winter manure management strategy to prevent land-applied wastes from leaving the site. Adopt innovative financial assistance programs to implement BMPs coordinated with sediment, nutrient, and bacterial loading reductions.

Personal out of pocket expense, not having access to the equipment needed, and lack of government funds for cost share were the reasons cited in the SIDMA survey as the major constraints preventing the adoption of BMPs.

Though businesses were not ranked very high as a trusted source of information on the SIDMA survey, neighboring Macatawa Watershed has found success in utilizing agronomic service providers as partners to reach farmers. Due to the proximity and success from the neighboring watershed, this partnership should be considered in the RCW.

Agricultural Partners listed below, with the cooperation of farmers, are most important for implementing these Recommended Actions.

CA13) Recommended Action- (Priority order: Sites within Jamestown, Byron, and Georgetown Townships): Adopt agricultural BMPs to reduce erosion, with a focus on the use of cover crops and conservation tillage. Cropland is a major source of sediment in the watershed, and carries other pollutants, including bacteria and phosphate. Overland erosion rates are highest is the south central portion of the RCW, in Jamestown and Byron Townships. The highest priority areas are locations with fine-grained soils, hills and agricultural land uses. Fine-grained soil retains more phosphate than coarse-grained soil and hilly topography leads to an increase of soil erosion during rain events. It is likely that the high phosphate concentrations during wet weather are a result of the addition of phosphate to soils in this agricultural area coupled with fine-grained soils and high susceptibility to erosion. Priority sites were also identified in the tillage survey (Appendix F). Priority farms include those identified in the tillage survey, those that own land in areas identified as critical areas for sediment reduction (Figure 10.3), Figure 10.3

identifies areas most susceptible to sediment erosion, as identified by the HIT model, topography, soil type most susceptible to erosion (fine grained soils and muck soils). Although the low lying, relatively flat muck area outlined in Figure 10.3 does not represent HIT model sedimentation concern, the muck area is highly susceptible to wind erosion and, therefore, represents a critical area for sediment reduction. As discussed, curbing erosion will help reduce *E. coli,* sediment, phosphorus, herbicide, and pesticide pollutants. There are an estimated 90 farmers in the RCW, ranging in scale from hobby farmers to farmers running large-scale operations.

The most trusted resources identified in the SIDMA survey are the Farm Bureau, Conservation Districts, and University Extension. Partnerships with these organizations should be established to solicit their help in implementing the recommendations of this WMP. A technical resource should be hired in coordination with the trusted resources, and should connect directly with the farmers to assess the farms, share a menu of appropriate BMPs, understanding that each farmer may need to implement a BMP specifically needed for their individual farm, and information on resources available. Technical assistance and financial incentives should be provided to the farmers for the implementation of the BMPs.

Personal out of pocket expense, not having access to the equipment needed, and lack of government funds for cost share were the reasons cited in the SIDMA survey as the major constraints preventing the adoption of BMPs.

Encourage the agriculture community to adopt applicable BMPs to reduce erosion, such as cover crop, gypsum amendment, filter and buffer strips, wind breaks, grassed waterways, conservation tillage (~42% of farmer survey respondents report using this BMP and ~80% respondents report willingness to try this BMP), soil testing and nutrient management (~18% of farmer survey respondents already have a CNMP, and ~68% are or may be willing to try this BMP), manure application guidance, redirecting stormwater, tile drain control structures, and others described in Chapter 7 and in Appendix G. Include I/E on BMPs for farms who utilize manifested CAFO waste.

Though businesses were not ranked very high as a trusted source of information on the SIDMA survey, it is important to note that the Macatawa Watershed groups have been successfully working with farmers, agricultural retailers and agronomists on planting cover crops to reduce sediment nutrient and *E. coli* loading and amending the soil with gypsum to reduce phosphorous loading. Phosphorus is considered a Threat to the RCW. As many farmers learn from each other and the local agricultural retailers, these BMPs are also anticipated to be successful in neighboring RCW.

The first year of working with a crop producer, cover crops should be a priority BMP to reduce erosion and pollutant loading. The second year of working with a crop producer, gypsum amendments should be a priority BMP where phosphorus pollutant loading is a concern.

Tables 10.2 and 10.3 include HIT modeling results that estimate sediment load reductions if varying percentages of the RCW adopt different erosion control BMPs. One BMP highlighted in these tables is conservation tillage. This BMP should be encouraged on cropland.

Agricultural Partners listed below, with the cooperation of farmers, are most important for implementing these Recommended Actions.

CA14) Recommended Action: Adopt the following BMPs at priority fields identified during the tillage survey in the Main Branch subwatershed: nutrient management, cover crops, reduced tillage, drainage water management and buffer strips BMPs. Complete a tillage survey for the East Branch subwatershed.

Recommendations from the Main Branch tillage survey completed and drafted by MDEQ are generally copied below from Appendix F with slight modifications. The agricultural survey identified 269 crop fields in the Main Branch Rush Creek subwatershed. Of those 269 fields, 42 were vegetable fields with 0% residue cover in the fall of 2017 and spring of 2018. Thirty-six of the 42 fields are within 150 feet of a surface water. All vegetable fields are a priority for BMPs. Figure 1 in Appendix F shows the 42 vegetable fields.

The agricultural survey identified 227 non-vegetable crop fields in the watershed. Of those 227 fields, 91 were identified to be within 150 feet of a surface water. Figure 2 in Appendix F shows those 91 fields and that 80 of those fields lack a buffer between the crop field and the surface water.

Crop fields with intensive fall tillage practices and little to zero crop residue remaining in the spring are at a higher risk for contributing sediment and nutrients to the watershed's surface waters. Based on the information collected from the agricultural survey, priority fields to be targeted for BMP implementation, are those 27 fields next to a waterbody, without a buffer, and that had less than 30% residue in the spring. See Figure 3 in Appendix F.

BMPs recommended for the priority fields include: nutrient management, cover crops, reduced tillage, drainage water management and buffer strips.

CA15) Recommended Action- (Hudsonville, Georgetown Township, Byron Township): Hold one-on-one technical assistance meetings with RCW muck farmers to increase BMP adoption such as windbreaks and wind erosion. There is approximately 3.02 square miles of muck fields in the RCW where there is a faster connection between stormwater, groundwater and ultimately surface water. These soils are typically higher in nitrogen. In the RCW, winter cover crops are less common for muck soils, and soil loss has become a large problem for the muck fields. Technical expertise in managing muck soils may be necessary.

Technical assistance about BMPs specific to muck farming is recommended from University Extension agents; University Extension was also listed as one of the most trusted resources in the SIDMA survey.

Agriculture Partners, and special technical muck farming expertise (MSU-E), with cooperation of farmers are most important for implementing these recommendations.

CA16) Recommended Action- (Priority order: Sites within Jamestown, Byron, and Georgetown Townships): Provide I/E to hobby horse farmers. Following the messaging and methods described in Chapter 8, share I/E related to *E. coli*, sediment, and nutrients impacting the surface water quality as well as recommended BMPs and available resources with hobby farmers who own a few horses on few (<10 acres). Share information through direct mailers, flyers, newspapers, and partners. Priority farmers include those that own land in areas identified as critical areas for sediment reduction (Figure 10.3). Agricultural technical resource should meet with willing landowners and help assess their properties to provide assistance on BMPs and resources. The windshield survey identified 18 homes with one to three horses, though there may be up to 50 residents with a few horses on less than ten acres.

