Paw Paw River Watershed Management Plan

"A Guide for the Protection and Improvement of Water Quality"

August 2008
Updated 2021

Paw Paw River Watershed Management Plan

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The 2021 update was developed with assistance from Aardvark Wordsmith.

This Nonpoint Source Pollution Control project has been funded in part through the Michigan Nonpoint Source Program by the United States Environmental Protection Agency under assistance agreement # C9975464-05 to the Southwest Michigan Planning Commission for the Paw Paw River Watershed Planning Project. The contents of the document do not necessarily reflect the views and policies of the EPA, nor does the mention of trade names or commercial products constitute endorsement or recommendation for use.

The plan update in 2021 was funded in part through the Michigan Department of Environment, Great Lakes and Energy through a grant from the Section 205(j) of the Federal Clean Water Act. Project #2017-0106.

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1 Introduction

The Paw Paw River Watershed (PPRW) is all of the land that drains into the Paw Paw River. Wetlands, lakes, streams, other surface water bodies on this land and groundwater are also part of the watershed. Water is a critical resource for recreation, irrigation, and increasing the value of adjacent real estate. These uses depend on good water quality, but they can also be a threat to it.

A watershed is all of the land that drains into a common body of water. Watersheds surpass political boundaries and connect communities with a common resource.

The PPRW is a priority for protection and preservation among southern Michigan watersheds because a relatively high percentage of its natural land cover remains in spite of increasing development pressure throughout the region. The PPRW Management Plan is intended to guide individuals, businesses, organizations and governmental units working cooperatively to ensure the water and natural resources necessary for future growth and prosperity are improved and protected. It can be used to educate watershed residents on how they can improve and protect water quality, encourage and direct natural resource protection and preservation, and develop land use planning and zoning that will protect water quality in the future. Implementation of the plan will require stakeholders to work across township, county, and other political boundaries.

Watershed management involves identifying and prioritizing problems, promoting involvement by stakeholders, developing solutions and measuring success through monitoring and data collection.

Chapters 2 and 3 of the management plan provide an overview of the watershed. Chapter 4 outlines the role governmental units play in protecting water quality. Chapter 5 describes the natural features of the watershed. The process used to develop the plan is reviewed in Chapter 6. Chapter 7 summarizes water quality throughout the watershed and Chapter 8 prioritizes the areas, pollutants and sources impacting it. Chapter 9 offers goals for the watershed and Chapter 10 provides strategies for achieving them. Lastly, Chapter 11 suggests a strategy for evaluating the progress toward the goals of the plan.

The State of Michigan protects all water bodies for designated uses such as water supply, fisheries and for partial and total body contact for recreation. This management plan was created as part of the PPRW planning project, which was funded with a Clean Water Act Section 319 grant administered by the Michigan Department of Environment, Great Lakes and Energy (EGLE), Nonpoint Source Program. The Southwest Michigan Planning Commission in collaboration with several partners was awarded the grant in January of 2006. Development of the PPRW Management Plan relied heavily on stakeholder input and agency support, as well as professional services and other partnerships. Another grant was awarded to the Southwest Michigan Planning Commission in 2017 by the Michigan Department of Environmental Quality (now the Department of Environment, Great Lakes, and Energy) to update the plan. The overall health of a river system can be difficult to determine. Characterizations and recommendations in this plan are based on the best available data.

2 Watershed Description

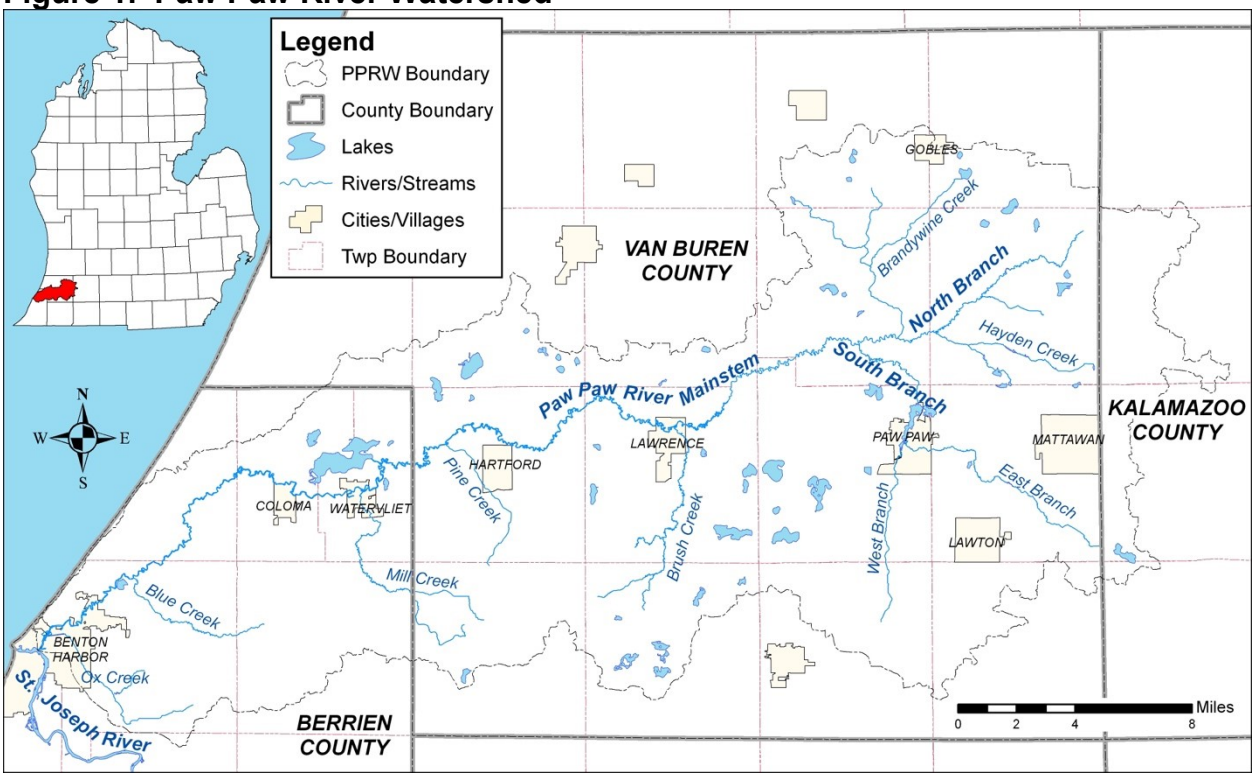
2.1 Geography

The term watershed describes an area of land that drains down slope to the lowest point. It includes all of the land, in which any drop of water falling within it, will leave in the same stream or river. Watersheds can be large or small and can traverse county, state or national boundaries. Every stream, tributary or river has an associated watershed; and small watersheds join to become larger watersheds. For example, within the Great Lakes watershed, the PPRW is part of the St. Joseph River watershed, which is part of the larger Lake Michigan watershed.

Pennsylvania Department of Environmental Protection

The Paw Paw River flows westward through southwestern Lower Michigan before joining the St. Joseph River and emptying into Lake Michigan near the City of Benton Harbor. The PPRW encompasses approximately 285,557 acres (446 square miles) in Kalamazoo, Van Buren and Berrien Counties with the largest portion in Van Buren County (203,720 acres). In the eastern portion of the watershed, the North Branch joins the South Branch to become the mainstem of the Paw Paw River. Other significant tributaries include Brandywine Creek, Hayden Creek, the East Branch, the West Branch, Brush Creek, Pine Creek, Mill Creek, Blue Creek and Ox Creek. The total length of the Paw Paw River and these significant tributaries is approximately 145 miles. The PPRW includes 5,818 acres of lakes and ponds.

Figure 1. Paw Paw River Watershed



Watersheds are typically identified by Hydrologic Unit Codes (HUCs). HUCs were developed by the United States Geologic Society to provide official boundaries for watersheds. HUCs identify a geographic area, which includes part or all of a surface drainage basin. The United States is divided into successively smaller hydrologic units. The units are classified into six levels starting with large areas such as the Great Lakes Region (2-digit) down to small areas like the Brandywine Creek subwatershed (14-digit). Often for management purposes, agencies focus on the smaller 14-digit HUC subwatershed level.

Each subwatershed has slopes, soils and other conditions, which direct runoff to the Paw Paw River or one of its tributaries. Figure 2 identifies the 17 subwatersheds (14-digit HUCs) of the PPRW. Table 1 lists the acreage and 14-digit HUC for each subwatershed, as well as the percentage of each governmental unit included in the subwatershed. Throughout the plan, the HUCs are labeled as subwatersheds 1-17 and the HUCs are not referenced except for in Table 1. The specific water bodies located in each subwatershed can be found in Table 8 (major streams) and Table 9 (lakes).

Figure 2. Subwatersheds of the Paw Paw River

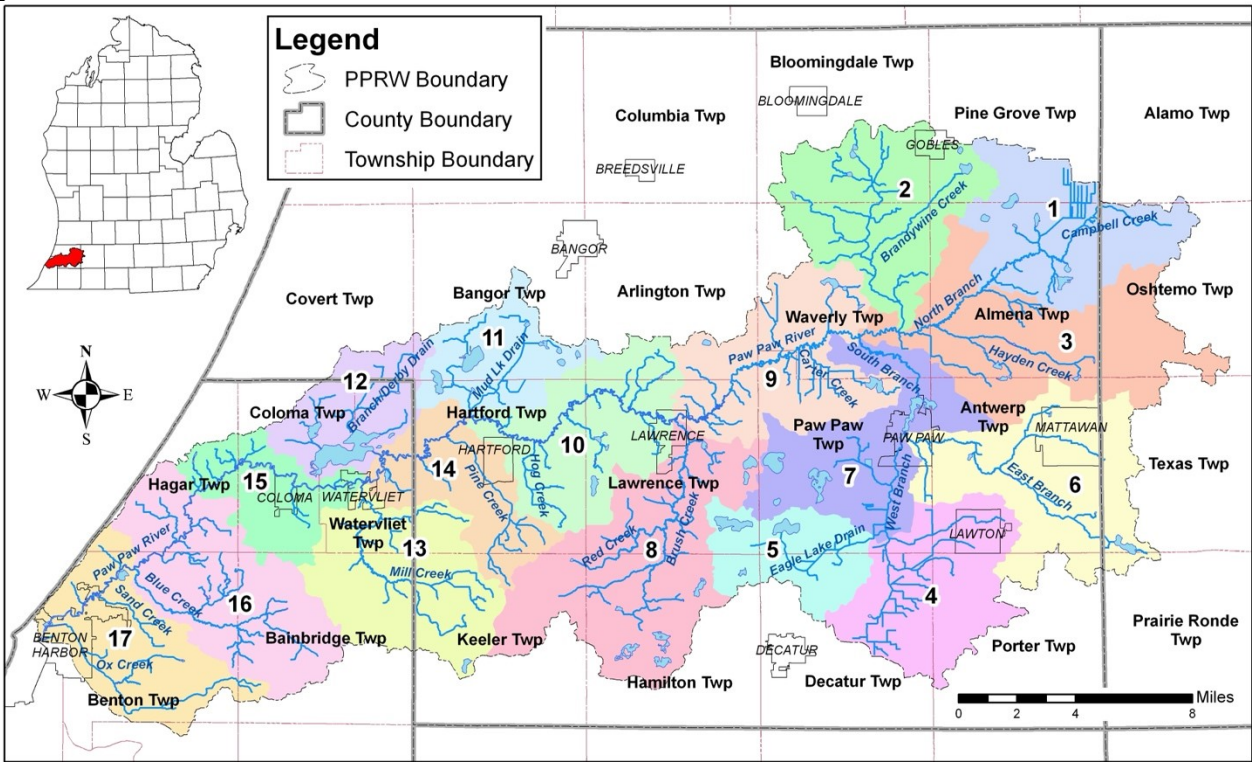


Table 1. Paw Paw River Subwatersheds

Map ID #	14-Digit HUC* (subwatershed name)	Total Area (Acres)	Governmental Units (% of Subwatershed)
1	04050001260010 (Campbell Creek and North Branch)	17,204	Almena Twp (53.45%), Oshtemo Twp (24.68%), Pine Grove Twp (21.53%), Alamo Twp (.34%)
2	04050001260020 (Brandywine Creek)	19,718	Waverly Twp (43.54%), Bloomingdale Twp (37.03%), Pine Grove Twp (12.09%), Almena Twp (4.83%), Gobles (2.51%)
3	04050001260030 (Hayden Creek and North Branch)	23,844	Almena Twp (50.30%), Oshtemo Twp (25.13%), Antwerp Twp (11.73%), Waverly Twp (7.65%), Texas Twp (5.19%)
4	04050001260040 (Lawton Drain and West Branch)	16,767	Decatur Twp (40.21%), Porter Twp (31.76%), Antwerp Twp (11.29%), Lawton Village (9.11%), Paw Paw Twp (7.63%)
5	04050001260050 (Eagle Lake Drain)	9,733	Decatur Twp (36.86%), Paw Paw Twp (31.98%), Lawrence Twp (18.32%), Hamilton Twp (12.85%)
6	04050001260060 (East Branch)	21,636	Antwerp Twp (54.54%), Texas Twp (18.02%), Mattawan Village (12.17%), Porter Twp (7.68%), Prairie Ronde Twp (2.66%), Paw Paw Twp (2.44%), Paw Paw Village (2.41%), Almena Twp (.07%)
7	04050001260070 (Maple Lake and South Branch)	16,875	Paw Paw Twp (67.57%), Waverly Twp (12.40%), Antwerp Twp (9.93%), Paw Paw Village (7.63%), Lawrence Twp (1.55%), Almena Twp (.91%)
8	04050001270010 (Brush Creek)	26,322	Hamilton Twp (40.23%), Lawrence Twp (36.55%), Keeler Twp (19.28%), Hartford Twp (1.92%), Lawrence Village (1.50%), Paw Paw Twp (.51%)
9	04050001260080 (Carter Creek and Mainstem)	18,907	Waverly Twp (38.20%), Paw Paw Twp (28.39%), Lawrence Twp (19.23%), Arlington Twp (13.63%), Lawrence Village (.54%)
10	04050001270020 (Hog Creek and Mainstem)	17,908	Hartford Twp (44.52%), Lawrence Twp (36.05%), Arlington Twp (12.83%), Lawrence Village (3.69%), Hartford City (1.73%), Bangor Twp (1.18%)
11	04050001270030 (Mud Lake Drain)	10,044	Bangor Twp (66.2 %), Hartford Twp (24.79 %), Pokagon Band of Potawatomi Indians (6.65 %), Arlington Twp (2.36 %)
12	04050001270040 (Paw Paw Lake)	10,280	Coloma Twp (41.70%), Watervliet Twp (33.87%), Covert Twp (18.59%), Bangor Twp (4.58%), Hartford Twp (1.25%), Watervliet City (.01%)
13	04050001270050 (Mill Creek)	18,499	Bainbridge Twp (35.11%), Keeler Twp (34.54%), Watervliet Twp (16.63%), Hartford Twp (10.83%), Watervliet City (1.98%), Coloma Twp (.91%)
14	04050001270060 (Pine Creek and Mainstem)	11,958	Hartford Twp (64.13 %), Watervliet Twp (16.38 %), Keeler Twp (8.18 %), Hartford City (5.67 %), Pokagon Band of Potawatomi Indians (4.55 %), Watervliet City (1.09 %)
15	04050001270070 (Ryno Drain and Mainstem)	9,732	Coloma Twp (55.39%), Hagar Twp (24.08%), Watervliet Twp (7.76%), Coloma City (5.85%), Bainbridge Twp (4.00%), Watervliet City (2.93%)
16	04050001270080 (Blue Creek and Mainstem)	20,720	Bainbridge Twp (40.42%), Benton Twp (30.97%), Hagar Twp (27.63%), Coloma Twp (.98%)
17	04050001270090 (Ox Creek and Mainstem)	15,421	Benton Twp (77.03%), Benton Harbor (14.12%), Hagar Twp (3.90%), Bainbridge Twp (3.04%), Sodus Twp (1.23%), St. Joseph City (.67%)

*HUC – Hydrologic Unit Code (Also see Table 8 and Table 9 for water bodies in each subwatershed.)

2.2 Climate

The proximity of the PPRW to Lake Michigan and prevailing westerly winds moderate the climate and produce lake effect precipitation during the fall and winter months. The climate is also influenced by the Maritime Tropical air mass, which tends to be a relatively warm and humid air mass. The average growing season (consecutive days with low temperatures greater than or equal to 32 degrees) is 148 days. Total annual precipitation is approximately 38.3 inches including approximately 72 inches of snowfall. (Berrien & Van Buren Soil Surveys) July is the hottest month for Benton Harbor with an average high temperature of 83.2°, which ranks it as warmer than most places in Michigan. The average January low temperature is 18.3^0.

The PPRW lies within the Southern Michigan, Northern Indiana Till Plains (SMNITP) ecoregion. Ecoregions are delineated by their climates, soils, vegetation, land slope and land use. The Paw Paw River is typical of rivers in the SMNITP ecoregion in that it: 1.) has good quality headwaters, 2.) is generally slow flowing, and 3.) is often bordered by extensive wetlands. Ditching and channelizing has been used throughout this ecoregion to drain areas that are too wet for settlement and agriculture. The PPRW is a priority for conservation because it contains more wetland and natural stream channel than many other rivers in the SMNITP ecoregion. (Chapter 6, MDEQ Integrated Report 2006)

2.3 Geology, Hydrology and Soils

The geological features, hydrology and soils of the PPRW combined with the current lack of impervious surface and abundance of intact natural land cover make the Paw Paw River one of the most hydrologically stable river systems in southern lower Michigan.

Geology and Hydrology

Virtually all of Michigan's topography and hydrology has been influenced by glacial action. Repeated advances of continental ice sheets eroded the pre-existing rock and soils and then re-deposited these materials as sediments as the ice advanced, melted and retreated during several cycles. These glacial materials were deposited as sands, gravels, silts and clays, as well as various mixtures, and vary in thickness within the watershed area from approximately 130 feet to over 400 feet. Ice movement and its meltwater influenced the patterns and distributions of various landforms, such as moraines and stream valleys. The meltwater created large rivers, which deposited glacial materials throughout the region. These glacial deposits and their associated landforms provide a foundation for the hydrology, soil types and land cover that exist today.

Soils

The National Cooperative Soil Survey publishes soil surveys for each county within the U.S. These soil surveys contain predictions of soil behavior for selected land uses, and also highlight limitations and hazards inherent in the soil, general improvements needed to overcome the limitations, and the impact of selected land uses on the environment. The soil surveys are designed for many different users. Planners, community officials,

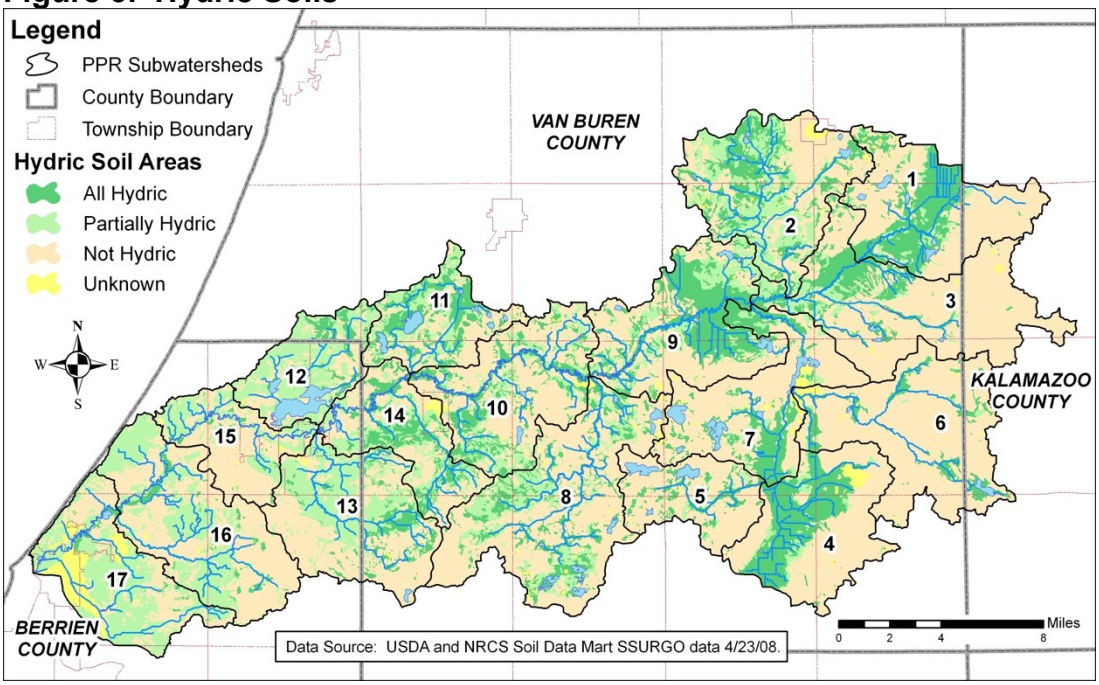
engineers, developers, builders, etc., use the surveys to help plan land use, select sites for construction, and identify special practices needed to ensure proper performance.

Protection of areas with high infiltration capacity (Group A soils) is important for maintaining hydrology and temperature regimes.

Hydrologic soil groups can help determine, which portions of the watershed are more important for groundwater recharge. The upper and middle sections of the PPRW are mostly made up of Group A soils. Group A soils are mostly sandy and loamy types of soils with a low runoff potential and high infiltration rate even when thoroughly wetted. These coarse soil types allow water to infiltrate and recharge the groundwater supply. As a result of these soils and a relative lack of impervious surface, the Paw Paw River system receives moderate groundwater inputs. Groundwater inputs are important for maintaining stream temperatures and flow throughout the system. The lower sections of the watershed mostly consist of Group C soils. Group C soils are sandy clay loam with a low infiltration rate when thoroughly wetted. (St. Joseph River Assessment, 1999) Protection of areas with high infiltration capacity (Group A soils) is important for maintaining hydrology and temperature regimes within the watershed.

Another important characteristic of soils is whether they are considered hydric. Hydric soils are defined as poorly or somewhat poorly drained soils. These soils are one of the indicators of wetlands, but many have been drained for building or agricultural purposes. Although wetland regulations do not apply to all hydric soil areas, they are poorly suited for development, especially for septic fields. Septic systems installed in areas with unsuitable soils are prone to failure, which can lead to nutrient and bacteria pollution of groundwater and surface water. Figure 3 shows the hydric and partially hydric soils in the PPRW, which are mostly found in the eastern part of the watershed in low-lying areas and along river and stream segments.

Figure 3. Hydric Soils



2.4 Land Cover

Prior to European settlement in the early-to-mid-1800's, much of the PPRW was forested. Beech-sugar maple forests were dominant, and oak-hickory forests, mixed hardwood swamps, mixed conifer swamps, white pine-mixed hardwood forests, and black ash swamps were all represented. There were openings in the forest as well, consisting primarily of mixed oak savanna and open wetlands.

Today, natural land cover in the PPRW has become fragmented by agricultural practices, as well as residential and commercial development. However, despite the increasing pressure from these competing land uses, significant portions of natural land cover remain. The forested floodplain corridor along the main stem of the Paw Paw River from Benton Harbor to the Village of Paw Paw in particular remains largely intact.

As seen in Figure 4 and Table 2, the watershed contains mostly agricultural (49%) and natural (39%) land cover. The relatively high percentage of natural land cover in the PPRW is threatened by increasing development pressure. An estimated 50% of wetlands have been lost in the PPRW in the last 200 years. Preservation and restoration of natural land cover, as well as proper management of agricultural lands will be critical to protecting and improving water quality in the PPRW.

Preservation and restoration of natural land cover, as well as proper management of agricultural lands, will be critical to protecting and improving water quality in the PPRW.

Table 2. Paw Paw River Watershed Land Cover (2016)

Class Name	Acres	Percent
Developed, High Intensity & Medium Intensity	4,922	1.7%
Developed, Low Intensity	12,586	4.4%
Developed, Open Space	8,300	2.9%
Cultivated Crops	120,088	42.1%
Pasture/Hay	20,178	7.1%
Grassland/Herbaceous	6,973	2.4%
Forest	55,624	19.5%
Wetland	51,988	18.2%
Water	4,877	1.7%

Source: NOAA, Coastal Change Analysis Program (C-CAP)

Figure 4. Paw Paw River Watershed Land Cover (2016)

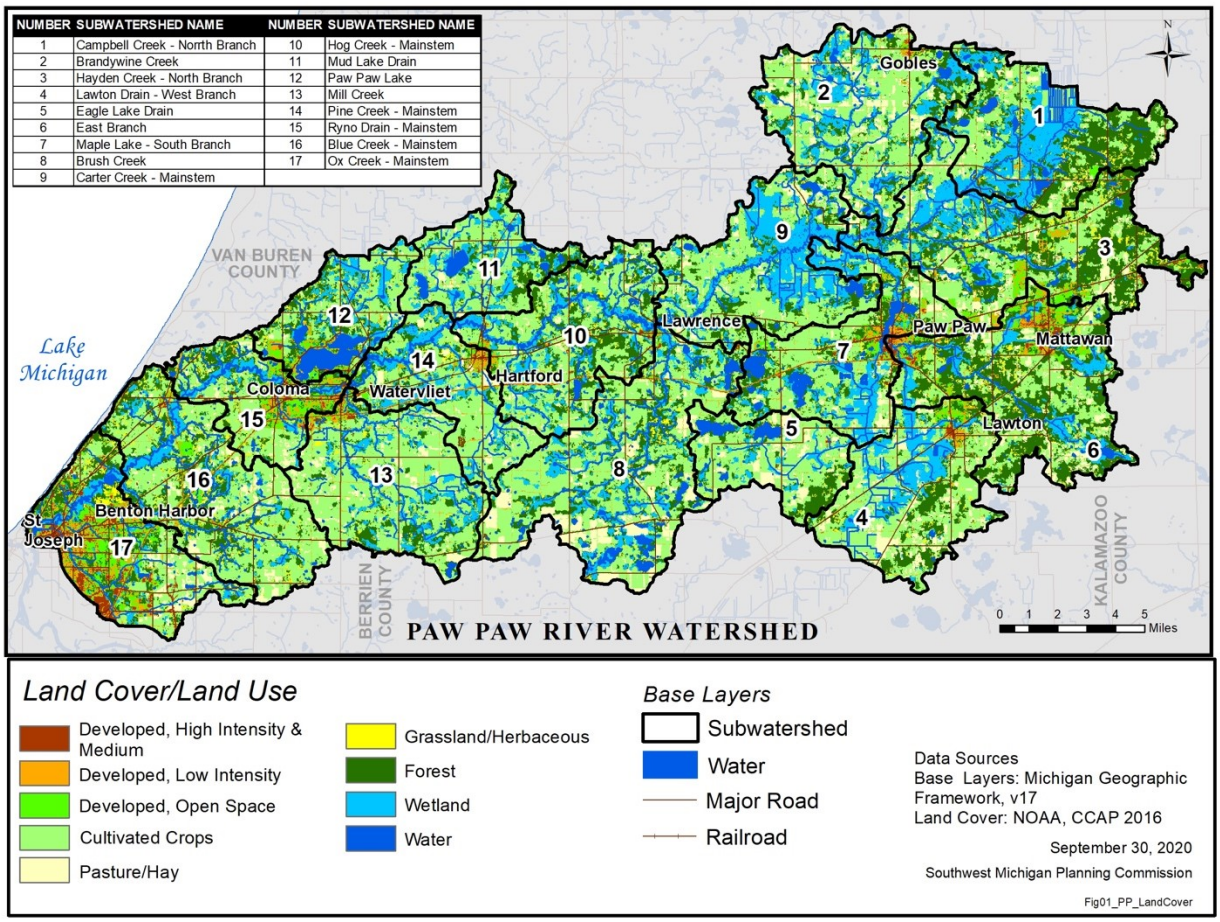
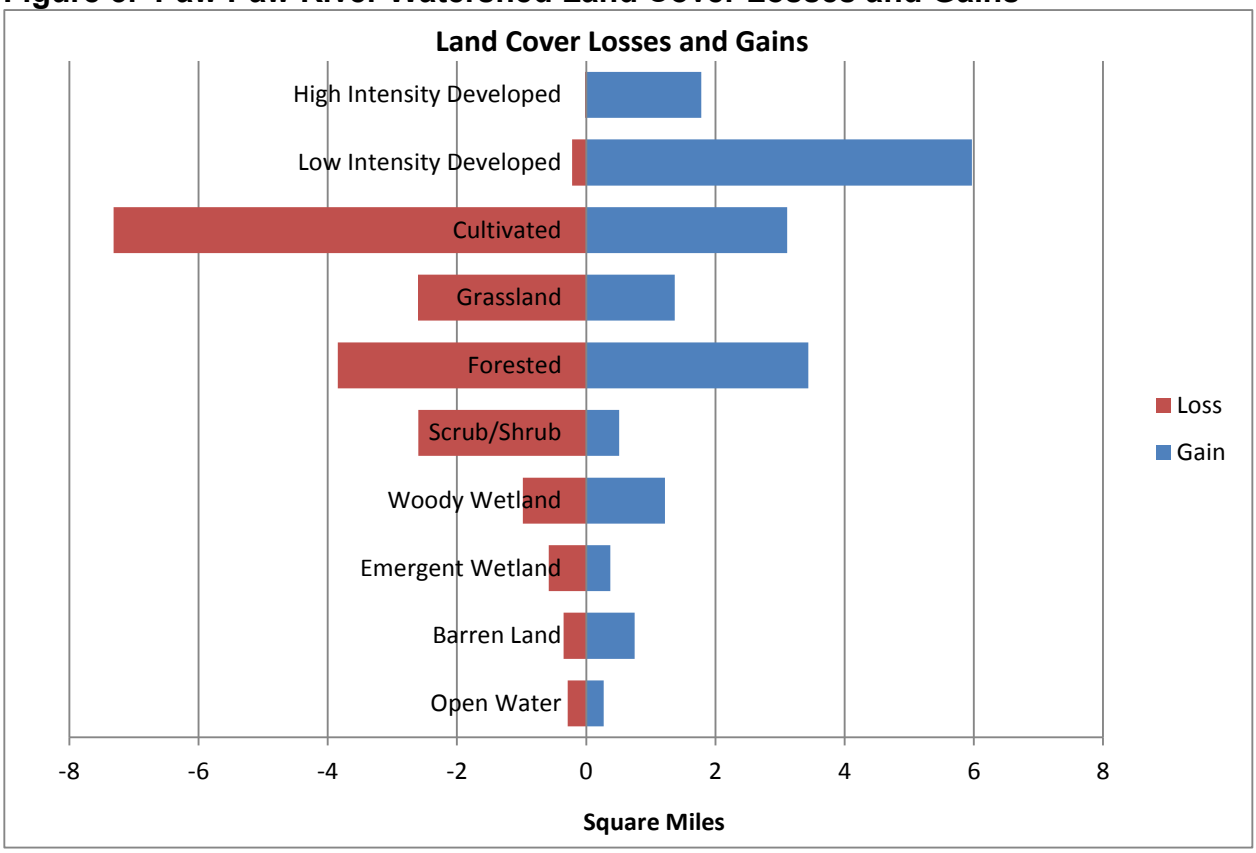


Table 3. Paw Paw River Watershed Land Use Change from 1975 to 2016

Level 1 Class Scheme	1975 (sq mi)	Loss (sq mi)	Gain (sq mi)	2016 (sq mi)	Net Change (sq mi)	Percent Change
High Intensity Developed	4.9	0.0	1.8	6.6	1.8	36.3%
Low Intensity Developed	26.9	-0.2	6.0	32.7	5.8	21.4%
Cultivated	223.5	-7.3	3.1	219.3	-4.2	-1.9%
Grassland	12.1	-2.6	1.4	10.9	-1.2	-10.1%
Forested	79.5	-3.8	3.4	79.1	-0.4	-0.5%
Scrub/Shrub	9.9	-2.6	0.5	7.9	-2.1	-21.0%
Woody Wetland	76.5	-1.0	1.2	76.7	0.2	0.3%
Emergent Wetland	4.8	-0.6	0.4	4.6	-0.2	-4.4%
Barren Land	1.1	-0.3	0.7	1.5	0.4	35.7%
Open Water	7.2	-0.3	0.3	7.2	0.0	-0.2%

Source: NOAA, C-CAP

Figure 5. Paw Paw River Watershed Land Cover Losses and Gains

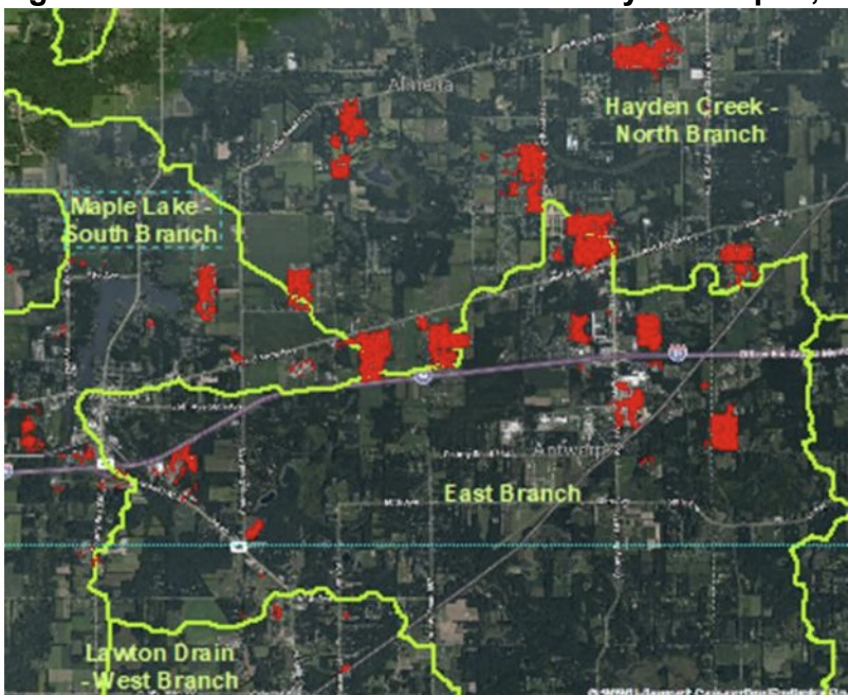


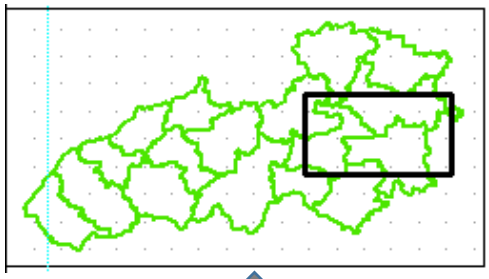
Land Use Change

By land area the biggest land use change was the gain of Low Intensity Developed, 5.75 sq mi and the loss of Cultivated, -4.20 sq mi. These changes are connected whereas approximately half of the loss in cultivated happened with the conversion to Low Intensity Development. Much of this conversion of Cultivated to Low Intensity

Development occurred in the eastern part of the watershed, east of Paw Paw Village shown below in red.

