BUCK CREEK WATERSHED MANAGEMENT PLAN

PREPARED BY:

SCHREMS WEST MICHIGAN
Environmentally Involved
Since 1962
TROUT UNLIMITED

WITH FUNDING AND SUPPORT FROM:

EGLE MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

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1.0 INTRODUCTION

The Buck Creek Watershed (BCW) (Hydrologic Unit Code [HUC] 40500060508) outlets to the Grand River, and drains approximately 51 square miles of land in portions of the Cities of Kentwood, Wyoming, Grand Rapids, and Grandville, as well as the more rural areas of Byron and Gaines Townships (Figure 1). The BCW is part of the Lower Grand River Watershed. The upper watershed contains much agricultural land, but is experiencing rapidly expanding residential, commercial and industrial development. The lower watershed is highly urbanized and subject to Phase II stormwater regulation. Large portions of the creek and its tributaries are currently listed as designated trout streams, and also county drains.

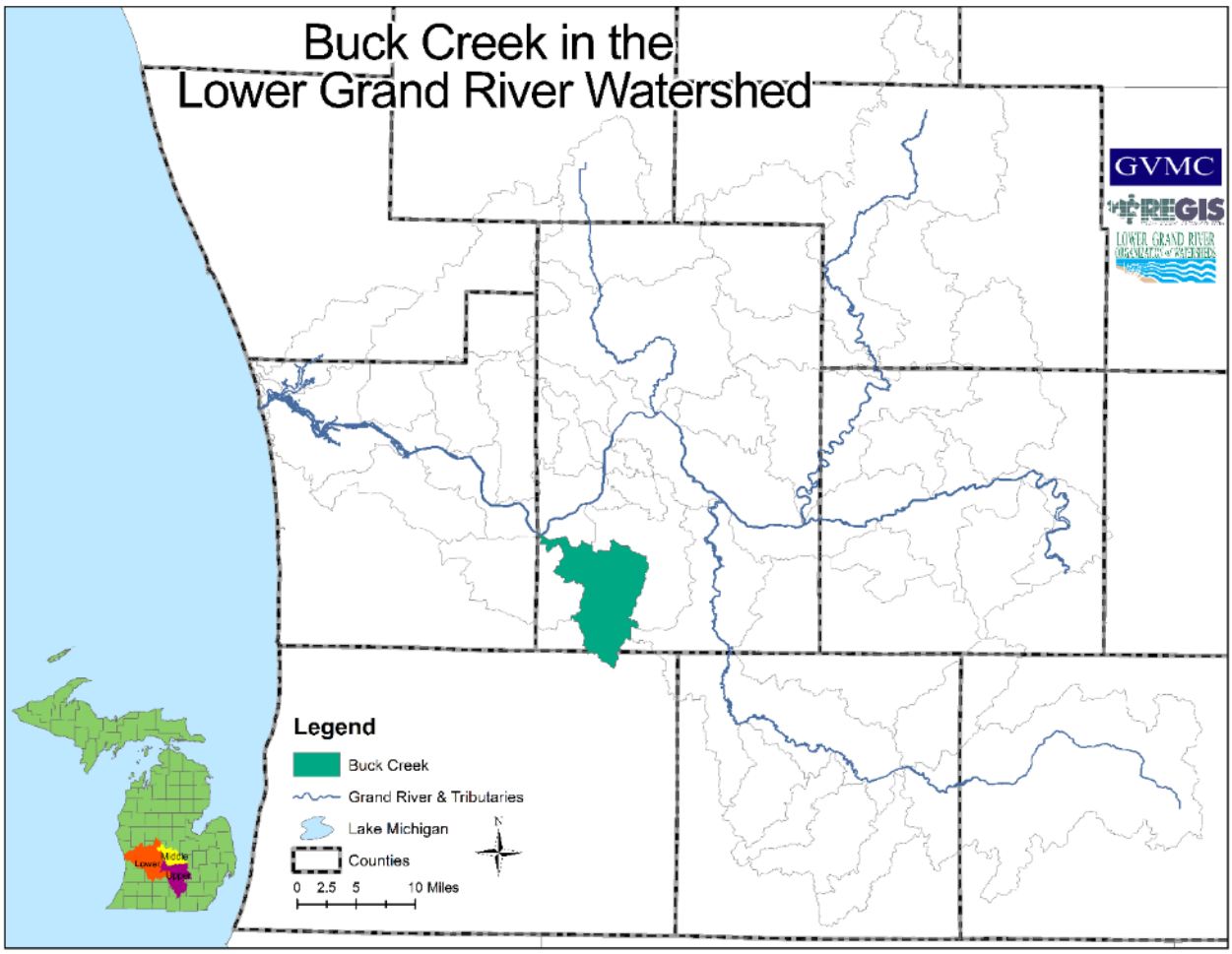

Figure 1. Buck Creek Watershed

Significant development of the watershed has led to a variety of impacts typically found in urban watersheds, including extreme hydrologic fluctuation, sedimentation and thermal pollution. The 2003 watershed management plan, which was updated in 2007, for Buck Creek suggested that trash and debris, sediment, pathogens, and nutrients were degrading the watershed. Water quality goals developed for that plan included: Improving or restoring the coldwater fisheries; Improving and protecting the safety and enjoyment of fishing, canoeing, and swimming, and; Improving and protecting the habitats for other indigenous aquatic life and wildlife. The Lower Grand River Watershed Management Plan (LGROW 2011) lists Buck Creek as a critical area for restoration due to pollution by pathogens and bacteria, sediment and nutrients, and the coldwater fishery as being threatened by sediment and nutrients.

Much work has been done in the watershed since the original Watershed Management Plan (WMP) was approved in 2003 (with 2007 updates). The Cities of Wyoming and Kentwood have implemented many of the managerial BMPs that were recommended in the plan to address urban stormwater issues. Kentwood is requiring a 50-foot buffer along Buck Creek and its tributaries, is promoting and requiring stormwater detention for new developments, and has been actively involved in public education through distribution of information to its residents. Representatives from all the cities in the watershed are involved with the Lower Grand River Organization of Watersheds. Schrems West Michigan Chapter of Trout Unlimited has completed water chemistry monitoring and survey of biological communities. The Friends of Buck Creek was organized to inspire, initiate, promote, and engage in activities improving the environmental quality and enhancing the beauty of Buck Creek. Schrems and the Friends have organized several river cleanups over the past several year, removing thousands of pounds of trash from the stream.

The current project aims to update the existing watershed management plan, which will assist local communities in ensuring healthy river ecosystems with clean water for all designated and desired uses. This WMP was authored by a management team with representatives from Streamside Ecological Services, Inc. (SES), Friends of Buck Creek (FOBC), Schrems West Michigan Trout Unlimited (Schrems) and the Grand Valley Metropolitan Council (GVMC). This team coordinated and guided all efforts related to the planning process and overall WMP development, including stakeholder engagement.

1.1 Goal of Watershed Planning

The goal of this WMP is to assist the Buck Creek community in ensuring the long-term protection and improvement of the creek and surrounding lands, with focus on the designated uses applicable to the BCW 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 NPS pollutants.

1.2 Key Elements of Developing a WMP

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], 2021).

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 with point source pollution that is discharged from an identifiable point such as a pipe (US EPA, 2021). Watershed management plans 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, financial, and regulatory assistance needed**, associated costs, and/or the sources and authorities that will be relied upon, to implement the plan.

5. Develop an **information and education (I/E) 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 WMP

Watershed management plans are intended to be a guidebook to be used by individuals and organizations interested in protection, improvement and wise use of our lands and waters. WMPs include a large amount of information in order to meet state and federal agency requirements for approval, and can become unmanageable to those interested in simple, straightforward implementation of the recommendations set forth. 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 has been crafted to stand alone as the primary driver for watershed protection and restoration.** The latter seven chapters provide the information used to write Chapter 2 and all of the information necessary to meet the required nine elements. In other words, Chapters 3-9 contain supporting information, data and analyses that may or may not be of interest to readers.

Chapter 2. Action Plan provides a list of activities that are recommended to protect and/or restore Buck Creek and its watershed. While this chapter is not meant to be all inclusive, it is a synopsis all of the information collected and analyzed for this plan and was written to stand alone as a “Quick Start” guidebook to be used by stakeholders of the resource.

The following chapters provide all of the pertinent background information, data, state and federal requirements, etc. that were used to create the Action Plan:

Chapter 3. Description of the Buck Creek Watershed. This chapter provides a general overview of the BCW. This is background information that does not include specific recommendations for project implementation.

Chapter 4. Water Quality in the Buck Creek Watershed – An Overview explains Water Quality Standards (WQS) in the State of Michigan, the protected designated uses that surface water bodies must attain and the pollutants that impair or threaten the designated and desired uses of the BCW. As well, the chapter includes detailed summaries of all data reviewed, collected and analyzed during this planning process.

Chapter 5. Pollutants, Sources and Causes lists all of the NPS pollutants that have been identified within the BCW. Where required, a loading estimate was calculated to determine overall contribution, and the source and cause of each pollutant was identified or speculated.

Chapter 6. Critical Sites/Areas and Pollutant Loading are those areas that are in dire need of attention to improve overall water quality. Each critical site/area identified is mapped and included in a table, with the estimated volume of pollution from that site.

Chapter 7. Addressing NPS Pollution to Protect/Restore Designated Uses makes recommendations for what needs to occur in the BCW, in terms of addressing critical sites and areas, information and education outreach and changes in local policies. Estimated costs for all improvements are included.

Chapter 8. Evaluation and Monitoring Plan provides the information necessary for measuring the successfulness of implementing this WMP.

Chapter 9. Literature Cited includes all of the studies and documents referenced in this WMP.

2.0 BUCK CREEK WATERSHED ACTION PLAN

This chapter provides a list of activities that are recommended to protect and/or restore Buck Creek and its watershed. While this chapter is not meant to be all inclusive, it is a synopsis all of the information collected and analyzed for this plan, and was written to stand alone as a "Quick Start" guidebook to be used by stakeholders of the resource. Much more detailed information follows in subsequent chapters, with Chapter 6 providing the most detail; however, directly contacting Schrems TU (www.swmtu.org) or Michigan Department of Environment, Great Lakes and Energy (EGLE), Water Resources Division, Grand Rapids District Office ((616) 356-0500)) is the most efficient way to find assistance with implementing this action plan.

Protect Existing Wetlands

The wetlands that remain within the watershed are critically important and must be protected. While all existing wetlands are essential to manage stormwater and to maintain current water quality and biological function, the 325 acres of wetland illustrated below have been determined to be of the highest priority for protection to address pollutants within the watershed. Conservation partners should work with local governments to adopt wetland protection ordinances that are more restrictive than state regulations.

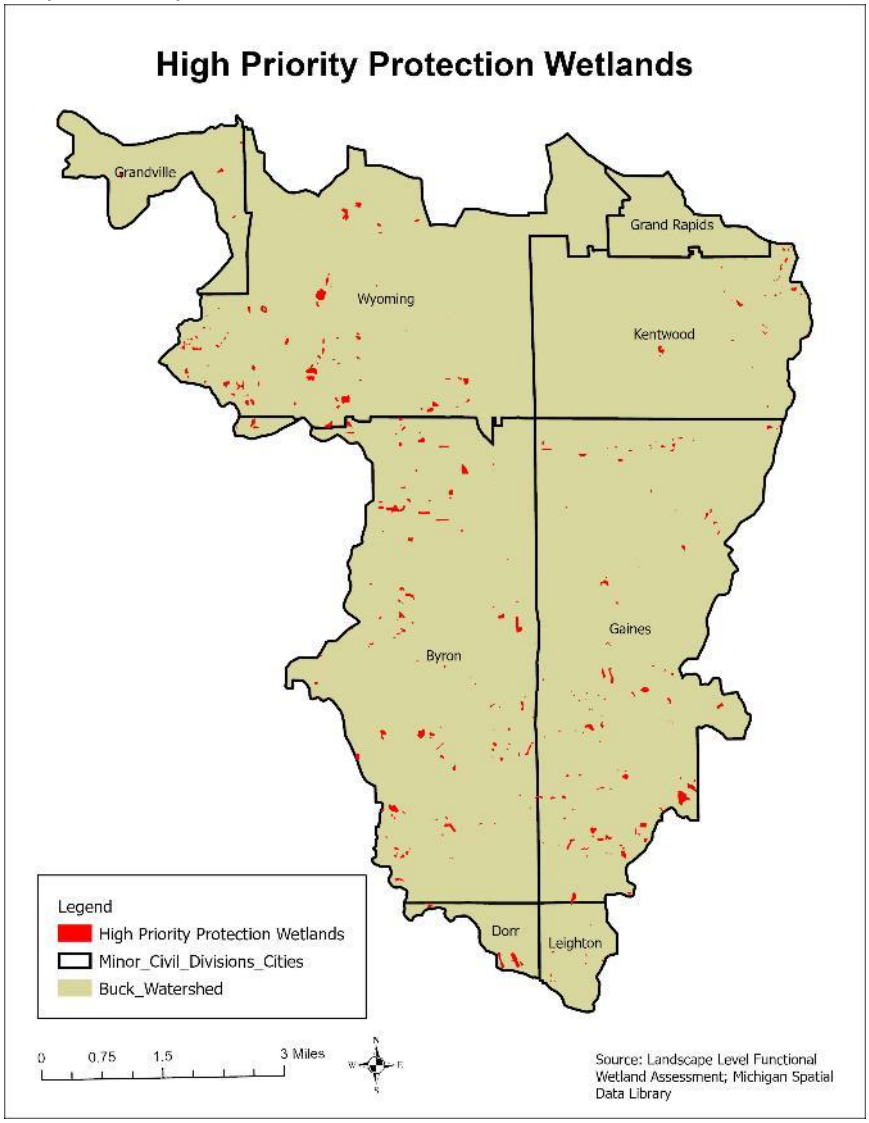

Figure 2. High Priority Wetlands for Protection

Restore/Create Wetlands

Already, loss of wetlands has severely altered the hydrology (led to increases in duration, magnitude and frequency in flow) and water quality (loss of free, natural filtering capacity) within the BCW. Restoration of wetlands is absolutely necessary to reverse negative impacts. The 1,910 acres of highest priority wetlands, for improving hydrology and reducing input of pollutants, are shown below. The single-most important consideration for restoration of these wetlands is interest and authorization from property owners.

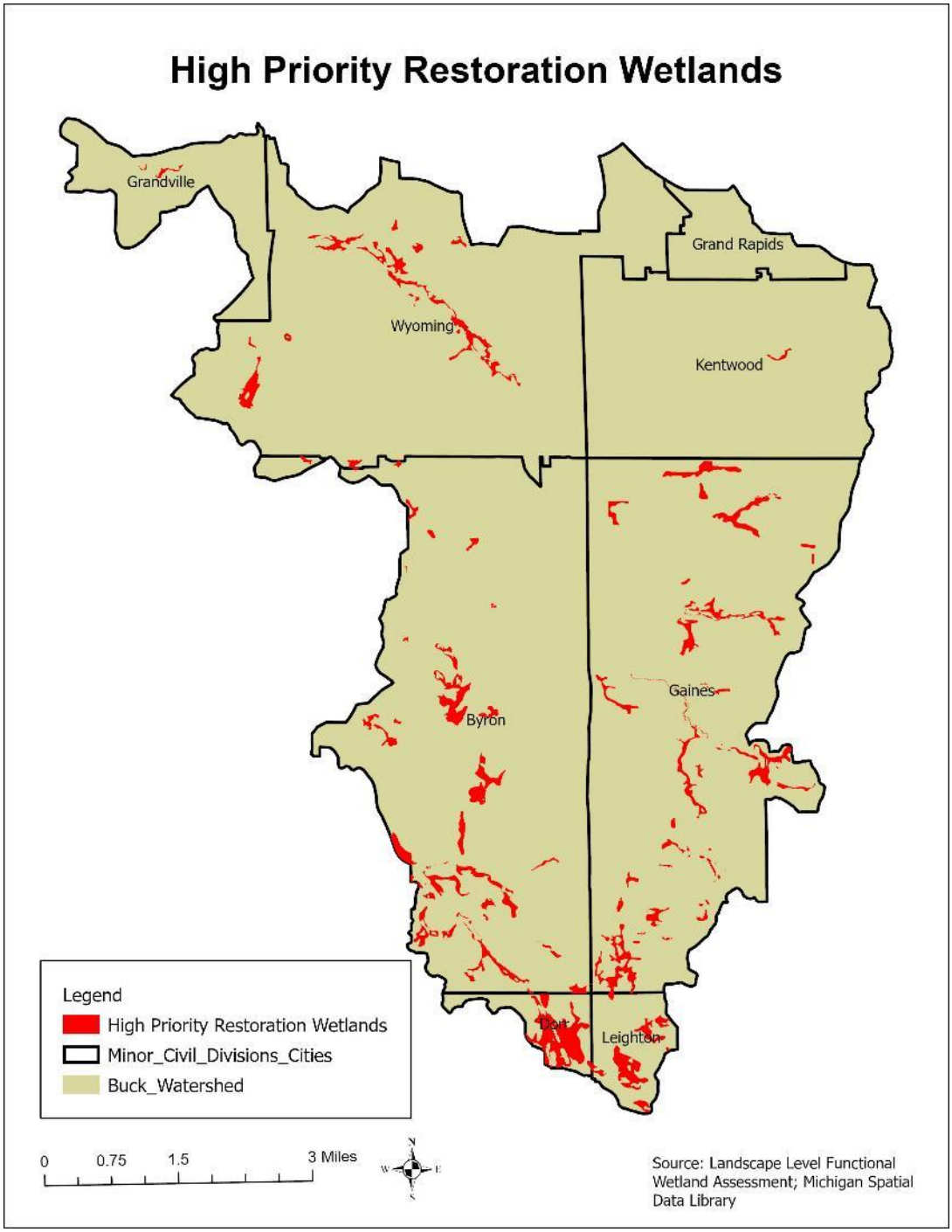

Figure 3. High Priority Wetlands for Restoration

Reduce Cropland Runoff to Streams (*E. coli*, nutrients, sediment)

Many potential pollutants, including livestock manure and chemical fertilizers, are applied to cropland. In areas of agricultural land use, runoff from this cropland is inevitable; however, minimizing the runoff on higher-risk lands or treating the runoff with best management practices is a proven method for protecting or improving water quality. Keeping soil, livestock manure and nutrients on the land is also in the best interest of the landowner. Fields with characteristics conducive for excessive pollutant loading to streams were prioritized and are mapped below. These fields should be examined on a site-specific basis to determine the best alternatives for keeping soil, fertilizer, etc. on the field, or for filtering or capturing runoff before it enters the stream.

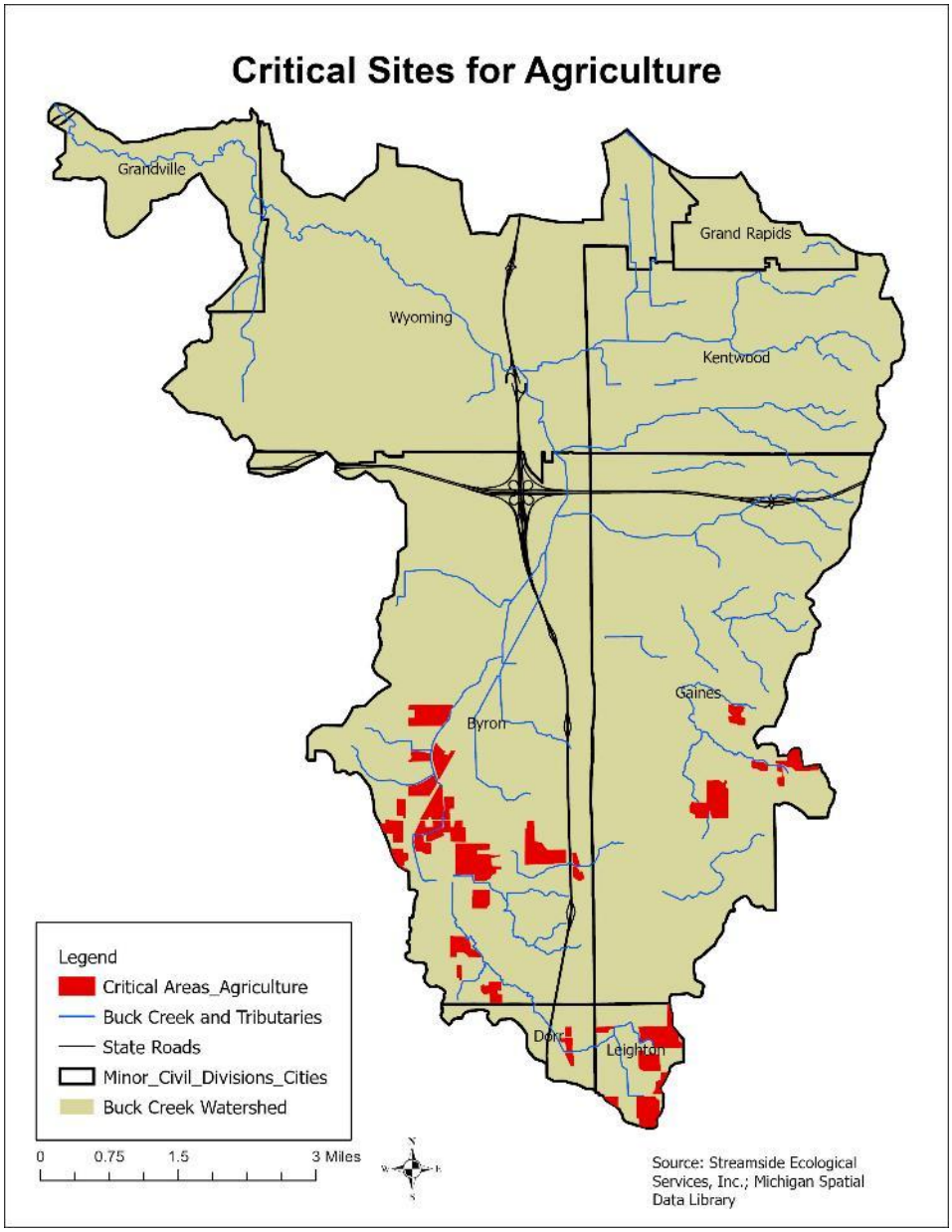

Figure 4. High Priority Agricultural Lands for Best Management Practices

Address Issues Related to Poor or Improper Riparian Management

From the headwaters to the mouth, many sections of Buck Creek suffer from removal of trees and mowing or farming to the edge of the stream. The lack of riparian vegetation reduces the amount of shade to maintain cool stream temperatures, the ability for pollution to be filtered by vegetation and the stability of streambanks. While not all inclusive, the areas illustrated below are high priority for improvement efforts.

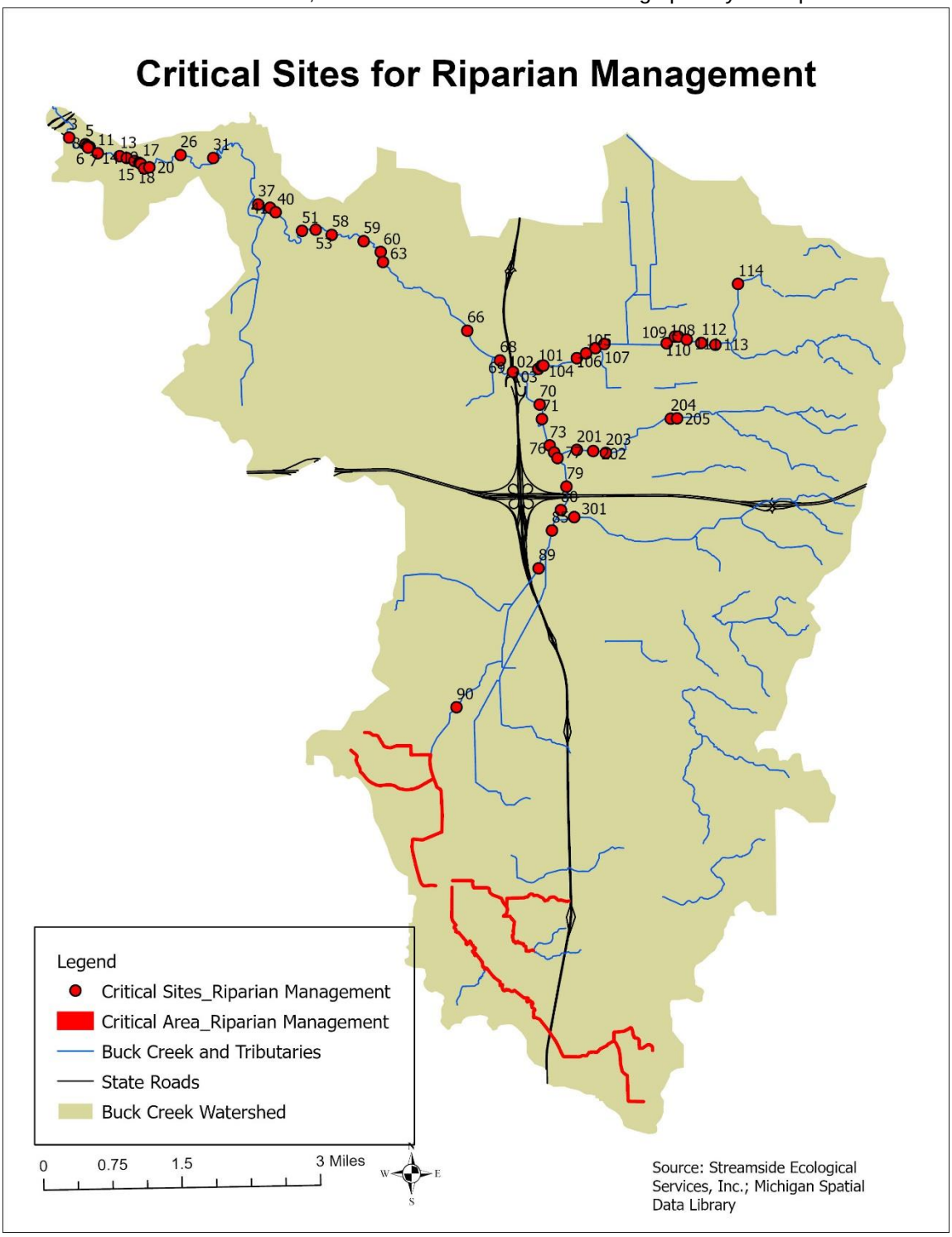

Figure 5. Critical Areas for Riparian Management

Reduce Sediment Input to Streams

Excessive sedimentation from sources such as streambanks is impairing the aquatic habitat, native aquatic species and the coldwater fishery, as well as stream function. Much of the streambank erosion in the BCW is caused by severely altered watershed hydrology and stream morphology. Excessive sediment may lead to increased streambank erosion and flooding. High priority areas for reducing sediment input are illustrated below.

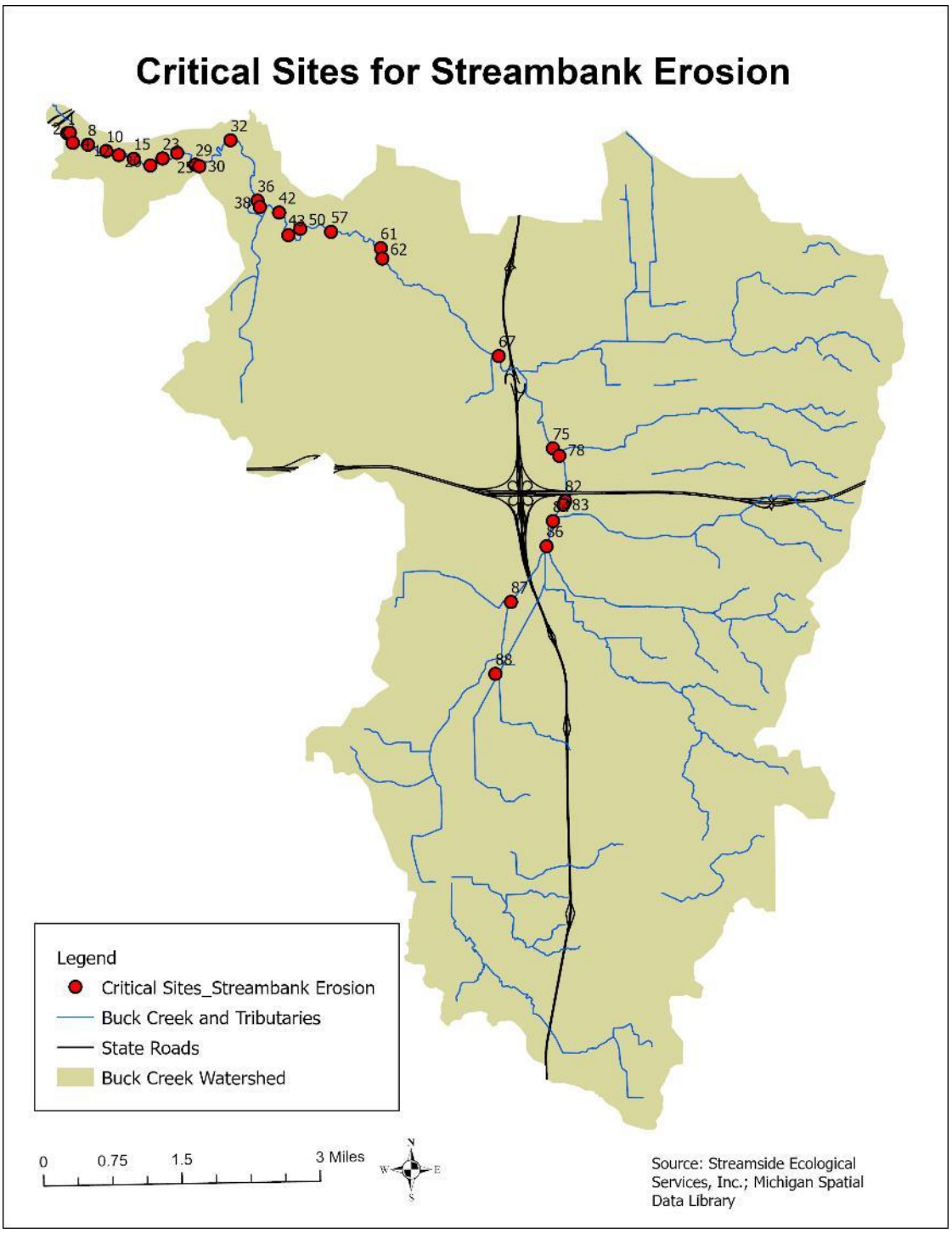

Figure 6. Critical Sites for Streambank Erosion

Keep Livestock out of/away from the Streams

At one time, it was commonly accepted practice to allow livestock access to streams as a source for drinking water or to move freely about a pasture/feedlot that is bisected by a stream or that drains directly to the stream. However, much has been learned over the past several decades and the negative impacts associated with trampling of streambanks and runoff of manure are well-documented, and many alternatives exist for providing clean drinking water, moving livestock across streams or pretreating manure-laden runoff. Most of these alternatives are even incentivized by financial assistance from various sources. In short, there is little reason for livestock to have access or to cause direct impact to surface waters. Sites identified as part of the project should be addressed immediately.

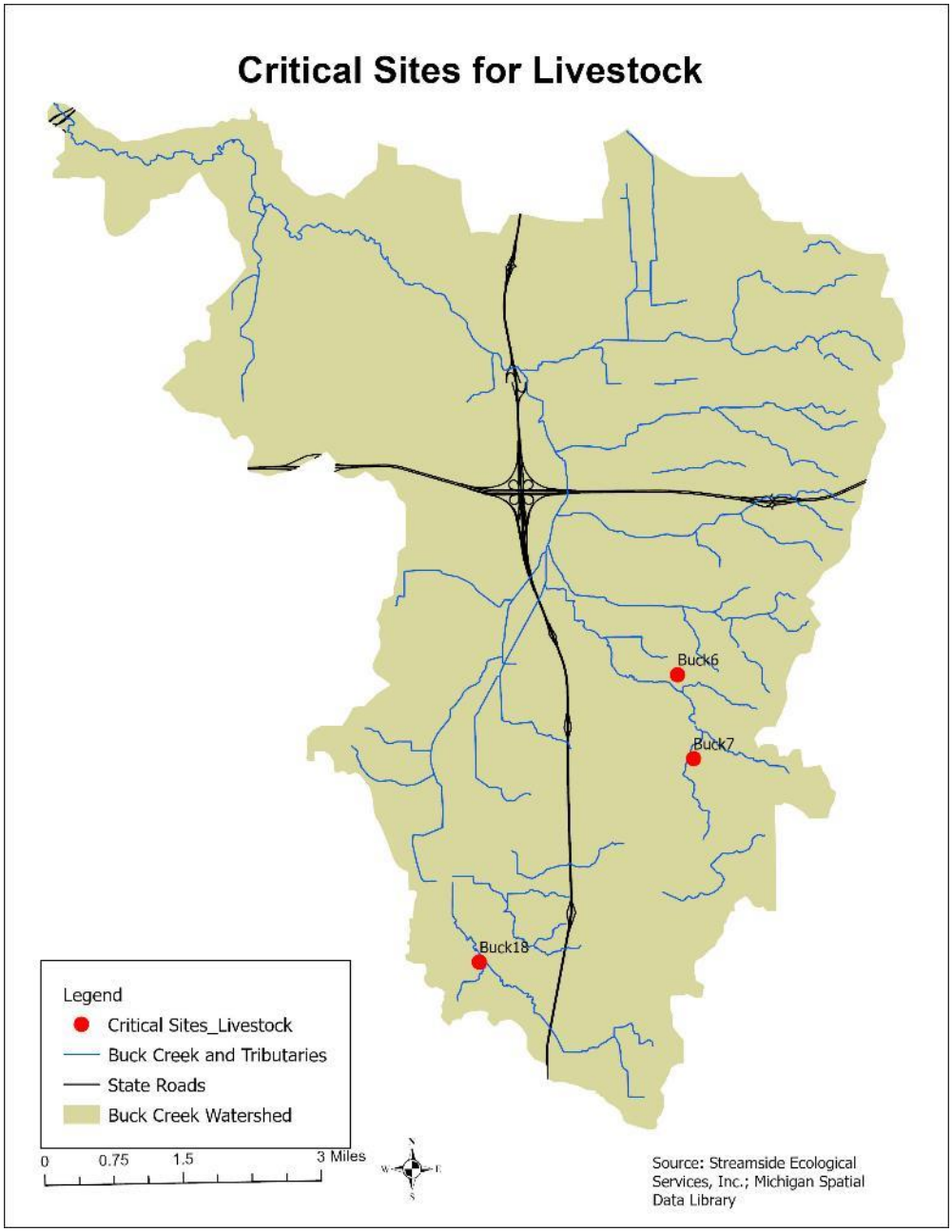

Figure 7. Critical Sites for Livestock

Reduce/Eliminate Input of Human Sewage

Human sewage has been detected in surface water throughout the BCW, through DNA source tracking and use of scent-trained canines. Like livestock manure, this waste is loaded with pathogens, bacteria and viruses and can cause severe illness; presently, use of the rivers and streams for wading, swimming, fishing, etc. should be limited, at times, due to exceedances of water quality standards. A growing body of evidence also suggests that pharmaceuticals and other chemicals ingested and passed by humans are having detrimental impacts on the environment. Past studies and programs conducted by the Barry-Eaton Health District found that as many as 27% of residential waste treatment systems are experiencing some level of failure (BEDHD, 2017).

Reduce Water Temperatures

Cold water and sufficient levels of dissolved oxygen are the lifeblood of many aquatic organisms, including trout. Even small increases in water temperature can permanently alter the biological community. Monitoring has shown that water temperatures in the upper portions of Buck Creek and in several of the main tributaries often exceed water quality standards, meaning that the coldwater fisheries are impaired. Targeted efforts to reduce stream temperatures using methods such as reforestation of riparian corridors and hydrologic improvements (e.g. wetland restoration, reducing runoff) are necessary. Tree and shrub planting on the south and west streambanks is a relatively easy and inexpensive way to begin.

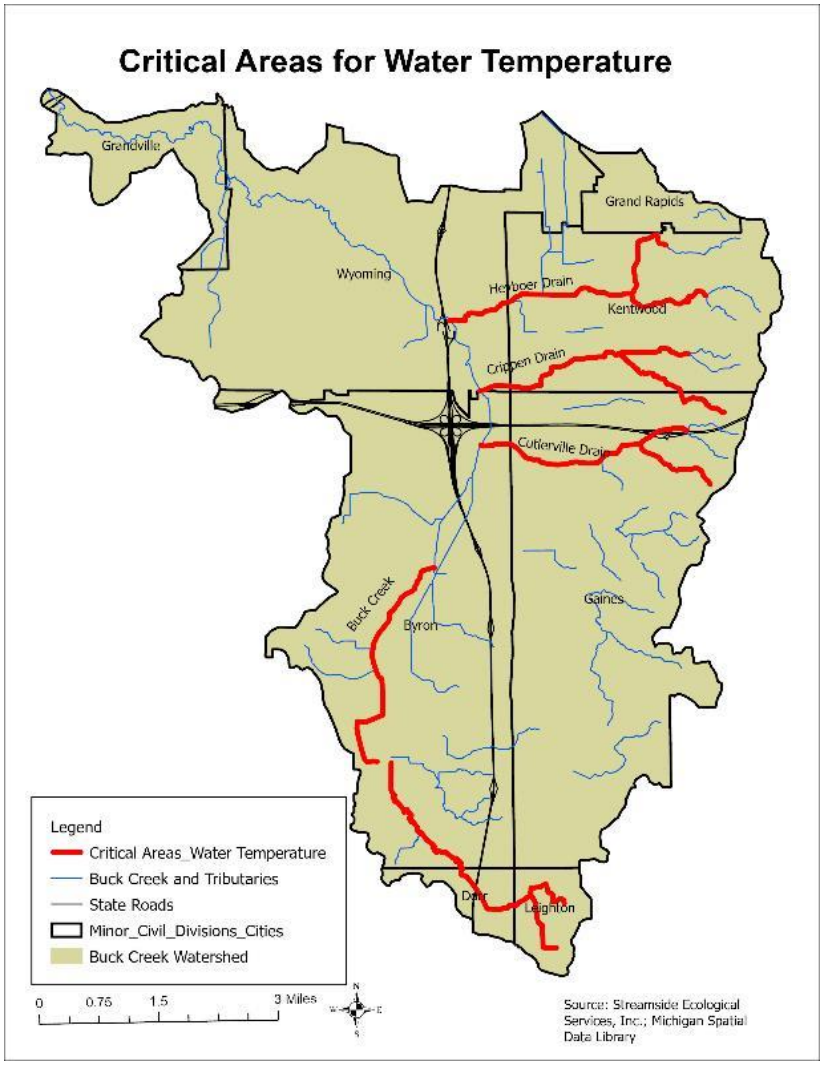

Figure 8. Critical Areas for Reducing Water Temperature

Reduce the Input of Trash

The volume of trash and debris found on the land and within the streams of the BCW is astounding. Fast food waste, plastic water bottles and grocery bags, furniture, hypodermic needles, shopping carts, bicycles and hundreds of other items were observed. Certain areas appear to be worse for the intentional dumping of trash, and are highlighted below. Many of these sites will require an educational outreach component in addition to clean up; it is not unusual to see intentional dumping of trash in residential backyards.

