COLDWATER RIVER WATERSHED MANAGEMENT PLAN

PREPARED BY:

SCHREMS WEST MICHIGAN TROUT UNLIMITED

Environmentally Involved Since 1962

WITH FUNDING AND SUPPORT FROM:

EGLE MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

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1.0 INTRODUCTION

The Coldwater River watershed (CRW) is located southeast of the City of Grand Rapids, Michigan and drains about 189 square miles of, primarily agricultural (70.6%), lands in Barry, Eaton, Ionia and Kent Counties (Figure 1). The Coldwater flows into the Thornapple River, which in turn discharges to the Grand River. The CRW is located within portions of Barry, Ionia, Kent and Eaton Counties.

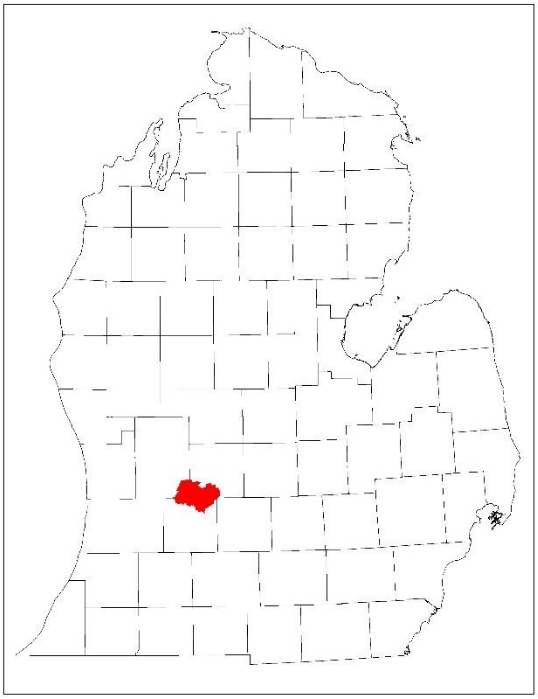

Figure 1. Location of CRW

The CRW has an existing watershed management plan, which was last updated in 2009. This WMP suggests that the coldwater fishery is the greatest and most valuable asset within the CRW. The Coldwater River is, in fact, a designated coldwater stream and the river and some of its tributaries are stocked with trout by Michigan Department of Natural Resources (MDNR), making the area a popular destination for anglers. The WMP identifies that the coldwater fishery is threatened by increasing water temperatures, low dissolved oxygen and excessive sedimentation, largely due to impacts associated with agricultural practices. Because the CRW is heavily farmed, and contains thousands of acres of prime farmland, conflicts of interest often arise between user groups.

The 2009 WMP also lists the designated uses of partial and full-body contact recreation as being impaired by *Escherichia coli* (*E. coli*) contamination, as described in the 2005 Total Maximum Daily Load (TMDL) document (MDEQ 2005). Ongoing studies of the CRW have concluded that fecal contamination continues to be a problem. Agricultural runoff and failing septic systems, among other issues, are leading to *E. coli* concentrations that exceed Water Quality Criteria established by the state of Michigan.

Much has occurred in the CRW since 2009, resulting in both improvement and additional challenges related to water quality. The existing WMP was used successfully as a catalyst for on-the-ground improvements, and to guide a substantial amount of monitoring work. The intercounty drain board commissioned a project to alleviate flooding issues associated with dead trees and debris, but resulted in significant clearing of about 11 miles of stream channel and riparian areas, wetland fill, and an Administrative Consent Order to repair the damage. Several violations have been issued by MDEQ/EGLE to farms and the Lakewood Wastewater Authority for discharge of fecal contamination to the surface waters. A non-exhaustive summary of these events, and others, follows:

- A Section 319 grant (2011-0017), awarded in 2011, was used to implement best management practices (BMPs), conduct information and education outreach and to monitor *E. coli* in the Tyler Creek subwatershed.
    - Two wetlands were modified on the “Zerbe” property. This first wetland site expanded the capacity of existing wetlands by about seven times. This wetland collects runoff from 40 acres of land, including about 20 acres of agricultural land. The second Zerbe wetland is 1.3 acres in size and collects runoff from 23 acres of land.

- The Craig wetland was created to collect runoff from 55 acres of agricultural land that drained directly to Bear Creek. The implementation project included diversion of surface runoff into the wetland restoration area which holds and treats about 2.2 acre-feet of water.
- The Craig parcel was previously farmed to the edge of the stream and the county drain commissioner had recently removed all of the trees. A buffer strip was installed along 2,700 feet of stream. This buffer strip included 60 large, balled and burlapped trees, 350 bare-root trees, 270 shrubs and four acres of native grass and wildflowers. The grass and wildflower plantings were part of a 13 acre CRP planting that the landowner arranged.
- The Calvary Grace Brethren Church planting area included approximately 300 lineal feet of land directly adjacent Tyler Creek. There was no existing stream buffer, the lawn and streambanks were mowed and portions of the streambank failed due to excess erosion. About 300 shrubs were planted, along with six balled and burlapped trees and 700 native perennials.
- The Calvary Grace Brethren Church has an approximately 30,000 square foot, asphalt-surfaced parking lot that drained almost directly to Tyler Creek. The primary concerns with this parking lot drainage were impacts to stream temperature and input of salt, oil, sediment and other pollutants typically associated with parking lot runoff. A small wetland was constructed in the existing floodplain to capture parking lot runoff. The wetland measures about 9,000 square feet in surface area and effectively captures and treats almost all rainfall events in a given year.
- Swisslane Farm had several fields that had little to no buffer, or lacked larger trees with canopies for shading the stream and dense root systems capable of pulling nutrients from the soil. About 4,300 feet of riparian buffer was planted or improved by planting 64 balled and burlapped trees, 300 bare-root trees and 1,200 shrubs.
- Large-scale Information and Education Outreach included printing and distribution of:
  - 3,000 watershed brochures
  - 7,900 Troutie Coloring Books
  - 900 Septic System Brochures
- Several project partners attended the Swisslane Neighborhood Picnic to meet with the community and to share project information and educational material.
- 24 one-on-one landowner meetings took place. Discussions with landowners ranged from about 10 minutes to over three hours in length. Project brochures, results of data analyses and similar information was passed out to some of the landowners. Of the 24 landowners, 17 were interested in future projects or improvements occurring on their land.
- 20 “Entering the Watershed” signs were constructed and installed by Kent County Road Commission.

- A 2013 Clean Michigan Initiative (CMI) (2013-0516) grant furthered our understanding of *E. coli* issues in Tyler Creek, and included the use of scent-tracking canines to verify the presence of human sources. One septic system was replaced as a result of this work. More detailed results of are reported in Chapter 4 of this WMP.
- A MiCorps sampling program was started on the Coldwater and several tributaries. The CRWC and Oakbrook Chapter of TU continue to monitor the macroinvertebrate communities at several sites during both the spring and the fall. Oakbrook has expanded their monitoring to include stream temperature and have deployed loggers at all macroinvertebrate monitoring sites.
- The Freeport Dam was removed in 2014, to restore fish passage, improve aquatic habitat and to eliminate the liability associated with the deteriorating structure. A wetland was constructed to capture and treat road runoff prior to discharge to the Coldwater River. As well, several acres of land that was farmed near the river was converted into a native upland habitat.

- Several instream aquatic habitat improvement projects were constructed in Tyler Creek and the Coldwater River.
- The Little Thornapple River Intercounty Drain Board cleared about 11 miles of stream channel and riparian vegetation; the project became known to conservation groups as the "Disaster on the Coldwater" (Burroughs, 2015). Much restoration and remediation work took place, in compliance with an Administrative Consent Order.
- MDEQ/EGLE has issued at least five notices of violation to three dairy farms within the CRW, for manure spills into the Coldwater River or its tributaries, improper storage of livestock manure or improper application of livestock manure (www.miwaters.deq.state.mi.us accessed on August 13, 2020).
- MDEQ/EGLE has issued at least seven notices of violation to the Lakewood Wastewater Authority – five of them in 2020 – for sewer overflow events.

This document is meant to update and replace the 2009 WMP. This updated WMP was created based upon: analysis of the existing WMP; data collected as part of recent Clean Michigan Initiative and Clean Water Act Section 319 funded studies of the watershed; review and summary of reports by MDNR, MDEQ/EGLE and others; several studies conducted as part of this WMP update and; input from many stakeholders that are active in the CRW.

This WMP was authored by the CRW Management Team, comprised of representatives from Streamside Ecological Services, Inc. (SES) the Schrems West Michigan Chapter of Trout Unlimited (Schrems) and the Grand Valley Metropolitan Council (GVMC). The management team coordinated and guided all efforts related to the planning process and overall WMP development, including stakeholder engagement. Several community partners were especially important to the development of this WMP, and include Kent Conservation District (KCD), Coldwater River Watershed Council (CRWC), Michigan Department of Environment, Great Lakes and Energy (EGLE) and Oakbrook, IL Chapter of Trout Unlimited (OBTU).

1.1 Goals and Objectives

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

The CRW Management Team set out to develop a WMP that is readable, understandable and useful for local organizations and communities to work individually or through collaborative efforts toward protection and improvement of the CRW.

The goals of this WMP are to:

1. Provide the direction necessary to:
    a. Restore water quality in impaired waters, so that the designated uses of total and partial body contact recreation, habitat for indigenous wildlife and the coldwater fishery are being met.
    b. At a minimum, maintain existing water quality in areas currently meeting designated uses
2. Establish a strategy to manage the CRW as an asset that maximizes residents' ability to use and enjoy the watershed.
3. Implement targeted education and action plans for the watershed's residents related to the pollutants, sources, and causes that lead to land management changes resulting in improved water quality.

Objectives:

a. Prioritize the sources and causes of *E. coli* contamination, increased water temperature/decreased dissolved oxygen, altered hydrology and excessive sediment and nutrients.
b. Recommend Best Management Practices (BMPs) to reduce the concentration and volume of pollution input to the Coldwater River and its tributaries
c. Encourage use of existing technical support to increase BMP implementation in key areas.
d. Provide clear direction on priorities and action items necessary to improve water quality.
e. Identify partnering organizations and stakeholders; encourage communication and collaboration.
f. Develop and implement an I/E campaign to target audiences, including landowners, agricultural producers, local governments, riparians and other stakeholders. Complete a WMP that includes the "nine elements", as required by the United States' Environmental Protection Agency.
g. Work with local governments to ensure that any existing programs are being implemented properly and to develop sensible protection ordinances.
h. Make the target audience aware of the unique resources in their watershed, aware of the pollutants and causes of pollution in the watershed, and that their day-to-day activities can affect the quality of those resources. Inform the target audiences of what actions and BMPs are recommended for them to adopt to reduce impacts.
i. Incorporate Watershed protection activities into local regulatory mechanisms, policies, land-use planning and land management decisions.

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], 2008).

Watershed Management Plans are meant to be a resource to be used to prevent and improve water quality problems, by understanding and addressing NPS pollution affecting a watershed. Nonpoint source pollution comes from diffuse sources, and is typically carried by stormwater across the land; it is in contrast to point source pollution that is discharged from an identifiable point such as a pipe (US EPA, 2008). These 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 and financial assistance needed**, associated costs, and/or the sources and authorities that will be relied upon, to implement the plan.

5. Develop an **information 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. Unfortunately, WMPs include a large amount of information and must meet many requirements to be approved by state and federal agencies. Experience suggests that a WMP can quickly become unmanageable to those interested in relatively simple, straightforward implementation of the recommendations set forth. As such, this WMP has been organized in a manner intended to promote short and long-term measures that can be easily identified and efficiently implemented. The WMP has been divided into nine chapters, which, to a degree, can be read and used collectively, or independently.

Chapter 2. Action Plan provides a list of activities that are recommended to protect and/or restore the Coldwater River 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 Coldwater River Watershed provides a general overview of the CRW. This is background information that will be interesting to certain individuals, but does not include specific information to be used for any type of implementation projects.

Chapter 4. Water Quality in the Coldwater River 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 CRW. 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 CRW. 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 CRW, 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 COLDWATER RIVER WATERSHED ACTION/IMPLEMENTATION PLAN

This chapter provides a prioritized list of activities that are recommended to protect and/or restore the Coldwater River 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. This chapter has been crafted with the goal of making an easy transition between planning and implementation (applying for grants, etc.). The voluntary participation of landowners is critical to many of the recommended activities. Much more detailed information follows in subsequent chapters, most specifically Chapter 7; 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 wetlands 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. More on wetland protection can be found in section 7.1.

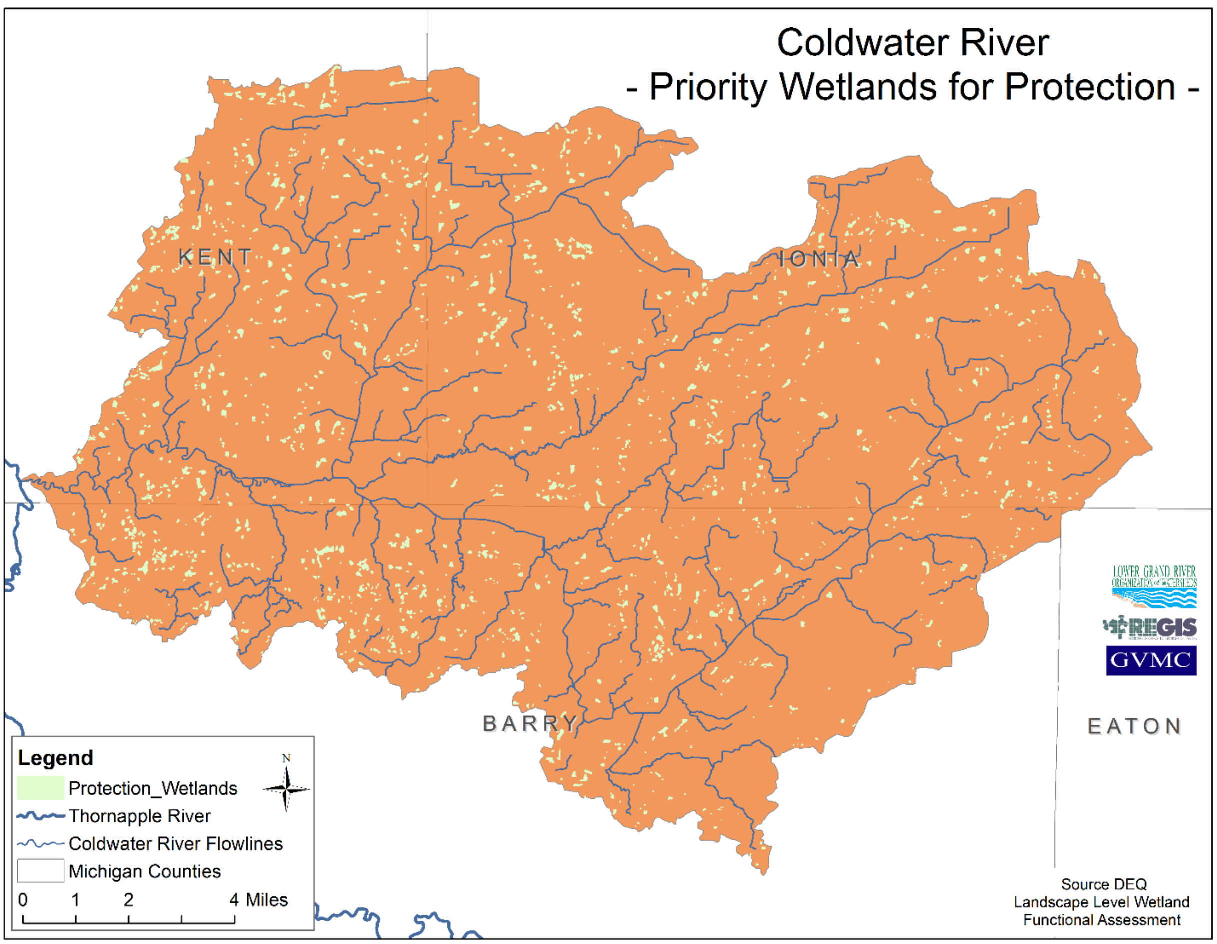

Figure 2. High Priority Wetlands for Protection

Restore/Create Wetlands

Already, loss of wetlands has altered the hydrology (led to erosion and sedimentation caused by increases in duration, magnitude and frequency in flow) and water quality (loss of free, natural filtering capacity) within the Coldwater River watershed. Restoration of wetlands is absolutely necessary to reverse negative impacts. The 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. Once landowners have agreed to restoration of wetlands on their property, site-specific survey, design, cost estimation and planning can occur.

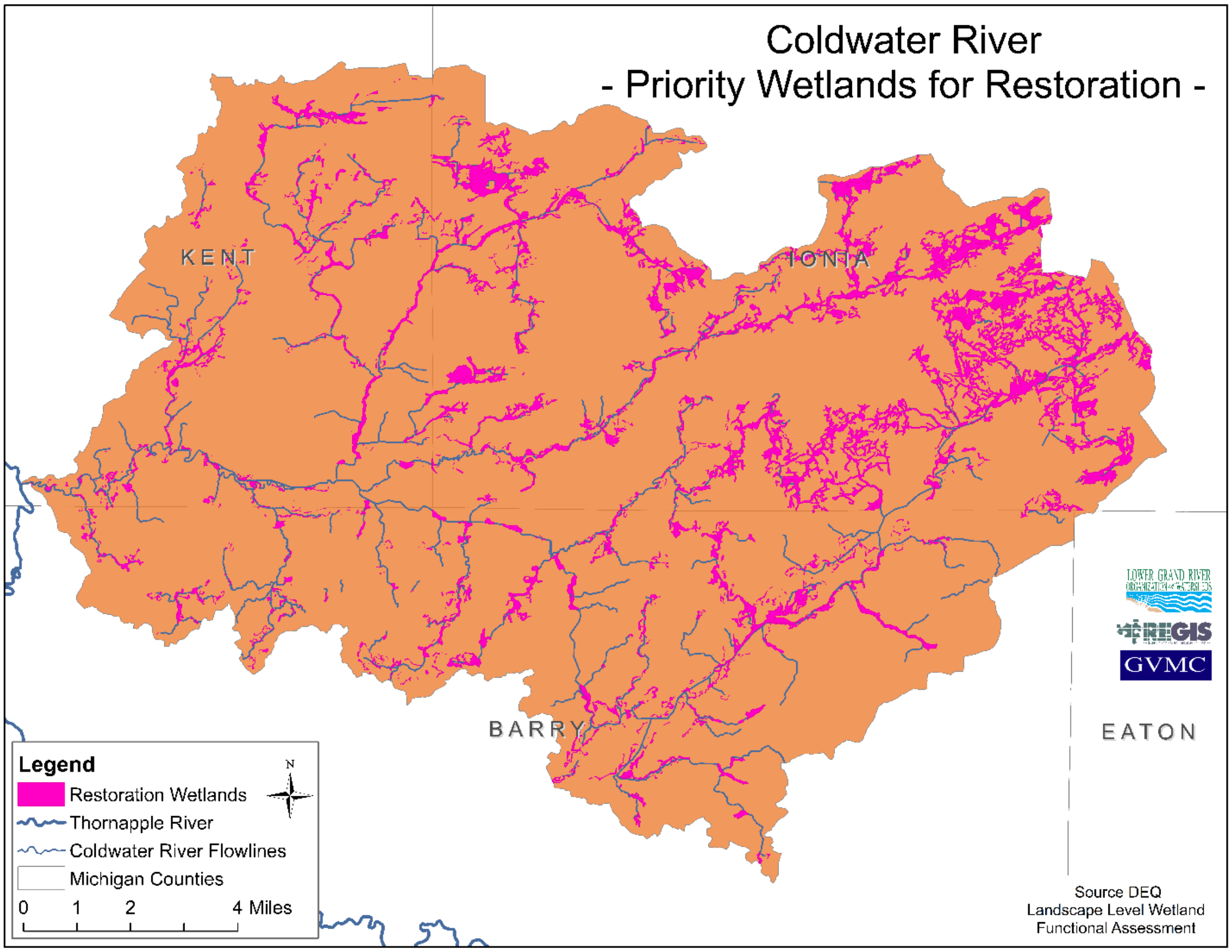

Figure 3. High Priority Wetlands for Restoration

Reduce/Eliminate Input of Human Sewage

Human sewage has been detected in surface water throughout the CRW, through DNA source tracking, use of scent-trained canines and direct observation of discharge from residential properties. The Lakewood WWTP, while regulated as a point source under the National Pollutant Discharge Elimination System (NPDES) program, is also a likely contributor to the problems, as many violations have been issued due to sewage overflow events. 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 (e.g. Niemuth and Klaper 2015). 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). The highest priority areas are illustrated below.

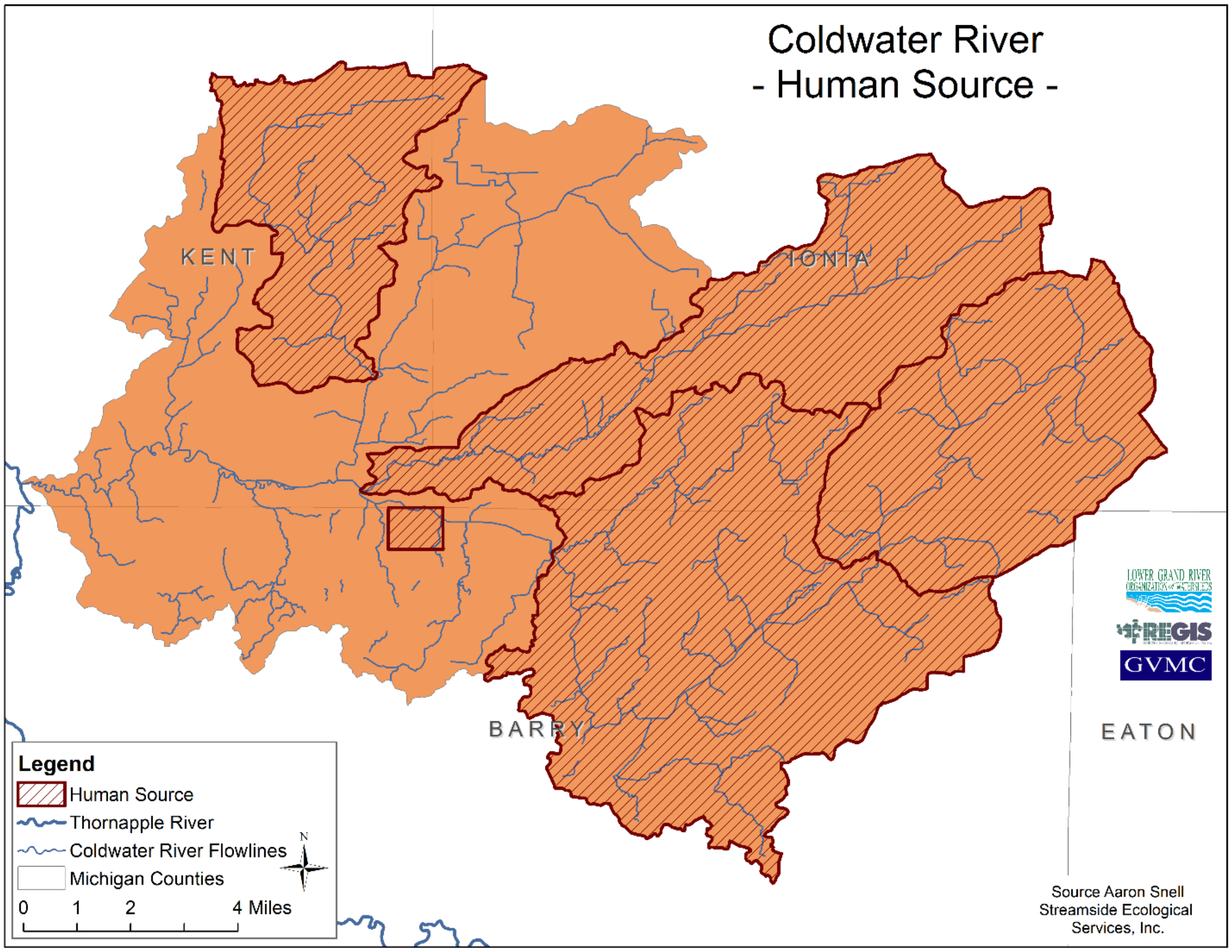

Figure 4. Critical Areas for Contamination by Human Wastewater

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 by contacting the landowners to seek permission or partnership.

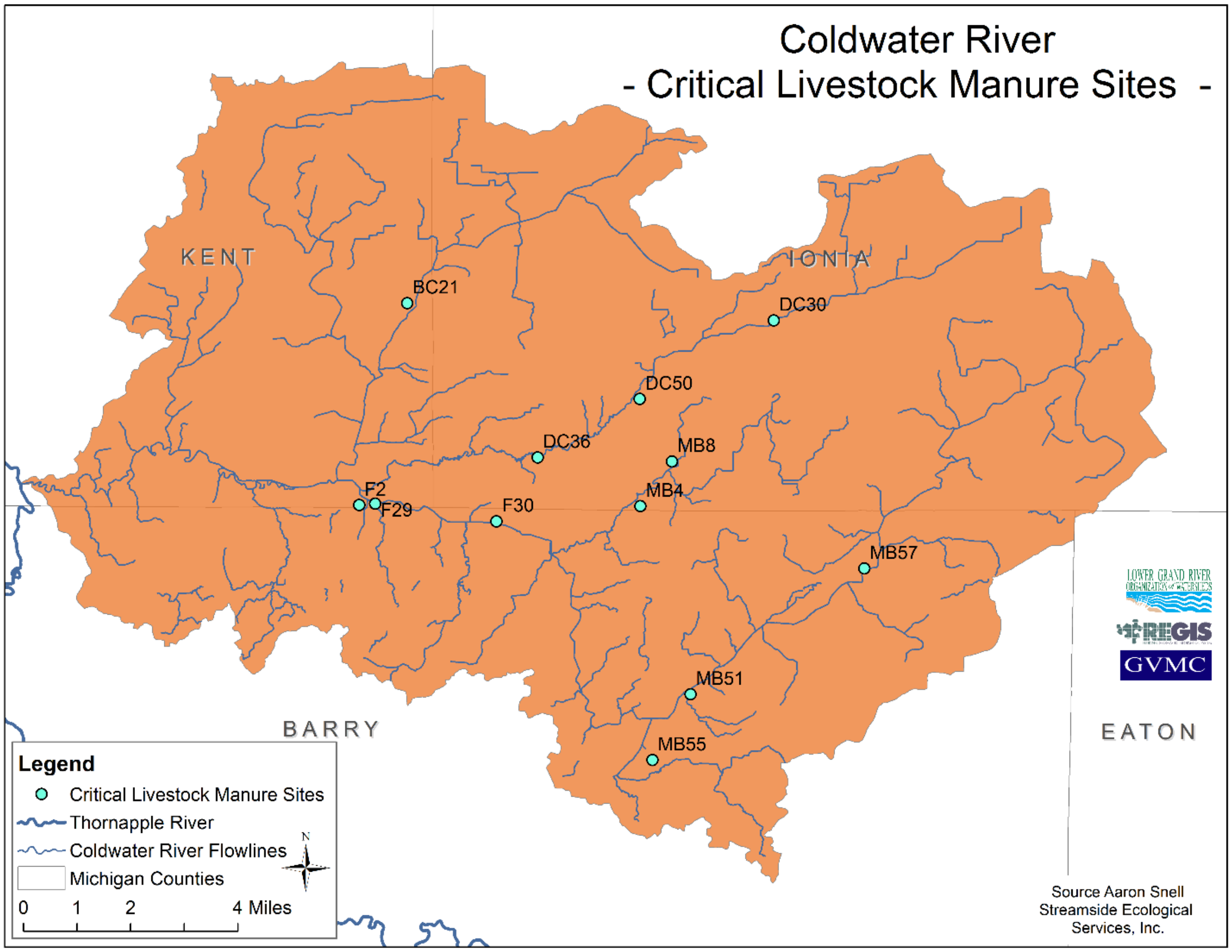

Figure 5. Critical Sites for Livestock Manure

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

Many potential pollutants, including livestock manure and chemical fertilizers, are applied to cropland. In an agricultural dominated watershed, 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. As well, because there have been so many EGLE violations associated with manure spills and manure management within the CRW, all of the fields that have been permitted to receive CAFO manure were also mapped. 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. Additional outreach should be implemented to increase the adoption of no-till agriculture in the Duck Creek sub, and there is an obvious opportunity for protection of water quality through expansion of the use of cover crops. The following figure only includes fields from a three subwatershed area and it is highly likely that additional high priority fields are found throughout the CRW. More information on how these priority fields were identified can be found in Chapters 4B.2 and 6.

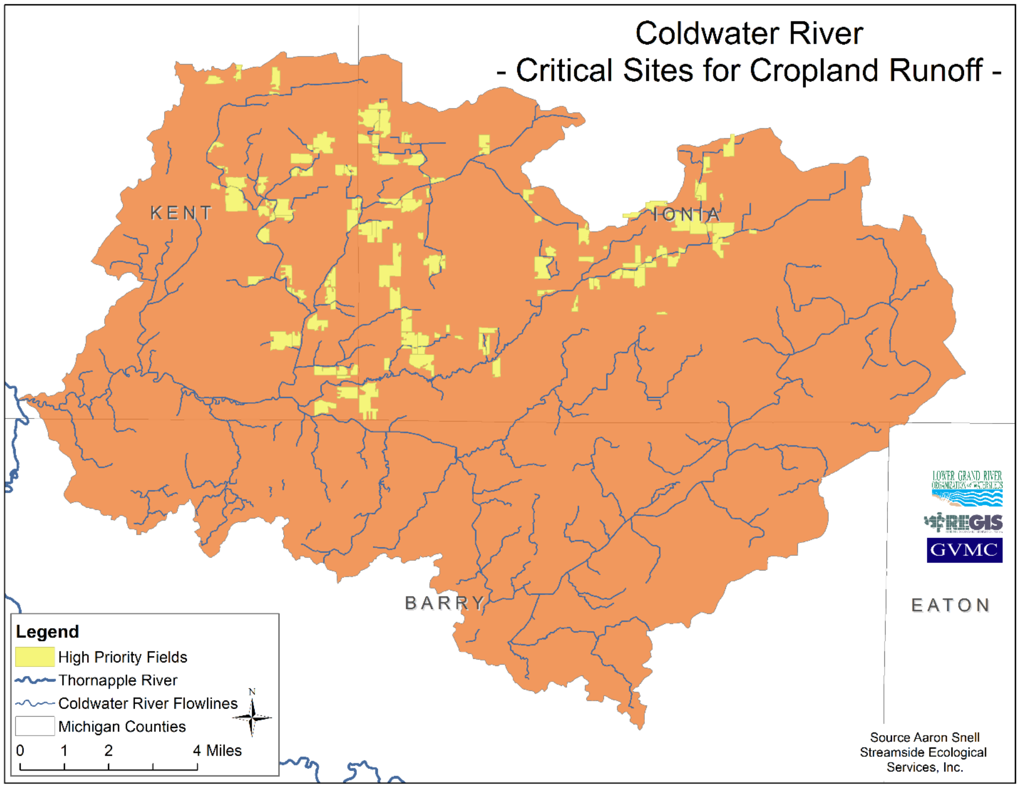

Figure 6. High Priority Fields for Reducing Cropland Runoff

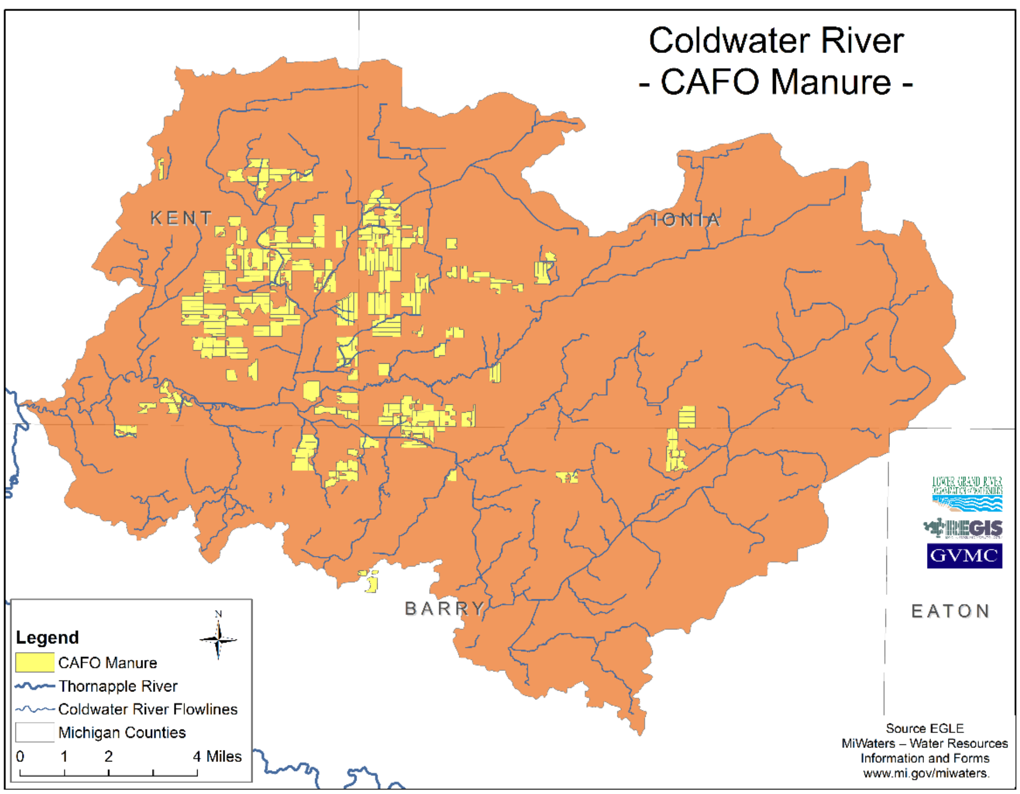

Figure 7. Fields Permitted for Land Application of CAFO Manure

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 Tyler and Duck Creeks and the Coldwater River 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 planting on the south and west streambanks is a relatively easy and inexpensive way to begin.