Figure 6. Converted Land to Low-Intensity Developed,





Low Intensity Developed
+ 5.5 mi^2

Cultivated
- 4.20 mi^2

By percentage the largest change is High Intensity Developed at 36.3%. Most of the change can be seen at Orchards Mall and US 31. Again, the same pattern occurs with cultivated land being converted to developed.

Figure 7. Converted Land to High-Intensity Developed

High Intensity Developed
+ 36 %

2.5 Dams and Barriers

Dams and barriers in the watershed pose issues with recreational use and also with the fragmentation of habitat. Dams can restrict the movement of fish in river systems. There are 20 registered dams in the PPRW. Many of these dams are obsolete (not serving any function) and they are generally low head and found in remote areas. Low head dams are artificial structures, which are less than 15 feet in height and extend across the river channel. There are no active hydroelectric dams; many of the dams are being used for recreational lake level control structures. (St. Joseph River Assessment, 1999) The Michigan Department of Natural Resources, U.S. Fish and Wildlife Service, Berrien County, Watervliet City, The Nature Conservancy and the Southwest Michigan Planning Commission worked in partnership to remove the spillway and diversion dams on the Paw Paw River in Watervliet City. This project eliminated the only major barrier on the Paw Paw River mainstem until Maple Lake in Paw Paw, Michigan.

Figure 8. Paw Paw River Dams Removal Project

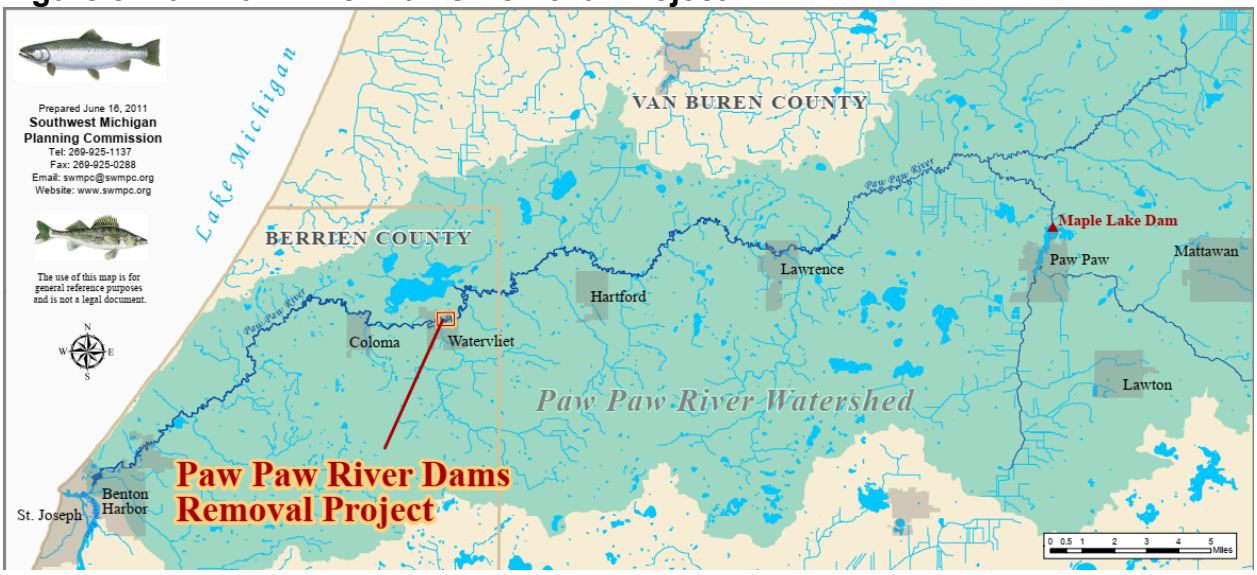
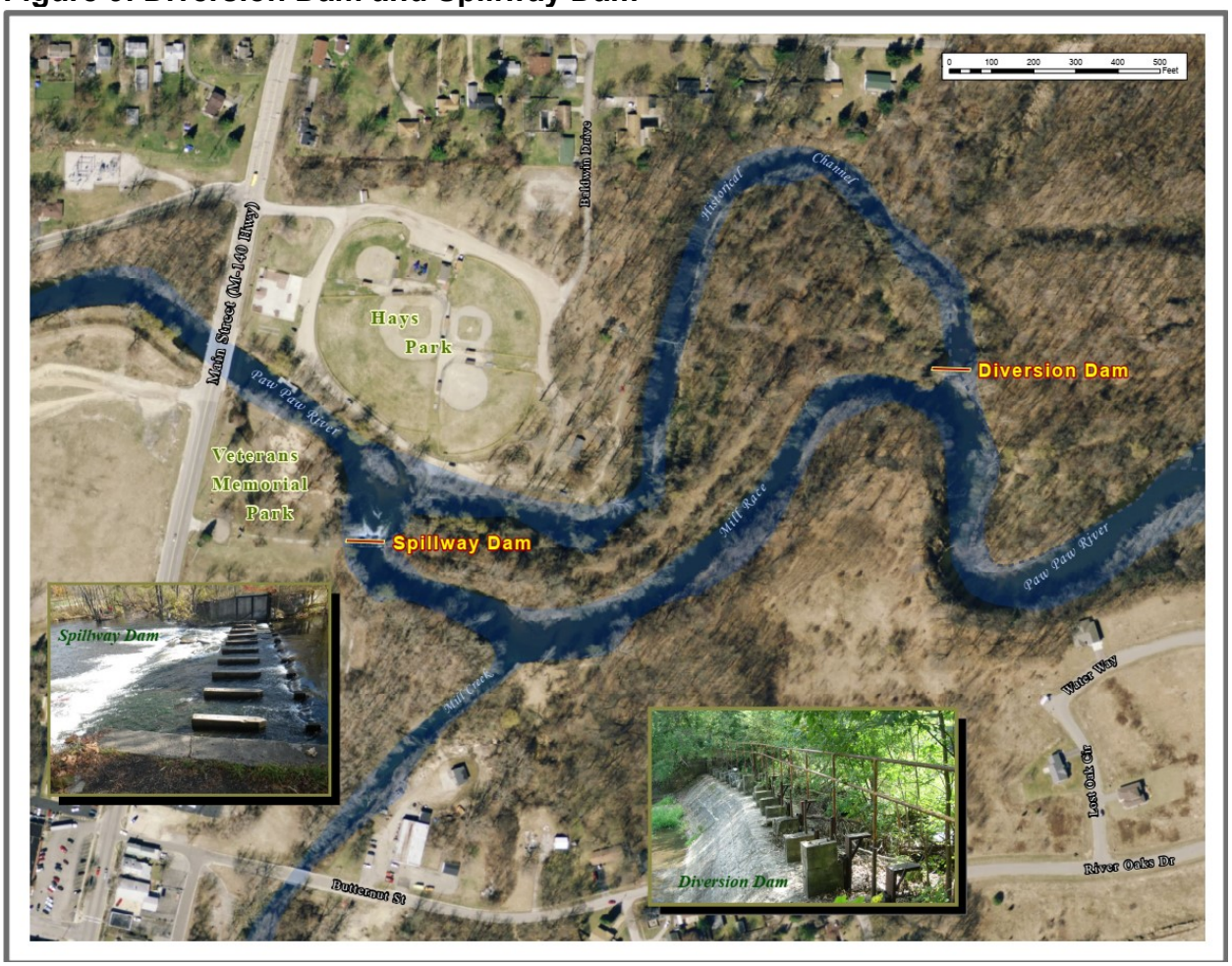


Figure 9. Diversion Dam and Spillway Dam



3 Community Profile

3.1 History of Region

Throughout history, water resources have been important for the culture and economy of southwest Michigan. The Hopewell inhabited the area from 500 BC to 900 AD, followed by the Algonquin groups and the Miami tribe. By the early 1700's the Potawatomi tribe was the predominant Native American people in this area. The French were the first European explorers to come to southwest Michigan. They were interested in the fur trade in this area. The French explorer, LaSalle, is known to have wintered near the City of St Joseph in 1680-81. A 1999 Michigan History magazine article indicates La Salle proceeded up the Paw Paw River and entered western Kalamazoo County at Prairie Ronde. British traders came here during the second half of the eighteenth century. Artifacts suggest that a trading post existed on the banks overlooking the Paw Paw River near Coloma.

The Erie canal was opened in 1825 and settlers poured into southwest Michigan from the east. Most settlements were located on streams or rivers and soon major water and steam driven mills were erected in every settlement. Until railroads were installed, flour and other products were transported by water to Lake Michigan. The Paw Paw River was, in the days of early settlement, an important highway for the transportation of freight from the Paw Paw Valley to St. Joseph, and many people were engaged in the business of boating flour on flatboats. The traffic on the Paw Paw continued with more or less regularity until the completion of the Michigan Central Railroad.

In 1893, an old sawmill in Watervliet was replaced with a paper mill. For the next hundred years the paper mill grew into the town's main industry, employing 400 people. Today Watervliet is reclaiming its waterfront from industrial uses and there is a nice stormwater demonstration project at Veterans Park with a porous parking lot, a rain garden and a riparian buffer along the Paw Paw River.

In the late 1800's tourism abounded at Paw Paw Lake (the largest lake in the watershed at 920 acres). Its eleven miles of shoreline, proximity to Benton Harbor/St. Joseph, and accessibility to railroads made it the perfect place for a resort destination. Double-decked steamboats 90 feet in length were circling the lake on a regular schedule. Vacationers came to town by the electric interurban train or by regular passenger trains. Train records from the early part of the 1900's show 40,000 people coming to Paw Paw Lake every summer. At one time, fifty hotels and four dance pavilions lined the lake. The area's popularity continued through the 1950's.

In April 1947 torrential rains caused a dam to break in Lawrence creating a domino effect of flooding downstream on the Paw Paw River. The record flooding of Paw Paw Lake resulted in hundreds of homes being damaged and many being pushed off their foundations. The cost of cleanup and repair was a staggering dollar amount for that time.

The Wolf Lake State Fish Hatchery was established in 1927 with land donated to the State by the Izaak Walton League who bought 78 acres for $5,000. This facility produces a wide range of fish species for both inland and Great Lakes waters. The hatchery has both indoor and outdoor rearing facilities.

Southwest Michigan is known for its fruit and vegetable production. The PPRW is the home to several wineries. The rural character, the Paw Paw River and area lakes continue to attract tourists and residents to southwest Michigan.

(History section is courtesy of Barb Cook)

Water resources are important to our economy, history and culture. These priceless treasures must be protected.

3.2 Governmental Units

In the PPRW, there are 39 governmental units including 25 townships, four (4) villages, six (6) cities, three (3) counties (Berrien, Van Buren and Kalamazoo counties), and one (1) tribe (Pokagon Band of Potawatomi Indians). Out of the 35 townships, cities and villages, only 22 have at least 75% of their land in the PPRW. The Pokagon Band of Potawatomi Indians owns over 1,200 acres within the watershed (Hartford and Bangor Townships). Approximately 775 acres of these lands are held in federal trust for the benefit of the Pokagon Band, and as a result, the Band possesses the jurisdiction to develop and implement its own land use plan, as well as regulate the resources and other activities within these lands. The majority of these lands are along the Paw Paw River. See Figure 10 for a map of governmental units in the PPRW.

Table 4 lists all of the governmental units located in the PPRW along with the approximate: 1.) number of acres of that governmental unit in the PPRW, 2.) percent of that governmental unit in the PPRW, 3.) number of miles of PPRW streams and rivers in that governmental unit, and 4.) number of acres of lakes and ponds in that governmental unit and within the PPRW. Almena, Waverly and Hartford Townships have the most river length in the PPRW. Paw Paw, Lawrence and Coloma Townships have the most surface water acreage in the PPRW.

Figure 10. Governmental Units in Paw Paw River Watershed

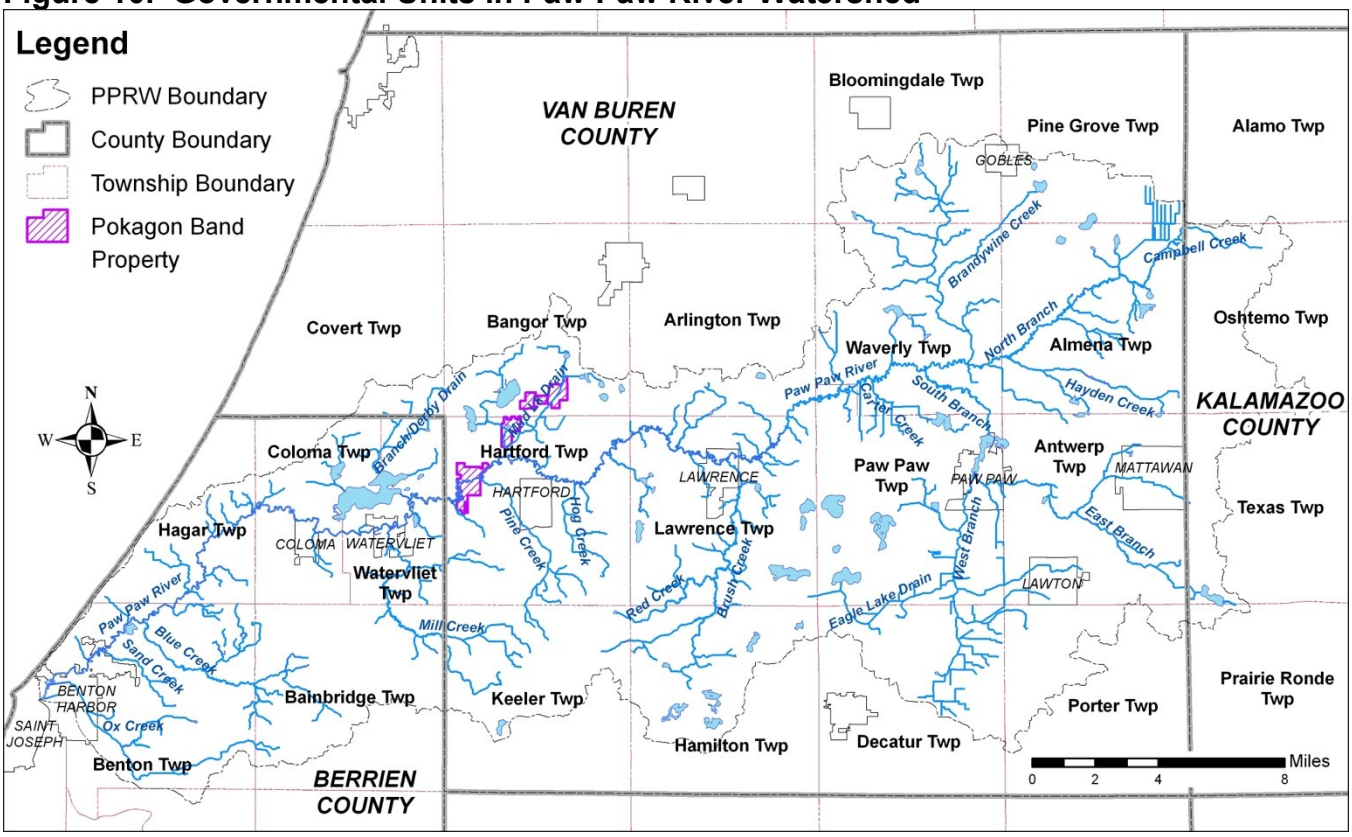


Table 4. Watershed Area, River Length and Water Acreage by Governmental Unit

Governmental Unit	County	Watershed Area (Acres)	% in Watershed	River Length (Miles)	Surface Water Area* (Acres)
Alamo Twp.	Kalamazoo	59	0.25	0	0
Almena Twp.	Van Buren	22,310	100	36.5	345
Antwerp Twp.	Van Buren	18,168	99.87	15	145
Arlington Twp.	Van Buren	5,112	22.86	1.9	79
Bainbridge Twp.	Berrien	15,729	69.54	5.1	87
Bangor Twp.	Van Buren	7,773	32.18	2.55	442.7
Benton Harbor, City of	Berrien	2,177	76.81	9.1	28
Benton Twp.	Berrien	18,292	86.94	19.8	165
Bloomingdale Twp.	Van Buren	7,301	33.66	4.3	109
Coloma, City of	Berrien	569	100	1.6	1
Coloma Twp.	Berrien	10,047	82.31	5.5	602
Covert Twp.	Van Buren	1,910	8.53	0.8	2
Decatur Twp.	Van Buren	10,326	47.15	9.8	16
Gobles, City of	Van Buren	495	74.88	0	0

Governmental Unit	County	Watershed Area (Acres)	% in Watershed	River Length (Miles)	Surface Water Area* (Acres)
Hagar Twp.	Berrien	8,672	72.5	6.7	57
Hamilton Twp.	Van Buren	11,840	52.04	12.5	536
Hartford, City of	Van Buren	988	100	0.4	4
Hartford Twp.	Van Buren	21,545	100	28.7	151
Keeler Twp.	Van Buren	12,442	55.55	11.2	122
Lawrence Twp.	Van Buren	21,753	100	27.1	644
Lawrence, Village of	Van Buren	1,158	100	3.9	6
Lawton, Village of	Van Buren	1,527	100	0	23
Mattawan, Village of	Van Buren	2,633	100	2.8	15
Oshtemo Twp.	Kalamazoo	1,0237	44.42	0	24
Paw Paw Twp.	Van Buren	21,832	100	9.1	1131
Paw Paw, Village of	Van Buren	1,811	100	2.1	140
Pine Grove Twp.	Van Buren	6,088	27.13	2.6	193
Pokagon Band of Potawatomi Indians	Van Buren	1,212	100	3.73	17.3
Porter Twp.	Van Buren	6,985	30.84	1.3	17
Prairie Ronde Twp.	Kalamazoo	575	2.47	0	6
Sodus Twp.	Berrien	190	1.48	0	0
St. Joseph, City of	Berrien	103	4.4	0.75	1
Texas Twp.	Kalamazoo	5,137	22.12	1.6	127
Watervliet, City of	Berrien	782	100	2.6	0
Watervliet Twp.	Berrien	9270	100	16.5	573
Waverly Twp.	Van Buren	19,723	89.3	32.3	174

*Surface Water Area does not include rivers and streams. Source: Michigan Center for Geographic Information

3.3 Demographics

The PPRW is an important resource for its human population, including parts of the metropolitan areas of Kalamazoo at the headwaters and Benton Harbor-St. Joseph at the mouth. It is important to understand the characteristics of the population in the watershed. By having a better understanding of the people, water quality related management and outreach efforts can be tailored to be more effective for the intended audience(s).

All of the demographic information presented here is from the ESRI Community Analyst which uses the US Census as the data sources. ESRI extrapolates demographic data according to spatial layers. In this case, the Paw Paw River Watershed was used to attend the demographic data.

According to the US Census prepared by ESRI, there were about 82,137 people living in the PPRW in 2021. The average population density in the watershed was 184 people per square mile. In 2021, the watershed contained about 31,439 households with 22,921 (73%) of these being owner occupied. The average household contained 2.6 persons. Figure 11 illustrates that the most densely populated areas of the watershed are located in the headwaters and near the mouth (Benton Harbor and Coloma/Watervliet areas). Table 5 lists the race breakdown of the population living in the watershed. About 78% were white only, about 13% were black or African American and about 9% were Hispanic or Latino.

Figure 11. Population Density (2010)

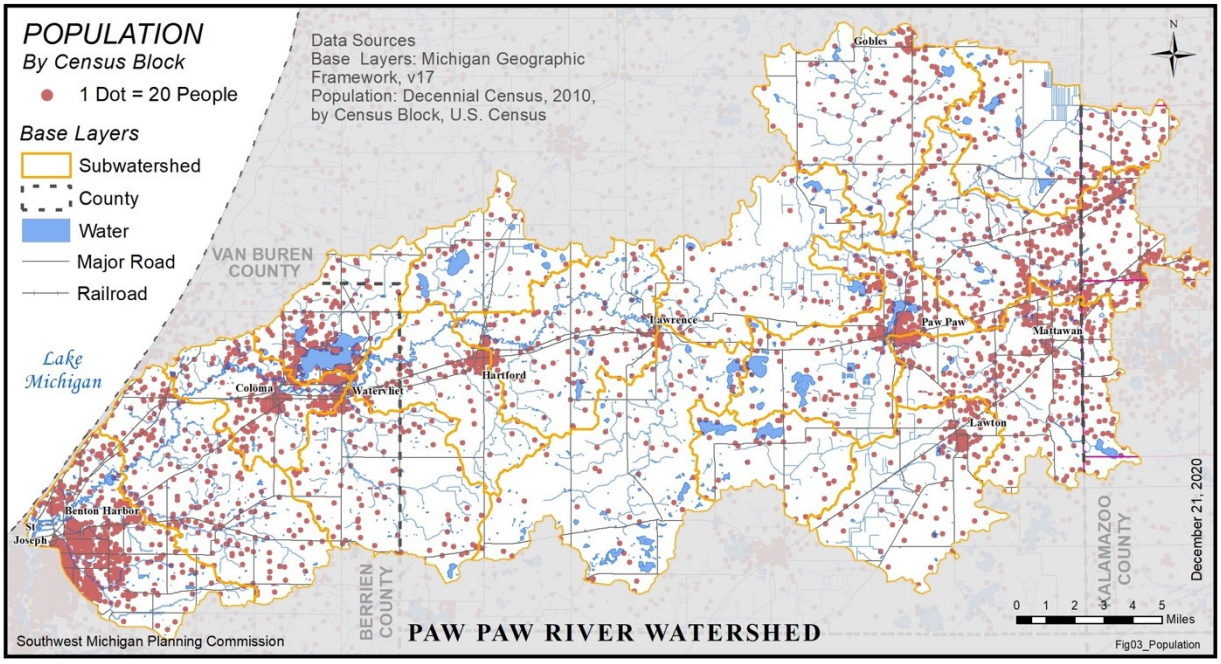


Figure 12. Infographic of Demographics in the Paw Paw River Watershed

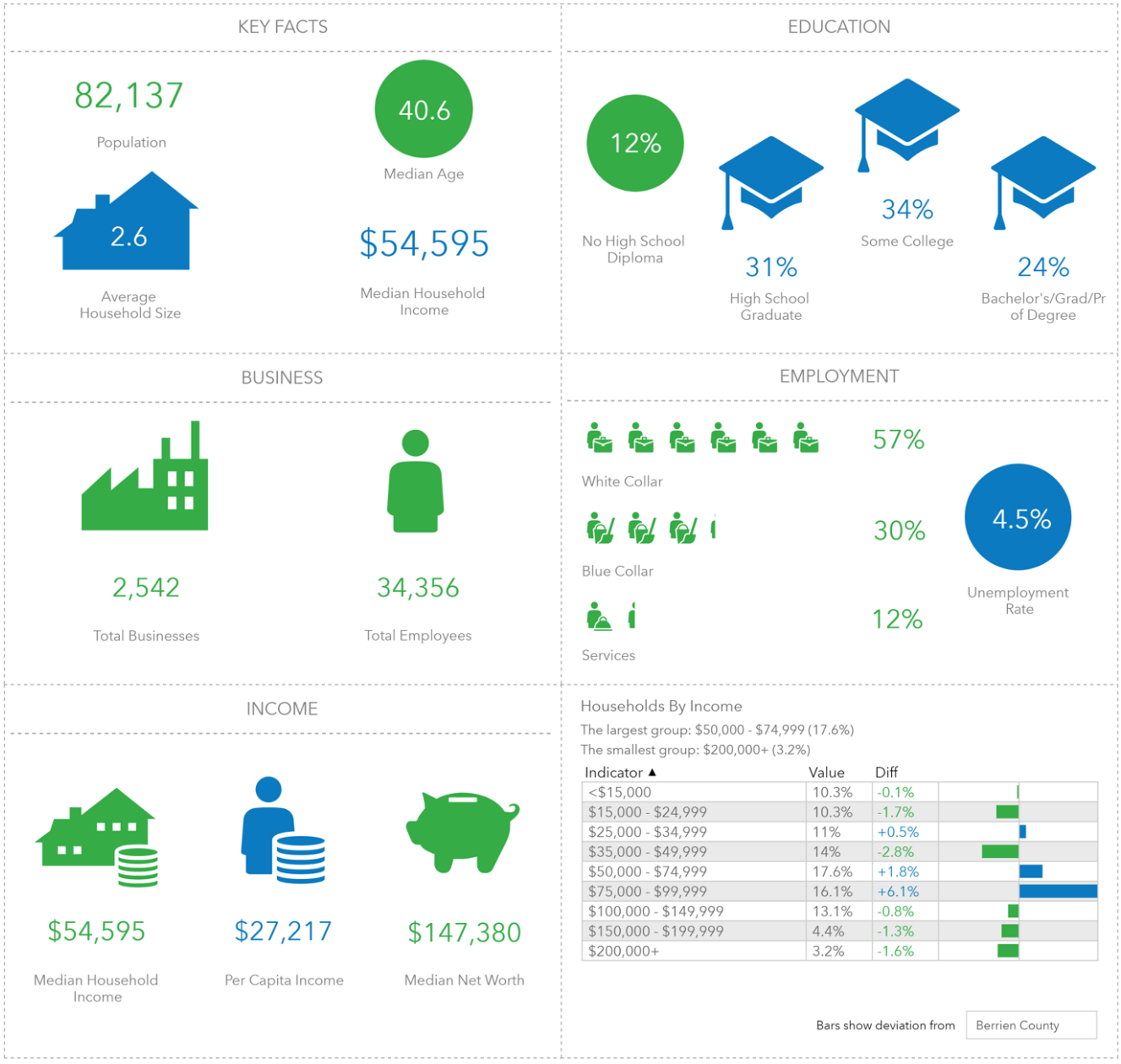
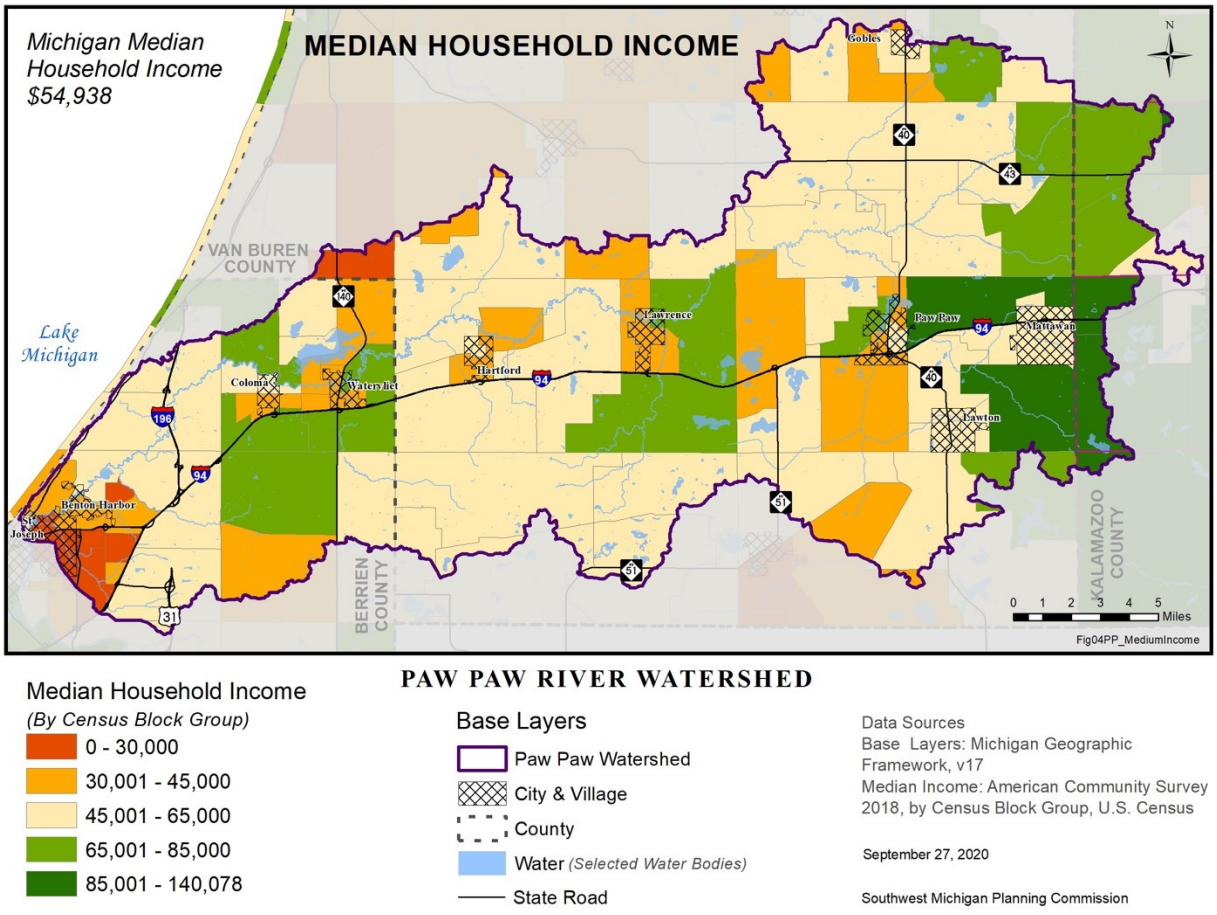


Table 5. Race by Census Block (2021)

Race and Ethnicity	Number	Percentage
White Alone	64,096	78.0%
Black Alone	10,872	13.2%
American Indian Alone	562	0.7%
Asian Alone	625	0.8%
Pacific Islander Alone	24	0.0%
Some Other Race Alone	3,520	4.3%
Two or More Races	2,438	3.0%
Hispanic Origin (Any Race)	7,206	8.8%

Figure 13. Median Household Income (2018)



3.4 Future Growth and Development

The PPRW has abundant natural and water resources that attract businesses, residents and tourists. Over the next few decades, the PPRW is expected to see population growth and land use change, especially in the eastern part of the watershed and along

the I-94 corridor. In 2008, MPI Inc. announced the expansion of its facilities in Mattawan and the creation of 3,000 jobs. In 2007, Harbor Shores built a 530-acre development in Benton Harbor City, Benton Township and St. Joseph City. This development has spurred further economic and population growth in the Benton Harbor area. The cities and townships along Red Arrow Highway are working cooperatively to attract industrial, commercial and residential growth to the area. With these projects, population growth and major land use changes are expected to occur throughout the watershed.