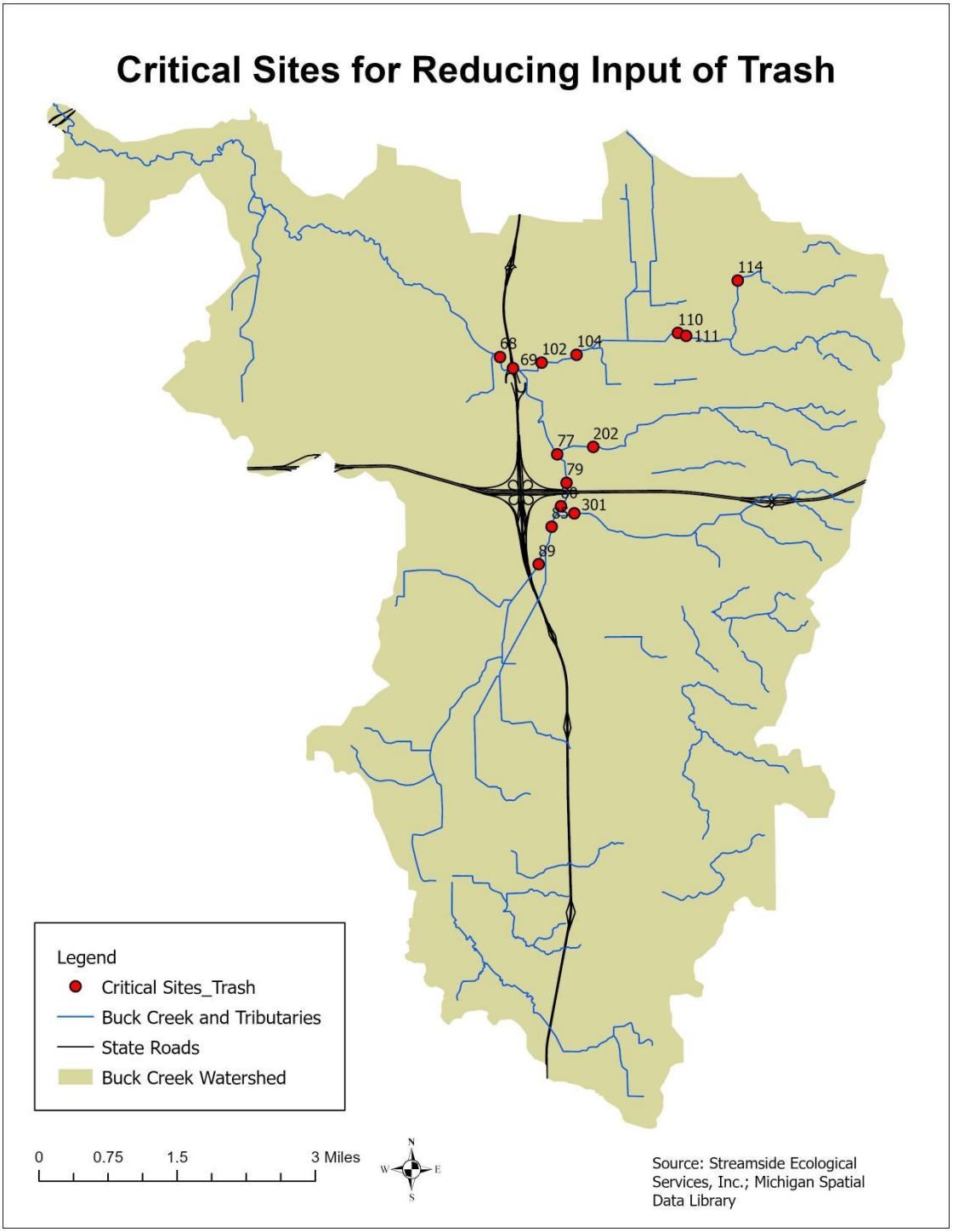

Figure 9. Critical Areas for Reducing Input of Trash

Collaborate with Drain Commissioners

The drain commissioners must know that many designated county drains are also valuable natural resources, and should be managed accordingly. Often, conservation groups can provide necessary input into drain projects and even assist with managing drains. For example, some log jam or debris removal projects can be completed by supervised volunteer labor. The "Clean and Open" method was developed to help conservation groups remove log jams while still protecting instream habitat. These projects are often viewed as "win-win", since drain commissioners can keep the drains (streams) running efficiently at little to no cost. Conservation groups can prevent large-scale drain clearing projects that often have negative impacts on the aquatic ecosystem.

Monitor the Watershed

Continual monitoring is necessary to collect up-to-date information for determining and planning the most cost-effective management strategies, measuring success of restoration projects and detecting changes associated with various impacts. Past monitoring has included macroinvertebrate and habitat assessments, fish community and trout population surveys, water chemistry studies and water temperature monitoring. These activities should be continued, and expanded into new tributaries or subjects of study, as necessary. Specific monitoring should include:

- Submit a Targeted Monitoring Request for EGLE to collect up-to-date information from the BCW in 2024 and subsequent monitoring years.
- Thermally classify all designated coldwater streams to describe each stream reach. Data loggers should be placed to expand on the existing data set for all stream in the BCW.
- Continue water temperature monitoring to ensure compliance/document exceedances of water quality standards and to understand long-term variability or change.
- Conduct periodic sampling for *E. coli* to document compliance or exceedances of water quality standards.
- Develop stream hydrographs to document existing hydrology and to monitor change over time.
- Understand macroinvertebrate density and diversity (including crayfish) by continuing semi-annual monitoring; at least one site on every tributary stream should be established.
- Periodically monitor the fish community to describe species composition and trout population density and size, in all designated coldwater streams.
- Conduct a detailed assessment and develop an inventory of potential wetland restoration or stormwater detention sites.
- Begin a nutrient monitoring program to develop an understanding of exceedances of WQS and impacts on designated uses.
- Develop and implement monitoring program to determine impact of ammonia and chloride on aquatic organisms.
- Develop and implement monitoring program to determine impact of biosolids on surface waters.
- Document occurrences of any new or particularly destructive invasive species.

Observe the Watershed

Things such as changes in water color, excessive foam or bubbles, oil sheen, odors or dead or dying aquatic organisms are likely indicators of a larger problem. For those that spend a lot of time in the BCW, observation of anything other than "normal" conditions should be considered and reported.

To report a manure spill or fish kill: Call the EGLE Pollution Emergency Alert System (PEAS) 800-292-4706

To report an illicit discharge of sewage, contact:

- Allegan County Health Department – (269) 673-5411
- Kent County Health Department – (616) 632-7100

Alternatively, EGLE accepts anonymous complaints through MiWaters: miwaters.deq.state.mi.us

Apply for Grants to Implement these Recommendations

Most non-profit groups and local municipalities are eligible to receive grants for water quality improvement efforts, including most of the activities discussed within this chapter. A Clean Water Act Section 319 grant is a good place to start, though other government agencies and local philanthropists have funded work in the BCW in the past. For most grant programs, several key pieces of information are necessary:

- Definition of the problem and a detailed description of how it will be remedied.
- For work on private property, written landowner authorization is required. Any proposed improvement work should be discussed in detail and site-specific plans can be developed once the landowner agrees to participate.
- For work in county drains or at road crossings, contact with the drain or road commissioner should be the first step.
- Detailed budget.
- Identify all partners that may be interested or able to contribute to the project goals and objectives.
- Matching contributions from the grantee and partners. Local match can be cash, but just as often involves the donation of time, labor, materials, meeting space, etc.
- A monitoring plan to determine if the project is successful.

3.0 DESCRIPTION OF THE BUCK CREEK WATERSHED

3.1 Geographic Scope

The BCW consists of two subwatersheds. The headwaters of Buck Creek are in light agricultural and urban developing areas of Byron and Gaines Townships in southern Kent County and an unusual mix of agriculture and industrial development in northern Allegan County. Pine Hill Creek and Sharps Creek flow west through the City of Kentwood, and enter Buck Creek in the residential areas of the City of Wyoming. From Wyoming, Buck Creek flows through the City of Grandville, where it enters the Grand River. The BCW drains approximately 51 square miles, with many of the tributaries and sections of Buck Creek maintained as designated county drains.

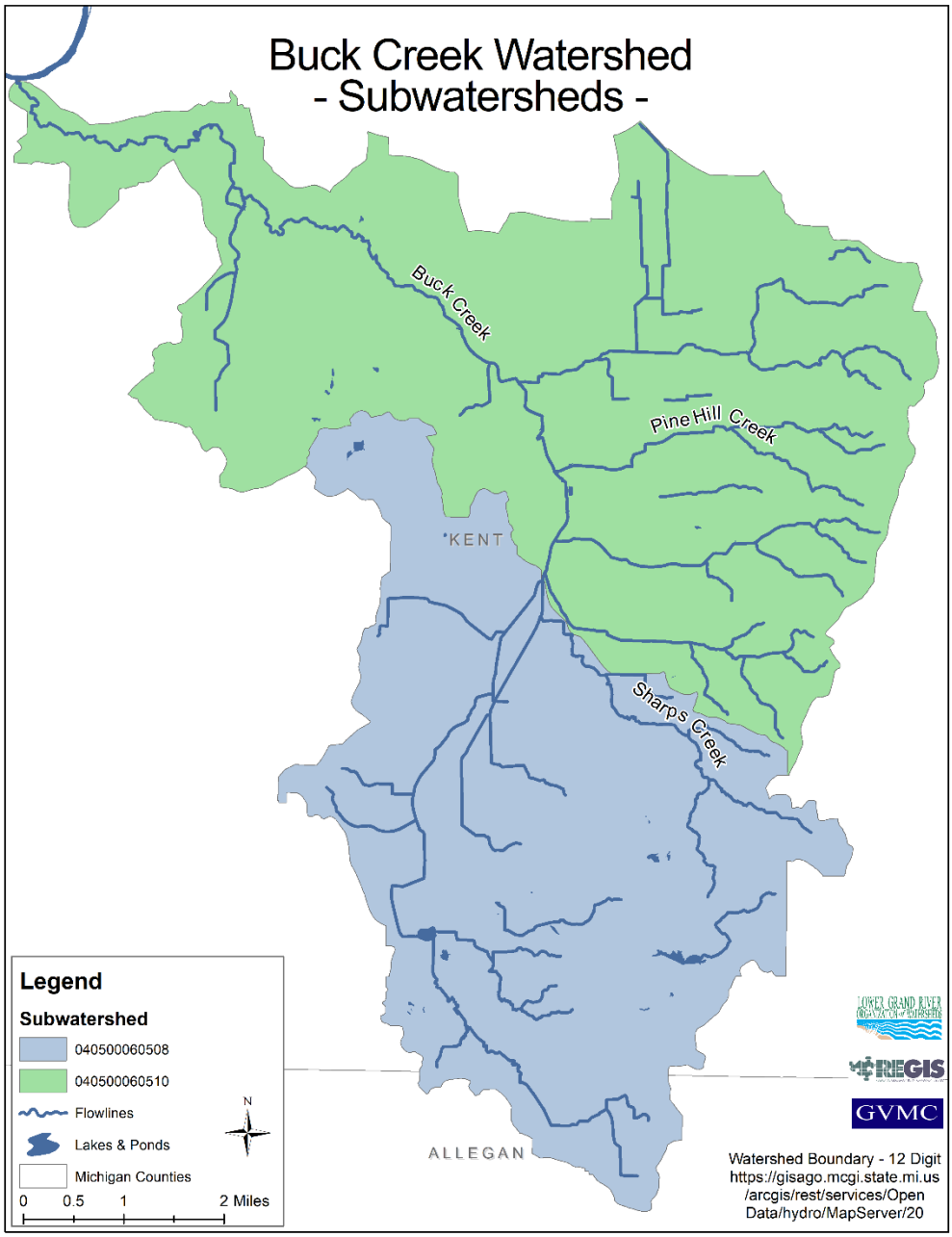

Figure 10. Buck Creek Subwatersheds

3.2 Land Use

Prior to settlement, the BCW was primarily sugar maple and beech forests and forested wetlands. In the mid-1800s clear-cut logging removed trees from most areas in the Lower Peninsula. The watershed was then used primarily for agriculture and pasture. During this period, the City of Grandville was established and surface mining of gypsum, gravel, and marl began to take place in Wyoming. Past mining operations are evident by the many artificial lakes northeast of Grandville and in Wyoming. Flooding that occurred in the Grand River floodplain and along Buck Creek left these areas relatively undeveloped. Today, many miles of forested riparian buffers still exist in the Cities of Grandville and Wyoming.

Table 1. Land Use

Land Use	Acres
Open Water	76
Development Open	5,141
Development Low	9,161
Development Medium	5,722
Development High	2,853
Barren Land	213
Forest	2,697
Cultivated	5,020
Wetland	1,498
	32,382

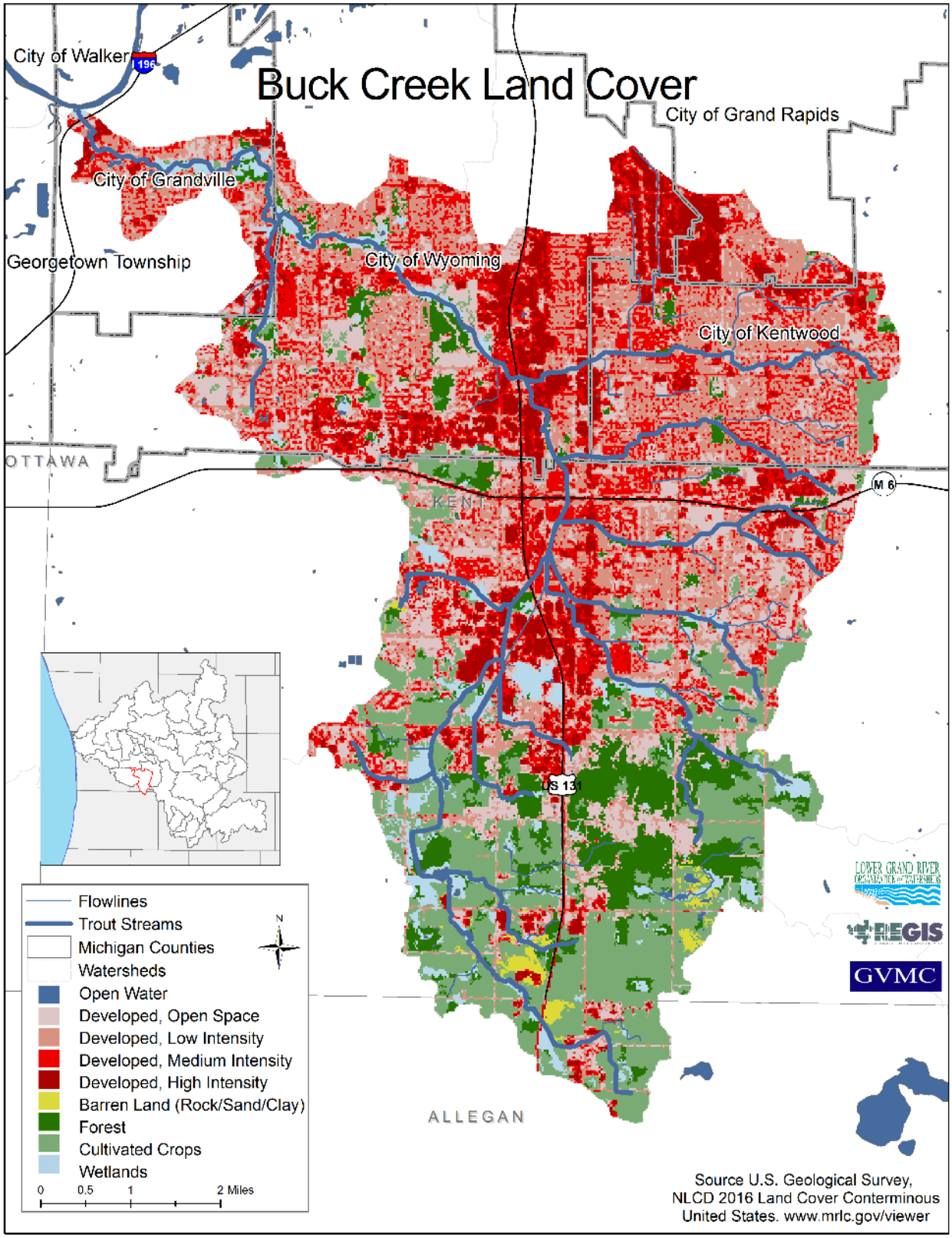

Figure 11. Land Use

3.3 Topography

Buck Creek originates in northern Allegan County (elevation 800 feet above sea level) and drops to the Grand River in Kent County (elevation 590 ft.) (USGS, 2020). This drop of 210 feet over 20 miles equates to an average slope of about 10.4 feet per mile, or 0.2%. The highest elevation in the BCW is 1,030 ft. and the lowest elevation is 590 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.

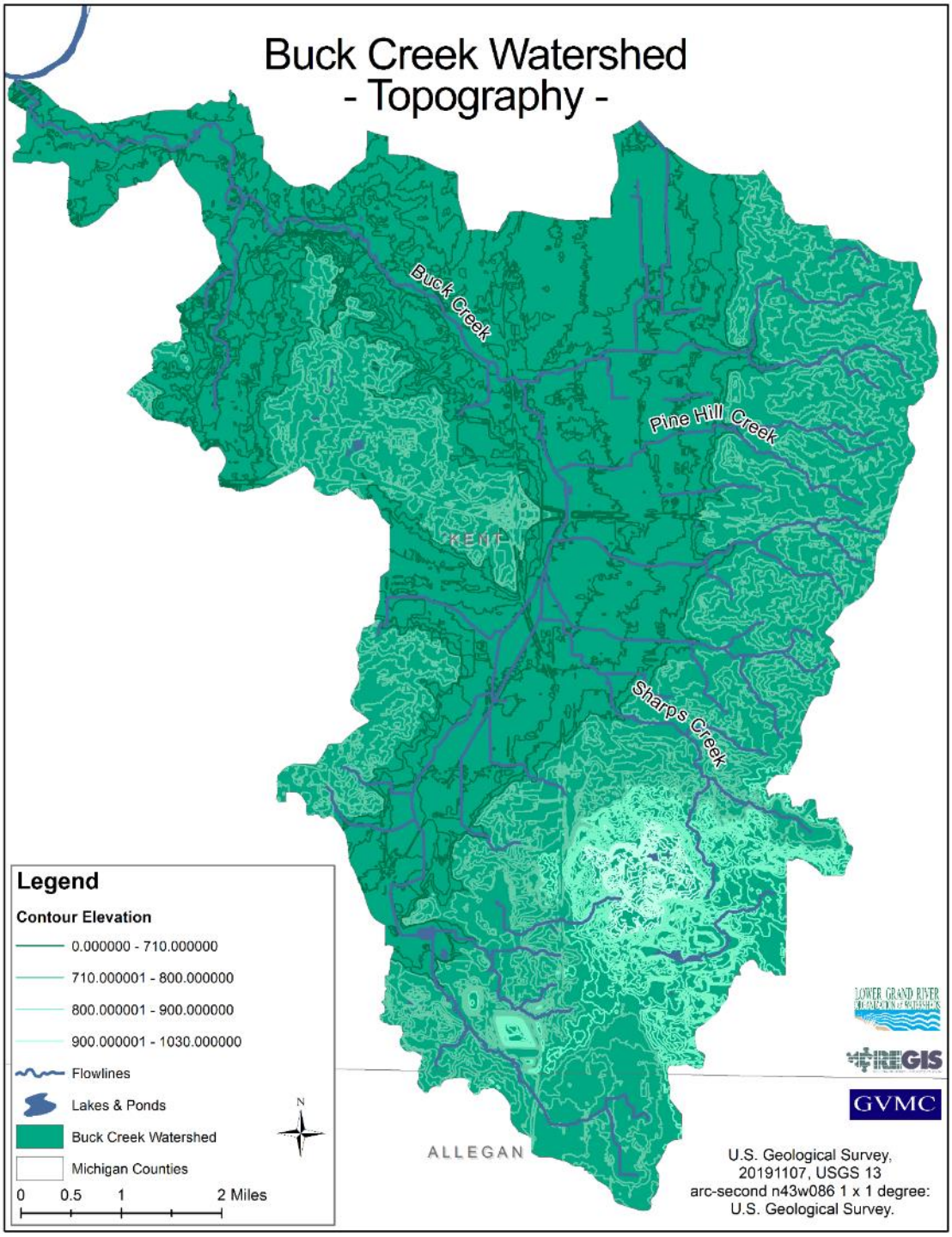

Figure 12. Topography

3.4 Geology

The soils in the watershed are the result of glacial processes that occurred during the Wisconsin glacial period. Two lobes of this glacier, the Michigan and the Saginaw, met in Kent County to form a complex system of moraines and till plains. Glacial melt water formed huge valleys with rivers that were much larger than the creeks and streams found in the same valleys today. The watershed is an example of one of these systems, and consists of nearly level valleys and lake plains with well-defined boundaries. The watershed has some of the thinnest glacial drift in Kent County. The lower reaches of the watershed, near Grandville and Wyoming, have layers of bedrock within a few feet of the surface (USDA, 1983) (Figure 3.4).

The watershed can be generally categorized by several soil associations. Northern areas of the watershed, above the creek valley, are made up of well drained sandy soils in the Plainfield-Oshtemo-Spinks Association. These soils are not suited to agriculture, although the well-drained nature of these soils make them excellent building sites. The poor filtering capacity of the soils, however, are not suited for septic systems (United States Department of Agriculture (USDA), 1983).

The Buck Creek valley, from Grandville upstream to Allegan County, has soils that fall into the Houghton-Cohoctah-Ceresco Association. These soils are nearly level, poorly drained, and are formed in organic material in alluvial deposits. Soils in this association have deep surface layers of dark muck. These soils are typically drained and used to cultivate specialty crops like celery, carrots, and lettuce. These sites are not suited for building sites or septic systems due to excessive wetness and seasonal ponding (USDA, 1983).

The headwaters of the tributaries that enter Buck Creek from the east are in the Ithaca-Rimer-Perrinton Association. These soils are nearly level to gently rolling hills formed in glacial deposits. Drainage varies from somewhat poorly drained to well-drained. These soils are well suited for cultivation, pasture, and woodland, if protected from seasonal wetness and soil blowing. These sites are not recommended for building sites due to high shrink-swell potential and wetness (USDA, 1983).

The watersheds western boundary and ridges between tributaries are made up of soils in the Marlette-Chelsea-Boyer Association. These soils are gently rolling to very steep, well drained soils formed in sandy glacial deposits. These soils vary widely in their ability to be used for both building sites and cultivation since slopes can range from 6% to 45%. Less steep slopes are usually well suited for building sites and septic leach fields (USDA, 1983).

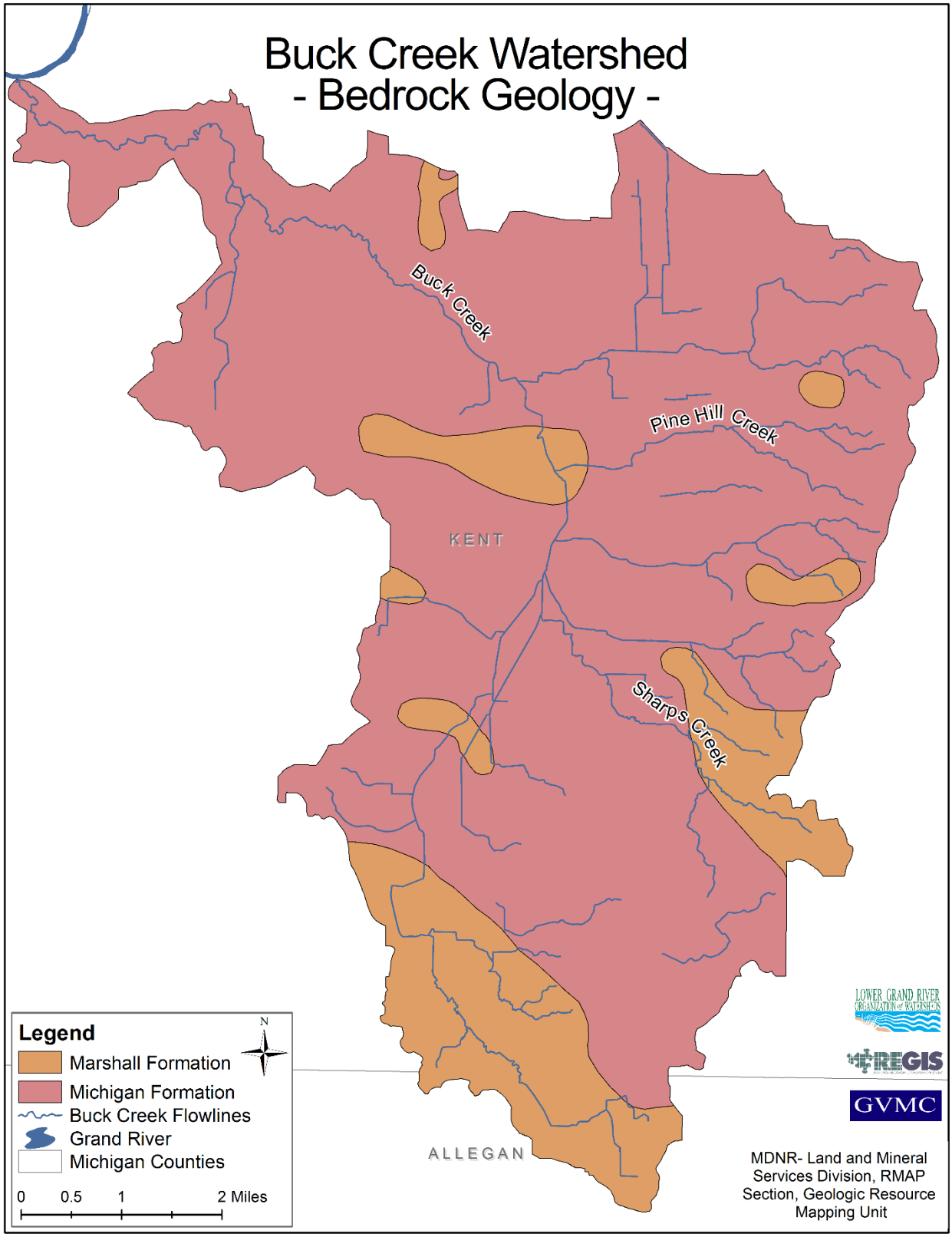

Figure 13. Bedrock Geology

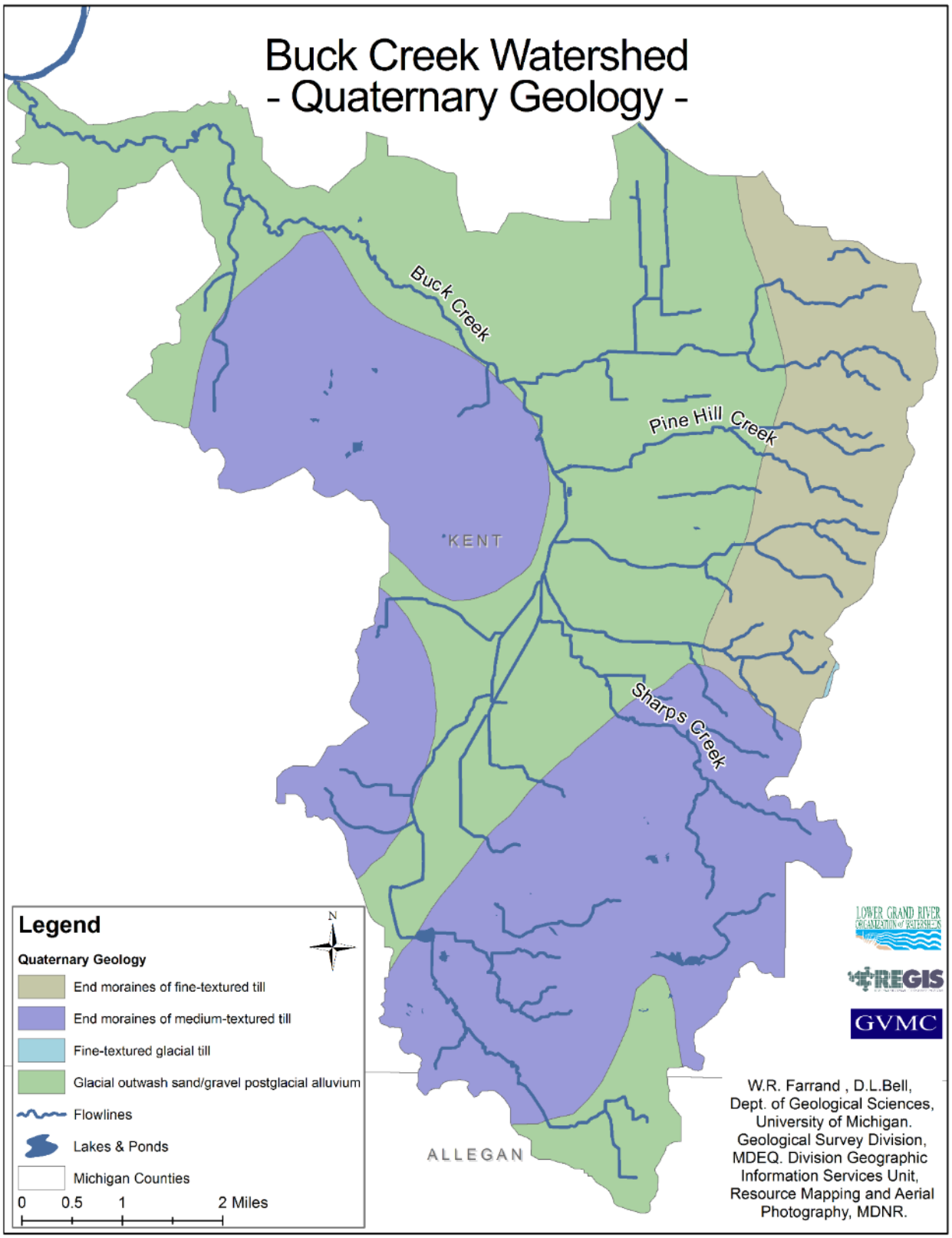

Figure 14. Quaternary Geology

3.5 Soils

The BCW 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.

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, such as manure, septage or fertilizers, are absorbed 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 3.3) (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 3.3 summarizes the differences in the four hydrologic soil groups. (WMP, p.15-16). Table 3.4 highlights the percentage of hydrologic soil groups throughout the BCW, and Figure 3.7 shows their spatial distribution. The predominant soil types are A (28%) and C (18%), with high and medium infiltration rates, respectively. Some soils (38%) 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 30% 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. Hydrologic Soil Groups

Hydrologic Soil Group	Definition
A	High Infiltration rate, low runoff potential. Well drained to excessively drained sands or gravelly sands, High rate of water transmission. The northern and upland areas of the watershed are mostly in this soil group.
B	Moderate infiltration rates. Moderately well to well drained. Moderately fine to medium coarse texture, moderate rate of water transmission. The western portions and ridges of the watershed are mostly this soil group.
C	Slow infiltration rate. Has layers that impedes downward movement of water moderately fine to fine texture, slow rate of water transmission. The soils in the headwaters of the watershed are in this soil group.

D	Very slow infiltration rate, high runoff potential. Clays with high shrink/swell potential. Permanent high water table. Clay pan or clay layer at or near surface. Shallow over nearly impervious material. Very slow rate of water transmission. Most of the Buck Creek valley and areas in the southern portion of the watershed that are drained for agriculture are associated with this soil group.

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.

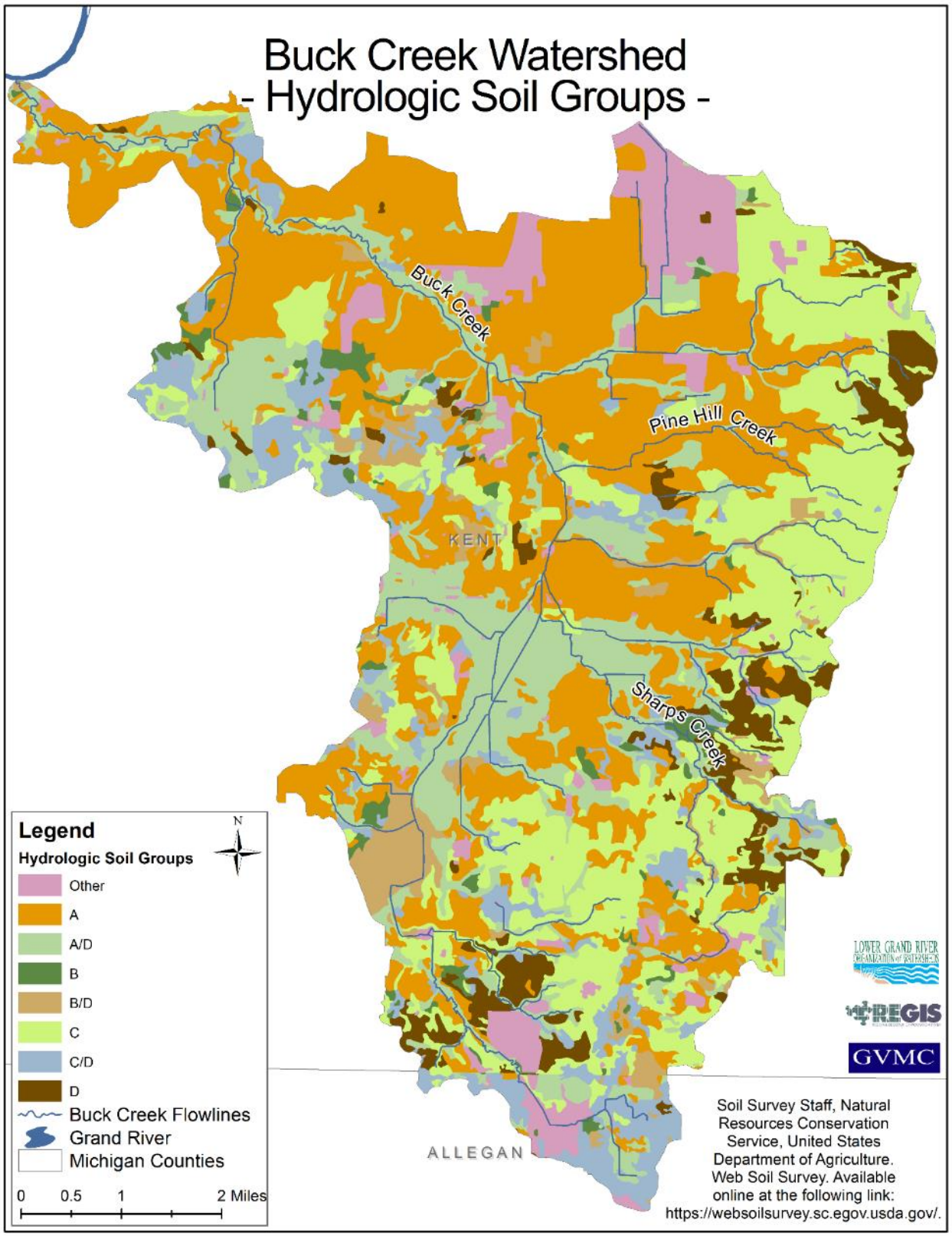

Figure 15. Soils

3.6 Climate

The BCW 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, 2019), 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).

3.7 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 BCW. There are approximately 77 miles of streams and 1,540 acres of wetlands (Michigan GIS Open Data, 2020). 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. Buck Creek and its tributaries are all extremely flashy streams, and the impacts of this flashiness, in terms of biological health, stream stability and water quality, are profound.

Stream hydrology and sediment transport are greatly affected by imperviousness of a watershed. In natural environments, trees and vegetation intercept storm water and slow the flow of runoff to the stream or river system. As development occurs, permeable land and wetlands are converted to impervious surfaces like roads, rooftops, and driveways. This eliminates most of the lands capacity to slow runoff by storing storm water flows and allowing infiltration, and results in rapid fluctuations in water levels. About 69% of the watershed is covered with impervious surfaces, such as pavement and roofs, which contribute to pollution from storm water runoff (www.usgs.gov/centers/eros/science/national-land-cover-database). The City of Wyoming, the City of Kentwood, and Byron Township have storm water master plans for Buck Creek. The storm water master plans require new developments to maintain storm water runoff rates that will not cause downstream flooding. However, older developments prior to storm water management have inadequate

onsite storm water retention that has resulted in localized flooding in the Cities of Wyoming and Grandville (Fishbeck, Thompson, Carr & Huber, Inc. (FTC&H) 2000).

A flood mitigation study of Buck Creek, completed for the Kent County Drain Commissioner in 2000, reviewed the hydrology of the creek and the feasibility of using regional detention. The study determined that regional detention of storm water was not feasible since the available open space for the detention ponds would not provide adequate capacity for storm water runoff storage. The study concluded that enlarging road crossings, removing log jams and debris, and installing floodway diversions would increase the stream capacity (FTC&H, 2000).

Prior to development, Buck Creek experienced bankfull flows at the one- and two-year rain events. These flows have the greatest effect on shaping stream channels. Development increases impervious surface and thus increases the frequency of bankfull events. Even with storm water regulations that require developments to maintain predevelopment runoff rates, the frequency of these events still increases due to increased impervious surface area (FTC&H, 2000).

The BCW is classified as a low gradient stream with groundwater base flows. Stream gradients are between 4 to 10 feet of drop per mile of stream in an unconfined groundwater aquifer. This type of stream is vulnerable to storm water runoff since its stream morphology is not capable of handling rapid fluctuations of surface water runoff. In predevelopment conditions, storm water infiltrated into the ground and slowly made its way to the creek via groundwater flows, resulting in stable base flow and coldwater temperatures that supported the coldwater fishery. Today, unstable hydrology due to increases in the magnitude, duration and frequency of storm events is suspected to be the leading cause of streambank erosion and habitat degradation.

Floodplains

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 BCW 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 3.8. 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.

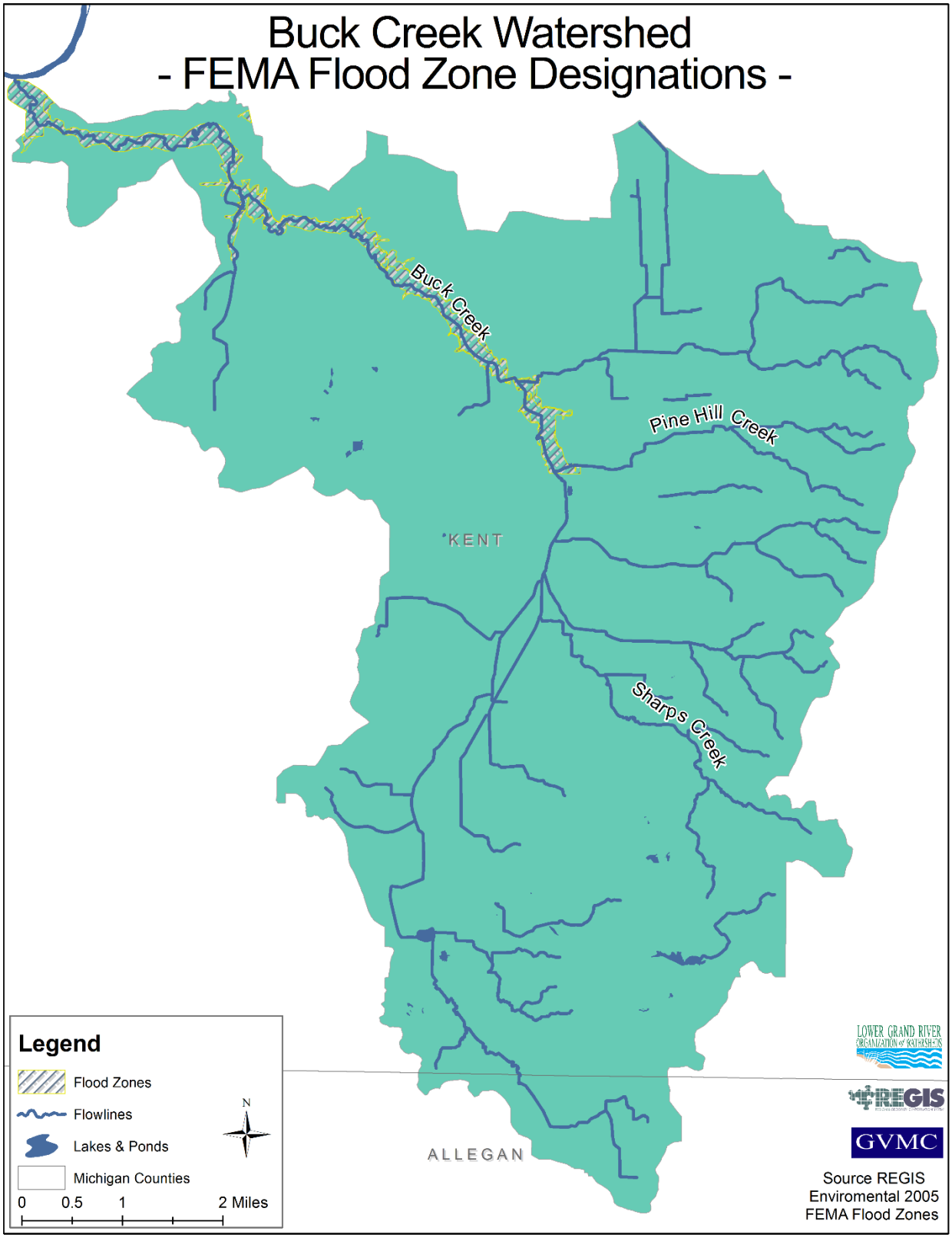

Figure 16. FEMA Flood Zone Designations

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.