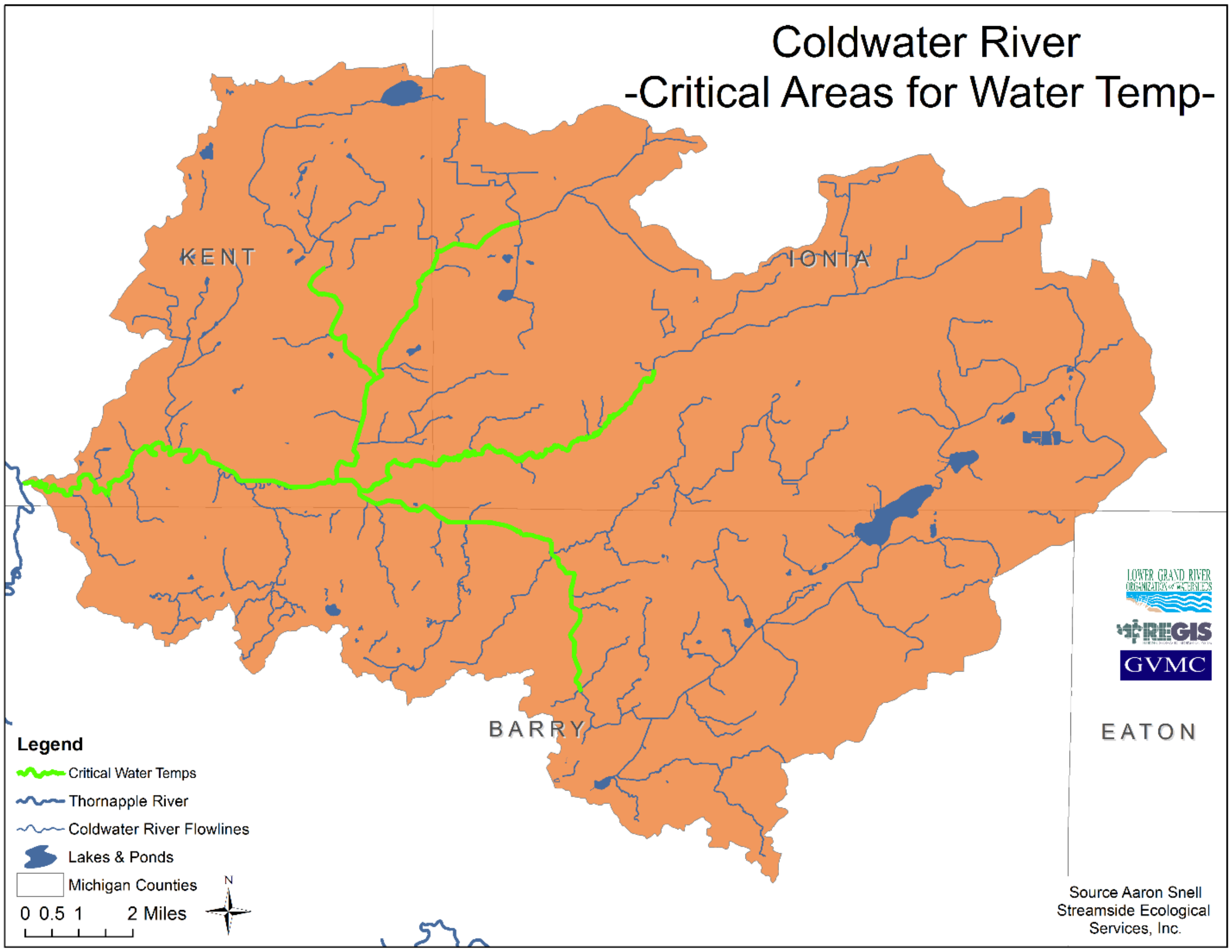

Figure 8. Critical Areas for Reducing Water Temperature

Reduce Sediment Input to Streams

Excessive sedimentation from sources such as streambanks, road crossings and runoff from gravel roads is impairing the aquatic habitat, native aquatic species and the coldwater fishery, as well as stream function. Excessive sediment may lead to increased streambank erosion and flooding. High priority areas for reducing sediment input are illustrated below. The first step for repairing many of these sites is contacting the county drain or road commission and developing a project plan and budget.

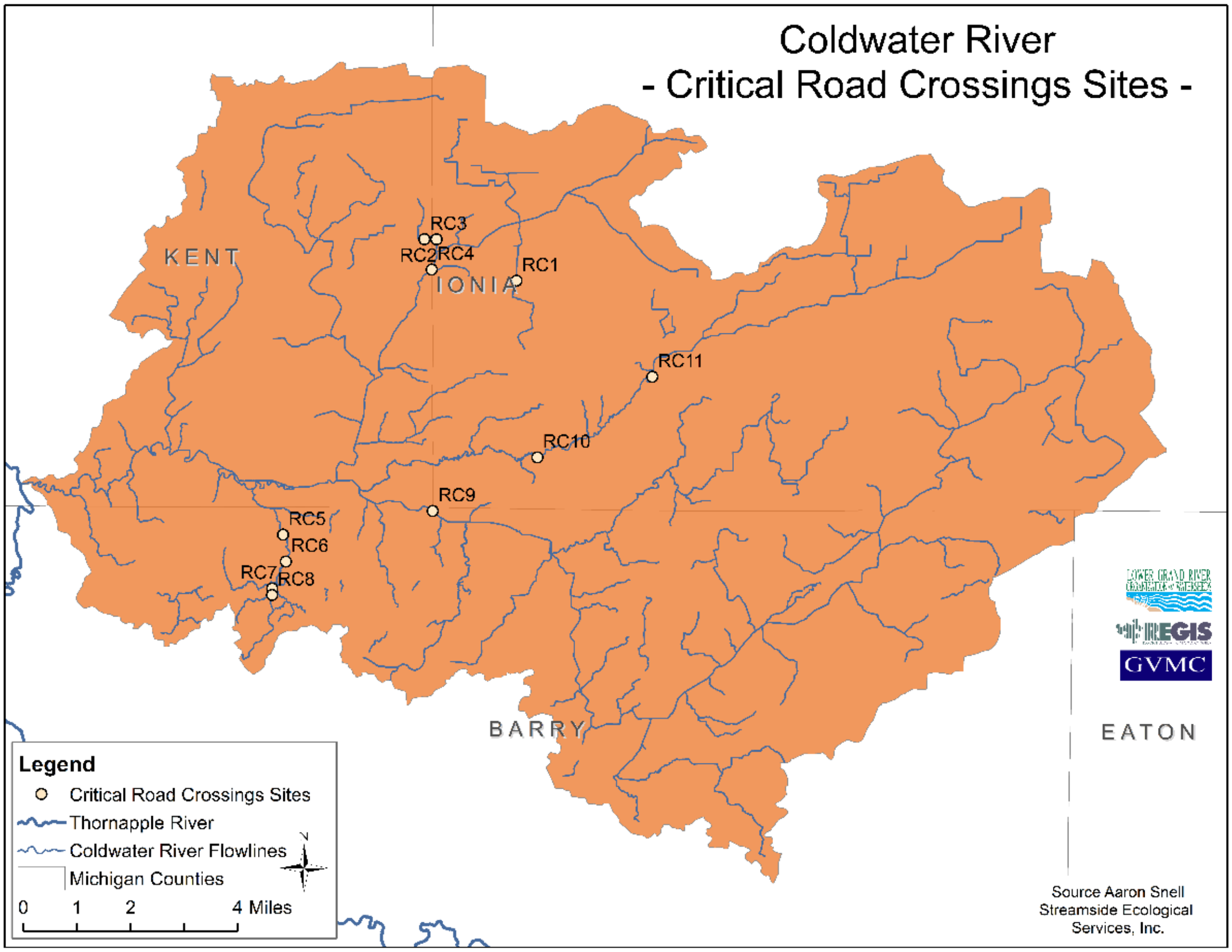

Figure 9. Critical Sites for Sedimentation from Road/Stream Crossings

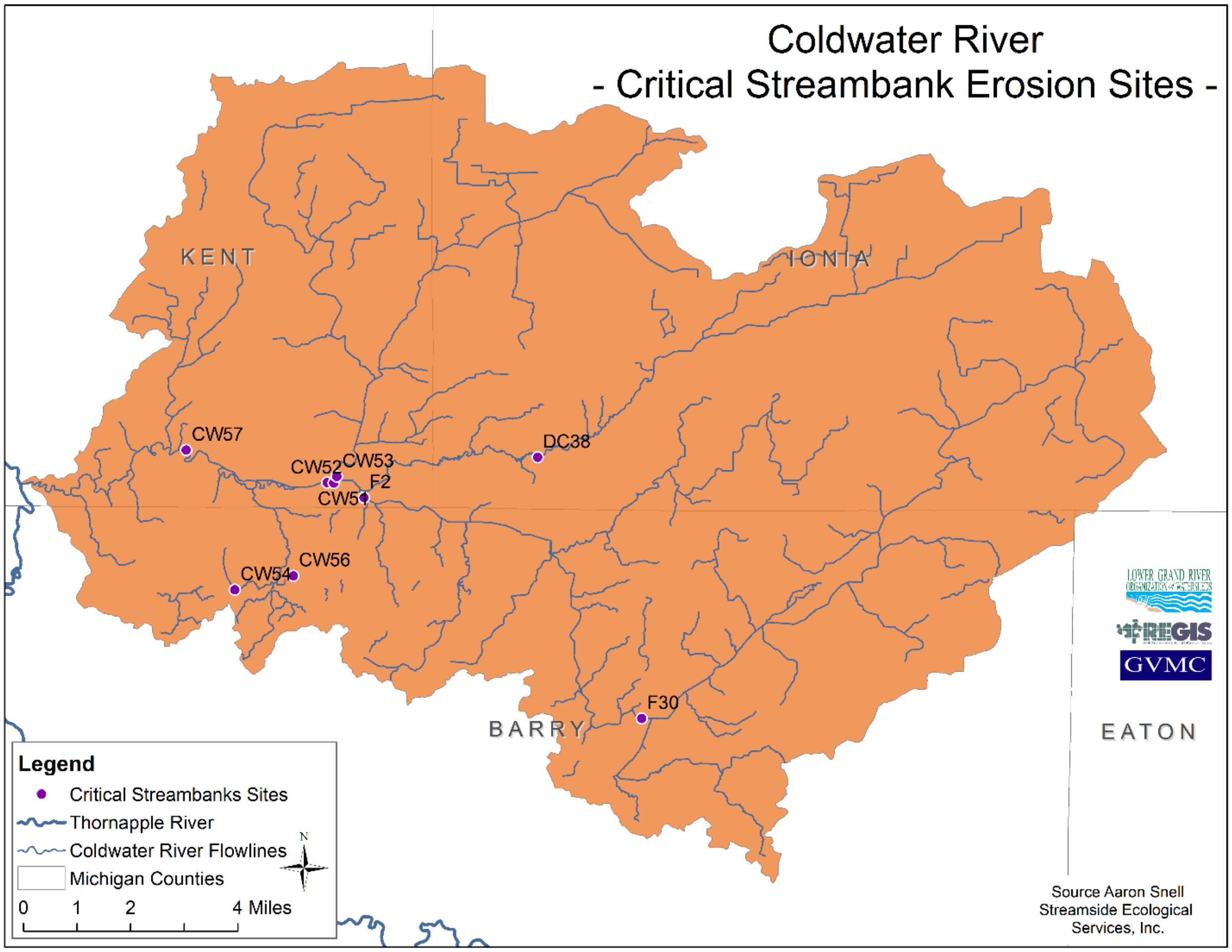

Figure 10. Critical Sites for Sedimentation from Streambanks

Monitor Water Quality in Jordan and Tupper Lakes

The Coldwater River begins at the outfall of Jordan Lake. Anything that enters Jordan and Tupper Lakes, including agricultural runoff, residential runoff (e.g. lawn fertilizers and chemicals), and herbicides and algaecides associated with treatment of nuisance species, eventually flows down the Coldwater River. In 2021, EGLE received and responded to two Pollution Emergency Alerting System (PEAS) complaints regarding water quality in Tupper Lake. Residents were concerned about the visible decline in water quality in the lake, particularly that the lake was green. EGLE staff determined an algae bloom was occurring in Tupper Lake and collected a water sample to test for microcystins and anatoxins. Fortunately, lab results indicated toxins were not present in the analyzed sample.

Collaborate with Drain Commissioners

Log and debris jams are often the target of removal by county drain commissioners charged with ensuring free-flow of the river to prevent flooding. Many 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. Specifically, it is recommended to:

- Thermally classify all designated coldwater streams to describe each stream reach. Data loggers should be placed to expand on the existing data set for the Coldwater River and Cain, Duck and Tyler Creeks. Unnamed coldwater tributaries should also be studied.
- 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.
- As recommended by EGLE (2021), conduct P51 monitoring for physical habitat and macroinvertebrates in lower Messer Brook and upstream of M-43 and Rush Road, to evaluate recovery of the river following 2015 drain maintenance activities.
- Periodically monitor the fish community to describe species composition and trout population density and size, in all designated coldwater streams.
- Monitor nutrients and other parameters in Tupper and Jordan Lakes.
- Develop and implement monitoring program to determine impact of biosolids on surface waters.
- Develop and implement monitoring program to determine impact of chlorides on surface waters.
- Document occurrences of any new or particularly destructive invasive species.
- Expand the Agricultural Conservation Planning Framework to include all subwatersheds.

Observe the Watershed

A number of incidents have occurred over the past several years that have been, or could have been, detrimental to the water quality and ecosystem of the Coldwater River and its tributaries. A complete fish kill in Tyler Creek, manure spills, dredging of the stream channels and filling/draining of wetlands, to name a few, have been reported by concerned citizens. Repeat offenses have been documented and are part of the public record. Use of the land, especially adjacent waterways, and protection of the environment are not mutually exclusive. Unfortunately, vigilant observation and reporting of suspect activities have become necessary for the long-term protection of the Coldwater River.

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:

- Barry Eaton Health District – (269) 945-9516
- Ionia County Health Department – (616) 527-5341
- 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 CRW 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 COLDWATER RIVER WATERSHED

3.1 Geographic Scope

The Coldwater River, identified with Hydrologic Unit Code (HUC) 0405000703 by the United States Geological Survey (USGS), begins in Odessa Township of Ionia County, just north of Tupper and Jordan Lakes. The river is approximately 34 miles in length and runs southwesterly to the Thornapple River, which empties into the Grand River. The watershed contains about 189 square miles (120,737 acres) and seven subwatersheds (12-digit HUC), with approximately 251 miles of tributaries, as illustrated below. Subwatersheds range from 12.5 to 46.1 square miles in size (MDTMB, 2019).

Due to the fact that much of the Coldwater River is also considered to be designated intercounty drain, the naming convention of the mainstream changes as the river flows to the Thornapple. From Jordan Lake downstream to Freeport Ave., the Coldwater is also known as the "Little Thornapple River Intercounty Drain (LTR)", which is 14.7 miles in length. From Freeport Ave. downstream to a point between Coldwater Ave. and Morse Lake Rd, the river is also known as the "Coldwater River Intercounty Drain (CRID)". From the downstream terminus of the CRID to the Thornapple River, the river is not designated as county drain and maintains the name "Coldwater River". For purposes of this WMP, the river is always referred to as the Coldwater River.

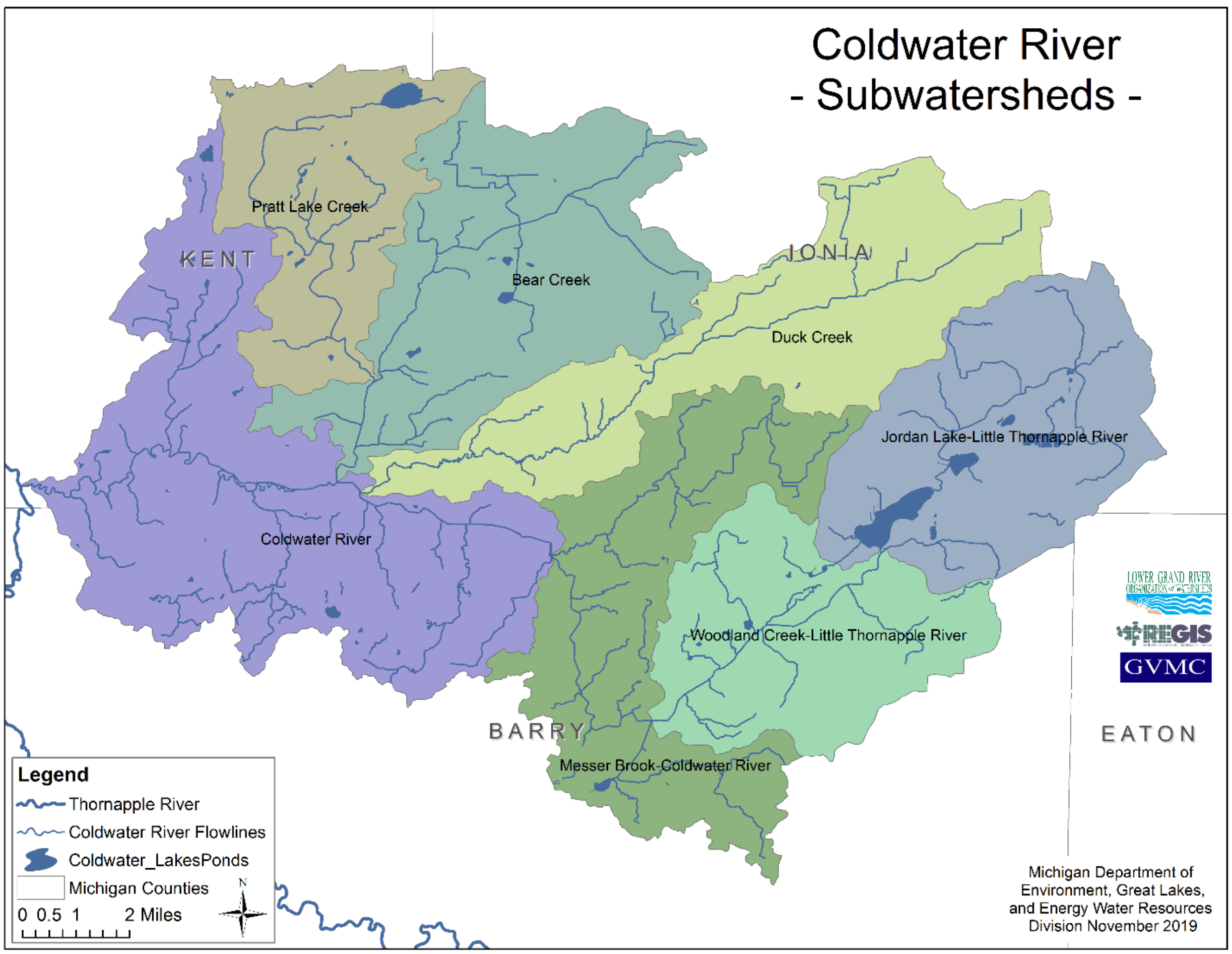

Figure 11. Subwatershed Boundaries

3.2 Land Use

According to USGS (2016), the dominant land use in the watershed is agriculture, which constitutes more than 83,000 acres and covers 69% of the watershed. There is no reason to expect that land use has changed drastically since 2016. The two main crops are corn and soybeans. Forest covers 15,700 acres and represents 13% of the landscape. Historically, central hardwoods, such as ash, basswood, beech, hickory, oak, and sugar maple; herbaceous upland grasslands; and scattered lowland conifer forests covered the watershed. Wetlands have been greatly reduced in size and quantity, over time, and cover around 11% of the landscape. Residential land use, and other urban development, accounts for 2,627 acres or just over 2.2% of land use in the watershed. Most of this urban development is located in the suburban towns of Alto in Bowne Township, Clarksville and Lake Odessa in Campbell Township, Freeport in Irving Township, and Woodland in Carlton Township.

Table 1. Current Land Use (USGS, 2016)

Land Use	Acres	Percent of CRW
Open Water	1,157	1.0%
Development Open	4,604	3.8%
Development Low	2,175	1.8%
Development Medium	332	0.3%
Development High	120	0.1%
Barren Land	37	0.0%
Forest	15,700	13.0%
Cultivated	83,374	69.0%
Wetland	13,315	11.0%
Total	120,815	100%

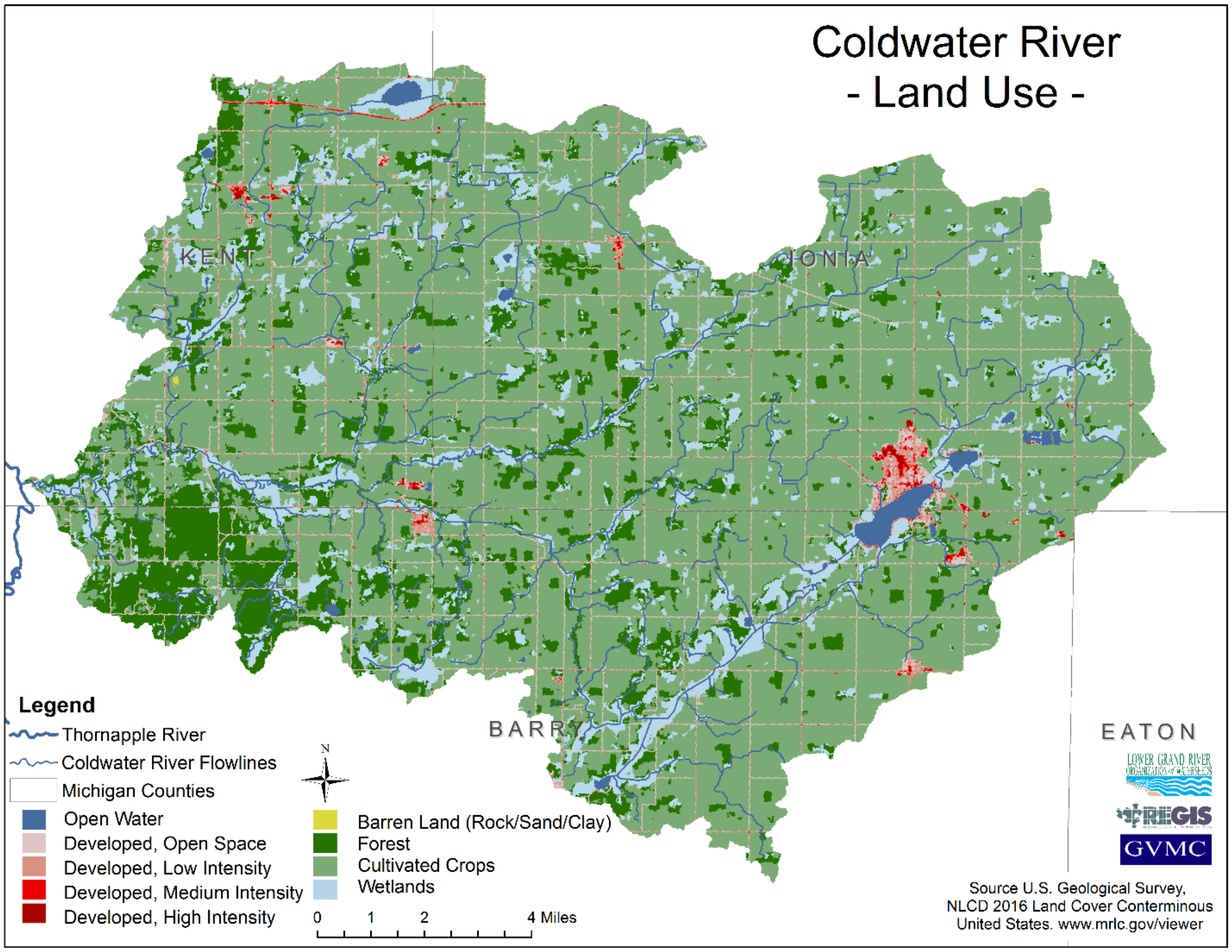

Figure 12. 2016 Land Use

3.3 Topography

The Coldwater River originates in Ionia County at an elevation 910 feet [ft.] above sea level and drops to the Thornapple River in Kent County (elevation approximately 700 ft.) (U.S. Geological Survey, 20191107, USGS 13 arc-second n43w086 1 x 1 degree: U.S. Geological Survey). This drop of 210 feet over 34 miles equates to an average slope of about 3.1 feet per mile, or approximately 0.06%. Generally, the stream slope is considerably higher from the western crossing of M-43 downstream to Whitneyville Avenue. The highest elevation in the CRW is over 1,000 ft. and the lowest elevation is 700 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.

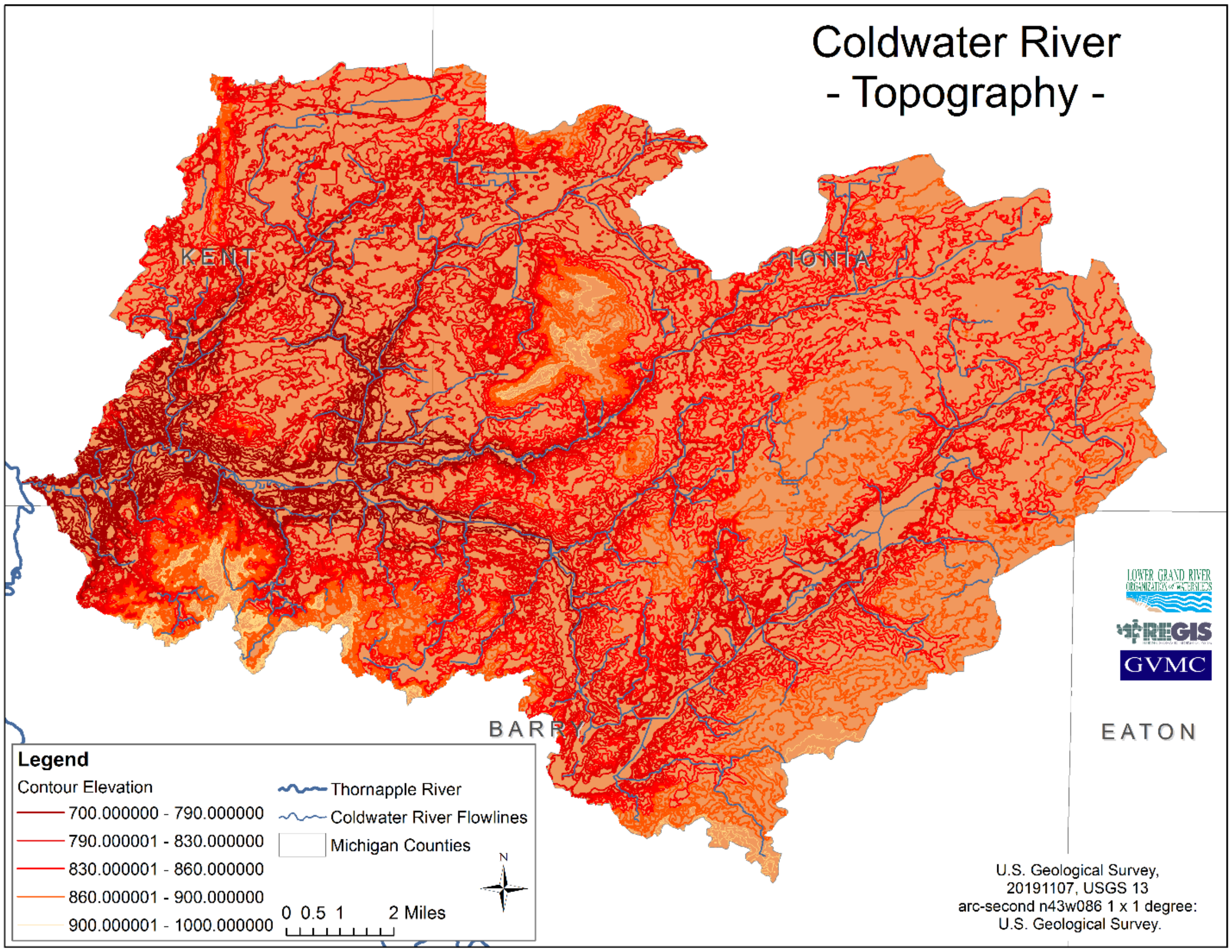

Figure 13. Topography

3.4 Geology

The CRW lies in the southwest quadrant of the Michigan Basin. Three bedrock formations are present in this area. The largest and oldest, formed in the Pennsylvanian period, is the Saginaw Formation comprised of sandstone, shale, limestone, and lignite. The Saginaw Formation meets with the Michigan Formation and the Bayport Formation, which were formed in the Upper Mississippian period. The Michigan Formation is comprised of shale, sandstone, limestone, dolomite, gypsum, and anhydrite (Brewer, 1991). These formations have created a watershed with varying soils and topography. The Bayport Formation is the youngest of the Mississippian rocks, made up of a very useable limestone. Bayport limestone is often used for an ornamental stone, as well as agricultural lime, cement, and concrete production (Davis, 1964).