The watershed coordinator and/or agriculture technical resource can help deliver this message. Agriculture, resident, and I/E partners are most important for implementing this recommendation.

Recommended Action- (Priority order: Sites within Jamestown, Byron, and Georgetown Townships): Hold a series of focus groups with farmers to understand their opinions about buffer

strips, and how to increase the adoption of buffer strips, or an equally effective BMP, in the RCW. Innovative technical and financial assistance programs should be considered. Buffer strips are not commonly used in the RCW, and are reportedly not a popular BMP in the agricultural community. Often buffer strips are not popular because they reduce productivity of some land adjacent to a drain or creek that may otherwise be farmed.

Agricultural Partners listed below, including the most trusted resources (Conservation Districts, Farm Bureau, and University Extension) with the cooperation of farmers, are most important for implementing these Recommended Actions.

Greenhouses

CA17) Recommended Action: Provide technical and financial assistance to support greenhouse operators in BMP adoption. There are approximately 25 greenhouses in the RCW. Adopt applicable BMPs at greenhouses to reduce nutrient, sediment, and pesticide loading to RCW, including BMPs such as soil testing, stone or grass lined swales and retention pond or constructed wetland, irrigation and rainwater harvesting, and nutrient, compost and pesticide management. Disconnect any possible floor drain connections from drains. Under some circumstances, greenhouses may require a permit to discharge their runoff.

Agriculture Partners, and special technical greenhouse expertise, with cooperation of farmers are most important for implementing these recommendations. MSU-E may be a useful partner for this recommendation, and is considered one of the most trusted resources by surveyed farmers.

Riparian Management

Recommended Action: Utilize existing KCDC and MDNR waterfowl programs to reduce waterfowl populations. To reduce bacteria contributions from wildlife, shoreline buffers and/or other control measures should be installed where high concentrations of waterfowl congregate.

Waterfowl were noted at Rushmore Lake, Georgetown Community Park, and the stormwater retention ponds near Rivertown Mall.

Biosolids

Recommended Action- (Entire RCW): Review of MDEQ biosolids application procedures and permits for biosolids haulers and users, and follow up with the local unit of government. Local municipalities can chose to adopt ordinances banning these practices. Application rates can be modified, buffer strips or other BMPs can be adopted at any of these 33 application sites. Though no problems were noted that are associated with the use of biosolids, and biosolids are partially treated, this recommendation is being included this they may be a possible source of pollution. Local units of government that are having problems with the use of biosolids may be most interested in this recommendation.

Policy Partners are most important for implementing.

Road/Stream Crossing

Recommendation: Evaluate need for additional street sweeping. Where road/stream crossings are being impacted by sediment from the roads, the street sweeping schedule could be modified to further reduce sediment/nutrient loading into the surface waters. Evaluate the need for an increase in street sweeping frequency to twice per year where warranted (Metropolitan Council, 1994), or the need to sweep streets that are currently not included in street sweeping programs.

Recommended Action: Prioritize and replace undersized culverts that are causing erosion/sediment problems and/or limiting fish passage, as identified in the recommended road/stream crossing survey additional investigations recommendation below.

Local volunteers, MiCorps, and the OCRC and KCRC are suitable partners for this action.

Recommended Action: Work with KCRC, OCRC, KCDC, and OCWRC to adopt and coordinate culvert replacement programs with corresponding road and bridge maintenance, to repair/replace undersized, multiple, or perched culverts that are known or suspected of causing water quality or fish passage issues.