EGLE 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.

Specific to the BCW, there are approximately 1,540 acres of existing wetlands, with about 4,520 acres (75%) of historic wetlands having been lost to farming and development (LLWFA).

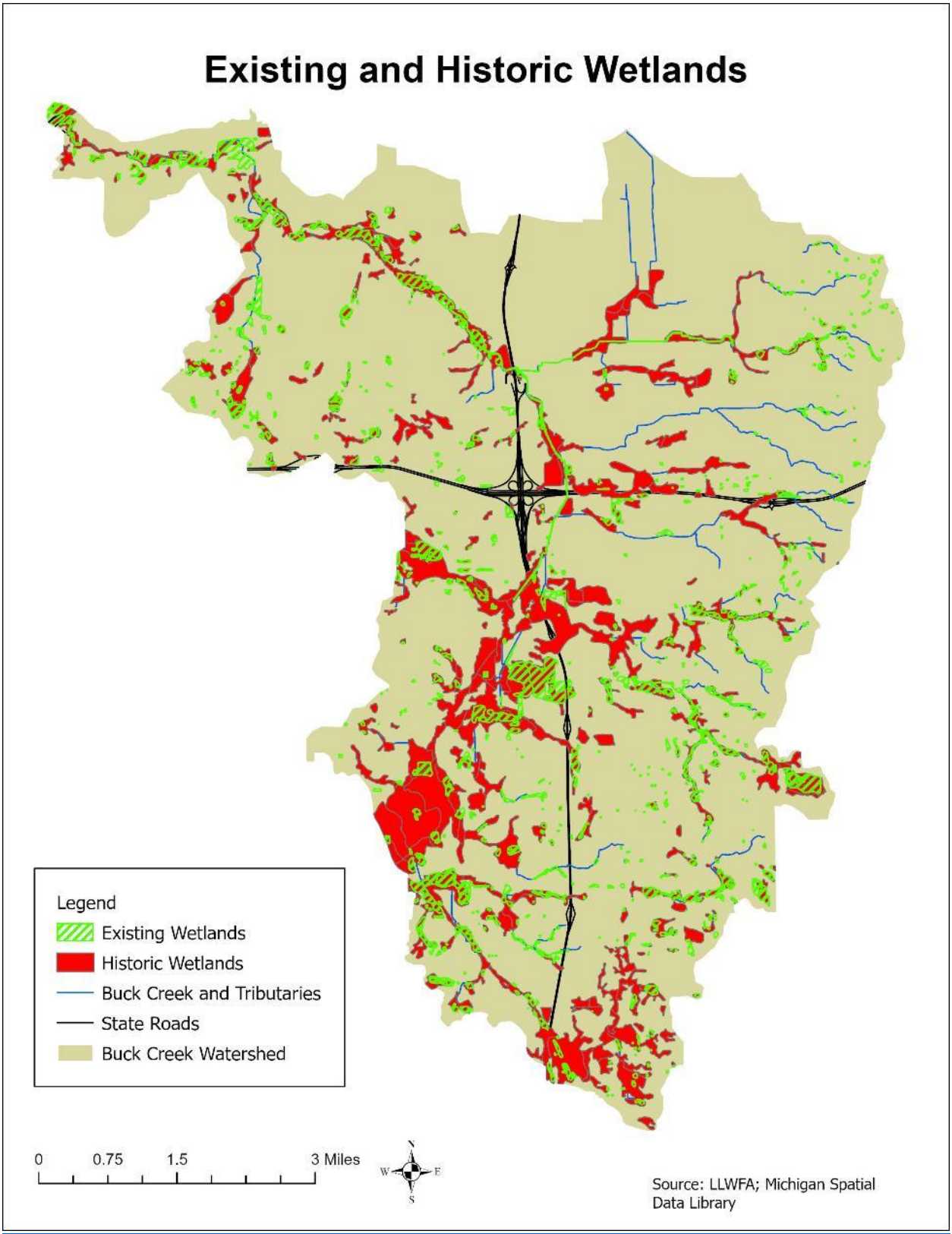

Figure 17. Existing and Historic (Presettlement) Wetlands

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. The commissioners oversee the construction, operation, and maintenance of established county drains. Most of Buck Creek and its tributaries are altered for efficient drainage and/or maintained as designated county drains; in fact about 54 miles (49.7 miles in Kent County and 4.25 miles in Allegan County), or 70%, of the open stream channels within 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 County Drain Commissioners, 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. The Kent County Drain Commissioner maintains 77 detention basins within the BCW, to help alleviate some of the impacts of the hydrologic changes.

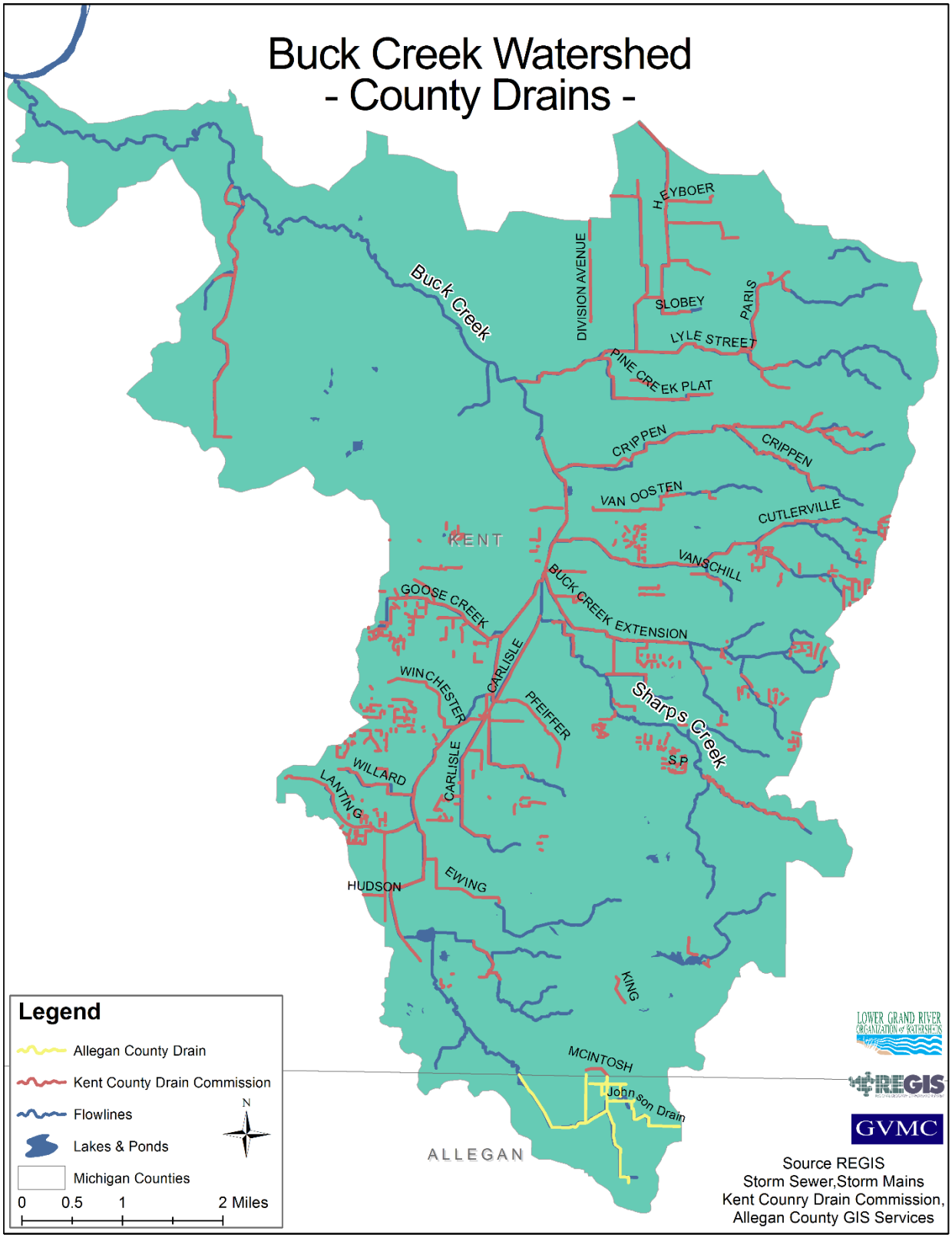

Figure 18. Designated County Drains

3.8 Aquatic Life

Buck Creek and its tributaries are currently listed as designated trout streams and have been stocked with brown trout for several years by the Michigan Department of Natural Resources (MDNR). Trout stocking was cancelled in 2012 due to ongoing degradation of the stream, until feedback from disgruntled anglers reversed this decision (Personal Communication, Scott Hanshue, MDNR Fisheries Biologist (2013)). The current MDNR Fisheries Biologist recently confirmed that fish stocking will continue (Personal Communication, Addie Dutton (2022)).

Water temperature data was collected by Schrems (2017) to thermally classify Buck Creek and its tributaries. In contrast to Hanshue and Harrington (2011), results of the study indicated that the headwaters are warm, but the water cools as it nears the lower portions of the watershed. Despite warm water associated with agricultural land use in the upper watershed and high-density urban development in the rest of the watershed, the stream cools enough from groundwater contribution (i.e. baseflow) and contains a fish community to be considered a designated coldwater stream (DNR) from approximately 84th Street downstream to Ivanrest. This portion of Buck Creek was meeting its use as a designated coldwater stream, pursuant to Part 4 of the WQC. The Cutlerville Drain nearly met the requirements of a cold-transitional stream and Sharps Creek appears to be especially important for protection since it was the coldest site in the study area.

Conversely, Buck Creek at Ivanrest and Carlisle Drain were pushing the upper limit for trout and slight warming, or a warmer than average summer, could make these stream reaches too warm. At several sites, the maximum July water temperatures could negatively impact trout populations, especially if colder water refuges, such as springs or groundwater seeps, are scarce or not accessible.

Fish surveys conducted by Schrems (2017) confirmed the presence of trout (along with associated coldwater species) and indicate that Buck Creek is meeting its coldwater designation at the Grandville Cemetery. Based only upon population estimates derived from fish surveys, and not considering the numbers of fish stocked, etc., the size of the trout population at the Grandville Cemetery appeared to be consistent with other, similarly sized, streams in the region. Despite having cooler water than the cemetery site, the data indicated that the trout population was depressed near Lemery Park. Though, the few trout captured during electrofishing surveys were, on average, larger in size and likely survived multiple years in the stream.

Data collected by Schrems indicated that environmental factors are conducive to trout survival for at least a single season. It was also evident from the survey data that some trout are surviving year-round, some for multiple years. Anecdotal evidence from anglers indicates that Buck Creek provides the environment necessary to grow low to moderate numbers of large trout; however, data also supports the suggestion that the coldwater fishery is threatened by water temperature in several reaches and impaired near Lemery Park.

In addition to elevated water temperature, reasons for threats or impairments to the coldwater fishery might include degraded water quality and/or physical habitat. Results of monitoring indicated that the stream is flashy and impacted by excessive sediment. Hydrolab data showed that levels of dissolved oxygen and total dissolved solids are far from ideal for supporting a high-quality aquatic community, and could be limiting the survival of sensitive aquatic species.

Significant development of the watershed has led to a variety of impacts typically found in urban watersheds, including extreme hydrologic fluctuation, sedimentation and thermal pollution. The Lower Grand River Watershed Management Plan (LGROW 2011) lists Buck Creek as a critical area for restoration

due to pollution by pathogens and bacteria, sediment and nutrients. This plan lists the coldwater fishery as being threatened by sediment and nutrients and as being impaired north of 84th Street to the limits of the City of Grandville, and severely impaired in Lemery Park and near Burlingame Avenue. The Draft Grand River Assessment recommended to “Survey water temperatures and trout survival in managed waters (e.g., Buck Creek, etc.) to determine if trout stocking is prudent...”.

3.9 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. 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. Black and pale swallow-wort, giant hogweed, Japanese knotweed, Poison hemlock, *Phragmites australis*, Eurasian bush honeysuckles, common and glossy buckthorn, barberry, multiflora rose, Oriental bittersweet, autumn olive and spotted knapweed are prevalent in the BCW, and often introduced through landscaping or conservation activities. Kent and Allegan Conservation Districts are actively working with their communities to control invasive species.

The round goby, which can be found through much of Buck Creek and its tributaries, is an invasive fish that has a voracious appetite and an aggressive nature. The goby has a well-developed sensory system and can feed in complete darkness, giving it a competitive advantage over native stream fishes.

3.10 Recreational Uses and Government Protected Lands

There are many township, city, and county owned parks in the BCW, but no state owned lands.

Buck Creek Trail, City of Grandville

Following along the north side of Buck Creek, between Canal Ave. and Wedgwood Park, the Buck Creek Trail provides a pleasant route through Grandville's neighborhoods and, with a newer extension, connects the downtown area with a network of trails along the Grand River and up to Grand Rapids via the Grand River Pathway and Kent Trails. The trail was built on a gypsum mine, which travelers can read about on two historical displays. A highlight of the Buck Creek Trail is its connection to Wedgwood Park, offering many recreational amenities, including a baseball field, volleyball court, horseshoe pits and picnic grounds.

Wedgwood Park, City of Grandville

Wedgewood Park, located in the heart of Grandville, offers outdoor recreation, sports fields, creek access and nature preservation. The park also offers open spaces under the maintenance of the Grandville Parks Department.

Charles Lemery Park, City of Wyoming

Lemery Park provides both active and passive recreational opportunities. The paved pathway within the park connects to the Buck Creek Nature Preserve pathway. The tennis and ball diamonds are used daily by residents and athletic teams. Access to the park is from Byron Center Avenue in the parking lot and pedestrian access with street parking is available from Holiday Drive in the adjacent neighborhood.

Buck Creek Nature Preserve, City of Wyoming

Buck Creek Nature Preserve is a 37.5-acre natural area which encompasses several miles of the main stem of Buck Creek as it flows northwest towards the Grandville area. The preserve offers

trailhead parking with public restrooms and a one-mile-long paved pathway that stretches through entire length of the preserve connecting Lemery Park to Palmer Park. Natural surfaced pathways that branch off the main trail can also be used by those who seek to view wildlife and access to the creek for fishing.

Palmer Park and L.E. Kaufman Golf Course, Kent County Parks
Palmer Park and LE Kaufman Golf Course connects to the Buck Creek nature preserve in a partnership with Wyoming. Park activities and facilities include: golfing, baseball diamonds, biking, cross country skiing, fishing, picnicking, hiking/walking, cross country skiing, a playground, several open shelter houses, clubhouse, maintenance facilities and restrooms. Palmer Park offers 334.7 acres of green space including a beautiful wooded main recreation area popular for group picnics and events.

Ideal Park, City of Wyoming
Ideal Park was initially developed in the 1930's, prior to the incorporation of the city, and is one of the oldest parks within the city. It is located in the southern region of the City, with Buck Creek flowing through the middle of the park. The park has historic structures including an art deco style bridge, a log cabin lodge, and stone structures. Historically, the park has been a gathering site for large group picnics and family reunions. Access to the park is at the end of Crippen Street with large parking areas. A paved pathway provides a connection to the Inter-urban Bike Trail. In April of 2013, the park experienced significant flooding that resulted in the loss of playability on the park's tennis and basketball courts. In July 2014, the park was hit by a tornado, resulting in the loss of over 90% of the park's trees, many of which were 100 to 300 years old, and the destruction of the playgrounds and picnic section areas.

Douglas Walker Park, Kent County Parks
Douglas Walker is one of the most active parks in the Kent County system. The park is very popular for picnic and shelter reservations and sees considerable use by field sports including soccer and rugby. The park is 81 acres in size, with a 20-acre undeveloped natural area. The park also serves as a trailhead for the east branch of Kent Trails, with a trail link entering the park at the northwest corner and crossing Buck Creek on the main service drive.

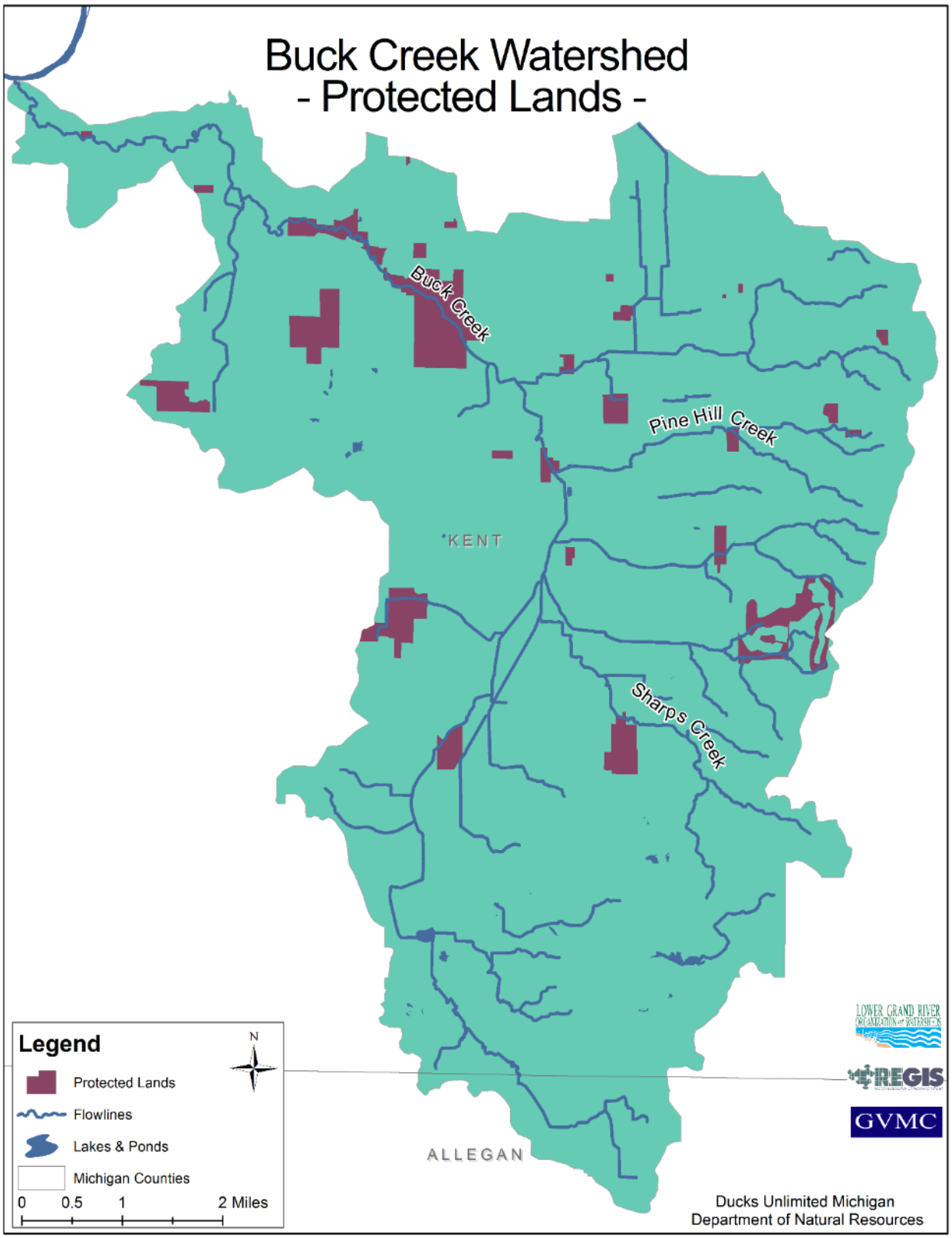

Figure 19. Government Protected Land

3.11 Political Jurisdictions

The local government entities (Kent and Allegan Counties, Cities of Kentwood, Wyoming, Grand Rapids and Grandville and Townships of Byron, Gaines, Dorr and Leighton) located within the BCW are illustrated below. Policies of local governments, as they relate to water quality, are discussed in Chapter 7.

In addition to the county, city, and township governments, state agencies with regulatory oversight include EGLE and MNDR. EGLE works to enforce federal and state environmental protection laws. EGLE 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, EGLE 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 Allegan County Health Department (ACHD) are the oversight agencies responsible for permitting onsite well and septic system installations.

County Road and Drain 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.

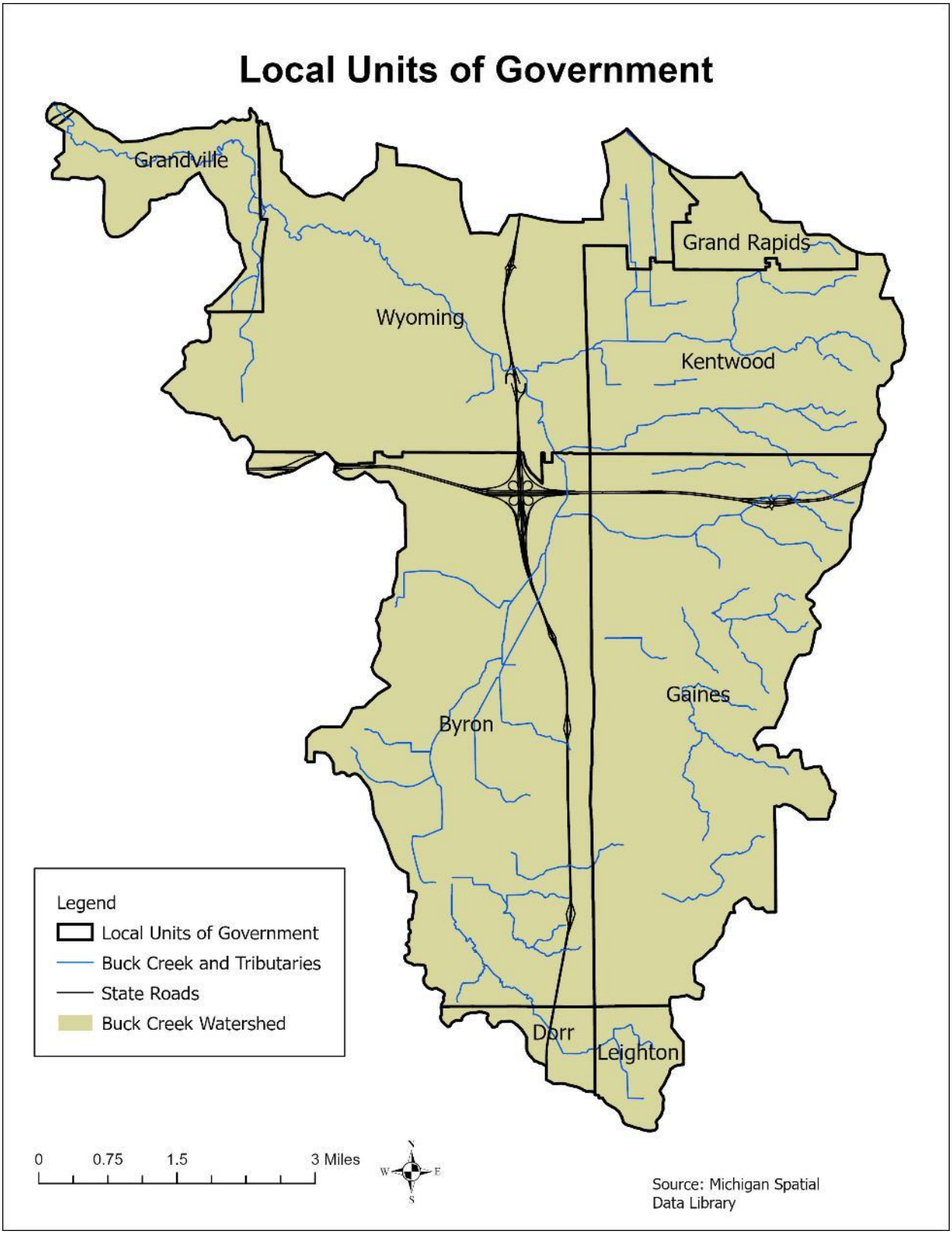

Figure 20. Local Units of Government

Table 3. Political Jurisdictions

Cities by County		Townships by County	
Kent County	**Allegan County**	**Kent County**	**Allegan County**
City of Grand Rapids		Byron Twp.	Dorr Twp.
City of Grandville		Gaines Twp.	Leighton Twp.
City of Kentwood			
City of Wyoming			

4.0 SUMMARY OF WATER QUALITY IN THE BUCK CREEK WATERSHED

This chapter describes the standards by which the State of Michigan determines water quality and how the water quality within the BCW compares to those standards.

4.1 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 meet WQS to provide eight designated uses. These **designated uses**, specified in Part 4 Rules issued in accordance with Part 31 of the NREPA (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 United States Army Corps of Engineers (USACE) definition of navigation (eg. Commercial shipping) is not considered to be a designated or desired use of the BCW.
- *Warmwater/coldwater fishery* – Water bodies designated as warmwater (WW) fisheries should be able to sustain populations of fish species. Water bodies designated as coldwater (CW) 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 EGLE to determine if a waterbody is attaining certain WQS and 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 will be noted as such in this WMP. Once waterways are listed as impaired, EGLE is required to develop a Total Maximum Daily Load (TMDL) for the corresponding waterway(s) and its watersheds. A TMDL is the maximum amount of a particular pollutant a water body can assimilate without violating numerical and/or narrative WQS. Each TMDL reach identified by EGLE is identified by a unique Assessment Unit Identification (AUID) number. It is important to note that not all subwatersheds or waterbodies are assessed by EGLE on a regular basis, thus, if a waterbody is not listed as impaired it does not mean that it is meeting all WQS; it may not have been assessed.

The WQS for pollutants measured and/or present in this watershed are listed in Table 4. For pollutants that do not have established WQS, including total phosphorus, ammonia, nitrates and nitrites and Total Kjeldahl Nitrogen (TKN), comparison values based upon USEPA Ecoregion data are used instead (Table 5). BCW is within the Southern Michigan/Northern Indiana Drift Plains (SMNIDP) Ecoregion VII. Finally, for Total

Dissolved Solids (TDS), which do not have WQS or USEPA comparison values, WQS for “point source discharges” were used for general comparison (Table 6).

Table 4. Water Quality Standards Used to Assess Pollutants of Concern

Parameter	Target Value	Units	WQS or Comparable	Type	Source
Escherichia coli (*E. coli)*	130	cfu/100 mL	WQS	Total Body Contact Recreation in all waters of the state. Calculated as a 30-day geometric mean from 5 or more sampling events.	EGLE Water Bureau Water Resources Protection. (2006, January 13). Part 4 Water Quality Standards
E. coli	300	cfu/100 mL	WQS	Total Body Contact in all waters of the state	EGLE Water Bureau Water Resources Protection. (2006, January 13). Part 4 Water Quality Standards
E. coli	1,000	cfu/100 mL	WQS	Partial Body Contact in all waters of the state	EGLE Water Bureau Water Resources Protection. (2006, January 13). Part 4 Water Quality Standards
Chloride	150	milligrams /Liter (mg/L)	WQS	Final Chronic Value	EGLE Water Bureau Water Resources Protection. (2019 Update). Part 4 Water Quality Standards
Chloride	320	mg/L	WQS	Aquatic Maximum Value	EGLE Water Bureau Water Resources Protection. (February, 2021 Update). Part 4 Water Quality Standards
Chloride	640	mg/L	WQS	Final Acute Value	EGLE Water Bureau Water Resources Protection. (February, 2021 Update). Part 4 Water Quality Standards
Water Temperature	68	Deg. F July mean	WQS	Coldwater Fishery	EGLE Water Bureau Water Resources Protection. (2006, January 13). Part 4 Water Quality Standards.
Dissolved Oxygen	7	mg/L	WQS	Waters connected to Great Lakes. Inland waters protected for coldwater fish	EGLE Water Bureau Water Resources Protection. (2006, January 13). Part 4 Water Quality Standards.
Dissolved Oxygen	5	mg/L	WQS	All other waters	EGLE Water Bureau Water Resources Protection. (2006, January 13). Part 4 Water Quality Standards.

Table 5. Comparable Values Used to Assess Pollutants of Concern

Parameter	Target Value	Units	WQS or Comparable	Type	Source
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)	0.031	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 (TSS)	30	mg/L	C	Informal target	EGLE Surface Water Quality Division. (2002, July). Total Maximum Daily Load for Biota for Plaster Creek Kent County, Michigan
Total Kjeldahl Nitrogen (TKN)	0.24	mg/L	C	Ambient WQ criteria recommendations; 25th percentile of region stream population	US EPA Office of Water Office of Science and Technology Health and Ecological Criteria Division. (2000, December). 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.
Nitrite (NO2-) and Nitrate-(NO31) 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 822-B-00-018). Washington D.C.
Chloride	640,000	ug/L	C	Final Acute Value	Michigan EGLE Chloride and Sulfate Water Quality Values Implementation Plan. 2019.
Chloride	320,000	ug/L	C	Aquatic Maximum Value	Michigan EGLE Chloride and Sulfate Water Quality Values Implementation Plan. 2019.
Chloride	150,000	ug/L	C	Final Chronic Value	Michigan EGLE Chloride and Sulfate Water Quality Values Implementation Plan. 2019.

Table 6. Point Source Target Values Used to Assess Pollutants of Concern

Parameter	Target Value	Units	WQS or Comparable	Type	Source
Total Dissolved Solids (TDS)	500	mg/L monthly avg	WQS	Point Source	EGLE Water Bureau Water Resources Protection. (2006, January 13). Part 4 Water Quality Standards.
TDS	750	mg/L at any time	WQS	Point Source	EGLE Water Bureau Water Resources Protection. (2006, January 13). Part 4 Water Quality Standards.

4.2 Impaired and Threatened Designated Uses in the Buck Creek Watershed

4.2.1 Impaired Designated Uses

The 2020 Integrated Report lists the designated uses of Partial and Total Body Contact Recreation (PBC and TBC) as being impaired due to *E. coli* contamination, and the designated use of Fish Consumption as being impaired by mercury and PCB contamination; because all waters of the state are impaired for Fish Consumption, these AUIDs are not included in the following table of figure (EGLE 2020). The warm and coldwater fisheries and habitat for other indigenous aquatic life and wildlife were not assessed.

Table 7. Areas of Impaired Designated Uses

Location	Size	Impaired Use	Cause
Sharps Creek- Buck Creek 040500060508-01	33.6 miles	Total Body Contact Recreation	*E. coli*
Sharps Creek- Buck Creek 040500060508-01	33.6 miles	Partial Body Contact Recreation	*E. coli*
Buck Creek 040500060510-01	35.8 miles	Total Body Contact Recreation	*E. coli*
Buck Creek 040500060510-01	35.8 miles	Partial Body Contact Recreation	*E. coli*
Buck Creek 040500060510-02	11.4 miles	Total Body Contact Recreation	*E. coli*
Buck Creek 040500060510-02	11.4 miles	Partial Body Contact Recreation	*E. coli*

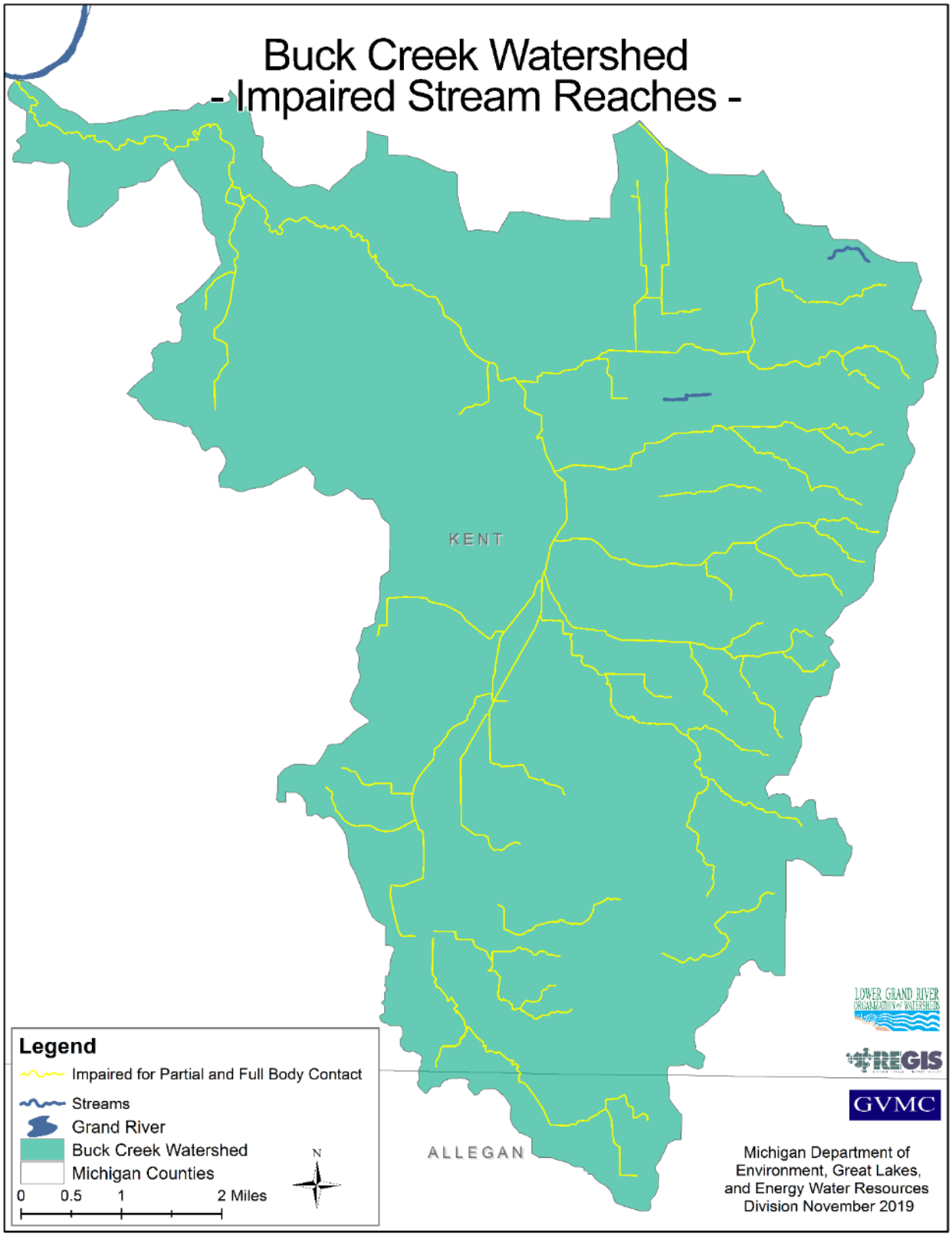

Figure 21. *E. Coli* TMDL and Impaired Areas

Partial and Total Body Contact 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. In order to meet the TBC recreation standard, 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 (three 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. The limit for the PBC recreation standard is a geometric mean of 1,000 *E. coli* per 100 mL water for any single sampling event at any time of the year (MDEQ, 2006).

The presence of *E. coli* in quantities greater than the WQS is impairing the designated uses of PBC and TBC water recreation in the BCW. The data indicate that *E. coli* contamination of the BCW is widespread and on-going:

- In 2006, a Total Maximum Daily Load for *E. coli* was established for an approximately 10-mile reach of Buck Creek (AUID: 04050006) (MDEQ, 2006).
- Schrems et. al. (2017) monitored *E. coli* concentration at twelve sites throughout the BCW. All sites, at some point, had levels that exceeded the water quality standard for TBC. The *E. coli* levels periodically exceeded PBC water quality standard at five of these sites. Generally, lower values were noted at the headwaters and near the outlet of Buck Creek, while the highest values were observed in the most urban portions of the watershed.
- In the 2020 Integrated Report, 80.8 miles of stream in the BCW are listed as impaired by PBC and TBC (EGLE 2020).
- *E. coli* data was collected in the BCW (2019) as a part of this watershed management planning process. Methods for data collection are found in the Quality Assurance Project Plan (QAPP) in Appendix A.
    - *E. coli* Concentration Sampling was completed at 16 sites throughout the BCW, on four separate occasions (two dry-events and two wet events).
        - All 16 sites exceeded WQS for PBC on at least one occasion.
        - All 16 sites exceeded WQS for TBC on at least one occasion.
        - Only five sites met WQS, and all five only met WQS during one sampling event.
        - Of 64 total samples collected, 58 (91%) exceeded WQS for TBC and 41 (64%) exceeded WQS for PBC.
    - Microbial Source Tracking (MST) was analyzed for the presence of bovine, horse, human, and canine host-specific bacteria using target DNA markers following one dry-weather events, and one wet-weather event.
        - Human was consistently the most prevalent source.
        - At four sites that included analysis for the canine marker, canine was the second most prevalent source.
        - Equine sources were second most prevalent source, except at sites that were tested for canine, in which equine was the third most prevalent.
        - Bovine was the source typically prevalent in the lowest quantities, or not at all.
    - Canine source tracking was also used in 2020 to track human sources of bacteria, at locations also analyzed by MST in dry weather conditions. Results are included here and in Appendix C.

Fish Consumption

Like all surface waters in Michigan, Buck Creek and its tributaries are considered impaired due to mecury and/or PCBs in the water column and/or fish tissue, which affects fish consumption. A statewide TMDL for Mercury was completed in 2013 by the MDEQ, and was approved by US EPA in 2019. Due to the ubiquitous

nature of these contaminants and their propensity to overlap watershed boundaries, data collection on, and the remediation of, these pollutants are not addressed in this WMP.

4.2.2 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 is trending toward not meeting its designated use is considered threatened. Through literature review, site investigations, data collection and stakeholder input, a variety of designated uses were identified as threatened in the BCW and are discussed below.

Habitat for Indigenous Aquatic Life and Wildlife

Surface waters must support native aquatic life and wildlife that use the water for any stage of their life cycle. This designated use is being threatened in the BCW because sediment, altered hydrology and nutrients are degrading several streams within the watershed.

- The MDNR (1992) biological survey report on Buck Creek found the macroinvertebrate communities were degraded at all survey stations, ranging from poor (severely impaired) to fair. Overall stream quality of Buck Creek was rated poor to fair. Sedimentation was identified as contributing to the severe impact on the macroinvertebrate communities. The report stated that stormwater runoff was causing flashy flows, which were impacting the macroinvertebrate communities by periodically scouring the streambed. The urbanization of the BCW is accelerating sedimentation and flow fluctuations from stormwater runoff, which causes impairments to the physical habitat conditions.
- MDEQ completed biological assessments of Buck Creek at 76th Street, Byron Center Ave., and Ivanrest Ave. in 2009 (MDEQ, 2011). The habitat was rated as marginal (moderately impaired) at Ivanrest and 76th Street.
- Schrems et. al. (2017) reported that water chemistry parameters, including ammonia, total dissolved solids, nitrate and nitrite, Total Kjeldahl Nitrogen and chloride, appear to be problems throughout the watershed, since they exceed WQS or regional comparison values. Elevated concentrations of phosphorus are of major concern in the upper watershed. Low concentration of dissolved oxygen was also documented. Specifically:
    - At some point during sampling, ammonia levels at all twelve sites exceeded the regional comparison values.
    - Approximately 97.5% of the total dissolved solids data exceed 250 mg/L. Total dissolved solids for healthy lakes and streams commonly range from 50 to 250 mg/L.
    - The highest chloride value (251.7 mg/L) exceeds WQS for chronic toxicity.
    - All twelve sites had average nitrate and nitrite values that exceeded comparison values.
    - The rural areas, upstream and south of Byron Center, had phosphorus values from six to 13 times higher than the urban sites. These rural sites had average phosphorous results that exceed comparison values.
    - All twelve sites had average Total Kjeldahl Nitrogen (TKN) values that exceeded comparison values.
    - Only 13.9% of the dissolved oxygen data was at, or greater than, the WQS of 7.0 mg/L for coldwater streams.
    - Approximately 59.6% of the dissolved oxygen data was above the minimum 60% saturation threshold. Less than 1% of the data fell within the range considered excellent for fish and aquatic organisms.
- TU National reported spikes in conductivity that were most likely due to excessive chloride.

Warmwater/Coldwater Fishery

Buck Creek and its tributaries are currently listed as designated trout streams (coldwater fisheries) and have been stocked with brown trout for several years by the MDNR. Designated trout streams are expected to sustain populations of coldwater fish species, including trout, and meet the WQS for water temperature (<68°F) and dissolved oxygen (>7 mg/L).