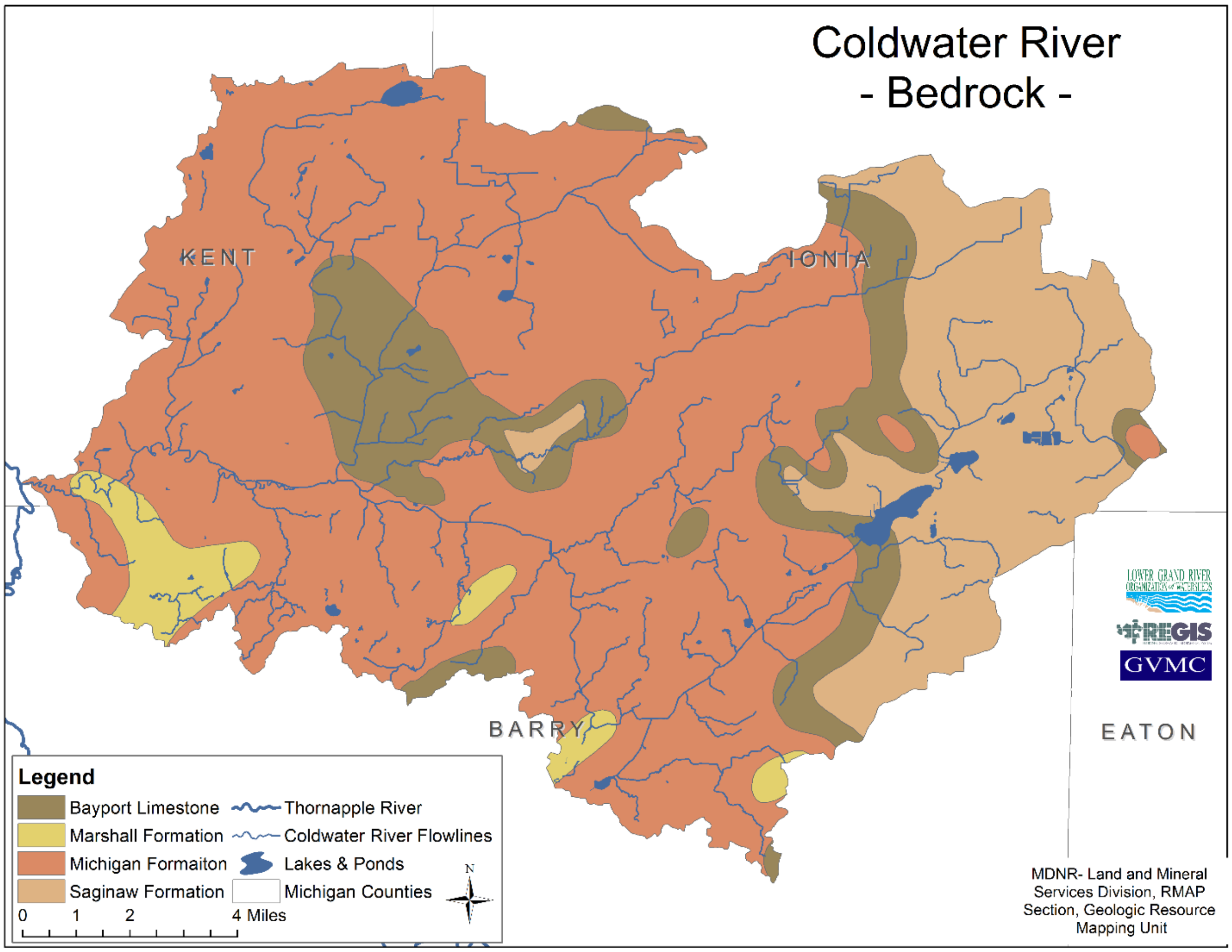

Figure 14. Bedrock Geology

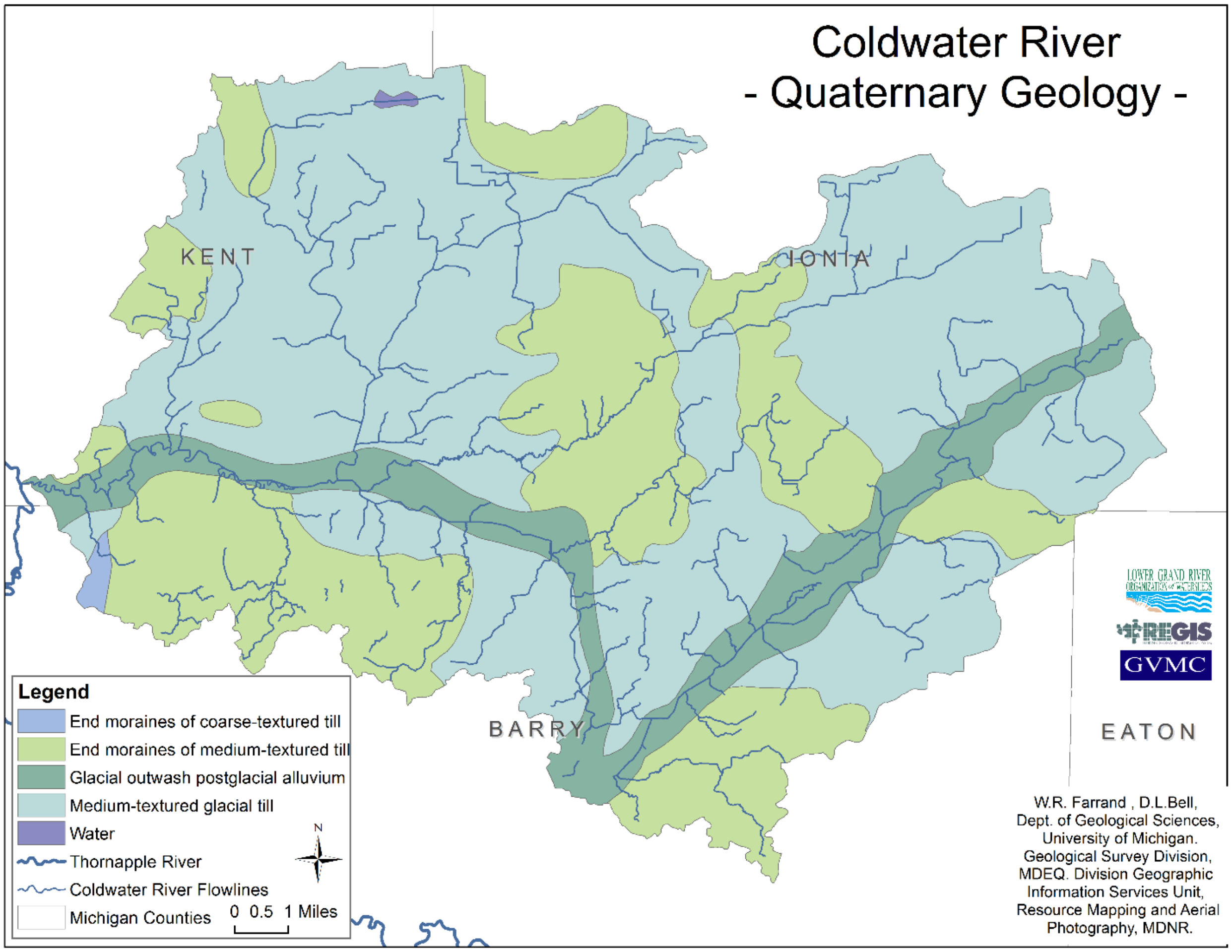

Figure 15. Quaternary Geology

3.5 Soils

Soil texture, the percent of sand, silt and clay within each soil horizon, and bulk density affect the rate and ability of water to infiltrate the soil. Low infiltration rates increase erosivity of soil. Soil properties ultimately affect how pollutants that are land applied or absorbed, such as manure, biosolids or fertilizers, are 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 (USDA NRCS, 2007). The infiltration rate is the rate at which water enters the soil at the soil surface, and is controlled by surface conditions. The hydrologic soil group also indicates the transmission rate, or the rate at which water moves within the soil. This rate is controlled by the soil profile.

Table 2. Hydrologic Soil Groups

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

Each of these different soil types also have 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 connected with erosion and the associated eroded sediment negatively impacting the water quality of the creeks and rivers. Certain soils have greater potential for overland erosion. Specifically, three types of erosion can be predicted: sheet, rill, and gully. Sheet erosion occurs when rainfall hits the ground and runs off the land in a large sheet, with little to none of the water actually penetrating the surface of the land, while at the same time taking with it loose dirt particles. An example is a plowed agricultural field being used for row crops that is not currently planted. When it rains on this field with exposed soil, water runs off the bare surface into a drainage ditch that connects to a nearby stream. Rill erosion occurs when precipitation cuts small drainage pathways into the surface of the land, giving the precipitation little time to sink into the ground. An example is a crevice in a hillside that continues to increase in size every time it rains. As more soil is carried away, a deeper crevice is carved into the hillside. Gully erosion occurs when rills become much larger. The depth of erosion defines the difference between rills and gullies. It is commonly accepted that rills can be easily repaired/removed by normal tillage practices, whereas gullies cannot. This watershed has many soils that are susceptible to both types of erosion. The land surrounding the Little Thornapple River and the eastern portion of the Coldwater River has a high potential for erosion damage, as does the land around the southern portion of Tyler and Duck Creeks.

The predominant soil types are C/D (36.6%) and C (30.9%), with low to very low infiltration rates. For soils with a dual classification, 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.

Table 3. Soil Types (USDA NRCS, 2015a)

Soil Type	Acres	Percent of CRW
A	11,681	9.7%
A/D	10,250	8.5%
B	7,128	5.9%
B/D	8,522	7.1%
C	37,287	30.9%
C/D	44,213	36.6%
D	332	0.3%
Other	1,393	1.2%
Total	120,807	100.0%

The prevalence of soils with low infiltration rates means that the Coldwater River and its tributaries are more susceptible to receiving sediment, along with any associated land applied nutrients (e.g., manure and fertilizers). 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.

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

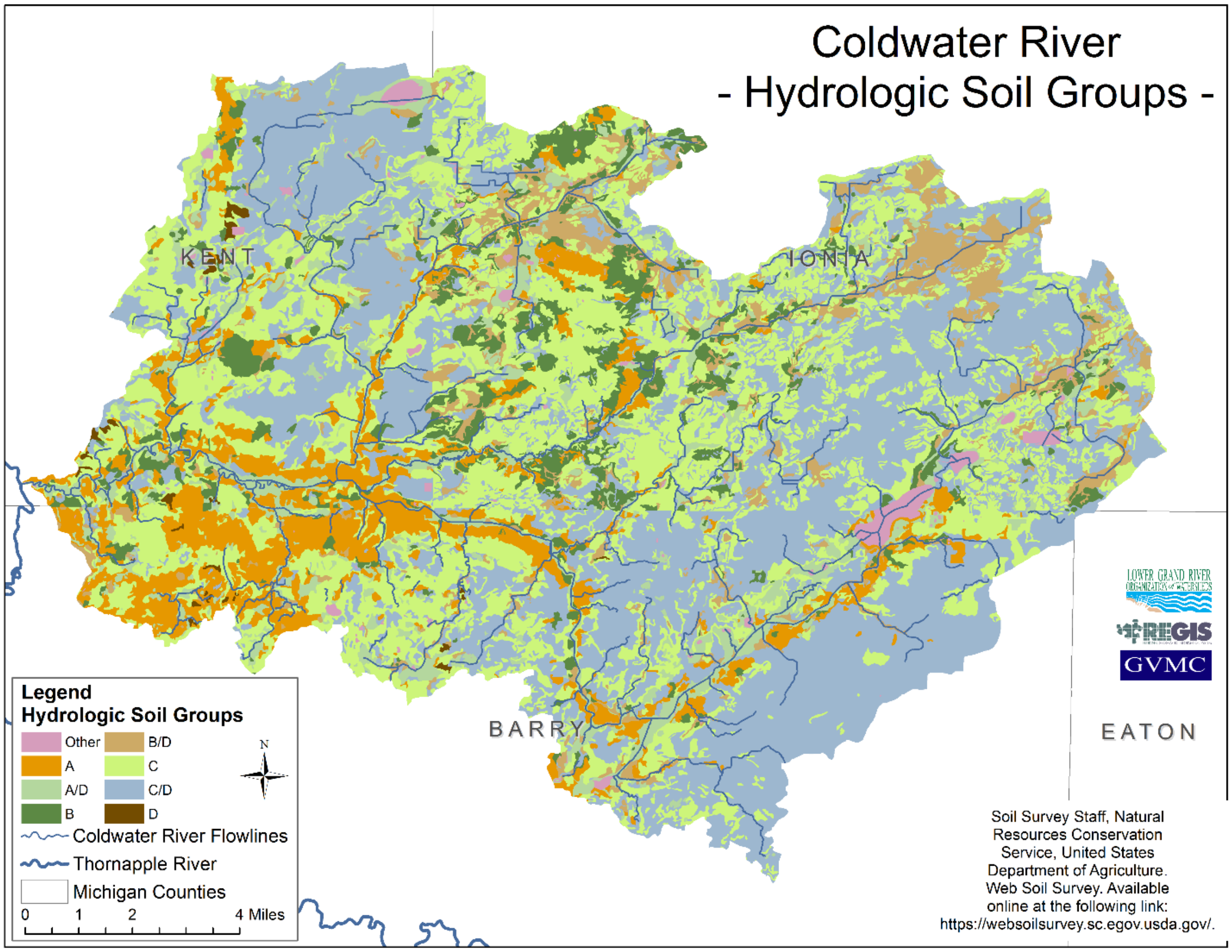

Figure 16. Hydrologic Soil Groups

3.6 Climate

The CRW has a modified continental climate. This means that this watershed is between source regions of contrasting bodies of polar and tropical air that create changing and complex weather patterns. Landmasses at similar latitudes have distinctive seasons, with very cold winters and hot summers. However, the CRW is also affected by Lake Michigan. The lake works to moderate climate, making for cool summers and mild winters. The average maximum temperature for this area is about 57.4°F, the average minimum temperature is 36.7°F, and the average annual temperature is 46.9°F. The warmest month is July, with an average high of 82°F, and the coldest month is January, with an average high of 30°F and average low of 15°F. The watershed will acquire approximately 37.4 inches of rainfall annually; the wettest months are typically May and June (US Climate Data, 2020).

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 are 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. NPS pollution is often driven by hydrology. Pollutants on the soil surface that are picked up by the runoff generated by rainfall can be carried into surface waters or percolate into groundwater.

A number of lakes, streams and wetlands are found throughout the CRW. There are approximately 251 miles of streams, 14,688 acres of wetlands and 1,268 acres of lakes and ponds (MDTMB, 2020). Tupper and Jordan Lakes form the headwaters of the Coldwater River. Jordan Lake is the largest in the watershed and covers 430 acres. In a natural state, water exists in these wetlands, lakes, ponds or other low areas for periods of time. These areas can provide groundwater filtering and recharge, recycling of waste products, flood control, spawning and mating grounds for fish and wildlife, and water for human use. Streams often originate from these locations or other small, undefined areas such as groundwater seeps that provide the water that flows downhill and maintains our river systems.

Changes to wetlands, lakes, ponds, 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 imperviousness. 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 for an equivalent rainfall and would typically derive more of its overall flow from groundwater. A less flashy stream is generally more desirable.

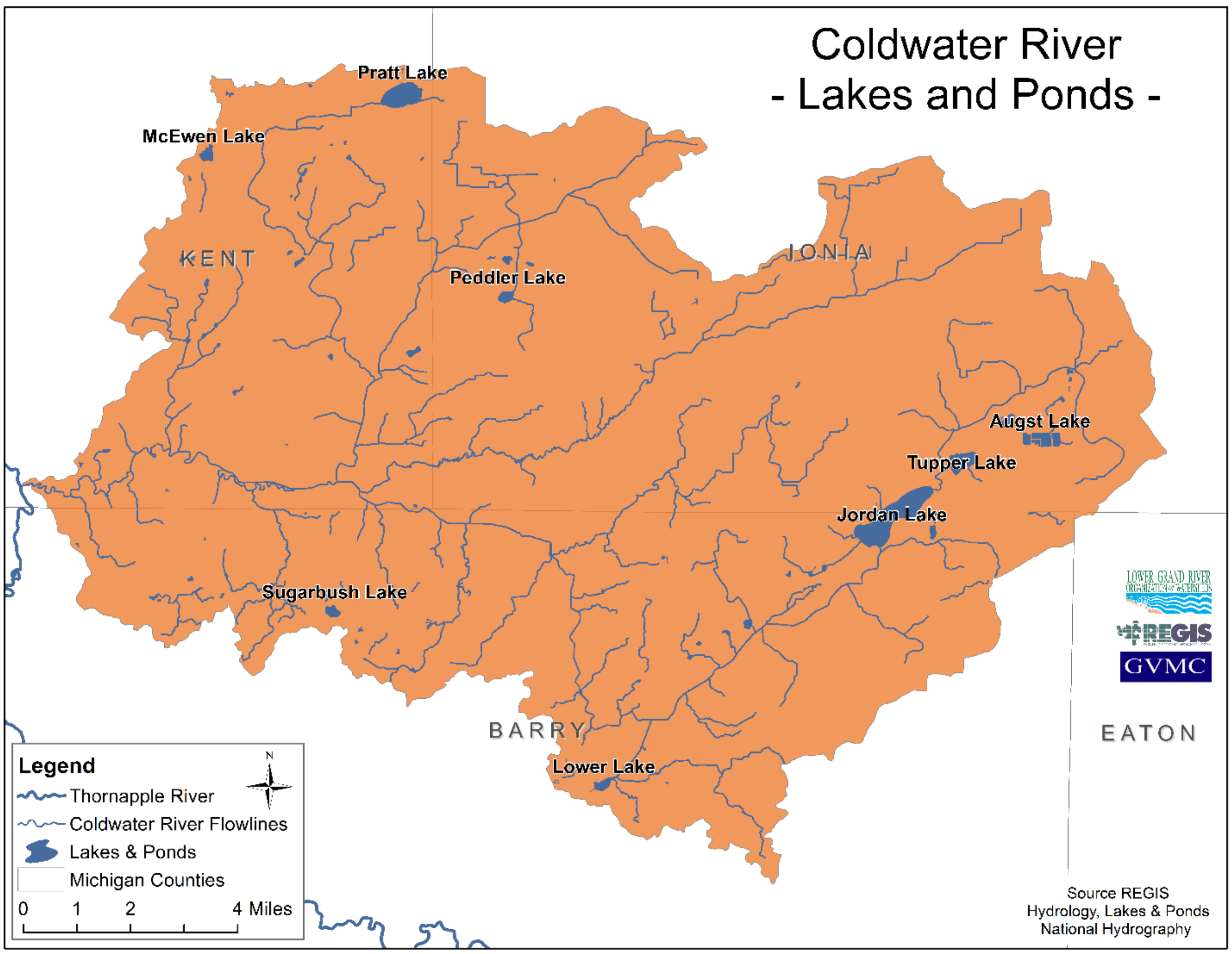

Figure 17. Lakes/Impoundments

Groundwater

Groundwater is a crucial part of a watershed, and in Michigan, groundwater is the primary source of drinking water for the residential dwellings. While this WMP deals mostly with surface water and the problem associated with NPS pollution, groundwater and surface water are connected and have great influence on each other. Groundwater input is particularly important for keeping the Coldwater and its tributaries cold enough in the summer to provide conditions for coldwater species, including trout.

Floodplains

Rivers, streams, lakes, and drains occasionally overflow their banks and flow 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 from 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 channel 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 snow melt 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 caused when storm sewer systems become overwhelmed by 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.

Flood Insurance Rate Maps (FIRM) are available as a planning tool for communities and land owners to help assess flood risk. Risks to structures and people located within the floodplain are calculated. If they are located within a floodplain, such as a 10 or 100-year floodplain, the inherent risks can impact insurance policies.

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, flooding of developed or utilized lands will be reduced.

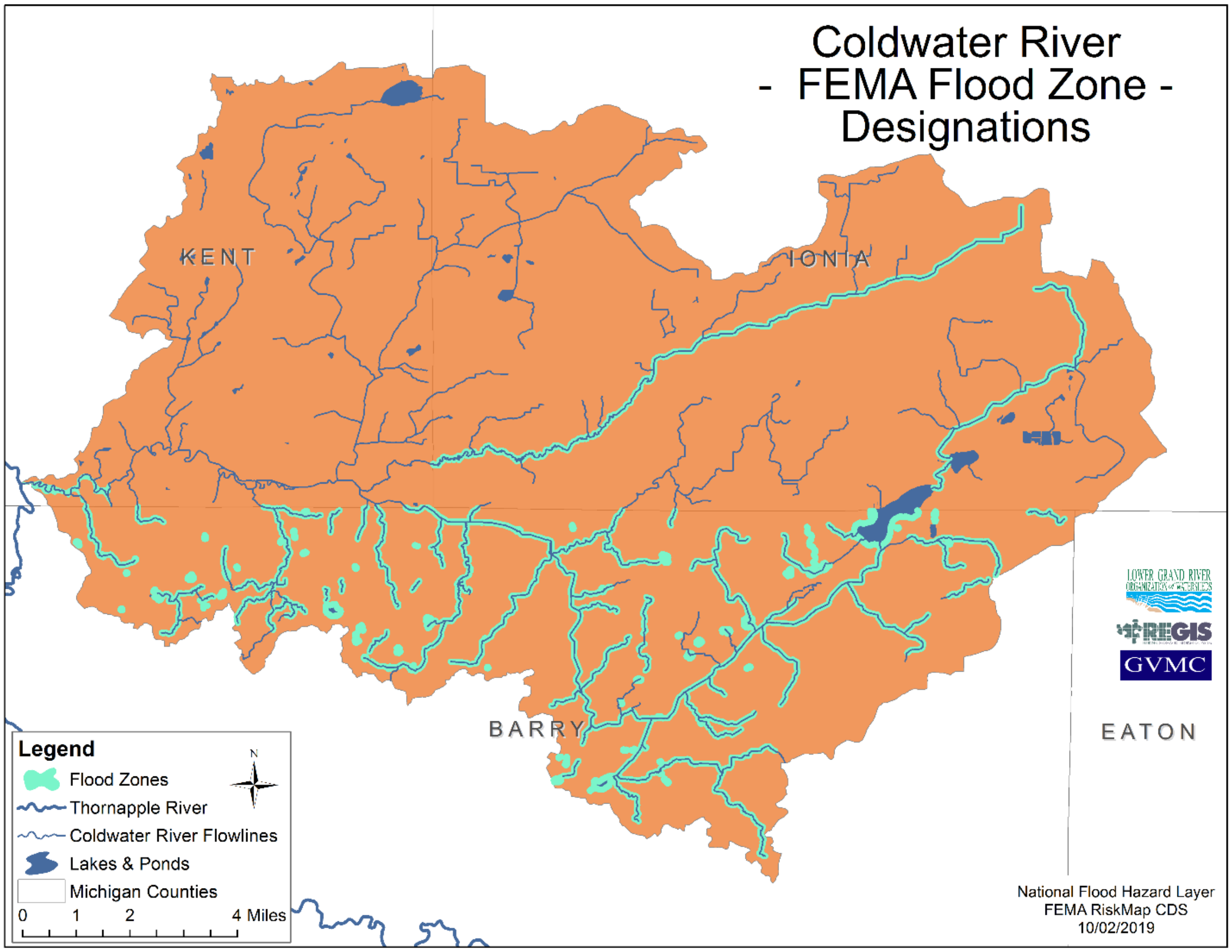

Figure 18. 100-Year Floodplain

<u>Wetlands</u>

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 inhabit 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 to protect cities can be in the millions of dollars.

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 Functional Wetland Assessment (LLFWA) is one tool that has been designed for targeting wetland protection and restoration efforts in a watershed. The LLFWA analyzes a variety of data to prioritize wetlands for protection or restoration based on how well those wetlands serve specific functions.

Based upon the LLFWA, the watershed contains approximately 14,688 acres of wetlands (approximately 12% of the total watershed). Evaluating the prevalence of hydric soil within the watershed provides an estimate of the wetland area that was present before the watershed was developed through farming and land use activities. Wetland (or hydric) soil exhibits characteristics of inundation, such as high organic matter content and distinctive soil colors that occur in saturated conditions. These indicators of wetland hydrology persist after wetlands are drained. The construction of numerous agricultural drains has contributed to the loss of approximately 18,039 acres of wetlands; wetlands are still being drained to accommodate farming.

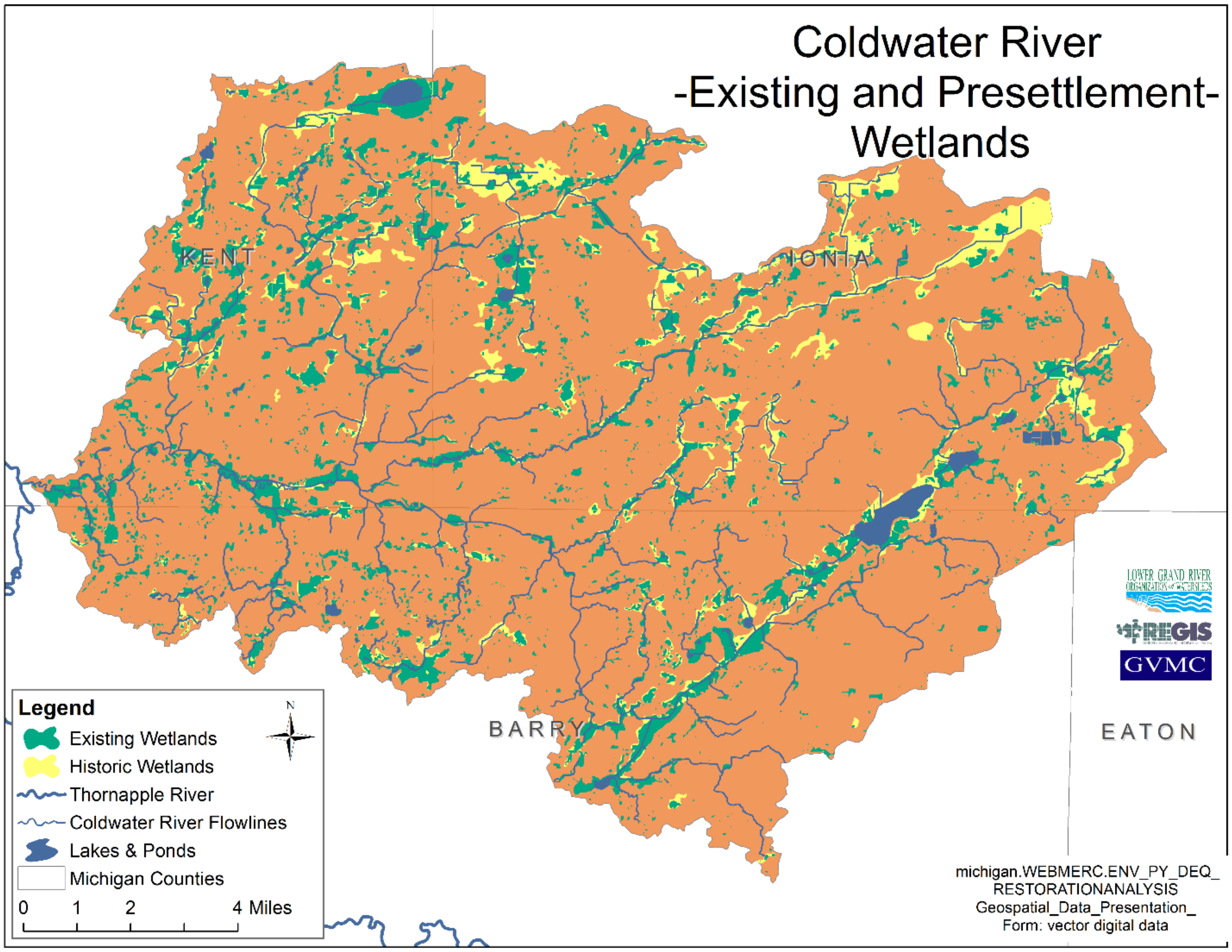

Figure 19. Existing and Historic (Presettlement) Wetlands

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 (CDCs). The CDC's are responsible for the construction, operation, and maintenance of established county drains. Many of the headwater streams and a large portion of the mainstem are altered for efficient drainage and/or maintained as designated 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, 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. Field drains leading to ditches and streams are exceptionally numerous in the CRW. Because much of the area was swampland when the first farm fields were cleared in the mid-1800s, burying field tile became standard practice to allow faster drainage of the soil after rainfall, and an earlier planting of crops. The ongoing demand for maintenance to provide efficient drainage from agricultural lands while balancing concerns of downstream riparians is often the responsibility of CDC's, 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 and filling or disconnection of floodplains have historically transferred problems such as flooding, streambank erosion and decreased water quality to downstream neighbors. Increased drainage can result in excessive flows in receiving streams. The results of excess flows can be increased streambank erosion, increased streambed scouring, sediment re-suspension, habitat destruction, and decreased diversity and number of fish and aquatic organisms. Along with water, the drains empty high amounts of soil, sands, gravel and organic matter into the streams. This contributes to high sediment buildup, over-nutrification, and eutrophication of the streams.

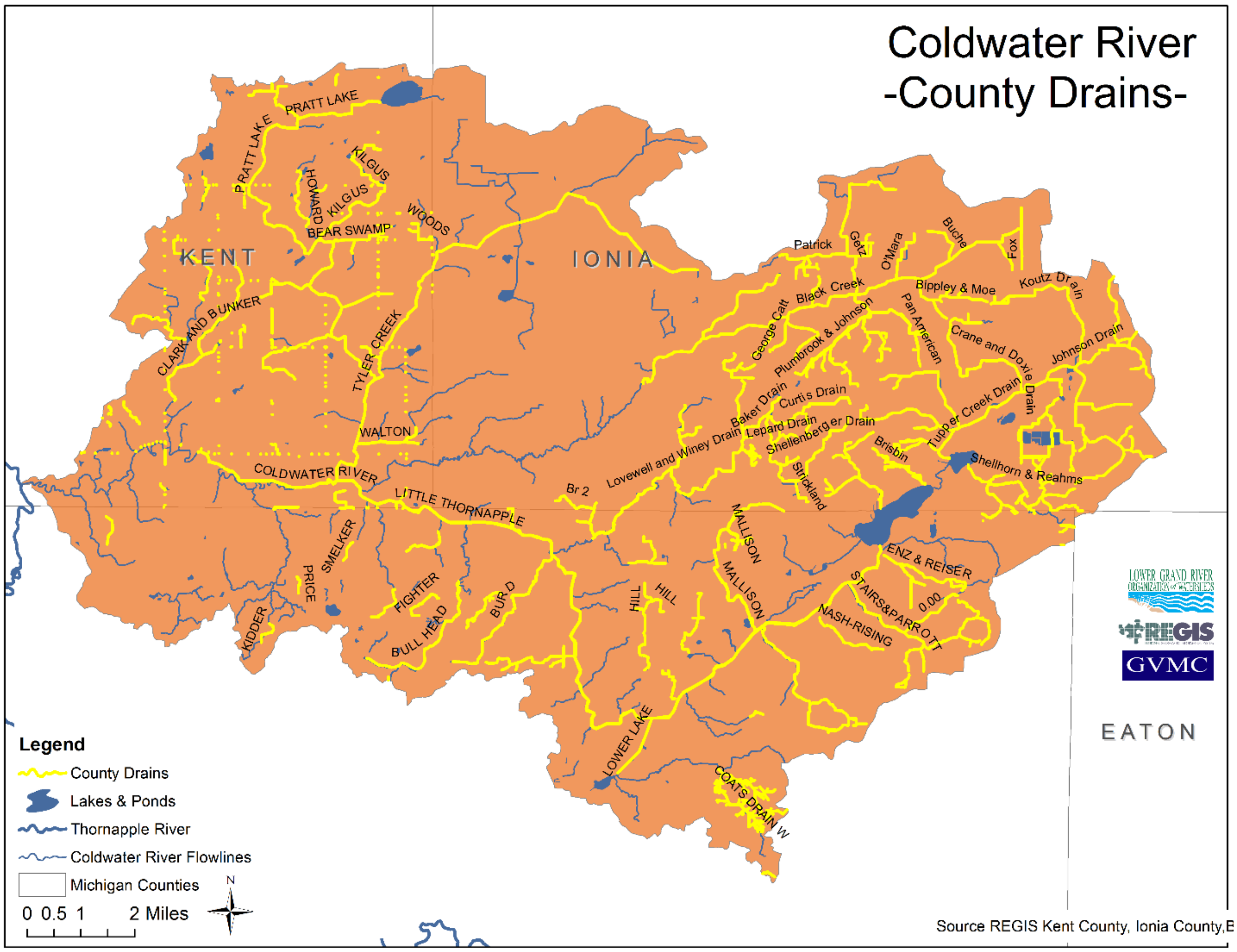

Figure 20. Designated County Drains and Natural Flowage

3.8 Aquatic Life

The Coldwater River is home to at least 34 species of fish, nearly all of them native. Upstream migration of fish from the Grand River is prohibited by dams on the Thornapple River. Much of the river and several tributaries are designated trout streams. Introduced brown and rainbow trout are stocked annually to help maintain a coldwater fishery that attracts many anglers. The coldwater fishery is, however, impaired by increasing water temperatures. A diversity of macroinvertebrates can be found at most locations in the river and tributaries, with many species present that are indicative of good water quality.