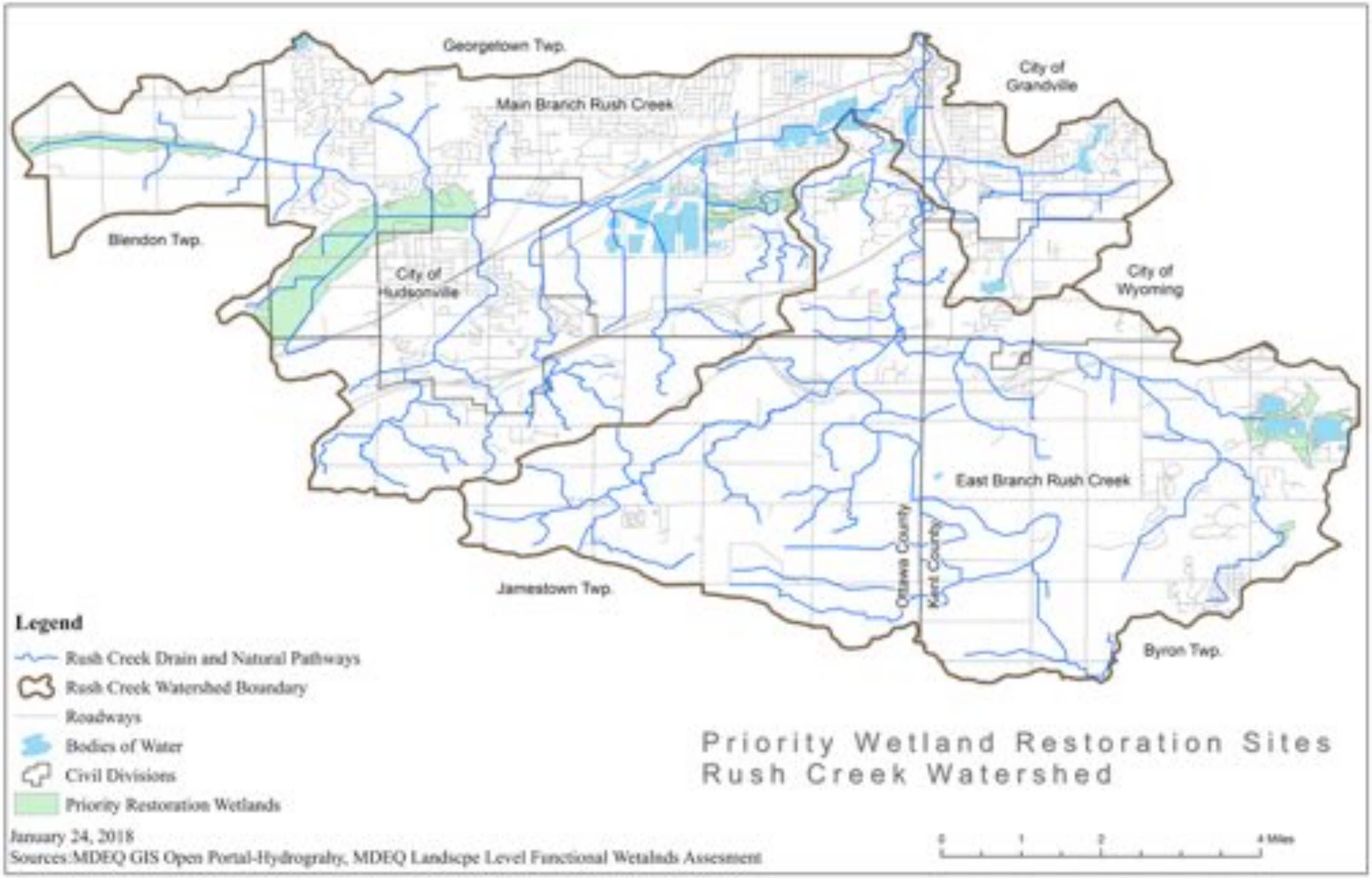

Figure 10.2 Priority Wetland Restoration Sites

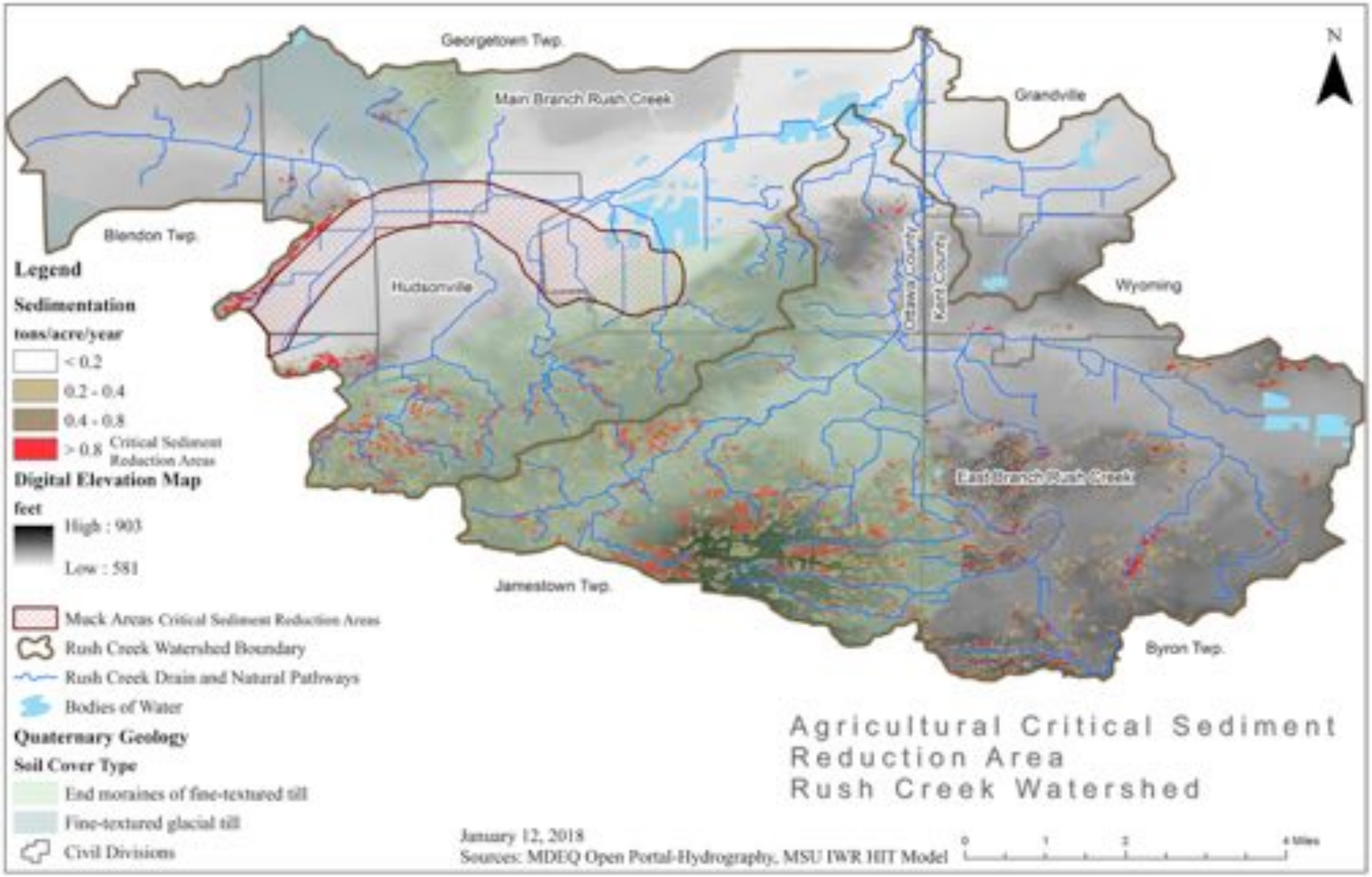

Figure 10.3 Agricultural Critical Sediment Reduction Area

10.8 Restoring Critical Sites

Site-specific locations that are known or strongly suspected to be contributing the highest priority non-point source pollutants were identified throughout the watershed through the windshield survey, stakeholder meetings, other studies completed in the RCW. These critical sites are summarized in each section below and shown in Figures 10.4. As known sites contributing pollutants, these sites are a high priority for BMP implementation in the short term.

The following sites have been identified for restoration to reduce pollutants entering the surface water. The categories are listed in priority order.

Altered Hydrology

CS1) Recommended Action (Georgetown Township): Restore wetlands at properties including AAA Turf (100-200 acres, Hudsonville), and Sunset Manor (18 acres near Port Sheldon), where landowners have expressed interest in pursuing wetland restoration. AAA Turf is located in the muck soils in what was historically river bottom. Sunset Manor includes land adjacent to the Main Branch of Rush Creek, and the portion of the property east of 18th Ave. could be restored to wetland. These sites are mapped in Figure 10.4.

Property landowners and stream restoration partners are most important for implementing.

CS2) Recommended Action (Grandville, Georgetown, Jamestown, and Byron Townships): Construct Intercounty Regional Detention, wetlands, and/or two-stage ditches with adjacent wetland plants for flood storage on Bliss Creek upstream of 44th and Kenowa. This location was studied by Spicer Group, and results and more specific recommendations are included in Appendix J. Recommendations include reducing the depth, duration, and frequency of flooding of at least one site located along Bliss Creek Intercounty Drain through wetland restoration, changing grades, increasing storage, or drain capacity.

Intercounty Drain Board and Drain Commissions are recommended partners.

CS6) Recommended Action: **Construct detention or retention ponds, wetlands, and/or two-stage ditches with adjacent wetland plants for flood storage and sediment retention along Buttermilk Creek.**

OCWRC is the recommended partner.

CS7) Recommended Action (Georgetown and Jamestown Township): Remediate erosion along the Corey Bishop Drain, reduce sediment loading from sites upstream, and capture sediment. There are complaints of excessive sediment in the Georgetown Shores neighborhood and lakes, south of 44th Ave. and Chicago Drive. One suspected source of the sediment is the construction of I-196 and subsequent bank erosion. This problem was studied by ENG and results and more specific recommendations are included in Appendix J (OCWR Linda Brown, personal communication, July 18, 2017 and January 5, 2018).

CS10) Recommended Action: Stabilize streambanks that have fallen ash trees and exposed uprooted root systems causing erosion problems. Over two-dozen sites have lost a number of ash trees from disease. The fallen trees are removed from the drains by the OCWRC, but approximately 25-50 feet of streambank is left in need of stabilization upon removal of the fallen trees at each site. One known location includes Bliss Creek near 44th Street.

Stream restoration partners are recommended to implement this task.

Septic Systems

CS3) Recommended Action (Jamestown Township): Connect an estimated 164 homes in Jamestown Township to sanitary service. The homes are currently connected to both septic tanks and sanitary sewer service. The septic tanks should be properly emptied and removed from service and all septage from the homes should be fully connected to the sanitary service.