- MDNR considered discontinued stocking of brown trout due to elevated stream temperatures and degraded habitat, but feedback from concerned anglers resulted in continuation of the program.
- Schrems et. al. (2017) placed water temperature loggers at sites throughout the BCW and found:
    - The upper reaches of Buck Creek appear to be managed strictly as agricultural drain, with little regard for ecological communities or processes. The water temperatures associated with this upper section are very high, but cool rapidly as the stream receives cooler water from Mink Creek and the Hudson Drain in the vicinity of 100th Street.
    - Buck Creek at Ivanrest and Carlisle Drain are pushing the upper limit for trout and slight warming could make these stream reaches too warm.
    - At several sites, the maximum July water temperatures could negatively impact trout populations, especially if colder water refuges, such as springs or groundwater seeps, are scarce or not accessible.
    - Data support the suggestion that the coldwater fishery is threatened by water temperature in several reaches and impaired near Lemery Park.
    - In addition to elevated water temperature, reasons for threats or impairments to the coldwater fishery might include degraded water quality and/or physical habitat. Results of monitoring indicate that the stream is flashy and impacted by excessive sediment. Data shows that levels of dissolved oxygen and total dissolved solids are far from ideal for supporting a high-quality aquatic community, and could be limiting the survival of sensitive aquatic species.

4.3 Desired Uses

Resources that are not listed as a designated use in the Part 4 Rules may still have significant local importance. These “desired uses” have been identified as important to the watershed community (LGROW partners, personal communication on January 22, 2020):

- Educational uses by local schools, including the Salmon in the Classroom Program, are threatened by excessive pathogens that prevent safe contact with the stream. As discussed, PBC is impaired due to violations of WQS.
- Passive recreation, such as walking next to, and enjoying the scenic views of the stream are threatened by an excessive volume of trash and debris. Despite the efforts by Schrems and FOBC to remove refuse on an annual basis, the BCW continues to be polluted with anthropogenic waste.

4B DETAILED DESCRIPTION OF WATER QUALITY IN THE BUCK CREEK WATERSHED

4B.1 Review of Existing Information

City of Kentwood

Select projects and studies completed by the City of Kentwood are outlined below (Jim Beke, personal communication, November 4, 2019):

- Reconstruction of 13 regional detention ponds/sediment basins;
- Construction of a one storm stage, 350ft long, meander loop bypass to protect sanitary sewer system and streambanks within the Kentwood Jaycee's Park;
- Replacement of four culverts at stream crossings to improve flow including riverbed/biota restoration as part of other municipal public works projects;
- Installation of four inline grade checks and three aerial carrier pipe crossings to minimize exposure from open channel sanitary sewer crossings;
- Reconstructed, dredged, cleaned, stabilized, and/or aligned 5.8 miles of tributary to Buck Creek;
- Working with Kentwood Public Schools to construct an offline sediment basin/wetland complex on the Bowen Elementary School to treat 654 acres of tributary drainage from impervious suburban/metropolitan area on the Paris Drain.

Michigan Department of Environmental Quality

The MDEQ (1992) biological survey report on Buck Creek rated the fish community structure as fair (moderately impaired) to good (slightly impaired). Macroinvertebrate communities were degraded at all survey stations, ranging from poor (severely impaired) to fair. Overall stream quality of Buck Creek was rated poor to fair. The survey rated the physical condition as good to poor, with sedimentation identified as contributing to the severe impact on the macroinvertebrate communities. The report stated that storm water runoff was contributing substantially to flow fluctuations, which were impacting the macroinvertebrate communities by periodically scouring the streambed. The urbanization of the BCW, with increased impervious surfaces, is accelerating sedimentation and flow fluctuations from storm water runoff, which causes impairments to the physical habitat conditions.

MDEQ (2011) completed biological assessments on Buck Creek at 76th Street, Byron Center Ave., and Ivanrest Ave. in 2009 (MDEQ, 2011). All sites had an acceptable rating for macroinvertebrates, with the Byron Center site scoring slightly better than the other two sites. The habitat was rated as marginal (moderately impaired) at Ivanrest and 76th Street, and as good (slightly impaired) at Byron Center Ave. Habitat metrics specific to flashiness and sedimentation scored poorly.

Michigan Department of Natural Resources

Stocking of brown trout was cancelled in 2012 due to ongoing degradation of the stream, until feedback from disgruntled anglers reversed this decision (Personal Communication, Scott Hanshue, MDNR Fisheries Biologist (2013)). Currently, the MDNR plans to continue stocking fish in Buck Creek.

Michigan State University

Verhougstraete and Rose (2008) reported that 15 of 16 water samples taken from two stations in the BCW in 2005 and 2006, one from the Crippen Drain and the other from the Heyboer Drain, exceeded the WQS for TBC. In follow-up source tracking, it was reported that the bovine marker was present at both sites*, and a human marker was present in the Heyboer Drain. In the Heyboer Drain, bovine polyomavirus and the

Bacteroides cow marker were found in four of six samples. One of six samples from the Crippen Drain contained the *Bacteroides* cow marker and three of six contained bovine polyomavirus.

*It has been suggested by project partners that the bovine marker used in this study is now considered to possibly be inaccurate. The site in the study was located in an industrial center.

Schrems West Michigan Chapter of Trout Unlimited

The Buck Creek Monitoring Project (CMI# 2015-0524) report (Schrems 2017) provides detailed information on water temperature, fish communities and water chemistry.

- Water temperature was monitored at 22 sites during 2015 and 2016 and sites were classified based upon average July water temperatures to determine if they are meeting the coldwater designation. Thermal classification of the entire watershed was completed using this data. Based upon the data that was presented, ten of the 22 sites would not meet the water temperature WQS for a coldwater stream (<68°F).

Table 8. Results of Water Temperature Monitoring, 2015-2016

				July Water Temp (F)		
Site ID	Stream	Road	Classification	Mean	Maximum	Meeting Coldwater Designation (<67.1 F mean)
1DS	Buck Creek	Chicago Drive	Cool	69.6	76.3	No
2WCT	Buck Creek	Canal	Cool	67.5	74.5	No
3WCT	Buck Creek	Ivanrest	Cold-Transitional	66.8	72.1	Yes
4WCT	Buck Creek	Burlingame	Cold-Transitional	65.7	71.6	Yes
5WCT	Heyboer Drain	Division	Cool	67.9	79.1	No
6WCT	Buck Creek	Clay	Cold-Transitional	65.0	73.0	Yes
7WCT	Crippen Drain	Division	Warm	70.8	84.1	No
8WCT	Buck Creek	68th	Cold-Transitional	65.3	71.5	Yes
9WCT	Buck Creek Ext. Drain	68th	Cold-Transitional	64.3	74.5	Yes
10WCT	Buck Creek	76th	Cold-Transitional	65.9	73.9	Yes
11WCT	Buck Creek	92nd	Warm	71.9	81.0	No
12WCT	Buck Creek	104th	Warm	71.9	81.0	No
13WCT	Buck Creek	Division	Warm	71.6	83.1	No
15T	Behan and Foley Drain	44th	Cool	69.8	80.5	No
16T	Heyboer Drain	Curwood	Cool	69.6	77.6	No
17T	Cutlerville Drain	Division	Cool	67.6	75.0	No
18T	Sharps Creek	Division	Cold-Transitional	64.2	68.4	Yes
19T	Carlisle Drain	Clyde Park	Cold-Transitional	65.6	77.1	Yes
20T	Hudson Drain	Burlingame	Cool	68.0	76.9	No
21T	Mink Creek	Clyde Park	Cool	69.6	79.7	No
22T	Heyboer Drain	Kalamazoo	Cool	69.6	80.4	No
23T	Buck Creek Ext. Drain	Eastern	Cool	67.4	78.2	No

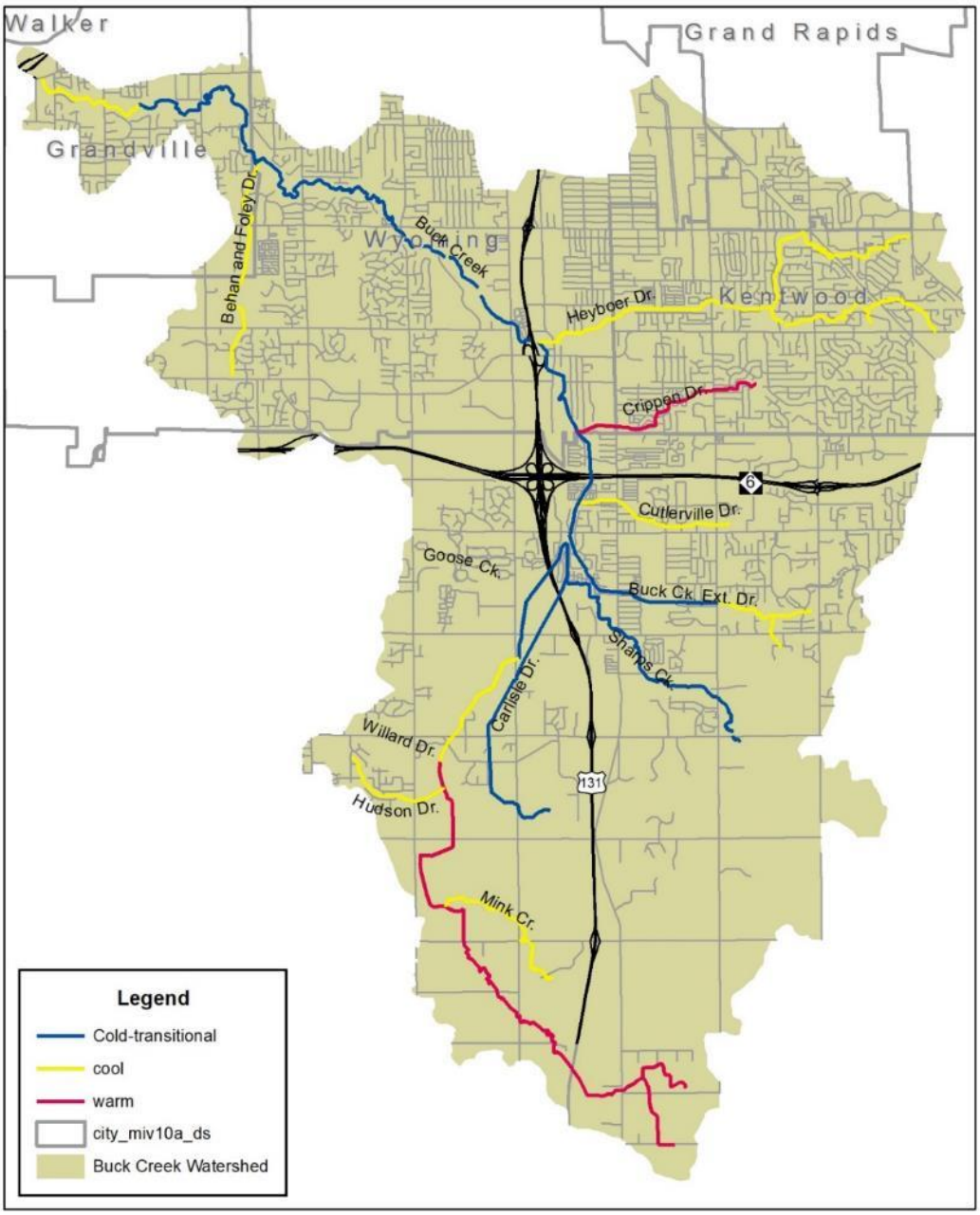

Figure 22. Water Temperature Classification of Buck Creek and Tributaries, 2015-2016

- Five water chemistry data collection events occurred at twelve sites throughout the BCW, on a quarterly basis, from the third quarter of 2015 to the fourth quarter of 2016. Ammonia, bacterial oxygen demand (BOD), chloride, *E. coli,* nitrate and nitrite, total phosphorus, soluble reactive phosphorus, total Kjeldahl nitrogen and total suspended solids were measured at each of the sites. Exceedances of WQS, or comparable values, were documented at all of the sites.

    - *E. coli* appears to be one of the pollutants of greatest concern. *E. coli* concentrations throughout the BCW exceed WQC. The highest values were found within the most urbanized areas of the watershed. The communities where the elevated levels of *E. coli* occurred have sewer use ordinances that mandate connection to the sanitary sewer

system. Thus, it is very unlikely that illicit connections exist where human sewage could be contributing to Buck Creek. Additionally, all MS4 communities in the Lower Grand River Watershed have conducted illicit discharge monitoring at least once in the last five years.

- Excessive nutrients, particularly nitrates, appear to be a ubiquitous problem in Buck Creek. All sites had nitrate/nitrite and TKN values that exceed EPA ambient water quality criteria recommendations. Ammonia levels were also elevated throughout Buck Creek. The nitrate/nitrite and ammonia nutrients had the highest concentration during the summer (June and August) sampling events, indicating that fertilizer runoff is a likely contributor. The TKN results were consistently high throughout the watershed and did not appear to seasonally fluctuate as dramatically as the nitrate/nitrite and ammonia results did. The ammonia, nitrate/nitrite and TKN values remained relatively consistent between the urban and rural areas.
- Phosphorus exceeded WQC in the more rural areas of the watershed, where levels were six times higher than the urban sites, with the most downstream site (13WCT) having an average value that was 13 times higher than those in the urban area. Seasonality does not seem to play a part in the phosphorus concentrations as almost no fluctuation was seen within each site. It is presumed that agricultural inputs are responsible for the phosphorus pollution. Excessive phosphorus can fuel nuisance growth of algae and macrophytes, which are both readily apparent in the stream south of Byron Center Road.

Table 9. Results of Nutrient Sampling, 2015-2016

Site ID	Stream	Road	Exceeds WQC or comparison value
2WCT	Buck Creek	Canal	Ammonia; E. coli; nitrate and nitrite; TKN; pH
3WCT	Buck Creek	Ivanrest	Ammonia; E. coli; nitrate and nitrite; TKN
4WCT	Buck Creek	Burlingame	Ammonia; E. coli; nitrate and nitrite; TKN
5WCT	Heyboer Drain	Division	Ammonia; E. coli; nitrate and nitrite; TKN
6WCT	Buck Creek	Clay	Ammonia; E. coli; nitrate and nitrite; TKN
7WCT	Crippen Drain	Division	Ammonia; E. coli; nitrate and nitrite; TKN
8WCT	Buck Creek	68th	Ammonia; E. coli; nitrate and nitrite; TKN
9WCT	Buck Creek Ext. Drain	68th	Ammonia; E. coli; nitrate and nitrite; TKN
10WCT	Buck Creek	76th	Ammonia; E. coli; nitrate and nitrite; phosphorus; TKN
11WCT	Buck Creek	92nd	Ammonia; E. coli; nitrate and nitrite; phosphorus; TKN
12WCT	Buck Creek	104th	Ammonia; E. coli; nitrate and nitrite; phosphorus; TKN
13WCT	Buck Creek	Division	Ammonia; E. coli; nitrate and nitrite; phosphorus; TKN

- A Hydrolab Data Sonde 4A was installed in Buck Creek at Canal Avenue, to monitor water temperature, pH, dissolved oxygen (mg/L and % saturation), specific conductivity and total dissolved solids at 15 minute intervals. This unit was deployed for approximately 19 weeks from April 15, 2016 to August 26, 2016.
    - The minimum daily water temperature occurred between approximately 8:00 am to 10:00 am. The maximum daily water temperature occurred late afternoon to early evening. Short term water temperature spikes routinely occurred during and immediately following a rainfall event.
    - The peak dissolved oxygen concentrations typically occurred early afternoon. The minimum dissolved oxygen concentrations occurred during overnight shortly after midnight. Only 13.9% of the dissolved oxygen data was at, or greater than, the Michigan minimum dissolved oxygen water quality standard of 7.0 mg/L.
    - Dissolved oxygen percent saturation values within the range of 80% to 120% are considered excellent for fish and aquatic organisms. Values less than 60% or greater than 125% are considered harmful and indicative of degraded water quality. Approximately 59.6% of the dissolved oxygen data was above the minimum 60% saturation threshold. Less than 1% of the data fell within the range considered excellent for fish and aquatic organisms.
    - Total dissolved solids for healthy lakes and streams commonly range from 50 to 250 mg/L. Approximately 97.5% of the total dissolved solids data exceed 250 mg/L. The elevated total dissolved solids is likely due to elevated chlorides in groundwater, since quarterly laboratory data are indicative of an increasing chloride concentration trend heading downstream, and the highest total dissolved solids concentrations occur during baseflow conditions. The most likely source of chlorides is the use of road salt during the winter months.
- Fish surveys were completed on the mainstem of Buck Creek at the Grandville Cemetery and at Lemery Park, on October 13 and 14, 2015.
    - At the cemetery site, the population estimate was 1,549 trout per mile of stream (420 trout/acre). Trout ranged from three to 15 inches in size, with about 22% of fish being at least eight inches in length, the legal size for harvest. Most trout (56%) were six to eight inches in length. Four trout were under five inches and presumed to be wild based upon their small size relative to the initial size of stocked trout. About 7% of the trout collected were presumed to be at least two years of age, based upon their larger size. Twenty-one other species of fish were collected at the site, with a diverse mix of cold, cool and warmwater species. White sucker was the dominant species.
    - At Lemery Park, only six brown trout and three rainbow trout were captured during the marking run – too few to complete a reliable population estimate. Brown trout were, on average, larger in size than those at the cemetery and likely greater than one year old. Only nine species of fish were collected and the community was dominated by approximately equal numbers of white sucker, round goby, mottled sculpin and johnny darter. Overall, numbers and diversity of fish seemed low for the relatively high-quality habitat.
- Procedure No. 51 physical habitat assessments were also conducted at Lemery Park and the Grandville Cemetery.
    - At Lemery Park, epifaunal habitat is relatively abundant and diverse in the form of woody debris and vegetation. Substrate is impacted by fine sediments, though a bit of gravel and manmade riffles do exist. Deep holes with overhanging banks and debris jams provide excellent cover. Flow appeared to be very flashy and, along with excess sedimentation,

appears to be the primary reason for degradation of this site. The stream corridor is quite natural on the north bank and upstream of the maintained park area. Within the park, parking lot runoff and erosion from foot traffic are evident.

- The Grandville Cemetery is bordered by residential development on the upstream side, and associated impacts to the riparian corridor are prevalent. The southern stream bank, however, is in natural condition and contains many mature trees that help shade the stream. Overall, the habitat at the cemetery is slightly better than that at Lemery Park. A nice combination of riffles, runs and both shallow and deep pools are present. Overhanging vegetation and woody debris harbored many fish. The stream appears to be flashy here as well, but is better equipped to handle high flows due to accessible floodplains. The impacts of fine sediment are not as profound as the park site.

Schrems attempted to gather information on work that has been accomplished since approval of the existing WMP in 2003.

- Friends of Buck Creek and Schrems TU have hosted annual river cleanups since 2015 and the number of volunteers has grown to well over 100. More than 60 garbage bags full of trash have been collected on an annual basis, along with dozens of tires and even some appliances.
- The Cities of Wyoming and Kentwood have implemented many of the managerial BMPs that were recommended to address urban stormwater issues. Kentwood is requiring a 50-foot buffer along Buck Creek and its tributaries, is promoting and requiring stormwater detention for new developments, and has been actively involved in public education through distribution of information to its residents. Representatives from all of the cities in the watershed are involved with the Lower Grand River Organization of Watersheds.

Spicer Group

The Spicer Group (2006) completed a master plan for drain maintenance within the City of Kentwood. Drains within the BCW include the Heyboer and Crippen Drains, and their tributaries. Specific to these drains, Spicer Group observed many areas of moderate to severe bank erosion, head cutting of steep stream beds, erosion associated with storm sewer and tile line outlets, drain blockages due to logs and debris (including refuse) and excessive sedimentation.

Trout Unlimited – National

In February, 2020, a real-time monitoring station (Buck Creek (BuckCreekWA_1) (monitormywatershed.org) reported significant spikes in conductivity. Jacob Lemon, Eastern Science Coordinator for Trout Unlimited National, reported that the station recorded conductivity levels up to nearly 2,500 us/cm. According to Lemon, these spikes were almost definitely the result of snowmelt washing road salt into the stream, and were high enough to negatively impact fish and macroinvertebrates (Jacob Lemon, personal communication, March 5, 2020.

City of Wyoming

Since participating in the Schrems (2017) study of the BCW, the City of Wyoming has continued to collect water chemistry data (ammonia, BOD, chloride, *E. coli*, nitrite, nitrate, pH, phosphorus, TSS) from 12 sites, on a quarterly basis. This data is available on the LGROW Data Repository (http://regis-apps-login.gvmc-regis.org/mlgrowdr). From 2018 to the present, the data indicates that ammonia, chloride, *E. coli*, phosphorus and the nitrogen components have continued to remain higher than the comparable values over the course of the year, at most sites. Chloride exceeded the Aquatic Maximum Value at Burlingame. Total suspended sediment appears to be a problem at 104th Street. It is clear from the data that the sites in the tributaries and upper BCW are more contaminated than the sites on lower Buck Creek; dilution is a likely factor in this observation.

4B.2 Studies Completed as part of Watershed Management Planning

***E. coli* concentration sampling**

Sixteen *E. coli* sampling locations were selected to determine the extent of contamination throughout the BCW. Sites were selected to provide data for the mainstream of Buck Creek, along with major tributaries, and to assist with identification of sources and causes of pollution. Each site was sampled on four separate dates in 2019: June 25, August 20 and 27, and September 30. The first two events were considered "dry" events, and the second two were considered "wet" events (>0.25" of rain in previous 12 hours or >0.5" of rain in previous 24 hours). More detailed methods and information regarding this sampling work can be found in the QAPP in Appendix A.

Table 10. *E. coli* Monitoring Sites, 2019

SITE ID	STREAM	ROAD	SURFACE WATER (*E. coli*)	LAT	LONG
BCW3	Buck Creek	Ivanrest	4 Events	42.9022	-85.7437
BCW4	Buck Creek	Burlingame	4 Events	42.8838	-85.7052
BCW5	Heyboer Drain	Clay	4 Events	42.8679	-85.6757
BCW6	Buck Creek	Clay	4 Events	42.8638	-85.6760
BCW7	Crippen Drain	Division	4 Events	42.8561	-85.6636
BCW8	Buck Creek	68th	4 Events	42.8398	-85.6732
BCW9	Cutlerville Drain	Division	4 Events	42.8454	-85.6637
BCW10	Buck Creek Ext. Drain	Division	4 Events	42.8323	-85.6635
BCW11	Buck Creek	92nd	4 Events	42.7973	-85.6954
BCW12	Buck Creek	100th	4 Events	42.7826	-85.6936
BCW13	Buck Creek	Division	4 Events	42.7614	-85.6633
BCW15	Behan and Foley Drain	44th St	4 Events	42.8847	-85.7348
BCW18	Sharps Creek	Division	4 Events	42.8269	-85.6635
BCW19	Carlisle Drain	Clyde Park	4 Events	42.8204	-85.6830
BCW20	Hudson Drain	Burlingame	4 Events	42.8027	-85.7031
BCW21	Mink Creek	Clyde Park	4 Events	42.7856	-85.6830

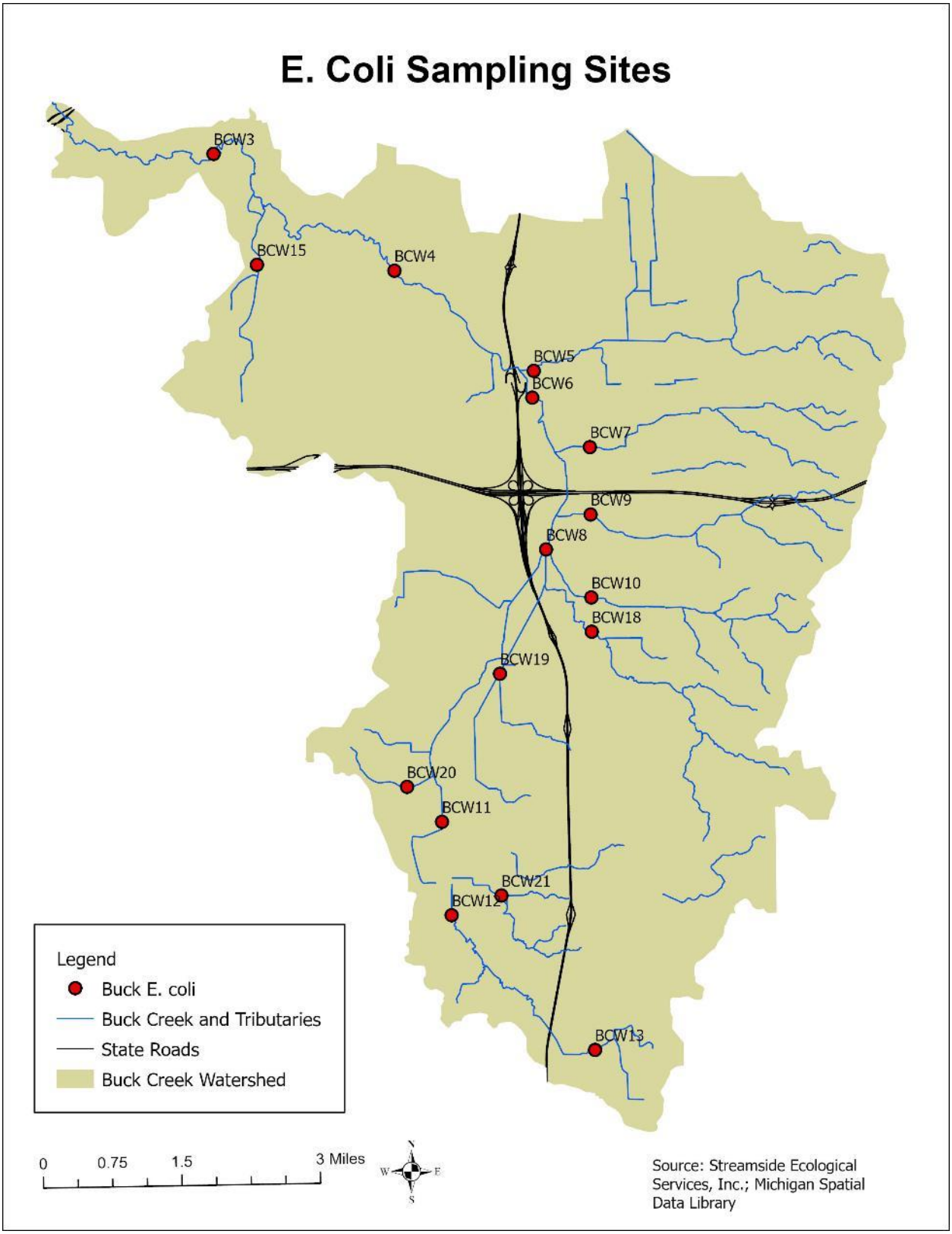

Figure 23. *E. coli* Monitoring Sites, 2019

On June 25, geomeans for *E. coli* ranged from 469 to 2,420 cfu/100 ml (2,420 was the maximum laboratory value on this date). Every site violated the WQS for TBC, and 12 sites exceeded the WQS for PBC. This sampling occurred during a dry-weather period, though 0.13" of rain fell in the previous 24 hours and the stream levels were approximately 18" above baseflow conditions (as measured at BCW3).

The sites were again sampled on August 20, during a dry-weather period and no precipitation during the previous 24 hours. Stream levels were approximately 25.5" above baseflow. Site geomeans ranged from 169 to 2,458 cfu/100 ml. This is the only sampling event where results indicated that any of the sites were meeting WQS; results for six of the sites (3, 9, 11, 12, 20 and 21) fell below the WQS of 300 cfu/100 ml. Ten sites exceeded the WQS for TBC and two of those sites (5 and 13) also exceeded the WQS for PBC.

A week later, August 27 was a wet-weather sampling event, since 0.43" of rain fell in the previous 24 hours. This is the only rain that fell since the previous sampling event. At BCW3, the stream level was about 8.5" lower than on August 20, at 17" above baseflow. All 16 sites exceeded the WQS for TBC and 15 of the sites exceeded the WQS for both TBC and PBC. Site 11 had the lowest concentration at 365 cfu/100 ml, while Site 18 had the highest concentration at 20,271 cfu/100 ml.

The final samples were collected on September 30, when the stream was near baseflow, despite this being a wet-event with 0.75" of rain falling in the previous 24 hours. Because the Hudsonville MSU Enviroweather station was down on this date, data was obtained from the Standale station. It is possible that less rain fell within the BCW. Regardless, all 16 stations exceeded the WQS for TBC and 11 of the stations exceeded the WQS for both TBC and PBC. Results ranged from 358 cfu/100 ml at Site 10 to 4,023 cfu/100 ml at Station 18.

Table 11. *E. coli* Monitoring Results, 2019

Site ID	06/25/19 Geometric Mean (cfu/100 ml)	08/20/19 Geometric Mean (cfu/100 ml)	08/27/19 Geometric Mean (cfu/100 ml)	09/30/19 Geometric Mean (cfu/100 ml)
BCW 3	2,266	197	6,368	1,437
BCW 4	2,087	330	6,017	1,218
BCW 5	1,215	1,087	4,978	431
BCW 6	2,087	422	18,940	1,025
BCW 7	2,420	897	6,389	1,531
BCW 8	1,752	393	11,556	1,724
BCW 9	2,166	229	4,105	806
BCW 10	1,613	990	2,231	358
BCW 11	802	169	365	2,915
BCW 12	2,266	289	8,896	1,956
BCW 13	2,420	2,458	1,455	3,136
BCW 15	469	399	2,589	645
BCW 18	2,420	399	20,271	4,023
BCW 19	983	332	2,733	626
BCW 20	2,420	261	2,154	1,058
BCW 21	1,553	175	5,684	2,232

Meets WQS
Exceeds TBC
Exceeds TBC and PBC

Aerial and Windshield Survey

Aerial and windshield surveys were completed to help identify possible sources of *E. coli* contamination, sediment and nutrient input and any other nonpoint sources and causes. The surveys followed a QAPP using protocols established by EGLE. Basically, a desktop analysis was conducted using high-resolution aerial photographs and field data was collected by driving the entire BCW. Review of aerial photography resulted in identification of farms, land use patterns and potential sources of pollution, some of which cannot be seen from the roads. The windshield survey entailed driving all of the roads and taking notes on land management practices, locations of farms housing large animals, estimating the number of large animals at each farm, streambank erosion, etc.; all survey work was conducted from public roadways. In some cases, additional inspection of areas, such as streams on state-owned land or legally accessed stream reaches, were completed on foot.

Based upon these surveys, there are approximately 19 animal feeding operations, with an estimated 135 cattle and 46 horses. It must be noted that this is only an estimate, since not all animals are visible from the road, many reside indoors at all times, etc. Importantly, though, the locations, relative size and proximity to surface waters can be mapped to provide information useful for improving water quality. As well, any sites where questionable land use practices, such as allowing direct livestock access or runoff to surface water, can be identified.

Several areas of excessive streambank erosion or unstable stream channels were also documented. Channel instability was determined to be a severe problem, leading to a walking survey of over 12 miles of channel, from 84th Street to the Grand River, to document specific sites and to collect data necessary for load estimates. In addition, poor management of the riparian area was noted. All of these locations are discussed in greater detail in Chapter 6.

While these surveys can be useful for identifying some sources of pollution, they are obviously not intended to document all nonpoint sources of pollution and do have limitations, including areas not easily spotted from roadway and sources of pollution that are typically not identifiable through simple one-time observations, such as failing/leaking septic systems, direct sanitary connections to ditch or field tiles, manure spreading or tillage practices. Other potential sources/causes of pollution were identified through other means.

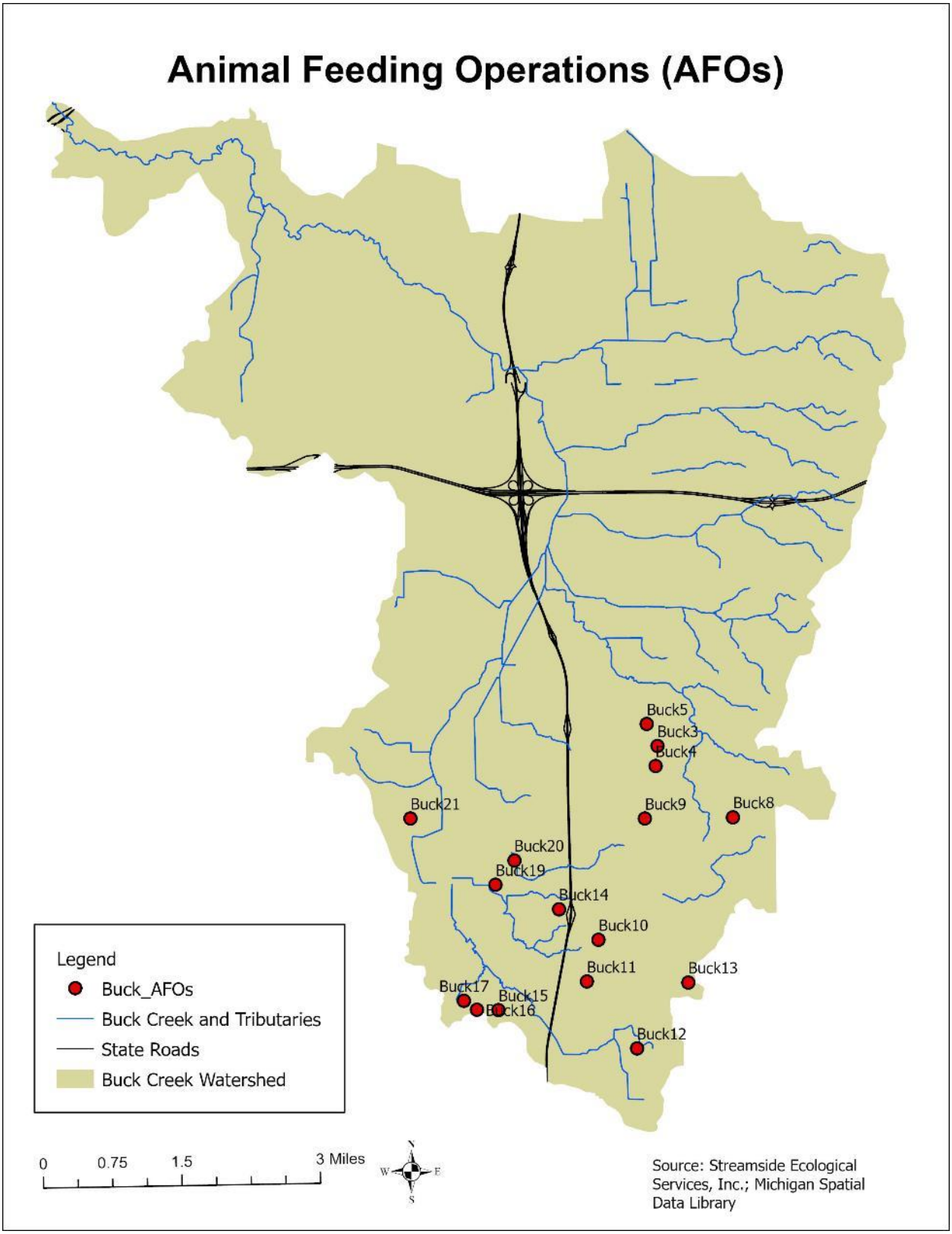

Figure 24. Animal Feeding Operations (AFOs) in the Buck Creek Watershed.

DNA source tracking

Water samples were collected from all 16 sampling stations (Figure 24) on June 25 and August 27, 2019, according to protocols described in the QAPP included in Appendix A. These water samples were sent to Helix Biolab for analysis of DNA to help determine what organisms are contributing to fecal pollution within the BCW. Results of the analysis indicate the presence (positive) or absence (negative) of host source specific DNA markers through PCR amplification of host source specific DNA marker sequences, as well as the proportional quantities of each host source DNA marker in instances where multiple host source DNA markers are detected. A positive result for a host source specific DNA marker at a collection station implies that host source is contributing to fecal contamination that may have been determined at the collection station during the collection period. A negative result for a source specific DNA marker at a collection station implies that host source is not contributing to fecal contamination that may have been determined at the collection station during the collection period. Quantitative MST analysis determines the proportional amounts of each host source specific DNA marker where multiple host source specific DNA markers are detected at a collection site.

The June 25 samples were analyzed for the presence of bovine (cattle), equine (horse) and human DNA biomarkers. In addition, samples within the higher density neighborhood areas associated with Sites 4, 6, 11 and 18 were analyzed for the canine (dog) biomarker. Results indicate that every marker was present at each of the 16 sites. Quantitative analysis shows that the human marker was the most prevalent at all of the sites, suggesting that human fecal contamination of the surface waters is ubiquitous throughout the BCW (Table 12). The human biomarker was followed by equine at all sites, except when canine was also included, in which canine was the secondary source. The human biomarker, however, was found to be four to 85 times more prevalent than the secondary source, and 744 to 23,494 times more prevalent than the source detected in the lowest concentration.

Table 12. Results of *E. coli* Microbial Source Tracking, 2019

	6/25/2019		8/27/2019	
Site ID	**Human to Secondary**	**Human to Lowest**	**Human to Secondary**	**Human to Lowest**
BCW 3	66	10,587	38	55,492
BCW 4	12	1,060	50	24,834
BCW 5	6	1,574	51	3,148
BCW 6	9	21,174	41	2,740
BCW 7	36	3,984	2	25
BCW 8	85	15,393	16	596
BCW 9	25	1,438	33	7,591
BCW 10	11	744	20	7,750
BCW 11	4	2,469	23	891
BCW 12	34	1,468	32	32
BCW 13	22	1,499	5	1,342
BCW 15	23	1,075	62	30,153
BCW 18	10	2,048	206	21,469
BCW 19	70	10,661	25	3,717
BCW 20	20	23,494	11	191
BCW 21	25	923	1	30

Samples collected from the 16 sites during the wet weather event of August 27 were also analyzed for the presence of bovine, equine and human DNA biomarkers. Again, all samples came back as positive for each marker, except for Site 12, which did not contain the bovine biomarker. The human biomarker was dominant at all sites, followed by equine and bovine, except at Site 7 where bovine was secondary and equine tertiary. The human biomarker was from one to 206 times greater than the secondary marker, and from 25 to 55,492 times more prevalent than the tertiary marker.

Canine source tracking

A total of 48 sites were scent-checked by canine Kenna, Environmental Canine Services, LLC., by collecting water samples in approved containers and bringing them to a central, clean location for testing. Of those 48 samples, 37 were positive for human wastewater. In addition, ECS handlers worked four different areas with Kenna on a long leash, to identify sources in the field. While no illicit discharges were discovered, ECS personnel suggested that leaking sanitary sewer lines were likely present in the vicinity of Ivanrest Ave. and John Brewer Drive; this information was shared with the City of Wyoming.