3.9 Protected Species

While dozens of threatened and endangered species are found in Kent, Barry and Ionia Counties, little information could be found specific to the CRW. Of particular interest, though, are the state endangered Virginia bluebells. The plant is found in abundance in at least two sites along the Coldwater River. In May, the showy flowers blanket the forest floor at the Dolan Nature Sanctuary and are available for public viewing and photography.

Under Part 365 of Public Act 451, people are not allowed to take or harm any endangered or threatened fish, plants or wildlife. Today, most rare species of plants and animals are threatened or endangered because of habitat destruction (including pollution) and introduction of non-native organisms. The loss of one species can affect many other species in the ecosystem, and the total impact of extinction is not always apparent. It is clear, however, that conserving biological diversity is essential for maintaining healthy, functioning ecosystems.

About 50 percent of Michigan's rare plant species depend on wetlands. An understanding of the presence or absence of threatened, endangered and special concern plant and animal species, and their habitats, can be used to help guide land conservation and management decisions in the watershed. Regional conservation efforts appear to have the greatest potential on private lands and through existing landowner habitat improvement or protections programs (Hyde et al., 2009). State Threatened, Endangered, and Special Concern species documented in Barry, Ionia and Kent Counties can be found on the Michigan Natural Features Inventory website: www.mnfi.anr.msu.edu.

3.10 Invasive Species

"Invasive species" refers to a species whose introduction does, or is likely to, cause economic or environmental harm or harm to human health. Like most areas, the CRW contains many invasive species. Some of the more pervasive include Eurasian water milfoil, curlyleaf pondweed, rusty crayfish and garlic mustard. Perhaps the most visibly destructive of late is the emerald ash borer, which has destroyed millions of ash trees, which are falling into the river and creating log jams that are having negative impacts on the hydrology, hydraulics and ecology of the river.

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. *Phragmites*, Japanese knotweed, frogbit, flowering rush, yellow floating heart, garlic mustard, oriental bittersweet and wild parsnip are especially of concern in the region and often introduced through landscaping or conservation activities.

Aquatic species that have been inadvertently or intentionally introduced into the watershed cause serious problems in aquatic ecosystems and threaten biodiversity and ecosystem function. The rusty crayfish, which is prolific in the CRW, is considered to be a threat to native crayfish populations. Native to the Ohio basin, they arrived here when anglers began using them as bait. Eurasian milfoil, curly-leaf pondweed and starry stonewort form thick mats in shallow areas of lakes and streams, which can alter fish and aquatic invertebrate populations and interfere with recreation. All of these plants are found in lakes and streams throughout the CRW, overtaking native wetland plants, and causing a reduction in food and habitat for wildlife.

3.11 Recreational Uses and Government Protected Lands

The coldwater fishery that this watershed provides is the greatest and most valued recreational asset in the watershed. Management measures to preserve the coldwater fisheries focus on maintaining minimum temperatures and reducing sedimentation. Schrems and CRWC have consistently invested funds and effort into this watershed to preserve and improve the fisheries. Kayaking/canoeing the Coldwater River has become increasingly popular over the past few years. Nature enthusiasts are often found hiking through the Dolan property and other publicly available lands, to view the spring wildflowers and abundant woodland wildlife. Jordan Lake is a popular destination for boating and water sports, and fishing. The North Country Trail passes through the CRW.

Parks and other protected lands found within the CRW, include Coldwater River Park, Two Rivers Greenspace, the Michigan Nature Association's "Dolan Nature Sanctuary", the Audubon Society's "Maher Sanctuary", and the MDNR public boat launch on Jordan Lake. Coldwater River Park is located on Morse Lake Avenue and is six acres in size. The park contains about one-third of a mile of river frontage. The Two Rivers Greenspace is a yet-to-be developed, 260-acre park located at the confluence of the Coldwater and Thornapple Rivers. Dolan Nature Sanctuary is a 127-acre preserve, located on Baker Road, with frontage on both the Coldwater River and Tyler Creek. The North County Trail passes through the Dolan. The Maher Sanctuary is a 77-acre preserve located on 108th Street, with frontage on Cain Creek.

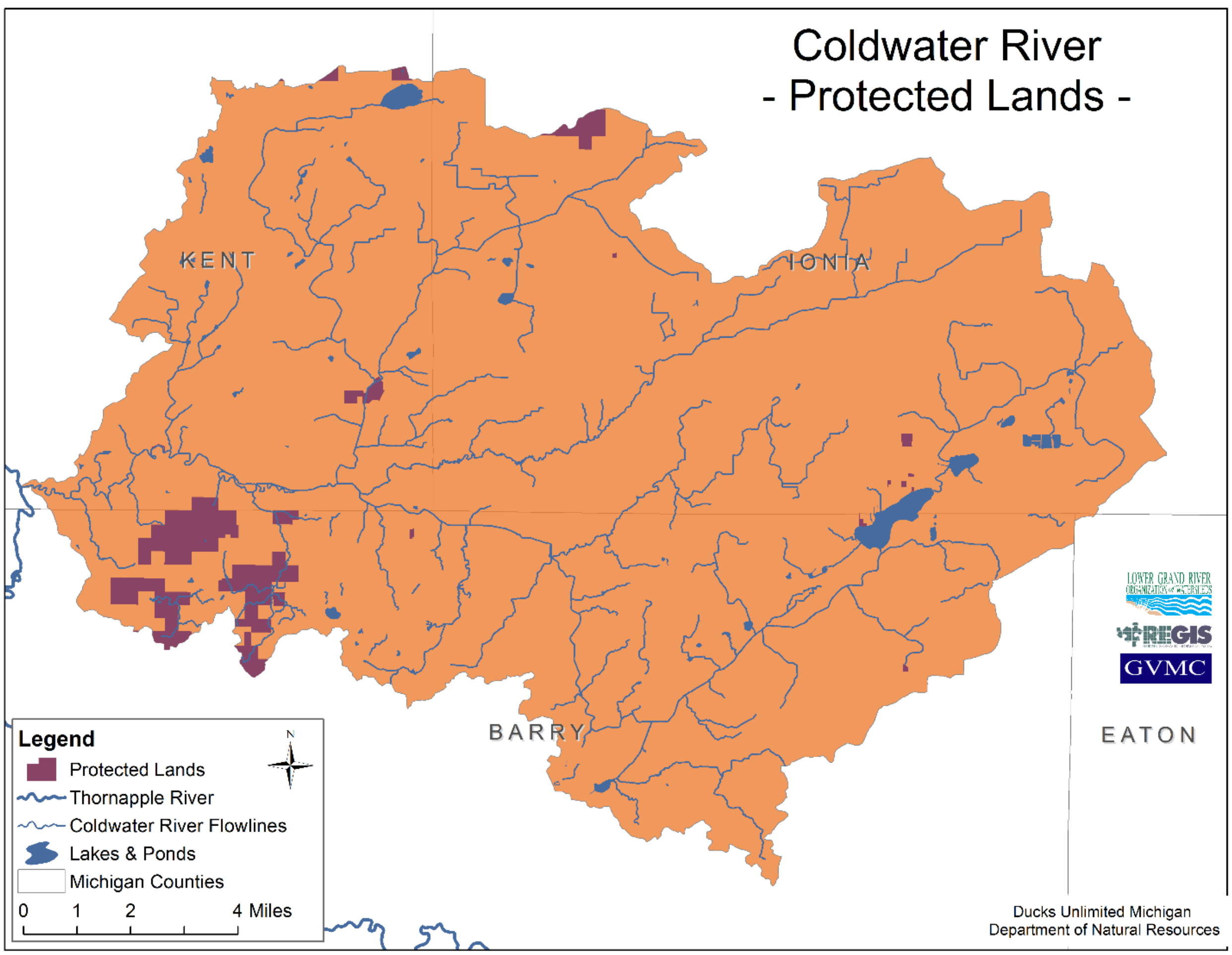

Figure 21. Government Protected Land

3.12 Political Jurisdictions

The CRW is located in portions of four counties and 15 townships: Carlton, Castleton, Hastings Charter, Irving, Thornapple, and Woodland Townships of Barry County; Sunfield Township of Eaton County; Berlin, Boston, Campbell, Odessa, and Sebewa Townships of Ionia County; and Bowne, Lowell, and Caledonia Townships of Kent County.

In addition to local county, city, and township governments, state agencies with regulatory oversight include EGLE and MNDR. EGLE works to enforce federal and state environmental protection laws and is the state's permitting authority for inland lakes and streams, wetlands, National Pollutant Discharge Elimination System (NPDES), concentrated animal feeding operation (CAFOs), Soil Erosion and Sedimentation Control (SESC), and storm water management. 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 onsite well and septic system installation, affecting groundwater resources. The four counties within the CRW are serviced by three different District Health Departments including:

- Kent County Health Department (KCHD)
- Ionia County Health Department (ICHD)
- Barry Eaton District Health Department (BEDHD)

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.

Part 91 of Natural Resources Environmental Protection Act (NREPA) SESC is administered and enforced by EGLE through various county and local government units. Counties have a designated County Enforcing Agency (CEA), and municipalities are able to designate Municipal Enforcing Agencies. County Enforcing Agencies and Municipal Enforcing Agencies are responsible for reviewing soil erosion and sediment control plans, issuing permits and reviewing compliance with Part 91, and taking enforcement actions when necessary. In the CRW, CEAs include:

- Barry County Planning Office – CEA
- Ionia County Drain Commission- CEA
- Kent County Road Commission- CEA

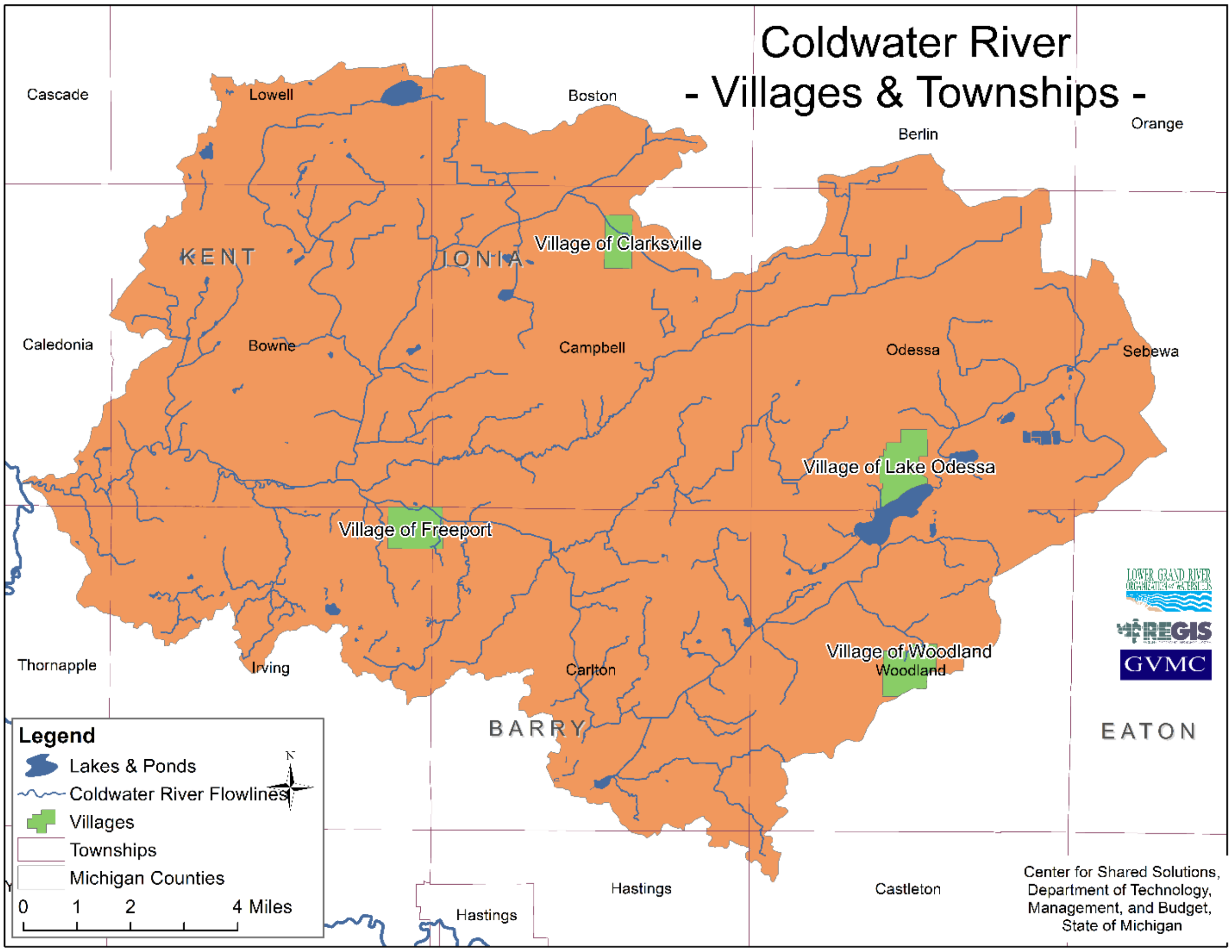

Figure 22. Local Units of Government

3.13 Demographics

According to the 2000 Census (U.S. Census Bureau, 2000), since 2020 data are not yet available, every county and almost every township and community in the watershed experienced population growth. Most of the CRW population is concentrated in small urbanized communities: Village of Woodland in Carlton Township, Village of Freeport in Irving Township, Clarksville in Campbell Township, Village of Lake Odessa in Odessa Township, and Alto in Bowne Township. Some of these townships are growing faster than the national average of 13.1% and faster than the state of Michigan average of 6.9% (U.S. Census Bureau). The predominant land use and character of the watershed, however, will remain agricultural for some time. Census blocks were tallied to get a more accurate idea of the population within the watershed boundary. The number of residents in the Coldwater River Watershed is approximately 18,440.

Table 4. Population by County

County	1990 Census	2000 Census	% Growth	County Population in Watershed by Census Block
Barry County	50,057	56,755	13.4	7,207
Ionia County	57,024	61,518	7.9	7,147
Kent County	500,631	574,335	14.7	4,086
Total				18,440

Table 5. Population by Township

Township	County	1990 Census	2000 Census	% Growth	Township Population in Watershed by Census Block
Carlton (includes Village of Woodland)	Barry	2,067	2,331	12.8	3,002
Castleton	Barry	3,379	3,475	2.8	58
Hastings Charter	Barry	2,830	2,930	3.5	65
Irving (includes Village of Freeport)	Barry	1,905	2,682	40.8	1,736
Thornapple	Barry	5,226	6,685	27.9	598
Woodland	Barry	2025	2,129	5.1	1,748
Berlin	Ionia	3,610	2,787	-22.8	87
Boston	Ionia	4,313	4,961	15	544
Campbell (includes Clarksville)	Ionia	1,814	2,243	23.6	2,195
Odessa (includes Village of Lake Odessa)	Ionia	3,885	4,036	3.9	3,979
Sebewa	Ionia	1,160	1,202	3.6	342
Bowne (includes Alto)	Kent	1,907	2,833	48.6	2,806
Caledonia	Kent	6,254	8,964	43.3	338
Lowell	Kent	4,774	5,219	9.3	942
Total					18,440

4.0 SUMMARY OF WATER QUALITY IN THE COLDWATER RIVER WATERSHED

This chapter describes the standards by which the State of Michigan determines water quality and how the water quality within the CRW 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 water quality standards (WQS) to provide eight designated uses. The WQS are established by Part 4 Rules issued in accordance with Part 31 of the Natural Resources and Environmental Protection Act (NREPA) (1994 PA 451, as amended). Designated uses, which are also specified in Part 4 Rules, **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 CRW.
- *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 6. Subsequent to beginning this WMP, EGLE added chlorides to the WQS and future monitoring efforts should include this pollutant. For pollutants that do not have established WQS, including total phosphorus and ammonia, comparison values based upon USEPA Ecoregion data are used instead. CRW is within the Southern Michigan/Northern Indiana Drift Plains (SMNIDP) Ecoregion VII.

Table 6. Water Quality Standards Used to Assess NPS Pollutants (EGLE 2021)

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
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	milligrams/Liter (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.
Chloride	150,000 320,000 640,000	µg/L	WQS	Final acute (640,000), aquatic maximum (320,000) and final chronic values (150,000) for aquatic life	EGLE Water Bureau Water Resources Protection. (2006, January 13). Part 4 Water Quality Standards. Rev. 02/21
Ammonia (NH3-N)	0.042	mg/L	C	Mean concentration calculated from SMNIDP ecoregion sites	Lundgren, R. 1994. Reference Site Monitoring Report 1992-1993. Michigan Department of Natural Resources, Surface Water Quality Division, Lansing, Michigan. Report No. MI/DNR/SWQ-94-048.
Total Phosphorus (TP)	0.03125	mg/L	C	Ambient WQ criteria recommendations; 25th percentile of ecoregion stream population	Ambient Water Quality Criteria Recommendations: Information Supporting the Development of State and Tribal Nutrient Criteria: Rivers and Streams in Nutrient Ecoregion VII. US EPA 822-B-00-018). Washington D.C.

4.2 Impaired Designated Uses in the Coldwater River Watershed

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, habitat for indigenous aquatic life and wildlife being impaired due to habitat alterations, and the coldwater fishery as being impaired due to flow regime and habitat modifications (Figure 22 and Table 7). The designated use of fish consumption is also impaired by mercury and PCB contamination throughout the entire watershed (EGLE 2020). In most cases, the warm and coldwater fisheries and habitat for other indigenous aquatic life and wildlife were not assessed.

Table 7. Areas of Impaired Use

Location	Size	Impaired Use	Cause
Little Thornapple River; 040500070301-01	26.0 miles	Indigenous Aquatic Life and Wildlife	Habitat Alterations
Messer Brook – Coldwater River; 040500070303-02	11.5 miles	TBC and PBC	*E. coli*
Duck Creek; 040500070304-01	15.2 miles	TBC and PBC	*E. coli*
Duck Creek; 040500070304-02	16.8 miles	Coldwater Fishery	Flow Regime and Habitat Modifications
Pratt Lake Creek; 040500070305-02	10.8 miles	TBC and PBC	*E. coli*
Pratt Lake Creek; 040500070305-02	10.8 miles	Coldwater Fishery	Flow Regime and Habitat Modifications
Pratt Lake Creek; 040500070305-03	5.3 miles	TBC and PBC	*E. coli*
Bear Creek; 040500070306-01	11 miles	TBC and PBC	*E. coli*
Bear Creek; 040500070306-02	16 miles	TBC	*E. coli*
Bear Creek; 040500070306-04	7.5 miles	TBC	*E. coli*
Coldwater River; 040500070307-02	10.9 miles	TBC and PBC	*E. coli*
Coldwater River; 040500070307-03	39.3 miles	TBC and PBC	*E. coli*

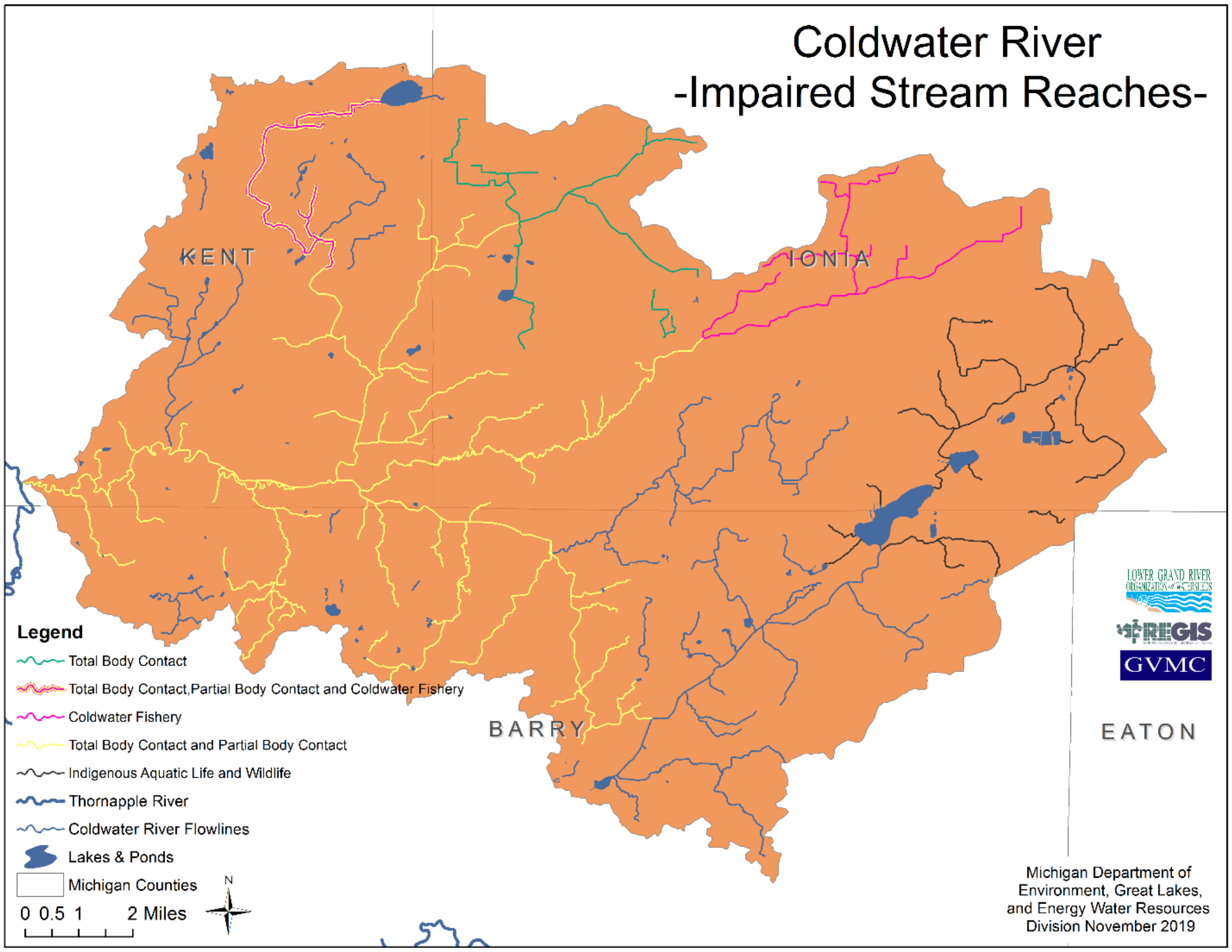

Figure 23. Impaired Stream Reaches

<u>Partial and Total Body Contact Recreation</u>

Michigan's WQS 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 CRW. The data indicate that *E. coli* contamination of the CRW is widespread and on-going.

<u>Warmwater/Coldwater Fishery</u>

The Coldwater River and most of its tributaries are currently listed as designated trout streams (coldwater fisheries) and have been stocked with brown trout for several years by the MDNR. Specifically, the mainstem of the Coldwater River from the Thornapple River upstream to M-43, Tyler Creek, Duck Creek, Bear Creek, Cain Creek, Unnamed Tributary (T5N, R9W, S31), Unnamed Tributary (T5N, R10W, S36) and

Unnamed tributary on north bank of Coldwater River (T4N, R7W, S18) 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). The 2020 IR lists the coldwater fisheries of Pratt Lake Creek and Duck Creek as impaired. Data also suggest that this impairment is more widespread, and that portions of the Bear Creek branch of Tyler Creek and the Coldwater River are also impaired.

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 impaired in areas of the CRW because of altered hydrology and modified habitat. Because most of the CRW was not assessed for this designated use, and observations and data collection indicate that dredging of tributaries is ubiquitous throughout the watershed, it is likely that this impairment should be expanded.

Fish Consumption

Like all surface waters in Michigan, the Coldwater River 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.

4B DETAILED DESCRIPTION OF WATER QUALITY IN THE COLDWATER RIVER WATERSHED

4B.1 Review of Existing Information

An effort was made to locate and summarize all of the relatively recent and pertinent data and reports related to water quality within the CRW, with specific attention to pollutants that may be impairing designated uses. This section includes the results of that effort, listed alphabetically by source.

Barry-Eaton District Health Department

In 2007, the BEDHD conducted a study of on-site wastewater systems in the Village of Freeport (BEDHD 2007). Results indicated that there were aging and/or outdated systems, improperly operating systems, unsuitable site conditions for on-site systems, lack of replacement area and sites where the use is exceeding the capability of the system, in addition to sites where the nature and condition of the system is unknown. Specifically:

- 48% of the buildings inspected had no known septic system in place, including 62 sites with no record of a septic system
- 14% of the systems evaluated were failed or malfunctioning, and another 21% were stressed
- 22% of sites had no, or inadequate, replacement area
- 20% of repair sites were identified as nonconforming, meaning that the site failed to meet Sanitary Code requirements

The BEDHD presented recommendations to the Village, but adoption of the recommendations is unknown at this time.

BEDHD (2017) reported that, over a period of ten years, there were almost 12,000 evaluations of on-site wells or sewage systems in the two county coverage area. Of these, action was required for approximately 20 percent of on-site wells and approximately 27 percent of on-site sewage systems. The actions required ranged from minor (e.g., new water samples, septic tank pumping) to major (e.g., full system replacement).

Coldwater River Watershed Council

In 2002, the CRWC collected data to determine if conductivity and dissolved oxygen (DO) are possible causes for the poor game fish establishment. The monitoring station that was deployed recorded: river rising stages, groundwater elevation, water temperature, DO, and total dissolved solids (TDS). As well, water samples were collected approximately twice a month from eight designated sites throughout the CRW. Samples were analyzed for total suspended solids (TSS), total phosphorus (TP), ammonia nitrogen, and fecal coliform. DO levels at Usborne Road were monitored hourly between May 19 and June 16, 2002. On 5 of the 29 days observed, the DO level was consistently below 7 mg/L for the full 24 hours. Twenty-three of these 29 days saw levels drop below 7 mg/L for some amount of time, a total of 368 hours of 677 total hours (54.36%). On 12 of the 29 days tested, DO levels went below 5 mg/L for some amount of time, a total of 119 hours of 677 total hours (17.56%), indicating poor water quality for freshwater systems (MDEQ, 1994a). According to these data, DO levels fell below minimum standards for a coldwater fishery in Michigan more than half of the observed days. Only 32 of 280 (approximately 11%) samples show "normal levels" (0.02 to 0.03 mg/l) of total phosphorus. Three percent to 6% of 33 water samples collected at each site contained ammonia concentrations at or above 0.03 mg/L.

Since 2014, the CRWC, in partnership with the Oakbrook (IL) Chapter of Trout Unlimited, has bi-annually monitored the macroinvertebrate communities, using the MiCorps method. Most sites appear to have stable macroinvertebrate communities over time, though scores at the Tyler Creek site have declined since higher scores were recorded during the early years of sampling.

Table 8. CRWC (Oakbrook TU) Macroinvertebrate Sampling Results

SITE	SAMPLING EVENTS	MINIMUM SCORE	MAXIMUM SCORE	AVERAGE SCORE
Tyler Creek @ Golf Course	13	20.9	51.9	29
Coldwater River @ M-43 (west)	7	16.9	39.5	27.6
Coldwater River @ Freeport Ave.	13	22.7	45.1	31.3
Coldwater River @ Baker Ave.	6	23.1	40	30.2
Messer Brook - Downstream End (Before Dredging)	4	31.5	44.3	36.6
Messer Brook - Downstream End (After Dredging)	2	21.7	21.8	21.8
Duck Creek @ Montcalm Ave.	12	19.7	40.7	28.5
Cain Creek @ 108th Ave.	7	18.3	36.9	31.2

Oakbrook TU also collected stream temperature data at four locations in 2020. The Coldwater River, at M-43 (west crossing), had an average monthly water temperatures of 73.8°F in July, which exceeds the WQS for a coldwater stream. Daily exceedances of 68°F occurred periodically in May, June, July and August. At Freeport Avenue, the Coldwater had an average July water temperature of 69.6°F, which also exceeds the WQS for a coldwater stream. Daily exceedances of 68°F occurred periodically in May, June, July and August. Tyler Creek, at the golf course, and Cain Creek, at 108th, had average July water temperatures that met the WQS for a coldwater stream.

Table 9. CRWC (Oakbrook TU) Water Temperature Monitoring (July 2020)

SITE	AVERAGE WATER TEMP (July 2020)	IMPAIRED
Tyler Creek @ Golf Course	64.3	No
Coldwater River @ M-43 (west)	73.8	Yes
Coldwater River @ Freeport Ave.	69.6	Yes
Cain Creek @ 108th Ave.	57.1	No

Grand Valley State University

Preville et. al. (2017) conducted monitoring (physical habitat, fish, crayfish and mussels) at six sites following drain improvement work. Habitat was found to be impacted by fine sediment. Water temperature exceeded WQS for a coldwater fishery at four of the six sites, and dissolved oxygen was found to exceed the WQS for a coldwater fishery at M-43. All sites, except M-43, met the P51 criteria for a coldwater fish community. Several species of freshwater mussels were recorded, though very few live mussels were found; invasive Asiatic clams and zebra mussels were widespread. Only one species of crayfish, the Calico crayfish, was found but was present at all sites. Researchers suggested that the drain work caused reduced instream habitat and altered the thermal regime.

Table 10. GVSU P51 Physical Habitat, Water Temperature and Dissolved Oxygen, Trout Population and Native Freshwater Mussel Monitoring (2017)

SITE ID	P51 Habitat	Avg. Max. Daily Temp. (F) (June 16 to July 20, 2017)	Dissolved Oxygen (mg/L) June 15, 2017	% of Fish Population that is Trout	# of Native Freshwater Mussel Species
M-43	73	73.6	5.3	0	3
Brown Road	122	71.2	10.2	3.9	5
Hastings Road	155	71.6	8.1	1.4	5
Baker Avenue	130	68	7.4	2.5	0
Tyler Creek at 92nd	130	66	8.4	12.8	0
Duck Creek at Montcalm	162	68.5	7.0	4.5	2

Michigan Department of Environmental Quality/Environment, Great Lakes and Energy

MDEQ (2003) developed a hydrologic model for the CRW to help determine the effect of drainage system alterations and land use changes on the Coldwater River's flow regime. Results indicated that, because of loss of natural areas, runoff volumes and peak flows have increased for both the 50 percent chance (2-year) and 4 percent chance (25-year) design storms. These increases could cause or aggravate flooding problems and increase channel-forming flows, causing stream channels to become unstable. Primary causes appeared to be the changes in land use and loss of storage, and best management practices associated with stormwater management, such as wetland restoration, were recommended.

MDEQ (2010) conducted P51 Physical Habitat and Macroinvertebrate surveys at seven sites in the CRW, and found impairments to physical habitat and the macroinvertebrate community.