For the long-term prosperity and health of these communities, the water quality and natural resources need to be recognized for their important role in the current and future economic development of the region. It will be imperative to have thoughtful and sensitive planning of these and other developments to ensure that the water quality and natural resources and the services they provide are protected. For more information on economic development and natural resources visit www.swmpc.org/growgreen.asp.

4 Resource Management

Federal, state, county and local governmental units and their agencies have exclusive, or share, responsibility for the management and protection of water, land and other natural resources. Local entities are obligated to comply with federal and state environmental statutes, county level ordinances and local ordinances. In the case of surface water protection, the federal and state laws generally provide a nation or statewide strategy for water quality protection. Because of their broad-scale nature there are often gaps in protection efforts. This presents opportunities for county and local governmental units to enact ordinances or standards that will support a more comprehensive water quality protection strategy.

For more information on opportunities for local government to protect water and other natural resources consult the "Filling the Gaps" documents at www.swmpc.org/gaps.asp.

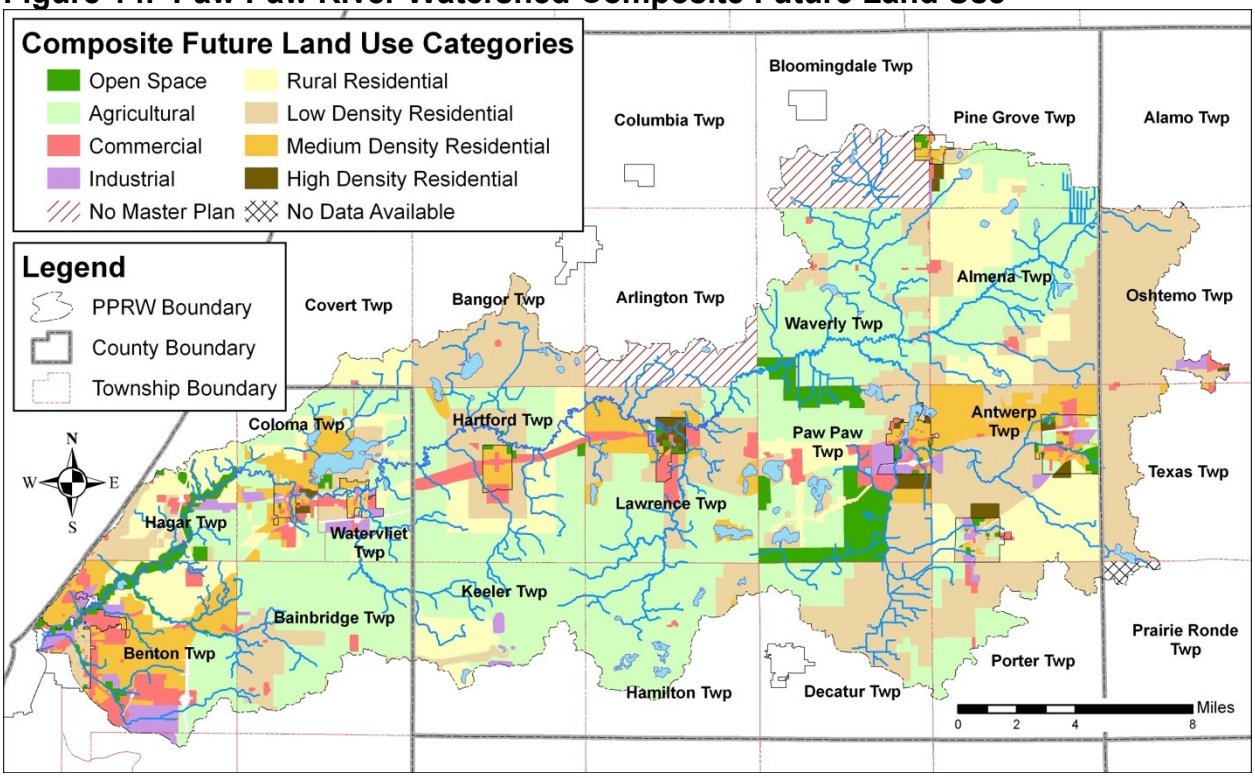
4.1 Land Use and Water Quality

The way land is managed, patterns of land use in relation to natural resources, and especially the way water is managed on a site to support the land use, has a large impact on the quality of water and the ecology of lakes, rivers, streams and shorelands. The authority to regulate land use rests primarily with local governments, largely through master plans and zoning ordinances. In addition, counties have the authority to enact ordinances that could affect the management of land. For example, several counties in Michigan have adopted phosphorus bans for fertilizer use. As a result, city, village, township and tribal governments have a significant role to play in protecting water resources. This role presents itself where federal and state statutes and county ordinances leave off.

The authority to regulate land use rests primarily with local governments. This gives cities, villages and townships a significant role in protecting water resources.

It is essential to plan for land uses with respect to existing natural features, soils and drainage patterns to lessen the impacts to water quality. Certain uses and activities should be located in areas where their impacts to water will be minimized. From a watershed perspective, land use will not only affect the immediate area, but also downstream areas and water bodies. Figure 14 is a composite map of future land use in the watershed. The future land use map was created from each governmental unit's master plan. The future land use map is a vision that is supposed to guide future development. Most of the land in the PPRW is planned for agriculture and rural or low - density residential use.

Figure 14. Paw Paw River Watershed Composite Future Land Use



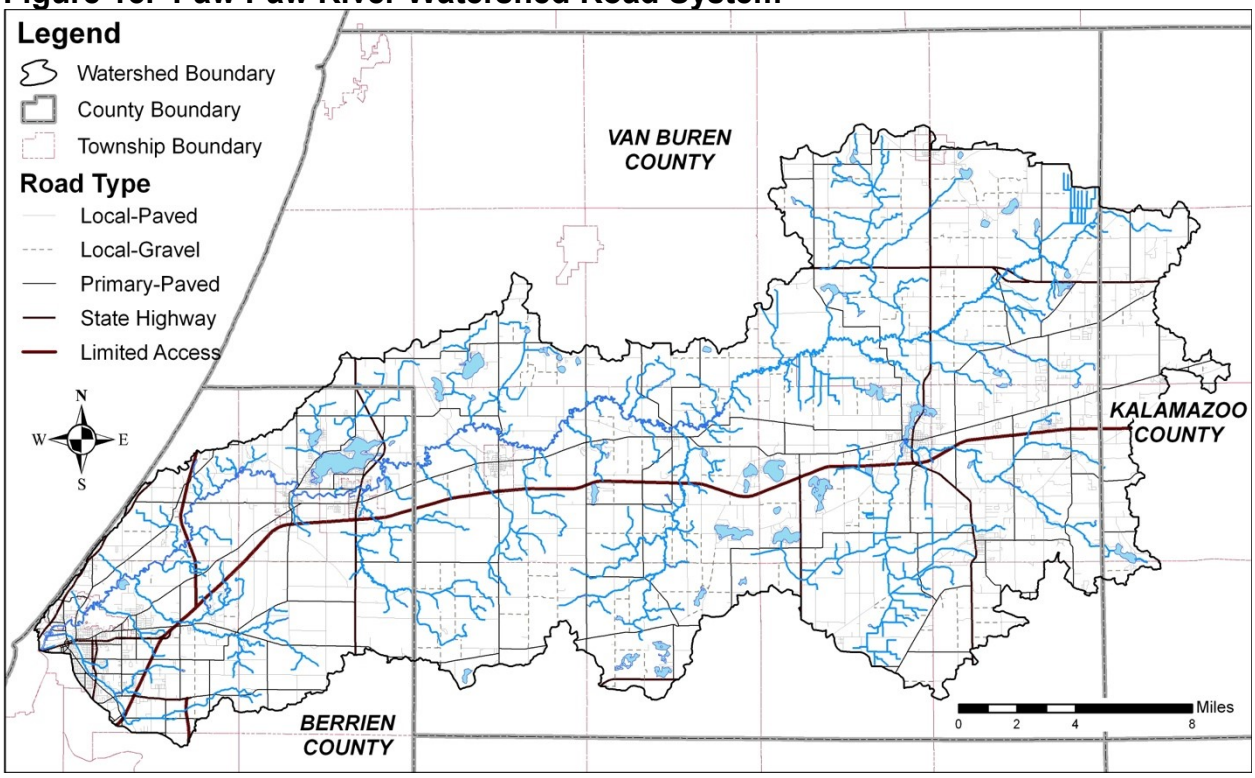
Once the placement of different future land uses (high density residential, low density residential, commercial, industrial, etc) are located with respect to soils, natural features, water bodies and drainage patterns, there should be great attention to how the land is developed. Land development can have a significant impact on water quality. The impacts to water quality that commonly result directly from development activity and increased drainage to support land development can be minimized through the use of smart growth and low impact development techniques. For more information on low impact development techniques visit www.swmpc.org/lid.asp.

Roads are a land use that can have substantial impacts on water quality. Controlling roadway-related pollution during project planning, construction and ongoing maintenance is important.

Roads and Water Quality

Roads are a land use that can have substantial impacts on water quality. Controlling roadway-related pollution during project planning, construction and ongoing maintenance is important. For example, the salting and sanding of roads during the winter can be a major pollution concern. Figure 15 shows the extent of the road system in the PPRW. MDOT and County Road Commissions are responsible for the construction and maintenance of most roads in the PPRW. However, the management of local roads is often shared with townships, cities and villages. In addition, many cities and villages have their own road systems, which they maintain. The Southeast Michigan Council of Governments (SEMCOG) published a guidance document designed to promote good planning practices and endorse consideration and integration of environmental issues into transportation projects. This guidance document is available on-line at www.swmpc.org/downloads/enviro_transpo_guidance.pdf.

Figure 15. Paw Paw River Watershed Road System



4.2 Regulatory Authority and Water Resources

Water Bodies (rivers, drains, streams, lakes)

At the federal level, the Army Corps of Engineers exercises jurisdiction for navigation on the Paw Paw River from the mouth up to Paw Paw Avenue in Benton Harbor (about 2 miles). The Michigan Department of Environment, Great Lakes and Energy regulates water bodies in the watershed based on the Natural Resources and Environmental Protection Act, PA 451, part 301 Inland Lakes and Streams. This statute regulates the dredging, filling, construction and any structural interference with the natural flow of a lake or stream. This act also regulates marina operations. Permits are needed for activities such as construction of docks or placing fill or structures in lakes and streams. The Michigan Department of Natural Resources (MDNR) has the authority to regulate the number of boats and size of engines at MDNR access sites if human health or protected species are being impacted. Cities, villages and townships should enact ordinances that further protect the water quality of lakes and streams. Model ordinances to protect water quality can be found at www.swmpc.org/ordinances.asp.

EGLE also regulates any discharges to lakes or streams such as those from industrial operations or municipal wastewater treatment plants through the National Pollutant Discharge Elimination System (NPDES) program. For a listing of NPDES permits in the watershed see Appendix 2. Further EGLE administers the Phase II stormwater program, which requires owners or operators of municipal separate storm sewer systems (MS4s) in urbanized areas to implement programs and practices to control polluted stormwater runoff. Benton Harbor City, Benton Charter Township, St. Joseph City, Berrien County Road Commission and Berrien County Drain Commissioner and

Administration participate in the Phase II stormwater program. More information on this program is available at www.swmpc.org/lsjr.asp.

The County Drain Commissioner is responsible for the administration of the Drain Code of 1956, as amended. The duties of the Drain Commissioner include the construction and maintenance of drains, determining drainage districts, apportioning costs of drains among property owners, and receiving bids and awarding contracts for drain construction. The Drain Commissioner also approves drainage in new developments and subdivisions and maintains lake levels. The soil erosion and sedimentation program is housed in the Drain Commissioner's office. The County Enforcement Agent for the soil erosion program has the responsibility of ensuring earth change activities that are one or more acres in area and/or within 500 feet of a watercourse or lake do not contribute soil to water bodies.

Wetlands

Michigan is one of two states that has the authority to administer section 404 of the Clean Water Act dealing with wetland protection. The Michigan Department of Environment, Great Lakes and Energy regulates wetlands and shares this responsibility with the Army Corps of Engineers for the wetlands connecting to the Paw Paw River from the mouth to Paw Paw Avenue in Benton Harbor. However, EGLE does not regulate all wetlands. Wetlands are regulated by EGLE if they meet any of the following criteria:

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

Local governmental units can enact building setbacks and a no disturb zone around wetlands to help protect water quality.

Since there are gaps in state protection of wetlands, a local unit of government (city, township, village, county) has the authority to create wetland regulations. A local wetland ordinance must be at least as restrictive as state regulations and EGLE must be notified if there is a local wetland ordinance in effect. Approximately 50 communities in Michigan have adopted local wetland ordinances and notified the Michigan Department of Environment, Great Lakes, and Energy. Although, none of these are in the PPRW, some jurisdictions within the watershed require building setbacks and a no-disturb zone around wetlands, which can be just as effective as a wetland ordinance.

Figure 16. Paw Paw River Watershed Wetlands

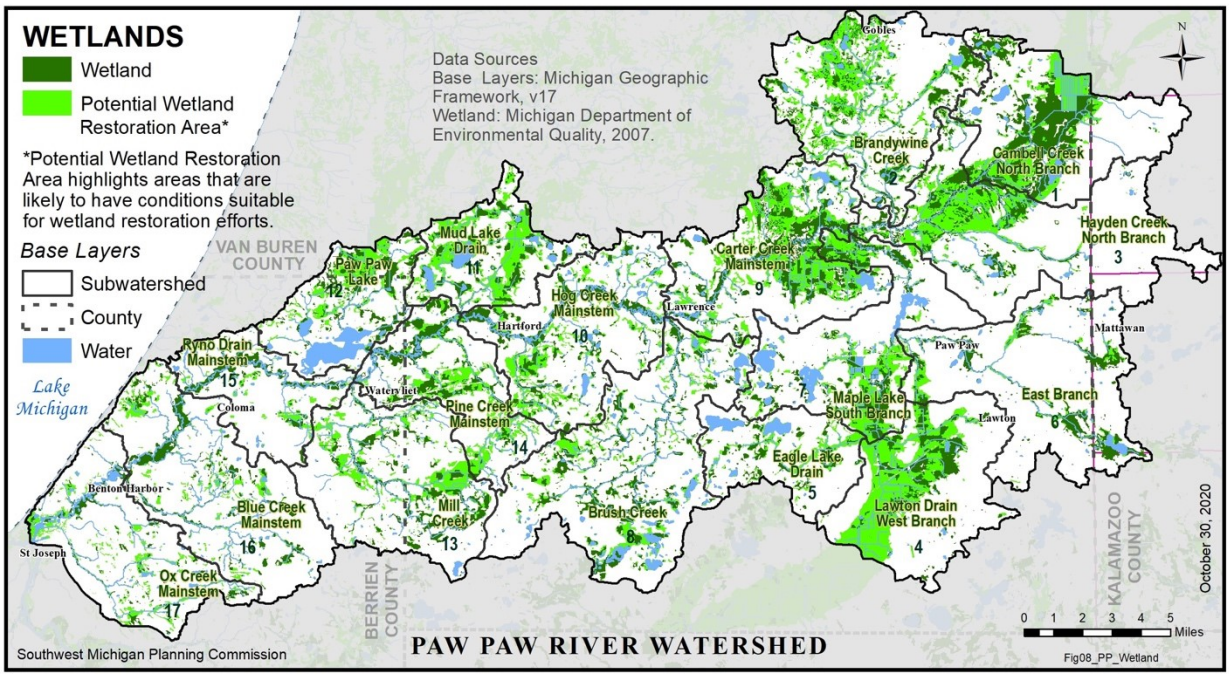


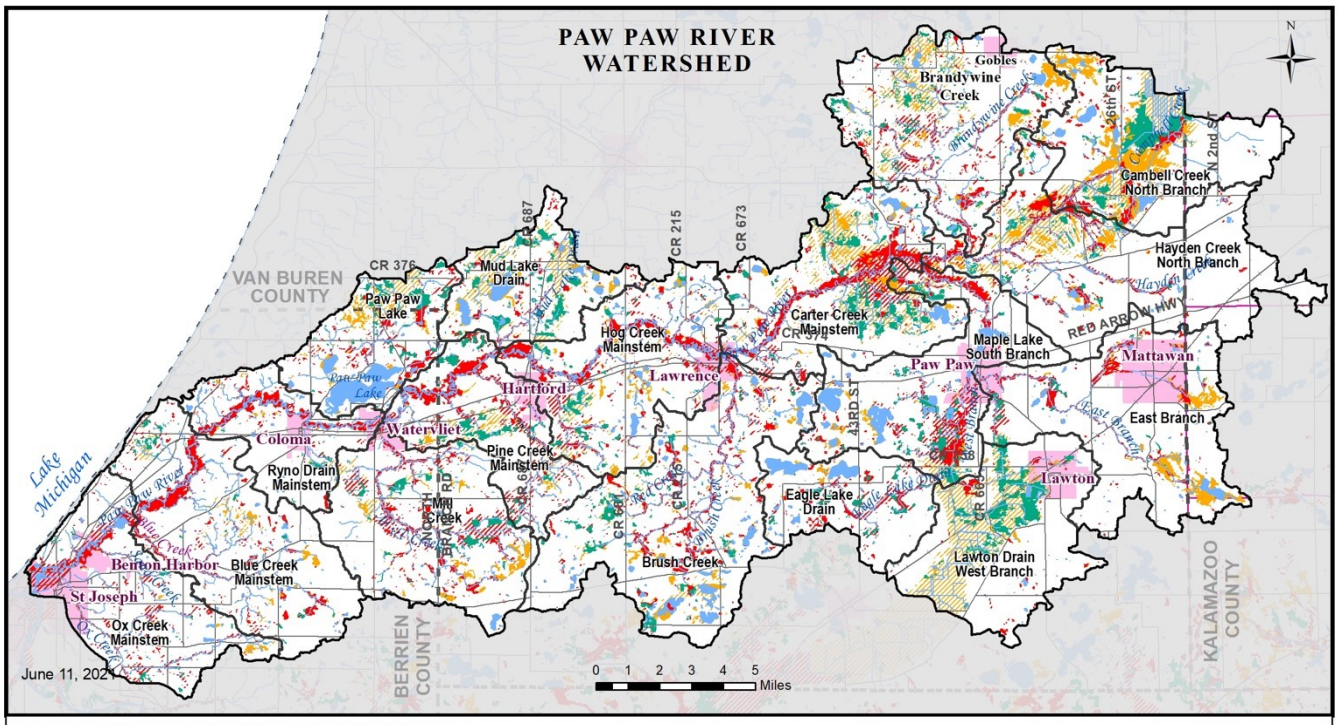
Table 6. Paw Paw River Watershed Wetlands, by subwatershed

SUBWATERSHED	CURRENT WETLANDS (ACRES)	PRESETTLEMENT WETLANDS (ACRES) *Note: includes current wetlands*	WETLAND LOSS (ACRES)	WETLANDS LOSS (PERCENT)
Blue Creek - Mainstem	1,980	2,748	768	28%
Brandywine Creek	2,464	5,151	2,687	52%
Brush Creek	3,283	4,720	1,437	30%
Campbell Creek - North Branch	3,828	6,024	2,196	36%
Carter Creek - Mainstem	3,480	7,195	3,715	52%
Eagle Lake Drain	775	1,432	657	46%
East Branch	1,962	2,499	537	21%
Hayden Creek - North Branch	2,408	4,387	1,979	45%
Hog Creek - Mainstem	2,477	4,319	1,843	43%
Lawton Drain - West Branch	1,700	5,828	4,128	71%
Maple Lake - South Branch	2,299	4,157	1,858	45%
Mill Creek	1,960	3,587	1,627	45%
Mud Lake Drain	1,397	3,411	2,014	59%
Ox Creek - Mainstem	912	2,662	1,750	66%
Paw Paw Lake	1,368	2,389	1,021	43%
Pine Creek - Mainstem	1,890	3,502	1,612	46%
Ryno Drain - Mainstem	1,038	1,404	366	26%
Grand Total	***35,221***	***65,416***	***30,195***	***46%***

The wetland resource base in the Paw Paw River Watershed has undergone significant disruption in the 200 years since Michigan was settled, losing almost 50% of its total wetland area, and in some cases up to 62% of its wetland function. There is evidence to suggest that the result of these losses is reduced surface water quality and total loss of some fisheries. The watershed itself has been extensively ditched since presettlement, and this has resulted in the destruction, degradation, and vegetative conversion of many of the wetlands and waterways that originally existed. Forested wetlands have been the most affected, with silviculture and drainage for agriculture responsible for most of the impact. Because of ineffective drainage and/or forestry practices, there has been a sharp increase in the amount of emergent and scrub-shrub wetland acreage over time.

While wetland loss in acres is 46%, it is helpful to understand what this means in terms of lost functions that wetlands serve. For the wetland functions evaluated for the Paw Paw River Watershed, there was a cumulative loss ranging from 27% (Waterfowl and Waterbird Habitat) to 62% (Conservation of Biodiversity). Several wetland functions were reduced in capacity by 50% or more in the watershed as a whole; Retention of Sediment and Other Particulates lost 51% capacity, Fish and Shellfish Habitat was reduced by 61%, and Conservation of Biodiversity by 62%. Others fell just below that mark, with streamflow maintenance, nutrient transformation, and other wildlife habitat all estimated to have lost 44-45% of their original capacity. Not one of the functions showed an increase in capacity. The following maps show the existing and lost wetlands for high and medium significance for the following selected functions that wetlands serve: floodwater storage, nutrient transformation, sediment and other particulate retention.

Figure 17. Wetland Function Assessment: Flood Water Storage



WETLAND FUNCTION ASSESSMENT*

Flood Water Storage

- High Significance
- Medium Significance

Lost Wetland

- High Significance
- Medium Significance

- Wetland (All other existing wetlands)

Base Layers

- Subwatershed
- County
- Water

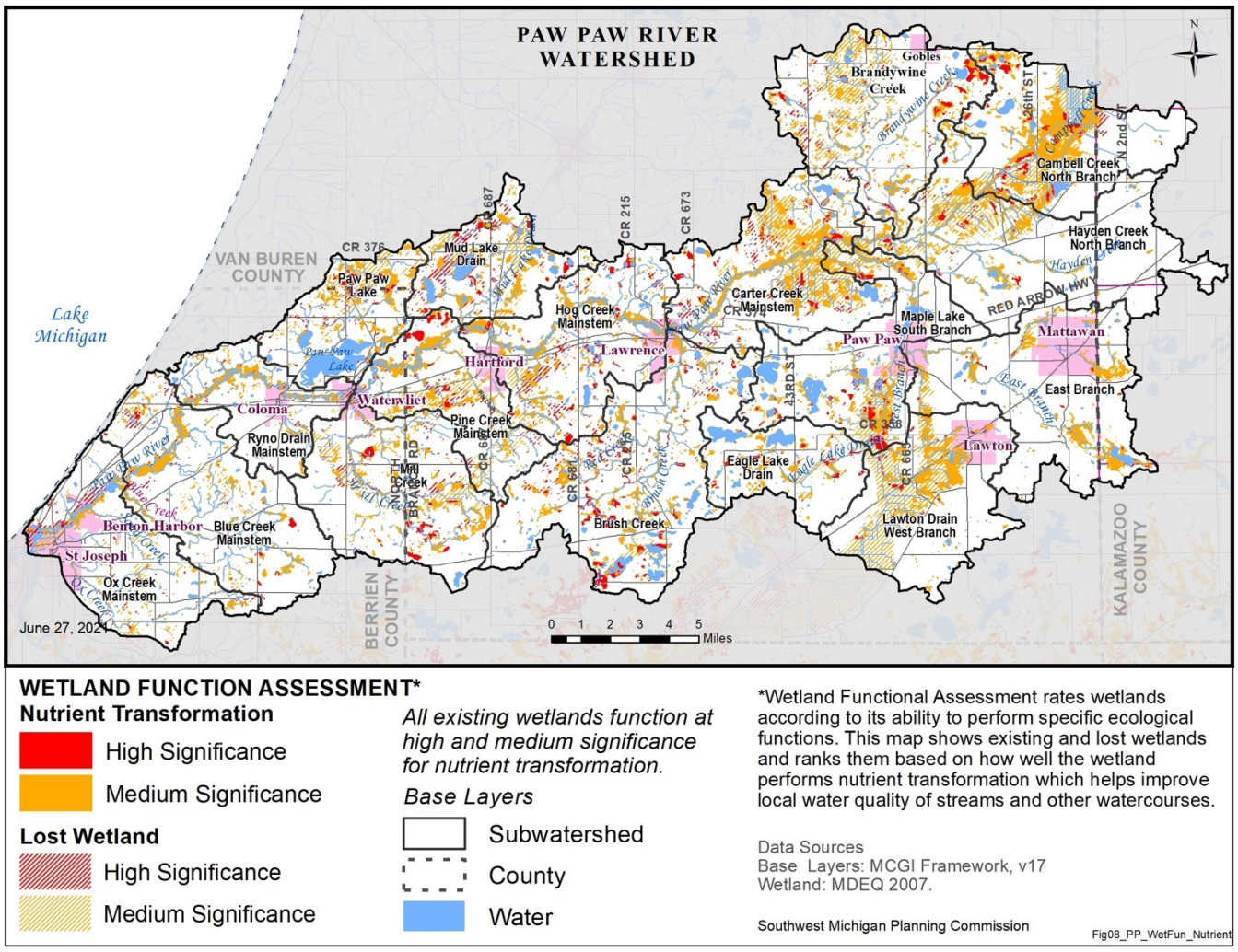
*Wetland Functional Assessment rates wetlands according to its ability to perform specific ecological functions. This map shows existing and lost wetlands and ranks them based on how well the wetland can store excess water during flood events, reducing flood damage to roads and property.

Data Sources
Base Layers: MCGI Framework, v17
Wetland: MDEQ 2007.

Southwest Michigan Planning Commission

Fig08_PP_WetFun_Flood

Figure 18. Wetland Function Assessment: Nutrient Transformation



WETLAND FUNCTION ASSESSMENT*

Nutrient Transformation

- High Significance
- Medium Significance

Lost Wetland

- High Significance
- Medium Significance

All existing wetlands function at high and medium significance for nutrient transformation.

Base Layers

- Subwatershed
- County
- Water

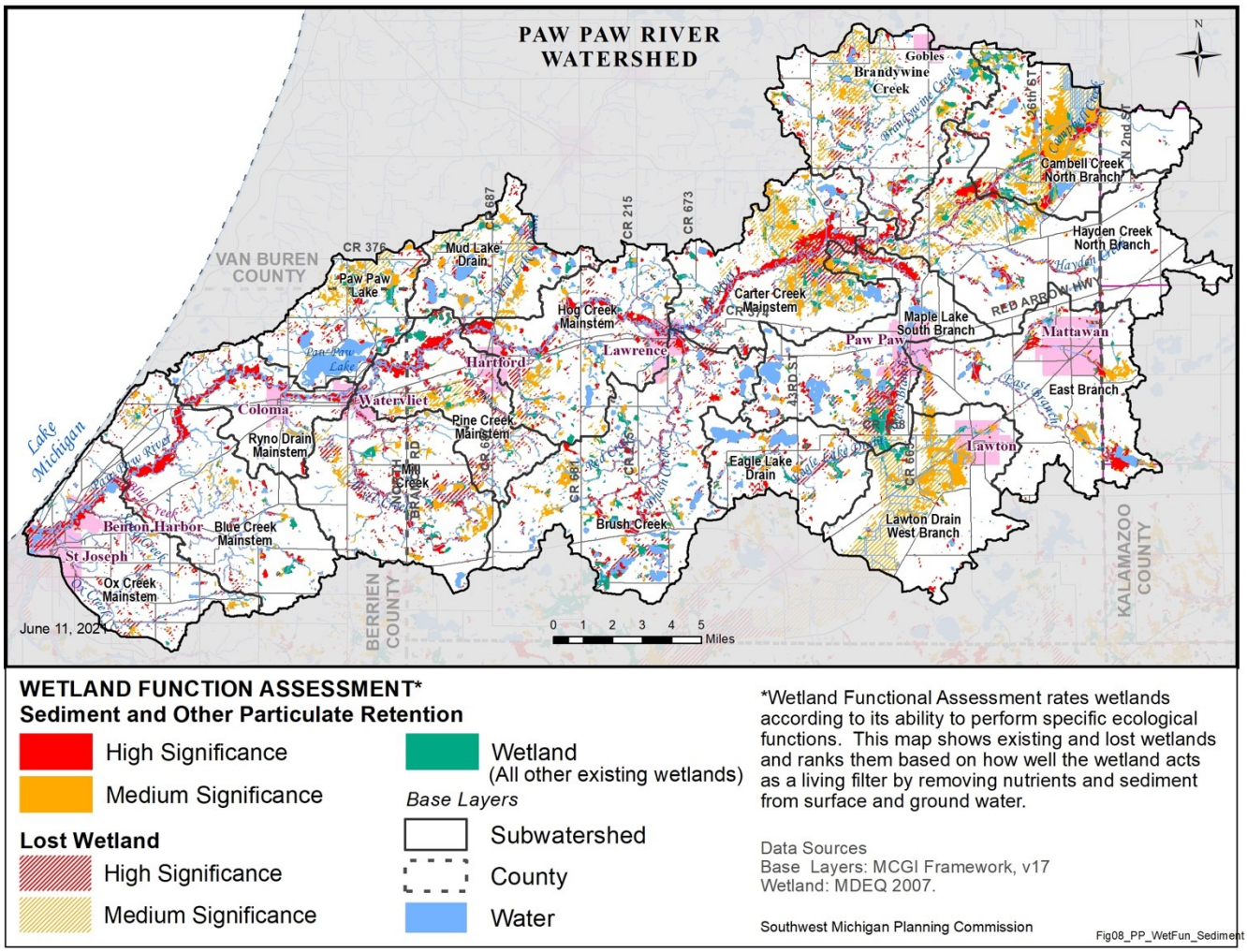
*Wetland Functional Assessment rates wetlands according to its ability to perform specific ecological functions. This map shows existing and lost wetlands and ranks them based on how well the wetland performs nutrient transformation which helps improve local water quality of streams and other watercourses.

Data Sources
Base Layers: MCGI Framework, v17
Wetland: MDEQ 2007.