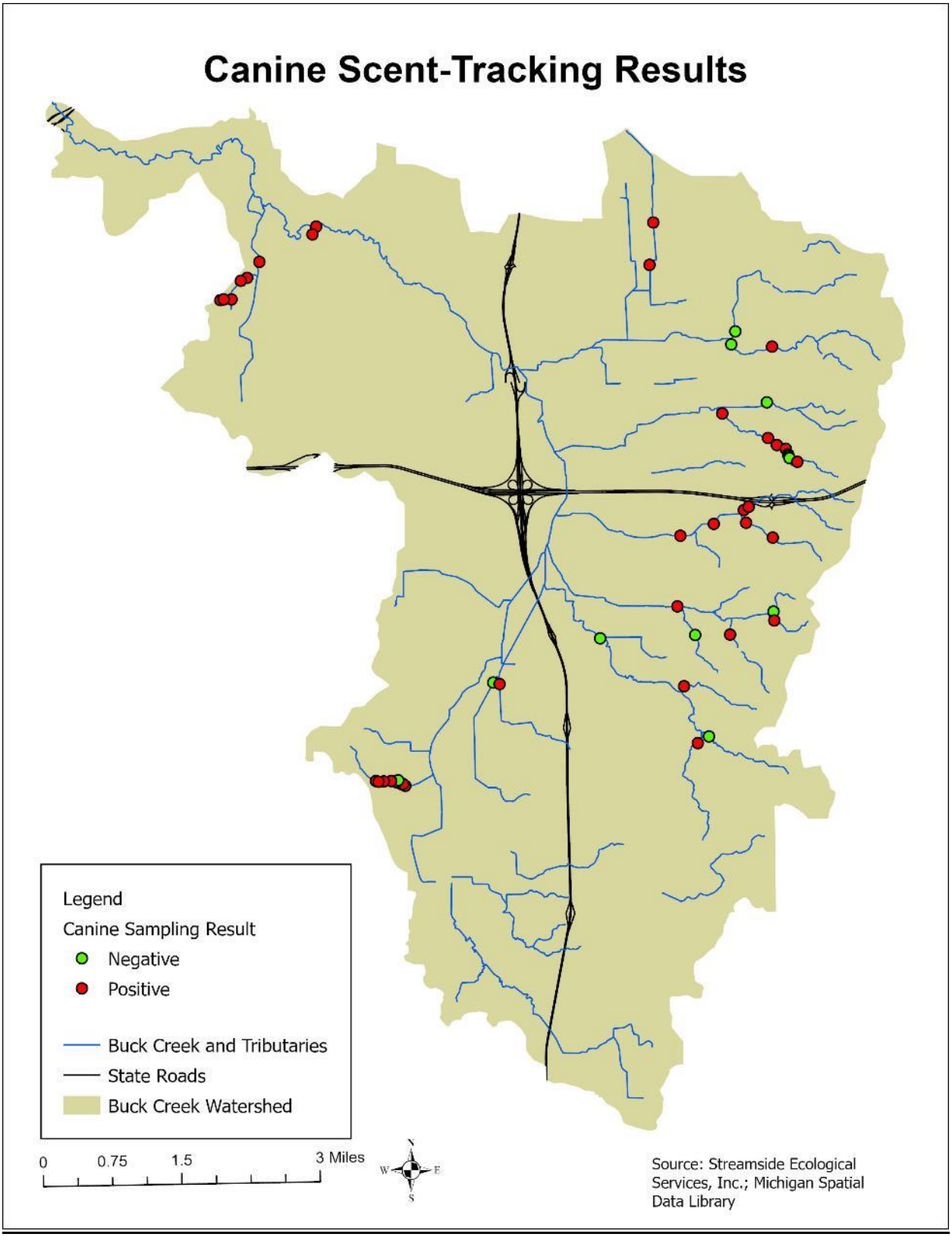

Figure 25. Canine Scent Tracking Results

Mapping of Biosolid and CAFO manure application sites

Since *E. coli* contamination is known to be a problem and human and livestock sources were positively identified during this project, research of existing, publicly-accessible data was conducted to aid in identification of possible pollution sources. Data included the locations of biosolids application sites, as well as permitted CAFO manure application sites; these data were obtained from MiWaters – Water Resources Information and Forms (state.mi.us), and digitized for use in GIS. Class B Biosolids, those that are treated but may still contain detectible levels of pathogens, are permitted to be applied at eight sites in the BCW. CAFO manure is applied to only about ten sites covering about 167 acres in the BCW. A notable shortcoming in the manure application data is the volume of manure that might be manifested from CAFOs to other landowners to be applied elsewhere, and the lack of information available for land application by AFOs.

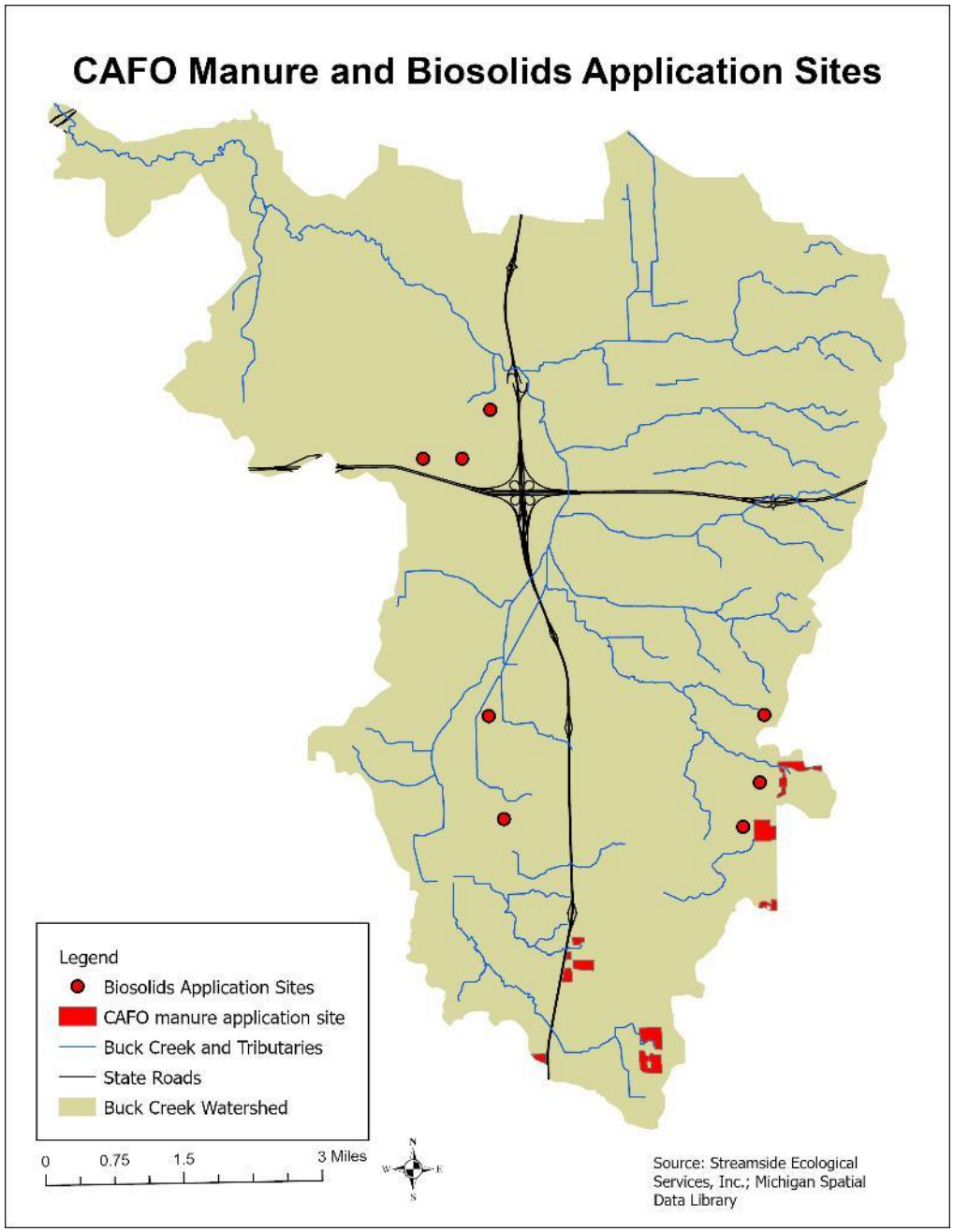

Figure 26. Biosolids and CAFO Manure Application Sites

Landscape Level Wetland Functional Assessment

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. Specifically, 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, therefore, GIS was used to prioritize existing, unregulated wetlands with the functions of pathogen, sediment or nutrient removal, for possible protection. These are:

- Existing wetlands with a pathogen removal, sediment reduction or nutrient treatment function, AND;
- Smaller than six acres in size (Because GIS shapefiles were developed from aerial photography and other desktop services, a one-acre margin of error was used), AND;
- Located greater than 500 feet from an inland lake or stream.

As previously discussed, the BCW has lost 75 percent of its historic wetlands. The restoration 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. High priority wetlands to restore were determined to those where existing land use might allow for restoration; historic wetlands were overlaid on current aerial photography and those that occupied lands that are not completely developed were identified as high priority.

Policy Review

A review was conducted of the municipalities located within the BCW (the City of Kentwood, the City of Wyoming, the City of Grandville, Byron Township, and Gaines Township) to determine which, if any, water quality management regulations and policies have been adopted. All five municipalities had their own zoning ordinances in place. The municipalities had the following additional police power protective ordinances (punishable by legal action, including civil infraction citations, injunctive relief, and/or misdemeanor prosecution, which provides a mechanism to ensure ordinance compliance) in place:

- **City of Kentwood**: Stormwater Management Ordinance & Soil Erosion and Sedimentation Control Ordinance
- **City of Wyoming**: Stormwater Ordinance; Stormwater Discharges Ordinance; & Floodplain Regulations Ordinance
- **City of Grandville**: Stormwater Management Ordinance
- **Byron Township**: Stormwater Management Ordinance
- **Gaines Township**: Stormwater and Illicit Discharge Ordinance

This review indicated potential updates that could be made to the zoning ordinances, other protective police power ordinances, and local government policies in order to provide stronger protections for water quality within the Watershed. It is noteworthy that the Plaster Creek Stewards also reviewed Gaines Township ordinances (https://calvin.edu/dotAsset/26bb96cb-fd0b-43c9-ab8b-ebbda003bfa3).

In implementing these recommendations and any other policies and regulations relating to water quality management, it is important to consider the “downstream” effect of activities within the Buck Creek Watershed. The Buck Creek Watershed is a tributary of the much larger Grand River Watershed, which covers much of the land in southern Michigan. As such, changes to the Buck Creek Watershed are likely to have large impacts on the entire regional watershed.

5.0 POLLUTANTS, SOURCES, CAUSES

5.1 Pollutants

All of the pollutants identified during past studies and described in previous chapters are summarized and prioritized in the tables below. This chapter focuses on these pollutants, along with their sources and causes based on detailed information collected, reviewed and analyzed.

Table 13. Summary of Prioritization of Pollutants Identified

Pollutant	Documented Source
1. Pathogens	MSU (2008); Schrems (2017); EGLE 2020 IR; COW (2020); MDEQ 2006
2. Altered Hydrology/Morphology	MDEQ (1992); Schrems (2017) (WMP)
3. Sediment	MDEQ (1992); GVMC (2003); Spicer (2006); MDEQ (2011); Schrems (2017)
4. Elevated Water Temperature/Reduced Dissolved Oxygen	MDNR; Schrems (2017)
5. Nutrients (ammonia, total dissolved solids, nitrate/nitrite, total phosphorus, TKN, chloride, BOD)	GVMC (2003); Schrems (2017); COW (2020); TUNA (2021)
6. Trash and Litter	GVMC (2003); Spicer (2006); Schrems and FOBC (2021)
7. Mercury and PCBs*	EGLE 2020 IR

*not addressed in this WMP

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 sources and causes of pollution were ranked in priority order according to how they were categorized:

- Known (k) – confirmed and measured through laboratory data or field assessment
- Suspected (s) – observed or reported by a stakeholder but not measured (ranked according to the largest amount of estimated pollution)
- Potential (p) – conditions are suitable for the pollutant to exist (ranked according to the largest amount of estimated pollution)

Table 14. Prioritized Pollutants, Sources and Causes

Pollutant	Source	Cause
1. *E. coli (k)*	1. Humans (k)	1. Aging or improperly maintained septic systems (k)
		2. Illicit Connections/Discharges (k)
		3. Issues with municipal wastewater treatment systems (k)
		4. Over or improper application of biosolids (p)
	2. Livestock (k)	1. Improper application of manure (k)
		2. Improper livestock and manure mangement (k)
		3. Unrestricted livestock access to streams (k)
		4. Manure spills (p)
	3. Wildlife (s)	1. Landscape modifications (p)
	4. Domestic pets (k)	1. Leaving pet waste on the landscape (k)
2. Altered Hydrology/Morphology	1. Urban Lands (k)	1. Dense, Efficient Drainage Network with modified channels (k)
		2. Loss of Wetlands, Floodplains, Trees, Vegetation, and Natural Areas (k and s)
	2. Agricultural Lands (k)	1. Dense, Efficient Drainage Network with modified channels (k)
		2. Loss of Wetlands, Floodplains, Trees, Vegetation, and Natural Areas (k and s)
3. Sediment (k)	1. Cropland (k)	1. Loss of Wetlands, Floodplains and Natural Areas (k)
		2. Dense County and Agricultural Drainage Network (s)
		3. Farming practices (s)
	2. Roads and Urban Landscapes (k)	1. Erosion and runoff (k)
	3. Streambanks (k)	1. Altered hydrology/morphology (k)
		2. Loss of trees and vegetation (k)
		3. Improperly Installed or Sized Culverts at Road/Stream Crossings (k)
		4. Unrestricted livestock access (k)
	4. Construction Sites (s)	1. Bare soil (s)
		2. Lack of, or inattention to, best management practices (s)
4. Elevated Water Temperature/Depleted Dissolved Oxygen (k)	1. Urban Lands (k)	1. Impervious surfaces (k)
		2. Dense County and Agricultural Drainage Network (s)
		3. Loss of Wetlands, Floodplains, Trees, Vegetation, and Natural Areas (k and s)
	2. Agricultural Lands (k)	1. Dense, Efficient Drainage Network with modified channels (k)
		2. Loss of Wetlands, Floodplains, Trees, Vegetation, and Natural Areas (k and s)
5. Nutrients (k)	1. Cropland (s)	1. Improper Application of Manure and/or Fertilizers (s)
(also including Chloride)		2. Tillage Practices (s)
		3. Dense County and Agricultural Drainage Networks (s)
	2. Livestock (s)	1. Improper Livestock and Manure Management (s)
		2. Unrestricted Livestock Access to Streams (k)
		3. Manure spills (p)
	3. Humans (s)	1. Aging or improperly maintained septic systems (k)
		2. Illicit Connections/Discharges (k)
		3. Over or Improper application of chloride products on winter roads (s)
		4. Over or Improper application of lawn fertilizers (s)
		5. Over or improper application of biosolids (p)
		6. Issues with municipal wastewater treatment systems (k)
	4. Wildlife (s)	1. Landscape modifications (p)
6. Trash and Litter (k)	1. Humans (k)	1. Unintentional introduction of human refuse (k)
		2. Intentional introduction of human refuse (k)

5.1.1 PRIORITY 1 POLLUTANT - *E. COLI* (k)

E. coli is ranked as the highest priority pollutant in the BCW because of the impaired designated uses and the existing TMDL. *E. coli* is used as an indicator of fecal contamination since it is easy to test for, relatively inexpensive and ELGE has developed a water quality standard for which to compare results. Designated uses for partial and full body contact are not being attained and human health is at risk when in contact with the surface water. Humans, cattle, horses and dogs were all positively identified as contributors to fecal contamination of surface waters.

Source 1: Humans (k)

The way human waste is managed and treated can affect the chances of *E. coli* reaching surface water. Suspected and potential causes of human *E. coli* are listed below, and ranked by the estimated relative size of the contribution.

Cause 1: Aging Septic Systems, Improper Installation and/or Improper Maintenance (k)

Septic systems typically consist of underground tanks to contain the solids within wastewater, and 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 located in poorly drained soils near surface waters; as previously discussed, about 30% of the BCW contains poorly drained soils. Installation of traditional septic systems in these soils could result in human septage reaching the groundwater and surface water prior to treatment.

The statewide *E. coli* TMDL summarizes factors that may make septic systems ineffective, including: age; land area is too small; poor soils for drainage; water table is too high; improper maintenance, and; hydraulic overload and undersized systems. Recent research in watershed of lower Michigan identify septic systems as the primary driver of human sources of *E. coli* in watersheds. More specifically, the study found that watersheds with more than 1,621 septic systems had significantly higher concentrations of human sources under baseflow conditions (Verhougstraete et. al., 2015). A study by Public Sector Consultants (2018), estimates local failing septic rates ranging between 10% and 25%. Recent studies completed by the Barry-Eaton District Health Department, found a failure rate of approximately 27% (2011). Without further testing, the location of the majority of these failing systems is undetermined. The State of Michigan, County Health Departments/Districts, and local municipalities have the authority to regulate septic systems.

Cause 2: Illicit Connections/Discharges (s)

Illicit connection of untreated household or business sewage systems to surface waters is illegal, but is probably contributing to pollution of the BCW.

Illicit connections are described, as follows, in the statewide *E. coli* TMDL: “In rural areas, illicit discharges are often referred to as “cheater pipes” because instead of routing sewage from the household plumbing to a septic system with a filter and adsorption field, a pipe takes sewage and wastewater directly to ditches, hillsides, or surface water. Illicit discharges occur more commonly in areas where soils are unsuitable for septic system adsorption fields, or where the property size is too small for a septic system, and a more expensive engineered system would be necessary.”

Small communities with no centralized sanitary wastewater treatment system are a significant issue in rural Michigan. Downtown business districts often have no room for septic systems and were constructed with sanitary waste connected to storm sewers, ditches, or underground tanks. These tanks may have been constructed with frequent pumping in mind, to dispose of the waste properly

(referred to as “pump and haul” systems); however, given that the average 3-bedroom home for a family of four produces 400 gallons per day of waste, pumping may need to occur almost daily (USEPA, 2008b). This is not a practical option and may lead to laundry and sink wastewater being illegally rerouted away from the tank, and to the ground surface or nearby surface water to save on pumping fees. Pump and haul systems are considered appropriate as a temporary option only.

Cause 3: Leaking Sanitary Sewer Systems (s)
Canine handlers suspect leaking sanitary sewer in at least one spot within the BCW, based upon the reaction of the canines to areas above and adjacent the sanitary pipes. This location is near Ivanrest Ave. and John Brewer Dr. The extent of the problem is unknown, as is the impact on surface waters. Local municipalities take this issue seriously and have programs in place to maintain the infrastructure. For example, the City of Wyoming has a robust sanitary sewer cleaning and televising program in place. Approximately 150,000 linear feet (10%) of sanitary sewer are cleaned and televised annually and evaluated using NASSCO PACP scoring. This information is used to prioritize segments for repair the following year. The majority of sanitary sewer main repairs are conducted with CIPP slip lining. Approximately 15,000 linear feet of sanitary sewer mains are slip lined annually. The City spends approximately $750,000 annually on these programs.

Cause 4: Over or Improper Application of Biosolids (p)
Biosolids applications are regulated by Residuals Management Programs that are required by the provisions of the originating facility's NPDES discharge permit for wastewater treatment or by a general permit (MIG960000). Michigan’s administrative rules require that pathogens in biosolids be significantly reduced through a composting process, prior to land application (R 323.2418, Part 24. Land Application of Biosolids, NREPA, 1994 PA 451).

Biosolids are categorized here as a potential point source, because they are regulated by an NPDES permit. Discharge of biosolids to surface waters of the state is prohibited; but if a spill should occur in violation of the permit, the permit holder (generator of the biosolids) is generally held accountable. Information, applicable rules/laws, and EGLE Biosolids Program staff contacts may be found at Michigan.gov/Biosolids.

Only “Class B” biosolids are spread in the BCW. The MDEQ’s TMDL outlines the different rules and classes of biosolids as follows: “Class B biosolids are treated but still contain detectible levels of pathogens. There are buffer requirements, public access, and crop harvesting restrictions for virtually all forms of Class B biosolids. Provisions contained in Part 24 that protect surface and groundwaters from contamination by bulk land-applied Class B biosolids include: isolation distances from surface water (50 feet for subsurface injection or surface application with incorporation or 150 feet for surface application without incorporation within 48 hours), sampling to ensure that pathogen density requirements in R 323.2414 are met, and restrictions (but not prohibition) of land application to frozen, saturated, or highly sloped land” (MDEQ, 2017).

Source 2: Livestock (k)

The way livestock and their manure are managed, including livestock access to streams, drainage from pastures or feedlots, and improper application or storage can affect the chances of contaminating surface water. Generally Accepted Agricultural and Management Practices for Nutrient Utilization (GAAMPS) have been established by the MDARD to provide uniform, statewide standards and acceptable management practices to enable producers to compare or improve their own managerial routines.

According to the 2019 Statewide *E. coli* TMDL: “Livestock are animals that are bred and raised for human use, and include cattle, swine (hogs), poultry, horses, and more uncommon types (such as llamas, sheep, goats). Livestock with access to surface waters, polluted runoff from livestock production area, pasture runoff, and discharges from artificial drainage, such as tiles, and the land application of manure are all potential sources of *E. coli* to surface waters. Many factors affect the amount of *E. coli* transported from fields when manure is land-applied or deposited by grazing animals; chief among them is the amount of *E. coli* present in the manure at the time of application. Liquid cattle manure, swine manure, and dairy slurry have been shown to contain *E. coli* concentrations of up to 1,500,000 *E. coli* per mL (Unc and Goss, 2004). Livestock farms in close proximity, or adjacent, to water bodies are more likely to contaminate surface waters from barnyard or pasture runoff, particularly if animal pasture areas slope towards the water bodies without buffer vegetation or embankments to contain runoff. Larger farms generate more waste that requires storage, disposal, or dispersal (land application). Smaller farms, such as hobby horse farms and small farms, can also contaminate surface water if the pastures slope into adjacent water bodies, animals have direct access, or if manure is stockpiled upslope of a water body. Large to medium livestock operations will generally land-apply manure in the early spring and late fall on fields available to them for land application as near as possible to their operations” (EGLE, 2019).

Cause 1: Improper Application of Manure (k)

Livestock manure is typically spread on cropland for use as fertilizer. Across the state of Michigan, “nearly one quarter of farm facilities with cropland used manure as fertilizer” (USDA, 2014) (*in* EGLE, 2019). The soil conditions, spreading rate, weather, proximity to surface water, tile and overland drainage all affect the runoff path of manure and associated *E. coli*. Field tiles and dense drainage networks are common in the BCW and increase the rate at which runoff reaches the surface water. Unfortunately, violations associated with manure spills into surface waters have also been common in recent years.

The Statewide *E. coli* TMDL summarizes the following as environmentally risky manure application practices:

- ***“Manure land application on frozen ground*** is known to be an environmentally risky practice for surface water quality (Thompson et al., 1979; Stratton et al., 2004; Srinivasan et al., 2006; and Frame 2012). The manure cannot be readily incorporated into the soil, and thus remains exposed to the forces of rain, sun, air, and snowmelt. Aside from causing bacterial contamination of nearby surface waters, this also causes nitrogen to be lost by volatilization (Atta, 2008), and high dissolved phosphorus losses in runoff (Frame, 2012). According to a five-year study of a Wisconsin beef farm, where manure was applied routinely on frozen and unfrozen ground, the months of February and March had the highest rates of field runoff (as much as 39 percent of monthly precipitation became runoff) and dissolved phosphorus losses peaked during these months at more than 0.8 pounds per acre; the study points out that it is not these months that were particularly hazardous for surface water pollution, but that the manure land application coincidentally occurred during or immediately prior to snow pack melting and led to increased losses (Frame, 2012). Frozen soil has a low infiltration capacity, causing high rates of runoff during snowmelt or rain (Fleming and Fraser, 2000). In a Wisconsin study of several fields with slopes less than 5 percent, it was found that 50 percent of all agricultural runoff occurred during snow melt (Stuntebeck et al., 2011). Land application of manure on frozen ground is particularly risky on sloped land, land with swales, or on land adjacent to surface waters…
- ***Manure applications on tile drained fields*** may pose an especially high risk of surface water contamination by *E. coli*, given that fissures in the natural soil structure can provide a relatively

unimpeded pathway for contaminated water to reach tiles, then surface water, without the benefits of filtration through soil or riparian buffer strips (Shipitalo and Gibbs, 2000; Cook and Baker, 2001; Haack and Duris, 2008). In Michigan, approximately 26 percent of all agricultural lands are artificially drained (USDA, 2014). Subsurface drainage tiles reduce the amount of surface runoff by up to 45 percent (Busman and Sands, 2002), but reroute precipitation through the soil vadose zone (3- to 5-foot depth) and into a permeable tile, which then routes directly to surface water bypassing buffer strips. The end result is an increased risk of contaminated storm water to a surface water body if manure is applied prior to rainfall.

- ***Manure applications just prior to heavy rainfall*** tend to have a higher risk of runoff if not fully incorporated or injected before the rainfall. Many studies have shown that time spent outside the host body, exposed to cold and the drying effects of the sun, can reduce pathogens over time, resulting in less risk of contaminating surface water (Crane et al., 1980; Jiang et al., 2002; Saini et al., 2003, Unc and Goss, 2004). Applying manure just prior to rainfall, or during snowmelt, would not allow time for pathogens to naturally die off.
- ***Manure applications on saturated ground****.* In fields where water infiltration rates are slow due to already saturated conditions or poorly drained soil types (including areas that are frequently flooded), runoff and ponding can be enhanced, causing sheet-flow of contaminated runoff if manure has been applied (MDARD, 2016)" (*in* EGLE, 2019).

Cause 2: Improper Livestock and Manure Management (k)

Holding facilities concentrate livestock feed and manure and, therefore, *E. coli*. When these facilities are adjacent to a waterway, pollutants in manure can enter the waterway through overland runoff. Other facilities may contribute pollution through tile drainage. Facilities without proper manure storage management, without a buffer strip, without a proper setback, or with intentional drainage to a surface water are suspected sources of pollution. Livestock operations directly adjacent to water bodies are more likely to contribute pollution than those that are not adjacent to water bodies. Even for small, hobby-type farms, direct runoff of manure is an issue.

Whether it is left in place or stored and spread, livestock manure requires proper handling and management. Michigan's Generally Accepted Agricultural Management Practices (GAAMPs) require storing manure 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 required (MDARD, 2014). Improper storage and handling of manure poses a risk of impacting both surface and ground water.

The Statewide *E. coli* TMDL summarizes the following as environmentally risky livestock management practices:

- "*Pastures sloped towards water bodies:* Pasture runoff can be an issue even when livestock are excluded from directly accessing surface water. Pastures that slope towards water bodies, or have swales running through them, are likely to contaminate surface water.
- *Stockpiling manure in fields:* Stockpiling manure in fields or open areas is a risky practice if done improperly. This practice involves concentrating manure in piles that are exposed to rainfall, thus increasing the risk of bacteria and nutrients entering surface or groundwater. From a water quality perspective, it is preferable to land apply and till under the manure. Occasionally, farms may not have the ability to land apply due to frozen or muddy ground, and view stockpiling as the best or only option" (EGLE, 2019).

Cause 3: Unrestricted Livestock Access to Streams (k)
Unrestricted livestock access to a stream results in livestock waste being directly discharged into water, trampled streambanks, over widening of a stream, streambank erosion, and sediment input.

The Statewide *E. coli* TMDL summarizes this as an environmentally risky practice: “Animals with access to surface waters can transport manure from pastures to the water on their hooves and via direct defecation into the water (MDARD, 2016). While controlled or restricted access sites, such as concrete crossing pads, can eliminate soil erosion issues, they may act as a hydrologic path for pasture runoff to flow into surface water and do not prevent direct defecation in the water; and therefore, do not alleviate pathogen contamination” (MDEQ, 2017).

Cause 4: Manure Spills (p)
While no records of manure spills exist in the MiWaters database, any time manure is being loaded, transported or applied near surface water, there is an opportunity for large quantities of manure to spill into the waterbody.

Source 3: Wildlife (s)
Wildlife is considered a source of *E. coli* in the BCW. MST was not completed on wildlife sources and populations were not counted or estimated. The populations of some wildlife are managed by the MDNR and are less manageable through the watershed planning process. Though, some wildlife can be encouraged to “congregate at nuisance levels” through landscape modifications (EGLE, 2019).

Cause 1: Landuse Modifications (p)
Raccoons, geese and deer are known to exist in nuisance populations near surface waters across the state of Michigan, contributing to surface water pollution. Many wildlife species are attracted to agricultural land as a food source. As well, landscape maintenance practices, such as mowing to the edge of the water and beaches are known to attract waterfowl.

Source 4: Domestic pets (k)

Cause 1: Leaving pet waste on the landscape (k)
Source tracking indicated that the canine marker was present in samples taken from surface water within the BCW. The most likely source of fecal contamination is from pet dogs and, specifically from dog waste being left on the ground. Pet waste should be collected and properly disposed of.

5.1.2 PRIORITY 2 POLLUTANT – ALTERED HYDROLOGY/MORPHOLOGY (k)
Altered hydrology and stream morphology are the second-ranked pollutant in the BCW. Changes to the landscape or to the stream channel that result in increased runoff, or increased magnitude, frequency or duration of flooding, have a direct impact on the function of the stream channel. Increased bank erosion, continued changes to channel morphology, etc. often result in excess sedimentation and habitat degradation. Road crossings can also alter the flow regime by forcing the flow to constrict through a culvert or multiple culverts. The erosion, transport, and deposition of excess amounts of sediment causes changes to the natural flow regime affecting the nutrients, habitat, temperature, and natural flood cycle. The health of biological communities is closely tied to the stability of the watershed and stream channels.

Source 1: Urban Lands and Dense Drainage Network
Urban lands and impervious surface are unable to soak up precipitation, resulting in rapid runoff. Additionally, modifications for efficient drainage include dredging and straightening of stream channels,

draining of wetlands and removal of native vegetation. The size and shape of many of the drains and streams in the BCW cannot handle the volume of water being supplied.

Cause 1: Dense, Efficient Drainage Network (k)
The urban portions of the BCW are extensively and efficiently drained through a network of roadside ditches, storm sewers, and designated county drains. This drainage network is intended to drain water from the land at a faster rate than a natural stream.

Cause 2: Loss of Wetlands, Floodplains, Trees, Vegetation, and Natural Areas (k)
Rainwater that falls on wetlands, floodplains, and natural areas is intercepted and infiltrated at a slower rate than rainwater that falls on landscapes that have altered. The loss of these natural areas affects the hydrologic cycle of rainwater. Rainwater that runs off the modified landscapes is warmer than rainwater that runs off or infiltrates into the natural areas. The practice of draining or filling wetlands is/was a widespread practice in the BCW and contributes to altered hydrology.

Source 2: Croplands and Dense Drainage Network (k)

Modifications for increased agricultural output include dredging and straightening of stream channels, draining of wetlands and removal of native vegetation.

Cause 1: Dense County and Agricultural Drainage Network (k)
The BCW has extensive artificial drainage including underground tile networks, roadside ditches, agricultural drains and designated county drains. The drains are intended to quickly drain water from the land at a faster rate than a natural stream.

Cause 2: Loss of Wetlands, Floodplains, Trees, Vegetation, and Natural Areas (k)
Rainwater that falls on wetlands, floodplains, and natural areas is intercepted and infiltrated at a slower rate than rainwater that falls on landscapes that have altered. The loss of these natural areas due to agricultural land uses affects the hydrologic cycle of rainwater. Rainwater that runs off the modified landscapes is warmer than rainwater that runs off or infiltrates into the natural areas. The practice of draining or filling wetlands is/was a widespread practice in the BCW and contributes to warming of the stream.

5.1.3 PRIORITY 3 POLLUTANT - SEDIMENT (k)

The process of sedimentation is natural, but human-related activities can speed up the process, resulting in sediment becoming a pollutant. Sediment pollution and impacts to the streambed and channel morphology are extreme in the BCW. Sediment causes turbidity in the water that limits light penetration and prohibits healthy plant growth, it covers the streambed and smothers aquatic life, and destroys the spawning grounds and habitat of many desirable aquatic species. Fine sediments also carry other pollutants, including pathogens and nutrients. Sediment is ranked as the third highest priority pollutant because it is contributing to the impairments of the designated uses of coldwater fishery and other indigenous aquatic life throughout the BCW. Sediment is considered a known pollutant based on a review of existing literature and visual observations.

Source 1: Cropland (k and s)

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. Specific land management practices in the watershed are the suspected sources of sediment in surface water, including disruptive tillage practices,

draining or filling wetlands, removing trees and fence rows, and cultivation on steep slopes or drainage ways. Cropland causes of sediment contributions are listed below and ranked by the size of the contribution.

Cause 1: Loss of Wetlands, Floodplains and Natural Areas (k)
Modification to the natural landscapes is widespread in the BCW. Activities that eliminate wetlands or functional floodplains result in loss of natural filters and/or sediment storage areas, resulting in more direct runoff to the stream.

Cause 2: Dense County and Agricultural Drainage Network (k)
A dense network of efficient drainage channels means that sediment does not have to travel far over land before entering the surface water and being transported downstream.

Cause 3: Farming Practices (k)
Different tillage practices disturb the soils to different extents. Some practices leave the ground more susceptible to erosion by leaving bare soil or little crop residue for protection from wind and precipitation impact and runoff. The NRCS recommends conservation tillage practices including no-till, mulch-till, and ridge-till (USDA NRCS, 2010). Steep slopes increase runoff velocity and have higher soil erosion rates. Cultivation on these steep slopes, or likewise in drainage ways that have an intermittent or constant flow of water, disturbs the stability of these soils and results in increased soil erosion. The NRCS recommends grassed waterways, instead of cultivated waterways, and contour farming on hillsides.

Source 2: Roads and Urban Landscapes (k)

Historically, roads were built adjacent to streams. Gravel roads, road/stream crossings, steep banks, and steep approaches to stream crossings can be significant sources of sediment. Proper construction and maintenance of both paved and gravel roads can reduce the input of sediment to surface waters.

Cause 1: Erosion and Runoff (k)
Sediment from roads is carried by wind, water, and traffic into roadside ditches, drains, and streams and rivers. The transport of road sediments into the drainage network is readily apparent during any precipitation event or snowmelt period.

Source 3: Streambanks (k)

Unstable streambanks can contribute sediment to streams and rivers. Streambank causes of sediment contributions are listed below and prioritized by the estimated relative volume of sediment contribution.

Cause 1: Altered Hydrology (k and s)

Changes to the landscape or to the stream channel that result in increased runoff, or increased magnitude, frequency or duration of flooding, have a direct impact on the function of the stream channel. Increased bank erosion, continued changes to channel morphology, etc. often result in excess sedimentation. Road crossings can also alter the flow regime by forcing the flow to constrict through a culvert or multiple culverts. Modifications to the courses of waterways made for farming, residential, and commercial uses of land are common in the BCW. These modifications can cause increased flow velocity, increased flashiness, or changes in course through engineered drainage or erosion, increasing the volume of sediment in the waterways. Hydrologic modifications that eliminate or disconnect floodplains and wetlands remove areas that filter or store sediment.

Cause 2: Loss of Trees and Vegetation (s and p)

Roots, shrubs and herbaceous vegetation provide protection against streambank erosion. Removal of riparian vegetation often results in a series of predictable changes that can include increased erosion rates, over-widening of a channel, loss of capacity to transport sediment and infilling of riffles and coarse substrate.

Cause 3: Improperly Installed or Sized Culverts at Road/Stream Crossings (s)

Stream and road crossings force streams to flow under a constructed road and through a culvert, set of culverts, or a bridge. Culverts that are undersized, or are installed at an incorrect slope or elevation, often result in sedimentation of the upstream channel and downstream bank and bed erosion and sediment bars. Also, runoff from the road often runs as concentrated flow down a steep bank toward the stream, frequently leaving an eroded gully in its path.

Cause 4: Unrestricted Livestock Access (k and s)

Livestock can trample streambanks, wear down vegetation and, consequently, increase erosion.

Source 4: Construction Sites (k)

Cause 1: Bare soil (s and p)

Bare soil is prone to erosion by wind and flowing water. The longer the soil remains bare, the greater the chances of it eroding and washing into nearby surface waters.

Cause 2: Lack of, or inattention to, best management practices

Best management practices should be used at any time there is exposed soil. It is common to see silt fence, gutter guards and other BMPs that were not installed properly or are not maintained after they are installed.

5.1.4 PRIORITY 4 POLLUTANT – EXCESSIVE WATER TEMPERATURE/DEPLETED DISSOLVED OXYGEN (k)

Buck Creek and its tributaries are expected to be meeting the designated use for coldwater fishery; however, monitoring results indicate that exceedances of the WQS for water temperature and dissolved oxygen (DO) are common.

Source 1: Urban Lands

Vast amounts of pavement and other impervious surfaces, modifications for efficient drainage, draining of wetlands and removal of native vegetation lead to warming of the stream and a shift in the aquatic community.

Cause 1: Impervious Surfaces (k)

Urban lands and impervious surfaces absorb and store heat from the sun. When summer rains fall onto these heated surfaces and run off into surface waters, the streams warm rapidly

Cause 2: Dense Drainage Network (k)

The urban portions of the BCW have extensive artificial drainage including roadside ditches, storm sewers, and designated county drains. The drains are intended to quickly drain water from the land at a faster rate than a natural stream. Many drains no longer have a tree canopy, adjacent vegetation or buffer.

Cause 3: Loss of Wetlands, Floodplains, Trees, Vegetation, and Natural Areas (k)

Rainwater that falls on wetlands, floodplains, and natural areas is intercepted and infiltrated at a slower rate than rainwater that falls on landscapes that have altered. The loss of these natural areas affects the hydrologic cycle of rainwater. Rainwater that runs off the modified landscapes is warmer than rainwater that runs off or infiltrates into the natural areas. The practice of draining or filling wetlands is/was a widespread practice in the BCW and contributes to warming of the stream.

Source 2: Croplands and Dense Drainage Network (k)

Modifications for increased agricultural output include dredging and straightening of stream channels, draining of wetlands and removal of native vegetation. These practices lead to warming of the stream and a shift in the aquatic community.

Cause 1: Dense County and Agricultural Drainage Network (k)

The BCW has extensive artificial drainage including underground tile networks, roadside ditches, agricultural drains and designated county drains. The drains are intended to quickly drain water from the land at a faster rate than a natural stream. Many drains no longer have a tree canopy, adjacent vegetation or buffer, and are farmed to the edge of the bank.

Cause 2: Loss of Wetlands, Floodplains, Trees, Vegetation, and Natural Areas (k)

Rainwater that falls on wetlands, floodplains, and natural areas is intercepted and infiltrated at a slower rate than rainwater that falls on landscapes that have altered. The loss of these natural areas due to agricultural land uses affects the hydrologic cycle of rainwater. Rainwater that runs off the modified landscapes is warmer than rainwater that runs off or infiltrates into the natural areas. The practice of draining or filling wetlands is/was a widespread practice in the BCW and contributes to warming of the stream.

5.1.5 PRIORITY 5 POLLUTANT - NUTRIENTS (k)

Nutrients, here within used as a general term for ammonia, total dissolved solids, nitrate/nitrite, total phosphorus, total Kjeldahl nitrogen, chloride and bacterial oxygen demand, are considered to be a known pollutant based a variety of measure data.

Source 1: Cropland (s)

Cropland receives periodic inputs of nutrients through chemical fertilizers and manure. Any nutrient attached to eroding soil may travel to nearby streams and ditches. Erosion is more likely from bare soil rather than fully planted fields.

Cause 1: Improper Application of Manure and/or Fertilizers (s)
Livestock manure and fertilizers are frequently spread on crops for use in promoting plant growth. 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.

Cause 2: Tillage Practices (s)
Sediment that erodes into the surface water can carry nutrients that are attached to the soil particles.

Cause 3: Dense County and Agricultural Drainage Networks (s)
The hydrologic modifications made for the drainage network speed the route of runoff to the stream, disconnect the runoff from the natural areas that filter sediment, and therefore contribute to an increase in nutrient load within the stream.

Source 2: Livestock (s)

Cause 1: Improper Livestock and Manure Management (s)
Holding facilities concentrate livestock feed and manure and, therefore, nutrients. When these facilities are adjacent to a waterway, pollutants in manure can enter the waterway through overland runoff. Other facilities may contribute pollution through tile drainage. Facilities without proper manure storage management, without a buffer strip, without a proper setback, or with intentional drainage to a surface water are suspected sources of pollution. Livestock operations directly adjacent to water bodies are more likely to contribute pollution than those that are not adjacent to water bodies. Even for small, hobby-type farms, direct runoff of manure is an issue.

Whether it is left in place or stored and spread, livestock manure requires proper handling and management. Michigan's Generally Accepted Agricultural Management Practices (GAAMPs) require storing manure 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 required (MDARD, 2014). Improper storage and handling of manure poses a risk of impacting both surface and ground water.

The Statewide *E. coli* TMDL summarizes the following as environmentally risky livestock management practices:

- "*Pastures sloped towards water bodies:* Pasture runoff can be an issue even when livestock are excluded from directly accessing surface water. Pastures that slope towards water bodies, or have swales running through them, are likely to contaminate surface water.
- *Stockpiling manure in fields:* Stockpiling manure in fields or open areas is a risky practice if done improperly. This practice involves concentrating manure in piles that are exposed to rainfall, thus increasing the risk of bacteria and nutrients entering surface or groundwater. From a water quality perspective, it is preferable to land apply and till under the manure. Occasionally, farms may not have the ability to land apply due to frozen or muddy ground, and view stockpiling as the best or only option" (EGLE, 2019).

Cause 2: Unrestricted Livestock Access to Streams (s)
Unrestricted livestock access to a stream results in livestock waste being directly discharged into water, trampled streambanks, over widening of a stream, streambank erosion, and sediment input.