Table 11. MDEQ Physical Habitat and Macroinvertebrate Sampling Results (2010)

STREAM	ROAD CROSSING	HABITAT	MACROINVERTEBRATES
Coldwater River	Winding River	Excellent (160)	Excellent (7)
Tyler Creek (Pratt Lake Drain)	84th Street	Good (135)	Acceptable (4)
Tyler Creek	92nd Street	Good (146)	Acceptable (2)
Tyler Creek (Pratt Lake Drain)	Wingeier (north crossing)	Good (127)	Acceptable (1)
Duck Creek	Jackson	Marginal (98)	Acceptable (-3)
Coldwater River	Wellman	Good (115)	Acceptable (0)
Coldwater River	M-43 (east crossing)	Good (113)	Poor (-5)

MDEQ (2015) conducted P51 Physical Habitat and Macroinvertebrate surveys at seven sites, and P51 fish surveys at two sites in the CRW. Degraded habitat associated with maintenance of county drains was discussed as the primary factor leading to poor fish communities and depressed macroinvertebrate communities.

Table 12. MDEQ Physical Habitat and Macroinvertebrate Sampling Results (2015)

STREAM	ROAD CROSSING	HABITAT	MACROINVERTEBRATES	FISH
Tyler Creek (Pratt Lake Drain)	Wingeier (north crossing)	Good (117)	Acceptable (-2)	Poor
Coldwater River	M-43 (east crossing)	Marginal (103)	Poor (-5)	
Duck Creek	Jackson	Good (109)	Acceptable (-2)	Poor
Coldwater River	Messer	Good (107)	Excellent (6)	
Coldwater River	Vedder/Broadway	Good (114)	Excellent (7)	
Coldwater River	Harwood	Marginal (95)	Poor (-5)	
Tyler Creek (Pratt Lake Drain)	84th	Good (121)	Acceptable (0)	

Since 2018, MDEQ/EGLE has issued at least five notices of violation to three dairy farms within the CRW, for manure spills into the Coldwater River or its tributaries, improper storage of livestock manure or improper application of livestock manure (www.miwaters.deq.state.mi.us accessed on August 13, 2020). Similarly, the Lakewood Wastewater Authority has received seven violations – five of them in 2020 – for sewer overflow events.

EGLE (2021) conducted macroinvertebrate and habitat surveys at nine sites in the Coldwater River watershed in 2015. The purpose of this sampling was to document conditions following unauthorized drain maintenance activities including tree canopy removal and dredging. Macroinvertebrate community and physical habitat were monitored at five sites where the activities directly occurred and at four sites downstream of the activity. Overall conclusions are as follows:

- Directly impacted sites had macroinvertebrate scores ranging from -3 to +2 (acceptable). Downstream sites had scores that were generally higher; from +1 to +5 (acceptable to excellent).
- The macroinvertebrate community at Coldwater River at Messer Rd was coincidentally also monitored in 2013 (MDEQ, 2015). The macroinvertebrate community at this site scored +6 (excellent) in 2013 and fell to acceptable in 2015 and 2018 (scores of +2 and 0, respectively) following drain maintenance activities. This site was directly impacted by channel dredging activities and as the most downstream impacted site, also received indirect impacts from the in-stream sediment disturbances and bank modifications upstream. In 2013, long cobble and gravel riffles were present at this survey location providing valuable habitat. Likely a direct result of drain activities, in 2018, these riffles were composed of sand and gravel, with cobble no longer present in the center of the stream channel and only at the edges.
- The macroinvertebrate community scores upstream of M-43 and at Rush Road both improved between 2015 and 2018 surveys, indicating some recovery. Instream structures to improve habitat were noted at Rush Road, and tree planting had occurred upstream of M 43.
- Habitat scores at all three sites which were monitored in both 2015 and 2018 improved slightly between years. In stream habitat was largely limited to aquatic macrophytes, with little or no large woody debris, no undercut banks, and little overhanging vegetation.
- The impacts of this drain maintenance project are likely to continue to be present at all sites in the form of potential increased sediment movement and flashiness resulting from tree removal.
- Messer Brook upstream of Darby Road had only one riffle, and the cobble which would normally provide macroinvertebrate habitat was covered with dead plant matter (likely algae or moss)

Michigan Department of Natural Resources

A Fish Kill Investigation Report Form, completed by Hanshue (2006), described a complete fish kill on July 27, 2006. The kill was noted to be begin about 100 yards downstream of Freeport Road, on the Bear Creek tributary. The fish kill extended about four miles downstream to the confluence with the Coldwater River. Suspected cause of the kill was noted to be runoff of manure from a wheat stubble field.

Michigan State University

Rose and Tomoyuki (2006) completed microbial analysis of dead trout collected during investigation of a fish kill in Tyler Creek. It was found that microbial fecal indicators were present at high concentrations. The study concluded that there was fecal contamination in the stream at the time of the fish kill and that material in the gills of the fish was of fecal origin. It was not possible to determine if the source of the contamination was from human, domestic or agricultural waste.

Michigan Trout Unlimited

Subsequent the large drain-clearing project commissioned by the Intercounty Drain Board, MITU conducted water and air temperature monitoring in 2015 and 2016 (MITU 2017). The data were compared to those collected by MDNR in 1997. 2015 and 2016 water temperature values were compared to those in 1997, as was air temperature. The air temperature in 1997 and 2015 was incredibly similar (Mean July air temperature in 1997 and in 2015 was 71˚F.), but 2016 had a much warmer July. Because of the similarity in climate in 1997 and 2015, focus was placed on those years. Sites where monitoring was completed in 1997 and 2015 showed a clear indication of a warmer system. 2015 mean July water temperatures were between 2 and 4.6˚F warmer than 1997 mean July water temperatures. This similarity in weather patterns further supports the hypothesis that the bank clearing which occurred in 2015 has led to warming of the water in the Coldwater River. It was also noteworthy that water temperature exceeded the WQS for a coldwater fishery at eight of the 12 sampling sites.

Schrems TU

Schrems completed an instream habitat improvement project in 2010 at the Dolan Property on Baker Road. Five years of post-construction cross section and scour chain monitoring indicated that accumulations of sediment, up to nine inches deep, covered the streambed in 2015, following upstream drain maintenance activities in 2014 and 2015.

Stakeholder Input

Stakeholder input was gathered at CRWC meetings, Schrems meetings, during discussions with landowners, residents and anglers, and through emails/phone calls from concerned stakeholders. For the most part, this information is viewed as anecdotal unless follow-up inspection by qualified individuals was completed and the reported issue was verified. Only the input that could be verified was included in this WMP, though some of the qualified individuals requested to remain anonymous.

- Unpermitted/illegal dredging of tributary streams.
- Illegal, unreported draining of wetlands.
- Excessive growth of invasive plants (curly-leaf pondweed) noted in Tyler Creek, with problem worsening in recent years.
- Runoff of land-applied livestock manure through concentrated flow paths leading directly to the Coldwater River.

Timberland Resource Conservation and Development Council

As part of their 319 Implementation Grant Project in 2011, TRCD fish surveys indicated that the trout populations at Swisslane Farm, Calvary Brethren Church and the Tyler Creek Golf Course were 411, 1,617 and 2,519 trout per mile, respectively. A diversity of age classes were found and trout ranged from two to 21 inches in size. Fifteen different species of fish were captured.

During 2012 and 2013, Timberland Resource Conservation and Development Council (TRCD) collected surface water, tile outlet and groundwater samples for analysis of *E. coli* concentration.

- In 2012:
    - 11 surface water sites were sampled for 21 weeks (occasionally a lack of flow at a site prevented sampling). All 11 sampling stations exceeded the WQS for TBC during at least ten of the sampling events. With the exception of one site on the upper Bear Creek branch, all locations exceeded the WQS for PBC on at least one occasion.
    - Nine tile line outlets were sampled between three and 20 times each, depending on if they were flowing on the sampling date. Five of the sites exceeded WQS for PBC on at least one occasion; six of the sites exceeded the WQS for TBC on at least one occasion. A site

in the upper Bear Creek, near 52nd Street, exceeded WQS for TBC 15 out of the 16 times it was sampled, and WQS for PBC 14 out 16 times. *E. coli* concentration exceeded 24,200 cfu/100 ml (upper testing limit) on two occasions.

- In 2013:
  - 11 surface water sites were sampled for 15 weeks. All locations had two or more events with *E coli* concentrations that exceeded the WQS for PBC. At eight sites, every sample collected exceeded the WQS for TBC; at the other three sites, at least 66% of samples exceeded the WQS for TBC.
  - Three monitoring wells were installed to measure *E. coli* concentrations in ground water. Two of the wells exceeded WQS for TBC and PBC on at least one occasion. The well downstream of 84th Street on the Pratt Lake Drain exceeded TBC 33% of the time and PBC 27% of the time; this well was located just downstream of a CAFO. All exceedances in both wells occurred in the first five weeks of sampling, up until July 24.

Also in 2012, TRCD collected water temperature data at five sites in the Tyler Creek subwatershed. Daily exceedances of the WQS for coldwater streams were documented in both the Pratt Lake Drain and Bear Creek branches, during the months of June, July and August. Average July water temperatures exceeded 68°F at four of the sites.

Table 13. TRCD Water Temperature Monitoring (2012)

STREAM	ROAD CROSSING	AVERAGE WATER TEMP (F) (July 2012)	IMPAIRED
Tyler Creek (Pratt Lake Drain)	64th	71.7	Yes
Tyler Creek (Pratt Lake Drain)	84th	64.0	No
Tyler Creek (Bear Creek)	84th	68.4	Yes
Tyler Creek (Bear Creek)	Bell	69.4	Yes
Tyler Creek (Bear Creek)	Montcalm	70.9	Yes

In 2015, TRCD reported findings from the Tyler Creek Monitoring Project (CMI #2013-0516). Monitoring was directed at measuring stream discharge and *E. coli* concentration and Suspended Sediment Concentration (SSC), and using canines to detect sources of human fecal contamination. Results of the study indicated that:

- Peak flows were seen in the stream channels within 24 hours of significant precipitation events and receded within four to five days. While likely variable based upon soil moisture conditions, etc., data demonstrate the efficiency of the drainage system in the watershed. Agricultural land use has an impact on the duration and magnitude of stream flow events. If the current trend of increasing drainage efficiency through field tiling and drain maintenance, along with net loss of wetlands, continues, effects on the stream channel and downstream receiving waters may be exacerbated.
- The Bear Creek branch contributes higher flow volumes and greater *E. coli* loading than the Pratt Lake Drain. Previous studies have shown the *E. coli* concentrations to increase substantially between Wingeier Road and 84th Street on the Pratt Lake Drain and between Montcalm Road and 84th Street on Bear Creek. All sites sampled consistently exceed WQS for PBC and TBC. *E. coli* and SSC concentrations and loading estimates were related to discharge rates; higher flows had greater concentrations of bacteria. The seasonal patterns of land application of livestock manure probably contribute to variability of data.

- The Tyler Creek watershed is impacted by *E. coli* contamination from a variety of sources. Human-related sources were discovered in the watershed, including a cheater pipe discharging raw sewage to a tributary stream.

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

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 (Appendix A). Basically, a desktop analysis was conducted using high-resolution aerial photographs and field data was collected by driving the entire CRW. 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, it is clear that animal agriculture is prolific and widespread in the CRW. There are approximately 220 locations that house animals, including three CAFOs, in the CRW, housing an estimated 10,500 cattle, 480 horses and 330 other medium to large livestock including sheep, goats and bison. It must be reiterated 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, were identified.

Several areas of excessive streambank erosion or unstable stream channels were also documented in Tyler Creek, on the mainstem of the Coldwater and, most notably, the Cain Creek subwatershed. As well, several road/stream crossings were identified where excessive sediment is entering the surface waters. These locations are discussed in greater detail in Chapter 7.

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.

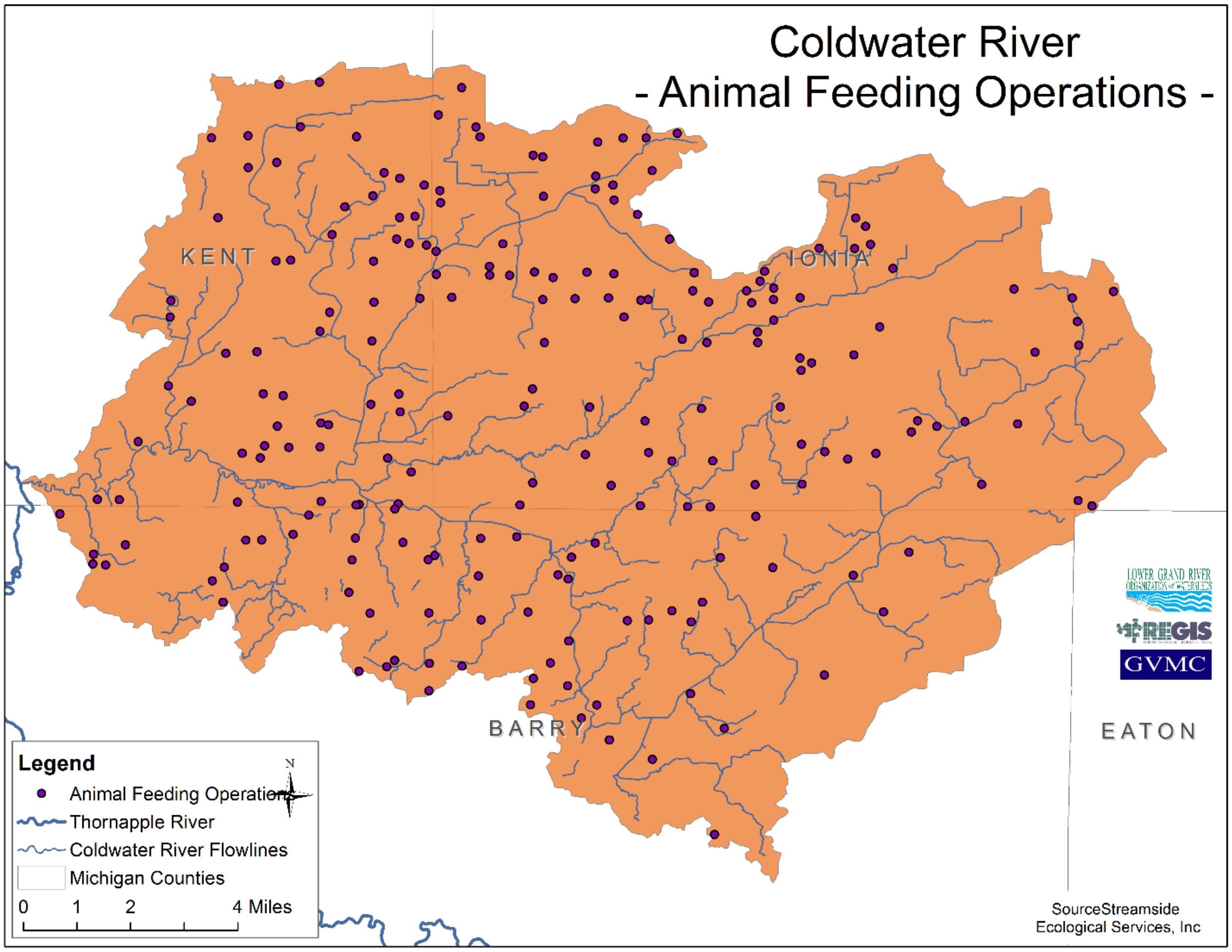

Figure 24. Animal Feeding Operations

***E. coli* concentration sampling**

Twenty-five *E. coli* sampling locations were selected to determine the extent of contamination throughout the CRW. Sites were selected to provide data for the mainstream of Coldwater River, along with major tributaries, and to assist with identification of sources and causes of pollution. With few exceptions, each site was sampled on four separate dates: April 30 (wet weather) and July 10 (dry weather), 2019, September 9, 2020 (wet weather) and May 26, 2021 (wet weather). Wet weather events were defined as having >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.

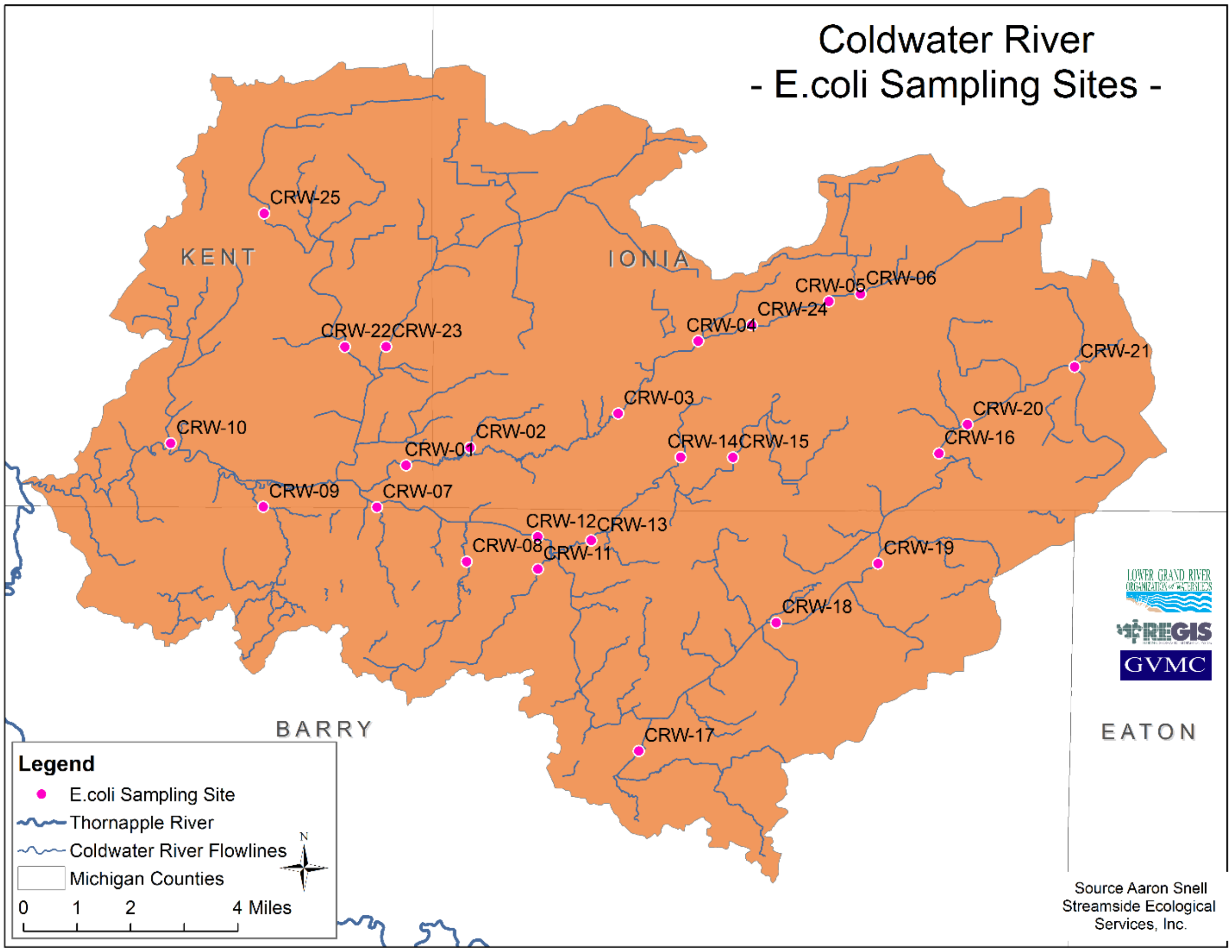

Figure 25. *E. coli* Sampling Sites (2019-2020)

April 30, 2019 was a wet weather sampling event, but during higher than average stream levels and following a two-week period in which nearly two inches of rainfall was recorded. Four of the 25 sites (16%) exceeded the WQS for PBC and 11 sites (44%) exceeded WQS for TBC. Ten sites met WQS.

On July 10, 2019, a dry weather sampling event was conducted. While the event was defined as dry weather based upon the QAPP, stream levels were high and over three inches of rain had been recorded in the preceding 30-day period. Of the 23 sites monitored on this date, 11 exceeded WQS for TBC and nine exceeded WQS for PBC; only three of the sites met WQS.

September 9, 2020 also qualified as a wet weather sampling event. Stream levels were high due to over three inches of rain falling in the preceding two weeks. Only one site, Coldwater River at Brown Road, met the WQS; this site also met WQS during the first two sampling events. Twenty-two sites exceeded the WQS for TBC, with 11 of these sites also exceeding the WQS for PBC.

Table 14. *E. coli* Monitoring Results (2019-2021)

Site ID	Stream	Road	APRIL 30, 2019 Geomean (cfu/100mL)	JULY 10, 2019 Geomean (cfu/100mL)	SEPT. 9, 2020 Geomean (cfu/100mL)	MAY 26, 2021 Geomean (cfu/100mL)
CRW 1	Duck Creek	Freeport	557	542	1,162	12,445
CRW 2	Trib to Duck Creek	Furlong	497	1,762	1,594	2,500
CRW 3	Duck Creek	Nash	992	423	762	7,709
CRW 4	Duck Creek	Elm	796	218	464	18,940
CRW 5	Duck Creek	Clinton Trail	107	1,735	616	6,024
CRW 6	Duck Creek	Tasker	105	1,368	525	2,296
CRW 7	Unnamed	108th	403	1,443	5,576	16,443
CRW 8	Bullhead Drain	Brown	365	1,249		33,913
CRW 9	Cain Creek	108th	157	547	975	10,370
CRW 10	Unnamed	100th	80	434	3,527	2,650
CRW 11	Burd Drain	Messer	270	1,489	1,160	4,600
CRW 12	Coldwater River	Messer	308	213	514	1,230
CRW 13	Messer Brook	Usborne	2,420	1,939	574	2,668
CRW 14	Trib to Messer Brook	Tupper Lake	81	505	501	17,244
CRW 15	Messer Brook	Tupper Lake	925	599	311	5,264
CRW 16	Tupper Creek	Russel	237	919	7,573	10,948
CRW 17	Trib to Coldwater River	Bowler	1,954			
CRW 18	Coldwater River	Rush	68	1,032	640	2,380
CRW 19	Coldwater River	Brown	6	162	28	353
CRW 20	Tupper Creek	Ainsworth	600	465	317	2,103
CRW 21	Tupper Creek	State	388		2,813	6,612
CRW 22	Pratt Lake Drain	84th	271	355	4,228	5,686
CRW 23	Bear Creek	84th	799	649	14,591	3,348
CRW 24	Duck Creek	Jackson	1,047	1,344	1,885	19,561
CRW 25	Pratt Lake Drain	64th	1,611	839	2,210	20,270

On May 26, 2021, an attempt was made to time the sampling event to capture runoff from a 0.4” rainfall during extremely low discharge and following a period of approximately six weeks of dry weather; stream conditions during sampling indicate that runoff had just begun to enter the streams at some of the sites, though most were still low and clear. Twenty three of the 24 sites sampled had results exceeding the WQS for PBC, and the one site exceeded WQS for only TBC. The lowest concentration (353 cfu/100 ml) was recorded at the Brown Road site on the Coldwater River. All but two sites had the highest concentrations recorded during the four sampling events. It is possible that the extreme concentrations of *E. coli* were the result of spring applications of livestock manure to agricultural fields and/or the fact that feedlots and pastures had not received significant precipitation. For example, on Duck Creek, the average geomean for two upstream sites was 4,160 cfu/100 ml, but as the stream flows past livestock access sites or feedlots directly adjacent the channel, the average geomean increased to 14,664 cfu/100 ml at the four downstream sites.

DNA source tracking

Water samples were collected from nine sampling stations on April 30, 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 CRW. 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 April 30 samples were analyzed for the presence of bovine (cattle), equine (horse) and human DNA biomarkers. Results indicate that every marker was present at each of the nine sites, except that the human marker was absent from Site CRW 3. Quantitative analysis shows that the human marker was the most prevalent at all of the sites where it was present, suggesting that human fecal contamination of the surface waters is ubiquitous throughout the CRW. The human biomarker was followed by equine at all sites, with bovine being the least prevalent in each sample. The human biomarker, however, was found to be two to 843 times more prevalent than the equine biomarker, and six to 14,664 times more prevalent than the bovine biomarker.

Table 15. DNA Source-Tracking Results (2019)

Site ID	Human to Secondary	Human to Lowest
CRW 3	human not present	
CRW 4	343	2,487
CRW 13	69	220
CRW 15	2	6
CRW 17	843	9,345
CRW 20	30	3,350
CRW 23	152	365
CRW 24	24	419
CRW 25	17	14,664

Canine Scent-Tracking

On September 9 and 10, 2019, canine “Kenna” and handlers conducted monitoring work to identify sources of human sewage in the watershed. The work consisted of two primary components: collection of water samples for screening at a central location, and working the canine in the field. Specifically, 29 water samples were collected in the field and brought to the Tyler Creek Golf Course for screening; 26 of these samples were positive. Kenna worked portions of Pratt Lake Creek in the area of 60th Street and much of the Village of Alto; while the canine alerted in several areas, it was unclear if the alerts were related to contamination or the presence of wastewater treatment infrastructure. No illicit discharges were identified in the field.

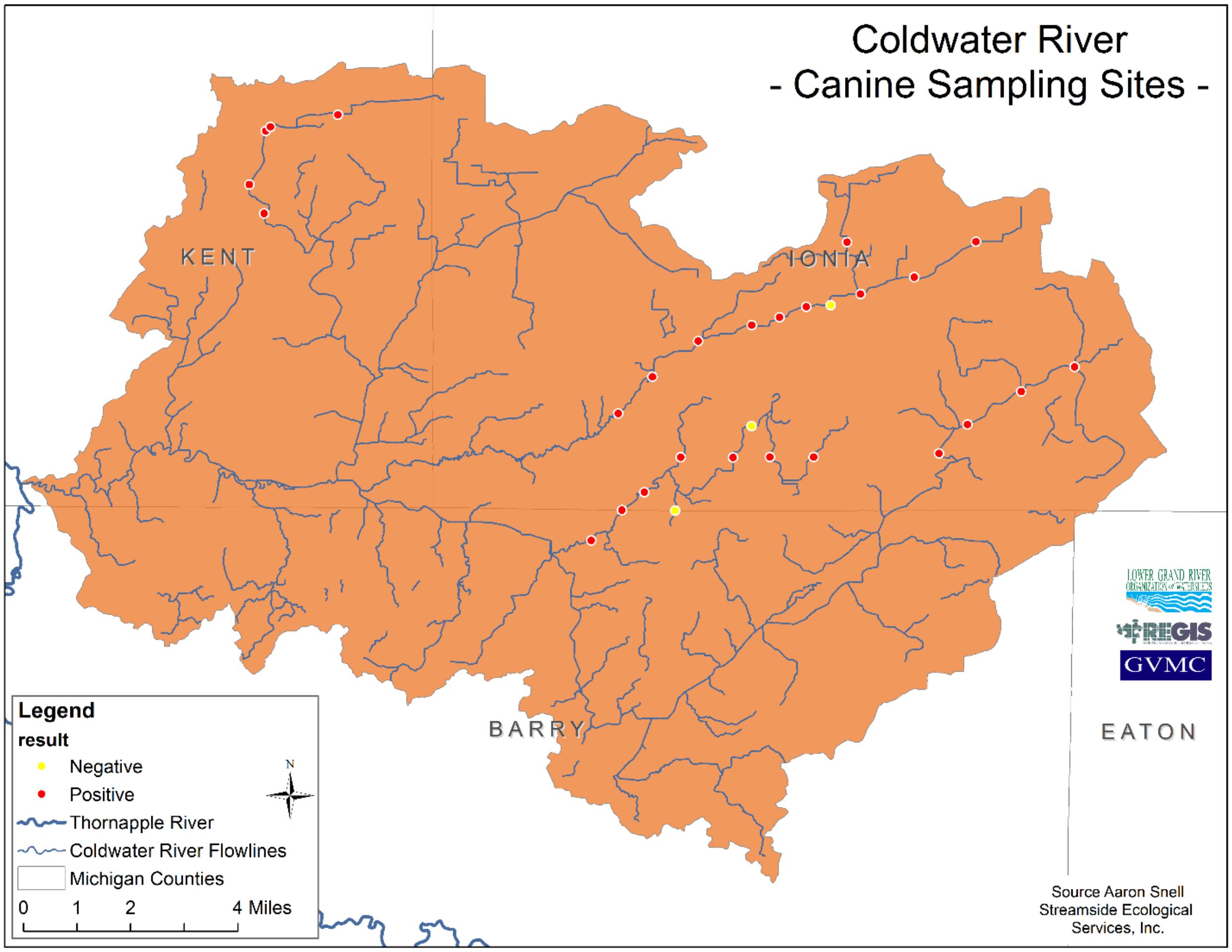

Figure 26. Canine Sampling Results (2019)

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 30 sites in the CRW, but concentrated in three subwatersheds. CAFO manure is applied to about 260 sites covering over 3,000 acres in the CRW. 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.

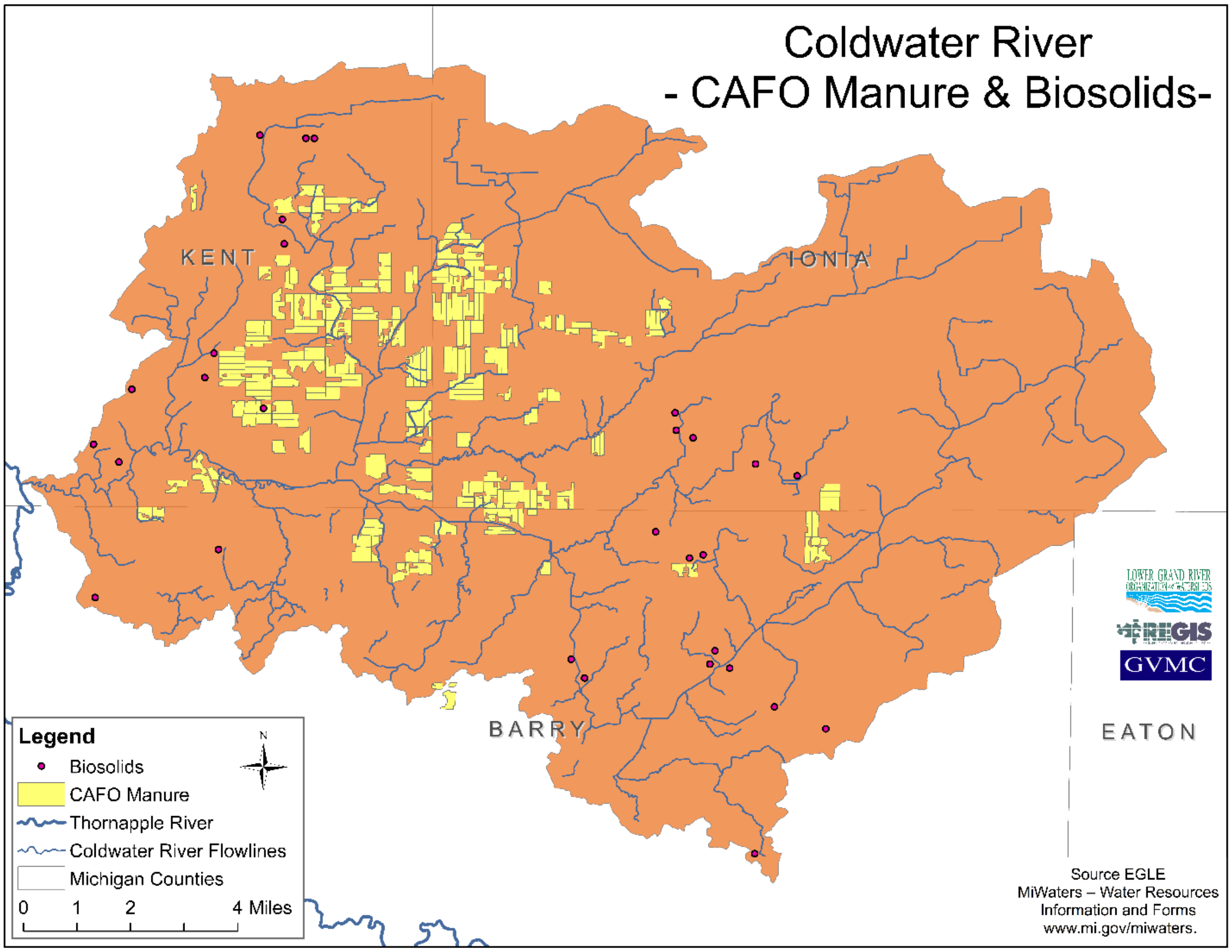

Figure 27. CAFO Manure and Biosolids Application Sites (2020)

Tillage/Residue Survey

A tillage and residue survey of three subwatersheds (Tyler Creek, Bear Creek, Duck Creek) was conducted to obtain an understanding of general agricultural management practices used in the watershed, identify potential agricultural based sources and causes of nonpoint source pollution, determine areas where management practices could be altered to better protect water quality, and to prioritize these areas based on their potential to contribute nonpoint source pollutants to surface waters during runoff events. These three subwatersheds were selected since their dominant land use is agriculture and they contain some of the largest crop production facilities in the CRW. Detailed methodology for this study is included in Appendix B.