CS4) Recommended Action (Byron Center): Inspect sites suspected of illicit discharge. Inspect restroom sanitary connection or septic system at Railside Golf Course and building on Ransom St. that is suspected to be discharging sewage. Inspect sanitary pipeline near southern shoreline Rushmore Lake.

CS5) Recommended Action (Jamestown Township): Provide septic system I/E materials to a community of approximately 12-15 homes located just outside of and near the border of the RCW at 40th and Riley St. This area has suspected septic system issues due to lot size and soil type, and discuss funding options with OCHD and Jamestown Township officials. Though the majority of this community is located outside of the RCW, some homes in this community may be near the border or just inside the RCW.

Agriculture

Recommended Action: Implement site-specific BMPs at critical locations, listed below, that are known or suspected to be sources of *E. coli* and nutrient pollution. For all recommendations related to agricultural BMPs, it is emphasized that an Agricultural BMP should be selected on a field-by-field and subfield basis. Individual site conditions, the preference of the agricultural producer, and the recommendations of the agricultural technician or expert should all be considered when selecting an agricultural BMP. The list below and Figure 10.4 inventory sites that were specifically noted as sources of pollutants considered critical to remediate. Agricultural Partners, with the cooperation of the specific farmers, listed below are most important for implementing this.

CS8) Uncontrolled Livestock Access to Surface Water

- Three cattle were observed in Rush Creek at a farm located on unnamed tributary of Rush Creek in Georgetown Township. Exclusion fencing and an alternate water source and/or controlled access as well as stream restoration are recommended.

CS9) Improper Manure Management

- A farm on Bliss Creek in Jamestown Township with approximately two horses appears to be improperly managing their manure. The farm is located adjacent to a drain, and a manure pile is stored behind the barn on a slope that drains into a wetland and stream. Improved manure management, manure storage, and site grading are recommended.

- An eroded gully/drain along the Brink Drain in Jamestown Township was identified through a pasture for approximately 500 feet. Exclusion fencing and an alternate water source and/or controlled access as well as stream restoration are recommended.

CS11) Streambank Restoration

- Excessive sediment and sediment bars, and an eroded yard and streambank were identified on Bliss Creek in Georgetown Township. Streambank stabilization at the site is recommended.

- A farm with two horses on a tributary of the Deweerd Drain in Jamestown Township was identified with an eroded stream. Runoff from two adjacent sites flows across the pasture, an adjacent development to the east appears to contribute runoff (clearer in color) and a farm to the south appears to contribute runoff with more sediment. Runoff from adjacent sites should be slowed, diverted, or infiltrated.

  Agriculture partners, stream restoration partners, and the landowner are recommended partners.

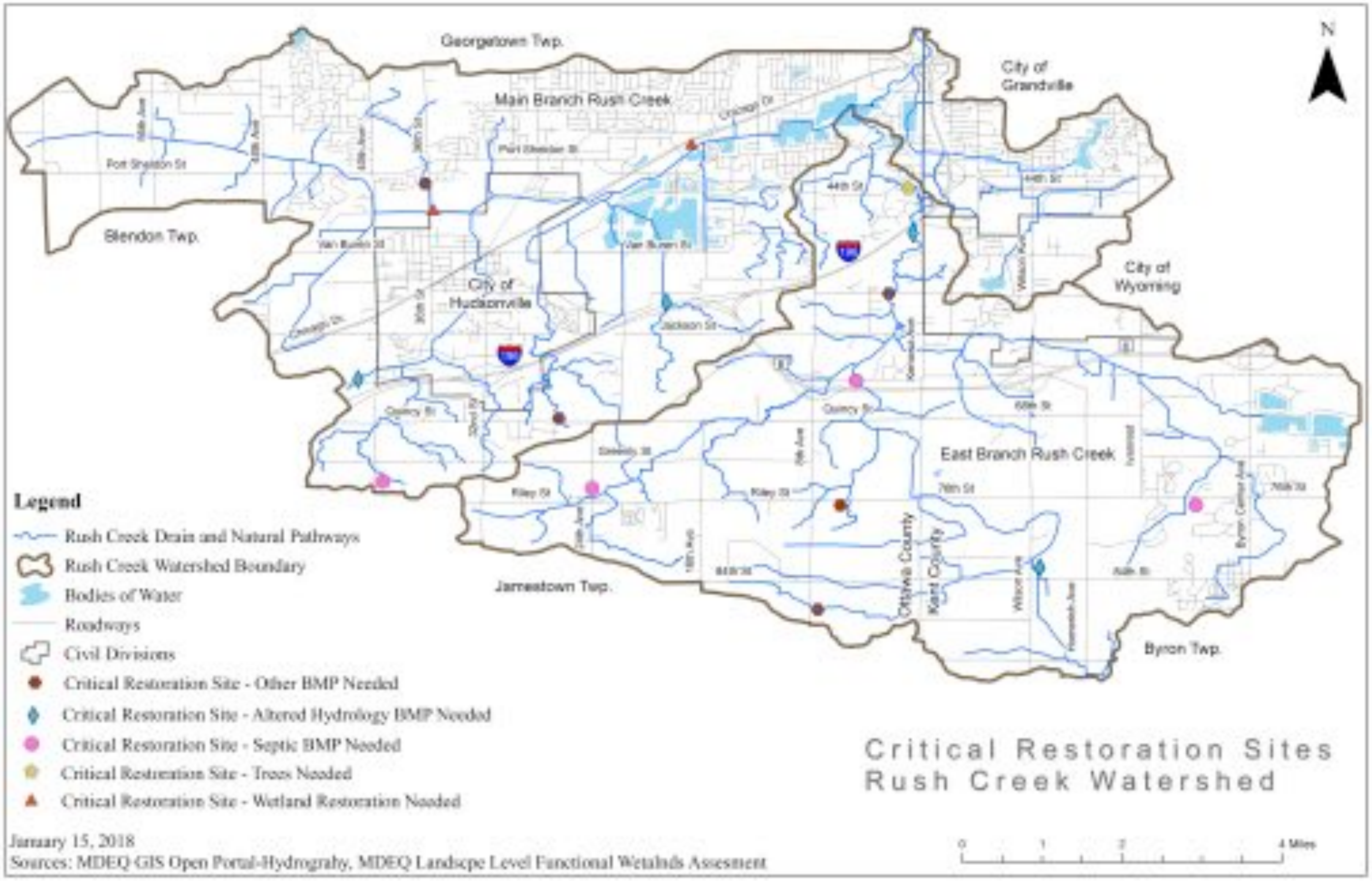

Figure 10.4 Critical Restoration Sites

10.9 Information and Education

Generally, RCW residents and agricultural producers understand some of the RCW pollutants, though they don't fully understand the scale of pollution. Some residents understand nutrients, bacteria, and sediments are pollutants in the RCW, but most report they do not know what pollutants are problems. RCW residents would benefit from a better understanding of what pollutants are problems in the RCW.

RCW residents and farmers generally understand their actions affect the water quality and report willingness to take action to improve water quality. However, fewer reported willingness to pay for changes to their behavior, and cost was the most common constraint to adopting BMPs. In addition to message information, technical and financial resources or incentives are also recommended. Cost savings that can be achieved by BMP adoption should be emphasized in I/E messaging.