The Statewide *E. coli* TMDL summarizes this as an environmentally risky practice: "Animals with access to surface waters can transport manure from pastures to the water on their hooves and via direct defecation into the water (MDARD, 2016). While controlled or restricted access sites, such as concrete crossing pads, can eliminate soil erosion issues, they may act as a hydrologic path for pasture runoff to flow into surface water and do not prevent direct defecation in the water; and therefore, do not alleviate pathogen contamination" (MDEQ, 2017).

Cause 3: Manure Spills (p)
While no records of manure spills exist in the MiWaters database, any time manure is being loaded, transported or applied near surface water, there is an opportunity for large quantities of manure to spill into the waterbody.

Source 3: Humans (k)
In addition to being a source of *E. coli,* human waste contains nutrients. If this water is not properly treated it can contribute nutrients to waterways. Each of the following causes are discussed in detail in Section 5.1.1.

Cause 1: Aging or improperly maintained septic systems (k)
Cause 2: Illicit Connections/Discharges (s)
Cause 3: Over or Improper application of chloride products on winter roads (s)
Cause 4: Over or Improper application of lawn fertilizers (s)
Cause 5: Over or improper application of biosolids (p)
Cause 6: Issues with municipal wastewater treatment systems (k)

Source 4: Wildlife (s)
Wildlife often congregate and live near water, and their droppings contain nutrients.

Cause 1: Human Alterations of Landscape that Attract Nuisance Populations (p)
Humans have modified landscapes in ways to attract nuisance populations (MDEQ, 2017).

5.1.6 PRIORITY 6 POLLUTANT – TRASH AND LITTER (k)
Human refuse, trash and debris are scattered in great volume throughout the BCW, both on the land and in the surface waters. Some of the waste is simply unsightly, but other waste can have harmful effects on aquatic life and humans.

Source 1: Humans (k)

Cause 1: Unintentional introduction of human refuse (k)
Trash and debris is commonly blown from trash cans or dumpsters, out of garbage collection trucks or otherwise, unintentionally, enters the natural environment and surface waters. Fast food waste, plastic shopping bags and similar items are pulled from Buck Creek and its tributaries on an annual basis.

Cause 2: Intentional introduction of human refuse (k)

Trash and debris is commonly thrown onto the ground, out vehicle windows or left in yards. Old tires, couches and other furniture, shopping carts, hypodermic needles, sheets of plywood and other intentionally thrown trash are commonly observed and often removed during river cleanups.

6.0 CRITICAL AREAS/SITES AND POLLUTANT LOADING

6.1 Agricultural Land Critical Sites

Using aerial photography, agricultural lands that border or drain to Buck Creek or its tributaries were identified as high priority. The sites also include application areas for livestock waste from CAFOs. These 911 acres of land potentially introduce a variety of pollutants to the surface waters, and are contributing an estimated 1,010 tons of sediment, 5,300 pounds of nitrogen and 1,570 pounds of phosphorus on an annual basis (Based upon the STEP-L model. The 911 acres of cropland was entered as an aggregate amount, using default values for the Grand Rapids International Airport in Kent County, Michigan). Not all of the sites identified necessarily have issues, but this map should serve as a starting point for site-specific assessments and recommendations for BMPs to reduce the input of pollutants.

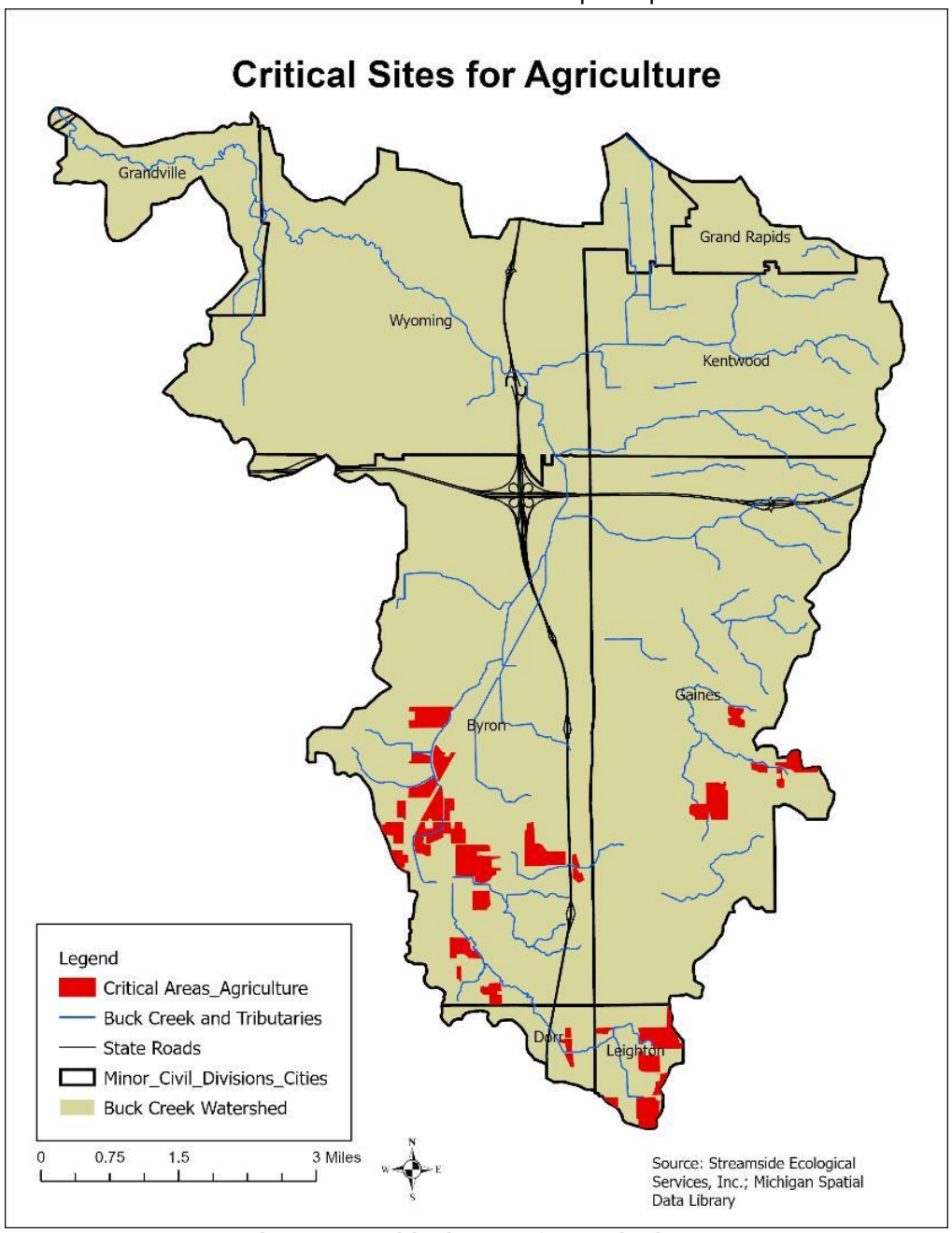

Figure 27. Critical Areas for Agriculture

6.2 Livestock Critical Sites

Based upon observations from aerial and windshield surveys, livestock problem sites were identified. These sites include animals in the stream and sites where livestock is being kept directly adjacent the stream and runoff is either intentionally or unintentionally directed into the stream. An estimate of animals present at each location was attempted for load calculations, but not always possible if livestock were indoors, seasonally present, out of view, etc. In some cases, assumptions were used based upon size of the facility. Per the STEP-L model, in total, these sites are contributing approximately 1,102 lbs. of nitrogen and 214 lbs. of phosphorus to surface water, on an annual basis (The number and type of animals at each site were entered into the model, using default values, as described in section 6.1).

Table 15. Estimated Pollutant Loading from Critical Livestock Sites

SITE ID	SITE DESCRIPTION	NITROGEN LOAD (LB/YEAR)	PHOSPHORUS LOAD (LBS/YEAR)	E. COLI SOURCE
Buck 6	30 cattle area sloping to stream	624	125	YES
Buck 7	3 horses with access to stream	60	6	YES
Buck 18	20 cattle with access to stream	418	83	YES

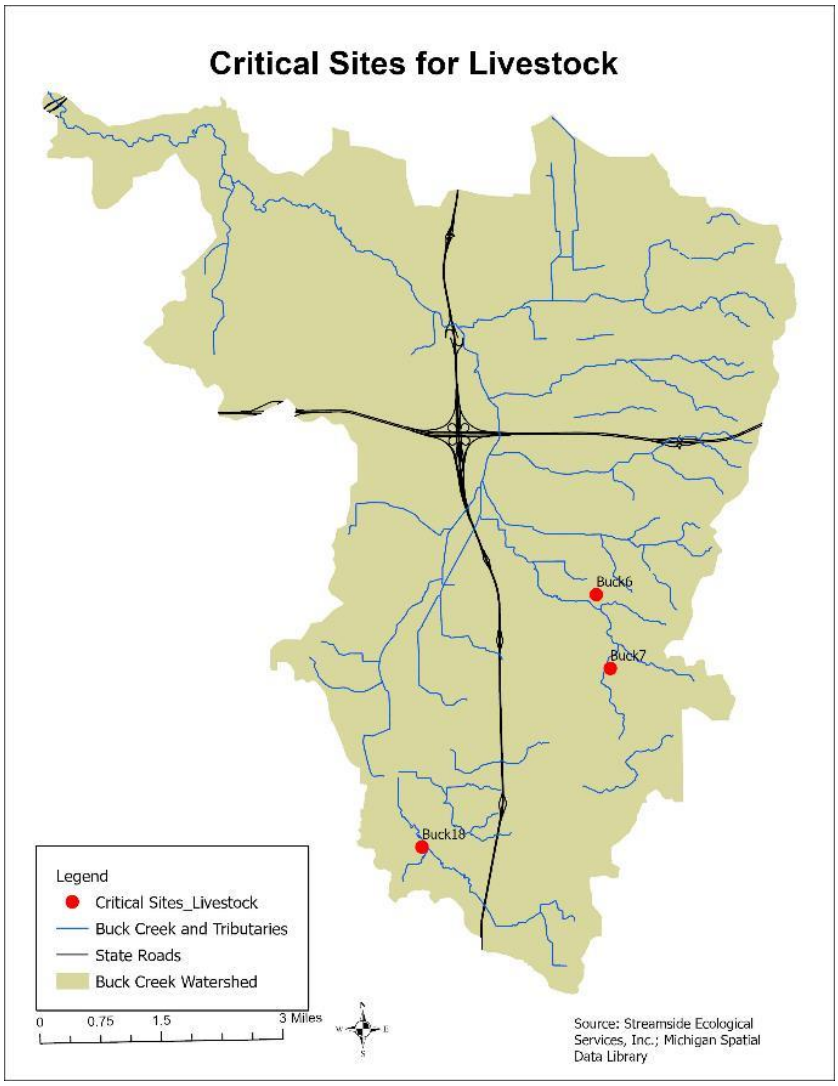

Figure 28. Critical Sites for Livestock

6.3 Riparian Management Critical Areas/Sites

Proper management of the riparian corridor is important for a variety of reasons, from maintaining streambank stability to filtering overland runoff to shading the stream to protect water temperatures. Many, many issues were noted during windshield and walking surveys. Because the area south of 84th Street is primarily agricultural in nature, and the stream is pretty ubiquitous in character (maintained county drain with little to no riparian vegetation), the entire upper watershed is considered to be a critical area for water temperature issues. Downstream (north) of 84th Street, myriad problems were identified, including removal of riparian vegetation, mowing to the edge of the stream and dumping of household garbage, among others. In certain areas, the volume and size of the trash in and around the stream is overwhelming; shopping carts, couches, dimensional lumber, bicycles, plastics of all shapes and sizes, syringes and more. Volunteer cleanup efforts would be futile due to safety and accessibility issues.

Table 16. Critical Sites for Riparian Management

SITE ID	SITE DESCRIPTION	LENGTH OF IMPACT AREA (ft)
3	Runoff from parking lot	50
5	Removal of riparian vegetation/maintained to edge of stream	100
6	Removal of riparian vegetation/maintained to edge of stream	125
7	Removal of riparian vegetation/maintained to edge of stream	200
8	Removal of riparian vegetation/maintained to edge of stream	200
11	Removal of riparian vegetation/maintained to edge of stream	100
13	Open riparian; lots of ducks and feeding	50
14	Hundreds of ducks; Mowed to edge; 50 pound bag of road salt dumped in grass	190
15	Removal of riparian vegetation/maintained to edge of stream	250
17	Many loads of grass clippings dumped on bank and in stream	25
18	Many loads of dog manure dumped on bank and in stream	20
19	Removal of riparian vegetation/maintained to edge of stream; dumping broken concrete	200
20	Removal of riparian vegetation/maintained to edge of stream	150
26	Removal of riparian vegetation/maintained to edge of stream	800
31	Loads of leaves, brush, organic material continually dumped into stream with tractor	50
37	Removal of riparian vegetation/maintained to edge of stream	350
40	Sideslopes of Kent Trails unstable and contributing sediment to floodplain and stream	400
41	Removal of riparian vegetation/maintained to edge of stream	400
51	Removal of riparian vegetation/maintained to edge of stream	400
53	Parking lot runoff creating gully into stream	25
58	Removal of riparian vegetation/maintained to edge of stream	80
59	Gully erosion down streambank, apparently from roof or yard runoff	40
60	Removal of riparian vegetation/maintained to edge of stream	500
63	Approx. 10 tile drains installed to protect bank; stormwater going directly to stream	250
66	Removal of riparian vegetation/maintained to edge of stream in golf course	1,000
68	Large volumes of trash and debris tossed into floodplain and stream	500
69	Large volumes of trash and debris tossed into floodplain and stream	500
70	Sediment input from gully; extremely unstable streambed	50
71	Stream located at base of railroad grade; large volume of trash and debris	1,200
73	Both streambanks are lined with poured concrete in Ideal Park	800
76	Removal of riparian vegetation/maintained to edge of stream in Ideal Park	200
77	Large volumes of trash and debris tossed into floodplain and stream	1,500
79	Large volumes of trash and debris tossed into floodplain and stream	900
80	Large volumes of trash and debris tossed into floodplain and stream	1,500
85	Bricks, cinder blocks, broken concrete, metal thrown on streambanks	550
89	Removal of riparian vegetation/maintained to edge of stream; trash and debris thrown in stream	1,400
90	Removal of riparian vegetation/maintained to edge of stream in Douglas Walker Park	650
101	Input pipes from parking lots. Dumping of concrete, bricks, mortar bags	100
102	Enormous log jam full of trash and debris	100
103	Removal of riparian vegetation	650
104	Homeless encampment. Trash and debris.	50
105	Removal of vegetation	200
106	Removal of vegetation under power lines	175
107	Removal of vegetation under power lines	400
108	Removal of vegetation under power lines	300
109	Dumping of lawn clippings, leaves, garden waste behind many houses.	500
110	Extreme case of trash dumping from residence	150
111	Dumping of trash and debris from residence	150
112	Removal of vegetation under power lines	300
113	Neighborhood dumping ground for yard debris and organic waste	50
114	Dumping of trash and debris from residence	100
201	Removal and maintenance of vegetation	600
202	Removal and maintenance of vegetation; homeless encampments full of trash and debris	300
203	Removal and maintenance of vegetation in mobile home park	1,500
204	Removal of vegetation; dumping of organic debris from community garden	150
205	Removal and maintenance of vegetation	200
301	Community dumping ground from mobile home park; shopping carts, car parts, carpet, etc.	100
302	Runoff from South Kent Landfill roads and sideslopes	500

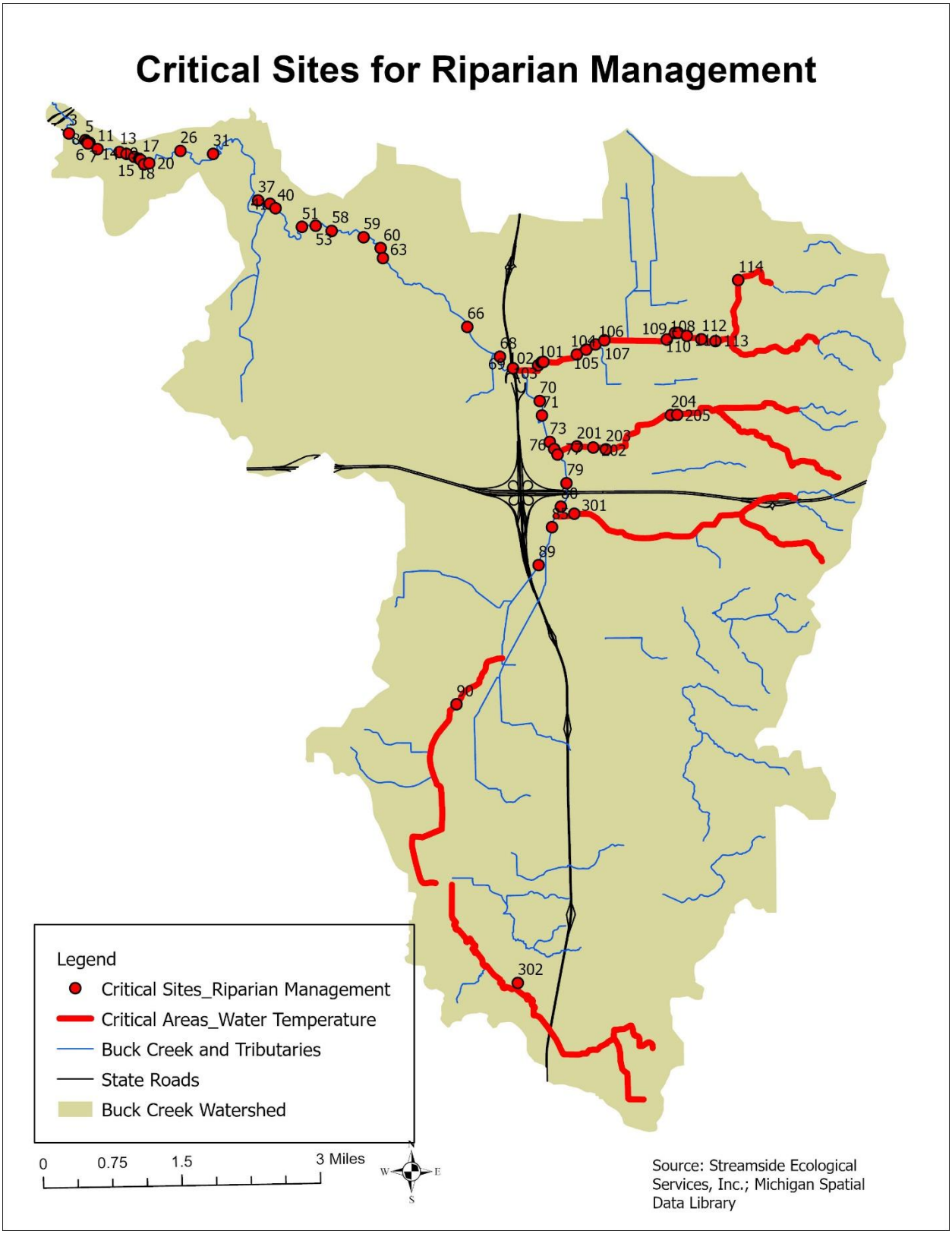

Figure 29. Critical Sites and Areas for Riparian Management

6.4 Streambank Erosion Critical Sites

Sites with excessive streambank erosion or stream instability were identified. Because a complete inventory of all streams was not conducted, this list should not be considered to be all inclusive, but a starting point for addressing some of the most critical sites documented using the described methods. These sites alone are contributing approximately 2,158 tons of sediment to Buck Creek on an annual basis. Note: Loads were calculated using methods in the MDEQ Pollutants Controlled Manual (length of eroding bank x height of the eroding bank x estimated erosion rate x soil density factor).

Table 17. Estimated Pollutant Loading from Critical Streambank Erosion Sites

SITE ID	SITE DESCRIPTION	ANNUAL SEDIMENT LOAD (TONS/YEAR)
1	Bank erosion on west bank. Rocks continually being dumped.	3.3
2	Bank erosion along toe of road on steep bank.	8.3
4	Bank erosion/mass wasting on west bank. Undercutting. Trees toppling.	88.9
8	Bank erosion along homes. Mowed to edge of stream.	11.1
10	Bank erosion along south bank.	2.2
12	Bank erosion.	1.7
15	Severe bank erosion along homes. Mowed to edge.	17.4
20	Severe bank erosion along yard. Mowed to edge.	8.3
23	Bank erosion along south bank.	5.2
25	Bank erosion along cemetery road. Mowed to edge.	12.5
29	Bank erosion.	8.3
30	Erosion on steep bank. Sheds at top.	152.8
32	Entire bank is undercut and slumping in places. Trees toppling.	33.3
36	Bank erosion along yards. Mowed to edge.	25.0
38	Bank erosion.	35.6
42	Bank erosion along all yards. Many maintained to edge. Junk dumped to protect bank.	34.7
43	Severe bank erosion along high, steep bank proximate Ramblewood Apt. buildings.	444.4
50	Long eroding bank, undercut, maintained to edge.	20.8
57	Bank erosion, undercut bank, mowed to edge.	3.1
61	Severe bank erosion on left and right banks. Clumps of earth falling in. Mowed to edge.	20.8
62	Erosion of toe and banks. High, steep bank with condos on edge. Many attempts at protection.	72.9
67	Erosion along edge of parking lot.	21.7
75	Bank erosion in Ideal Park. Mowed to edge.	11.1
78	Bank erosion along edge of mobile home park.	3.3
82	Bank erosion along edge of mobile home park.	50.0
83	Severe erosion associated with bridge.	11.1
84	Bank erosion. Tons of debris dumped in attempt to control erosion.	111.1
86	Severe erosion on sand bank.	16.7
87	Long reach (2,800 feet) choked with wood, severe erosion. Parking lots undermined and falling into stream.	622.2
88	Severe instability despite vegetation. Bank slumping and erosion.	300.0

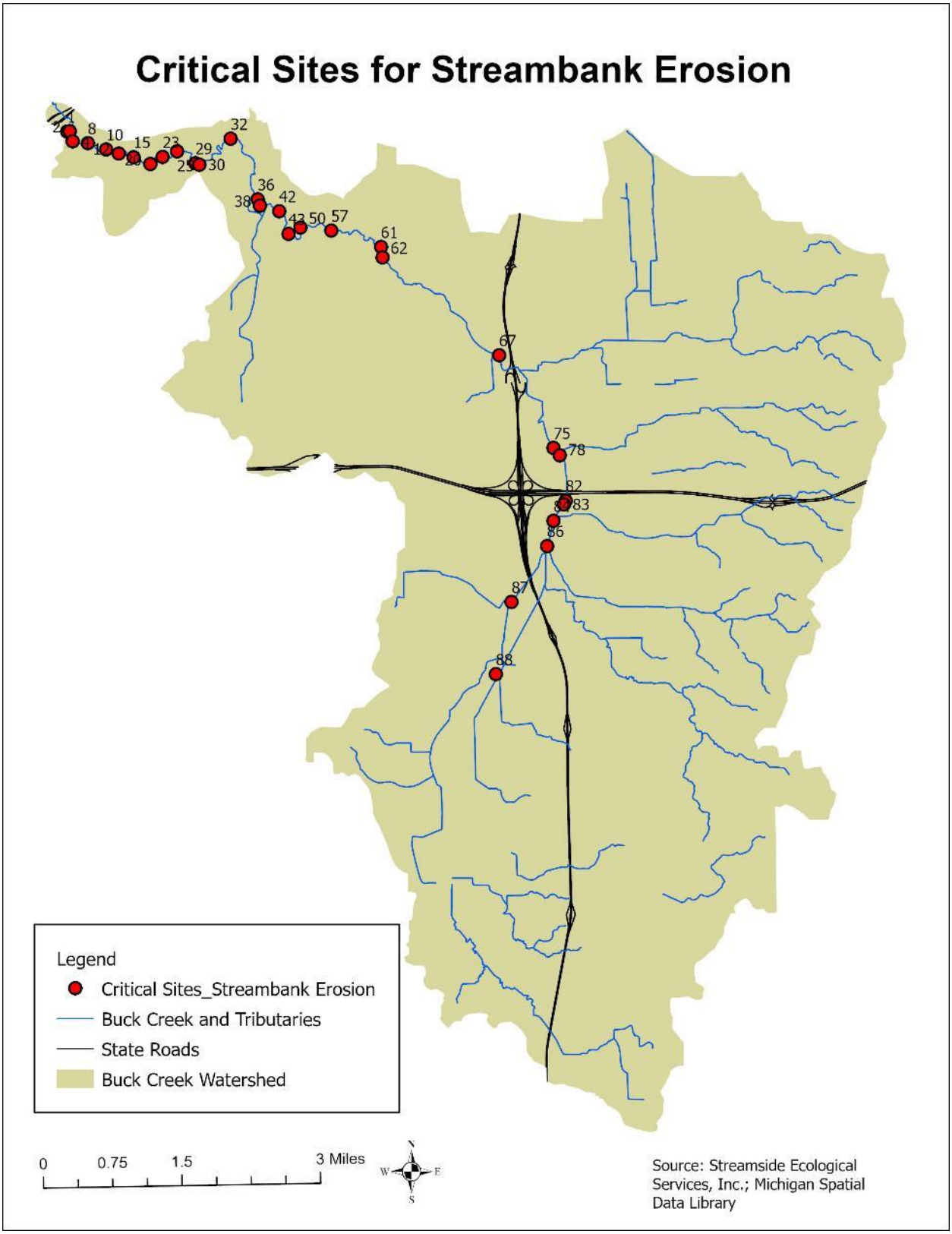

Figure 30. Critical Sites for Streambank Erosion

6.5 Human Fecal Contamination Critical Areas

Critical areas for human-sourced fecal contamination were identified through a combination of literature review, biosolids application sites, DNA source tracking and canine-scent tracking data. Because everywhere that was sampled was dominated by positive samples (Table 12) and most of the data show exceedances in WQS (Table 11), the entire BCW should be considered a critical area.

6.6 Elevated Water Temperature Critical Areas

Critical areas for elevated water temperature includes all designated coldwater streams that are not meeting the WQS. The upper portion of Buck Creek, as well as the Crippen, Heyboer, and Cutlerville Drains are all considered to be critical areas since water temperatures exceed the WQS (Table 8).

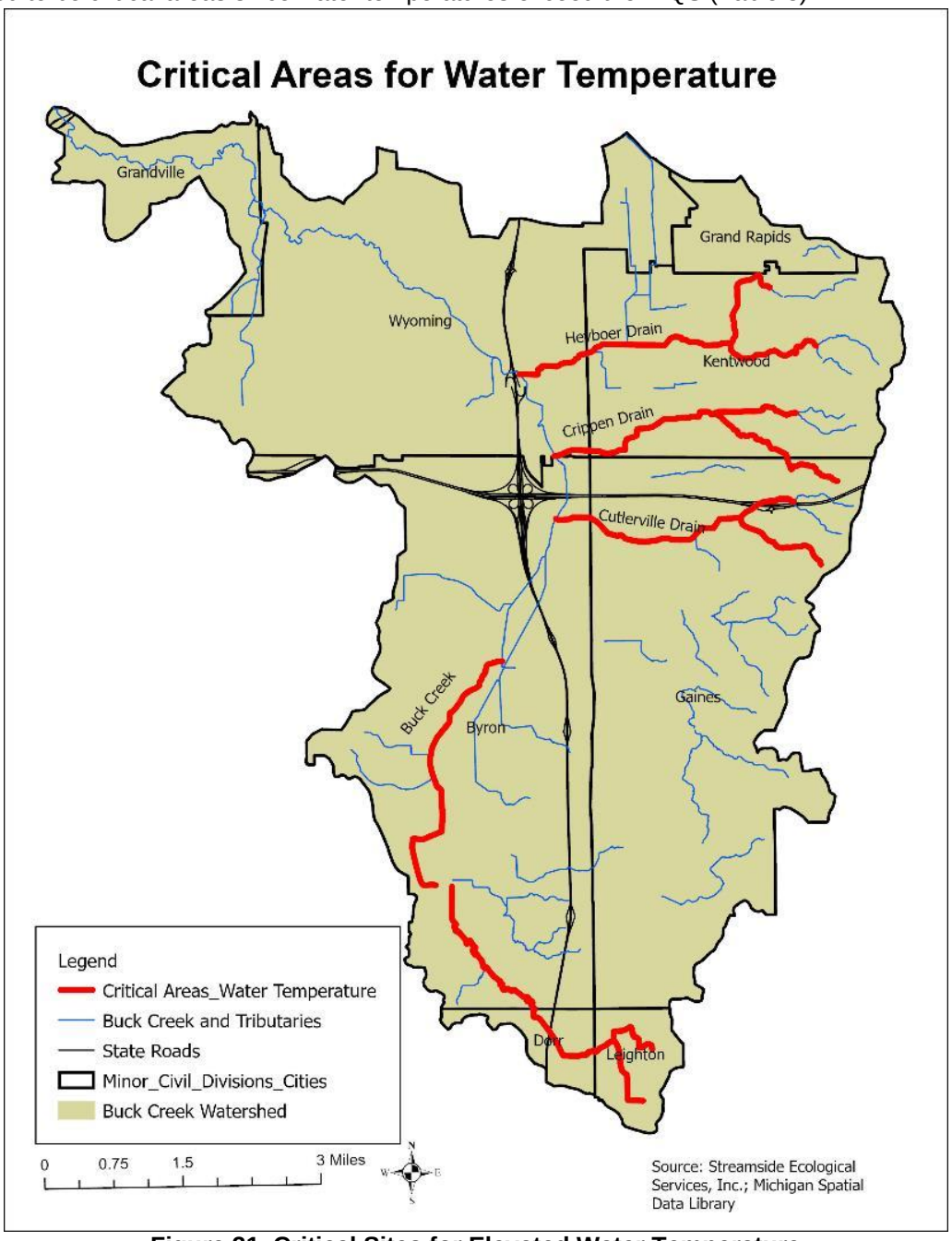

Figure 31. Critical Sites for Elevated Water Temperature

7.0 ADDRESSING NPS POLLUTION TO PROTECT/RESTORE DESIGNATED USES

The previous chapters clearly identify that water quality impairments exist in the BCW. This chapter outlines a plan for addressing the sources and causes of various NPS pollutants at all of the critical sites and areas, as well as a plan for addressing the larger, more general issues that the BCW is facing. Recommended solutions include various best management practices (physical and policy-based (Section 7.4)) and educational outreach (Section 7.5). Best management practices are methods that have been determined to be the most effective and practical means of preventing or reducing non-point source pollution to help achieve water quality goals. BMPs include measures to prevent pollution and measures to mitigate pollution. BMP adoption through the WMP process is on a voluntary basis and should be done in a collaborative manner.

Many BMPs are generally accepted as a means to prevent or reduce pollution and are well-documented in sources such as Michigan's Statewide *E. coli* TMDL and in various WMPs (i.e. Flat River WMP, Upper Pine River WMP, Rush Creek WMP). However, this plan focuses on recommended BMPs for each critical site, as well as general wetland protection and restoration. Particular focus was given to wetland protection and restoration as a management tool due to the myriad benefits that wetlands provide, the critical role they play in ensuring water quality and their ubiquitous use for capture and treatment of pollutant-laden runoff.

Though certain BMPs are recommended, ***it cannot be stressed enough that BMPs must be selected and designed on site-specific basis***. Cost, site conditions, removal efficiency, and preference of the party installing the BMP should all be taken into consideration and, often, more than one BMP is a feasible alternative.

7.1 Wetland Protection

Under Michigan law, wetlands greater than five acres in size or contiguous with other bodies of water are generally protected from development and draining through a permitting process. However, there are dozens of exceptions to this permitting process that allow wetlands to be diminished or mitigated in alternate locations. For example, agriculture does not always require a permit to drain or impact wetlands, and applications to fill a wetland are often approved. Though a mitigation process may require 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, it is important to protect all wetlands, and more importantly wetlands that have functions that reduce the pollutants that have been identified in the BCW. About 325 acres of existing wetlands with bacteria, sediment, and/or nutrient reducing functions are recommended as priority wetlands to protect through local ordinances, which is the most cost-effective means of protecting wetlands; the goal is to have each municipality adopt a wetland protection ordinance by 2023. More on wetland protection can be found in Policy Recommendations.

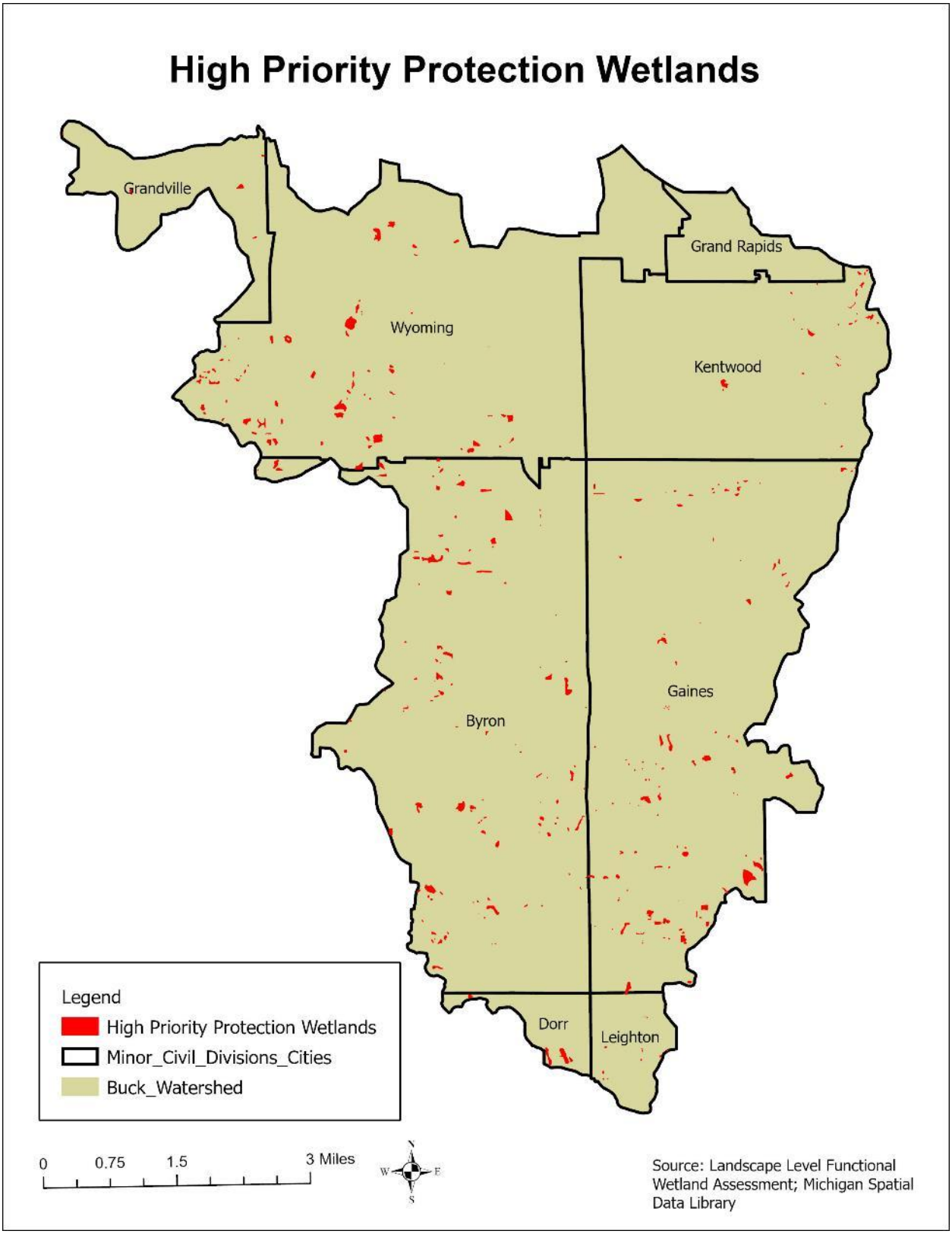

Figure 32. Priority Wetlands for Protection

Table 18. Recommendations for Wetland Protection

MUNICIPALITY	COUNTY	EXISTING WETLAND (ACRES)	RECOMMENDED BMP	ESTIMATED COST	TIMELINE	PARTNERS
City of Kentwood	Kent	20	Wetland Ordinance	$4,000 - $7,500	2023	FSBR; Schrems; FOBC
City of Wyoming	Kent	90	Wetland Ordinance	$4,000 - $7,500	2023	FSBR; Schrems; FOBC
Byron-Gaines Township	Kent	203	Wetland Ordinance	$4,000 - $7,500	2023	FSBR; Schrems; FOBC
Dorr Township	Allegan	12	Wetland Ordinance	$4,000 - $7,500	2023	FSBR; Schrems; FOBC

FSBR = Fahey Schultz Burzych Rhodes – or other experienced law firm; FOBC = Friends of Buck Creek

7.2 Wetland Restoration

Already, loss of wetlands has altered the hydrology (led to increases in duration, magnitude and frequency in flow) and water quality (loss of free, natural filtering capacity) within the BCW. Restoration of wetlands will be necessary to reverse negative impacts. The highest priority 1,910 acres of wetlands, for improving hydrology and reducing input of pollutants, are shown below. Realistic milestones, estimated costs and likely project partners are shown below. The single-most important consideration for restoration of these wetlands is interest and authorization from property owners. Once landowners have agreed to restoration of wetlands on their property, site-specific survey, design, cost estimation and planning can occur.

Table 19. Recommendations for Wetland Restoration

HIGH-PRIORITY RESTORATION WETLANDS	SHORT-TERM RESTORATION GOAL (2022-2025)	ESTIMATED COST (2022-2025)	LONG-TERM RESTORATION GOAL (2022-2032)	ESTIMATED COST (2022-2032)	PARTNERS
1,910 acres	20 acres	$50,000-500,000	250 acres	$625,000-6,250,000	Schrems; EGLE; ACD; ACDC; KCD; KCDC; DU; USFWS

ACD = Allegan Conservation District; ACDC = Allegan County Drain Commissioner; KCD = Kent Conservation District; KCDC = Kent County Drain Commissioner; DU = Ducks Unlimited; USFWS = United States Fish and Wildlife Services

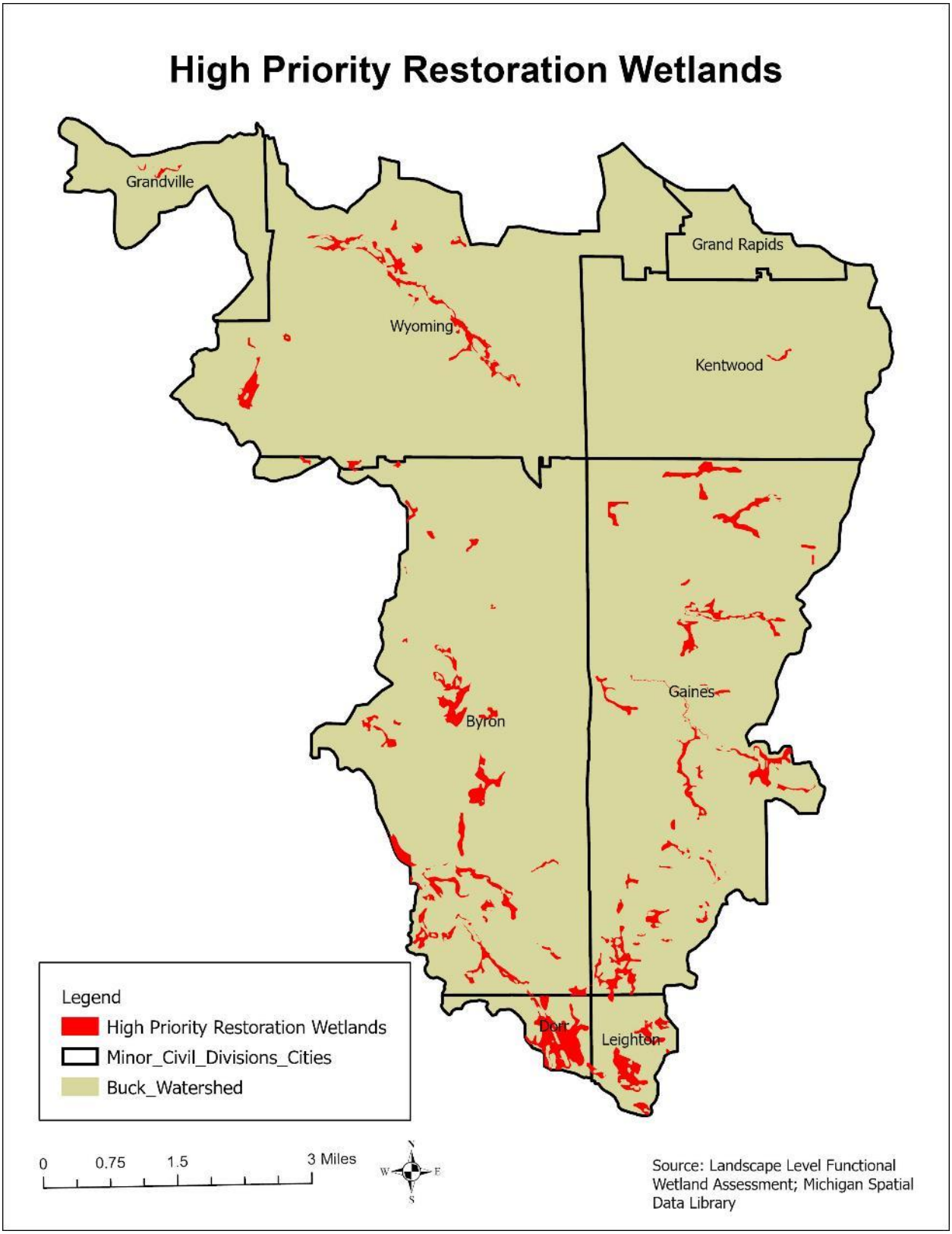

Figure 33. Priority Wetlands for Restoration

7.3 Physical BMPs and I&E for Critical Sites/Areas

7.3.1 Agricultural Land Critical Sites

About 900 acres of high-priority cropland was identified as contributing sediment and other pollutants to surface waters (Figure 28). These sites should be addressed by working to educate landowners (details in Section 7.5) and by installing physical BMPs. BMPs outlined in conservation programs such as MAEAP and NRCS programs and Generally Accepted Agricultural Management Practices (GAAMPs) are recommended, as are the following generally recommended BMPs from the State of Michigan *E. coli* TMDL: Avoid manure land application on frozen or saturated ground; Injection or incorporation of manure and; Tile line control structures.