Southwest Michigan Planning Commission

Fig08_PP_WetFun_Nutrient

Figure 19. Wetlands Function Assessment: Sediment/Other Particulate Retention



Floodplains

The Michigan Department of Environment, Great Lakes and Energy requires that a permit be obtained prior to any alteration or occupation of the 100-year floodplain of a river, stream or drain to ensure that development is reasonably safe from flooding and does not increase flood damage potential. Local ordinances restricting development in floodplains can be more restrictive than regulations.

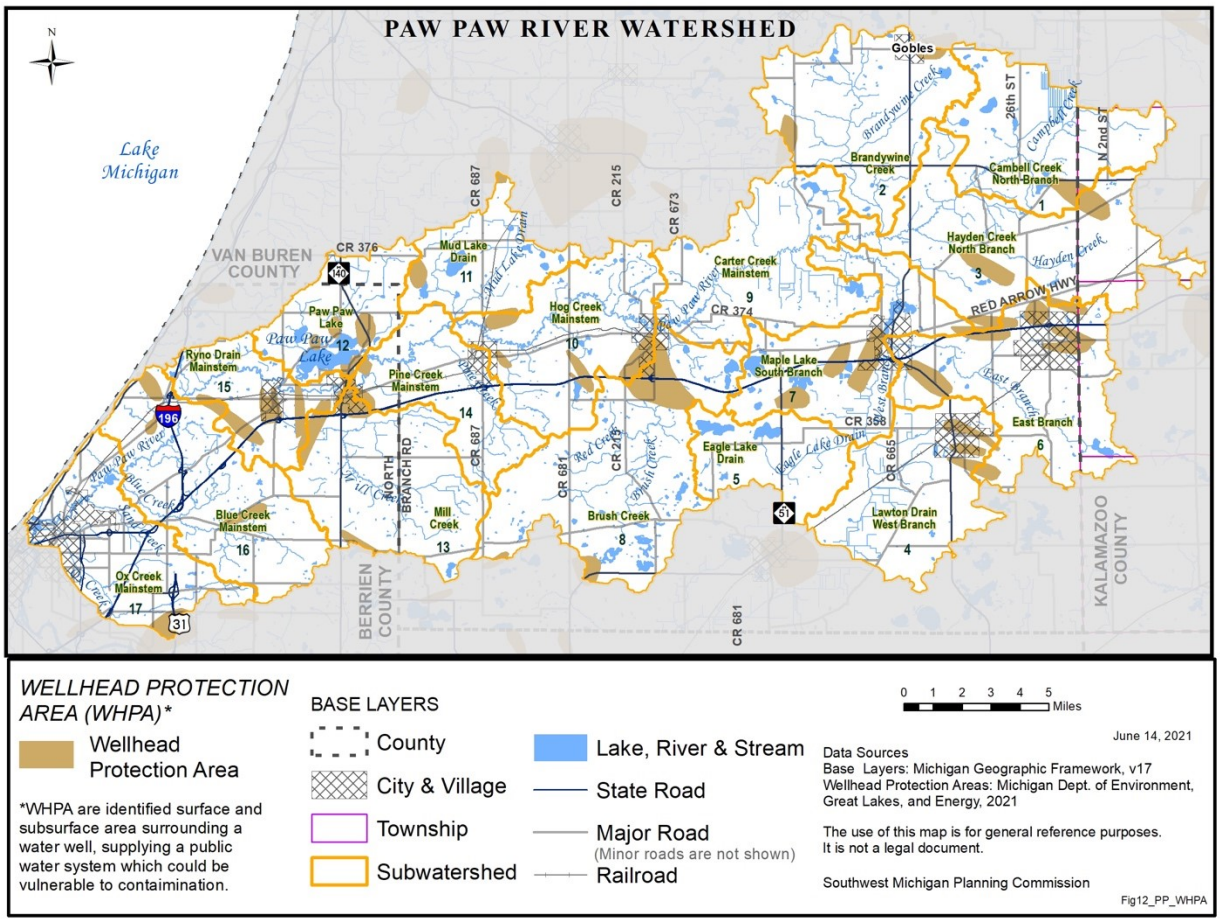
Some communities in the PPRW participate in FEMA's National Flood Insurance Program (NFIP) (see Table 7). The NFIP is a Federal program enabling property owners in participating communities to purchase insurance protection against losses from flooding. The program is designed to provide an insurance alternative to disaster assistance to meet the escalating costs of repairing damage to buildings and their contents caused by floods. The overall intent of NFIP is to reduce future flood damage through community floodplain management ordinances and provide protection for property owners against potential losses through an insurance mechanism that requires a premium to be paid for the protection.

Groundwater

Locally, the health department plays a role in groundwater protection with the regulation of the installation and design of septic systems. Local units of government have the authority to require the maintenance of septic systems through a septic system maintenance district ordinance. Another local groundwater protection option is a point of sale inspection ordinance for septic systems. With this ordinance, when property is sold there is a requirement to inspect the septic system. In Van Buren County, Columbia Township has recently adopted a point of sale septic inspection ordinance.

At the state level, the Department of Environment, Great Lakes and Energy and the Department of Agriculture monitor groundwater use. All large quantity withdrawals, defined as having the capacity to withdraw more than 100,000 gallons of water per day average over any 30-day period, equivalent to 70 gallons per minute pumping, must be registered and water use must be reported annually. The Comprehensive State Groundwater Protection Program is a statewide program that looks at groundwater uses, including drinking water, and its role in sustaining the health of surface water bodies (rivers, streams, wetlands, marshes). The Wellhead Protection Program is intended to protect the drinking water supply. The program minimizes the potential for contamination by identifying and protecting the area that contributes water to municipal water supply wells and avoids costly groundwater clean-ups. The following cities and villages in the PPRW participate in a local Wellhead Protection Program: Gobles, Hartford, Lawrence, Lawton, Mattawan and Watervliet.

Figure 20. Paw Paw River Watershed Wellhead Protection Area



4.3 Local Water Quality Protection Policies

Local governments regulate land use mostly through master plans and zoning ordinances. Table 7 presents a list of governmental units in the PPRW that possess master plans and zoning ordinances as well as participation in the Federal Emergency Management Agency (FEMA) National Floodplain Insurance Program (NFIP). Community participation in the NFIP is voluntary and based on an agreement between local governmental units and the Federal Government that states if a governmental unit will adopt and enforce a floodplain management ordinance to reduce future flood risks to new construction in Special Flood Hazard Areas, the Federal Government will make flood insurance available within the community as a financial protection against flood losses.

As part of the PRRW Planning Project, several communities agreed to have their master plans and zoning ordinances reviewed by the Southwest Michigan Planning Commission (SWMPC). The goal of these evaluations was to assist with the identification of strengths and limitations in the master plan and zoning ordinances that support the protection of water quality and natural resources. The communities volunteering to have their plans and ordinances reviewed by SWMPC included:

Almena Township, Antwerp Township, Decatur Village, Decatur Township, Hamilton Township, Hartford Township, Hartford City, Paw Paw Village, Waverly Township

In addition to the municipalities listed above, the Pokagon Band of Potawatomi Indians provided a copy of their draft master land use plan to SWMPC for evaluation of its content. The plan does an excellent job of addressing natural resources and utilizes the information to influence growth and development decisions. Subsequent to the finalization of the Land Use Plan, a Tribal Land Use and Conservation Code will be developed to support the land use plan vision and may include any other form of land use requirement, restriction, or management practice considered necessary for the protection, sound use and development of the property and resources of the Band.

The full reviews of the plans and zoning ordinances are available on the SWMPC website at www.swmpc.org/pprw_pz_review.asp. In summary, the master plans generally did not relate water quality and natural resource protection to the safety and welfare of the residents and community. Most of the master plans did not address the connection between land use and water quality. Further, the plans generally did not discuss the negative impacts of increased impervious surfaces and the need for stormwater management and low impact development techniques to protect water quality. Lastly, most plans did not include much language on natural resources (lakes, wetlands, streams, riparian buffers, woodlands, open space etc.) and their value to the community and their role in protecting water quality. The following provisions were generally missing from most zoning ordinances reviewed:

1. Waterbody Protection

- require adequate building setbacks along rivers/drains and wetlands
- require naturally vegetated buffers along streams, rivers, lakes and wetlands
- floodplain protection regulations

2. Site Plan Review Process

- show the location of natural features, such as lakes, ponds, streams, floodplains, floodways, wetlands, woodlands, steep slopes, and natural drainage patterns on site plans
- show and label all stormwater best management practices on the site plan (rain gardens, swales, etc)
- site plan review criteria - require the preservation of natural features, such as lakes, ponds, streams, floodplains, floodways, wetlands, woodlands, steep slopes, and natural drainage patterns to the fullest extent possible and minimize site disturbance as much as possible
- require drain commissioner review of stormwater management during the site plan review process
- require the use of native plants in all landscaping plans and vegetative stormwater bmps (to help reduce storm water velocities, filter runoff and provide additional opportunities for wildlife habitat)
- require the use of Low Impact Development techniques whenever feasible (see Low Impact Development for Michigan: A Design Guide for Implementers and Reviewers at www.swmpc.org/downloads/lidmanual.pdf

3. Open Space and Agricultural Land Preservation

- use bonus densities or other incentives to encourage open space developments
- require all Planned Unit Developments to provide 25-50% open space
- require open space areas to be contiguous and restrict uses of open space area to low impact uses
- in agricultural zoning districts, utilize methods, such as sliding scale, to limit fragmentation of farmland and to lessen conflicts between farming and residential uses
- require buffers between agricultural operations and residential uses
- allow for clustering/open space developments in agricultural districts to protect natural features

4. Parking Lots and Roads – Reducing Impervious Surfaces

- allow for more flexibility in parking standards and encourage shared parking
- require a portion of large, paved parking lots to be planted with trees/vegetation
- require treatment of stormwater parking lot runoff in landscaped areas
- require 30% of the parking area to have compact car spaces (9 x18 ft or less)
- allow driveways and overflow parking to be pervious or porous pavement
- use maximum spaces instead of minimums for parking space numbers
- require landscaped areas in cul-de-sacs and allow hammerheads
- allow swales instead of curb and gutter (if curbs are used require perforated or invisible curbs, which allow for water to flow into swales

5. Stormwater BMPs (refer to Low Impact Development for Michigan: A Design Guide for Implementers and Reviewers at www.swmpc.org/downloads/lidmanual.pdf or see model stormwater ordinance at www.swmpc.org/ordinances.asp)

- allow the location of bioretention areas (rain gardens, filter strips, swales) in required setback areas and common areas
- encourage the use of best management practices (BMPs) that improve a site's infiltration and have BMPs labeled and shown on site plans
- require use of native plants for landscaping plans and for runoff/stormwater controls (prohibit invasive and exotics species)
- require use of BMPs and encourage use of above ground BMPs instead of below ground stormwater conveyance systems
- prohibit direct discharge of stormwater into wetlands, streams, or other surface waters without pre-treatment
- require periodic monitoring of BMPs to ensure they are working properly and require that all stormwater BMPs be maintained

Table 7. Zoning, Master Plans and NFIP Participation by Governmental Unit

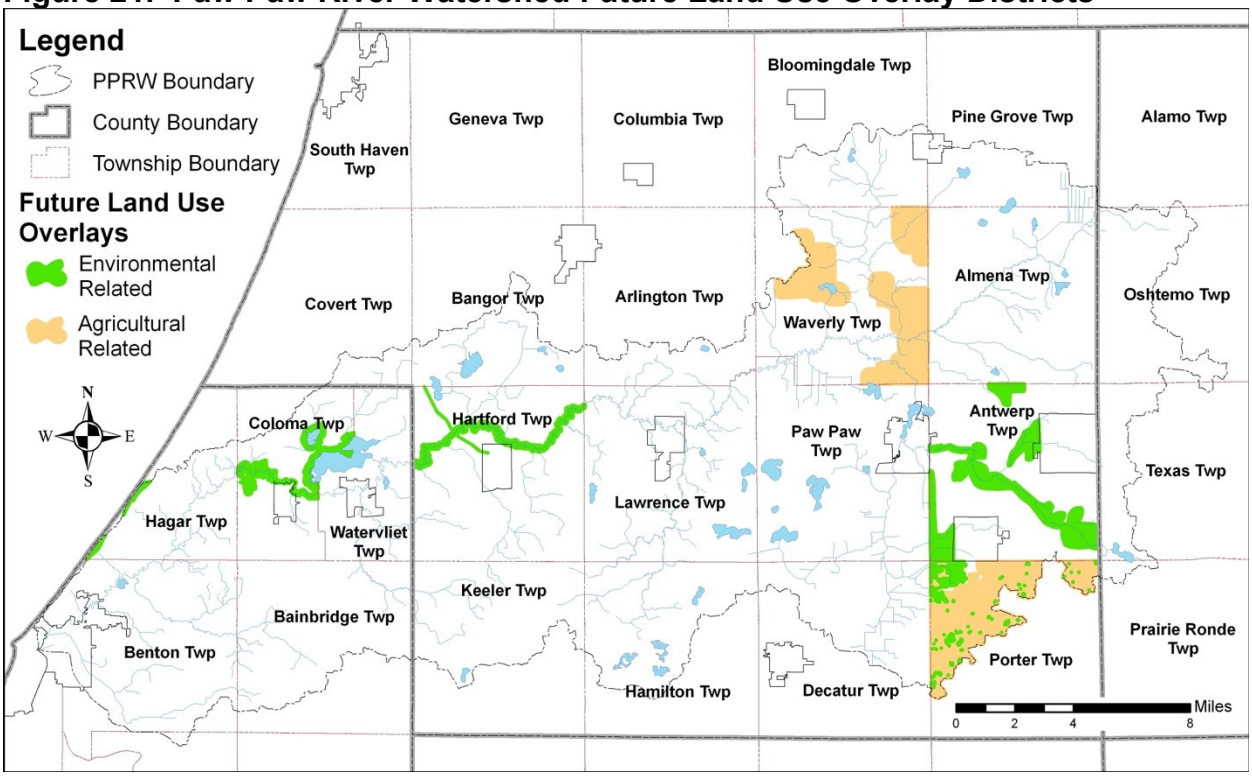
Governmental Unit	County	Zoning?	Master Plan Date*	FEMA NFIP Participation
Alamo Twp.	Kalamazoo	Yes	Unknown	No
Almena Twp.	Van Buren	Yes	2017	Yes
Antwerp Twp.	Van Buren	Yes	2009	Yes
Arlington Twp.	Van Buren	Yes	Draft in progress	Yes
Bainbridge Twp.	Berrien	Yes	2019	Yes
Bangor Twp.	Van Buren	Yes	Draft in progress	No
Benton Harbor, City of	Berrien	Yes	2011	Yes
Benton Twp.	Berrien	Yes	2019	Yes
Bloomingdale Twp.	Van Buren	No	None	No
Coloma, City of	Berrien	Yes	1991	Suspended
Coloma Twp.	Berrien	Yes	2015	Yes
Covert Twp.	Van Buren	Yes	2004	Yes
Decatur Twp.	Van Buren	Yes	2017	Yes
Gobles, City of	Van Buren	Yes	2006	No
Hagar Twp.	Berrien	Yes	2009	Yes
Hamilton Twp.	Van Buren	Yes	2017	Yes
Hartford, City of	Van Buren	Yes	2015	No
Hartford Twp.	Van Buren	Yes	2015	Yes
Keeler Twp.	Van Buren	Yes	2022	Yes
Lawrence Twp.	Van Buren	Yes	2017	Yes
Lawrence, Village of	Van Buren	Yes	2017	No
Lawton, Village of	Van Buren	Yes	2004	No
Mattawan, Village of	Van Buren	Yes	2010	Yes
Oshtemo Twp.	Kalamazoo	Yes	2017	Yes
Paw Paw Twp.	Van Buren	Yes	2003	Yes
Paw Paw, Village of	Van Buren	Yes	2017	Yes
Pine Grove Twp.	Van Buren	Yes	2006	Yes
Pokagon Band of Potawatomi	Van Buren	In Progress	2008	?
Porter Twp.	Van Buren	Yes	2014	No
Prairie Ronde Twp.	Kalamazoo	Yes	2010	Yes
Sodus Twp.	Berrien	Yes	2004	Yes
St. Joseph, City of	Berrien	Yes	2016	Yes
Texas Twp.	Kalamazoo	Yes	2020	No
Watervliet, City of	Berrien	Yes	2018	Yes
Watervliet Twp.	Berrien	Yes	2018	Yes
Waverly Twp.	Van Buren	Yes	2012	Yes

A few municipalities have implemented specific protection regulations for the Paw Paw River and its tributaries. Figure 21 illustrates local protection initiatives for agricultural lands and natural and water resources through the use of overlay districts.

- Waverly and Porter Townships have agricultural related overlays to encourage farmland preservation.
- Hagar Township has an environmental overlay district along the Lake Michigan shoreline; much of this area is critical dune.
- Antwerp, Porter, Coloma and Hartford Townships have environmental overlay districts protecting water resources.
- Hartford Township has an overlay district along the Van Buren Trail.

It is evident from Figure 21 environmental overlay districts do not protect most of the Paw Paw River and its tributaries. However, several jurisdictions have ordinances that mandate building setbacks along water bodies and wetlands, which provide protection of water quality. These setbacks also provide room for a stream to meander and change its course over time. A building setback of at least 100-150 feet is ideal (this width may need to be increased if the floodplain is wider or if it is a coldwater stream).

Figure 21. Paw Paw River Watershed Future Land Use Overlay Districts



4.4 Private Land Management

Beyond, federal, state and local laws protecting water quality, the greatest opportunity to protect and preserve water quality and natural resources rests with the landowner in how they manage their lands. Most of the land in the watershed is in private ownership. Many organizations are willing to provide technical assistance to landowners on how to better manage their lands to protect natural resources and water quality. These

organizations include MSU County Extension Offices, Conservation Districts, Natural Resources Conservation Service, Southwest Michigan Land Conservancy, The Nature Conservancy, Sarett Nature Center, Department of Natural Resources and United States Fish and Wildlife Service (Partners for Wildlife Program). See Appendix 3 for more detailed information on protection and management options available for private lands.

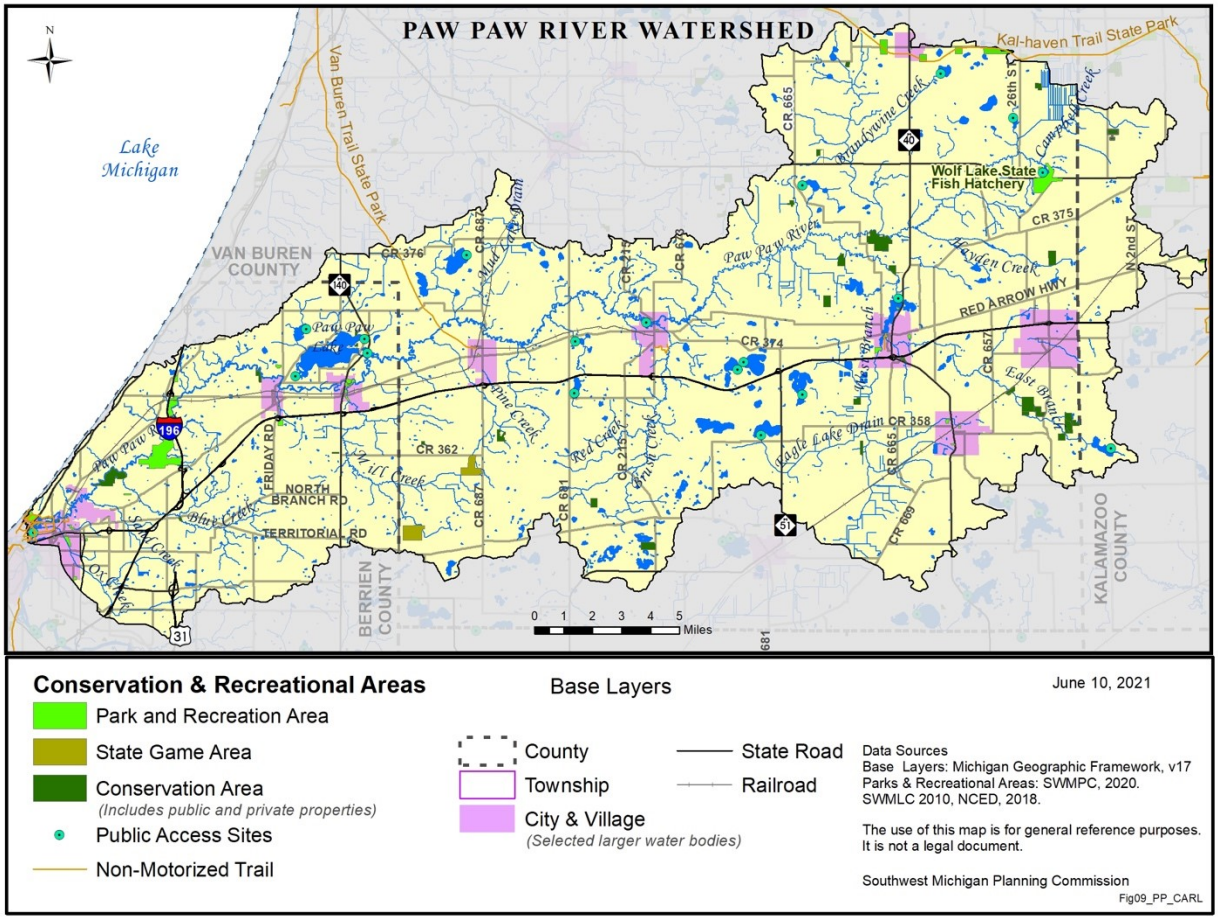
5 Natural Features

The natural features of the PPRW provide ecosystem services that benefit humans, such as recharging groundwater, cleansing air and filtering water. These natural features also provide recreational opportunities including fishing, hunting and boating. The Nature Conservancy has identified the Paw Paw River mainstem and certain tributaries as high-quality representative aquatic systems important for conserving freshwater biodiversity in the Great Lakes Basin.

5.1 Protected Lands

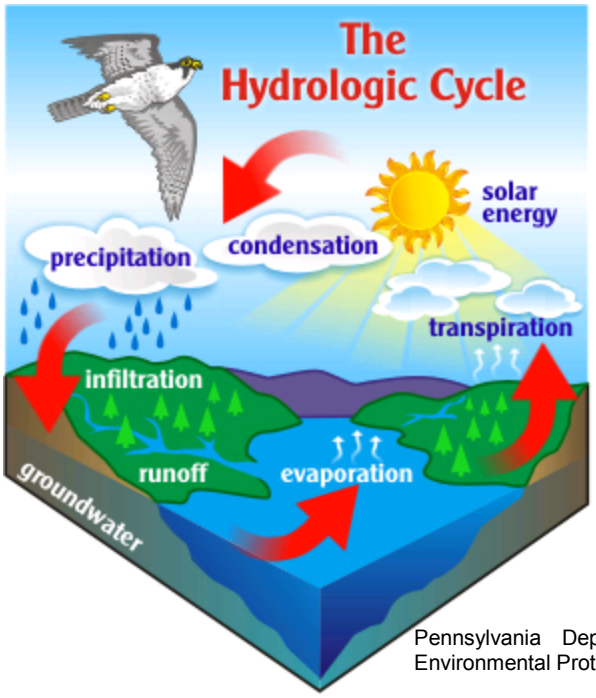
Figure 22 shows that over 2,000 acres in the watershed are under some form of protection. These lands include those owned by Sarett Nature Center, Michigan Department of Natural Resources, The Nature Conservancy (TNC), Southwest Michigan Land Conservancy (SWMLC), Michigan Nature Association and cities, villages and townships. The map also includes privately owned lands with conservation easements held by either TNC or SWMLC.

Figure 22. Paw Paw River Watershed Conservation and Recreation Lands, 2021



5.2 Generalized Hydrologic Cycle

The earth's water is one large, continuous feature that exists within a complex and dynamic cycle, and is commonly categorized as distinct features such as surface water, groundwater and wetlands. Although the cycle has no beginning or end, it is convenient to describe the generalized cycle with a starting point of surface water. Water evaporates from oceans, lakes and other surface waters to the atmosphere and is carried over land surfaces, where it condenses and is precipitated onto the land surfaces as rain, snow, etc. Some water will drain across the land as runoff into a water body. The land cover will affect how this water moves across the land. If the surface soil is permeable, some water will infiltrate to the subsurface under the influence of gravity and will saturate the soil and/or rock. This zone of saturation is recognized as groundwater. Due to gravity, groundwater generally moves from areas of higher elevations to lower elevations to locations where it discharges to wetlands and/or surface water (lakes, streams, rivers). Wetlands may be viewed as a transition of groundwater to surface water, and visa-versa.



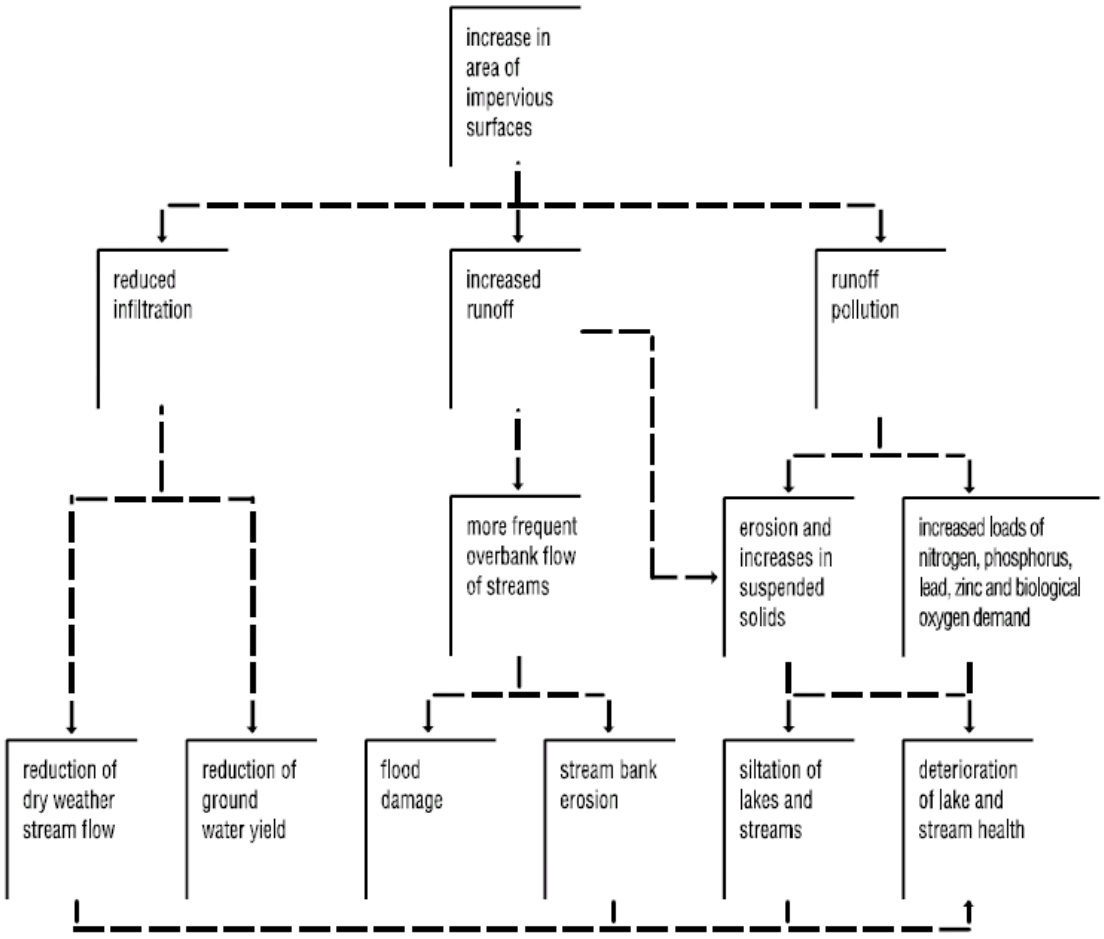
Pennsylvania Department of Environmental Protection

A properly functioning hydrologic cycle is greatly dependant upon the land cover and natural features in the watershed. Natural vegetation, such as forested land cover, usually has high infiltration capacity and low runoff rates. Whereas urbanized land cover has impervious areas (buildings, parking lots and roads) and networks of ditches, pipes and storm sewers, which augment natural stream channels. Impervious surfaces in urban areas reduce infiltration and the recharge of groundwater while increasing the amount of runoff. This runoff carries pollutants contributing to poor water quality. Agricultural lands, including row crops, orchards, vineyards, rangelands and animal farms can also have a significant impact on runoff and groundwater resources. Agricultural lands are often heavily compacted by farm equipment, which lessens their ability to infiltrate water. In addition, many agricultural lands are extensively ditched to move water off of the land as quickly as possible. Further, irrigation can alter the groundwater resources. These activities disrupt the natural hydrologic cycle and negatively impact the functioning of the remaining natural features in the watershed.

Figure 23 illustrates the many impacts of the loss of natural lands and an increase in impervious surfaces on water quality and quantity. The impacts resulting from land use change also negatively impact the fragmented natural areas left in the watershed. Following is a discussion of the different natural communities found in the PPRW and the major threats to their existence and quality. The interdependent natural systems

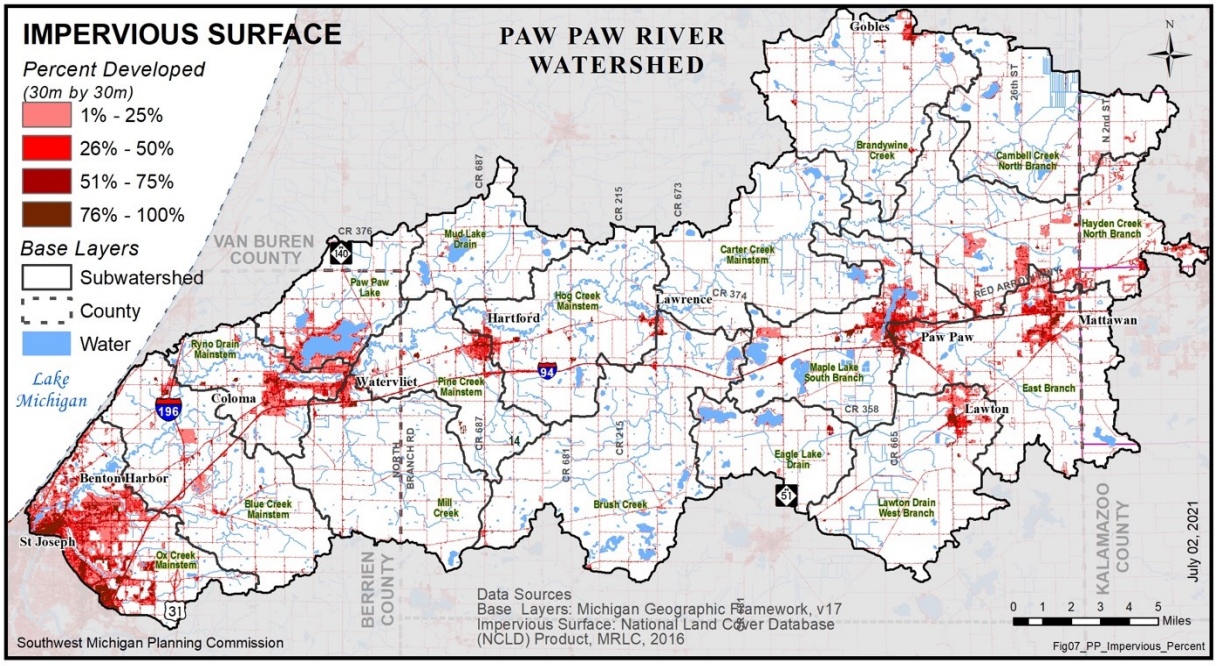
and communities discussed in this chapter include rivers, lakes, wetlands, groundwater, floodplain forests, upland forests, oak savanna and prairie remnants and rare species.