The known pollutants in the RCW are altered hydrology, pathogens and bacteria, sediment, nutrients, and increasing water temperatures. Outreach is necessary to help inform and educate key residents and stakeholders. I/E recommendations are included in detail in Chapter 8.0 and Tables 8.4-8.7. The recommendations below are listed in priority order. Additional I/E recommendations are integrated into the recommendations in Chapter 10.4-10.8, and Chapter 10.9 as I/E and technical assistance can be used to address Critical Areas, Preservation, and Critical Sites.

Recommended Action: Contact residents who own priority wetlands to protect and encourage wetland protection. Identify properties with the largest quantity of and highest quality wetlands identified as priority preservation wetlands. Contact landowners who own wetlands identified as priority preservation wetlands with information about wetland preservation programs through flyers, door hanger, letters, or phone call. Share information about wetland protection programs.

Preservation partners are most important to implement this recommendation.

Recommended Action: Encourage the use of lawn care BMPs with local landscaping companies. Set up a RCW "Lawn Care Seal of Approval Program" or expand or modify MACC program by connecting with local landscaping companies. Annually seek landscaping company commitments to lawn care BMP use, advertise Lawn Care Seal of Approval companies. Seek municipal support in hiring only approved companies. Provide BMP I/E for companies to include proper fertilization, herbicide, pesticide, mowing heights, watering schedule, clippings management, etc.

A watershed coordinator could develop and connect with local landscaping companies to set up this program.

Recommended Action: Encourage diligent management of the SESC program. Two residential sites were identified during the NSA with bare soil exposed. These sites are sources of sediment, and are of concern due to the rapid development of the RCW.

County Enforcing Agencies, KCRC and OCWRC, are most important for implementing.

Recommended Action: Share I/E messaging included in Chapter 8 and within this WMP to local students of the RCW.

I/E partners are most important for implementing.

Recommended Action: Stencil storm drains to indicate their direct connection to the RCW. Not all stormdrains assessed during the NSA were stenciled, and stenciling them can help deter illicit discharges and NPS.

I/E partners are recommended for implementing.

Recommended Action: Encourage Municipalities to include pet waste cleanup requirements in ordinances. The watershed coordinator or watershed council can work with municipalities to encourage pet waste cleanup.

Municipalities are most important for implementing.

Recommended Action: Encourage Homeowner Associations to include pet waste cleanup requirements in neighborhood association rules or by-laws.

The watershed coordinator or watershed council can work with neighborhood associations to encourage pet waste cleanup rules. Neighborhood associations are most important for implementing.

10.10 Potential Partners

A list of potential Partners for implementing work in this area include, but is not limited to:

Septic Partners	Residential Partners	Agricultural Partners
County Conservation Districts (Kent, Ottawa)	Church Community	Agriculture Businesses/Industry
County Health Departments (Kent, Ottawa)	County Conservation Districts (Kent, Ottawa)	County Conservation Districts (Kent, Ottawa)
Lake Associations (Rushmore Lake, Georgetown Shores, and others)	County Health Departments (Kent, Ottawa)	Farm Bureau
Lower Grand River Organization of Watersheds	Lake Associations (Rushmore Lake, Georgetown Shores and others)	Grand Valley State University
Macatawa Area Coordinating Council	Lawn Care Companies	Lower Grand River Organization of Watersheds
Michigan Department of Environmental Quality	Lower Grand River Organization of Watersheds	Macatawa Area Coordinating Council
Michigan State University- Extension	Macatawa Area Coordinating Council	Michigan State University- Extension or other Extension Agents
Municipalities (Blendon Township, Byron Township, Georgetown Township, Grandville, Hudsonville, Wyoming)	Michigan State University- Extension	Municipalities (Blendon Township, Byron Township, Georgetown Township, Grandville, Hudsonville, Wyoming)
Septic Business/Industry	Municipalities (Blendon Township, Byron Township, Georgetown Township, Grandville, Hudsonville, Wyoming)	Natural Resource Conservation Service
	Neighborhood Associations	

Information and Education Partners	Policy Partners	Regulatory Partners
Businesses/Industry	Drain/Water Resources Commissioner (Kent County, Ottawa County)	County Conservation Districts (Kent, Ottawa)
Church Community	County Conservation Districts (Kent, Ottawa)	County Health Departments (Kent, Ottawa)
Drain Commissioner (Kent County, Ottawa County)	County Health Departments (Kent, Ottawa)	Michigan Department of Environmental Quality
FFA	Ducks Unlimited	Michigan Department of Agriculture and Rural Development
Farm Bureau	Lake Associations (Rushmore Lake, Georgetown Shores, and others)	Michigan Department of Natural Resources
Groundswell	Land Conservancy of West Michigan	Municipalities (Blendon Township, Byron Township, Georgetown Township, Grandville, Hudsonville, Wyoming)
Lake and Neighborhood Associations (Rushmore Lake, Georgetown Shores, and others)	Lower Grand River Organization of Watersheds	
Local Media Outlets (Advance, Mlive, and others)	Macatawa Area Coordinating Council	
Local Schools (Hudsonville High School)	Michigan Department of Environmental Quality	
Lower Grand River Organization of Watersheds	Michigan State University- Extension	
Macatawa Area Coordinating Council	Municipalities (Blendon Township, Byron Township, Georgetown Township, Grandville, Hudsonville, Wyoming)	
Michigan Department of Agriculture and Rural Development	Road Commission (Kent County, Ottawa County)	
Michigan Natural Shoreline Partnership	Schrems West Michigan Trout Unlimited	
Natural Resource Conservation Service		
Michigan State University- Extension		
Municipalities (Blendon Township, Byron Township, Georgetown Township, Grandville, Hudsonville, Wyoming)		
River City Wild Ones		
Schrems West Michigan Trout Unlimited		

Veterinary Offices
West Michigan Environmental Action Council

Preservation Partners	Stream Restoration Partners
County Conservation Districts (Kent, Ottawa)	County Conservation Districts (Kent, Ottawa)
Ducks Unlimited	Ducks Unlimited
Land Conservancy of West Michigan	Rush Creek Intercounty Drain Drainage Board
Lower Grand River Organization of Watersheds	Schrems West Michigan Trout Unlimited
Macatawa Area Coordinating Council	
Municipalities (Blendon Township, Byron Township, Georgetown Township, Grandville, Hudsonville, Wyoming)	
Natural Resource Conservation Service	

10.11 Additional Investigation

Some sites were identified where the exact cause of the pollution could not be clearly identified, and additional investigations are recommended.

Recommended Action: Monitor the stream temperatures of the East Branch subwatershed. Use the results of the monitoring to better manage the stream and to reclassify the stream as a coldwater stream if the temperatures warrant the change.

MDNR and Stream Restoration Partners are important partners for this task.

Recommended Action: Work with OCRC and KCRC to extend the road and stream crossing inventory and evaluation program in order to further identify and prioritize stream crossing repair and replacement with in the RCW. Through the MiCorps program, the MACC had successfully been working to inventory road and stream crossings and sharing data with partner OCRC. This program can be extended into the RCW. Data collected from this inventory can be compared against the OCRC and KCRC schedule of maintenance to look for opportunities to further improve the road and stream crossings. Culvert replacements should be prioritized with the data collected to reduce sediment and erosion problems and

Local volunteers, MiCorps, and the OCRC and KCRC are suitable partners for this action.