Table 20. Goals and Estimated Costs for BMPs on Cropland

SHORT-TERM GOAL (2022-2025)	ESTIMATED COST (2022-2025)	LONG-TERM GOAL (2022-2032)	ESTIMATED COST 2022-2032	PARTNERS
10 BMPs; 300 acres	$50,000-$400,000	50 BMPs; 900 acres	$250,000-$2,000,000	ACD; ACDC; KCD; KCDC; EGLE; Schrems; FOBC

FOBC = Friends of Buck Creek

7.3.2 Livestock Critical Sites

A total of three critical sites with livestock manure issues have been identified (Figure 29). These sites should be addressed by working to educate landowners (details in Section 7.5) and by installing physical BMPs. The Statewide *E. coli* TMDL recommends: Outreach to farmers and producers to connect them with existing voluntary conservation programs; all livestock producers in *E. coli*-impaired watersheds should develop CNMPs or Manure Management System Plans that address manure management and storage practices; Avoid livestock access to streams and; Implement runoff management to minimize or eliminate contaminated pasture or barnyard runoff.

Table 21. Goals and Estimated Costs for BMPS on Livestock Critical Sites

SITE ID	SITE DESCRIPTION	RECOMMENDED BEST MANAGEMENT PRACTICE(S)*	ESTIMATED COST	TIMELINE	PARTNERS
	Livestock Critical Sites				
Buck 6	Cattle area sloping to stream	Fencing; Alternative Water Source	$12,000	2022-2027	KCD; KCDC; Schrems; EGLE
Buck 7	Horses with access to stream	Fencing; Alternative Water Source	$8,000	2022-2027	KCD; KCDC; Schrems; EGLE
Buck 18	Cattle with access to stream	Fencing; Alternative Water Source	$10,000	2022-2027	KCD; KCDC; Schrems; EGLE
		SUBTOTAL	**$30,000**		

7.3.3 Riparian Management Critical Areas/Sites

A total of 58 critical sites with riparian management issues have been identified (Figure 30). These sites should be addressed by working with landowners to raise awareness and by installing physical BMPs.

Table 22. Goals and Estimated Costs for BMPS on Riparian Management Sites

SITE ID	SITE DESCRIPTION	RECOMMENDED BEST MANAGEMENT PRACTICES*	ESTIMATED COST	TIMELINE	PARTNERS
3	Runoff from parking lot	Detention or wetland swale	$20,000	2025	Landowner; Schrems; KCDC
5	Removal of riparian vegetation/maintained to edge of stream	Discontinue mowing	$0	2022	Landowner; Schrems; FOBC
6	Removal of riparian vegetation/maintained to edge of stream	Discontinue mowing	$0	2022	Landowner; Schrems; FOBC
7	Removal of riparian vegetation/maintained to edge of stream	Discontinue mowing	$0	2022	Landowner; Schrems; FOBC
8	Removal of riparian vegetation/maintained to edge of stream	Discontinue mowing; 200 feet of Planting	$2,000	2022-2026	Landowner; Schrems; KCD; KCDC; FOBC
11	Removal of riparian vegetation/maintained to edge of stream	Discontinue mowing	$0	2022	Landowner; Schrems; KCDC
13	Open riparian; lots of ducks and feeding	Appoximately 50 feet of Planting	$500	2022-2026	Landowner; Schrems; KCD; KCDC; FOBC
14	Hundreds of ducks; Mowed to edge; 50 pound bag of road salt dumped in grass	Appoximately 100 feet of Planting; Information and Education	$1,100	2022-2026	Landowner; Schrems; KCD; KCDC
15	Removal of riparian vegetation/maintained to edge of stream	Discontinue mowing; 250 feet of Planting	$2,500	2022-2026	Landowner; Schrems; KCD; KCDC; FOBC
17	Many loads of grass clippings dumped on bank and in stream	Information and Education	$250	2022	Schrems; KCDC; FOBC; GVMC
18	Many loads of dog manure dumped on bank and in stream	Information and Education	$250	2022	Schrems; KCDC; FOBC; GVMC
19	Removal of riparian vegetation/maintained to edge of stream; dumping broken concrete	Information and Education; Discontinue mowing; 200 feet of Planting	$2,250	2022-2026	Landowner; Schrems; KCD; KCDC; FOBC; GVMC
20	Removal of riparian vegetation/maintained to edge of stream	Discontinue mowing; 150 feet of Planting	$1,500	2022-2026	Landowner; Schrems; KCD; KCDC; FOBC
26	Removal of riparian vegetation/maintained to edge of stream	Discontinue mowing; 800 feet of Planting	$8,000	2022-2026	Landowner; Schrems; KCD; KCDC; FOBC
31	Loads of leaves, brush, organic material continually dumped into stream with tractor	Information and Education	$250	2022	Schrems; KCDC; FOBC; GVMC
37	Removal of riparian vegetation/maintained to edge of stream	Discontinue mowing; 350 feet of Planting	$3,500	2022-2026	Landowner; Schrems; KCD; KCDC; FOBC
40	Sideslopes of Kent Trails unstable and contributing sediment to floodplain and stream	Stabilize sideslopes/Capture sediment at bottom of sideslopes	$5,000	2025	Landowner; Schrems; KCDC
41	Removal of riparian vegetation/maintained to edge of stream	Discontinue mowing	$0	2022	Landowner; Schrems; KCDC
51	Removal of riparian vegetation/maintained to edge of stream	Discontinue mowing; 400 feet of Planting	$4,000	2022-2026	Landowner; Schrems; KCD; KCDC; FOBC
53	Parking lot runoff creating gully into stream	Redirect runoff to better area	$2,500	2025	Landowner; Schrems; KCDC
58	Removal of riparian vegetation/maintained to edge of stream	Discontinue mowing	$0	2022	Landowner; Schrems; KCDC
59	Gully erosion down streambank, apparently from roof or yard runoff	Redirect runoff to better area	$1,000	2025	Landowner; Schrems; KCDC
60	Removal of riparian vegetation/maintained to edge of stream	Discontinue mowing; 500 feet of Planting	$5,000	2022-2026	Landowner; Schrems; KCD; KCDC; FOBC
63	Approx. 10 tile drains installed to protect bank; stormwater going directly to stream	Redirect runoff to better area	$1,000	2025	Landowner; Schrems; KCDC
66	Removal of riparian vegetation/maintained to edge of stream in golf course	Discontinue mowing; 1,000 feet of Planting	$10,000	2022-2026	Landowner; Schrems; KCD; KCDC; FOBC
68	Large volumes of trash and debris tossed into floodplain and stream	Information and Education; River cleanup	$2,250	2022-2023	Landowner; Schrems; KCD; KCDC; FOBC; GVMC
69	Large volumes of trash and debris tossed into floodplain and stream	Information and Education; River cleanup	$2,250	2022-2023	Landowner; Schrems; KCD; KCDC; FOBC; GVMC
70	Sediment input from gully; extremely unstable streambed	Detention or wetland swale	$10,000	2025	Landowner; Schrems; KCDC

SITE ID	SITE DESCRIPTION	RECOMMENDED BEST MANAGEMENT PRACTICES*	ESTIMATED COST	TIMELINE	PARTNERS
71	Stream located at base of railroad grade; large volume of trash and debris	Information and Education; River cleanup	$250	2022-2023	Landowner; Schrems; KCD; KCDC; FOBC; GVMC
73	Both streambanks are lined with poured concrete in Ideal Park	Remove concrete; Naturalize streambanks	$80,000	2030	Landowner; Schrems; KCD; KCDC; FOBC
76	Removal of riparian vegetation/maintained to edge of stream in Ideal Park	Discontinue mowing; 200 feet of Planting	$2,000	2022-2026	Landowner; Schrems; KCD; KCDC; FOBC
77	Large volumes of trash and debris tossed into floodplain and stream	Information and Education; River cleanup	$2,250	2022-2023	Landowner; Schrems; KCD; KCDC; FOBC; GVMC
79	Large volumes of trash and debris tossed into floodplain and stream	Information and Education; River cleanup	$2,250	2022-2023	Landowner; Schrems; KCD; KCDC; FOBC; GVMC
80	Large volumes of trash and debris tossed into floodplain and stream	Information and Education; River cleanup	$2,250	2022-2023	Landowner; Schrems; KCD; KCDC; FOBC; GVMC
85	Bricks, cinder blocks, broken concrete, metal thrown on streambanks	Information and Education; River cleanup	$2,250	2022-2023	Landowner; Schrems; KCD; KCDC; FOBC; GVMC
89	Removal of riparian vegetation/maintained to edge of stream; trash and debris thrown in stream	Discontinue mowing; 1,400 feet of Planting; Information and Education; River cleanup	$15,000	2022-2026	Landowner; Schrems; KCD; KCDC; FOBC
90	Removal of riparian vegetation/maintained to edge of stream in Douglas Walker Park	Discontinue mowing; 650 feet of Planting	$6,500	2022-2026	Landowner; Schrems; KCD; KCDC; FOBC
101	Input pipes from parking lots. Dumping of concrete, bricks, mortar bags	Treat runoff prior to discharge to stream. Clean up debris	$10,000	2022-2026	Landowner; Schrems; FOBC
102	Enormous log jam full of trash and debris	Log and debris removal	$2,000	2022-2023	Schrems; KCDC; FOBC
103	Removal of riparian vegetation	Discontinue mowing; 650 feet of Planting	$6,500	2022-2023	Landowner; Schrems; KCD; KCDC; FOBC
104	Homeless encampment. Trash and debris.	Clean up trash and debris	$4,000	2022-2023	Schrems; COK; FOBC, KCDC
105	Removal of vegetation	200 feet of tree planting	$2,000	2022-2023	Landowner; Schrems; KCD; KCDC; FOBC
106	Removal of vegetation under power lines	350 feet (both sides) of shrub planting	$2,500	2022-2023	Landowner; Schrems; KCD; KCDC; FOBC
107	Removal of vegetation under power lines	800 feet (both sides) of shrub planting	$6,000	2022-2023	Landowner; Schrems; KCD; KCDC; FOBC
108	Removal of vegetation under power lines	600 feet (both sides) of shrub planting	$4,000	2022-2023	Landowner; Schrems; KCD; KCDC; FOBC
109	Dumping of lawn clippings, leaves, garden waste behind many houses.	Information and Education; River cleanup	$2,250	2022-2023	Landowner; Schrems; KCD; KCDC; FOBC; GVMC
110	Extreme case of trash dumping from residence	Information and Education; River cleanup	$5,000	2022-2023	Schrems; COK; FOBC, KCDC; GVMC
111	Dumping of trash and debris from residence	Information and Education; River cleanup	$4,000	2022-2023	Schrems; COK; FOBC, KCDC; GVMC
112	Removal of vegetation under power lines	600 feet (both sides) of shrub planting	$4,000	2022-2023	Landowner; Schrems; KCD; KCDC; FOBC
113	Neighborhood dumping ground for yard debris and organic waste	Information and Education; River cleanup	$2,500	2022-2023	Landowner; Schrems; KCD; KCDC; FOBC; GVMC
114	Dumping of trash and debris from residence	Information and Education; River cleanup	$2,500	2022-2023	Schrems; COK; FOBC, KCDC; GVMC
201	Removal and maintenance of vegetation	Discontinue mowing; 1,200 feet of Planting	$13,000	2022-2023	Landowner; Schrems; KCD; KCDC; FOBC
202	Removal and maintenance of vegetation; homeless encampments full of trash and debris	Discontinue mowing; 600 feet of Planting; Clean up trash and debris	$8,500	2022-2023	Schrems; COK; FOBC, KCDC; GVMC
203	Removal and maintenance of vegetation in mobile home park	Information and Education; Discontinue mowing	$2,000	2022-2023	Landowner; Schrems; KCD; KCDC; FOBC; GVMC
204	Removal of vegetation; dumping of organic debris from community garden	Information and Education; Discontinue mowing	$2,000	2022-2023	Landowner; Schrems; KCD; KCDC; FOBC; GVMC
205	Removal and maintenance of vegetation	Discontinue mowing; 400 feet of Planting	$2,500	2022-2023	Landowner; Schrems; KCD; KCDC; FOBC
301	Community dumping ground from mobile home park; shopping carts, car parts, carpet, etc.	Information and Education; River cleanup	$3,500	2022-2023	Schrems; COK; FOBC, KCDC; GVMC
302	Runoff from South Kent Landfill roads and sideslopes	Information and Education; BMP's	$20,000	2022-2026	Landowner; Schrems; FOBC
		SUBTOTAL	$306,600		

7.3.4 Streambank Erosion Critical Sites

A total of 30 critical sites with streambank erosion issues have been identified (Figure 31). These sites should be addressed by working with county drain commissioners to raise awareness and by installing physical BMPs. The BMPs recommended here are very general in nature and, the fact of the matter is, that the hydrology and morphology of the streams in the BCW are so highly altered that most streambank erosion sites will be difficult and expensive to repair.

Table 23. Goals and Estimated Costs for BMPs on Critical Streambank Erosion Sites

SITE ID	SITE DESCRIPTION	RECOMMENDED BEST MANAGEMENT PRACTICES (BMPs)*	ESTIMATED COST	TIMELINE	PARTNERS
1	Bank erosion on west bank. Rocks continually being dumped.	Properly designed and constructed bank stabilization	$15,000	2025	KCD; KCDC; FOBC; EGLE; Schrems; Landowner
2	Bank erosion along toe of road on steep bank.	Rock riprap; Instream structures	$7,000	2025	KCD; KCDC; FOBC; EGLE; Schrems; Landowner
4	Bank erosion/mass wasting on west bank. Undercutting. Trees toppling.	Rock riprap; Instream structures	$25,000	2030	KCD; KCDC; FOBC; EGLE; Schrems; Landowner
8	Bank erosion along homes. Mowed to edge of stream.	Discontinue mowing to edge, let vegetation grow. 200 feet of planting. Information and Education.	$2,000	2022-2026	KCD; KCDC; FOBC; EGLE; Schrems; Landowner
10	Bank erosion along south bank.	Rock riprap; Instream structures	$5,000	2030	KCD; KCDC; FOBC; EGLE; Schrems; Landowner
12	Bank erosion.	Rock riprap; Instream structures	$5,000	2030	KCD; KCDC; FOBC; EGLE; Schrems; Landowner
15	Severe bank erosion along homes. Mowed to edge.	Discontinue mowing to edge, let vegetation grow. 250 feet of planting. Information and Education.	$2,500	2022-2026	KCD; KCDC; FOBC; EGLE; Schrems; Landowner
20	Severe bank erosion along yard. Mowed to edge.	Discontinue mowing to edge, let vegetation grow. 150 feet of planting. Information and Education.	$1,500	2022-2026	KCD; KCDC; FOBC; EGLE; Schrems; Landowner
23	Bank erosion along south bank.	Rock riprap; Instream structures	$15,000	2030	KCD; KCDC; FOBC; EGLE; Schrems; Landowner
25	Bank erosion along cemetery road. Mowed to edge.	Discontinue mowing to edge, let vegetation grow. 800 feet of planting. Information and Education.	$8,000	2022-2026	KCD; KCDC; FOBC; EGLE; Schrems; Landowner
29	Bank erosion.	Rock riprap; Instream structures	$10,000	2030	KCD; KCDC; FOBC; EGLE; Schrems; Landowner
30	Erosion on steep bank. Sheds at top.	Rock riprap; Instream structures	$40,000	2030	KCD; KCDC; FOBC; EGLE; Schrems; Landowner
32	Entire bank is undercut and slumping in places. Trees toppling.	Rock riprap; Instream structures	$25,000	2030	KCD; KCDC; FOBC; EGLE; Schrems; Landowner
36	Bank erosion along yards. Mowed to edge.	Discontinue mowing to edge, let vegetation grow. 300 feet of planting. Information and Education.	$3,000	2022-2026	KCD; KCDC; FOBC; EGLE; Schrems; Landowner
38	Bank erosion.	Rock riprap; Instream structures	$40,000	2030	KCD; KCDC; FOBC; EGLE; Schrems; Landowner
42	Bank erosion along all yards. Many maintained to edge. Junk dumped to protect bank.	Rock riprap; Instream structures	$50,000	2030	KCD; KCDC; FOBC; EGLE; Schrems; Landowner
43	Severe bank erosion along high, steep bank proximate Ramblewood Apt. buildings.	Rock riprap; Instream structures	$200,000	2022-2026	KCD; KCDC; FOBC; EGLE; Schrems; Landowner
50	Long eroding bank, undercut, maintained to edge.	Discontinue mowing to edge, let vegetation grow. 250 feet of planting. Information and Education.	$2,500	2022-2026	KCD; KCDC; FOBC; EGLE; Schrems; Landowner
57	Bank erosion, undercut bank, mowed to edge.	Discontinue mowing to edge, let vegetation grow. 75 feet of planting. Information and Education.	$1,000	2022-2026	KCD; KCDC; FOBC; EGLE; Schrems; Landowner
61	Severe bank erosion on left and right banks. Clumps of earth falling in. Mowed to edge.	Discontinue mowing to edge, let vegetation grow. 250 feet of planting. Instream structures. Rock riprap. Information and Education.	$20,000	2022-2026	KCD; KCDC; FOBC; EGLE; Schrems; Landowner
62	Erosion of toe and banks. High, steep bank with condos on edge. Many attempts at protection.	Rock riprap; Instream structures	$100,000	2022-2026	KCD; KCDC; FOBC; EGLE; Schrems; Landowner
67	Erosion along edge of parking lot.	Rock riprap; Instream structures	$30,000	2030	KCD; KCDC; FOBC; EGLE; Schrems; Landowner
75	Bank erosion in Ideal Park. Mowed to edge.	Discontinue mowing to edge, let vegetation grow. 200 feet of planting. Information and Education.	$2,500	2022-2026	KCD; KCDC; FOBC; EGLE; Schrems; Landowner
78	Bank erosion along edge of mobile home park.	Discontinue mowing to edge, let vegetation grow. 60 feet of planting. Instream structures. Rock riprap. Information and Education.	$7,500	2030	KCD; KCDC; FOBC; EGLE; Schrems; Landowner
82	Bank erosion along edge of mobile home park.	Discontinue mowing to edge, let vegetation grow. 1200 feet of planting. Instream structures. Rock riprap. Information and Education.	$80,000	2022-2026	KCD; KCDC; FOBC; EGLE; Schrems; Landowner
83	Severe erosion associated with bridge.	Rock riprap; Instream structures	$10,000	2022-2026	KCD; KCDC; FOBC; EGLE; Schrems; Landowner
84	Bank erosion. Tons of debris dumped in attempt to control erosion.	Rock riprap; Instream structures	$100,000	2030	KCD; KCDC; FOBC; EGLE; Schrems; Landowner
86	Severe erosion on sand bank.	Discontinue mowing to edge, let vegetation grow. 1200 feet of planting. Instream structures. Rock riprap. Information and Education.	$10,000	2022-2026	KCD; KCDC; FOBC; EGLE; Schrems; Landowner
87	Long reach (2,800 feet) choked with wood, severe erosion. Parking lots undermined and falling into stream.	Stream restoration	$2,800,000	2030	KCD; KCDC; FOBC; EGLE; Schrems; Landowner
88	Severe instability despite vegetation. Bank slumping and erosion.	Rock riprap; Instream structures	$190,000	2030	KCD; KCDC; FOBC; EGLE; Schrems; Landowner
			$3,807,500		

7.3.5 Human Fecal Contamination Critical Areas

Human fecal contamination is a widespread and ongoing problem that will not get better without a sustained effort to address the causes listed in this WMP.

The following voluntary activities are recommended as possible actions to be completed by local responsible agencies and organizations:

- Adopt a periodic inspection program, such as time-of-sale.
- Outreach to educate residents on the signs that their residence may have improper connections to a sanitary or storm sewer or a surface water body.
- Educate residents on the importance of clean water to human health and the dangers of surface water contamination by raw sewage.
- Modify ordinances to include a periodic inspection mechanism for existing and new septics (such as time-of-sale).
- If applicable, modify existing on-site septic system isolation distances in local ordinances to treat open county drains as conservatively as other surface waters. Open county drains are waters of the state, and the same WQS apply.
- Educate residents on the importance of clean water to human health and the dangers of surface water contamination by raw sewage.
- Investigate on-site septic systems (with assistance from the local responsible agency), prioritizing in areas that are considered high risk; for instance, older housing or housing that is located on poor soils, or densely populated/small lots. Particular attention should be paid to small rural communities in unsewered areas. Effort directed at aging or densely populated housing areas may be the most productive use of resources. Community-wide problems with failing septic systems may best be resolved through a comprehensive solution such as centralized or cluster wastewater treatment systems.
- Outreach to educate residents on the routine maintenance of a septic system and signs that their residence may have a failure. (MDEQ, 2019).
- Ensure that all local municipalities have the funds to conduct periodic inspections of municipal sewer infrastructure, similar to the program that City of Wyoming has implemented.

Table 24. Goals and Estimated Costs for BMPs for Human Fecal Contamination

RECOMMENDED BMP	SHORT-TERM GOAL (2022-2025)	LONG-TERM GOAL (2022-2032)	ESTIMATED COST	PARTNERS
I&E	See Section 7.4			
Develop and Adopt County Septic Ordinance (Allegan, Kent)		Two county ordinances	$500,000	ACHD; KCHD; EGLE
Monitor biosolids applications to determine extent of problem	8 sites		$8,000	Schrems; FOBC; EGLE
Monitoring/Inspection and Improvement of Municipal Sewer Infrastructure		COG and COK	$1,500,000	COG; COK

ACHD = Allegan County Health Department; KCHD = Kent County Health Department; COG = City of Grandville; COK = City of Kentwood

7.3.6 Elevated Water Temperature Critical Areas

Critical areas for exceedances of WQS for water temperature are displayed in Figure 32; however, addressing the issue must also focus on those areas upstream of, and draining to, the critical areas.

Table 25. Goals and Estimated Costs for BMPs for Elevated Water Temperature

RECOMMENDED BMP	SHORT-TERM GOAL (2022-2025)	ESTIMATED COST (2022-2025)	LONG-TERM GOAL (2022-2032)	ESTIMATED COST 2022-2032	PARTNERS
I&E	See Section 7.4				
Tree planting along streambanks and tributaries	2,500 feet	$37,500	15,000 feet	$225,000	Schrems; FOBC; KCD; KCDC; EGLE
Wetland restoration	2 acres	$80,000	10 acres	$400,000	Schrems; FOBC; KCD; KCDC; DU; USFWS; EGLE
Policy Management at County or Township Level (Riparian zone protection, stormwater management, etc.)	See Section 7.5				

7.4 Policy Review and Recommendations

The following recommendations apply to each municipality within the BCW:

1. **Develop wetlands regulations.** A municipality-specific wetlands protection ordinance was not found for any of the municipalities. While state regulations provide for some protections, Part 303, Wetland Protection, of the NREPA, 1994 PA 451 does not protect wetlands that do not meet one of the following designations:

   > "(i) Is a water of the United States as that term is used in section 502(7) of the federal water pollution control act, 33 USC 1362.
   > (ii) Is contiguous to the Great Lakes, Lake St. Clair, an inland lake or pond, or a stream. As used in this subparagraph, "pond" does not include a farm or stock pond constructed consistent with the exemption under section 30305(2)(g).
   > (iii) Is more than 5 acres in size.
   > (iv) Has the documented presence of an endangered or threatened species under part 365 or the endangered species act of 1973, Public Law 93-205.
   > (v) Is a rare and imperiled wetland." MCL 324.30301(n).

   Local governments have the authority to regulate these wetlands, which were identified through GIS (Figure 33). Wetlands protection ordinances can be adopted under a municipality's general police powers to protect the general health, safety, and welfare. Such ordinances provide protections that are not always considered in municipal zoning, including regulations that apply to currently established land uses and developments, not just new construction. Municipalities have the ability to make violations of a police power ordinance punishable by legal action. This could include civil infraction citations, injunctive relief, and/or misdemeanor prosecution, which provides a mechanism to ensure compliance. EGLE provides a guide for local governments in establishing wetlands protection ordinances, as well as a sample local wetland ordinance. These materials can be accessed online at EGLE's website.

2. **Implement or extend setback requirements.** While all the reviewed municipalities had some setback requirements in place, most were insufficient to address water quality within the watershed. Setbacks are important mechanisms in preventing pollution in surface water runoff and preserving water quality. Setbacks can be created through municipal zoning and written into existing zoning ordinances. The following is a list of recommended setback requirements that may be adjusted as necessary:

a. Require that residential buildings, including homes, garages, sheds, and similar structures, be set back 100 feet from Buck Creek and 25 feet from the 100-year floodplain.

b. Prohibit development within wetlands.

c. Require that residential buildings be set back 50 feet from the top of any bluff.[1]

d. Require that septic tanks and all component parts be set back 100 feet from Buck Creek and prohibit their placement within the 100-year floodplain.

e. Require that outhouses and earthen privies be set back 100 feet from Buck Creek and prohibit their placement within the 100-year floodplain. Require that the bottom of all earthen privies be located at least four feet above the high-water table.

f. Prohibit construction of alternative onsite wastewater treatment systems, such as pump and haul systems, within a wetland or the 100-year floodplain.

g. Require that mining activities be set back 300 feet from Buck Creek.

3. **Enhance Stormwater Regulations.** Stormwater regulations could be enhanced by requiring stormwater compliance permits prior to any development. A stormwater compliance permit requirement could be implemented through a Stormwater Management Ordinance and through site plan reviews in the Zoning Ordinance. Municipalities should consider implementing zoning ordinance compliance permits that: (1) requires an approval from their county Drain Commissioner; or (2) ensures that certain developments and/or improvements adhere to their respective county Drain Commissioner's stormwater management design requirements, if applicable.

   The Stormwater Ordinance Committee of the Lower Grand River Watershed prepared a Proposed Model Stormwater Ordinance for Local Governments within the Lower Grand River Watershed that can be utilized as a resource for further developing a municipality's stormwater ordinance.

Municipality-Specific Recommendations

The following recommendations are tailored to the individual municipalities based on the zoning ordinances, other police power protective ordinances, and local government policies they currently have in place.

City of Kentwood

The City of Kentwood has its own zoning ordinance in place, along with both a Stormwater Management Ordinance and a Soil Erosion and Sedimentation Control Ordinance. Collectively, these ordinances provide the following protections:

1. There are stormwater detention requirements in place for site condominium projects, manufactured housing communities, and planned unit developments.
2. The City can require submission of a Development Impact Assessment, which includes consideration of the impact to stormwater, water quality, and natural water courses, for developments of five acres or more for site plan review, special land use review, or rezoning.
3. Site plans are required for several categories of developments. When required, site plans must include information related to drainage, soil erosion, and sedimentation control, including storm

[1] The Natural River Zoning rules, Rule 281.51(e), defines "bluff" as follows: "Bluff" means a bank that rises at a slope of 33 degrees or greater from within 10 feet of the river's edge. The crest of the bluff is the first riverward facing area (approximately parallel to the river) that breaks to a slope of less than 18 degrees for a distance away from the river of at least 25 feet.

sewers, stormwater retention and detention ponds, drainage patterns and stormwater management measures, and soil erosion and sedimentation control measures.
4. There is a zoning district designated for the preservation of open space.
5. The Soil Erosion and Sedimentation Control Ordinance requires that all grading plans and specifications, which are required under the Stormwater Management Ordinance, contain erosion and sediment control provisions in accordance with the Kent County Drain Commissioner's Standards and Specifications for Soil Erosion and Sedimentation Control.
6. A permit and a soil erosion and sedimentation control plan are required for specified earth changes.

The following suggestions, if implemented, could further improve the City of Kentwood's mechanisms for maintaining and improving water quality:

1. Integrate low impact development ("LID") practices into regulations and policy, especially in relation to parking, roads, lot sizes and setbacks, construction, landscaping, and open space. Such practices can be required through the Zoning Ordinance or the existing Stormwater Management Ordinance. LID practices could also be encouraged through a local recognition program or by giving preference for developments utilizing LID practices in the site plan or special land use approval process. The Soil Erosion and Sedimentation Control Ordinance already provides for protections related to soil erosion and sedimentation control, and the Zoning Ordinance provides for the preservation of open space. Other possible LID techniques include street sweeping, permitting and/or setback requirements for development in environmentally sensitive areas, and protection of mature trees. SEMCOG's "Low Impact Development Manual for Michigan" and Trout Unlimited's "Rogue River Watershed: A Stormwater Guidebook" offer additional guidance on LID practices.
2. The Stormwater Management Ordinance currently requires the maintenance of a Do Not Disturb/Natural Erosion Control Zone in the vegetative strip on the bank immediately adjacent to the 100-year floodplain and prohibits alteration in that Zone. The Ordinance also provides for rear setback of 35 feet from the top of streambanks for homes, unless there is an approved development plan that does not disturb the top of the banks. The City of Kentwood could provide additional protections by expanding the protected area to include a natural vegetation strip within 25 feet of Buck Creek and the 100-year floodplain, except for removal of any dead, diseased, or unsafe tree, noxious plant, or shrub.

   The City should also prohibit direct and indirect discharges, excepting stormwater, into any water body. When stormwater is discharged, there should be requirements in place to ensure that pollutants are not discharged with it. Alteration of any natural or constructed drain, water body, or floodplain should be prohibited unless a drainage plan is approved, and standards should be created for permissible alterations.

   In enforcing the Stormwater Management Ordinance, the City should be given authority to issue a stop work order to prevent further violations. The City should also be given emergency authority as needed to protect the public health, safety, and welfare, as well as to prevent damage to property.
3. Require obtaining a stormwater compliance permit prior to any development. A stormwater compliance permit requirement could be implemented through the Stormwater Management Ordinance and by enhancing the stormwater regulations through a site plan review in the Zoning Ordinance. Application for a stormwater permit should require submission of a drainage plan that include the provision of adequate stormwater management facilities for the site. This can help ensure that proposed development activities include an adequate plan for managing stormwater and are consistent with the City's standards.

City of Wyoming

The City of Wyoming has its own zoning ordinance in place, along with a Stormwater Ordinance, Stormwater Discharges Ordinance, and Floodplain Regulations Ordinance. Collectively, these ordinances provide the following protections:

1. Site plans must include information related to the location of existing drainage courses, floodplains, lakes and streams, wetlands with elevations, and woodlands and information related to stormwater retention and detention ponds. Approval of a site plan may only be granted if any stormwater management system preserves natural drainage to the maximum extent possible and does not substantially reduce or increase natural retention or storage capacity of a wetland, water body, or watercourse and there are measures in place to prevent soil erosion and sedimentation.
2. A development may not alter the course of natural or constructed drain or drainageway, including by fences, vegetation, waste, mulch, or other landscape material, without obtaining approval from the City.
3. For development of sites of one acre or greater, the developer is required to submit a drainage plan.
4. Discharge of pollutants into a drainage facility or water body is prohibited and there are enforcement mechanisms in place.
5. Certain uses are prohibited in a floodway area, including residences, landfills, and sewage disposal systems.
6. It is believed that the City of Wyoming intends to adopt the Proposed Model Stormwater Ordinance for Local Governments within the Lower Grand River Watershed; however, the City had not yet done so at the time this review was conducted.

The following suggestions, if implemented, could further improve the City of Wyoming's mechanisms for maintaining and improving water quality:

1. Develop soil erosion and sediment control regulations. While state regulations provide for some protections, Part 91, Soil Erosion and Sedimentation Control, of the NREPA, 1994 PA 451 requires a permit only for earth changes that disturb more than one acre or are located within 500 feet of a lake or stream. Section 9106 specifically allows for adoption of a local ordinance that is more restrictive than Part 91. Like a wetlands protection ordinance, a soil erosion and sediment control ordinance can be adopted and enforced through a municipality's general police powers. The EPA provides a model local soil erosion and sediment control ordinance as well as sample ordinances from around the country. These materials can be accessed online at the EPA's website. Alternatively, the City of Wyoming could enhance soil erosion and sediment control regulations within its Zoning Ordinance through site plan requirements and review.
2. Require and/or encourage the preservation of open space. The Zoning Ordinance currently sets a maximum lot coverage in each zoning district and requires that designated common open space be no less than 15% of the total area in a PUD but does not otherwise require large areas of open space or "green space." The City of Wyoming should consider the creation of an open space zoning district to designate and preserve larger areas of open space. The City of Wyoming could also consider proposing a millage for land acquisition for the purpose of preserving open space. Additionally, or alternatively, the City of Wyoming could consider implementing a recognition program for property owners that preserve large areas of open space.
3. Prohibit the alteration of land within the natural vegetation strip within 25 feet of Buck Creek and the 100-year floodplain, except for removal of any dead, diseased, or unsafe tree, noxious plant, or shrub. This could be implemented through zoning or through a provision in the Stormwater Ordinance.

City of Grandville

The City of Grandville has its own zoning ordinance in place, along with a Stormwater Management Ordinance. Together, these ordinances provide the following protections:

1. The Zoning Ordinance designates an entire article (Article 4) to floodplain regulations and specifically references lands prone to flooding that adjoin Buck Creek.
2. Site plans must include information related to physical features of the site, including floodplains, bodies of water, and areas that are unbuildable due to wetlands. Site plans must also include information related to existing and proposed drainage systems. The Planning Commission may require submission of an environmental impact statement, including analysis of water courses and site drainage, for any development of five acres or larger. In review of a site plan, the Planning Commission is required to consider surface and stormwater impacts.
3. Adequate drainage is considered in requirements related to building grades, landscaping, driveways, and parking lots.
4. Low impact development techniques, including rain gardens, sunken parking lot islands, pervious pavements, vegetated swales, and other techniques are encouraged in site plan review.
5. Discharge of pollutants into a stormwater drainage system, river, lake, stream, creek or other watercourse, or wetlands is prohibited, and there are enforcement mechanisms in place.

The following suggestions, if implemented, could further improve the City of Grandville's mechanisms for maintaining and improving water quality:

1. Develop soil erosion and sediment control regulations. While state regulations provide for some protections, Part 91, Soil Erosion and Sedimentation Control, of the NREPA, 1994 PA 451 requires a permit only for earth changes that disturb more than one acre or are located within 500 feet of a lake or stream. Section 9106 specifically allows for adoption of a local ordinance that is more restrictive than Part 91. Like a wetlands protection ordinance, a soil erosion and sediment control ordinance can be adopted and enforced through a municipality's general police powers. The EPA provides a model local soil erosion and sediment control ordinance as well as sample ordinances from around the country. These materials can be accessed online at the EPA's website. Alternatively, the City of Grandville could enhance soil erosion and sediment control regulations within its Zoning Ordinance through site plan requirements and review.
2. Require and/or encourage the preservation of open space. The Zoning Ordinance currently sets specific setback requirements from each side of the lot, which preserves some amount of open space, and requires that planned unit developments meet specific minimum open space requirements, depending on the type of PUD, but does not otherwise require large areas of open space or "green space." The City of Grandville should consider the creation of an open space zoning district to designate and preserve larger areas of open space. The City of Grandville could also consider proposing a millage for land acquisition for the purpose of preserving open space. Additionally, or alternatively, the City of Grandville could consider implementing a recognition program for property owners that preserve large areas of open space.

Byron Township

Byron Township has its own zoning ordinance in place, along with a Stormwater Management Ordinance. Together, these ordinances provide the following protections:

1. Industrial waste is prohibited from being discharged directly into a river or stream. Sewage disposal and industrial waste treatment and disposal must be approved by the Township, along with the appropriate county and state departments.
2. The Planning Commission may require submission of a community impact assessment that describes the effects and impacts of a proposed planned unit development on adjacent and nearby streams, rivers, wetlands, and the quality and volume of surface and groundwater.
3. Site plans and sketch plans must include information related to site conditions relating to existing drainage courses, floodplains, lakes, streams, and wetlands; site grading, drainage patterns, and other stormwater management measures; and the location of underground storm sewers and drains. Approval of a site plan may be granted only where stormwater detention and drainage systems are designed so that neighboring properties and public stormwater drainage systems will not be adversely affected.
4. A stormwater permit from the Township is required for any development.
5. Several of the requirements under the Stormwater Management Ordinance also require adherence to the Site Development Rules as published by the Kent County Drain Commissioner.
6. The Stormwater Management Ordinance devotes an entire section to soil erosion and sedimentation control protections.

The following suggestions, if implemented, could further improve Byron's Township's mechanisms for maintaining and improving water quality:

1. Require and/or encourage the preservation of open space. The Zoning Ordinance currently sets specific setback requirements and creates minimum open space requirements for planned unit developments and certain manufactured housing communities but does not otherwise require large areas of open space or "green space." Byron Township should consider the creation of an open space zoning district to designate and preserve larger areas of open space. Byron Township could also consider proposing a millage for land acquisition for the purpose of preserving open space. Additionally or alternatively, Byron Township could consider implementing a recognition program for property owners that preserve large areas of open space.
2. Prohibit the alteration of land within the natural vegetation strip within 25 feet of Buck Creek and the 100-year floodplain, except for removal of any dead, diseased, or unsafe tree, noxious plant, or shrub. Under the current regulations, alteration of a floodway within the 100-year floodplain must be approved by the Township. It is unclear which Township department/official this approval should come from.
3. Integrate low impact development ("LID") practices into regulations and policy, especially in relation to parking, roads, lot sizes and setbacks, construction, landscaping, and open space. Such practices can be required through zoning or the existing Stormwater Management Ordinance, or encouraged through a recognition program or preference for developments utilizing LID in the site plan or special land use approval process. The Zoning Ordinance already encourages low impact design, including use of native vegetation, rain gardens, and vegetated swales, in landscaping. These practices could be expanded to other areas of the Zoning Ordinance and/or be framed as mandatory rather than suggestive. Other possible LID techniques include street sweeping, permitting and/or setback requirements for development in environmentally sensitive areas, and protection of mature trees. SEMCOG's "Low Impact Development Manual for Michigan" and Trout Unlimited's "Rogue River Watershed: A Stormwater Guidebook" offer guidance on LID practices.