Tillage practices, crops planted, crop residue, and existing best management practices on cropland were all observed and recorded. All observations were made from accessible roadways while driving the watershed. All fields and sites visible from roadways were included in the survey. The data was used to identify critical areas and to prioritize sites for future outreach and best management practice implementation efforts, to develop recommendations for best management practices and for loading calculations and targets for future pollutant reductions.

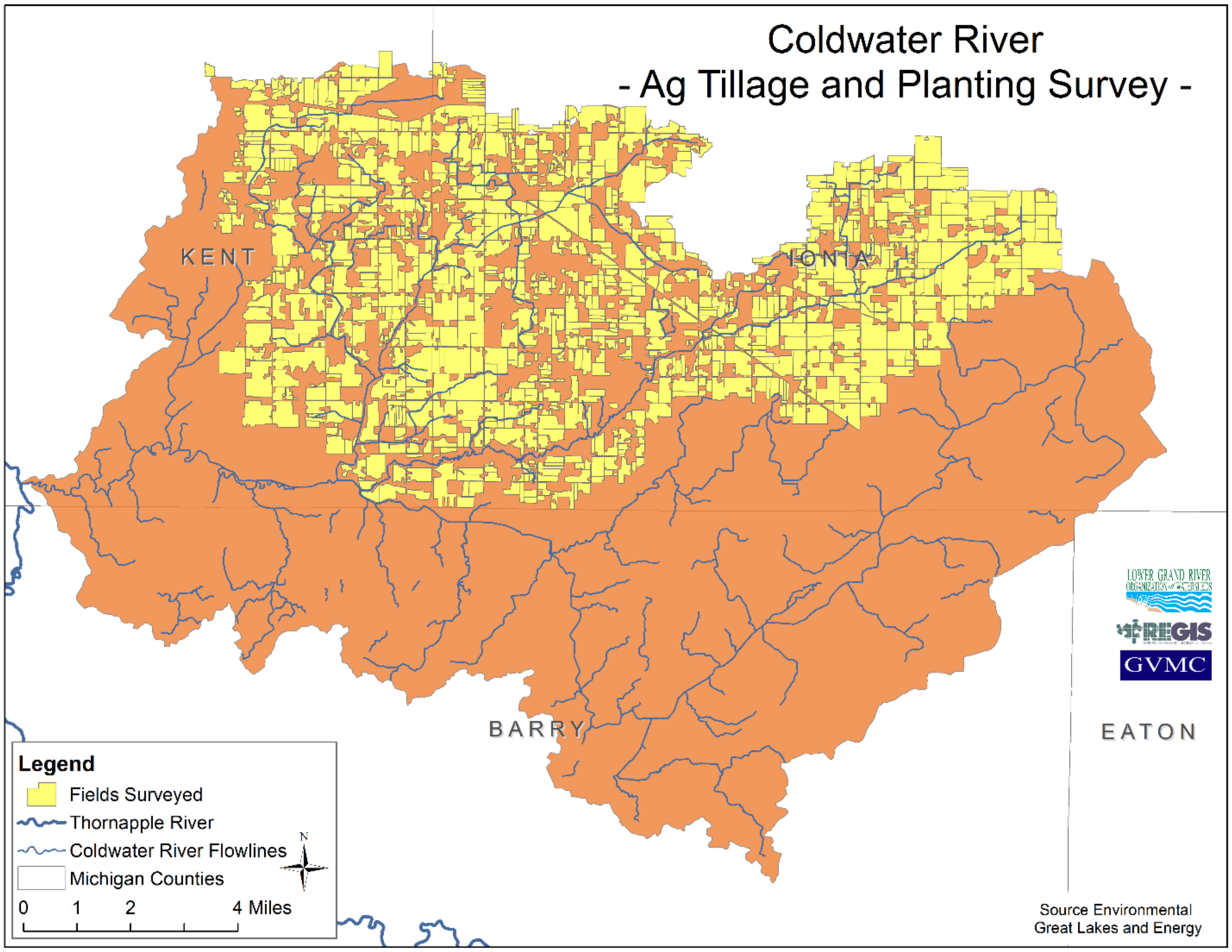

Figure 28. Fields Assessed for the Tillage and Residue Survey

Agricultural Conservation Planning Framework

The Agricultural Conservation Planning Framework (ACPF) is an ArcGIS compatible toolbox developed by the United State Department of Agriculture's Agricultural Research Service. The ACPF utilizes the Soil Survey Geographic Database (SSURGO) and high resolution LiDAR data to identify candidate locations within the landscape for a variety of agricultural BMPs, including grassed waterways, water and sediment control basin (WASCOBs) and nutrient removal wetlands.

The ACPF utilizes terrain analysis and identifies primary terrain attributes like slope, flow direction and flow accumulation. The ACPF slope analysis gives information on what percent of a field falls within six predefined slope ranges, as well as its mean and 75th percentile slope value. The flow visualization tool estimates where over land flow concentrates and routes over the landscape.

The ACPF slope table was used, in association with tillage data from Tyler, Bear and Duck Creeks, to identify critical agricultural fields with the greatest potential for contributing sediment, pathogens and/or nutrients to surface waters. Results of three years of tillage and spring residue surveys (2018, 2019 and 2020) indicate that no-till is a dominant practice in all three subwatersheds, being implemented on 42% of fields in the Duck Creek subwatershed, 46% in Bear and 59% in Tyler. In the Duck Creek sub, 19% of the fields are still being chisel plowed, which is generally accepted as the most invasive method of farming and has the potential to be the most problematic, in terms of water quality. Additional outreach should be implemented to increase the adoption of no-till agriculture in the Duck Creek sub. Regarding cover crops, 6% of fields in the Bear and Tyler Creek subs were planted, while the Duck Creek subs had only 5% of fields planted with cover crops. There is an obvious opportunity for protection of water quality through expansion of no-till practices and the use of cover crops.

To identify the highest priority fields for sediment input to the stream, those that are located within 300 feet of a stream channel, have an average slope greater than 3% and were chisel plowed or had less than 30% cover during the spring residue surveys, were selected. About 131 fields, or 1,700 acres, were identified as high priority; these fields represent about 30% of all agricultural fields in the three subwatersheds. It must be reiterated that the fields depicted here were identified based upon a model of only three subwatersheds, so not all of these fields may be a source of NPS pollution, and many fields that are not illustrated may have NPS issues.

Most importantly, the ACPF will be housed by the Kent Conservation District to be available as a tool for watershed improvement. With KCDs ability to house and use the model, the BCD, ICD or other watershed partners can participate in improvement efforts focused on agricultural lands. The tool may be especially useful for evaluating lands and potential improvements even prior to on-site meetings with landowners.

Landscape Level Functional Wetland Assessment

The Landscape Level Functional Wetland Assessment (LLFWA) is a tool that has been designed by EGLE for targeting wetland protection and restoration efforts in a watershed. The LLFWA analyzes a variety of data to prioritize wetlands for protection or restoration based on how well those wetlands serve specific functions.

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 CRW has lost 55 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 within 300 feet of a stream and had historic functions related to pathogen, sediment or nutrient removal.

Policy Review

A review was conducted of the municipalities located within the Coldwater River Watershed (Bowne Township, Carlton Township, and Woodland Township) to determine which, if any, water quality management regulations and policies they had adopted. Bowne Township has its own Zoning Ordinance and regulations in place, while Carlton and Woodland Townships do not have township zoning and their zoning is regulated by Barry County's Zoning Ordinance. This review indicated potential updates that could be made to the zoning ordinances, other protective ordinances, and local government policies in order to provide stronger protections for water quality within the 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 16. Summary and Prioritization of Identified in the CRW

Pollutant	Documented Source	General Location
1. Pathogens	MSU (2006); BEDHD (2007); TRCD (2013); TRCD (2015); EGLE 2020 IR; Schrems (WMP)	Entire watershed
2.Elevated Water Temperature/Low Dissolved Oxygen	CRWC (2002); TRCD (2012); GVSU (2017); MITU (2017); CRWC (2020)	Coldwater River; Duck Creek, Tyler Creek
3. Altered Hydrology/Habitat	MDEQ (2010, 2013); TRCD (2015); GVSU (2017); MITU (2017)	Entire watershed
4. Sediment	Stakeholders; Schrems (2015); GVSU (2017); Schrems (WMP)	Coldwater River; Cain Creek
5. Nutrients	CRWC (total phosphorus and ammonia) (2002); Schrems (WMP); Stakeholder/Agency reports of: manure spills, sewage overflows, nuisance growth of algae and aquatic vegetation	Coldwater River; Tyler Creek; Messer Brook; Trib. To Duck Creek
6. Mercury and PCBs*	EGLE 2020 IR	Entire watershed

*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 17. 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. Over or improper application of biosolids (p)
		4. Issues with municipal wastewater treatment systems (k)
	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 (k)
	3. Wildlife (s)	1. Landscape modifications (p)
2. Elevated Water Temperature/Depleted Dissolved Oxygen (k)	1. Croplands (s)	1. Loss of Wetlands, Floodplains, Trees, Vegetation, and Natural Areas (k and s)
		2. Dense County and Agricultural Drainage Network (s)
	2. Developed Areas (s)	1. Overland runoff (s)
		2. Loss of Wetlands, Floodplains, Trees, Vegetation, and Natural Areas (k and s)
3. Altered Hydrology	1. Cropland (s)	1. Loss of Wetlands, Floodplains, Trees, Vegetation, and Natural Areas (k and s)
		2. Dense County and Agricultural Drainage Network (s)
4. 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)
		4. Cultivation of Slopes and Drainageways (p)
	2. Public Roads (k)	1. Erosion and runoff (k)
	3. Streambanks (k)	1. Altered hydrology/morphology (k)
		2. Loss of tree and vegetation (k)
		3. Improperly Installed or Sized Culverts at Road/Stream Crossings (k)
		4. Unrestricted livestock access (k)
5. Nutrients (k)	1. Cropland (s)	1. Improper Application of Manure and/or Fertilizers (s)
		3. Tillage Practices (s)
		3. Dense County and Agricultural Drainage Networks (s)
	2. Livestock (k)	1. Improper Livestock and Manure Management (s)
		2. Unrestricted Livestock Access to Streams (k)
		3. Manure spills
	3. Humans	1. Aging or improperly maintained septic systems (k)
		2. Illicit Connections/Discharges (k)
		3. Over or improper application of biosolids (p)
		4. Issues with municipal wastewater treatment systems (k)
		5. Over or Improper application of lawn fertilizers (s)

5.1.1 Priority 1 Pollutant - *E. coli* (k)

E. coli is ranked as the highest priority pollutant in the CRW because of the impaired waters and 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, horses and cattle 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, nearly 70% of the CRW 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 25% (2011). The BEDHD found major problems within the Village of Freeport. 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 (k)
Illicit connection of untreated household or business sewage systems to surface waters is illegal, but is contributing to pollution of the CRW. Illicit connections have been identified with the CRW in recent years.

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: 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 CRW. 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 groundwater 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).

Cause 4: Issues with Municipal Wastewater Treatment Systems (k)
Even when a community has a centralized sanitary wastewater treatment system, such as the Lakewood Wastewater Authority, problems with collection, delivery or discharge of wastewater may still occur. This entity has received seven violations from MDEQ/EGLE – including five in 2020 – for sewer overflow events.

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" (*in* 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 CRW 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).

Many holding facilities inventoried in the watershed during the windshield survey are proximate to, and drain directly to, surface waters and are known sources of pollution in the CRW.

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 (k)
Several manure spills have been documented in the CRW. Within the past few years, spills have occurred in Tyler Creek, Messer Brook and the Coldwater River.

Source 3: Wildlife (s)
Wildlife is considered a source of *E. coli* in the CRW. Source-tracking 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: Landscape 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.

5.1.2 Priority 2 Pollutant - Excessive Water Temperature/Depleted Dissolved Oxygen (k)
The Coldwater River 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. Stream water temperatures affect the types of aquatic life that can be sustained, as well as the solubility of oxygen. High water temperatures contain lower levels of dissolved oxygen. Coldwater habitats, which support trout and other cold water-dependent species, are less prevalent in lower Michigan than are warmwater habitats, and are of particular interest in the CRW. Stakeholders in the CRW are especially interested in the coldwater fishery and, therefore, excessive water temperature/DO depletion is ranked as the second highest priority pollutant.

Source 1: Croplands (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: 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 CRW and contributes to warming of the stream.

Cause 2: Dense County and Agricultural Drainage Network (k)
The CRW 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. Drain maintenance still continues to include removal of riparian trees and chemical control of shrubs and other vegetation.

Source 2: Developed Areas

Cause 1: Overland Runoff (k)

Precipitation falling on developed areas runs off quickly and, in warm months, is rapidly heated prior to discharge to the nearest stream. Past data have shown that rain falling on an asphalt parking reached 120°F before discharging to Tyler Creek (TRCD 2011).

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 residential, commercial or industrial development 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 CRW and contributes to warming of the stream.

5.1.3 Priority 3 Pollutant - Altered Hydrology/Morphology (k)

Changes to the landscape 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. 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. Road crossings can also alter the flow regime by forcing the flow to constrict through a culvert or multiple culverts. An altered flow regime and past and on-going channel alterations are negatively impacting aquatic habitat for warm and coldwater fishes and other aquatic wildlife, and contributing to reductions in water quality.

Source 1: Croplands (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 hydrologic changes, habitat alterations and a shift in the aquatic community.

Cause 1: 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. The practice of draining or filling wetlands and constructing drainage ways with little consideration of floodplain processes is/was a widespread practice in the CRW and contributes to greater volumes of water being transported by streams.

Cause 2: Dense County and Agricultural Drainage Network (k)

The CRW 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. County drains that outlet to natural watercourses usually transfer negative impacts downstream due to alterations in natural processes.

5.1.4 Priority 4 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 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 contributing to the impairments of the designated uses of coldwater fishery and other indigenous aquatic life throughout the CRW. 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 CRW. 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). In addition, cover crops maintained through winter months hold the soil in place.

Cause 4: Cultivation of Slopes and Drainageways (k)

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: Public Roads (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/Morphology (k and s)

Modifications to the courses of waterways made for farming, residential, and commercial uses of land are common in the CRW. 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.

5.1.5 Priority 5 Pollutant - Nutrients (s)

Nutrients are considered a suspected pollutant based upon land use, known fecal contamination of surface waters, history of manure spills and observation of excessive growth of nuisance plants and algae. Nutrient pollution is often associated with agricultural practices, lawn maintenance, and leaking septic systems. Overland nutrient sources of pollution can be transported by sediment through runoff. Similar to *E. coli*, dry weather sources of nutrients can be attributed to such things as leaking or failing septic systems. Wet weather sources of nutrients are carried with overland runoff, such as fertilizer and manure spread on lawns and crops.

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 nutrients, 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.

Cause 2: Unrestricted Livestock Access to Streams (k)
Unrestricted livestock access to a stream results in livestock waste, along with the nutrients it carries, being directly discharged into water.

Cause 3: Manure Spills (k)
Several manure spills have been documented in the CRW. Within the past few years, spills have occurred in Tyler Creek, Messer Brook and the Coldwater River.

Source 3: Humans (k)
Human waste, including grey water (water that is used for laundering, bathing, or washing) and black water (water from flushed toilets) contains nutrients from soaps and human waste. If this water is not properly treated it can contribute nutrients to waterways. Maintained lawns and landscapes can also be a significant source of nutrients.

Cause 1: Aging septic systems, improper installation and/or improper maintenance (k and s)
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, nearly 70% of the CRW 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.

Cause 2: Illicit Connections (k and s)
Illicit connection of untreated household or business sewage systems to surface waters is illegal, but is contributing to pollution of the CRW. Illicit connections have been identified with the CRW in recent years.

Cause 3: Over or Improper Application of Biosolids (p)
Class B Biosolids are permitted to spread at 30 sites within the CRW. While treated, these biosolids still contain high levels of nutrients and are considered to be fertilizer.

Cause 4: Issues with Municipal Wastewater Treatment Systems (k)
Several violations have been issued by MDEQ/EGLE to the Lakewood Wastewater Authority for discharge of fecal contamination to the surface waters.

Cause 5: Over or Improper Application of Lawn Fertilizers (p)
Application of lawn fertilizers, especially in proximity to surface water, can lead to elevated levels of nutrients and excessive growth of plants and algae. Many homes surrounding Jordan Lake have well-maintained lawns to the edge of the water.

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

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

6.0 CRITICAL SITES/AREAS AND POLLUTANT LOADING ESTIMATES

6.1 Agricultural Land Critical Sites

The ACPF was used to identify 131 fields, or about 1,700 acres, as high priority; these fields represent about 30% of all agricultural fields in the three subwatersheds in which the survey was conducted. Because of their proximity to surface water, greater slope of the land, and the tillage practices or lack of cover crops or other "off-season" cover, it is likely that these fields are contributing sediment, nutrients, pathogens and other potential pollutants. It must be reiterated that the fields depicted here were identified based upon a model of only three subwatersheds, so not all of these fields may be a source of NPS pollution, and many fields that are not illustrated here or are within other subwatersheds may have NPS issues. 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. Based upon the STEP-L model, these sites are contributing an estimated 1,660 tons of sediment, 9,186 lbs of nitrogen and 2,657 lbs of phosphorus on an annual basis (Based upon the STEP-L model. The 1,700 acres of cropland was entered as an aggregate amount, using default values for the Grand Rapids International Airport in Kent County, Michigan). Many of these fields are also managed in a way (e.g. tiling, ditching, removing trees along watercourses) that contributes to increases in water temperature and alteration of hydrology.

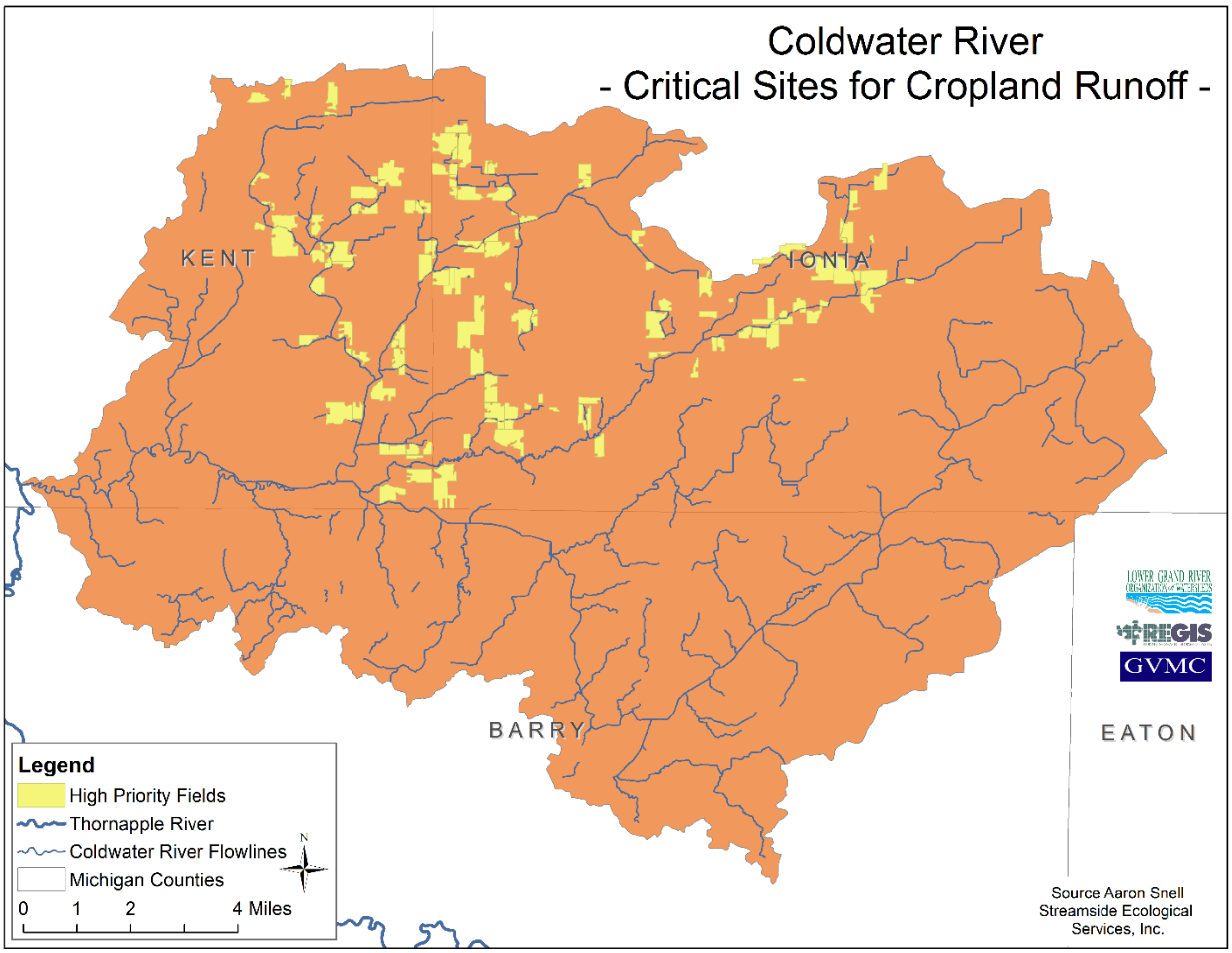

Figure 29. Critical Sites for Cropland Runoff

In addition to the critical sites identified through the ACPF model, historic and ongoing issues with manure spills and manure management at CAFOs are evidence that all CAFO operations, and their fields that are permitted for spreading of manure, should be considered to be critical areas.

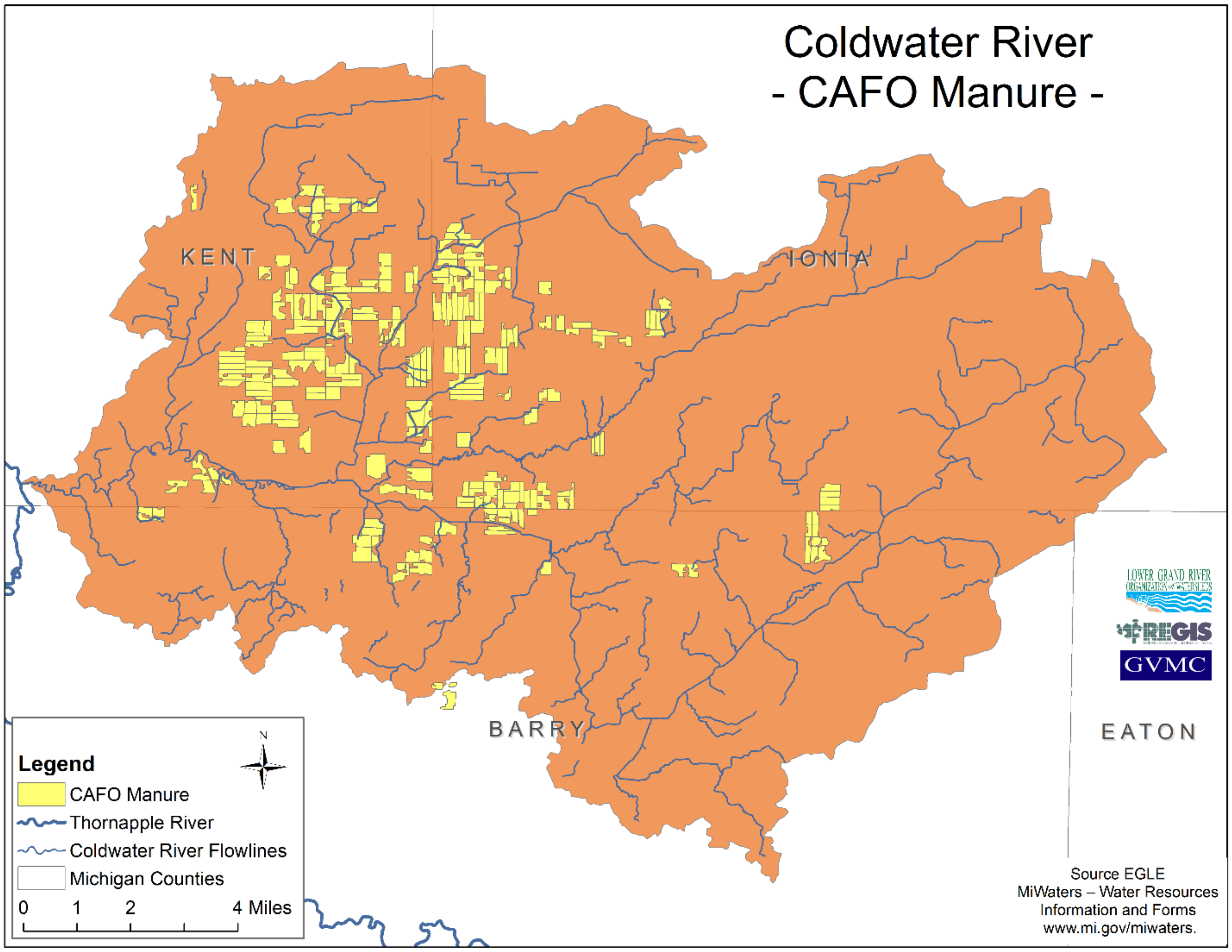

Figure 30. CAFO Critical Areas

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, mostly, 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 27,641 lbs of nitrogen and 4,194 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 18. Estimated Pollutant Loading from Critical Livestock Sites

SITE ID	SITE DESCRIPTION	NITROGEN LOAD (LB/YEAR)	PHOSPHORUS LOAD (LBS/YEAR)	E. COLI SOURCE
BC21	Cattle pasture slopes to stream; 20 cattle on 3.7 acres	418	83	YES
DC30	Feedlot adjacent to and draining to stream; standpipe draining feedlot into stream; 30 cattle on 2 acres	624	125	YES
DC38	Livestock access to stream, trampled and grazed; 10 cattle.	211	42	YES
DC50	Manure spreading observed on land sloping directly to creek; 2 horses on 1 acre.	40	4	YES
F2	Large pasture draining to river. Substantial bank erosion; 500 cattle on 4 acres.	11,225	2,076	YES
F29	Part of Site F2, cattle pasture sloping to river, access to tributary; 200 cattle on 8 acres.	8,549	934	YES
F30	Runoff from distant ag field with manure application, through gully to river. 100 cattle.	4,190	467	YES
MB4	Cattle and horse feedlot bisected by concentrated flow sloping to stream; 25 cattle and 3 horses on 2 acres	576	109	YES
MB51	Feedlot with drainage to river; 4 cattle and 3 horses.	141	22	YES
MB55	Cattle pasture slopes to stream; 40 cattle on 9 acres.	831	166	YES
MB57	Cattle feedlot and pastures adjacent and sloping to river; 20 cattle.	418	83	YES
MB8	Cattle pasture sloping to stream; controlled access across stream; 20 cattle.	418	83	YES

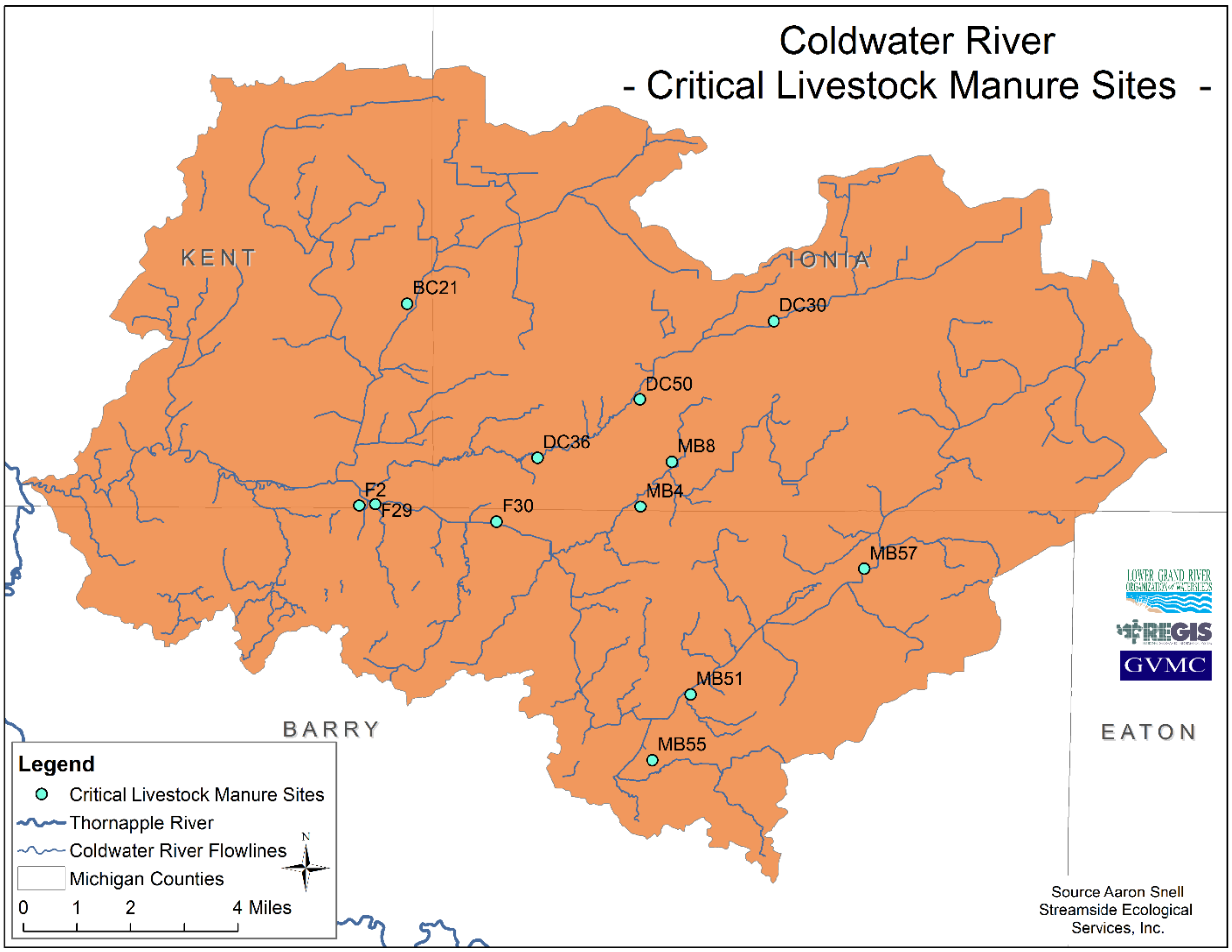

Figure 31. Critical Sites for Livestock Manure

6.3 Public Road Runoff Critical Sites

All road crossings were inspected in the Cain, Duck and Tyler Creek subwatersheds, as well as along the entire mainstem of the Coldwater River. While sediment enters the river at most crossings – especially on gravel roads - during runoff events, those contributing excessive volumes are presented below. In total, these critical sites are contributing an estimated 3,951 tons of sediment per year to the Coldwater River and/or tributaries. Note: Loads were calculated by multiplying the contributing area by an estimated erosion rate, based on observation of sites after a significant rainfall, and multiplying that load by four (assuming four significant runoff events per year).