Recommended Action: Complete a tillage survey for the East Branch subwatershed.

Recommended Action: Further quantify existing RCW tree counts and develop an Urban Forest Management Plan for the RCW or communities within the RCW, as recommended in the Grandville Community Tree Project Strategic Plan (Tornga, November, 2017). Utilize existing tools such as i-Tree (itreetools.org) where they are helpful, and update the tree planting related recommendations in the Rush Creek WMP to more accurately reflect the findings of this additional research.

Recommended Action: Investigate and address agricultural drains as a source of *E. coli* and nutrients pollutant loading. Stream Restoration and Agriculture Partners are most important for implementing this.

Recommended Action: Measure herbicide and pesticide concentrations in RCW surface water. The improper application of herbicides and pesticides is suspected of being a NPS pollutant, but was not measured during this WMP.

Recommended Action: Aerially monitor the County Drains by drone every few years to monitor flooding, diseased trees, and blockages from fallen trees. Much of the RCW is designated as county drain. Problems in county drains are frequently managed in a reactive manner, relying on the public to report problems. Monitoring the drains by drone could provide more proactive management.

10.12 Funding

There are a variety of technical and financial resources available for implementation of the WMP and ultimately water quality improvements. Programs differ in their funding priorities, opportunities change over time, and applications must be made to each program. It is important to use a variety of the funding resources available. A non-exhaustive list of technical and financial resources, including descriptions and links obtained from the Thornapple WMP (Barry Conservation District, 2015) and Flat River Watershed Management Plan (2016) includes:

10.12.1 Federal Programs

Conservation Reserve Program and Continuous Conservation Reserve Program: These USDA NRCS programs encourage agricultural producers to voluntarily protect sensitive areas through establishment of long-term vegetative cover to address the environmental issues of soil erosion, water quality and wildlife habitat. Qualified landowners can enroll for conservation practices including grass waterways, contour grass buffer strips, shelterbelts, field windbreaks, shallow water areas for wildlife riparian buffers and filter strips. Producers signing 10-15 year agreements receive annual per-acre rental payments and cost-sharing for up to 90% of establishment costs and 50% of management costs. Landowners may enroll eligible acres into the Continuous Conservation Reserve Program at any time. More information can be found: http://www.fsa.usda.gov/programs-and-services/conservation-programs/conservation-reserve-program/index.

Environmental Quality Incentive Program (EQIP): The USDA NRCS's EQIP is a voluntary conservation program providing financial and technical assistance to agricultural producers to reduce threats to soil, water, air and related natural resources. EQIP promotes agricultural production and environmental quality as compatible goals and offers financial and technical assistance to eligible participants for installing or implementing structural and management practices, including waste storage facilities, agrichemical containment facilities, conservation tillage, buffer strips and pest management. These practices are identified through conservation planning and implemented using NRCS technical standards adapted to local conditions. Important EQIP programs include:

- Conservation Planning**:** Conservation planning is a natural resource problem-solving and management process. The process integrates ecological (natural resource), economic, and social considerations to meet private and public needs. This approach, which emphasizes identifying desired future conditions, improves natural resource management, minimizes conflict, and addresses problems and opportunities.

- Comprehensive Nutrient Management Plan (CNMP): A CNMP is a conservation plan that is unique to animal feeding operations. It is a grouping of conservation practices and management activities which, when implemented as part of a conservation system, will help to ensure that both production and natural resource protection goals are achieved. A CNMP incorporates practices to utilize animal manure and organic by-products as a beneficial resource. A CNMP addresses natural resource concerns dealing with soil erosion, manure, and organic by-products and their potential impacts on water quality. A CNMP is developed to assist an animal feeding owner/operator in meeting all applicable local, tribal, State, and Federal water quality goals or regulations. For nutrient impaired stream segments or water bodies, additional management activities or conservation practices may be required to meet those water quality goals or regulations.

More information can be found on the website: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/mi/programs/financial/eqip/.

Wetland Reserve Program: This USDA-NRCS program provides protection, in the form of a 10-year, 30-year or permanent conservation easement, for prior-converted farmland that is returned to functioning wetland capacity. In return for program enrollment, landowners receive cost share funds for wetland restoration and are reimbursed for a percentage of the value of the easement. More information can be found: http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/easements/wetlands/.

Wildlife Habitat Incentive Program: This is a voluntary NRCS program for private landowners, including non-agricultural landowners to create or enhance high-quality habitat for significant wildlife species. Cost share rates of up to 75% of installation are available for conservation cover, tree and shrub establishment and habitat restoration. More information can be found: http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/whip/.

Conservation Stewardship Program: The NRCS program provides annual payments and cost share for producers who are currently meeting stewardship thresholds for at least one resource concern and are willing to address an additional priority resource concern during the stewardship contract. More information can be found: http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/csp/

Rural Utilities Service: The USDA Rural Utilities Service program assists rural communities in funding water and waste treatment facilities. Funding assistance extends to repair and expansion of existing facilities. More information can be found: http://www.rd.usda.gov/about-rd/agencies/rural-utilities-service.

US EPA 319 Funds: The US EPA provides grants to states, which in Michigan, are directed through MDEQ, to implement nonpoint source programs and projects related to the Clean Water Act. Funding can address issues in agriculture, forestry, construction and urban environments and also protect high-quality habitat. A searchable database of funding sources can be found here: https://ofmpub.epa.gov/apex/watershedfunding/f?p=fedfund:1.

Dam Removal Programs: Funding for dam removal to restore fish passage is available through both federal and state sources, including the US FWS Fish Passage Program. More information can be found here: https://www.fws.gov/fisheries/whatwedo/NFPP/nfpp.html.

Partners for Fish and Wildlife Program: The US FWS Partners Program emphasizes stewardship, partnership, fish and wildlife and future generations through working in collaboration with conservation organizations and agencies and private landowners to restore and enhance fish and wildlife habitat. In

Michigan, the primary focus is wetland restoration, with additional assistance for grassland, stream and riparian corridor restoration. Restoration of habitat critical to federally-listed threatened or endangered species is also within the scope of the Partners Program. Program commitment is a minimum of 10 years. More information can be found: https://www.fws.gov/partners/contactInfo3.html.

National Fish and Wildlife Foundation: This Foundation is a collaboration of government agencies, nonprofit organizations and corporations working to protect fish, wildlife, plants, and habitats. They are one of the largest conservation grant makers, and some of their applicable programs include:

- **Five-Star and Urban Waters Restoration Program:** This program focuses on wetland, riparian or in-stream restoration, educational opportunities, and diverse community partnerships.
- **Sustain Our Great Lakes:** This program provides funding for aquatic connectivity, riparian and stream habitat, and wetlands projects in the Great Lakes region.
- **Bring Back the Natives/More Fish:** The Bring Back the Natives/More Fish Initiative focuses on the restoration of native aquatic species, including native brook trout, through rehabilitation of aquatic habitat.

More information can be found: http://www.nfwf.org/whatwedo/programs/Pages/home.aspx.