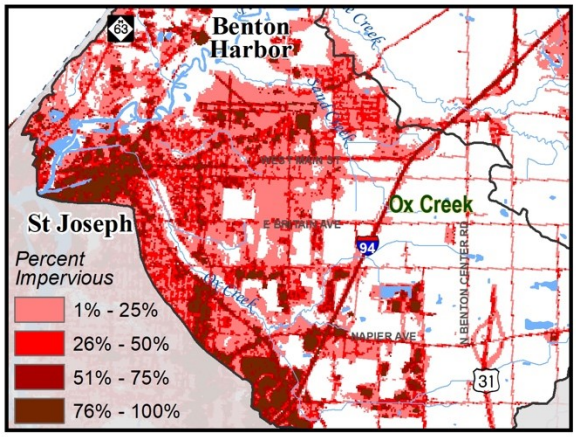
Figure 23. Impacts of Impervious Surfaces

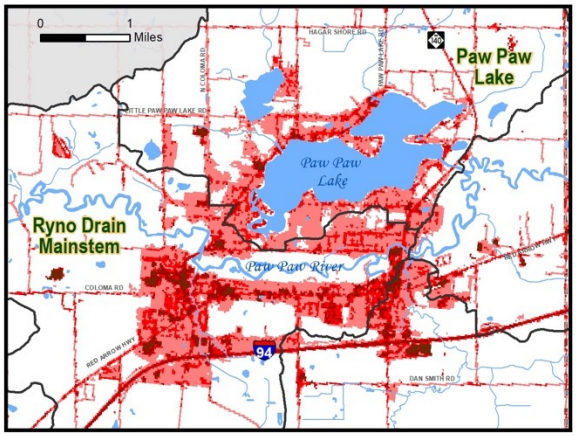


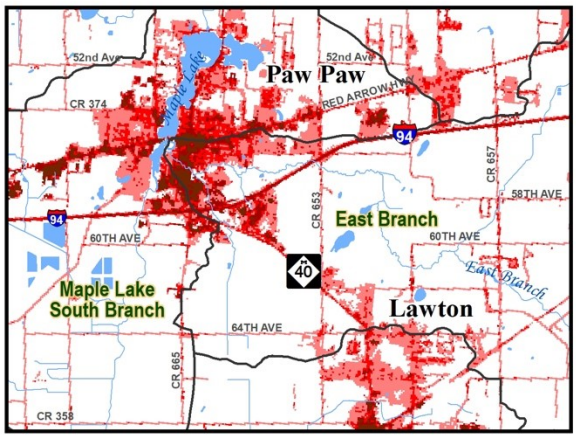
As can be seen from the following maps, the most impervious areas are around Benton Harbor, Coloma/Watervliet (Paw Paw Lake), Hartford, Paw Paw and Mattawan.

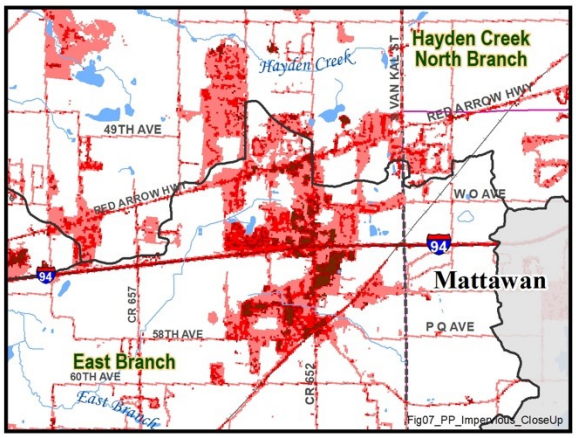
Figure 24. Paw Paw River Watershed Impervious Surface











5.3 Rivers/Streams

The Paw Paw River is a coolwater system containing warmwater and coldwater tributaries. Approximately 159,728 acres (56%) of the PPRW drain into designated coldwater streams. The remaining 125,829 acres (44%) drain to warmwater or coolwater water bodies. Figures 14 and 15 show the streams and rivers in the PPRW. These figures also show the watershed area contributing to coldwater streams. Coldwater streams are a unique natural feature providing important spawning habitat and thermal refuge for coldwater aquatic species such as trout.

Coldwater streams contribute to the hydrologic stability of the PPRW because they have large groundwater inputs. Coldwater streams with a July monthly average of 70 degrees Fahrenheit or lower comprise 69% (100 miles) of the river distance within the watershed. Designated trout streams (MDNR Fisheries Division regulations) found in the watershed are characterized by having fish communities dominated by mottled sculpin, brown trout, and coldwater minnows. Sand Creek, Blue Creek, Mill Creek, Pine Creek, Brush Creek, North Branch Paw Paw River and tributaries above M-40, West Branch and East Branch above M-40 are designated coldwater trout streams within the watershed.

Warmwater streams typically have higher surface water inputs than groundwater inputs and as a result these streams have higher flow variability. Species richness is typically higher in southern Michigan streams, like the Paw Paw River, as a result of the overlap of regions supporting coldwater and warmwater species. The major tributaries in the PPRW that are considered warmwater are Ox Creek, Mud Lake Drain, Hog Creek, Branch Derby Drain and the Brandywine Creek. Table 8 lists primary streams and drains by subwatershed.

Figure 25. Water Bodies in the Paw Paw River Watershed (West)

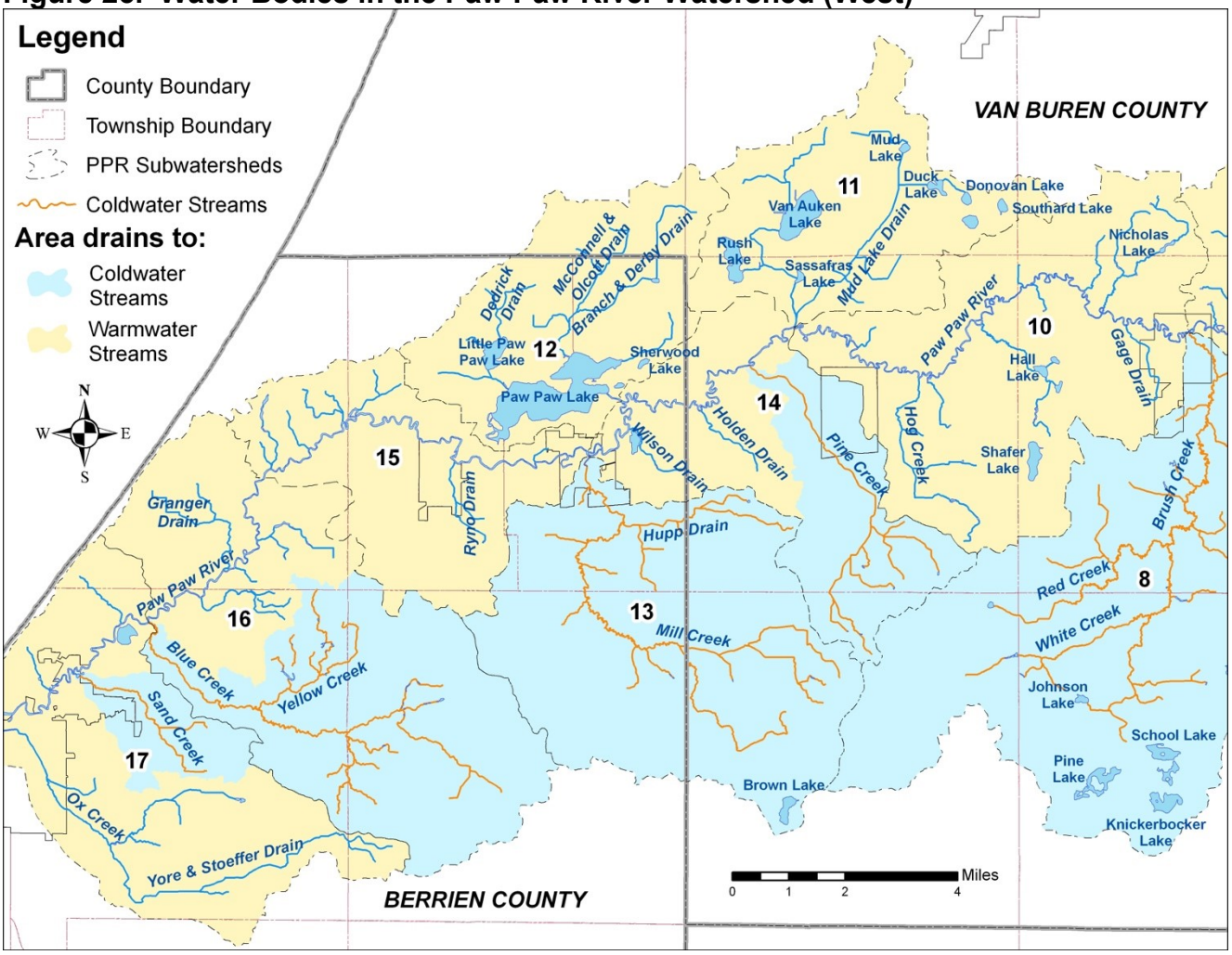
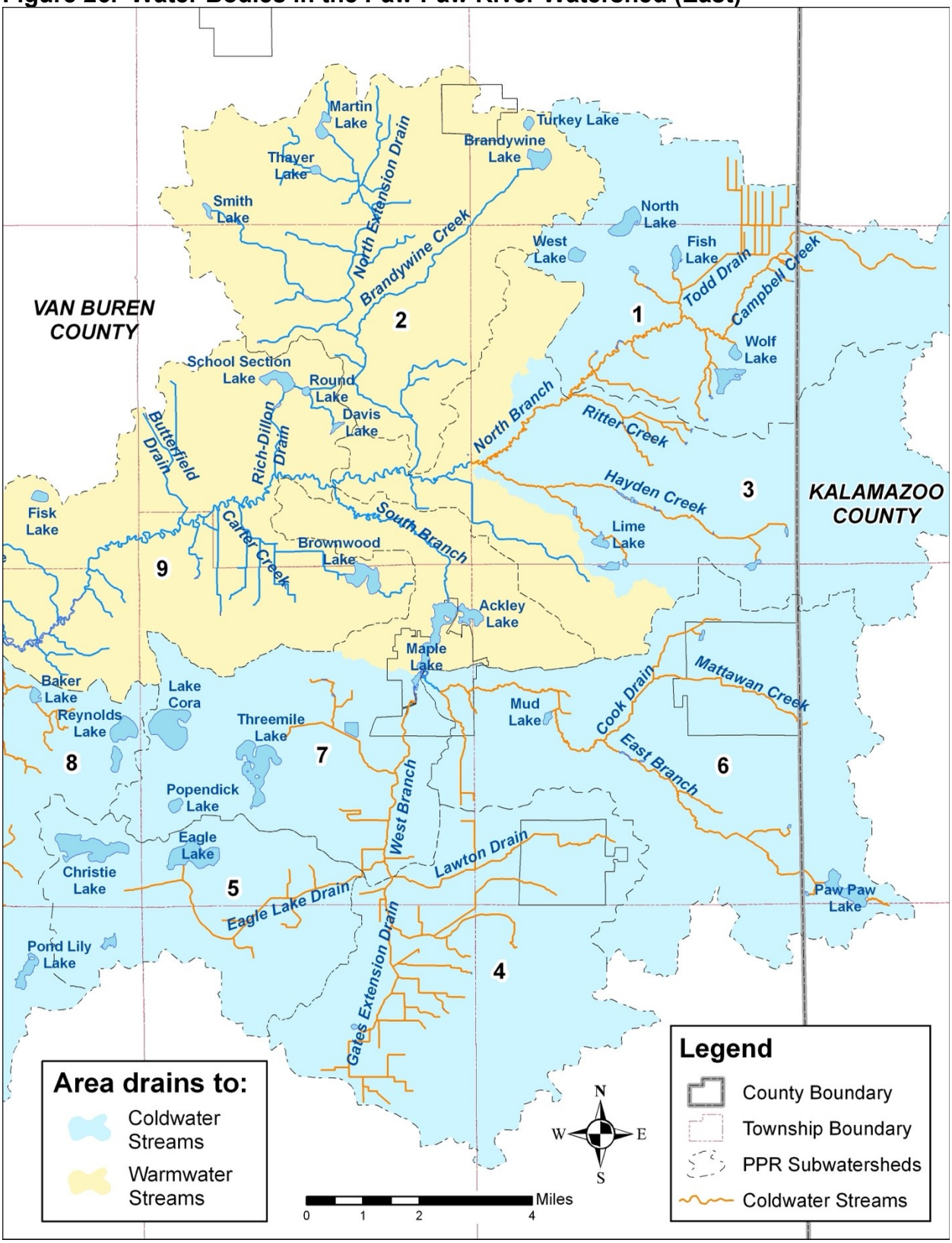


Figure 26. Water Bodies in the Paw Paw River Watershed (East)



The Paw Paw River and its tributaries can be characterized in terms of ecologically similar subwatersheds. Similarities within each subwatershed include soil types, surface geology and landscape patterns that relate to groundwater inflow and fish species composition. An MDNR report classifying the Paw Paw River subwatersheds on the basis of ecologically similar conditions is available online at www.swmpc.org/downloads/pprw_dnr_report.pdf.

Table 8. Streams in the Paw Paw River Watershed

Subwatershed ID #	Primary Streams & Drains
1	North Branch*, Campbell Creek*, Todd Drain
2	Brandywine Creek*, North Extension Drain, Martin Lake Drain
3	North Branch*, Hayden Creek*, Ritter Creek
4	West Branch*, Lawton Drain, Gates Extension Drain
5	Eagle Lake Drain*
6	East Branch*, Cook Drain, Mattawan Creek
7	West Branch*, South Branch*, Three Mile Lake Drain
8	Brush Creek*, Red Creek*, White Creek
9	Paw Paw Mainstem*, Carter Creek*, Butterfield Drain, Rich-Dillon Drain
10	Paw Paw Mainstem*, Hog Creek*, Gage Drain
11	Mud Lake Drain*, Van Auken Lake Drain, Rush Lake Outlet
12	Branch & Derby Drain*, McConnell & Olcott Drain, Dedrick Drain
13	Mill Creek*, Hupp Intercounty Drain
14	Paw Paw Mainstem*, Pine Creek*, Wilson Intercounty Drain, Holden Drain
15	Paw Paw Mainstem*, Ryno Drain
16	Paw Paw Mainstem*, Blue Creek*, Yellow Creek, Granger Drain
17	Paw Paw Mainstem*, Ox Creek*, Sand Creek*, Yore & Stoeffer Drain

*Additional information can be found in Appendix 4.

Threats

As discussed at the beginning of this chapter, water pollution and hydrologic alterations from changes in land use are a major threat to rivers and streams. This management plan is intended to address the major threats to surface water. Detailed information on water pollutants, their sources and causes can be found in Appendices 4 and 9.

Water pollution comes from all land uses in the watershed including residential, commercial, industrial and agricultural.

Invasive species are species that are not native to the habitat that they inhabit, and cause damage to the local environment, economy, or human health. They can destroy habitat for native plants and animals, greatly inhibiting biodiversity, impacting water quality, and increasing erosion. Additionally, economic impacts range from loss of ecosystem services, impacts to infrastructure, lowered recreation access, and decreased property values. Invasive species in the wetlands and waterways of the Black River Watershed include Purple Loosestrife (*Lythrum salicaria*), Eurasian Milfoil (*Myriophyllum spicatum*), invasive *Phragmties* (*Phragmites*

australis var. australis), and Zebra mussels (*Dreissena polymorpha*). Several other invasive species inhabit upland habitats in the watershed, including Garlic Mustard (*Alliaria petiolata*), kudzu (*Pueraria montana*), and *Japanese knotweed (Fallopia japonica).*

Aquatic invasive species are of high concern throughout Michigan, especially in watersheds with high recreation use. Most aquatic plants, such as hydrilla and Eurasian milfoil, can reproduce via fracturing, making both motorized and paddle boats major vectors. Additionally, recreation can increase the introduction of fish diseases or invasive species used as bait, such as red swamp crayfish or, more commonly, earthworms. Lastly, illuvial flow can lead to the spread of some invasive species designed to take advantage of these pathways, including knotweeds, which can lead to bank collapse and then utilize river flow to move reproductive pieces of the plant downstream, establishing new populations.

Interestingly, Invasive species pose a unique threat to Southwest Michigan and the Black River, in that their introduction and establishment is likely to be exacerbated by climate change. Climate change will have a significant impact on many aspects of our waters, but with increased disturbance, invasives will flourish in areas denuded of native species. Additionally, species that have traditionally been unable to establish in Michigan, such as mile-a-minute vine (*Pericaria perfoliata*), will be able to create new populations. A prime current example of this is Hemlock woolly adelgid (*Adelges tsugae*), which was found in its first established population in Michigan in 2016. Hemlock woolly adelgid, or HWA, has been found in the Eastern USA for over 50 years, killing millions of trees, but had failed to establish in the Upper Midwest due to low winter temperatures. However, with warming winters, HWA has now been established in at least 5 Michigan counties, including Allegan. HWA threatens the over 170 million hemlock trees in Michigan, which are key to maintaining our rivers and streams, particularly in cooling sport fisheries. In all likelihood, this kind of establishment will only increase as Michigan's climate continues to change. As such adaptive, forward looking planning is key.

In managing invasive species, prevention is always considered a better, more effective, cheaper option than management and removal. The window during which established species can be eradicated is very short, before it becomes too large of an infection to effectively remediate. Therefore, prioritization should be given to prevention, survey, and early detection and rapid response efforts. However, some species, such as invasive *Phragmites*, are well established on a landscape scale, but many wetlands would benefit from active management and removal of this species. Therefore, population specific planning and treatment, both to restore high quality areas and minimize seed source, will be vital in management.

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5.4 Lakes

The PPRW includes approximately 5,818 acres of lakes and ponds. There are 78 lakes greater than 10 acres in size that comprise 4,659 acres within the watershed. Paw Paw Lake in Berrien County is the largest lake in the watershed covering 920 acres. The only lakes in the PPRW with municipal sewer service are Paw Paw (Berrien County), Little Paw Paw, Brownwood, Maple and Ackley Lakes. Table 9 contains information on lakes greater than 5 acres in the PPRW. The maps of PPRW water bodies (Figure 25 and Figure 26) display the name of all lakes greater than 10 acres.

Bluegill-largemouth bass communities dominate fish assemblages in lake environments in southern Michigan watersheds including the PPRW. Largemouth bass are found in most lakes in the watershed and are the primary predator on bluegill, which is the most abundant fish in these lakes. Fish communities in the watershed are comprised of a diverse number of other fish, averaging 20 species in each lake. In the PPRW, there are two rare fish species, lake herring (listed as state threatened) and spotted gar (a species of special concern) commonly found in lake environments. Two-story fisheries that support both coldwater fish (trout and lake herring) and coolwater fish (black bass and northern pike) are rare resources in southwest Michigan. They occur in Little Paw Paw Lake (Kalamazoo County) and Shafer Lake (Van Buren County). (Kregg Smith, MDNR, 2007)

A "two-story" fishery is a lake capable of providing two different types of fisheries. In the PPRW, the two-story fishery lakes contain coolwater and coldwater fish populations.

Table 9. Lakes in the Paw Paw River Watershed

Name	Sub watershed ID	County	Area (Acres)	Elevation	**Surface Water Connection	Maximum Depth (Approx.)	Public Access	Sewer System?
Ackley Lake	7	Van Buren	63	715	Outflow	15	Yes	Yes
Baker Lake	8	Van Buren	25	678	Throughflow	50		
Brandywine Lake*	2	Van Buren	73	771	Throughflow	25	Yes	
Brown Lake	13	Van Buren	50	768	Isolated	60		
Brownwood Lake	9	Van Buren	124	696	Throughflow	44	Yes	Yes
Carroll Lake	10	Van Buren	9	710	Outflow			
Christie Lake	5	Van Buren	238	756	Bidirectional		Yes	
Cornwall Lake	10	Van Buren	10		Outflow			
Davis Lake	9	Van Buren	12		Outflow	20		
Donovan Lake	11	Van Buren	18	669	Outflow	80		
Duck Lake	11	Van Buren	31		Bidirectional	40	Yes	
Dustin Lake	3	Kalamazoo	10	845	Isolated			
Eagle Lake*	5	Van Buren	196	755	Outflow		Yes	
East Lake	1	Van Buren	8		Outflow	22		
Fish Lake*	1	Van Buren	34	718	Throughflow		Yes	
Fisk Lake	9	Van Buren	30		Bidirectional			
Hall Lake*	10	Van Buren	21	695	Throughflow		Yes	
Hawk Lake	1	Van Buren	11		Outflow			
Hemlock Lake	1	Van Buren	12	774	Throughflow			

Name	Sub watershed ID	County	Area (Acres)	Elevation	**Surface Water Connection	Maximum Depth (Approx.)	Public Access	Sewer System?
Hillocher Lake	10	Van Buren	7		Outflow			
Johnson Lake	8	Van Buren	16		Outflow	20		
Kibler Lake	16	Berrien	11		Isolated			
Knickerbocker Lake	8	Van Buren	82	770	Bidirectional			
Lake Cora*	7	Van Buren	234	751	Bidirectional	60	Yes	
Lime Lake	3	Van Buren	28		Throughflow	40		
Little Paw Paw Lake	12	Berrien	101	624	Throughflow	29		Yes
Lower Reynolds Lake	8	Van Buren	40	756	Bidirectional			
Lyle Lake	2	Van Buren	6		Isolated			
Maple Lake*	7	Van Buren	166		Throughflow	15		Yes
Martin Lake*	2	Van Buren	44	747	Throughflow	35	Yes	
Mud Lake	11	Van Buren	15	656	Bidirectional	20		
Mud Lake	6	Van Buren	15		Outflow	50	Yes	
Mud Lake	4	Van Buren	5		Outflow			
Nelson Lake	9	Van Buren	7		Throughflow			
Nicholas Lake	10	Van Buren	11		Throughflow			
Paw Paw Lake*	12	Berrien	920	621	Throughflow	90	Yes	Yes
Paw Paw Lake*	6	Kalamazoo	123	871	Throughflow	56	Yes	
Pine Lake	8	Van Buren	96		Bidirectional			
Pond Lily Lake	8	Van Buren	66		Bidirectional			
Popendick Lake	7	Van Buren	29	757	Bidirectional	35	Yes	
Red Lake	8	Van Buren	6		Outflow			
Round Lake	9	Van Buren	12	685	Throughflow	40	Yes	
Rush Lake*	11	Van Buren	121	645	Bidirectional	56	Yes	
Sand Lake	6	Van Buren	19	754	Bidirectional	25	Yes	
Sassafras Lake	11	Van Buren	14		Throughflow			
School Lake	8	Van Buren	63		Bidirectional			
School Section Lake*	9	Van Buren	79	685	Throughflow	45	Yes	
Shafer Lake*	10	Van Buren	72	739	Throughflow	67	Yes	
Shaw Lake	9	Van Buren	10	683	Bidirectional	45		
Sherwood Lake	12	Berrien	12		Bidirectional			
Simmons Lake	2	Van Buren	13		Outflow	40		
Smith Lake	2	Van Buren	15		Throughflow	12		
Southard Lake	11	Van Buren	20	690	Bidirectional	40		
Tamarack Lake	1	Van Buren	12		Throughflow	30		
Thayer Lake	2	Van Buren	15	742	Throughflow	50		
Threemile Lake*	7	Van Buren	258	754	Bidirectional	40	Yes	
Turkey Lake	2	Van Buren	20	771	Bidirectional			
Upper Reynolds Lake*	8	Van Buren	96	756	Bidirectional	40	Yes	

Name	Sub watershed ID	County	Area (Acres)	Elevation	**Surface Water Connection	Maximum Depth (Approx.)	Public Access	Sewer System?
Van Auken Lake*	11	Van Buren	252	650	Bidirectional	60	Yes	
West Lake	1	Van Buren	37	748	Bidirectional	45		
Wolf Lake	1	Van Buren	25	718	Outflow	40	Yes	

*Additional water quality information in Appendix 4.

**Surface water connections were identified as part of the MDEQ Wetland Functional Assessment; groundwater linkages and hydrological relationships to wetlands and other water bodies are more complex than what could be determined by the simple visual assessment of surface water conditions performed by EGLE. Isolated – receives precipitation and runoff from adjacent areas with no apparent outflow. Outflow – water flows out of the water body, but does not flow in from another water body. Throughflow – water flows through water body, often coming from a stream or uphill sources. Bidirectional – inflow and outflow patterns are subject to the rise and fall of lake or reservoir levels

Threats

Threats to lake environments within the watershed are primarily related to shoreline development and land uses. Residential development around lakes with no connection to municipal wastewater treatment facilities can increase nutrient levels and bacteria counts in the lake. The only lakes within the PPRW that have municipal sewer systems are Paw Paw (Berrien County), Little Paw Paw, Brownwood, Maple and Ackley Lakes. With residential development, coarse woody material abundance and shoreline habitat diversity strongly declines while nutrient loading increases. Aquatic plant assemblages are also influenced by residential development, and interestingly, reproductive success of black bass nests declines almost two fold with increasing residential development. (Kregg Smith, MDNR Fisheries Division, 2007)

Human activities negatively affect inland lake ecosystems through alterations in water quality and physical habitat. For example, increased nutrient loadings from lawn fertilizers can increase algae and aquatic vegetation to nuisance levels and decrease concentrations of dissolved oxygen when excess algae and vegetation decompose. In addition, the quantity and quality of physical habitat available to fishes in the area between high and low water marks is altered by removal of coarse woody debris, by an increase or decrease (via chemical or mechanical removal) of aquatic plants, and by homogenization of the shoreline through erosion control efforts (e.g., rip-rap and sheet piling). Such changes in water quality and habitat features have been shown to negatively impact fish growth, limit natural reproduction of certain fish species, and reduce fish species richness while shifting assemblage structure towards more tolerant species. (Kregg Smith, MDNR Fisheries Division, 2007)

5.5 Wetlands

Wetlands provide critical ecosystem services such as cleansing water, storing water and providing wildlife habitat. The wetland resource base in the PPRW has undergone significant disruption in the 200 years since Michigan was settled, losing approximately 50% of its total wetland area, and in some cases up to 62% of its wetland functionality. There is evidence to suggest that the result of these losses is reduced surface water quality and total loss of some fisheries. The watershed itself has been extensively ditched since pre-settlement, and this has resulted in the destruction, degradation, and vegetative conversion of many of the wetlands and waterways that originally existed. Forested wetlands have been the most affected, with silviculture and drainage for agriculture responsible for most of the impact. Because of ineffective drainage and/or forestry practices, there has been a sharp increase in the amount of emergent and scrub-shrub wetland acreage over time. According to the MDEQ Landscape Level Wetland Functional Assessment report for the PPRW, several wetland functions were reduced in capacity by 50% or more in the watershed as a whole; retention of sediment and other particulates lost 51% capacity, fish and shellfish habitat was reduced by 61%, and conservation of biodiversity by 62%. Other functions fell just below that mark, with streamflow maintenance, nutrient transformation, and other wildlife habitat all estimated to have lost 44-45% of their original capacity. No wetland functions have increased in the last 200 years.

A few large intact wetland complexes can be found in the watershed. One is located in the headwaters of the North Branch known as the Almena Swamp. Another is in Waverly Township north of the Paw Paw River. These wetlands perform functions that protect water quality and provide habitat for many species.

Still a few large intact wetland complexes can be found in the watershed. One is located in the headwaters of the North Branch known as the Almena Swamp. Another is in Waverly Township north of the Paw Paw River. (See Figure 16.) These wetlands perform functions that protect water quality and provide habitat for many species.

Wetlands of special interest in the PPRW include Great Lakes marsh and prairie fens. Great Lakes marsh is an herbaceous wetland community restricted to the shoreline of the Great Lakes and their major connecting rivers. Great Lakes Marsh exist from the City of Benton Harbor upstream to the Brown Sanctuary of Sarett Nature Center. Species of interest in these wetlands include the Swamp Rose Mallow (Hisbiscus moscheutos) and the Blanding's turtle (Emydoidea blandingii). For more information on Great Lakes Marsh visit www.swmpc.org/downloads/great_lakes_marsh.pdf.

Prairie fens are geologically and biologically unique wetlands found only in the glaciated Midwest. In Michigan, they occur in the southern three to four tiers of counties. The groundwater springs, which characterize prairie fens, are very rich in calcium and magnesium. Typical plants found in prairie fens are switchgrass, Indiangrass, big bluestem, sedges, rushes, Indian-plantain, and prairie dropseed. The wettest part of a prairie fen, which is usually found near the water source, is called a "sedge flat" because members of the sedge family dominate the vegetation. The "fen meadow" is the largest part and is more diverse with many lowland prairie grasses and wildflowers.

Slightly elevated areas, especially around the upland edge, also support tamarack, dogwood, bog birch and poison sumac. In the PPRW, prairie fens are found in the Blue Creek watershed, at Sarett Nature Center, near Lime Lake, in the Paw Paw Prairie Fen Preserve and around Paw Paw Lake in Kalamazoo County.

Threats

Historically the PPRW contained 65,254 acres of vegetated wetland or 23% of the total watershed area. By 1998, the total wetland area had been reduced to 57% of its original extent. Conversion to farmland was the main reason for wetland loss. Conversion of forested wetland to emergent/scrub-shrub wetland due to logging practices and drainage also played a role in the cumulative impact of wetland functional loss. (Fizzell, 2007)

Current threats to wetlands include filling or draining to accommodate industrial, residential, agricultural or recreational land uses. Altered hydrology is a significant threat to most wetland types, whether it is due to a change in groundwater contributions to a fen or diversion of the water that feeds a swamp or marsh due to new road construction. Exotic species invasion, altered fire regime and polluted runoff with sediment, nutrients and chemicals also threaten wetlands. The loss of functions that are lost when wetlands are lost are a significant concern. See earlier maps on wetland loss and functions.

5.6 Floodplains

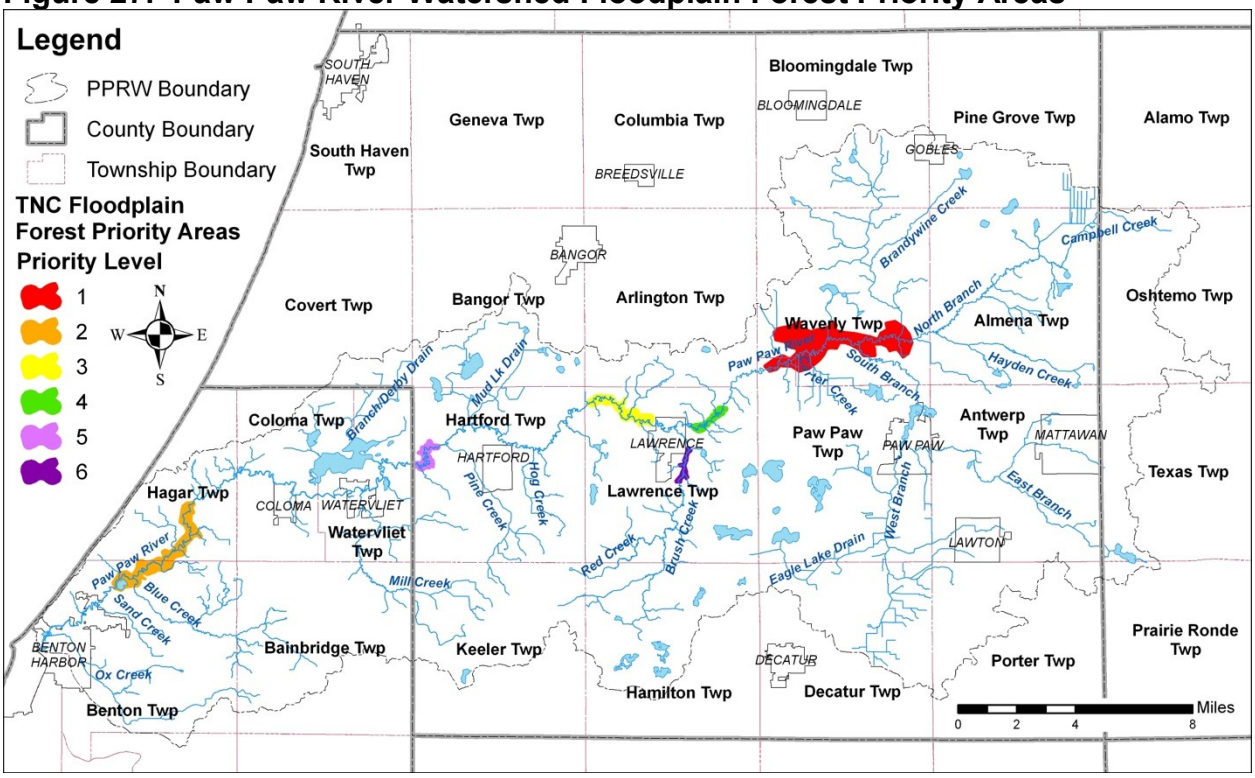
A river, stream, lake, or drain may on occasion overflow their banks and inundate adjacent land areas. The land that is inundated by water is defined as a floodplain. In Michigan, and nationally, the term floodplain has come to mean the land area that will be inundated by the overflow of water resulting from a 100-year flood (a flood which has a 1% chance of occurring any given year). Often, floodplains are forested with silver maple (Acer saccharinum) and red ash (Fraxinus pennsylvanica) being the major over-story dominant trees. These dynamic forested systems represent an interface between terrestrial and aquatic ecosystems and are extremely valuable for storing floodwaters, allowing areas for sediment to settle and providing wildlife habitat.