Table 19. Estimated Pollutant Loading from Critical Road/Stream Crossing Sites

SITE ID	SITE DESCRIPTION	ANNUAL SEDIMENT LOAD (tons)
RC1	Culvert at low point in roadway, gravel road and shoulders flow to channel/culvert	36
RC2	Culvert at low point in roadway, gravel road and shoulders flow to open bridge	53
RC3	Gravel road runs directly adjacent channel and direct inputs are evident	178
RC4	Culvert at low point in roadway, gravel road and shoulders flow to channel/culvert	694
RC5	Culvert at low point in roadway, gravel road and shoulders flow to channel/culvert	83
RC6	Culvert at low point in roadway, gravel road and shoulders flow to channel/culvert	880
RC7	Culvert at low point in roadway, gravel road and shoulders flow to channel/culvert	53
RC8	Gravel road runs directly adjacent channel and direct inputs are evident	53
RC9	Gravel road to north runs on to paved road and downhill to open bridge	720
RC10	Bridge at low point in roadway, gravel road and shoulders flow to open bridge	400
RC11	Bridge at low point in roadway, gravel road and shoulders flow to open bridge	800

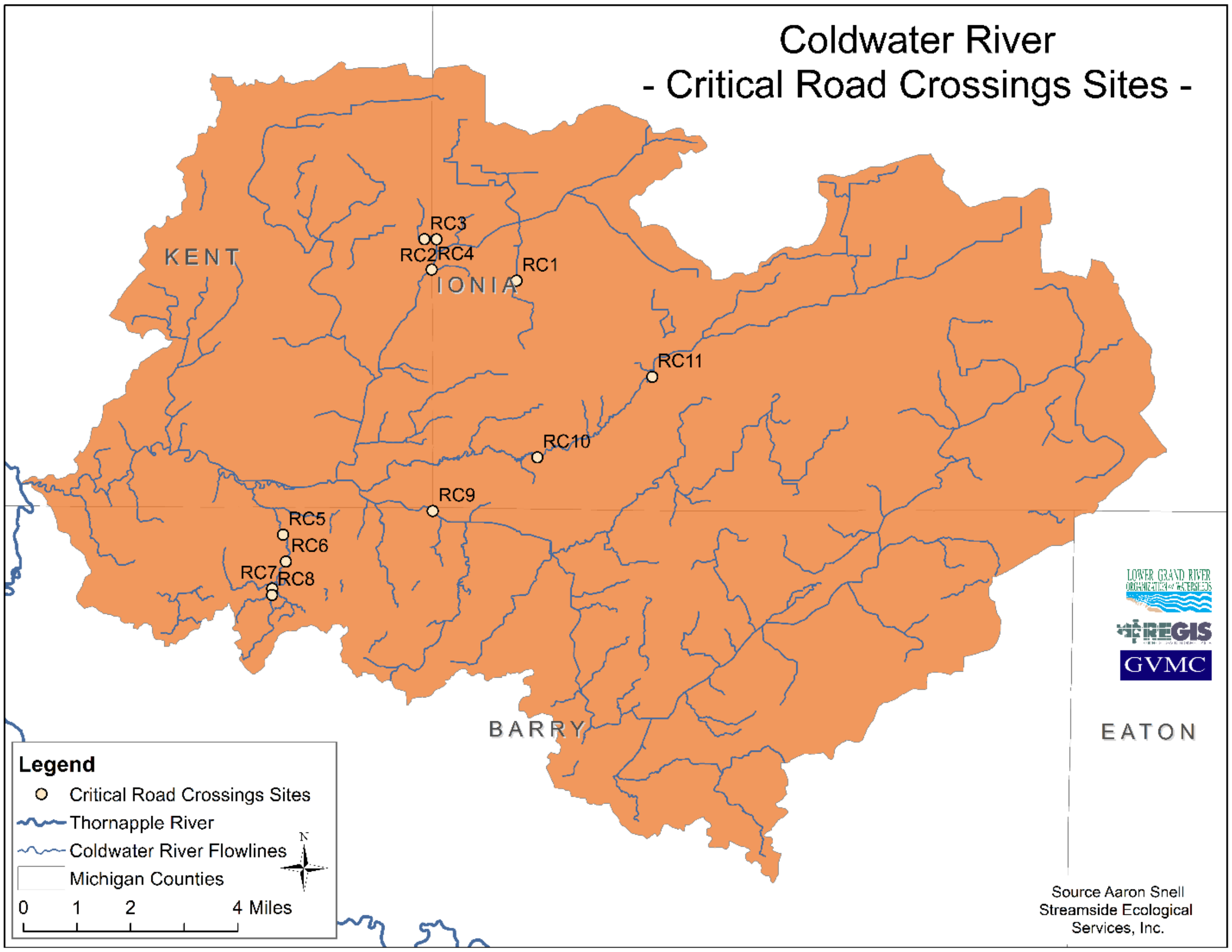

Figure 32. Critical Sites for Sedimentation from Road/Stream Crossings

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 1,870 tons of sediment to the Coldwater River 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 20. Estimated Pollutant Loading from Critical Streambank Erosion Sites

SITE ID	SITE DESCRIPTION	ANNUAL SEDIMENT LOAD (tons)
CW51	Streambank erosion; south bank	42
CW52	Streambank erosion; south bank	38
CW53	Streambank erosion; lower Tyler Creek	400
CW54	Severe instability in Cain Creek; channel erosion, culverts	1,067
CW56	Severe streambank and streambed erosion in tributary to Cain Creek	42
CW57	Streambank eroding near house	7
DC38	Severe streambank erosion associated with livestock access	200
F2	Severe streambank erosion associated with livestock	56
F30	Streambank erosion; north bank	18

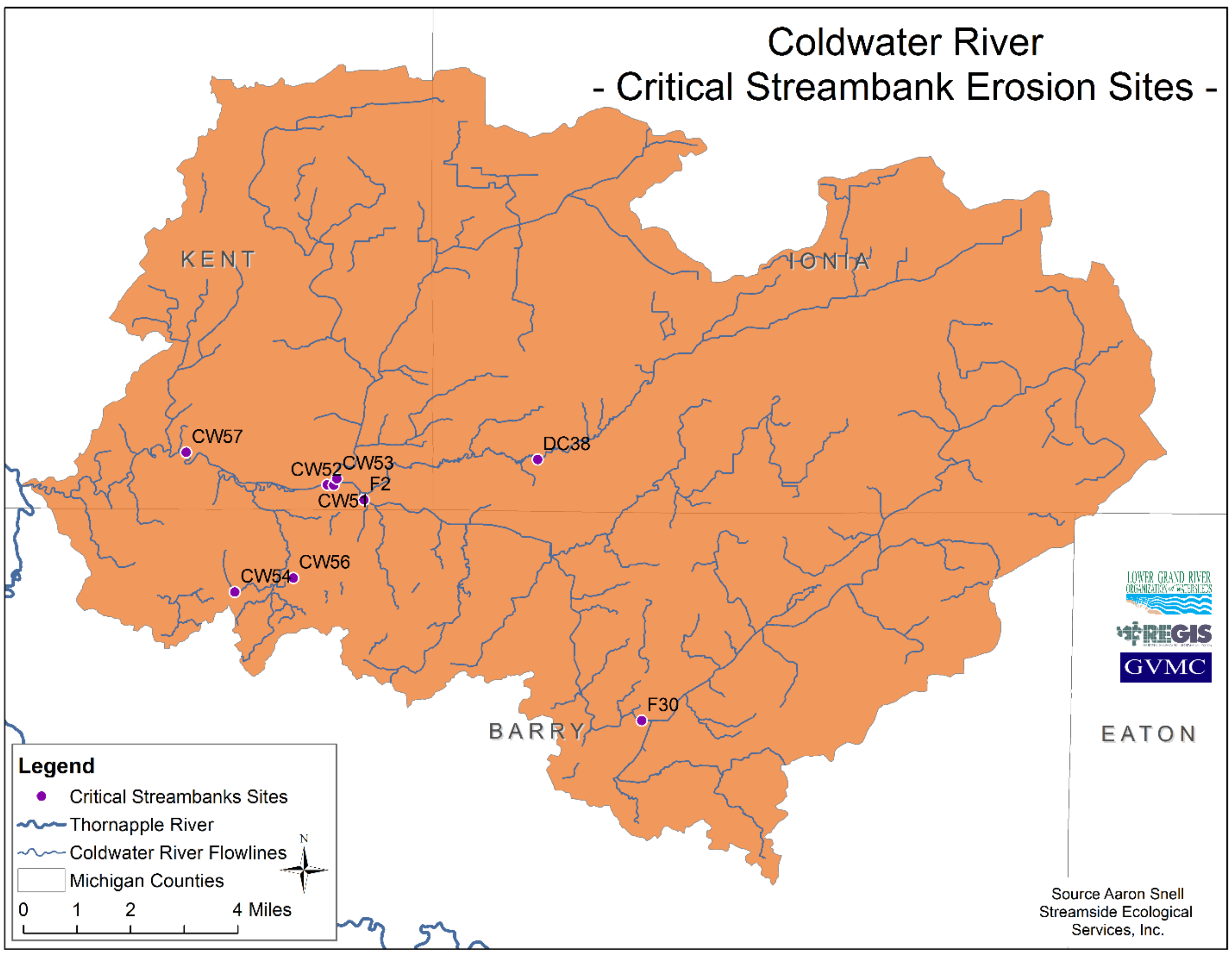

Figure 33. Critical Sites for Sedimentation from Streambank Erosion

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. While it is probable that contamination is watershed-wide, the areas presented below are known at this time to have problems.

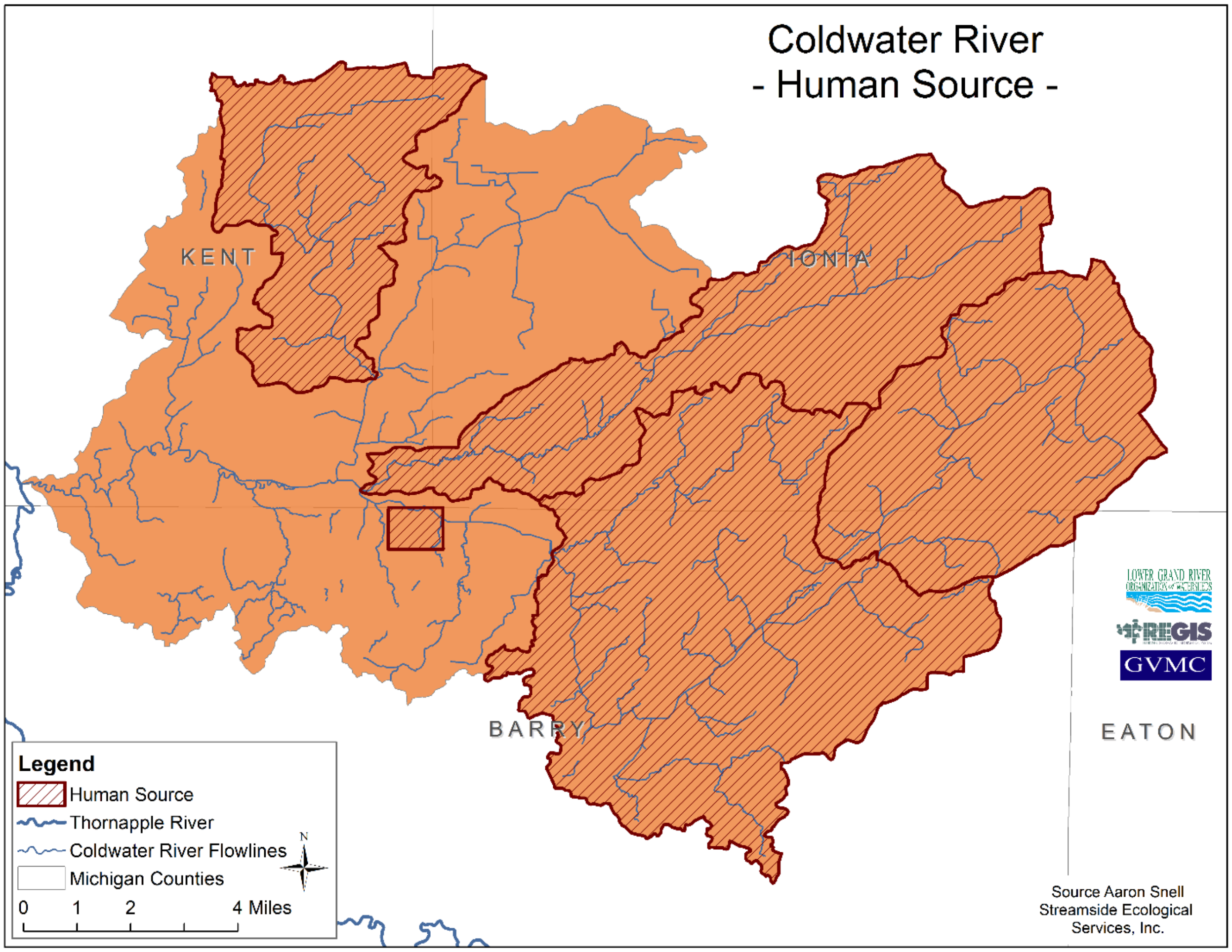

Figure 34. Critical Areas for Contamination from Human Wastewater

6.6 Elevated Water Temperature Critical Areas

Critical areas for elevated water temperature includes all designated coldwater streams that are not meeting the WQS. Tyler Creek, Duck Creek and the Coldwater River (M-43 to Freeport Ave.) are all considered to be critical areas.

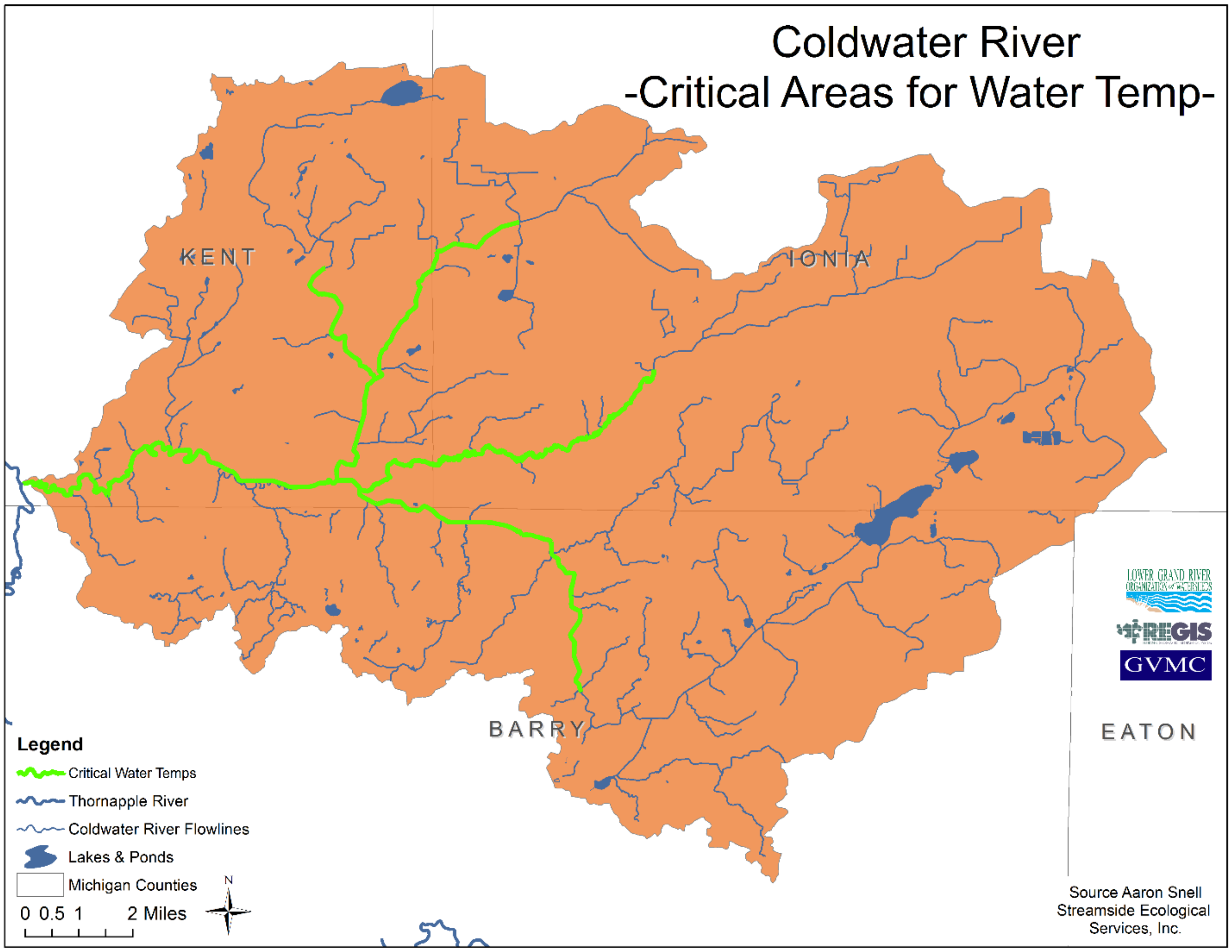

Figure 35. Critical Areas for Water Temperature

7.0 ADDRESSING NPS POLLUTION TO PROTECT/RESTORE DESIGNATED USES

The previous chapters clearly identify that water quality impairments exist in the CRW. 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 CRW 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 CRW. About 2,379 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 township adopt a wetland protection ordinance by 2025 (Table 21). More on wetland protection can be found in Policy Recommendations.

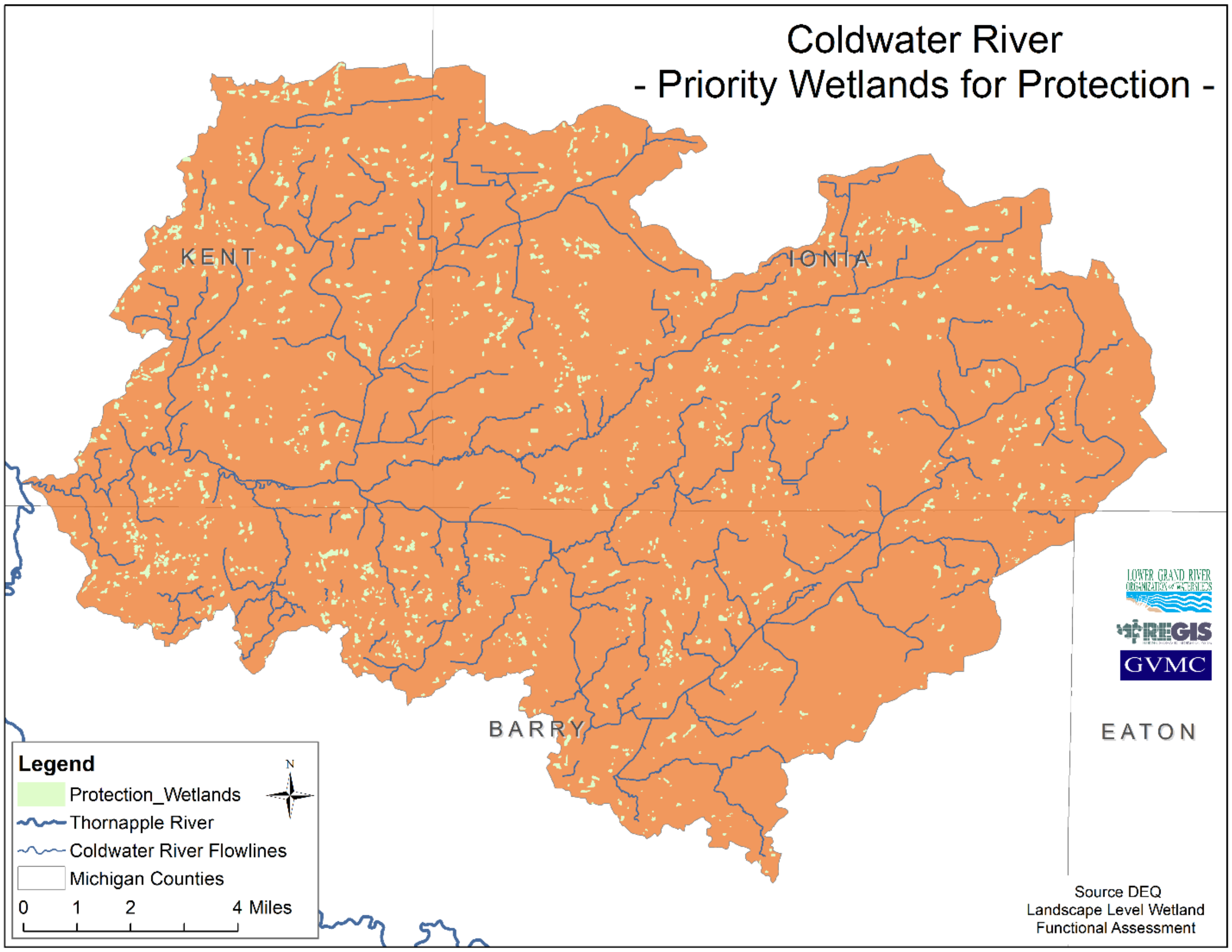

Figure 36. Priority Wetlands for Protection

Table 21. Recommendations for Wetland Protection

TOWNSHIP	COUNTY	EXISTING WETLAND (ACRES)	RECOMMENDED BMP	ESTIMATED COST	TIMELINE	PARTNERS
Carlton	Barry	310	Wetland Ordinance	$2,500	2023	FSBR; Schrems
Woodland	Barry	100	Wetland Ordinance	$2,500	2023	FSBR; Schrems
Bowne	Kent	510	Wetland Ordinance	$2,500	2023	FSBR; Schrems
Lowell	Kent	185	Wetland Ordinance	$2,500	2023	FSBR; Schrems
Caledonia	Kent	20	Wetland Ordinance	$2,500	2024	FSBR; Schrems
Thornapple	Kent	30	Wetland Ordinance	$2,500	2024	FSBR; Schrems
Boston	Ionia	70	Wetland Ordinance	$2,500	2025	FSBR; Schrems
Campbell	Ionia	415	Wetland Ordinance	$2,500	2025	FSBR; Schrems
Irving	Ionia	350	Wetland Ordinance	$2,500	2025	FSBR; Schrems
Odessa	Ionia	365	Wetland Ordinance	$2,500	2025	FSBR; Schrems
Sebewa	Ionia	25	Wetland Ordinance	$2,500	2025	FSBR; Schrems

FSBR = Fahey Schultz Burzych Rhodes

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 CRW. Restoration of wetlands will be necessary to reverse negative impacts. The highest priority wetlands, for improving hydrology and reducing input of pollutants, are shown below. Realistic milestones, estimated costs and likely project partners are included in Table 22. 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.

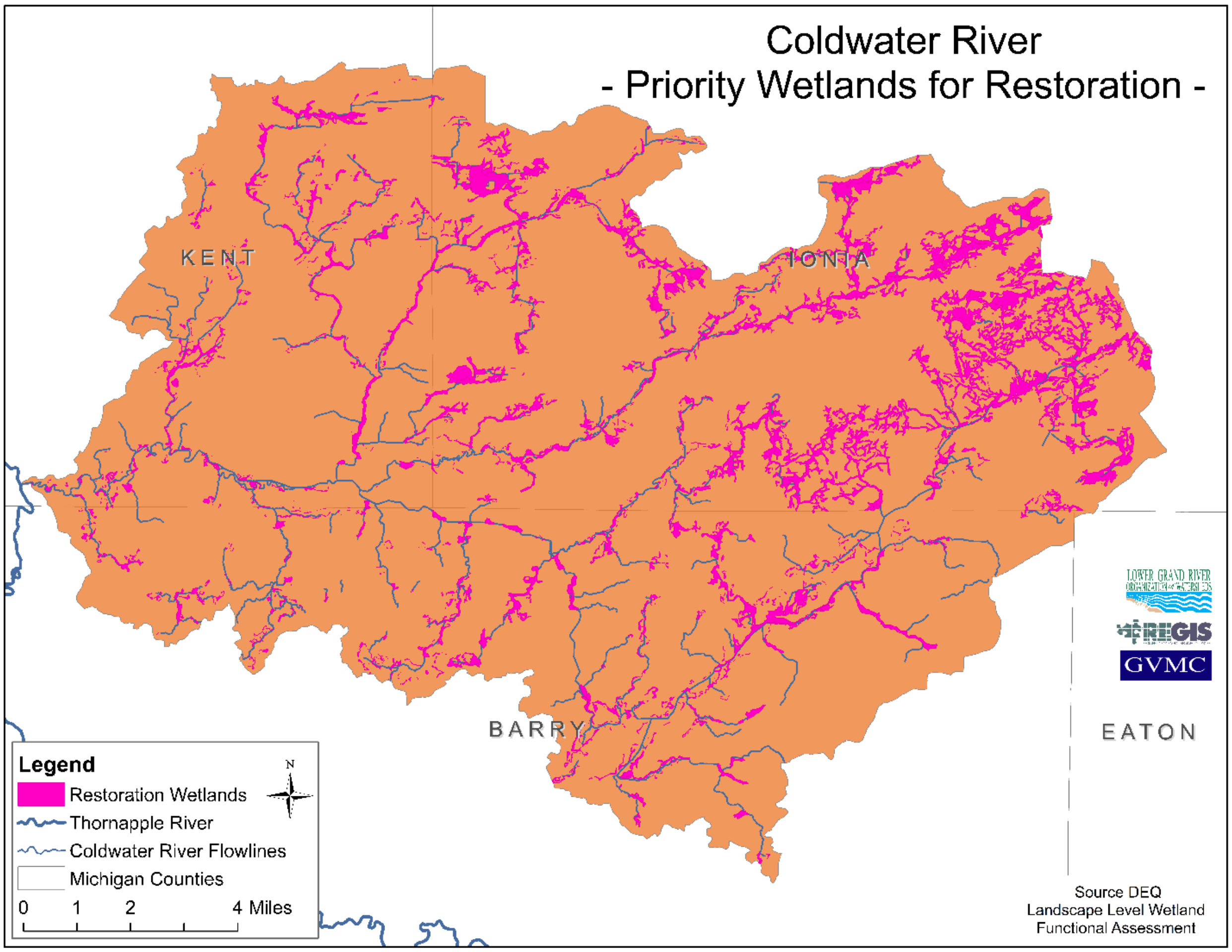

Figure 37. Priority Wetlands for Restoration

Table 22. 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
15,217 acres	20 acres	$50,000-500,000	250 acres	$625,000-6,250,000	Schrems; EGLE; BCD; BCDC; ICD; ICDC; KCD; KCDC; DU; USFWS

BCD = Barry Conservation District; BCDC – Barry County Drain Commissioner; ICD – Ionia Conservation District; ICDC = Ionia County Drain Commissioner; KCD = Kent Conservation District; KCDC = Kent County Drain Commissioner; DU = Ducks Unlimited; USFWS = United States Fish and Wildlife Service

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

7.3.1 Agricultural Land Critical Sites

About 1,700 acres of high-priority cropland was identified as contributing sediment and other pollutants to surface waters. These sites should be addressed by working to educate landowners (details in Section 7.5) and by installing physical BMPs (Table 23). 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.

Based upon results of the tillage and planting surveys, additional outreach should be implemented to increase the adoption of no-till agriculture in the Duck Creek sub, and there is an obvious opportunity for protection of water quality through expansion of the use of cover crops in all three subwatersheds.

Table 23. 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; 1,000 acres	$250,000-2,000,000	BCD; BCDC; ICD; ICDC; KCD; KCDC; EGLE; Schrems
I&E to 15 landowners	$30,000	I&E to 60 landowners	$120,000	BCD; ICD; KCD

7.3.2 Livestock Critical Sites

A total of 12 critical sites with livestock manure issues have been identified (Figure 31). These sites should be addressed by working to educate landowners (details in Section 7.5) and by installing physical BMPs (Table 24). 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 24. 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				
BC21	Cattle pasture slopes to stream	I&E; Move 950 feet of fence back to increase buffer width. Construct 0.25 acre linear wetland to capture runoff prior to discharge to stream.	$25,000	2022-2027	KCD; KCDC; Schrems; EGLE
DC30	Feedlot adjacent to and draining to stream; standpipe draining feedlot into stream	I&E; Remove stand pipe and tile drain. Construct 0.25 acre linear wetland to capture runoff.	$20,000	2022-2027	ICD; ICDC; Schrems; EGLE
DC38	Livestock access to stream, trampled and grazed.	I&E; 1,400 feet of fencing (700 feet on both sides) along stream. Controlled access stream crossing.	$20,000	2022-2027	ICD; ICDC; Schrems; EGLE
DC50	Manure spreading observed on land sloping directly to creek.	I&E	$500	2022-2027	ICD; Schrems; EGLE
F2	Large pasture draining to river. Substantial bank erosion.	I&E; Fencing, treatment wetlands	$25,000	2022-2027	KCD; CRIDB; Schrems; EGLE
F29	Part of Site F2, cattle pasture sloping to river, access to tributary	I&E; Fencing, treatment wetlands and controlled access stream crossing	$25,000	2022-2027	KCD; CRIDB; Schrems; EGLE
F30	Runoff from distant ag field with manure application, through gully to river	I&E; Stabilize gully; Wetland restoration/creation	$30,000	2022-2027	BCD; BCDC; Schrems; EGLE
MB4	Cattle and horse feedlot bisected by concentrated flow sloping to stream	I&E; Construct 0.1 acre linear wetland along Messer Brook	$20,000	2022-2027	ICD; ICDC; Schrems; EGLE
MB51	Feedlot with drainage to river	I&E; Move 400 feet of fence back to increase buffer width, re-grading of pasture/wetland creation.	$15,000	2022-2027	BCD; LTRIDB; Schrems; EGLE
MB55	Cattle pasture slopes to stream	I&E; Construct 0.25 acre wetland to capture runoff	$25,000	2022-2027	BCD; BCDC; Schrems; EGLE
MB57	Cattle feedlot and pastures adjacent and sloping to river	I&E; Improve 800 feet of fencing to protect riparian buffer; Wetland restoration.	$50,000	2022-2027	BCD; LTRIDB; Schrems; EGLE
MB8	Cattle pasture sloping to stream; controlled access across stream	I&E; Improve 1,100 feet of fencing to increase buffer width; Improve controlled access crossing.	$10,000	2022-2027	ICD; ICDC; Schrems; EGLE
		SUBTOTAL	**$265,500**		

CRIDB = Coldwater River Intercounty Drain Board; LTRIDB = Little Thornapple River Intercounty Drain Board

7.3.3 Public Road Runoff Critical Sites

A total of 11 critical sites with road runoff issues have been identified (Figure 32). These sites should be addressed by working with county road commissioners to raise awareness and by installing physical BMPs (Table 25).

Table 25. Goals and Estimated Costs for BMPs on Road Runoff Critical Sites.