Great Lakes Restoration Initiative: This initiative is funded through various federal government agencies as a means to protect and restore the Great Lakes ecosystem. The most recent Action Plan includes priorities including protecting nearby watersheds from polluted run-off, restoring wetlands and other habitats, and education efforts with strategic partners. For more information: https://www.glri.us// and https://www.epa.gov/great-lakes-funding/great-lakes-restoration-initiative-glri.

10.12.2 State Resources

State resources are provided primarily through the Departments of Agriculture, Environmental Quality and Natural Resources. Programs are funded by earmarked sources, federal grants and departmental budgets. Programs vary from year to year depending upon available funding.

Michigan Wildlife Habitat Grant Program: The MDNR Michigan Wildlife Habitat Grant Program provides financial assistance to enhance, restore and protect wetland and grassland habitats to enhance game species in Michigan. Assistance can be sought for prairie planting, restoration and management, wetland restoration and exotic or invasive species removal. More information can be found: http://www.michigan.gov/dnr/0,4570,7-153-58225_67395-324696--,00.html.

MAEAP: MAEAP provides technical assistance to the entire FRW from the Kent, Ionia and Montcalm Conservation District Offices. On-farm groundwater risk assessments are available for all producers, with customized tools for various practices including crops, livestock, orchards and greenhouses. MAEAP is an innovative, proactive program that helps farms of all sizes and all commodities voluntarily prevent or minimize agricultural pollution risks. MAEAP teaches farmers how to identify and prevent environmental risks and comply with state and federal environmental regulations. Farmers who successfully complete the three phases of a MAEAP system become verified in that system. Verification, provided to producers who follow the state's GAAMPS affords nuisance protection for producers under the Michigan Right to Farm Act. There are multiple “systems” or areas of concentration for MAEAP verification, including, livestock, crops, small farms, orchards and others. Verification in each MAEAP system requires meeting all three phases for that system, which include attendance at an educational session, completing an on-farm risk assessment and undergoing third-party verification. More information can be found: http://www.maeap.org.

Clean Michigan Initiative: The Clean Michigan Initiative provides grant funds for several water protection programs. Loans made through this program can be utilized for the same purpose. CMI provides grant funds for watershed management planning and implementation, distributed through MDEQ's Nonpoint Source Control Program. Clean Michigan Initiative funds support local water quality monitoring through beach monitoring, volunteer stream monitoring and volunteer river stream and creek clean up grants. These funds also support parks and recreation grant programs. For more information: http://www.michigan.gov/deq/0,4561,7-135-3307_3515-314499--,00.html.

NPS Program: The MDEQ's NPS program provides technical and financial assistance in developing and implementing watershed management plans. Financial assistance comes through CMI and the Federal Clean Water Act Section 319 grant programs. Additionally, the NPS program develops NPS information and education tools and activities, provides compliance and enforcement for NPS complaints, and monitoring to identify pollutant sources and remediation effectiveness. For more information: http://www.michigan.gov/deq/0,4561,7-135-3313_71618_3682_3714---,00.html.MDEQ SAW.

Michigan Natural Resources Trust Fund and Land and Water Conservation Fund: MDNR provides funding through the Michigan Natural Resources Trust Fund and Land and Water Conservation Fund to municipalities with approved Parks and Recreation plans in order to acquire or improve parks and recreation facilities. These funds could be used to purchase properties in critical areas of the watershed and to provide attractive and environmentally sustainable water-based recreation destinations. For more information: http://www.michigan.gov/dnr/0,4570,7-153-58225_58301---,00.html and http://www.michigan.gov/dnr/0,4570,7-153-58225_58672---,00.html.

Aquatic Habitat Grant Program: The MDNR's Aquatic Habitat Grant Program provides funds and technical assistance to support habitat improvement for fish and other aquatic organisms. For more information: http://www.michigan.gov/dnr/0,4570,7-153-58225_67220---,00.html.

Dam Management Grant Program: The MDNR's Dam Management Grant Program provides support through funding and technical assistance to repair or remove dams in order to improve aquatic habitat and fisheries. For more information: http://www.michigan.gov/dnr/0,4570,7-153-58225_62891---,00.html.

Michigan Invasive Species Grants Program: This MDNR program supports strategic efforts to identify, prevent, control or eradicate terrestrial or aquatic invasive species. For more information: http://www.michigan.gov/dnr/0,4570,7-153-58225_69835---,00.html.

10.12.3 Local/Regional Resources

Land Conservancy Programs: The Land Conservancy of West Michigan, Mid-Michigan Land Conservancy, and the Chippewa Land Conservancy serve the FRW. These non-profit organizations accept the donation of, and at times purchase properties or conservation easements on properties considered critical habitat areas. With the assistance of land conservancy staff, landowners develop and carry out habitat management and protection plans to increase the habitat value of their properties.

FRWC: The FRWC, a non-profit watershed organization, is working to protect, enhance, and maintain land and water quality, and other natural resources in the Flat River Watershed. The group began meeting in 2011 and a Board of Directors and volunteers meet monthly. For more information:

http://www.flatriverwatershed.org/index.html.

Conservation Districts: The four Conservation Districts in the FRW each provide local points of landowner contact and information regarding land and water management in their respective counties of Kent, Montcalm, Ionia and Mecosta. Districts provide educational workshops, tours and field days to raise awareness of natural resource protection and promote BMPs. Conservation Districts also work closely with local units of government to address natural resource concerns through educational programs, ordinance development and program development. The FRW's Conservation Districts, as the local centers for information, education and BMP programs for watershed improvement, are vital to watershed plan implementation.

Michigan Natural Shoreline Partnership and Michigan Inland Lakes Partnership: These collaborative programs provide tools and training to help landowners and contractors manage lakes as ecosystems by adopting beneficial riparian land management techniques. For more information: http://www.mishorelinepartnership.org and http://michiganlakes.msue.msu.edu.

11.0 EVALUATION AND MONITORING PLAN

11.1 Measuring Indicators, Benchmarks and Outcomes

Reduced NPS pollution loading and improved water quality is the ultimate goal of this watershed management planning process.

The progress made in achieving the objectives and goals of this plan must be measured to determine effectiveness of this plan. Chemical, physical and biological water quality monitoring, in addition to interim indicators of success, can be used to help assess progress towards meeting watershed goals. Methods for evaluating the progress made towards intermediate benchmarks and the results of this process are described here.

Data collected through monitoring should be utilized to take an adaptive management approach to refining the implementation of the WMP.

Progress in implementing this WMP can be tracked by monitoring:

- Social indicators
- Use of Existing Partnership Programs
- Policy Adoption and Implementation
- BMP Adoption
- Water quality
- Water quantity (flooding)

<u>Social Indicators</u>

Through measuring the participation at educational events, evaluations and surveys at workshops, focus groups, meetings, media coverage, and social media participation, program assessments can be conducted on an ongoing basis. Likewise, SIDMA surveys of residents in the watershed can also be used to assess a change in knowledge, opinions and behaviors. Tracking of the implementation of the I/E plan will be measured as outlined in Tables 8.4-8.7.

<u>Partnership Programs</u>

A number of existing partner's programs that also assist in protecting water from NPS pollutants, such as conservation easements, NRCS Farm Bill Programs, and the MAEAP, are recommended to be leveraged through this WMP. An evaluation of participation in these programs, as compared to previous years, can be used as a monitoring benchmark. New Partnership Programs as proposed in this WMP should also be monitored. An increase in partnerships and a record of their watershed related efforts can be used to measure an improvement in watershed conditions.