The forested floodplain along the Paw Paw River from Sarett Nature Center to the Paw Paw River Preserve in Waverly Township is largely intact.

The forested floodplain along the Paw Paw River from Sarett Nature Center to the Paw Paw River Preserve in Waverly Township is largely intact. This intact forest is important for migratory birds. Bird species of interest along the mainstem include the Prothonotary warbler (Protonotaria citrea), Wood thrush (Hylochichla mustelina) and the Cerulean warbler (Dendroica cerulea). For general information on floodplain forests visit www.swmpc.org/downloads/floodplain_forest.pdf.

For more specific information, a report on the prioritization of forested floodplain areas in the PPRW completed by The Nature Conservancy in 2006 is available online at www.swmpc.org/downloads/pprw_tnc_floodplain.pdf. Figure 17 is from the TNC report.

Figure 27. Paw Paw River Watershed Floodplain Forest Priority Areas



Threats

Current threats to floodplains include conversion to industrial, residential, or recreational uses, wetland or floodplain fill or drainage, exotic species invasion, chemical pollution, sedimentation, and nutrient loading from agriculture and other land uses. Almost all rivers and their floodplains are subject to multiple hydrologic alterations, such as changes in land use, human-made levees, impoundments, channelization, and dams. The Nature Conservancy stated in the 2006 prioritization floodplain forest report, “even at the best floodplain forest sites, there is a serious threat from invasive species, because the forests here have extensive boundaries along agricultural lands offering numerous routes for invasion. Additional buffering of these core floodplain forest areas with more native upland forest would benefit them.”

5.7 Groundwater

Groundwater is the water that saturates the tiny spaces between soil and rock. Most groundwater is found in aquifers, which are underground layers of porous rock that are saturated from above or from structures sloping toward it. For water to reach the aquifer, it must be able to infiltrate through the soil.

Groundwater and surface water are fundamentally interconnected. In fact, it is often difficult to separate the two because they "feed" each other. Aquifers feed streams and provide a stream's baseflow. Those streams with a high baseflow are often coldwater streams. Often groundwater can be responsible for maintaining the hydrologic balance of streams, springs, lakes and wetlands.

Most of the PPRW is underlain with Coldwater Shale bedrock, which contains no aquifers. The only groundwater source is the water located in the coarse textured drift material left by the glaciers. These glacial sources typically yield high amounts of groundwater (20-1,400 gallons per minute) and are very vulnerable to groundwater pollution.

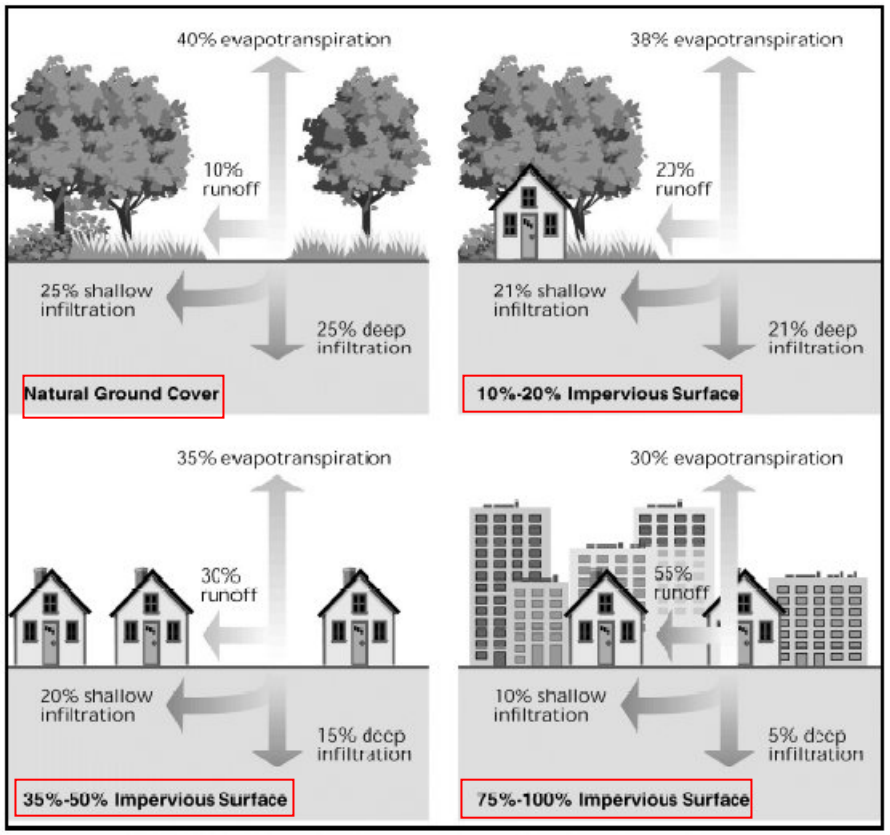
Overall, groundwater in southwest Michigan is very vulnerable to groundwater pollution.

Threats

Increased groundwater withdrawal to meet the demands of a growing population is a threat. Despite a general abundance of groundwater in the PPRW, there is growing concern about the availability of good quality groundwater for municipal, industrial, agricultural and domestic use, and for adequate baseflow to our lakes, streams and wetlands. Increased withdrawal can cause groundwater overdraft, which occurs when water removal rates exceed recharge rates. This depletes water supplies and may even cause land subsidence (the gradual settling or sudden sinking of the land surface from changes that take place underground).

In addition to groundwater withdrawals, increases in impervious surface and soil compaction limit infiltration and reduce groundwater recharge. These land use changes along with improvements in drainage efficiency (adding drain tiles, storm drains and ditches) further reduce groundwater recharge (see figure 18). The reduction in infiltration alters the hydrology of surface water causing increased flooding and streambank erosion.

Figure 28. Effects of Impervious Cover



Groundwater contamination can often be linked to land use. What goes on the ground can seep through the soil and turn up in drinking water, lakes, rivers, streams and wetlands. Activities in urban areas that pose significant threats to groundwater quality include industrial and municipal waste disposal, road salting, and the storage of petroleum products and other hazardous materials. In rural areas, different threats to groundwater quality exist such as animal waste, septic systems, fertilizers and pesticides. Table 10 lists common groundwater contaminant sources. Table 11 lists known areas of groundwater contamination in the PPRW.

Table 10. Common Groundwater Contaminant Sources

Source	Contaminant	Source	Contaminant
Salting practices & storage	Chlorides	Solid waste landfills	Hazardous materials, Metals
Snow dumping	Chlorides	Industrial uses	Hazardous materials
Agricultural fertilizers	Nitrates	Households	Hazardous materials
Manure handling	Nitrates, pathogens	Gas stations	Hydrocarbons, Solvents
Home fertilizer	Nitrates	Auto repair shops	Hydrocarbons, Solvents
Septic systems	Nitrates, pathogens	Recycling facilities	Hydrocarbons, Solvents
Urban landscapes	Hydrocarbons, pesticides, pathogens	Auto salvage yards/junk yards	Hydrocarbons, Solvents
Agricultural dealers	Hydrocarbons, pesticides, nitrates	Underground storage tanks	Hydrocarbons
Agricultural feedlots	Nitrates, pathogens	Industrial floor drains	Hydrocarbons, Solvents

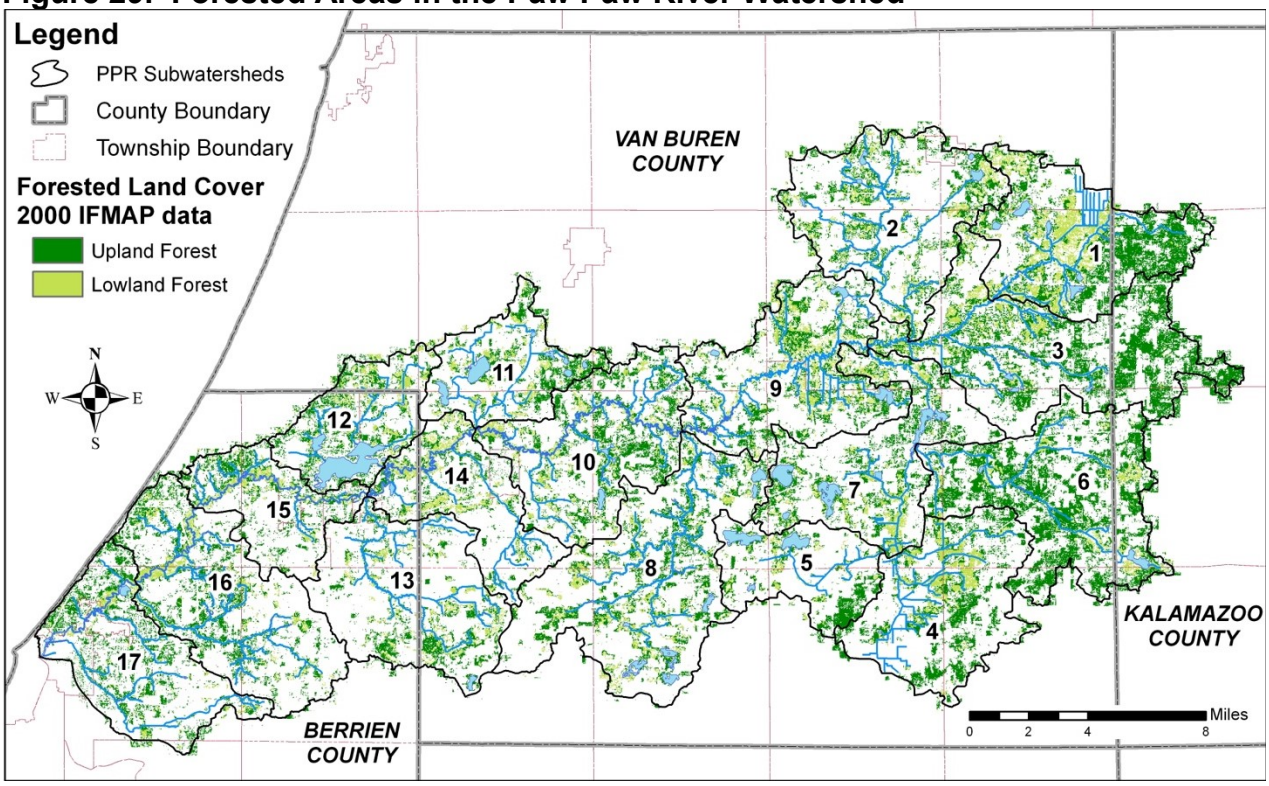
Table 11. Known Groundwater Contamination Areas

Area	Contaminant	Source
Coloma Township area	Dacthal®, a pre-emergent herbicide	Unknown
Ox Creek	trichloroethylene and hexavalent chromium	Harbor Plating, an abandoned chrome plating company
Oshtemo Township area	organic compounds, including chloroform, trichloroethylene, and perchloroethylene	West KL Avenue Landfill Superfund Site
Hartford	Heavy metals such as chromium, lead, and nickel	Burrows Sanitation Superfund Site
Benton Harbor	VOCs trichloroethene (TCE) and tetrachloroethene (PCE) and their breakdown products: 1,1-dichloroethene (1,1-DCE), vinyl chloride, and cis-1,2-dichloroethene (cis-1,2-DCE)	Aircraft Components Superfund Site

5.8 Forests

Forest lands protect rivers and streams and provide habitat for many species. Forest tress and the underlying organic humus layer intercept and help to infiltrate rainfall runoff contributing to the stability of the hydrologic cycle. According to Figure 29, the most intact forested areas are located along streams and rivers and in the PPRW headwaters area. Woodlands of southern Michigan that are dominated by beech and sugar maple also contain red oak, basswood, white ash, tulip tree, black cherry, black walnut and bitternut hickory. Upland forests on drier soils are generally an oak and hickory composition with black, red, white, and bur oaks, shagbark and pignut hickories, black cherry, black walnut and red maple.

Figure 29. Forested Areas in the Paw Paw River Watershed



Threats

The largest threats to natural forest communities in the PPRW are continued fragmentation and invasive species (e.g., garlic mustard). Fragmentation often results in nest predation and nest parasitism (mainly by cowbirds), which accounts for population declines of forest birds, especially neotropical migrants. Fragmentation also increases the ability of invasive species to penetrate forested areas. Invasive species can disrupt the forest's role in managing water and the hydrologic cycle. For more information on forests visit www.swmpc.org/downloads/mesic_southern_forest.pdf.

5.9 Savanna and Prairie Remnants

The PPRW has oak savanna and prairie remnants. Southwest Michigan is part of the tallgrass prairie region, which is dominated by grasses such as big bluestem and Indian grass. The tallgrass prairie vegetation sometimes reaches a height of 10 feet or more. Oak savannas, characterized by a grassy prairie-type ground cover underneath an open tree canopy, are common in areas that border the prairies. Prairies and oak savannas are fire-dependent systems.

Oak savanna and prairies support many species such as the Eastern box turtle and the Great Plains spittlebug. These systems in the PPRW also support plants that are rare in Michigan and indicative of high-quality savannas, including Rattlesnakemaster, prairie coreopsis, sand grass, and black haw. The savannas with their native plants play an integral part of the hydrologic cycle by providing areas where water can easily infiltrate the soil. For more information on oak savannas visit www.swmpc.org/downloads/oak_barrens.pdf.

Threats

The largest threat to savanna areas is the conversion to developed uses. Developing these natural areas can disrupt the natural water infiltration capacity of these areas. In addition, invasive alien plants have become extensively established in oak savanna and prairie remnants. These aggressive species are encouraged by the conversion of open lands to homes. Development creates large amounts of disturbed open ground and roadways that are new invasion routes for invasive species. Increased human recreational and other activities connected to development also tend to spread invasive plants' seeds further into natural areas. Suppression of natural fire regimes in developed areas further encourages the dominance of invasive over native plants, which are often adapted to recurring fire. Invasive plant species can actually result in reduced groundwater recharge, which disrupts the hydrologic cycle.

5.10 Rare Features

A variety of rare species and communities have been documented in the PPRW. The Michigan Natural Features Inventory (MNFI) maintains a list of threatened, endangered, and special concern species/communities in Michigan. Twenty-three species of animals, 46 species of plants, 7 communities, and one "other" element (Great Blue Heron Rookery) are listed as either federally endangered, a candidate for federal status under the Endangered Species Act of 1998, state special concern, state threatened, state endangered or probably extirpated for the PPRW. The list of species and communities can be found in Appendix 5.

Threats

The major threat to rare species and features is habitat loss and fragmentation. As natural habitats become more fragmented and disrupted, invasive species can be accidentally or deliberately introduced into high quality habitat areas. Invasive species can displace or eliminate native species, particularly rare species that have specific habitat requirements. Invasive species can substantially alter the structure and functioning of high-quality natural communities including an alteration of the amount of water that is infiltrated. Further, new construction can affect groundwater infiltration rates and consequently reduce the amount of water discharging from a spring. An altered hydrologic cycle can change the conditions necessary for the continued health of rare species populations and some natural communities such as prairie fens.

6 Plan Development Process

This PPRW Management Plan was developed utilizing the best available data along with input from stakeholders. The planning process included

- soliciting public input
- reviewing previous studies and reports
- conducting a volunteer inventory to identify problem sites and areas
- conducting research on topics of concern such as wetland functions, floodplain forests, agricultural concerns and hydrology
- developing models to determine priority areas

6.1 Public Input

For the 2008 plan, public participation was relied upon heavily during the planning process to solicit input on all stages of plan development. The results from previous public forums and meetings were utilized to identify watershed concerns. Further, during the planning process, several methods were used to engage stakeholders and solicit input. These methods included steering committee meetings, sub-committee meetings, a website with feedback opportunities, and extensive email communications to interested citizens and groups.

Public participation methods included steering committee meetings, sub-committee meetings, a website with feedback opportunities, and extensive email communications to interested citizens and groups.

Steering committee and sub-committee participants were instrumental in identifying and commenting on designated uses, desired uses, pollutants, sources and causes of pollutants, priority or critical areas and in developing goals, objectives and an action plan. A list of steering committee participants can be found in Appendix 6. Many partners were instrumental in providing information, completing modeling efforts, organizing and implementing the volunteer inventory and providing feedback on early versions of the plan. The key governmental and non-profit partners included the Michigan Department of Environment, Great Lakes and Energy, Michigan Department of Natural Resources, the Berrien and Van Buren Conservation Districts, Southwest Michigan Land Conservancy, Sarett Nature Center, The Nature Conservancy, Pokagon Band of Potawatomi Indians, the Paw Paw Lake Association, Van Buren County Drain Commissioner, Hamilton Township, Village of Paw Paw and Almena Township.

The Internet was used throughout the plan development process. An email communication list containing over 150 addresses was used to keep stakeholders informed and to offer the opportunity to comment on the information being presented. The PPRW website contained information relating to the development of the plan including all steering committee meeting summaries. An on-line forum allowed individuals to submit comments throughout the process.

The media assisted in alerting watershed stakeholders and residents about the PPRW Management Plan and encouraged them to comment on the draft plan either on-line, by

phone or in person. In May 2008, SWMPC held an open house for stakeholders to review and comment on the plan. Channel 3 News announced the open house and several concerned citizens came to the open house to learn about the watershed and the management plan. For the 2021 update, the Two Rivers Coalition provided data such as the E. coli monitoring, participated in the agricultural inventory work and provided feedback on the action plan which was incorporated into chapter 10 - Implementation Strategies and Chapter 11- Evaluation.

Stakeholder Concerns

Paw Paw River Watershed Stakeholders have identified known or perceived impairments and problems within the PPRW at Steering Committee meetings from 2006 to 2008 and in a public watershed forum held in November of 2004. Stakeholders expressed concerns about several issues in the PPRW. One issue that united the stakeholders was preservation of the connected forested floodplain corridor along the Paw Paw mainstem. Including the Paw Paw River in the state's Natural Rivers Program was discussed as an option for protecting the floodplain corridor. Another issue was large-scale wetland filling or draining for proposed projects such as the Paw Paw Wal-Mart, Harbor Shores in Benton Harbor and the Hartford - Watervliet Area Development Corridor along Red Arrow Highway. Specific pollution concerns included discharge from the Coca-Cola/Minute Maid facility near Paw Paw, bacteria and pathogens from the Hartford Dairy CAFO and groundwater contamination in Coloma and Oshtemo Townships. Sedimentation was a concern for all water bodies but is especially noticeable in Maple and Paw Paw Lakes. Stakeholders were also concerned about the potential negative impacts on natural resources from increased recreational use. A full list of stakeholder concerns have been compiled and organized by topic in Appendix 7.

Wetlands are often filled to create roads, driveways, and building sites.

6.2 Previous Studies/Reports

Several studies and reports pertaining to the PPRW were reviewed during the development of this management plan. The information contained in these reports provided much of the background information and also helped to prioritize protection and management areas. A list of known studies and reports pertaining to the PPRW are listed in the Appendix 8.

6.3 Volunteer Inventory

A volunteer inventory project was conducted in the PPRW throughout the summer of 2006. The purpose of the inventory project was to establish a baseline characterization of the watershed and identify potential or existing problem sites. Volunteers completed a riparian survey form at 217 road/stream crossing sites within the PPRW. The survey assessed stream bank erosion potential using Rosgen's Bank Erosion Hazard Index (BEHI) methodology. The survey also addressed other riparian criteria, such as stream width, canopy coverage and vegetation type. Volunteers took several photographs at each survey location. A database was used to store survey results, calculate erosion potential (based on BEHI criteria) and organize photographs taken during the survey.

The value of the survey results for characterizing erosion potential throughout the watershed was limited due to inconsistency between volunteers. However, data collected for other riparian conditions and the 941 photographs taken during the inventory project were useful for establishing a baseline characterization of the watershed. Volunteers identified several problem sites during the inventory process. The types of problems included unrestricted livestock access to streams, soil erosion from new construction and soil erosion from road runoff. Some of these problems were corrected after the inventory was completed; the remaining problem sites are included in Figure 49. The volunteer inventory final report is available online at www.swmpc.org/downloads/pprw_volunteer_inventory.pdf.

6.4 Watershed Research and Modeling

Landscape Level Wetland Functional Assessment

Wetlands are critical for providing diverse wildlife habitat, improving water quality and stabilizing stream flows throughout the watershed. In 2007, Michigan Department of Environmental Quality (MDEQ) (now EGLE) completed a landscape level analysis to better understand the functions of existing and lost wetlands in the PPRW. The results from this analysis can be utilized to locate wetlands with important functions such as protecting water quality, providing habitat and reducing flood impacts in the watershed. The results can help pinpoint potential restoration, enhancement, and protection activities to appropriate areas of the watershed that are most in need of a particular wetland function. These functions include 1) surface-water detention 2) streamflow maintenance 3) nutrient transformation 4) sediment and other particulate retention 5) shoreline stabilization 6) provision of fish and shellfish habitat 7) provision of waterfowl and waterbird habitat 8) provision of other wildlife habitat, and 9) conservation of biodiversity (rare or imperiled wetland habitats in the local region with regional significance for biodiversity). The final report is available online at www.swmpc.org/downloads/pprw_WetlandFunctionAssmnt.pdf.

TNC Prioritization of Forested Floodplain

The largely intact floodplain forest corridor along the Paw Paw River mainstem from Benton Harbor to Paw Paw Village is one of the greatest assets of the PPRW. The forested floodplain not only provides habitat for several migratory birds and other species, but it also maintains water quality, stabilizes flows and reduces flooding in the Paw Paw River. In 2006, The Nature Conservancy (TNC) completed a report that prioritized six areas of forested floodplain along the Paw Paw River and identified threats to these areas. The results from this report will help to focus TNC's protection and management efforts. Further, the results assisted with the prioritization of protection areas in the PPRW management plan. The TNC report is available online at www.swmpc.org/downloads/pprw_tnc_floodplain.pdf.

TNC Agricultural Assessment

Based on soil types and lack of ground cover (using Google Earth), problem agricultural areas within the PPRW were identified in this assessment. The report recommends which best management practices should be implemented in each problem area. The TNC report is available online at www.swmpc.org/downloads/pprw_tnc_ag_assmnt.pdf.

SWAT Model

The Soil and Water Assessment Tool (SWAT) was used in the PPRW because of its ability to simulate agricultural best management practices (BMPs). It was also utilized in the St. Joseph River Watershed Management Plan. The SWAT model was used to assess sediment and nutrient loads within the PPRW, and to predict load reductions from selected agricultural BMP scenarios. The report is available online at www.swmpc.org/downloads/pprw_swat_report.pdf.

Build Out Model

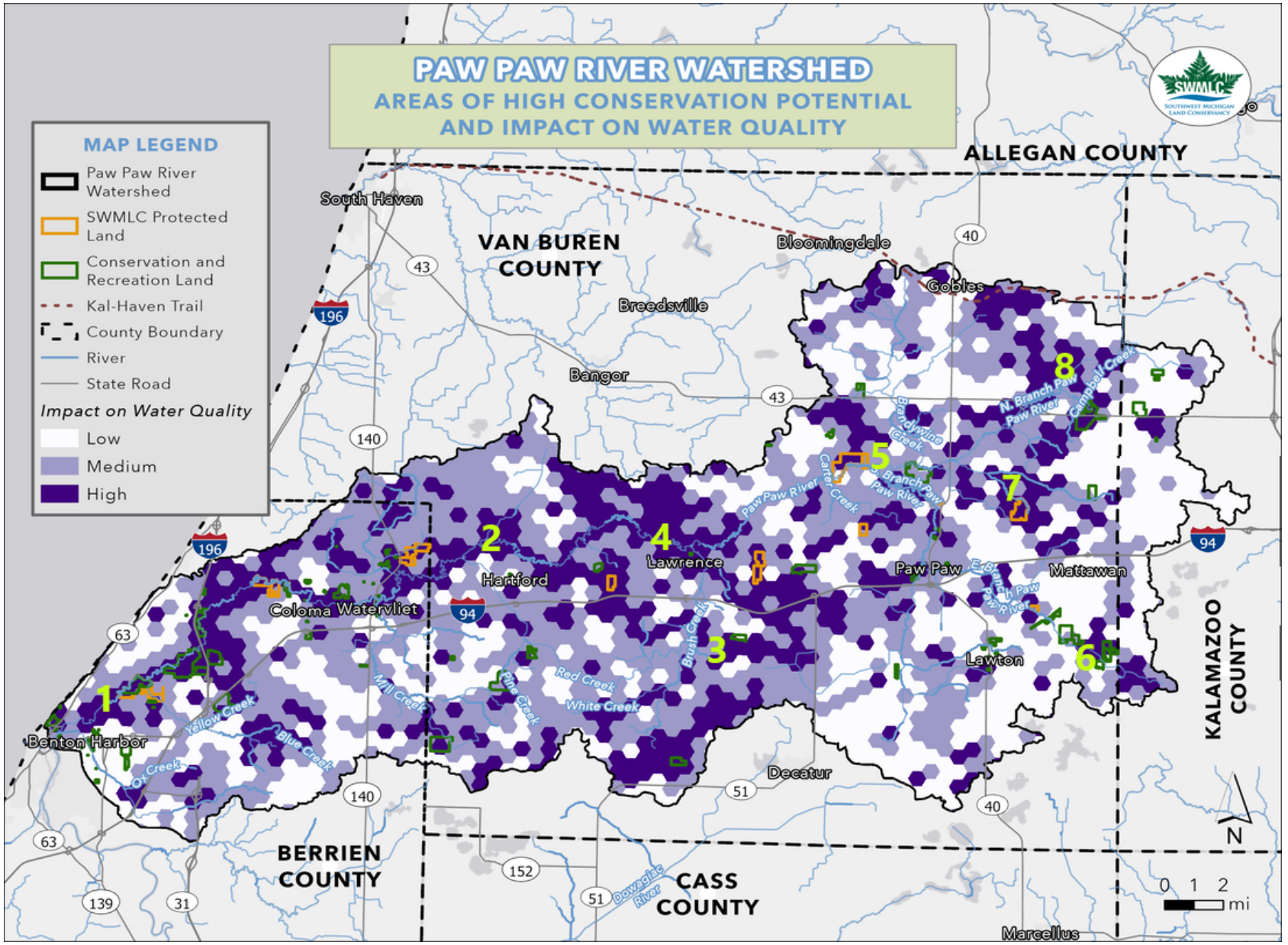
In 2008, Keiser & Associates completed a build out model for the PPRW. The purpose of this effort was to evaluate the impact of future land use changes on water quality, specifically runoff volume, total suspended solids, phosphorus and nitrogen. In the model, land use change was based on the future land use maps from local municipal master plans. This report will be instrumental in working with governmental units on master plan and zoning ordinance updates to improve and/or protect water quality. Further, the results from this effort helped identify areas where future development is expected to threaten water quality. The report is available online at www.swmpc.org/downloads/pprw_buildout_report.pdf.

SWMLC Conservation Priority Model

The PPRW Land Protection Committee assisted the Southwest Michigan Land Conservancy (SWMLC) in the development of a model used to map critical areas for preservation. These areas were identified in order to assist land conservancies, governmental units, and other groups in locating high priority sites for preservation. The model united local knowledge and human values with the best available scientific data. The model was refined throughout the planning process as more data was received. The final report from this modeling effort is available online at www.swmpc.org/downloads/pprw_cp_mdl_report.pdf.

For the 2021 plan update, the Southwest Michigan Land Conservancy (SWMLC) created an updated Strategic Land Conservation Plan for the Black and Paw Paw River Watersheds. This plan identified eight high priority areas in the Paw Paw River Watershed to concentrate on for land protection (Figure 30). The plan identifying priority landowners and associated methodology and maps can be found in the appendix.

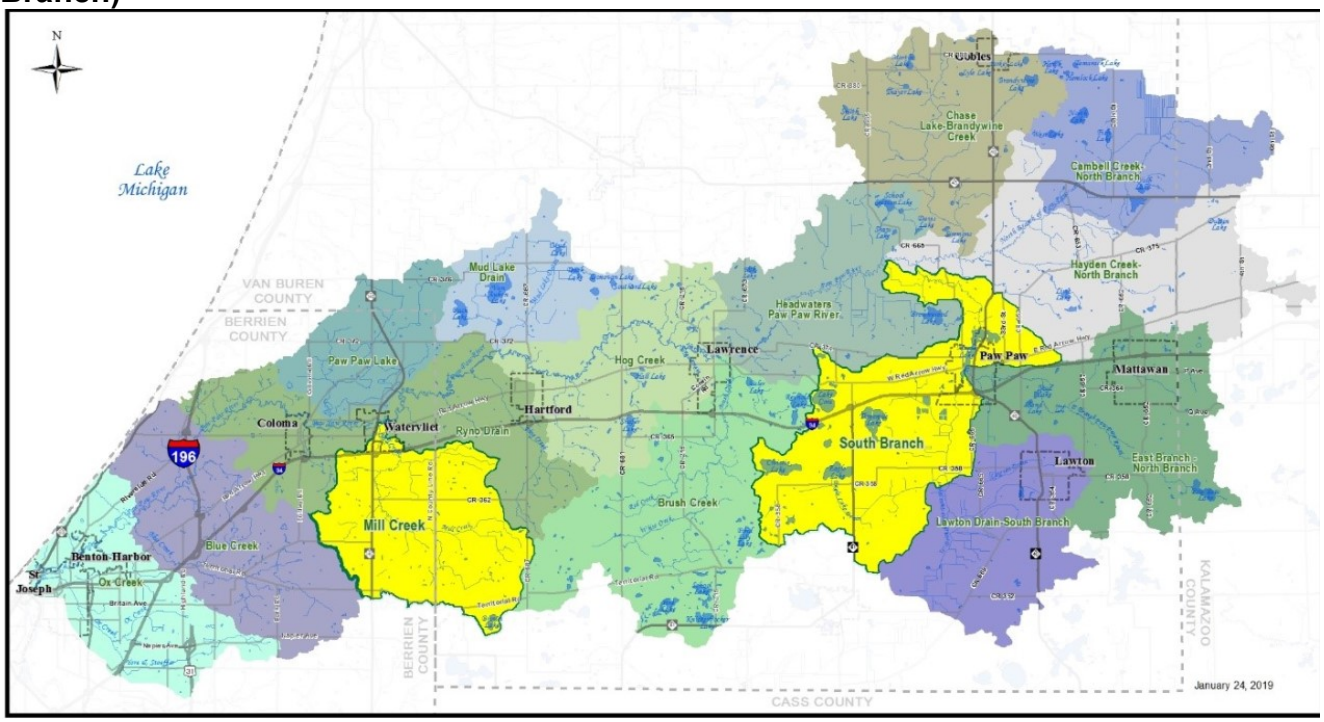
Figure 30. Areas of High Conservation Potential and Impact on Water Quality



Agricultural Inventory (tillage, cover crop, livestock)

For the 2021 plan update, an agricultural inventory was conducted. The purpose of the agricultural inventory was to obtain an understanding of general management practices used in the watersheds, 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. The inventory was conducted for two watersheds in the Paw Paw, Mill Creek and South Branch. The inventory was coordinated by SWMPC and the Berrien County Conservation District with assistance from the Van Buren Conservation District and Michigan Department of EGLE. The Two Rivers Coalition provided volunteers for the inventory effort.