SITE ID	SITE DESCRIPTION	RECOMMENDED BEST MANAGEMENT PRACTICE(S)*	ESTIMATED COST	TIMELINE	PARTNERS
	Road/Stream Crossing Critical Sites				
RC1	Culvert at low point in roadway, gravel road and shoulders flow to channel/culvert	Divert runoff prior to stream crossing.	$2,000	2022-2025	BCRC; Schrems, EGLE
RC2	Culvert at low point in roadway, gravel road and shoulders flow to open bridge	Create sediment basin and divert runoff prior to stream crossing.	$5,000	2022-2025	ICRC; Schrems; EGLE
RC3	Gravel road runs directly adjacent channel and direct inputs are evident	Grade road to flow south	$10,000	2022-2025	KCRC; Schrems; EGLE
RC4	Culvert at low point in roadway, gravel road and shoulders flow to channel/culvert	Create sediment basin and divert runoff prior to stream crossing.	$5,000	2022-2025	KCRC; Schrems; EGLE
RC5	Culvert at low point in roadway, gravel road and shoulders flow to channel/culvert	Create sediment basin and divert runoff prior to stream crossing.	$10,000	2022-2025	BCRC; Schrems, EGLE
RC6	Culvert at low point in roadway, gravel road and shoulders flow to channel/culvert	Create sediment basin and divert runoff prior to stream crossing.	$5,000	2022-2025	BCRC; Schrems, EGLE
RC7	Culvert at low point in roadway, gravel road and shoulders flow to channel/culvert	Create sediment basin and divert runoff prior to stream crossing.	$5,000	2022-2025	BCRC; Schrems, EGLE
RC8	Gravel road runs directly adjacent channel and direct inputs are evident	Regrade road, create sediment basin and divert runoff prior to stream crossing.	$7,500	2022-2025	BCRC; Schrems, EGLE
RC9	Gravel road to north runs on to paved road and downhill to open bridge	Regrade Vedder Rd to flow north or create sediment basin and divert runoff prior to stream crossing.	$7,500	2022-2025	BCRC; ICRC; Schrems; EGLE
RC10	Bridge at low point in roadway, gravel road and shoulders flow to open bridge	Create sediment basin and divert runoff prior to stream crossing.	$5,000	2022-2025	ICRC; Schrems; EGLE
RC11	Bridge at low point in roadway, gravel road and shoulders flow to open bridge	Create sediment basin and divert runoff prior to stream crossing.	$5,000	2022-2025	ICRC; Schrems; EGLE
		SUBTOTAL	**$67,000**		

BCRC = Barry County Road Commission; ICRC = Ionia County Road Commission; KCRC = Kent County Road Commission

7.3.4 Streambank Erosion Critical Sites

A total of nine critical sites with streambank erosion issues have been identified (Figure 33). These sites should be addressed by working with county drain commissioners to raise awareness and by installing physical BMPs (Table 26). While in most cases the streambank erosion may actually be caused by the altered hydrology/morphology, site-specific bank restoration would be beneficial to reduce excessive sediment input.

Table 26. Goals and Estimated Costs for BMPs on Streambank Erosion Critical Sites.

SITE ID	SITE DESCRIPTION	RECOMMENDED BEST MANAGEMENT PRACTICE(S)*	ESTIMATED COST	TIMELINE	PARTNERS
	Streambank Erosion Critical Sites				
CW51	Streambank erosion; south bank	Approximately 280 feet of bank stabilization.	$28,000	2022-2025	CRIDB; Schrems; EGLE
CW52	Streambank erosion; south bank	Approximately 250 feet of bank stabilization.	$25,000	2022-2025	CRIDB; Schrems; EGLE
CW53	Streambank erosion; lower Tyler Creek	Approximately 1,600 feet of bank stabilization/channel restoration (800 feet along both banks).	$160,000	2022-2027	KCDC; Schrems; EGLE
CW54	Severe instability in Cain Creek mostly on DNR land; channel erosion, culverts	Approximately three miles of stream restoration and three culvert replacements	$1,000,000	2022-2032	BCDC; BCRC; MDNR; Schrems; EGLE
CW56	Severe streambank and streambed erosion in tributary to Cain Creek	Approximately one mile of stream restoration	$400,000	2022-2032	BCDC; BCRC; MDNR; Schrems; EGLE
CW57	Streambank eroding near house	Approximately 150 feet of bank stabilization.	$15,000	2022-2025	CRIDB; Schrems; EGLE
DC38	Severe streambank erosion associated with livestock access	Discussed above			
F2	Severe streambank erosion associated with livestock	Approximately 500 feet of bank stabilization.	$50,000	2022-2025	CRIDB; Schrems; EGLE
F30	Streambank erosion; north bank	Approximately 200 feet of bank stabilization. Discontinue mowing to increase buffer width.	$20,000	2022-2025	LTRIDB; Schrems; EGLE
		SUBTOTAL	**$1,698,000**		

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 areas shown in Figure 34 are the highest priority for immediate action.

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, and unsewered homes around lakes. 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).

Table 27. Goals and Estimated Costs for BMPs in Human Fecal Contamination Areas

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 (Ionia, Kent)		Two county ordinances	$500,000	KCHD; ICHD; EGLE
Re-instate County Septic Ordinance (Barry)	One county ordinance		$100,000	BEHD; EGLE
Monitor biosolids applications to determine extent of problem	30 sites		$30,000	Schrems; EGLE

KCHD = Kent County Health Department; ICHD = Ionia County Health Department; BEHD = Barry Eaton Health District

7.3.6 Elevated Water Temperature Critical Areas

Critical areas for exceedances of WQS for water temperature are displayed in Figure 35; however, addressing the issue must also focus on those areas upstream of, and draining to, the critical areas.

Table 28. 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; CRWC; CRAG; BCD; BCDC; ICD; ICDC; KCD; KCDC; EGLE
Wetland restoration	2 acres	$80,000	10 acres	$400,000	Schrems; CRWC; BCD; BCDC; ICD; ICDC; KCD; KCDC; DU; USFWS; EGLE
Policy Management at County or Township Level (Riparian zone protection, stormwater management, etc.)	See Section 7.5				

CRAG = Coldwater River Action Group

7.4 Policy Review and Recommendations

A review was conducted of three municipalities located within the Coldwater River Watershed (Bowne Township, Carlton Township, and Woodland Township) to determine which, if any, water quality management regulations and policies they had adopted. Bowne Township has its own Zoning Ordinance and regulations in place, while Carlton and Woodland Townships do not have township zoning and their zoning is regulated by Barry County's Zoning Ordinance. This review indicated potential updates that could be made to the zoning ordinances, other protective ordinances, and local government policies in order to provide stronger protections for water quality within the CRW.

General Recommendations

- **Enhance stormwater management regulations.** Barry County's Zoning Ordinance requires site plan approval to consider erosion control and the discharge of stormwater. Additionally, the Zoning Ordinance requires an environmental impact summary for all site plans or land uses that may generate significant impacts on surrounding land uses or public facilities, along with additional requirements pertaining to groundwater protection when hazardous substances are involved. The Zoning Ordinance requires that Open Space Subdivisions meet the requirements of the Barry County Drain Commissioner for containing stormwater and that premises shall not be graded or filled to discharge surface run-off onto abutting properties except as permitted by the Drain Commissioner; however, Open Space Subdivisions are generally limited in townships. Barry County's Zoning Ordinance also considers adequate drainage of stormwater in the construction of private roads, golf courses, and parking areas. In general, Barry County's site plan review is performed by its Planning Commission and Zoning Administrator.

  Bowne Township's Zoning Ordinance simply requires that site plan reviews take storm water drainage into consideration. In general, Bowne Township's site plan review is performed by the Planning Commission and potentially the Township Site Plan Review Committee.

  None of the reviewed municipalities had specific stormwater ordinances (such as an independent police power ordinance) in place. Although Bowne Township's Zoning Ordinance referenced a stormwater ordinance, the information provided by the Township indicated that a stormwater ordinance did not exist, and a stormwater ordinance was not located. To improve stormwater management regulations, local governments within the CRW could consider implementing any of the following options:

  Option 1: Create a stormwater ordinance. Stormwater ordinances adopted under a municipality's general police powers to protect the general health, safety, and welfare provide for protections that are not always considered in municipal zoning. This includes providing regulations that apply to currently established land uses and developments, not just new construction. Additionally, municipalities have the ability to make violations of a police power ordinance punishable by legal action, including civil infraction citations, injunctive relief, and/or misdemeanor prosecution, which provides a mechanism to ensure ordinance compliance.

  Municipalities can adopt a stormwater management ordinance to govern development activities that affect stormwater runoff and to prevent flooding, pollution, soil erosion, and other harmful impacts of stormwater. Such ordinances could require on-site stormwater retention and treatment, impervious surface limitations, and regular street vacuuming or sweeping. Local governments may additionally or alternatively coordinate with the county drain commissioner to adopt or improve stormwater management practices.

  Option 2: Require a stormwater construction permit for new development. Local governments can independently require a stormwater-specific permit for construction of any improvement. Similar to a stormwater ordinance, this could be accomplished under a municipality's general police powers to protect the general health, safety, and welfare.

The application for a stormwater permit should consist of a stormwater management plan, including a drainage map of the area surrounding the proposed development, identification of the body of water into which stormwater will be discharged and the point at which it will be discharged, and a description of the sedimentation and soil erosion control measures that will be implemented on the proposed development site. The local government should create standards for approval or denial of stormwater construction permits and their associated stormwater management plans.

Option 3: Include approval by the county drain commissioner as a requirement of the application process for obtaining a zoning or land use permit. Conditioning the issuance of a zoning or land use permit on approval by the county drain commissioner can help ensure that water quality issues are considered and accounted for prior to issuance of a permit for new developments. This is especially beneficial because it front ends compliance by requiring a review and approval before a project begins (as opposed to the police power, which creates standards that must later be prosecuted for non-compliance).

- **Regulate currently unregulated wetlands.** The Townships indicated that they did not have any township-specific wetland ordinances. While both Barry County's Zoning Ordinance and Bowne Township's Zoning Ordinance take wetlands into consideration in various provisions and requirements, neither municipality has a wetland ordinance in place beyond the state regulations.

  Part 303, Wetland Protection, of the NREPA, 1994 PA 451, does not protect wetlands that do not meet one of the following: (1) greater than 5 acres in size; (2) contiguous to the Great Lakes, Lake St. Clair, an inland lake or pond, or a stream; (3) considered a "water of the United States" as defined by the federal water pollution control act; (4) has the presence of an endangered or threatened species; or (5) is a "rare and imperiled wetland." Local governments have the authority to regulate these wetlands, as illustrated in Figure 36. EGLE provides a guide for local governments in establishing wetland ordinances, as well a sample local wetland ordinance. Similar to the above-mentioned stormwater ordinances, wetland ordinances can be implemented through a municipality's police powers and would provide for additional protections to wetlands by regulating currently established land uses and developments, not just new construction.

<u>Municipal Zoning Ordinance Review Recommendations</u>

- **Low-impact development practices.**
  - Barry County's Zoning Ordinance has density standards for development, which include low-impact development practices. The practices help to filter or treat stormwater and/or minimize the adverse impacts of stormwater, especially for new developments. Such practices should especially be emphasized in locations with concentrated development and those near waterways, rivers, and streams. These practices can be encouraged through site plan review and zoning requirements. Bowne Township should also consider taking into account low-impact development practices near waterways, rivers, and streams. Useful resources include the Southeast Michigan Council of Governments (SEMCOG) "Low Impact Development Manual for Michigan" and EGLE/Trout Unlimited National's "Rogue River Watershed: A Stormwater Guidebook".

- **Designate lands for the preservation of open space.**
  - Barry County's Zoning Ordinance encourages the preservation of open space in a variety of mechanisms, including Open Space Subdivisions and Open Space Neighborhoods. Additionally, it encourages residential development near recreation areas, such as parks

and playgrounds. Bowne Township's Zoning Ordinance also includes provisions for Open Space Preservation Development and dedicated open space in Planned Unit Developments.

  - In addition to current zoning provisions, the municipalities should set land aside for a variety of uses, including conservation easements, protected sensitive lands and water bodies, parks, wildlife corridors and preserves, or dedicated open spaces, to help to preserve open space. Each zoning ordinance should plan for both present and future development, including urban-to-rural transition methods, street and public utility connectivity, and the preservation of recreational and open space. This may be accomplished through open space overlay districts, open space subdivisions, and/or similar zoning designations.

- **Development Requirements.**
  - It is recommended that each municipality update setback requirements to require that all structures be set back at least 100 feet from the ordinary high-water mark and 25 feet from the 100-year flood plain.
  - Bowne Township's Zoning Ordinance does not regulate bluffs (as defined by Natural River Zoning Rule 281.51(e)), and Barry County's Zoning Ordinance is mainly limited to the protection of bluffs that are currently eroding or in danger of eroding. It is recommended that the municipalities prohibit change in the look and grade of all bluffs, require that all structures be set back 50 feet from the top of any bluff, and prohibit alteration of land between the top of any bluff and the residential setback.
  - Each zoning ordinance requires the consideration of wetlands for new developments. It is recommended that construction and use be prohibited within wetlands and that new construction be setback at least 40 feet from wetlands.

- **Land Management.**
  - It is recommended that each zoning ordinance be updated to prohibit the alteration of land within 25 feet of the river. Any dead, diseased, or unsafe tree, noxious plant or shrub, within the natural vegetation strip may be removed.
  - The Barry County Zoning Ordinance currently requires consideration of erosion control measures in the site plan approval process and mentions bank stabilization practices; while the Bowne Township Zoning Ordinance does mention soil erosion, it does not currently have any specific provisions dealing with streambank stabilization. It is recommended that erosion control measures and stabilization of streambanks be encouraged and implemented when there is an identified need.
  - The zoning ordinances currently do not mention fish or aquatic habitat. It is recommended that each zoning ordinance be updated to encourage the creation or improvement of fish habitat when there is an identified need.
  - Each zoning ordinance refers to mining activities. It is recommended that all mining activities be required to take place at least 300 feet from the ordinary high-water mark.

- **On-Site Wastewater Treatment Systems.**
  - Septic systems are prohibited from being placed within 100 feet of the ordinary high-water mark in the Bowne Township Zoning Ordinance. The Barry County Zoning Ordinance does not require specific setbacks for septic tanks. It is recommended that septic tanks and all component parts, outhouses, and earthen privies be set back at least 100 feet from the ordinary high-water mark and prohibited within the 100-year floodplain, wetlands, and drains.
  - Additionally, alternative onsite wastewater treatment systems be prohibited within the 100-year floodplain or wetlands.

- Safe disposal of sewage is not addressed in either zoning ordinance. The zoning ordinances should be updated to provide for a safe mechanism for sludge disposal.

Kent County Recommendations

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 EGLE/Trout Unlimited National's "Rogue River Watershed: A Stormwater Guidebook".

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:

Activity	Estimated Cost
Implement/extend setback requirements	$1,400 - $2,800
Enhance existing stormwater regulations	$2,400 - $3,700
Create new stormwater regulations	$4,000 - $8,000
Enhance zoning ordinance protections – minor changes*	$600 - $900
Enhance zoning ordinance protections – significant changes*	$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 (I&E) 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. 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 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 will be created for specific audiences such as homeowners with septic systems, agricultural producers, municipalities, and schools within the watershed.

Goal 1: Improve water quality to restore: designated uses of full body and partial body contact recreation, coldwater fisheries and other indigenous aquatic life and wildlife.

Goal 2: Improve community understanding of NPS pollution and associated water quality problems through education and outreach.

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

Goal 4: Encourage septic system owners to do routine maintenance to reduce failure of system as well as testing well-water quality through their local health department to ensure their system is not impacting drinking water.

Implementing I&E Strategy
Implementation of the I&E strategy will be the responsibility of the watershed groups, municipalities, and other stakeholders in the watershed. Focus areas are listed in Tables 29-33 with priority pollutants, target audiences, messages, delivery mechanisms, and evaluation measures for each.

Target Audiences
The CRW is in a rural part of West Michigan and is made up of over 70% agricultural land. 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 specific target audiences will include:

- Agricultural Producers, Landowners, and Combined Animal Feed Operations (CAFOs)
- Residential Landowners with septic systems and riparian landowners
- Schools (Lakewood Schools, Faith Christian School, Alto Elementary School, Thornapple-Kellogg Schools, Hastings Schools)
- Municipalities - All (Clarksville, Freeport, Lake Odessa, Bowne Township, Lowell Township, Odessa Township, Campbell Township, Woodland Township, Carlton Township)
- Recreational Users (Kent County Parks and Recreation, Tyler Creek Golf Course, Caledonia Sportsman Club)

Messages
Messaging must be specific for each target audience to focus their concerns and are action-oriented, understandable and create a desire to change. Some messages will be applicable to all audiences. Messages should focus on protecting and enhancing water quality.

- 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.
  - Creating buffer zones along the edges of crop fields using native plants 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 pathogen, *E. coli* 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.
  - Ensure that your waste is going to a septic system, rather than straight to a stream or other drainage-way.
- 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.

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 will then likely act.

- Targeted Mailings/E-mailings
  - Farmers
  - Agricultural landowners
  - Septic system owners
  - Riparian landowners
- Events
  - Farm Demonstration Days
  - Workshops
  - School Presentations
  - Community Gatherings
- Newsletters (Digital and Printed)
  - School Newsletters
  - Township/City Newsletters
- Local Newspapers
- Social Media
  - Community Facebook and Instagram pages
- Informational Signs and Pet Waste Stations
  - Public Recreation Sites
  - Trail heads

Partners

Partnerships 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. The following groups have been identified:

- Coldwater River Action Group
- Coldwater River Watershed Council
- Thornapple River Watershed Council
- Trout Unlimited
- Groundswell
- Lower Grand River Organization of Watersheds (LGROW)

- Lakewood Wastewater Authority (WWTP)
- Municipalities (Clarksville, Freeport, Lake Odessa, Bowne Township, Lowell Township, Odessa Township, Campbell Township, Woodland Township, Carlton Township)
- Schools (Lakewood Schools, Faith Christian School, Alto Elementary School, Thornapple-Kellogg Schools, Hastings Schools)
- Public Recreational Areas (Tyler Creek Golf Course, Caledonia Sportsman Club, Freeport Disc Golf Course, Pratt Lake Boat Launch)
- Kent District Library (Alto)
- Chamber of Commerce
- Bowne Twp. Historical Museum
- Jordan Lake Association
- Houses of Worship
- Boulder Ridge Wild Animal Park
- Conservation Districts (Barry, Ionia, and Kent)
- County Drain and Road Commissioners (Barry, Ionia, and Kent)
- Michigan State University Extension and Clarksville Research Center
- 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))
- Federal Governmental Organizations (USDA, NRCS)

Previous I&E Implementation Efforts

Many successful activities have taken place in the watershed to inform and educate community members and stakeholders about water quality. Community outreach in the agricultural sector has greatly improved since the last watershed management plan (see Chapter 1), and with a properly planned effort, it is anticipated that continued success will follow. MAEAP, MDARD, and Local Conservation Districts work with the agricultural sector in hopes to get producers aligned with water quality improvement management practices. Residents and recreational users have become more environmentally focused and are eager to improve water quality whenever possible.

Table 29. I&E Recommendations for *E. coli* Contamination

Focus: *Escherichia coli* (*E. coli*) and pathogens						
Message(s): *E. coli* and other harmful pathogens are dangerous to human health and may be coming from your property. 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. Have septic systems serviced every 3-5 years to prevent costly failures in the future and prevents *E. coli* and other pathogens from entering waterways.						
Critical Area(s): See Figures 29, 30, 31 and 33						
		Measurable Milestones				
Target Audience	**Source/Cause**	**Awareness/Education (within 3 years)**	**Action (3 or more years)**	**Potential Partners**	**Estimated Cost**	**Evaluation Method**
Agricultural Producers (Cropland)	Over or improper application of manure on cropland	One-on-one meetings with producers to evaluate Nutrient Management Plans (NMPs)	Revised NMPs	Conservation Districts, Farm Bureau	$40/hr per meeting $5,000 for revision of NMP	# of NMPs revised
Agricultural Producers (Livestock)	Uncontrolled livestock access to waterways	3 Farmer Demonstration Days to distribute info about impacts of uncontrolled livestock access to waterways and possible funding for fencing	Outreach and assistance with technical and financial issues for exclusion fencing	MAEAP, MDARD, Conservation Districts, MSUE	$1,200 for 3 Farmer Demo Days No cost for technical and financial assistance, if provided through existing programs	# Of exclusion fences installed
Septic System Owners	Aging and improperly connected septic systems	Develop, print, and mail 1,500 septic maintenance brochures, Post infographics on county/local social	Reinstate TOST or similar program	MDHHS, CRWC, TRWC, Realtors	$1,500 to develop, print, and distribute brochures $200 to develop and insert in	# of septic systems repaired or replaced

		media, Print ad in local newspaper			local newspapers	
Pet Owners and Riparian Landowners	Pet and Wildlife Waste	Identify locations for new waste stations at parks, public recreation areas, along popular walking trails/sidewalks. Goose management techniques	Install pet waste stations at all identified locations. Plant riparian buffers to deter geese	Municipalities, Public Libraries, Parks, Conservation Districts, LGROW	\$700 to install and maintenance each pet waste station \$40/hr for installation of riparian buffer zones + \$7/sq. ft. for plants and materials	# of stations installed # sq. ft of buffers installed

Table 30. I&E Recommendations for Excessive Water Temperature

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 and shrinkage of waterbodies. Agricultural runoff, lack of riparian habitats, and urban storm water runoff all cause increased stream temperatures and decreased amounts of dissolved oxygen.						
Critical Area(s): See Figure 35						
		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 District, LGROW, CRWC, Drain Commissioners	$200 to develop and insert in local newspapers $2,100 for 3 workshops $40/hr to plant trees + $150 per tree	# of trees planted in the riparian zone Advertising metrics
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	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 technical and financial assistance, if provided through	# of producers enrolled in programs # of BMPs installed

					existing programs	
Government Officials	Impervious surfaces	Develop and distribute fact sheets on Low Impact Development (LID) practices to reduce impervious surfaces. Conduct 3 trainings on LID practices	Adopt LID ordinances in all communities in watershed to reduce impervious surfaces	Road Commissions, Conservation Districts, LGROW	$1,500 to develop and distribute fact sheets $3,000 for 3 trainings $5,000 per community ordinance development	# of LID ordinances adopted

Table 31. I&E Recommendations for Altered Flow/Hydrology

Focus: Altered Hydrology/Flow						
Message(s): Changes in land use impact stream flows creating water quality, stream stability, and flooding concerns. The flow system of a waterway can change when land use is altered and when river/stream banks are modified. Modified waterways often have steeper banks, lack riparian vegetation, are prone to fluctuating water levels, and have elevated flow. This can harm aquatic life due to impaired water clarity, influx of nutrients and sediments, and altered species composition.						
Critical Area(s): Riparian land, commercial/residential land with water access, roads						
		Measurable Milestones				
Target Audience	**Source/Cause**	**Awareness/Education (within 3 years)**	**Action (3 or more years)**	**Potential Partners**	**Estimated Cost**	**Evaluation Method**
Agricultural Producers	Modified streambanks, tiling, field drainage, draining wetlands	Facilitate 3 workshops with BCD, ICD and KCD to teach producers about the downstream impacts associated with changes they make to their land	Develop guidelines for agricultural producers to use for stabilizing or making positive changes to affect water quality	Conservation Districts, NRCS, County Drain Commissioners	$3,000 for 3 workshops $40/hr outreach and technical assistance	# of producers participating in workshops # of producers involved in BMP implementation
Riparian Landowners	Modified streambanks	Reoccurring social media posts on conservation districts and HOAs pages on the value of wetland/floodplain restoration and the impacts of no riparian buffer zones	Develop guidelines for homeowners to implement riparian vegetation expectations. Distribute infographics and brochures on riparian vegetation importance and modified waterway impacts at local libraries	County Drain Commissioners, Conservation Districts, NRCS, Homeowners Associations (HOAs), Local Libraries	$1,500 to develop, print, and distribute brochures $200 to develop and insert in local newspapers	# of local libraries distributing information # of HOAs adopting riparian vegetation guidelines # acres of restored wetlands/floodplain

Road Commissions	Modified streambanks	Facilitate 3 workshops for Barry and Ionia Co. Road Commissioners to learn about National Pollutant Discharge Elimination System (NPDES) practices that Kent Co. already implements under MS4	Assist Barry, Ionia, and Kent Co. Road Commissions in updating maintenance practice procedures for better water quality	Engineers, EGLE, Kent Co. Road Commission	$3,000 for 3 workshops $40/hr outreach and technical assistance	# reduction of road crossing inputting sediment into waterways # NPDES practices voluntarily implemented

Table 32. I&E Recommendations for Sediment Contamination

Focus: Sediment						
Message(s): Sediment loss through gully and 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 water absorption. 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. Plant buffer zones with native species whose roots will secure shorelines and increase habitat for both aquatic and terrestrial species.						
Critical Area(s): See Figures 32 and 33						
		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	At least 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 through existing programs	# 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	Conservation districts, Public 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	Township and village officials, NRCS, TU	$7,500 per community ordinance development	# of communities that adopted a shoreline buffer ordinance

Table 33. I&E Recommendations for Nutrient Contamination

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. 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/Lawn Care Companies	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. Information on selecting environmentally conscientious lawn care companies.	Test soil for at least 100 landowners (voluntary) and send samples to MSUE for analysis	MSUE, Lawn and garden retailers, Conservation Districts, Local libraries	$500 to create a display 25$ per soil sample for landowners	# of people who visited informational 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	Conduct a total of 30 evaluations for Farmstead System, Cropping System, and Livestock System through MAEAP and MDARD. Assist with	MAEAP, MDARD, Conservation Districts	$1,200 for 3 Farmer Demo Days $40/hr for evaluation	# of MAEAP verified farms # of CNMPs completed

		Farmer Demonstration Days and connect farmers with local MAEAP technician	completion of 10 Comprehensive Nutrient Management Plans (CNMP)		$5,000 per CNMP	

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.

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 Coldwater River 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 CRW.

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

Several rare species, including the Virginia bluebell, are known to occur within the CRW. Areas that host these 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 of agricultural watersheds 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 Coldwater River from the Thornapple River upstream to M-43, Tyler Creek, Duck Creek, Bear Creek, Cain Creek, Unnamed Tributary (T5N, R9W, S31), Unnamed Tributary (T5N, R10W, S36) and Unnamed tributary on north bank of Coldwater River (T4N, R7W, S18) 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).

Coldwater River

The Coldwater River has been found to be impaired along much of its length, from M-43 downstream to Freeport Avenue. In this reach, water temperatures must be reduced by 1.6-5.8°F.

Duck Creek

Data collected from Duck Creek in 2017 found water temperature to occasionally exceed the WQS by about 0.5°F.

Tyler Creek

Based upon existing water temperature data, temperature reductions of 0.4-3.7°F, depending on location, are necessary for Tyler Creek to meet the WQS for a coldwater stream.

It is unknown how many BMPs are necessary to meet the WQS for coldwater fishery, but the “Disaster on the Coldwater” made it clear that removal of the riparian canopy warmed the river between 2-4.6°F. Logic would suggest that replanting of the riparian corridor will reduce stream temperatures when the canopy is restored

Altered Hydrology

Load reductions associated with altered hydrology are very difficult to quantify, since there are no WQS associated with this pollutant and, really, no true “loads”. The basic concept of altered hydrology, which is explained in detail throughout this WMP, is that water is reaching the stream channels much quicker and in larger volumes now than in the past. Unmitigated wetland loss, improvements in the efficiency of drainage networks (i.e. field tiles), and direct channel alterations all contribute to the problems. Field measurements related to flashiness and flow volume in the P51 analysis are good ways to monitor the degree of alteration. Developing hydrographs for specific stream reaches – which can be derived from data currently being collected at Mayfly monitoring stations - is also a great way to understand how quickly stream levels rise, how long they peak and how quickly the water levels recede to normal. Over time, as BMPs are implemented, one should notice improved P51 metrics and a more stable hydrograph. If no improvements are evident, more BMPs must be implemented.

Sediment

Three primary sources of sediment were identified in this WMP; agricultural lands, public roads and streambanks. Evaluation methods for sediment could include measurement of total suspended solids, with comparison to WQS, or sediment-specific P51 habitat metrics including embeddedness, pool variability, pool substrate characterization and sediment deposition. 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 just the critical sites identified in Figure 30 of this WMP - is 1,660 tons. Pollutant reduction goals for agricultural sites are notoriously difficult since landowners within the CRW have been slow to embrace the importance of water quality, and because the critical sites are owned by scores of individual landowners. While a reduction goal of 1,660 tons per year certainly seems feasible, a larger effort to engage agricultural producers is necessary before that might happen.

Public Roads

The annual loading from the 11 critical sites identified in this WMP is 3,951 tons. Assuming that BMPs are 90% effective, a reduction goal of 3,556 tons/year is appropriate if installing 11 BMPs.

Streambanks

The annual loading from the nine critical sites identified in this WMP is 1,870 tons. Assuming that streambank stabilization BMPs are 90% effective, a reduction goal of 1,683 tons/year is appropriate if installing nine BMPs.

Nutrients

Nutrient reduction goals are based upon WQS and WQC in Table 6; all waters of the state must be meeting these criteria and be able to support the designated uses. Specific to the critical sites and areas identified in this WMP, the following reductions have been calculated:

Agricultural Lands

The annual loading from critical sites identified in this WMP is 25,000 lbs of nitrogen and 6,940 lbs of phosphorus on an annual basis. As previously discussed, pollution reduction on farmland often takes many years to achieve. Reduction goals of 25,000 lbs of nitrogen and 6,940 lbs 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 27,641 lbs of nitrogen and 4,194 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 24,877 lbs and phosphorus loading by 3,775 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.

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 Barry, Kent and Ionia 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, many of which have previously been used to fund work in the CRW, 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 Program

8.0 EVALUATION AND MONITORING PLAN

The goal of this WMP is to assist the Coldwater River community in ensuring the long-term protection and improvement of the river and surrounding lands, with focus on the designated uses applicable to the CRW that are mandated by state and federal water quality programs. The progress made in achieving the goals and objectives of this plan 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, including ensuring that the CRW is meeting WQS and providing the designated uses. Data collected through monitoring should be utilized to take an adaptive management approach to refining the implementation of the WMP. Adaptive management is a complicated process, but essentially involves accruing information necessary to guide future management. It is an iterative and ongoing process that connects project objectives, implementation, timelines and budgets with some measure of success (monitoring).

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. 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 the Coldwater River and its tributaries.

<u>Partnership Programs</u>

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. Monitoring associated with BMPs provides evidence that progress is or is not 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:

- Thermally classify all designated coldwater streams to describe each stream reach. Data loggers should be placed to expand on the existing data set for the Coldwater River and Cain, Duck and Tyler Creeks. Unnamed coldwater tributaries should also be studied.
- 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.
- As recommended by MDEQ (2021), conduct P51 monitoring for physical habitat and macroinvertebrates in lower Messer Brook and upstream of M-43 and Rush Road, to evaluate recovery of the river following 2015 drain maintenance activities.
- Periodically monitor the fish community to describe species composition and trout population density and size, in all designated coldwater streams.
- 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 biosolids on surface waters.
- Document occurrences of any new or particularly destructive invasive species.
- Expand the Agricultural Conservation Planning Framework to include all subwatersheds.

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. 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 CRW 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.

Table 34. Recommended Water Quality Monitoring for Determination if CRW 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, CRWC, EGLE, Conservation Districts
Nutrient Monitoring	Annually	$75/sampling location	Schrems, CRWC, EGLE, Conservation Districts
Water Temperature	July mean temperature; annually	$200/sampling location	Schrems, CRWC, OBTU, EGLE, Conservation Districts
Chloride	Monthly for two years	$200/sampling location	Schrems, CRWC, OBTU, EGLE, Conservation Districts
Stream Habitat (following P51) and Macroinvertebrate Assessment (Volunteer monitoring should follow MiCorps methods; EGLE or trained volunteers should follow P51)	Annually; pre-and post BMP implementation	$500/Site	Schrems, CRWC, OBTU, EGLE, Conservation Districts
Biosolids application sites	Annually	$100/Site	Schrems, CRWC, OBTU, EGLE

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 (based upon criteria described in Table 6), if designated uses are being attained and, importantly, what must be done to steer the project if no measureable progress is being made based upon the timelines established within this WMP.

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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