<u>Policy Adoption and Implementation</u>

Recommendations were included in this plan related to wetland protection, septic system policies, and other protective policies at the local municipality level, among others. The number of policies adopted and being implemented should be measured as a benchmark, as outlined in the I/E Tables 8.4-8.7 and the BMP Table G2 in Appendix G.

BMP Tracking and Interim Measureable Milestones

BMPs recommended in this plan to address the watershed impairments and Threats are practices known to help improve water quality. A measure of the quantities of installed BMPs, or quantities of incentives redeemed, provides support that progress is being made at reducing pollutant loading from various causes. Measurable interim milestones are outlined for the implementation of BMPs in Table G2 in Appendix G. The priority parameters to measure include altered hydrology, *E. coli*, sediment, nutrients, and stream temperature.

Partner programs and electronic resources may help in keeping track of BMPs. In particular, Conservation Districts may be helpful in tracking BMPs adopted through partner programs such as MAEAP and NRCS. As it is not practical to measure the impact of trees individually, the i-tree software (itreetools.org) may be a useful tool in measuring the impact of trees, including tools to help quantify water quality and quantity effects from tree cover.

Land Use and Wetlands

Intense land development and agricultural uses are major sources of pollution in the RCW. A measure of the changes of land use and population should be used as a benchmark. A measure of the changes in the quantity of wetlands in the watershed should also be used as a benchmark at five to ten year intervals during the WMP updates, or when the data are available. These measurements are indicators of watershed hydrology and quality, and should inform adaptive management modifications to this WMP and its implementation. Land use changes can also indicate where efforts of the WMP implementation are being offset by changes in land use.

Water Quality Monitoring

Direct surface water measurements of *E. coli*, nutrients, sediment, temperature, and biological monitoring can be used to determine if the watershed is meeting the goals and objectives of this WMP. Because of the existing *E. coli* TMDL and the need to meet the partial and full body contact designated uses in the watershed, *E. coli* will be the highest priority parameter to be measured. Nutrients, stream temperature, habitat and macroinvertebrate assemblage should also be sampled.

Tracking water quality improvements due to the implementation of BMPs will be the top monitoring priority. Maintaining the water quality where designated uses are currently being met and assessing subwatersheds where the conditions are unknown is a secondary monitoring priority. The locations of monitoring sites should be determined at the time of monitoring.

Appropriate sites to monitor include:

- Sampling locations with water quality data history that may be used for comparison purposes;
- New site locations where pollution is suspected;
- Up and downstream of an implemented BMP.

Water quality monitoring should follow an approved QAPP and results should be compared against WQS and WQC in Table 3.1, historical data where available, and/or metrics outlined in the methods. Since there are no WQC or WQS for flow, historical data (e.g. collected by FEMA, USGS, and/or this through this watershed management planning process) should be used as a comparison. When monitoring locations where there is data history, data should be collected using the same methods used to collect the historical data. The approved QAPPs used for this planning process are included in Appendix C. The proposed water quality monitoring activities are in Table 11.1.

Monitoring within the first three years following the completion of this WMP should include monitoring up and downstream of site specific BMPs installed. Critical Sites are identified in Figure 10.4. Monitoring should be performed on the targeted pollutants being addressed by the installed BMP, and could include macroinvertebrate assessment, *E. coli*, nutrient, and sediment monitoring. As altered hydrology is a priority pollutant, continuous flow monitoring stations are recommended for installation annually.

Much RCW historical data is included in this WMP, though more detailed MDEQ Rush Creek monitoring data can be found within the Lower Grand River Watershed report in the following link: https://www.michigan.gov/deq/0,4561,7-135-3313_3681_3686_3728-452037--,00.html. Rush Creek and the Lower Grand River Watershed is monitored on a 5 year interval by MDEQ, and is next scheduled for monitoring in 2019. MDEQ accepts recommendations for monitoring locations during their scheduled monitoring events. The public can submit a targeted monitoring request through MDEQ, following the instructions in this link: https://www.michigan.gov/deq/0,4561,7-135-3313_3681_3686_3728-12735--,00.html.

Table 11.1 Proposed Water Quality Monitoring Activities

Type of Analysis (Methods)	Timeline/Frequency	Estimated Cost	Responsible Party
Stream Habitat (following P51) and Macroinvertebrate Assessment (Volunteer monitoring should follow MiCorps methods; MDEQ should follow P51)	Baseline, 1 year later, 3 year interval after BMP implementation	$1,000/Site	SES, Trinity Christian Reformed Church, Schrems, MDEQ
Fish Community (following P51 2008)	Every Five years	$2,000	SES, Schrems, MDNR
Flow Monitoring (Follow hydrologic measurements methods outlined in 2016 QAPP)	Four distinct flow events in one year to establish baseline	$7,500	SES, TES, Conservation Districts, Schrems
Continuous Flow Monitoring	3 level loggers/year	$1,500 first year $1,000/year after	SES, TES, Schrems
E. coli Monitoring	30-day geomeans; annually Wet weather sampling as needed	$75/sampling location	SES, TES, Conservation Districts, Municipalities, Schrems
Nutrient Monitoring	annually	$75/sampling location	SES, TES, Conservation Districts, Municipalities, Schrems
Temperature	July mean temperature; annually	$400/sampling location	SES, TES, Schrems, MDNR
Biological Survey at stratified random and targeted sites	5 year Interval	TBD	MDEQ
Pesticides and herbicides	Baseline	$25-$50 (screening); $125+ (moderate quantitative); $350+ (certified quantitative)/ Site	MDEQ, SES, TES, Conservation Districts, Schrems

11.2 WMP Implementation Plan and Updates

The planning team responsible for the development of this WMP is made up of individuals from SES, TES, and Jamestown Township, with input from a number of local partner organizations and municipalities. It is anticipated that this team will be responsible for periodic plan updates and monitoring, although the WMP is written so that anyone within the watershed can actively participate in, implement, or modify this plan.

It is recommended that the WMP be updated at least every five years to highlight completed implementation projects, to re-assess the watershed condition, and update the recommendations for the watershed. More specifically, updates can include a summary of water quality conditions, benchmarks and improvements related to implemented programs and BMPs, changes to TMDL status, impairments or Threats, changes in responsibility of existing and newly identified project partners, or additional pollutants.

However, as this WMP is implemented and monitored, an adaptive management approach should be taken. At any point in time, if additional NPS pollution related needs arise, the WMP or implementation should be amended to address the additional need.

Water quality monitoring results and benchmarks will be assessed to determine whether the practices are resulting in the desired water quality pollutant load reductions. If pollutant load reductions or water quality improvements are realized, it can be assumed that the BMPs are effectively achieving the goals of the WMP and TMDL.

If however, water quality does not improve despite the implementation of the recommended components of this WMP, additional investigation should be done to determine if new sources and causes of pollution are present in the watershed, or if additional or different BMPs are necessary. The ultimate desired outcome is to reduce NPS pollution loading, improve water quality, and meet the water quality standards that support the designated and desired uses by meeting the goals and objectives of this WMP.

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