Figure 31. Targeted Watersheds for Agricultural Inventory (Mill Creek and South Branch)



The features in Table 12 were assigned points to rank the inventoried fields to prioritize them for further follow-up like using the U.S. EPA Spreadsheet Tool for Estimating Pollutant Loads (STEPL) Model and to contact owners for outreach about best management practices for tillage, cover crops and buffers.

Table 12. Paw Paw River Watershed Priority Fields Ranking Method

FIELD	FEATURE	POINTS ASSIGNED	DETAILS	SOURCE
Priority_Quap	Manure Fields	5	No fields in Paw Paw - South Branch Paw Paw - Mill selected by hand - 9 fields	Livestock Inventory
Pr_X_Water	Stream or Drain crosses Field with no filter strip/riparian buffer (minimum 25 ft)	25	Visual check for filter strip/riparian buffer– ESRI imagery	Selection using Paw Paw – Hydrolines, Hydropoly (MCGI) Berrien County Drains (Berrrien County) Van Buren County Drains (Van Buren County)
Pr_Water25Nor	Parcel is within 25 ft of water with No Filter Strip/Riparian Buffer	10	Visual check using ESRI imagery for filter strip/riparian buffer (minimum of 25 ft)	Same list as above for selection
Pr_FilterStrip	No Filter Strip present– Initial digitizing work	1	No Filter strip	Original Data Creation
Pr_CoverCrop	No Cover Crop - No	1	Paw Paw – Mill using 2019 data South Branch using the 2019 data Note: Using the same year for Fall Tillage FEATURE	Field Survey
Pr_FallTillage	Fall Tillage - Plowed Chisel Plowed	P = 1 CP = 1	No fall tillage = P (Plowed) in any watershed	Field Survey
Pr_Farm	Farm (flag) - Flagged: Manure Storage Issues Visible and Run off Pathways Visible YES	15	Both fields had YES in all cases for manure storage issues and run off pathways visible, Visual check to farm fields and added number. None flagged in Paw Paw - Mill Creek Watershed	Windshield Survey by Nancy Carpenter BCCD Paw Paw Nov 2020,
Priority_Total	Sum of the above fields			

Table 13. Summary of Fields with Priority Total Numbers

Priority Total*	42-35	16, 15	12	11, 10	6,5	4-2
Sub-Watershed	**Number of Fields by Priority Total**					
Paw Paw – Mill Creek	6	1	3	21	30	30
Paw Paw – South Branch	2	4	3	8	25	24

*The higher the Priority Total number, the higher the priority for BMP outreach and implementation efforts

The maps below show which fields conducted cover crop or reduced/no-tillage practices and which fields are within 25 feet of a river, stream, drain or lake. Based on the summary of features presented above, a map of priority fields was created (with red being the highest priority). These high priority fields potentially pose the most threat to water quality and BMP outreach and implementation efforts should be focused in these areas.

Figure 32. Paw Paw River Watershed Agricultural Fields

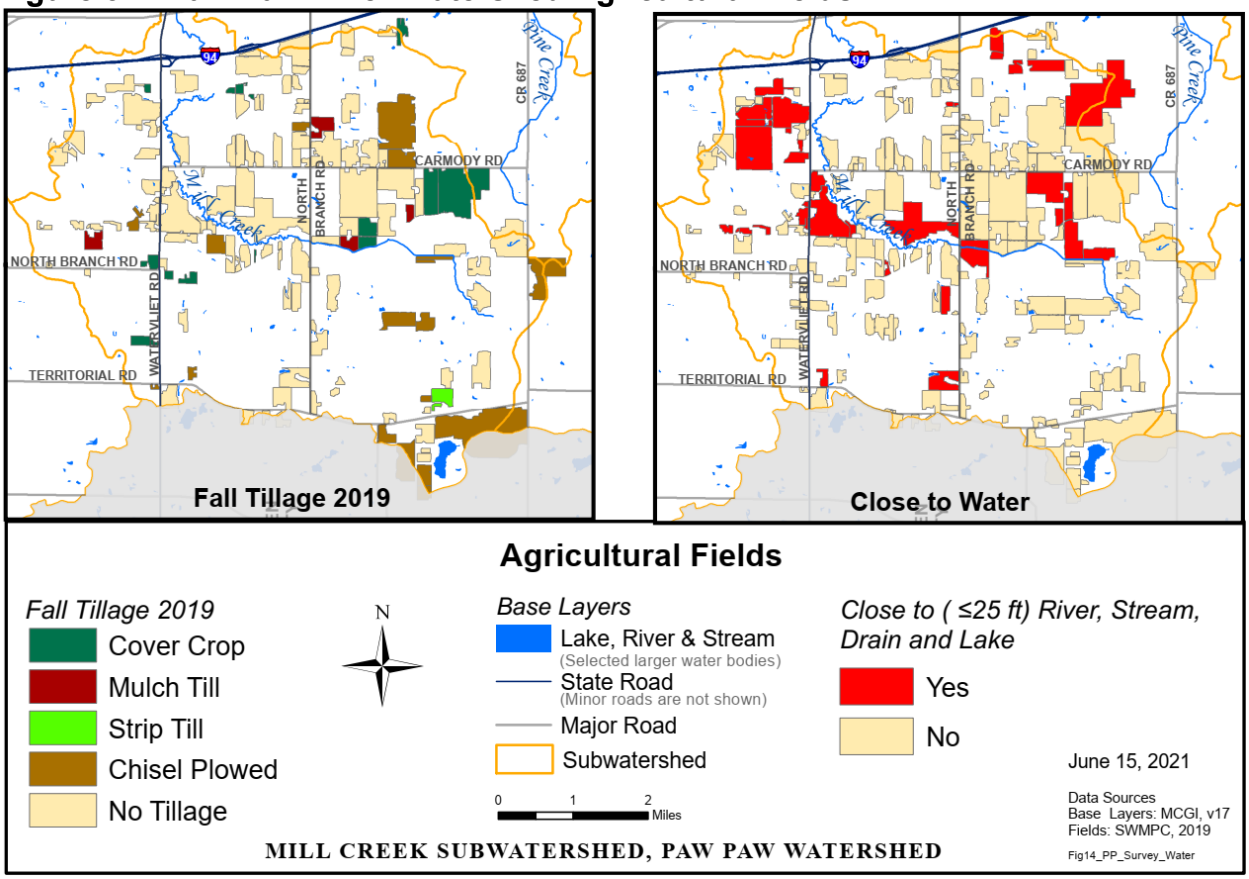
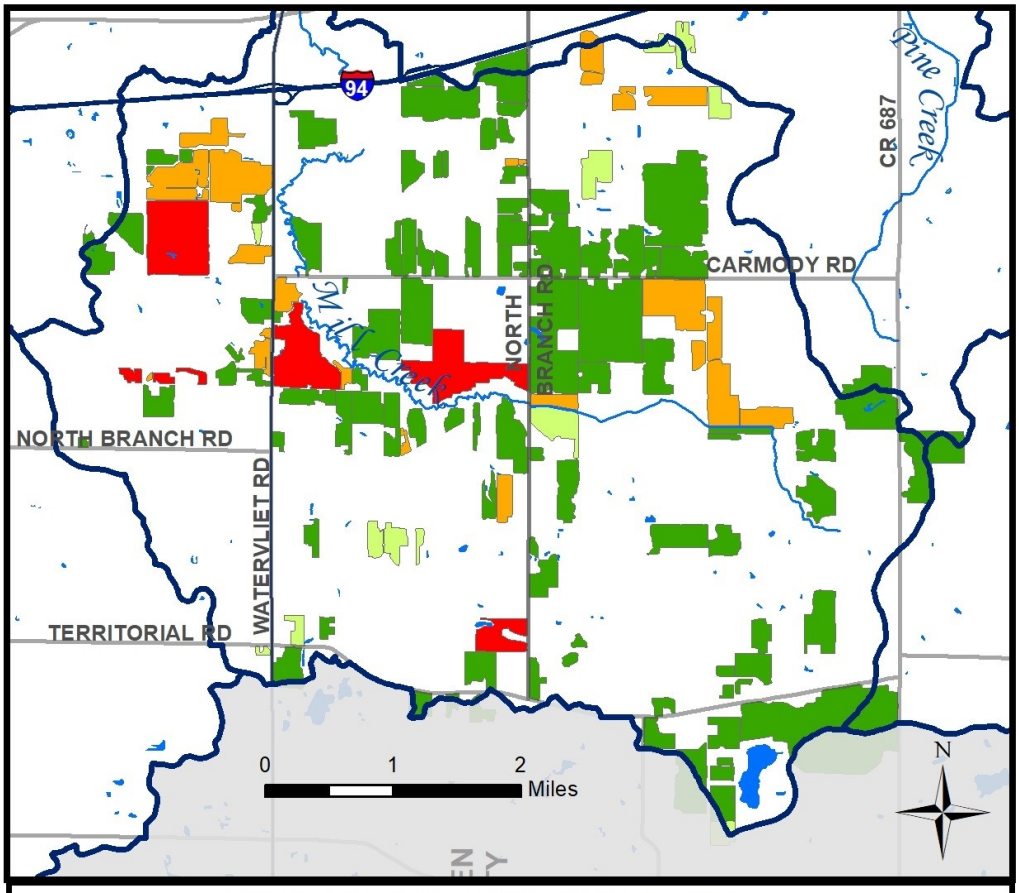


Figure 33. Mill Creek subwatershed agricultural fields



MILL CREEK SUBWATERSHED
PAW PAW WATERSHED

Agricultural Fields

*PRIORITY FIELDS**

- 1 - 2
- 3 - 10
- 11 - 15
- 16 - 37

*Fields were ranked as to the risk of contributing to runoff to water bodies. The higher numbers indicates a greater risk of agricultural runoff.

Base Layers

- Lake, River & Stream (Selected larger water bodies)
- State Road (Minor roads are not shown)
- Major Road
- Subwatershed

Data Sources
Base Layers: MCGI, v17
Fields: SWMPC, 2019

June 15, 2021 Fig14_PP_Survey_Priority

Figure 34. Fall Tillage 2018, South Branch subwatershed

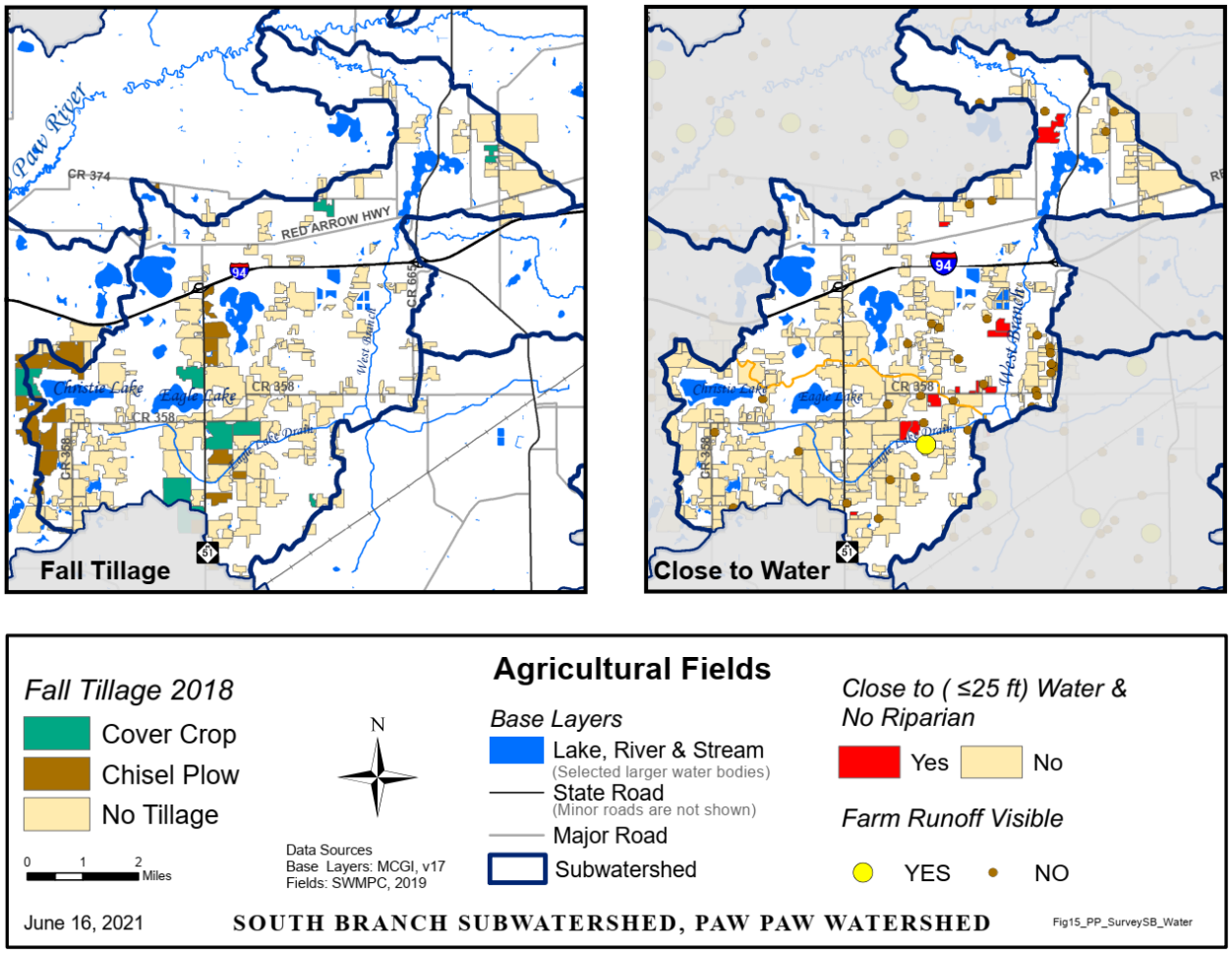


Figure 35. Priority Fields, South Branch subwatershed

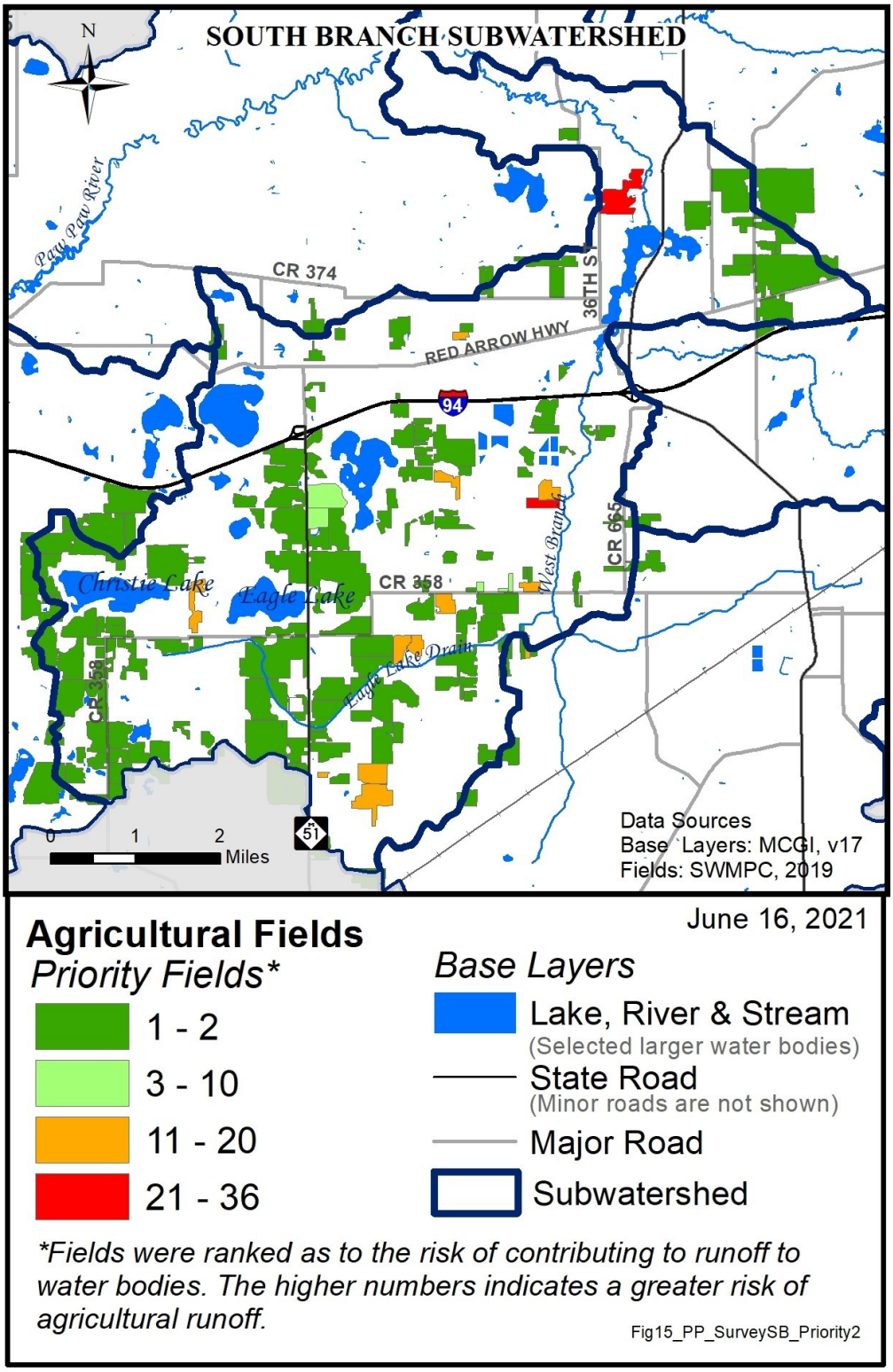
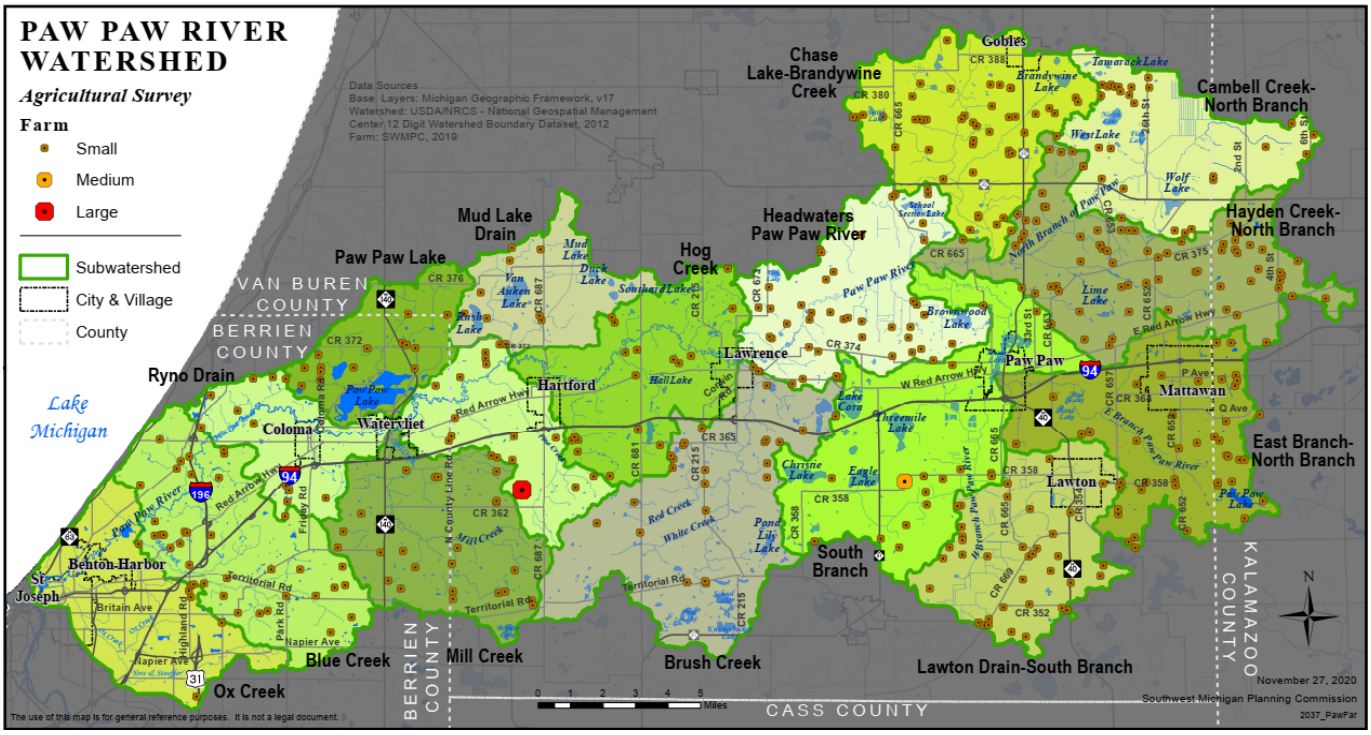


Figure 36. Paw Paw River Watershed Animal Feeding Operation Inventory



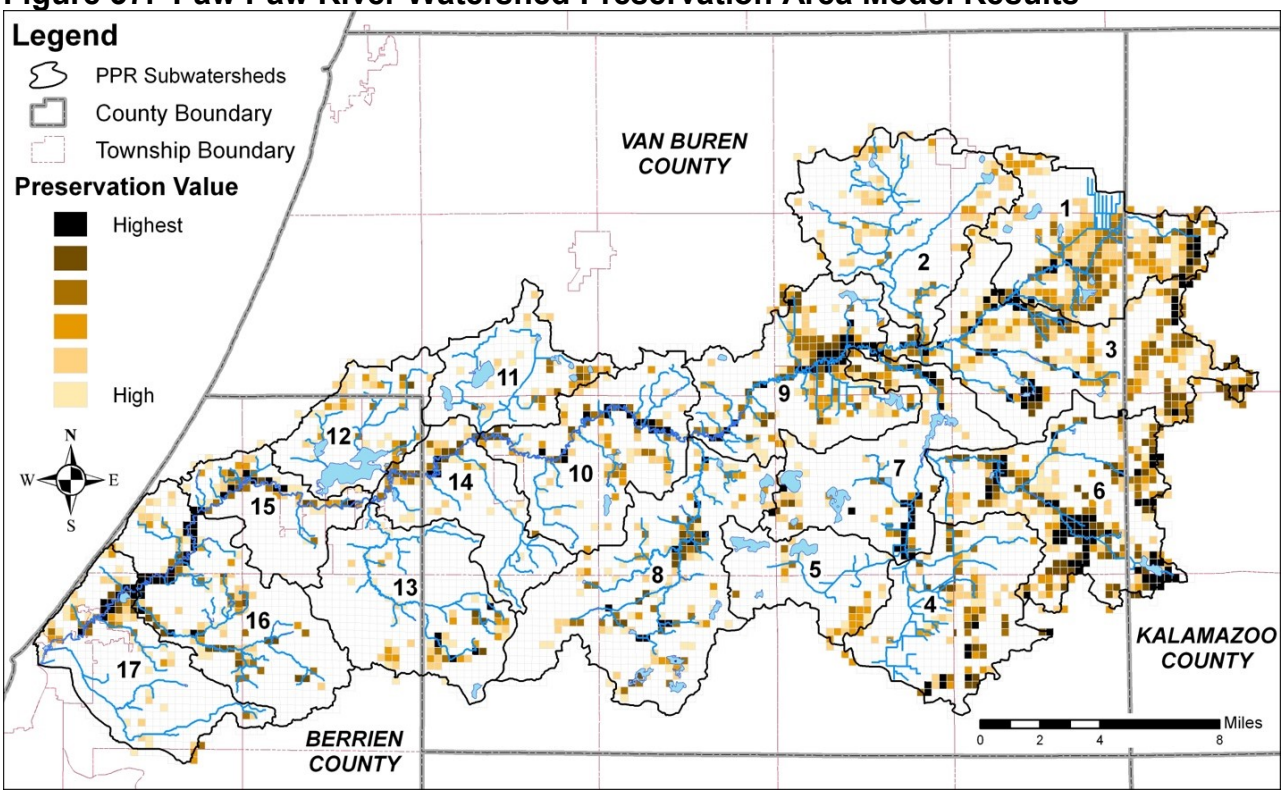
SWMPC Models

The Southwest Michigan Planning Commission (SWMPC) adapted the methodology used in the SWMLC Conservation Priority Model to create three new models. These models were developed to help understand the significance and geographical distribution of protection and management areas in the PPRW. The models divided the entire watershed into 7605 "squares" known as quarter-quarter sections (QQs). Each "square" or QQ is approximately 40 acres. GIS software was used to calculate a score for each QQ based on the presence, absence or significance of certain criteria. For each model, the PPRW Steering Committee helped determine which criteria were used, as well as how much "weight" or value each criterion was given. Combining the value of each criterion for each QQ allowed for ranking on the basis of preservation or management priority.

1. Preservation

The preservation area model was developed to help locate high quality natural areas. It can be utilized to influence planning and zoning decisions (such as water body setbacks and low impact development techniques) and also to target the private land protection efforts of land conservancies. The following criteria were considered when calculating the preservation value of each QQ: 1) land cover – percent of natural land cover, 2) hydrology – presence and/or quality of water features, 3) groundwater recharge potential, 4) proximity to already protected areas, 5) presence of priority floodplain forest areas and 6) presence of wetlands with significant habitat related functions. Figure 37 illustrates the top 25% of all QQs for preservation value. More information on the SWMPC Preservation Area Model is available online at www.swmpc.org/downloads/pprw_pres_mdl.pdf.

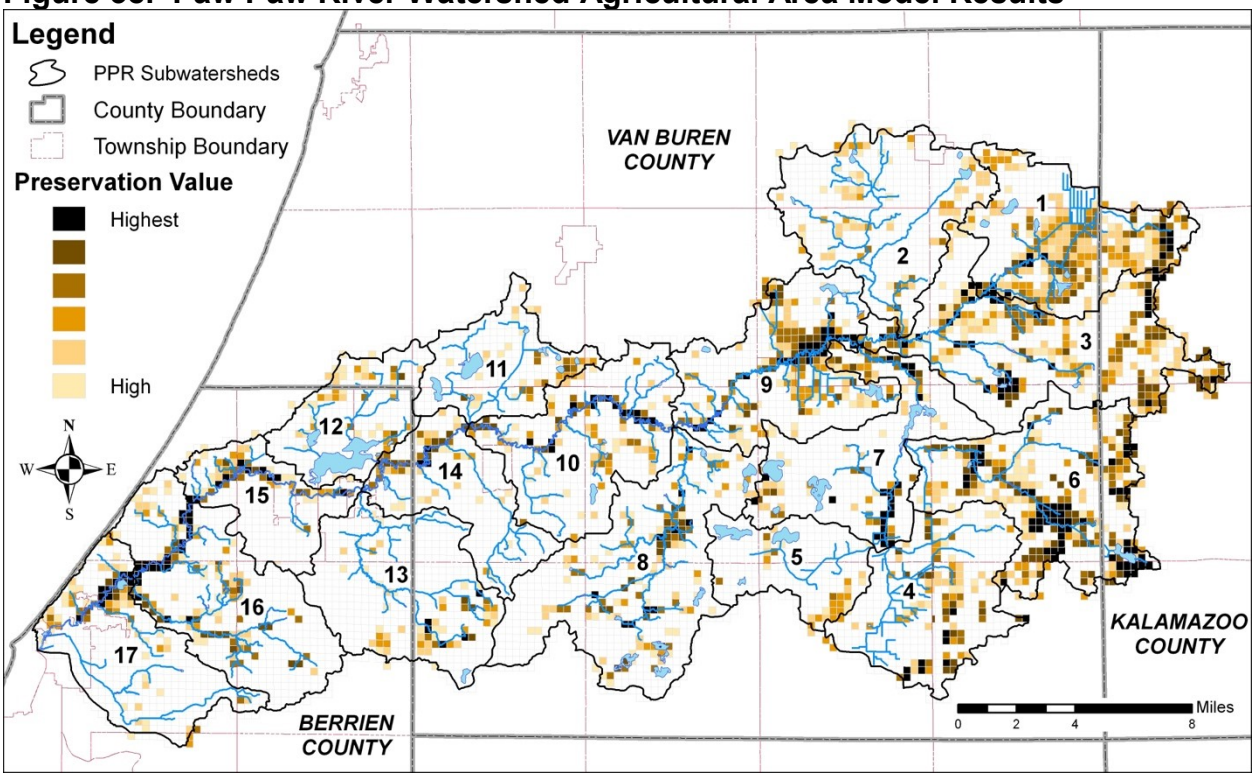
Figure 37. Paw Paw River Watershed Preservation Area Model Results



2. Agricultural

The agricultural area model was developed to help locate agricultural areas that could have an impact on water quality. It can be used to target best management practices, restoration efforts and outreach to the agricultural community. The following criteria were considered when calculating the impact value of each QQ: 1) land cover – percent of agricultural land cover, 2) impaired water bodies – the presence and severity of water quality impairments, 3) pollutant loading – estimates from SWAT model and 4) lost wetland functionality – absence of historic wetlands with a high significance for nutrient transformation and/or sediment and other particulate retention. Figure 38 illustrates the top 40% of all QQs for agricultural related impact value. More information on the SWMPC Agricultural Area Model is available online at www.swmpc.org/downloads/pprw_ag_mdl.pdf.