Gaines Township

Gaines Township has its own zoning ordinance in place, along with a Storm Water and Illicit Discharge Ordinance. Together, these ordinances provide the following protections:

1. The Planning Commission may require submission of a developmental impact statement, addressing such items as streams, rivers, wetlands, quality of surface and ground waters, drainage, and stormwater impacts, with a preliminary plan for rezoning.
2. During construction, the Zoning Administrator has the authority to suspend or revoke a zoning permit if the requirements related to stormwater runoff, flooding, and other water problems are violated. Property owners have a responsibility to ensure that drainage and stormwater do not adversely impact nearby lakes, streams, or wetlands upon completion of construction.
3. A site plan is required to conform to the Kent County Drain Commissioner's surface water drainage standards, along with the Township Stormwater Ordinance. Natural drainage characteristics are to be preserved to the maximum extent possible.
4. A stormwater permit from the Township is required prior to any development.
5. The Stormwater and Illicit Discharge Ordinance devotes an entire section to soil erosion and sedimentation control protections.

The following suggestions, if implemented, could further improve Gaines Township's mechanisms for maintaining and improving water quality:

1. Integrate low impact development ("LID") practices into regulations and policy, especially in relation to parking, roads, lot sizes and setbacks, construction, landscaping, and open space. Such practices can be required through the Zoning or the existing Stormwater and Illicit Discharge Ordinance. LID practices could also be encouraged through a recognition program or preference for developments utilizing LID practices in the site plan or special land use approval process. The Stormwater and Illicit Discharge Ordinance already provides for soil erosion and sedimentation control, and the Zoning Ordinance provides for the preservation of open space. Other possible LID techniques include street sweeping, permitting and/or setback requirements for development in environmentally sensitive areas, and protection of mature trees. SEMCOG's "Low Impact Development Manual for Michigan" and Trout Unlimited's "Rogue River Watershed: A Stormwater Guidebook" offer guidance on LID practices.
2. Require and/or encourage the preservation of open space. The Zoning Ordinance currently contains provisions regarding open space in planned unit developments and reduced minimum lot sizes for plats and site condominiums that include open space but does not otherwise require large areas of open space or "green space." Gaines Township should consider the creation of an open space zoning district to designate and preserve larger areas of open space. Gaines Township could also consider proposing a millage for land acquisition for the purpose of preserving open space. Additionally, or alternatively, Gaines Township could consider implementing a recognition program for property owners that preserve large areas of open space.
3. Prohibit the alteration of land within the natural vegetation strip within 25 feet of Buck Creek and the 100-year floodplain, except for removal of any dead, diseased, or unsafe tree, noxious plant, or shrub.

Kent County

In addition to water-quality management at the township level, Kent County can also help to facilitate the protection of water quality within the Watershed. Currently, the Kent County Parks Ordinance provides for the protection of waters by prohibiting the discharge of any substance into any stream, brook, creek,

wetland, pond, tributary, river, storm sewer, or drain. Kent County has the potential to further maintain and protect water quality through the following recommendations:

1. Utilize setbacks and/or prohibit the alteration of land within the natural vegetation strip within 25 feet of Buck Creek where it traverses county parks and other county-owned land, except for removal of any dead, diseased or unsafe tree, noxious plant, or shrub. Additionally, or alternatively, implement and maintain vegetative buffer strips of at least 15 feet in width on both sides of Buck Creek or any tributaries that flow through county land.

2. Implement LID practices in county parks and on other county-owned property. These practices can include landscaping with low impact design, including use of native vegetation, rain gardens, and vegetative swales; street sweeping; and protection of mature trees. SEMCOG's "Low Impact Development Manual for Michigan" and Trout Unlimited's "Rogue River Watershed: A Stormwater Guidebook" offer guidance on LID practices.

3. Facilitate the preservation of open space through land acquisition. This can be implemented through the identification and purchase of existing natural areas. After such areas are obtained, Kent County can continue to preserve and maintain them in their natural state. Once land has been acquired, land management expectations can be put in place to offer further preservation and protection mechanisms.

Cost Estimate

The following is a *general estimate* of the costs for implementing varying water quality management activities. Actual costs may vary depending on the municipality's current regulations and type of recommendation to be implemented:

Table 26. Cost Estimates for Policy Changes.

Activity	Estimated Cost
Implement/Extend Setback Requirements	$1,400 - $2,400
Enhance Existing Stormwater Regulations	$2,400 - $3,700
Create New Stormwater Regulations	$4,000 - $8,000
Enhance Zoning Ordinance Protections - Minor Revisions*	$600 - $900
Enhance Zoning Ordinance Protections - Significant Revisions**	$3,000 - $6,000
Create and Implement a Stormwater or Wetland Ordinance***	$4,000 - $7,500
Other Miscellaneous Activities	$1,200 - $2,800

*The cost of zoning amendments, either as a result of a new police power ordinance or independently as a mechanism for improving water quality, will be specific to each municipality. Because zoning ordinances can vary greatly between municipalities, the necessary amendments will also vary for each municipality. Minor amendments will generally cost less than more significant amendments that affect multiple sections of a zoning ordinance.

**The cost of implementing a stormwater, wetland, or similar ordinance under a municipality's police powers is dependent on the number of municipalities within the watershed that are interested in implementation. The creation of an initial police power ordinance within a watershed will likely correspond with the cost estimate above. However, if several municipalities within the watershed are interested in implementation, the initial ordinance can be used as a model and updated according to the needs of each municipality. In that case, much of the cost of the initial ordinance can be split between the participating municipalities, which will decrease the cost to each individual municipality. Any municipality that is interested in a police power ordinance should correspond with other municipalities within the watershed to ensure the most efficient implementation.

The above figures are intended as estimates only. Interested municipalities should consult with legal counsel regarding the exact costs of implementation.

7.5 Information and Education Strategy

The I&E Strategy is the proposed approach to reach target audiences with specific messaging to educate the watershed population about the priority watershed pollutants and how their actions on land impact the water quality. The I&E Strategy will primarily be administered by the Friends of Buck Creek watershed group. A variety of messaging and distribution techniques are outlined in the tables below to distribute specific messages to specific audiences. The tables in this section discuss the focus areas, messages, critical areas, target audiences, pollutant information, action items, potential partners in the watershed, estimated costs, and evaluation methods.

Goals and Objectives

The I&E goal is to increase the involvement of the community in restoration activities and watershed protection. To assist in meeting this goal, this I&E Strategy recommends coordinating efforts with the Public Education Plan (PEP) being implemented by Lower Grand River Watershed communities in accordance with NPDES MS4 Storm Water Regulations[2]. The objective of the I&E strategy is to create a usable guide for watershed stakeholders to disseminate information in the most effective way possible to make a measurable improvement in water quality. Targeted messages have been created for specific audiences such as homeowners with septic systems, agricultural producers, municipalities, and schools within the watershed. Three major objectives must be met to achieve the I&E goal. These objectives will move target audiences through three phases of outreach: awareness, education, and action. The messages and delivery mechanisms used to achieve these outcomes will vary with each target audience.

Goal 1: Improve water quality to restore: designated uses of full body and partial body contact recreation, cold-water fisheries, warm-water fisheries, and other indigenous aquatic life and wildlife that are threatened throughout watershed.

Goal 2: Improve community understanding of non-point source pollution and associated water quality problems through education, outreach, and opportunities for action.

Goal 3: Promote and incentivize sustainable agricultural practices throughout the watershed to reduce polluted runoff entering waterways.

Objective 1 - Awareness: Bring awareness to the target audiences that they live in a watershed with a rare urban trout stream and other unique resources, and that their day-to-day activities affect the quality of those resources.

Objective 2 - Education: Educate target audiences on the link between urban development, agricultural activities, and water quality impacts then highlight what actions can be taken to reduce impacts.

Objective 3 - Action: Motivate the target audiences to adopt and implement practices that will result in water quality improvements. These practices may include homeowner activities such as reducing fertilizer application, maintaining septic systems, purchasing properties with low-impact design elements, maintaining stream buffers on their properties, or supporting land use planning practices in the Watershed.

[2] PEP for the MS4 Communities in the Lower Grand River Watershed is accessible at https://www.lgrow.org/ms4information

Implementing I&E Strategy

Implementation of the I&E strategy will be the responsibility of the Friends of Buck Creek watershed group, committees, municipalities, and other stakeholders in the watershed. Focus areas are listed in Tables X with priority pollutants, target audiences, messages, delivery mechanisms, and evaluation measures for each. It is recommended that watershed stakeholders consider hiring a watershed coordinator to implement the WMP, including the I&E strategy.

Target Audiences

The BCW is mostly in an urban part of West Michigan. Land use in the lower section of the watershed is primarily urban and the upper portion is primarily rural and agricultural. In order to achieve the goals, the disbursement of information must be done in a way that is effective and well received by those who live and work in the watershed. The following target audiences include groups known to impact, or be impacted by, water quality:

- Agricultural Producers
- Builders and Developers
- Business Owners
- Faith-Based Organizations
- Lawn Care Companies
- Local Units of Government
- Michigan Department of Transportation
- Municipalities (Allegan, Byron Center, Gaines Township, Kentwood, Wyoming, Grandville, Grand Rapids)
- Pet owners
- Recreational Users (Golf & Disc Golf courses, ORV users, Outdoor Enthusiasts)
- Residential Landowners with Septic Systems
- Riparian Landowners
- Schools
- Stormwater Operators
- Urban Residents
- Watershed Groups

Audience Characteristics

Characterizing each target audience is an important part of implementing an I&E strategy. The level of understanding of watershed management, the types of values and concerns, and the level of enthusiasm that people have for participation in watershed management activities are expected to differ across the diverse groups that make up the community. Collecting demographic information will help define the socioeconomic structure of each target audience. Information on existing knowledge of watershed issues, current attitudes and beliefs, and existing communications channels should be determined before initiating an education campaign. This information will ensure that appropriate messages are reaching the designated target audiences using effective formats and distribution methods which will contribute to getting individuals involved in the watershed management process.

I&E Messages

Messaging must be specific for each target audience to focus their concerns and are action-oriented, understandable and create a desire to change. Messages should focus on protecting and enhancing water quality. These messages should be repeated frequently to be effective. Each audience will respond differently to the information presented, and it is critical that the information be tailored to each audience. Some messages will be applicable to all audiences. Each target audience must have a clear understanding

of the watershed problems being addressed and how the project is addressing these problems before any behavioral changes are to take place.

- Sustainable Agriculture Practices
    - Proper manure storage will prevent loss and contaminated runoff from entering nearby waterways.
    - Livestock exclusion fencing should always be used to prevent water contamination of local waterways.
    - Changing tillage practices from conventional till to no till or reduced till will improve soil health, reduce soil loss, and increase water absorption.
    - Creating buffer zones along the edges of crop fields using native plants or cover crops prevents erosion and can increase the presence of pollinators.
    - Installing grassed waterways where gullies appear will reduce soil loss and erosion.

- Proper Septic System Care
    - Have septic systems serviced every 3-5 years to prevent costly failures in the future. Problems that are likely to occur in a malfunctioning septic system include the release of disease-causing pathogens or nitrate contamination of surface waters.
    - Test your well water annually to make sure your water supply is not being impacted by a malfunctioning septic system. Contact your County Health Departments for more information.
    - Avoid pouring fats, grease, oil and solids down the drain which can clog the drain field and cause system malfunction.

- Riparian Stewardship
    - Maintaining a minimum of a 10’ no mow/riparian zone/buffer zone along shorelines will prevent erosion and shoreline loss.
    - Plant buffer zones with native species whose roots will secure shorelines and increase habitat for both aquatic and terrestrial species.
    - Buffer zones with tall grasses and other tall plants decrease geese presence along shorelines.
    - Use phosphorus free fertilizer to prevent harmful algae blooms.

- General Watershed/Stormwater Awareness
    - A watershed is the area of land that drains to a common waterbody.
    - Groundwater and surface water are connected within a watershed, and both supply our drinking water, agricultural irrigation, and manufacturing processes.
    - Storm drains lead directly to waterways.
    - Stormwater runoff is generated from rain and snowmelt that flows over land or impervious surfaces, such as paved roads, parking lots or building rooftops, that does not soak into the ground.
    - Clean water supports businesses, agriculture, wildlife, recreation, and community health and safety.

- Best Practices to protect your watershed
    - Pick up pet waste to prevent *E. coli* and harmful bacteria from entering waterways.
    - Wash your car at the car wash where used water is recycled or treated or wash on the grass where contaminated water can soak into the ground instead of carrying pollutants like soap and oil into storm drains.

    - Do not put anything in a storm drain.
    - Keep storm drains clear of debris and trash to prevent street flooding and pollution from entering waterways.
    - Use phosphorus free fertilizer to prevent harmful algae blooms in local waterways. Traditional lawns do not need phosphorus to grow lush and green, but if soil tests indicate a need, always use as directed.
    - When snow falls, shovel first and salt second. Removing snow first will reduce the amount of salt needed. Be sure to not over salt, when snow melts the salt will be washed into storm drains and can make waterways inhabitable to aquatic life.

Delivery Mechanisms

Delivery mechanisms must be diverse to reach the largest possible audience and will include events, presentations, both print and virtual materials. Repetition is key for changed behavior and to get the best results. Some delivery mechanisms will be more appropriate for certain target audiences than others. It is widely accepted that the method for each target audience should be awareness, education, and action. Target audiences will be made aware of the issue, educated on how to prevent or remedy the issue, and become empowered to act.

- Targeted Mailings/E-mailings
    - Agricultural landowners
    - Septic system owners
    - Riparian landowners
- Events
    - Farm Demonstration Days
    - Workshops / Trainings
    - School Presentations
    - Community Gatherings
- Newsletters (Digital and Printed)
    - School Newsletters
    - Township/City Newsletters
- Local Newspapers
- Media Outlets
    - M-Live
    - Newsrooms (Fox17, WOODTV)
- Social Media
    - Friends of Buck Creek Facebook page
    - Community Facebook and Instagram pages
- Informational Signs and Pet Waste Stations
    - Public Recreation Sites
    - Trail heads
    - Parks
    - City and Township Halls
    - Restaurants

Collaboration and Partnerships

Partnerships with Friends of Buck Creek will increase the overall reach of the I&E implementation plan. Partnerships will regulate messaging so that target audiences will receive the same information and resources from multiple trusted sources which will increase the likelihood of awareness, education, and action.

- **Potential Partners**
    - Chamber of Commerce
    - County Conservation Districts (Allegan & Kent)
    - County Drain Commissioners (Allegan & Kent)
    - District Libraries (Allegan & Kent)
    - Federal Governmental Organizations (USDA, NRCS)
    - Groundswell (GVSU)
    - Houses of Worship
    - Lake and Homeowners Associations (HOAs)
    - Lower Grand River Organization of Watersheds (LGROW)
    - Michigan Department of Health and Human Services (MDHHS)
    - Michigan State University Extension (MSUE) and Clarksville Research Center
    - Municipalities (Allegan, Byron Center, Gaines Township, Kentwood, Wyoming, Grandville, Grand Rapids)
    - Public Recreational Areas (Golf Courses, Boat Launches, Trails, Disc Golf Courses)
    - Schools
    - State Governmental Organizations (Michigan Department of Environment, Great Lakes, and Energy (EGLE) and Michigan Department of Agricultural and Rural Development (MDARD), Michigan Agriculture Environmental Assurance Program (MAEAP))
    - Trout Unlimited

Table 27. Recommended I&E for *E. coli*

Focus: *Escherichia coli* (*E. coli*) and pathogens						
Message(s): *E. coli* and other harmful pathogens are dangerous to human health. You can help keep our waters safe. Have septic systems serviced every 3-5 years to prevent costly failures in the future and prevent *E. coli* and other pathogens from entering waterways. Proper manure storage will prevent loss and contaminated runoff from entering nearby waterways. Livestock exclusion fencing should be used to prevent water contamination of local waterways. Pick up pet waste to prevent *E. coli* and harmful bacteria from entering waterways.						
Critical Area(s): Agricultural land, riparian land, rural/residential areas with septic systems, walking trails/sidewalks, public parks						
		Measurable Milestones				
Target Audience	**Source/Cause**	**Awareness/Education (within 3 years)**	**Action (3 or more years)**	**Potential Partners**	**Estimated Cost**	**Evaluation Method**
Rural Residents	Aging and/or improperly connected septic systems	Print and distribute "A Homeowners guide to septic systems", Post infographics on county/local social media, distribute media releases	Support a "Time of Sale or Transfer" (TOST) program or something similar in your community that requires properties with on-site wells and/or on-site sewage systems to be checked when property sold or transferred to a new owner	MDHHS, Municipalities, Realtors, Friends of Buck Creek	$1,500 to develop, print, and distribute brochures $200 to develop and insert in local newspapers	# of septic systems repaired or replaced
Riparian Landowners	Urban Wildlife	Offer 3 walking/ demonstration tours incentivized with food to display effective goose determent through riparian buffers and no mow areas around waterbodies	Develop guidelines for homeowner associations to implement riparian buffer vegetation expectations to manage goose population	Conservation Districts, Lake and Homeowners Associations, LGROW	$40/hr outreach and technical assistance $50/hr for installation of riparian buffer zones + $7/sq. ft. for plants and materials	# of attendees # of HOAs implementing guidelines
Agricultural Landowners	Over or improper application of manure on cropland; Uncontrolled livestock access to river	One-on-one meetings with producers to evaluate Nutrient Management Plans (NMPs). Conduct 3 Farmer Demonstration Days to distribute info about impacts of uncontrolled livestock access to river and possible funding for fencing	Revised NMPs, Outreach and assistance with technical and financial issues for exclusion fencing	MAEAP, MDARD, Conservation Districts, MSUE	$1,200 for 3 Farmer Demo Days $40/hr for evaluation No cost for technical and financial assistance, if provided	# Linear feet of exclusion fencing installed # of NMPs revised

Local Governments	Faulty sanitary sewer connections Aging and/or improperly connected septic systems Urban Wildlife	Conduct 3 workshops on locating and correcting faulty connections and sanitary system regulations. Participate in EPA's annual SepticSmart education campaign in September. Distribute brochures and videos on successful wildlife management techniques	Adoption of regulations/ ordinances for septic system inspections. Apply for needed funding for sewer upgrades. Evaluate water areas in need and Install signs with "Please don't feed waterfowl"	MDHHS, EGLE, Municipalities	$3,000 for 3 workshops $5,000 per community ordinance development $40/hr for evaluation $300 per sign	# miles of upgraded sanitary sewer # of septic systems inspected Ordinance adopted # of signs installed
Pet Owners	Animal waste	Identify locations for new waste stations at parks, public recreation areas, along popular walking trails/sidewalks.	Install pet waste stations at all identified locations.	Municipalities, Public Recreation Areas, LGROW	$700 to install and maintenance each pet waste station	# of stations installed

Table 28. Recommended I&E for Water Temperature and Dissolved Oxygen

Focus: Temperature and Dissolved Oxygen						
Message(s): As temperatures increase, dissolved oxygen decreases. This causes an increase in pathogens, invasive species, and algal blooms. It may cause certain aquatic species to die off. Increased temperatures lead to increased rates of evapotranspiration, resulting in volume loss in waterbodies. Agricultural runoff, lack of riparian habitats, and urban storm water runoff from impervious surfaces all cause increased stream temperatures and decreased amounts of dissolved oxygen.						
Critical Area(s): Agriculture land, riparian land, urban areas						
		Measurable Milestones				
Target Audience	**Source/Cause**	**Awareness/Education (within 3 years)**	**Action (3 or more years)**	**Potential Partners**	**Estimated Cost**	**Evaluation Method**
Riparian Landowners	No riparian buffer	Develop and advertise a program for riparian planting in local newspapers and conservations districts' tree and native plant sale notices. Conduct 3 workshops about importance of riparian habitats and tree plantings/ native plant sales in coordination with Arbor Day	Assist 10 riparian landowners with planting trees and native plants, host 3 volunteer plantings at local businesses	Conservation Districts, LGROW, Drain Commissioners, Friends of Buck Creek, TU	$200 to develop and insert in local newspapers $2,100 for 3 workshops $40/hr to plant trees + $150 per tree	# of trees/ native plants planted in the riparian zone # of people reached through advertising methods
Local Governments	Impervious surfaces	Develop and distribute fact sheets on Low Impact Development (LID) practices to reduce impervious surfaces. Conduct 3 trainings to local officials on LID practices	Adopt LID ordinances in all communities in watershed to reduce impervious surfaces	Road Commissioners, LGROW, EGLE, Municipalities	$1,500 to develop and distribute fact sheets $1,000/training $5,000 per ordinance development	# of LID ordinances adopted
Agricultural Landowners	Agricultural Runoff	Direct mailings and e-mailing's to 100 producers about CCRP, CREP, and EQIP programs to manage manure and feedlot runoff	Assist 15 producers in installing BMPs to reduce runoff. Outreach and assistance with technical issues with enrolling in CCRP, CREP, and EQIP programs	MAEAP, MDARD, MSUE, NRCS, Conservation Districts	$400 for printing and mailing No cost for assistance, if provided through existing programs	# of produces enrolled in programs # of BMPs installed

Table 29. Recommended I&E for Sediment

Focus: Sediment						
Message(s): Sediment loss through streambank erosion causes loss of habitat in waterways. Changing tillage practices from conventional till to no till or reduced till will improve soil health, reduce soil loss, and increase infiltration. Creating buffer zones along the edges of crop fields using native plants can increase pollination and prevent erosion. Installing grassed waterways where gullies appear will reduce soil loss and erosion. Planting cover crops will reduce soil loss, erosion, and improve soil health. Maintaining a minimum of a 10' no mow/riparian zone/buffer zone along shorelines will prevent erosion and shoreline loss. Planting buffer zones with native species will stabilize shorelines and increase habitat for both aquatic and terrestrial species.						
Critical Area(s): Agricultural land, riparian land						
		Measurable Milestones				
Target Audience	**Source/Cause**	**Awareness/Education (within 3 years)**	**Action (3 or more years)**	**Potential Partners**	**Estimated Cost**	**Evaluation Method**
Agricultural Producers	Conventional Tillage Practices, Gully erosion	Conduct 3 Farmer Demonstration Days to distribute information about cover crops, buffer zones, grassed waterways and no-till practices	Provide incentives through EQIP to implement no-till practices, buffer zones, and grassed waterways	MAEAP, MDARD, Conservation Districts, NRCS	$1,200 for 3 Farmer Demo Days No cost for technical and financial assistance, if provided	# of soil conservation practices implemented
Riparian Landowners	Streambank erosion	Offer 6 walking/ demonstration tours incentivized with food, get participants contact info (email)	Distribute Michigan Natural Shoreline Partnership (MNSP) educational materials through email. Conduct Green Infrastructure Site Assessments with participants who provided their contact information	Conservation Districts, District Libraries, TU, NRCS, Local businesses, LGROW	$2,400 for 6 demonstration tours + $600 for food and supplies $80 per site assessment	# of participants in tours # of Shoreline Care Guides distributed # of site assessments
Local Government	Streambank erosion	Establish buffer ordinances for a minimum of 10 ft. along shorelines. Complete drafts of ordinance	Complete final ordinance. Work with 3 communities to get ordinance approved	NRCS, TU, Municipalities, Road Commissioners	$7,500 per community ordinance development	# of communities that adopted a shoreline buffer ordinance

Table 30. Recommended I&E for Nutrients

Focus: Nutrients						
Message(s): Use phosphorus free fertilizer to prevent harmful algae blooms in local waterways. Traditional lawns do not need phosphorus to grow lush and green, but if needed, always use as directed and be careful not to over fertilize. Avoid detergents and household cleaners that contain phosphorus/phosphates. Nutrient rich waters encourage excessive plant growth, deplete oxygen, and impair aquatic habitats.						
Critical Area(s): Homeowner land, Agricultural land						
		Measurable Milestones				
Target Audience	**Source/Cause**	**Awareness/Education (within 3 years)**	**Action (3 or more years)**	**Potential Partners**	**Estimated Cost**	**Evaluation Method**
Homeowners	Over or Improper fertilization	Create a display about effects of excessive nutrients and BMPs to control overuse. Display at local libraries, county fairs, town meetings, and at local lawn and garden retailers. Provide informational website link/QR code on display. Post display info on Conservation districts social media	Test soil for at least 100 landowners (voluntary) and send samples to MSUE for analysis	MSUE, Lawn and garden retailers, Conservation Districts, District Libraries, TU	$500 to create a display 25$ per soil sample for landowners	# of people who visited website # of soil samples sent for analysis # of interactions with people at events
Agriculture Producers	Over or improper fertilization	Distribute information about Farmstead Systems, Cropping Systems, Livestock Systems, as well as possible tax credits at 3 Farmer Demonstration Days and connect farmers with local MAEAP technician	Conduct a total of 30 evaluations for Farmstead System, Cropping System, and Livestock System through MAEAP and MDARD. Assist with completion of 10 Comprehensive Nutrient Management Plans (CNMP)	MAEAP, MDARD, Conservation Districts, MSUE	$1,200 for 3 Farmer Demo Days $40/hr for evaluation $5,000 per CNMP	# of MAEAP verified farms # of CNMPs completed

Table 31. Recommended I&E for General NPS Pollution

Focus: Non-Point Source Pollution						
Message(s): Storm drains lead directly to waterways. Wash your car at the car wash where used water is recycled or treated or wash on the grass where contaminated water can soak into the ground instead of carrying pollutants like soap and oil into storm drains. Keep storm drains clear of debris and trash to prevent street flooding and pollution from entering waterways. When snow falls, shovel first and salt second. Removing snow first will reduce the amount of salt needed. Be sure to not over salt, when snow melts the salt will be washed into storm drains and can make waterways inhabitable to aquatic life. Mercury and polychlorinated biphenyls (PCBs) are the main pollutants that build up in fish in this watershed. You can prevent mercury from building up in your body by choosing species of fish with low mercury concentrations and spacing your fish meals out. PCBs build up in your body over time, it is important to reduce your lifetime exposure to PCBs by avoiding fish from locations with high concentrations of PCBs.						
Critical Area(s): Everywhere						
		Measurable Milestones				
Target Audience	**Source/Cause**	**Awareness/Education (within 3 years)**	**Action (3 or more years)**	**Potential Partners**	**Estimated Cost**	**Evaluation Method**
General population	Non-point source pollution	Identify existing activities for K-8 grades to learn about non-point source (NPS) pollution. Distribute activities at school presentation days. Promote LGROW's Adopt a Drain program	Give educational presentations at elementary and middle schools about pollution in our watershed and focus on NPS pollution. Hold block parties for people who adopted drains to distribute materials	Conservation Districts, LGROW, MSUE, Local Schools, Groundswell	$50/hr to create, distribute, and present materials	# of educational school presentations given # of storm drains adopted

7.6 Land 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, 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 incentives are available for landowners preserving high priority areas tax-incentives, conservation easement-purchase, or other programs such as the NRCS Wetlands Reserve Program, Land Conservancy of West Michigan or Kent County Farmland Preservation 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 should be protected. Lands that meet both water quality and land conservancy partner goals are considered more likely to be protected. Land conservancy partners indicate they focus "on projects with significant natural resources including river frontage and wetland, larger sized tracts, and those pieces with either adjacent protection or public ownership" (CRA, 2011). Therefore, the very highest priority areas for preservation generally meet a combination of these criteria. Where possible, these types of properties should be priority for protection: Protection of riparian buffer along streams; Presence of high quality wetlands or other high quality or rare habitats; Connectivity with other protected lands or; Presence of pre-settlement vegetation.

Protection of riparian buffer along streams

Wetlands, forested or vegetated lands that are located within 500' (and contiguous) of the Buck Creek mainstem or tributaries and cold-water streams are the highest priority. These lands provide good habitat and protect water quality by filtering water prior to it reaching the streams and rivers. Riparian areas adjacent streams also include groundwater recharge areas critical to cold-water and groundwater fed systems found in the BCW.

Presence of pre-settlement vegetation

Areas known to contain European pre-settlement wetlands, habitats or vegetation are prioritized for protection. Of most interest are areas that are still in a natural land cover state. As previously described, wetlands are particularly important ecosystems for wildlife, aquatic life, threatened and endangered species, water quality, storage capacity during flooding, and hydrology.

Presence of high quality wetlands or other high quality or rare habitats

Areas that host rare species are typically undisturbed and otherwise worthy of protection for a variety of reasons. Preserving biorarity areas preserves a diversity of species that are less commonly found and the highest quality habitats for the designated use of "habitat for other indigenous aquatic life and wildlife."

Connectivity with other protected lands

The preservation of natural lands adjacent and/or nearby existing public lands maintains contiguous habitats and corridors, which is important to sustaining a diversity of flora and fauna, functioning ecosystems, and ultimately protecting water quality. Large natural areas are more likely to provide a properly functioning ecosystem than small natural areas, which are often more susceptible to anthropogenic disturbances (Denning, 2008).

7.7 Pollutant Reduction Goals

Reduction goals were calculated specific to each pollutant, based upon existing data and WQS. Pollutant loadings should be monitored after BMP implementation so progress toward reduction goals can be evaluated. Implementation schedules and the rate of BMP adoption should then be adjusted to ensure that the TMDL goals will be met.

E. coli

Reduction goals for this project are based upon the relationship between existing *E. coli* concentrations and the WQS. The ultimate goal is to have all water bodies meet the WQS. Because the *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 for TBC; 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.

Though it is unknown how many BMPs are needed to attain the WQS on a watershed scale, previous studies suggest that significant reductions in *E. coli* concentrations are possible. Horizon (2010) reports 58% reductions as a result of site-specific wetland restoration in the Tyler Creek watershed. This study suggests that if BMPs are installed on a watershed scale, large-scale reductions in *E. coli* concentrations are feasible.

Water Temperature

The mainstem of the Buck Creek and all of its tributaries are listed as designated trout streams in under Michigan Fisheries Order 210.08. Designated trout streams are expected to sustain populations of coldwater fish species, including trout, and meet the WQS for water temperature (<68°F) and dissolved oxygen (>7 mg/L). It is unknown how many BMPs are necessary to meet the WQS for coldwater fishery.

Buck Creek

The upper reaches of Buck Creek have been found to be impaired, from the headwaters downstream to 84th Street. In this reach, water temperatures must be reduced by approximately 4.0°F.

Crippen Drain

Data collected from Crippen Drain in 2015 found water temperature to occasionally exceed the WQS by about 1.0°F.

Cutlerville Drain

Data collected from Cutlerville Drain in 2015 found water temperature to occasionally exceed the WQS by about 1.0°F.

Heyboer Drain

Data collected from Heyboer Drain in 2015 found water temperature to occasionally exceed the WQS by about 1.0°F.

Sediment

Three primary sources of sediment were identified in this WMP; agricultural lands, public roads and streambanks. There is no true numerical WQS for “sediment”, but 30 mg/L is considered to be the maximum value for total suspended sediment and can be used as a comparison value. According to the MDEQ Pollutants Controlled Manual, sediment BMP’s can be considered 100% effective; however, 90% efficiency was determined to be a more realistic goal for this planning effort.

Agricultural Lands

The annual loading from critical sites identified in this WMP is 1,010 tons. Pollutant reduction goals for agricultural sites are notoriously difficult since landowners are slow to embrace the importance of water quality, and because the critical sites are owned by dozens of individual landowners. While a reduction goal of 1,010 tons per year certainly seems feasible, a larger effort to engage agricultural producers is likely necessary before that might happen.

Streambanks

The annual loading from the critical sites identified in this WMP is 2,158 tons. Assuming that streambank stabilization BMPs are 90% effective, a reduction goal of 1,942 tons/year is appropriate if installing BMPs.

Nutrients

Three primary sources of nutrient were identified for this WMP. As well, chlorides were determined to be a concern and are included under nutrients for purposes of the plan.

Agricultural Lands

The annual loading from critical sites identified in this WMP is 5,300 pounds of nitrogen and 1,570 pounds of phosphorus on an annual basis. As described above, pollution reduction on farmland often takes many years to achieve. Reduction goals of 5,300 pounds of nitrogen and 1,570 pounds of phosphorus per year would not be difficult if landowners are willing to cooperate with water quality improvement efforts.

Livestock Sites

These sites are contributing approximately 1,102 lbs. of nitrogen and 214 lbs. of phosphorus to surface water, on an annual basis. Assuming that landowners will work cooperatively and BMPs are 90% effective, the goals for this WMP are to reduce nitrogen loading by 992 lbs. and phosphorus loading by 193 lbs. per year.

Humans

As discussed previously, nutrient loads from leaking septics, failing or improperly maintained sewage treatment infrastructure and biosolids applications are difficult, at best, to quantify. Chloride products applied to roadways in winter run into the stream and affect the aquatic community; the load is impossible to quantify but recent updates to WQS provide a value for comparing field measurements.

7.8 Technical Assistance

Technical assistance is often necessary for non-profit or volunteer based groups to implement many of the activities recommended in a WMP. Even for those with significant experience in grant writing, project management and BMP installation, a team-oriented approach is often the best option. This WMP was authored by SES, Schrems and GMVC, with guidance and assistance from EGLE. This team is also very capable of providing the direction and technical assistance necessary for implementing this plan. As well, the Allegan and Kent Conservation Districts, Land Conservancy of West Michigan, United States Fish and Wildlife Service, Michigan Department of Natural Resources and Natural Resources Conservation Service are likely to provide input.

7.9 Funding Watershed Management Activities

Relative to costs to implement this WMP, which are overwhelming, a variety of funding assistance is available. Funding assistance can be specific to installing BMPs, monitoring, improving road crossings, and more. Most of the groups associated with this planning effort or listed as partners are savvy to grant programs and other sources of funding, usually related to their areas of interest or their discipline. Examples include:

- Federal Clean Water Act Section 319
- Trout Unlimited's National Embrace-A-Stream
- USFWS Partners for Fish and Wildlife

- Sustain Our Great Lakes
- National Fish and Wildlife Foundation
- USFWS Fish Passage Program
- NRCS cost sharing programs
- Grand Rapids Community Foundation
- Frey Foundation
- Clean Michigan Initiative
- Great Lakes Restoration Initiative
- Clean Water State Revolving Fund
- MDNR Aquatic Habitat Grant Program

8.0 EVALUATION AND MONITORING PLAN

The goal of this WMP is to assist the Buck Creek community in ensuring the long-term protection and improvement of the river and surrounding lands, with focus on the designated uses applicable to the BCW that are mandated by state and federal water quality programs. The progress made in achieving the goals and objectives of this plan, and the goals of the TMDL, must be measured to determine overall effectiveness. Chemical, physical and biological water quality monitoring, as well as social monitoring, can be used to help assess progress towards meeting watershed goals. 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

<u>Social Indicators</u>

Program assessments can be conducted on an ongoing basis through evaluations and surveys at workshops and educational events, focus groups, meetings, media coverage, and social media participation. Community feedback from the public can be gathered through interactive events with the public. This feedback can be used to adapt the I/E strategy, as needed.

Evaluation measures will provide feedback to determine what methods work and areas that still need improvement, including TMDL areas. Tables 28-32 have specific evaluation measures for each pollutant and target audience to assess the success of each delivery mechanism. Although evaluation of specific components within the I&E Strategy will occur continuously, the I&E Strategy should be periodically reviewed and adjusted, as necessary. Questions that should be considered during implementation of the I&E Strategy are listed below.

- Are the planned activities being implemented according to the schedule?
- Is additional support needed?
- Are additional activities needed?
- Do some activities need to be modified or eliminated?
- Are the resources allocated sufficient to carry out the tasks?
- Are all of the target audiences being reached?

- What feedback has been received and how does it affect the I&E strategy program
- How do the Best Management Practices (BMP) implementation activities correspond to the I&E strategy?

The most meaningful evaluation measure will be improved water quality and stability of Buck Creek and its tributaries.

Partnership Programs

A number of existing 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. If efforts are made to encourage participation in these programs as a part of implementing this WMP, an evaluation of participation in these programs, as compared to previous years, can be used as a monitoring benchmark.

Policy Adoption and Implementation

Recommendations are included in this plan related to septic system policies, wetland protection, 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.

BMP Tracking and Interim Measureable Milestones

BMPs recommended in this plan to address the watershed impairments are practices known to help improve water quality. A measure of the quantities of installed BMPs provides evidence that progress is being made at reducing pollutant loading.

Water Quality Monitoring

Direct surface water measurements and biological monitoring can be used to determine if the watershed is meeting the goals and objectives of this WMP. Tracking water quality improvements associated with the implementation of BMPs is a top 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. Specific monitoring should include:

- Submit a Targeted Monitoring Request for EGLE to collect up-to-date information from the BCW in 2024 and subsequent monitoring years.
- Thermally classify all designated coldwater streams to describe each stream reach. Data loggers should be placed to expand on the existing data set for all stream in the BCW.
- Continue water temperature monitoring to ensure compliance/document exceedances of water quality standards and to understand long-term variability or change.
- Conduct periodic sampling for *E. coli* to document compliance or exceedances of water quality standards.
- Understand macroinvertebrate density and diversity (including crayfish) by continuing semi-annual monitoring; at least one site on every tributary stream should be established.
- Periodically monitor the fish community to describe species composition and trout population density and size, in all designated coldwater streams.
- Conduct a detailed assessment and develop an inventory of potential wetland restoration or stormwater detention sites.
- Begin a nutrient monitoring program to develop an understanding of exceedances of WQS and impacts on designated uses.
- Develop and implement monitoring program to determine impact of ammonia and chloride on aquatic organisms.

- Develop and implement monitoring program to determine impact of biosolids on surface waters.
- Document occurrences of any new or particularly destructive invasive species.

Water quality monitoring should follow an approved QAPP and results should be compared against existing WQS and WQC described in Table 6 of Chapter 4. The QAPP that was approved for work completed as part of this WMP is included in Appendix A. Water quality monitoring results and benchmarks will be assessed to determine whether the practices are resulting in the desired water quality pollutant load reductions – the ultimate goal of this WMP is to ensure that the BCW is meeting the designated uses described in Chapter 4. If pollutant load reductions or water quality improvements are realized following BMP adoption or I/E program implementation, it can be assumed that the BMPs are effectively achieving the goals of the WMP and TMDL.

Determining the location of monitoring sites is extremely important in establishing a quality data set. Site locations will depend on a variety of factors, including the parameter being measured, the purpose of the monitoring (to describe baseline conditions, to understand long-term trends, to record change over time, to evaluate site-specific BMPs, etc.), accessibility and more. As monitoring plans are developed, expertise of local project partners must be utilized to determine the best site locations for all data collection.

Of interest specific to monitoring conducted within the BCW over the years, LGROW maintains a publicly accessible database (https://www.lgrow.org/communityscience). In addition, the City of Wyoming continues to collect water quality data that can also be found in this database.

The following monitoring is recommended, but should be coordinated with City of Wyoming and any other entities involved in monitoring work. It is suggested that a “Monitoring Committee” is established to ensure the most efficient use of time and resources.

Table 32. Recommended Water Quality Monitoring for Determination if BCW Sites are Meeting Water Quality Standards and if Designated Uses are Being Met.

Type of Analysis (Methods)	Timeline/Frequency	Estimated Cost	Responsible Party
E. coli Monitoring	30-day geomeans; annually Wet weather sampling as needed	$75/sampling location	Schrems, FOBC, EGLE, KCD
Nutrient Monitoring	Annually	$75/sampling location	Schrems, FOBC, EGLE, KCD
Water Temperature	July mean temperature; annually	$200/sampling location	Schrems, FOBC, EGLE, KCD
Chloride	Monthly for two years	$200/sampling location	Schrems, COW, FOBC, EGLE, Conservation Districts
Stream Habitat (following P51) and Macroinvertebrate Assessment (Volunteer monitoring should follow MiCorps methods; EGLE or	Annually; pre-and post BMP implementation	$500/Site	Schrems, FOBC, EGLE, KCD

trained volunteers should follow P51)			
Biosolids application sites	Annually	$100/Site	Schrems, FOBC, KCD
Biological Survey at stratified random and targeted sites	5 year Interval	TBD	EGLE

It is recommended that a committee of qualified and interested partners begins meeting on a semi-annual basis to plan and implement relevant monitoring activities. This committee will be tasked with organizing and evaluating data to determine if BMPs are working, if WQS are being met, if designated uses are being attained and, importantly, what must be done to steer the project if no measurable progress is being made based upon the timelines established within this WMP. All pertinent data should be uploaded to the LGROW data repository, by an appointed individual, perhaps the committee chair. EGLE staff will continually be updated on the status of designated uses and exceedances of WQS.

Finally, it is recommended that this WMP is updated every five years to highlight completed implementation projects, to re-assess the watershed condition, and to 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. When implementation is underway, yearly progress summaries may be beneficial to aid communities and agencies to see progress and to see where more work is needed. 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.

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