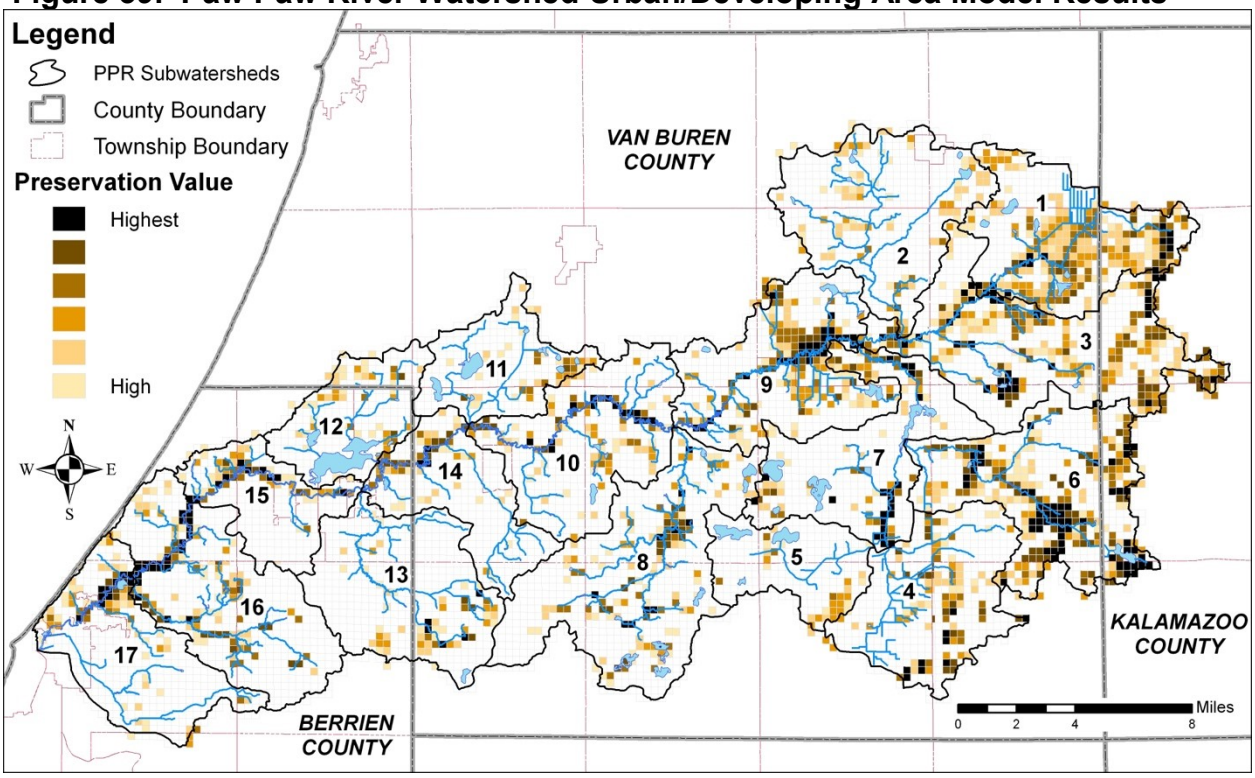
Figure 38. Paw Paw River Watershed Agricultural Area Model Results



3. Urban/Developing

The urban/developing area model was created to help understand the extent of existing urbanized areas, as well as areas that are expected to develop rapidly in the near future. It can be utilized to influence planning and zoning decisions in developing areas (such as water body setbacks and low impact development techniques) and for targeting existing urban areas for improved stormwater management practices. The following criteria were considered when calculating the impact value of each QQ: 1) land cover – percent of urban land cover, 2) development potential – population trends and future land use plans, 3) hydrology – impaired water bodies and 4) accessibility – proximity to primary road networks. Figure 39 illustrates the top 34% of all QQs for urban/developing impact value. More information on the SWMPC Urban/Developing Area Model is available online at www.swmpc.org/downloads/pprw_urban_mdl.pdf.

Figure 39. Paw Paw River Watershed Urban/Developing Area Model Results



E. coli Monitoring

Two Rivers Coalition has been conducting E. coli testing in both the Black River and Paw Paw River watersheds since 2017. That testing is expensive and has only been possible thanks to the generosity of the following donors: Jimmy Scott family, Freshwater Future, Van Buren Conservation District, Dick and Carol Purdy and a recent MEGLE grant. TRC has been monitoring 10 sites in the Paw Paw River watershed over the years during dry and wet weather conditions. Along with testing for E. coli, Two Rivers Coalition also utilized canines to determine if human sewage was present in the samples collected. These results are shown in the maps and graphs below.

Test results are presented in the maps below. For each watershed, the 4-year average E. coli cfu levels for each site for both Dry Event and Wet Event testing are color coded.

A green dot indicates the 4-year average is less than 300 cfu (colony-forming units per milliliter). The United States E.P.A. has set a standard that does not allow total body immersion (think swimming) in water over 300 cfu.

A yellow dot indicates the 4-year average was between 300 and 1,000 cfu. The E.P.A. has set a standard of no partial body contact (think wading or paddling) in water over 1,000 cfu. A red dot indicates where the 4-year average was over 1,000.

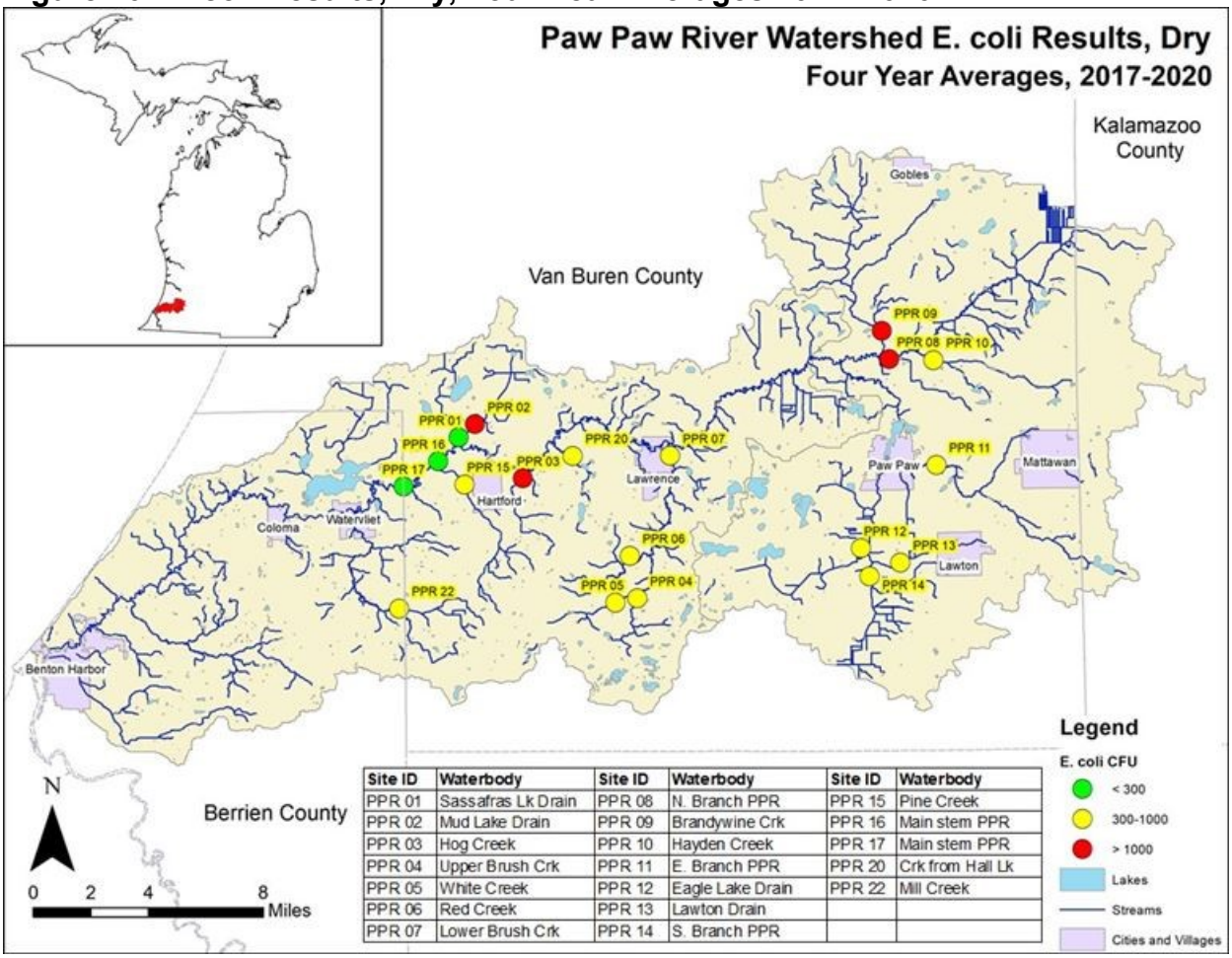
A map was generated that shows the results of canine testing in the year 2020. Remember, all the sites that are submitted for canine testing have already had a lab test showing elevated E. coli levels. A green dot means no human sewage was detected in

2020. A yellow dot indicates the canine testing was inconclusive. An orange dot indicates that human sewage was detected but in a lesser amount. Usually, this means that a dog with a more sensitive nose alerted while another dog that was less sensitive did not alert. A red dot means human sewage was definitely detected.

Finally, the data is presented graphically in a box plot with error bars showing the statistical validity of the sample size. Credit goes to Kyle Boone and the Pokagon Band of Potawatomi DNR for analyzing the data and preparing the maps and graphs. An important caveat: although TRC believes that their testing over the last 4 years reveals important findings and trends, it does not meet the testing protocol for EGLE. and has no legal weight. TRC has conducted this testing and is publishing the results to let the general public know about the problem of E. coli in our streams and rivers and to hopefully encourage further efforts to reduce E. coli contamination in our waterways.

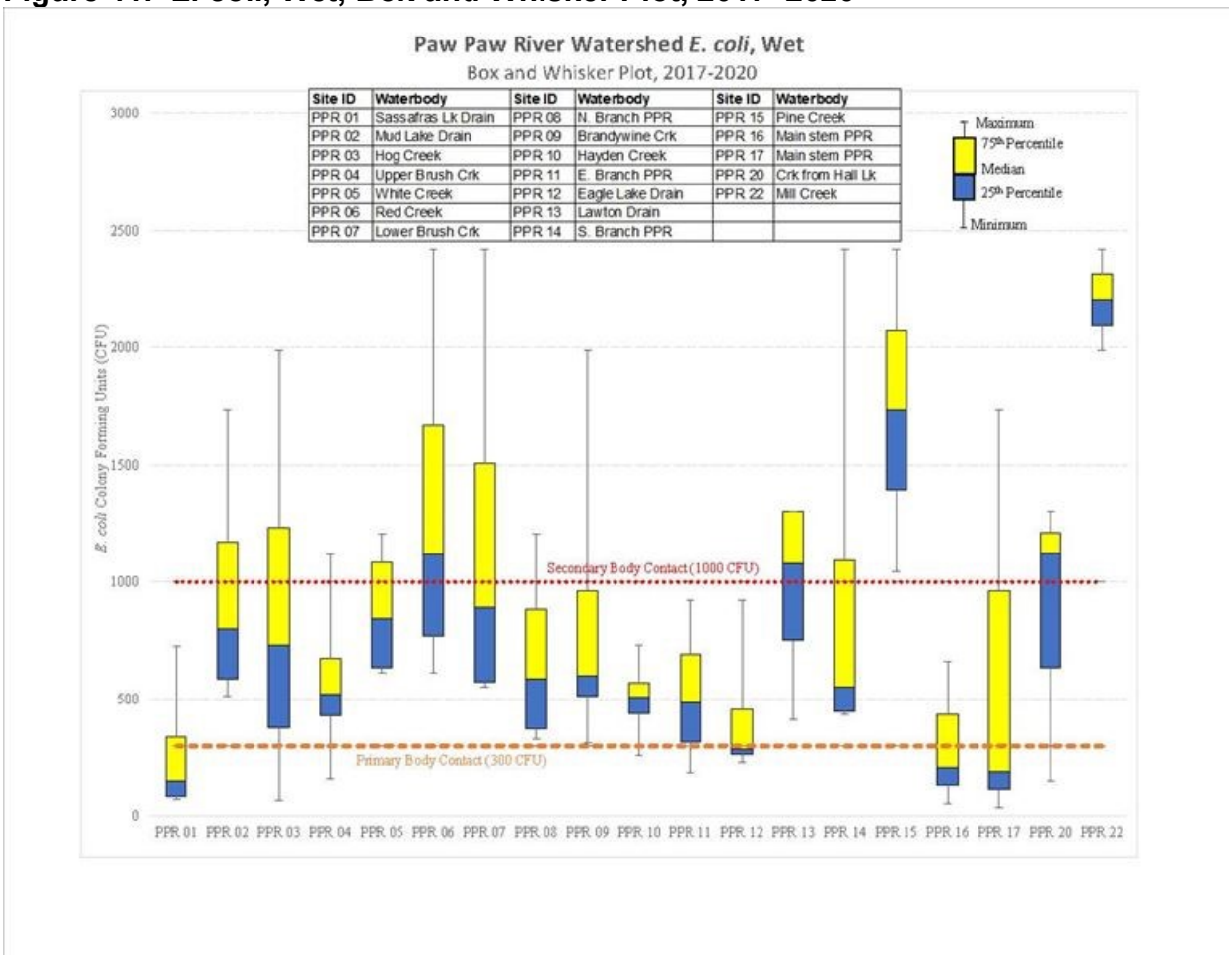
The map below contains the 4-year averages for wet event testing in the Paw Paw River watershed. It shows 14 sites exceeded the full-body contact threshold. An additional four sites exceeded the partial body contact threshold. Only one site (again Sassafras Lake Drain) met the recreational use standard.

Figure 40. E-coli Results, Dry, Four-Year Averages 2017–2020



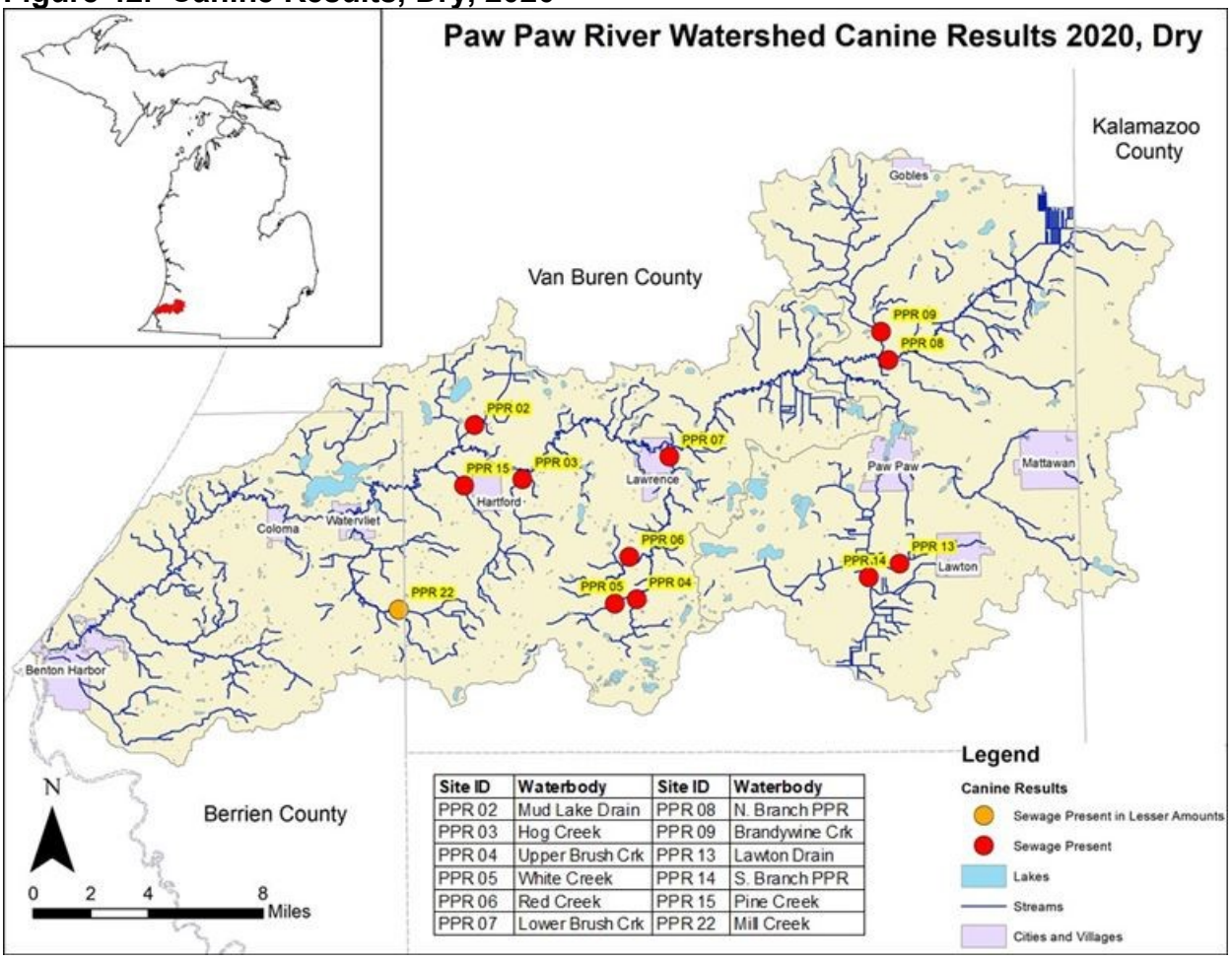
Site ID	Waterbody	Site ID	Waterbody	Site ID	Waterbody
PPR 01	Sassafras Lk Drain	PPR 08	N. Branch PPR	PPR 15	Pine Creek
PPR 02	Mud Lake Drain	PPR 09	Brandywine Crk	PPR 16	Main stem PPR
PPR 03	Hog Creek	PPR 10	Hayden Creek	PPR 17	Main stem PPR
PPR 04	Upper Brush Crk	PPR 11	E. Branch PPR	PPR 20	Crk from Hall Lk
PPR 05	White Creek	PPR 12	Eagle Lake Drain	PPR 22	Mill Creek
PPR 06	Red Creek	PPR 13	Lawton Drain		
PPR 07	Lower Brush Crk	PPR 14	S. Branch PPR		

Figure 41. E. coli, Wet, Box and Whisker Plot, 2017–2020



The map below of the Paw Paw River watershed shows the results of canine testing for the presence of human sewage in 2020 when there had been no rain for at least three days. Out of the 12 sites where the lab had detected high levels of E. coli, duplicate samples from 11 sites showed a strong presence of human sewage. One site (Mill Creek in Berrien County) showed the presence of human sewage in a lesser amount.

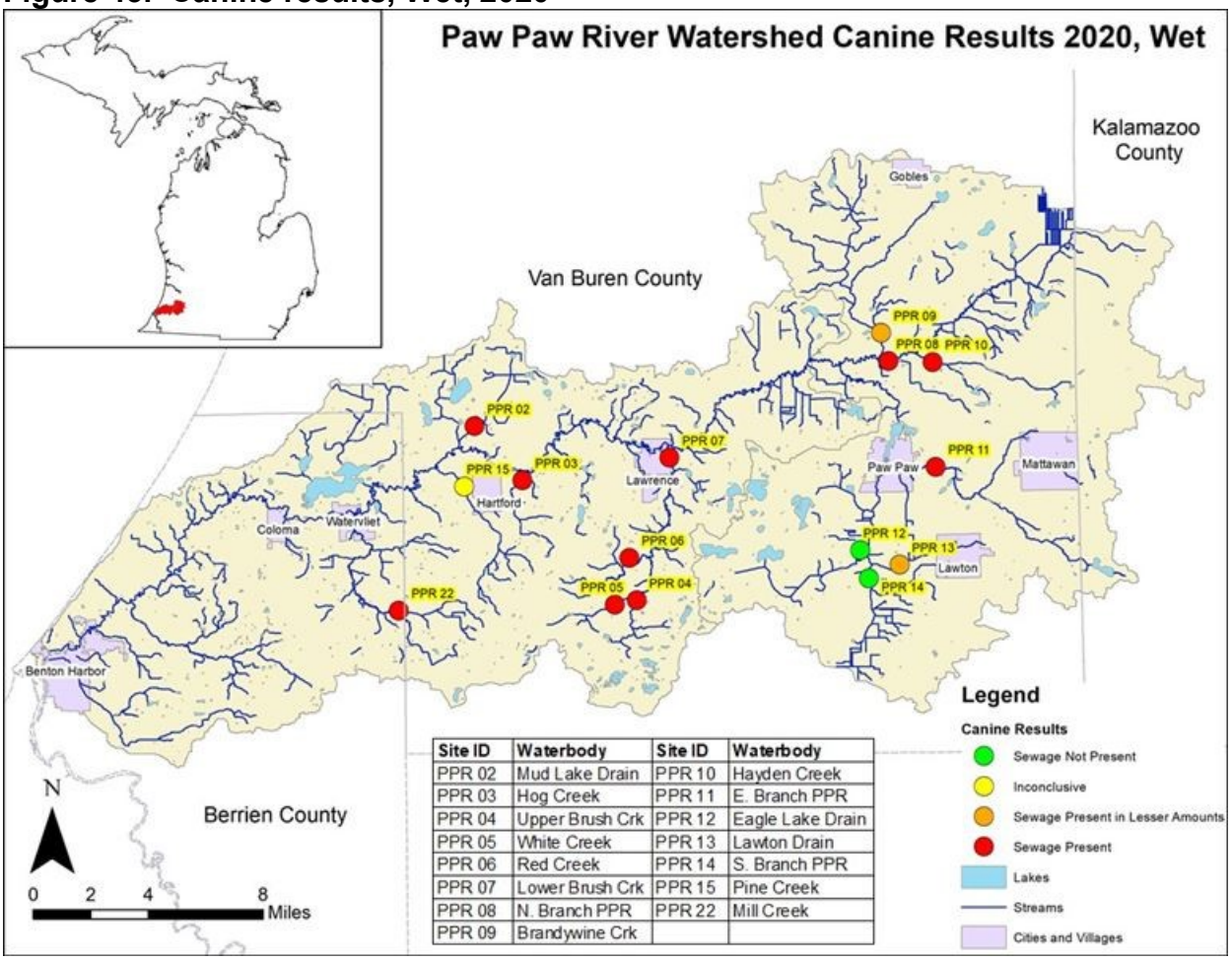
Figure 42. Canine Results, Dry, 2020



Site ID	Waterbody	Site ID	Waterbody
PPR 02	Mud Lake Drain	PPR 08	N. Branch PPR
PPR 03	Hog Creek	PPR 09	Brandywine Crk
PPR 04	Upper Brush Crk	PPR 13	Lawton Drain
PPR 05	White Creek	PPR 14	S. Branch PPR
PPR 06	Red Creek	PPR 15	Pine Creek
PPR 07	Lower Brush Crk	PPR 22	Mill Creek

The map below of the Paw Paw River watershed shows the results of canine testing for the presence of human sewage in 2020 when there had been a significant rain event. Out of 15 sites where the lab had detected high levels of E. coli, duplicate samples from 10 sites showed the strong presence of human sewage. Two other sites showed the presence of human sewage in a lesser amount. Two sites, although containing high levels of E. coli, showed no presence of human sewage. One site was inconclusive.

Figure 43. Canine results, Wet, 2020



Site ID	Waterbody	Site ID	Waterbody
PPR 02	Mud Lake Drain	PPR 10	Hayden Creek
PPR 03	Hog Creek	PPR 11	E. Branch PPR
PPR 04	Upper Brush Crk	PPR 12	Eagle Lake Drain
PPR 05	White Creek	PPR 13	Lawton Drain
PPR 06	Red Creek	PPR 14	S. Branch PPR
PPR 07	Lower Brush Crk	PPR 15	Pine Creek
PPR 08	N. Branch PPR	PPR 22	Mill Creek
PPR 09	Brandywine Crk		

7 Water Quality Summary

7.1 Designated Uses

According to EGLE, the primary criterion for water quality is whether the water body meets designated uses. Designated uses are recognized uses of water established by state and federal water quality programs. All surface waters of the state of Michigan are designated for and shall be protected for the uses listed in Table 14. (Citation: R323.1100 of Part 4, Part 31 of PA 451, 1994, revised 4/2/99). A watershed management plan provides direction for protecting and restoring designated uses.

Table 14. Definitions of Designated Uses

Designated Use	General Definition
Agriculture	Water supply for cropland irrigation and livestock watering
Industrial Water Supply	Water utilized in industrial processes
Public Water Supply	Public drinking water source
Navigation	Waters capable of being used for shipping, travel, or other transport by private, military, or commercial vessels
Warmwater Fishery	Supports reproduction of warmwater fish
Coldwater Fishery	Supports reproduction of coldwater fish
Other Indigenous Aquatic Life and Wildlife	Supports reproduction of indigenous animals, plants, and insects
Partial Body Contact	Water quality standards are maintained for water skiing, canoeing, and wading
Total Body Contact	Water quality standards are maintained for swimming

Designated uses of many water bodies in the PPRW are threatened or impaired due to habitat loss or fragmentation, rather than any specific pollutant. For the designated use assessment, only pollutant-based impairments and threats are considered. For detailed information on the most common pollutants (sediment, nutrients, temperature, flow, bacteria and chemicals) their sources and Michigan's water quality standards see Appendix 9.

7.2 General Water Quality Statement

Overall, the following designated uses are threatened in the PPRW: Partial and Total Body Contact, Coldwater and Warmwater Fishery and Other Indigenous Aquatic Life and Wildlife. The Coldwater Fishery designated use only applies to MDNR designated coldwater streams. The following water bodies in the PPRW are designated as coldwater fisheries: Sand Creek, Blue Creek, Mill Creek, Brush Creek, North Branch and its tributaries above M-40, West Branch, East Branch above M-40 and Pine Creek.

The designated uses of Agriculture, Industrial Water Supply and Navigation are being met throughout the watershed. The Public Water Supply use is not applicable in the PPRW because no communities withdraw water directly from the Paw Paw River. Benton Harbor is the only community in the PPRW relying on surface water for its municipal water supply and their water intake is located offshore in Lake Michigan.

The State of Michigan also considers Fish Consumption a designated use for all water bodies. For all streams within the PPRW and Maple Lake, the Fish Consumption designated use is considered non-attaining due to elevated levels of PCB's found in several locations. There is a generic, statewide, mercury-based fish consumption advisory that applies to all of Michigan's inland lakes. In the PPRW, Van Auken and Rush were the only lakes sampled for mercury in fish tissue. In both lakes, elevated levels of mercury were found in fish tissue, as a result the Fish Consumption designated use is considered non-attaining in those lakes.

7.3 Individual Water Body Assessment

Within a watershed, water quality can vary greatly from one water body to the next. An assessment of individual water bodies was completed for the PPRW and can be found in Appendix 4. Table 15 provides a summary of the assessment. Not all water bodies within the watershed were evaluated. Only water bodies with enough information to make a water quality statement were included. The assessment includes: 1) which designated uses are threatened or impaired, 2) the reasons why the designated uses are being threatened or impaired, 3) the pollutants causing the threat or impairment, and 4) the sources of the pollutants and the causes related to those sources. Several sources of information were used in this assessment, such as the 2006 and 2008 and 2020 Integrated Reports by EGLE; MDNR Fisheries Division staff input; MDNR Fisheries Reports; Spicer Study on Paw Paw Lake; TNC Agricultural Impact Study; TNC Floodplain Forest Study; Van Buren County Drain Commissioner input; MDEQ/EGLE Biosurvey Reports; PPRW Volunteer Inventory; Road Stream Crossing Inventory, Wetland Functional Analysis and Flashiness Report.

The Clean Water Act (CWA) requires Michigan to prepare a biennial Integrated Report on the quality of its water resources as the principal means of conveying water quality protection/monitoring information to the United States Environmental Protection Agency (USEPA) and the United States Congress. For each water body, the report classifies each designated use as: 1) fully supported, 2) not supported or 3) not assessed. Designated uses other than fish consumption, which were considered not supported by EGLE in 2020, are identified in Table 15. Designated uses not supported because of a specific pollutant often require the development of a Total Maximum Daily Load (TMDL). Table 17 lists the water bodies in the PPRW that require a TMDL and the year the TMDL is scheduled or was developed.

A Total Maximum Daily Load (TMDL) is a calculation of the maximum amount of a pollutant a water body can receive and still meet applicable water quality standards.

Table 15. Paw Paw River Watershed Water Bodies at a Glance

Water Body (12 digit HUC-AUID)	Sub Watershed ID+	Impaired Uses 2020	Threatened Uses	Pollutants (known (k) or suspected (s))
Paw Paw Mainstem	9, 10, 14, 15, 16, 17		Warmwater Fishery Other Indigenous Wildlife	Sediment (k), Nutrients (s), Pesticides (s)
Coldwater Tributaries				
Blue Creek and Yellow Creek (040500012508-01)	16	Partial & Total Body Contact due to E. coli	Coldwater Fishery Other Indigenous Wildlife	Sediment (k), Nutrients (s), Temperature (s), Bacteria/ Pathogens (k), Pesticides (s)
Brush, Red and White Creeks (040500012501-01)	8	Other Indigenous Aquatic Life and Wildlife due to Mercury in Water Column	Coldwater Fishery Other Indigenous Wildlife Partial and Total Body Contact (insufficient information)	Sediment (k), Pathogens(s), Nutrients (s), Temperature (s), Pesticides (s)
Campbell Creek (040500012403-03)	1		Coldwater Fishery Other Indigenous Wildlife	Sediment (s), Nutrients (s), Temperature (s), Pesticides (s)
Eagle Lake Drain (040500012405-09)	5		Other Indigenous Aquatic Life and Wildlife due to flow regime modification and other anthropogenic substrate	Sediment (k), Nutrients (s), Temperature (s), Pesticides (s)
East Branch	6		Coldwater Fishery Other Indigenous Wildlife	Sediment (k), Nutrients (s), Temperature (s), Pesticides (s)
Hayden Creek (040500012406-02)	3		Coldwater Fishery Other Indigenous Wildlife	Sediment (s), Nutrients (s), Temperature (s), Pesticides (s)
Mill Creek (040500012506-01)	13	Partial & Total Body Contact due to E. coli	Coldwater Fishery Other Indigenous Wildlife	Sediment (k), Nutrients (s), Temperature (s), Bacteria/ Pathogens (k), Pesticides (s)
North Branch (040500012406-01)	1, 3		Coldwater Fishery Other Indigenous Wildlife Partial & Total Body Contact	Sediment (k), Nutrients (s), Temperature(s), Bacteria/ Pathogens (s), Pesticides (s)
Pine Creek (040500012507-02)	14	Coldwater Fishery and Other Indigenous Aquatic Life and Wildlife due to flow regime modification and other anthropogenic substrate Partial & Total Body Contact due to E. coli		Sediment (k), Nutrients (s), Temperature (s), Bacteria/ Pathogens (k), Pesticides (s)

Water Body (12 digit HUC-AUID)	Sub Watershed ID+	Impaired Uses 2020	Threatened Uses	Pollutants (known (k) or suspected (s))
Sand Creek - (040500012509-03)	17		Coldwater Fishery Other Indigenous Wildlife	Sediment (k), Nutrients (s), Temperature (s), Oils/Grease/Metals (s), Pesticides (s)
West Branch* from Three Mile Lake Drain to 60th Avenue including Three Mile Lake Drain (040500012405-01)	4, 7		Coldwater Fishery due to Dissolved Oxygen Partial & Total Body Contact	Sediment (k), Bacteria/Pathogens (s), Nutrients (s), Temperature (s), Pesticides (s)
Warmwater Tributaries				
Brandywine Creek (040500012404-01)	2		Warmwater Fishery Partial & Total Body Contact	Sediment (k), Nutrients (s), Bacteria/Pathogens (s), Pesticides (s)
Branch & Derby Drain	12		Warmwater Fishery Other Indigenous Wildlife Partial & Total Body Contact	Sediment (k), Nutrients (s), Bacteria/ Pathogens (s), Pesticides (s)
Carter Creek (040500012502-03)	9		Warmwater Fishery Other Indigenous Wildlife	Sediment (k), Nutrients (s), Pesticides (s)
Hog Creek (040500012504-02)	10		Warmwater Fishery Other Indigenous Wildlife	Sediment (k), Nutrients (s), Pesticides (s)
Mud Lake Drain (040500012503-03)	11		Warmwater Fishery Other Indigenous Wildlife	Sediment (k), Nutrients (s), Pesticides (s)
Ox Creek and Yore-Stoeffer Drain (040500012509-02)	17	Other Indigenous Aquatic Life and Wildlife due to Total Suspended Solids (TSS), Flow Regime Modification and Sedimentation/Siltation	Warmwater Fishery	Sediment (k), Nutrients (s), Oils/Grease/Metals (k), (chromium, copper, lead PCBs, organic compounds; zinc, PAHs; BNAs), Pesticides (s)
South Branch	7		Warmwater Fishery Other Indigenous Wildlife	Sediment (k), Nutrients (s), Pesticides (s), Oils/Grease/Metals (s)
Lakes				
Paw Paw Lake	12		Warmwater Fishery Other Indigenous Wildlife	Sediment (k), Nutrients (k), Oils/ Grease/ Metals (s), Pesticides (s)
Maple Lake	7		Warmwater Fishery Other Indigenous Wildlife	Sediment (k), Nutrients (s), Oils/Grease/Metals (s), Pesticides (s)

+Refer to Figure 2 for subwatershed boundaries
*Referred to in the Integrated Report as South Branch

Figure 44. Paw Paw River Watershed Impaired Designated Use

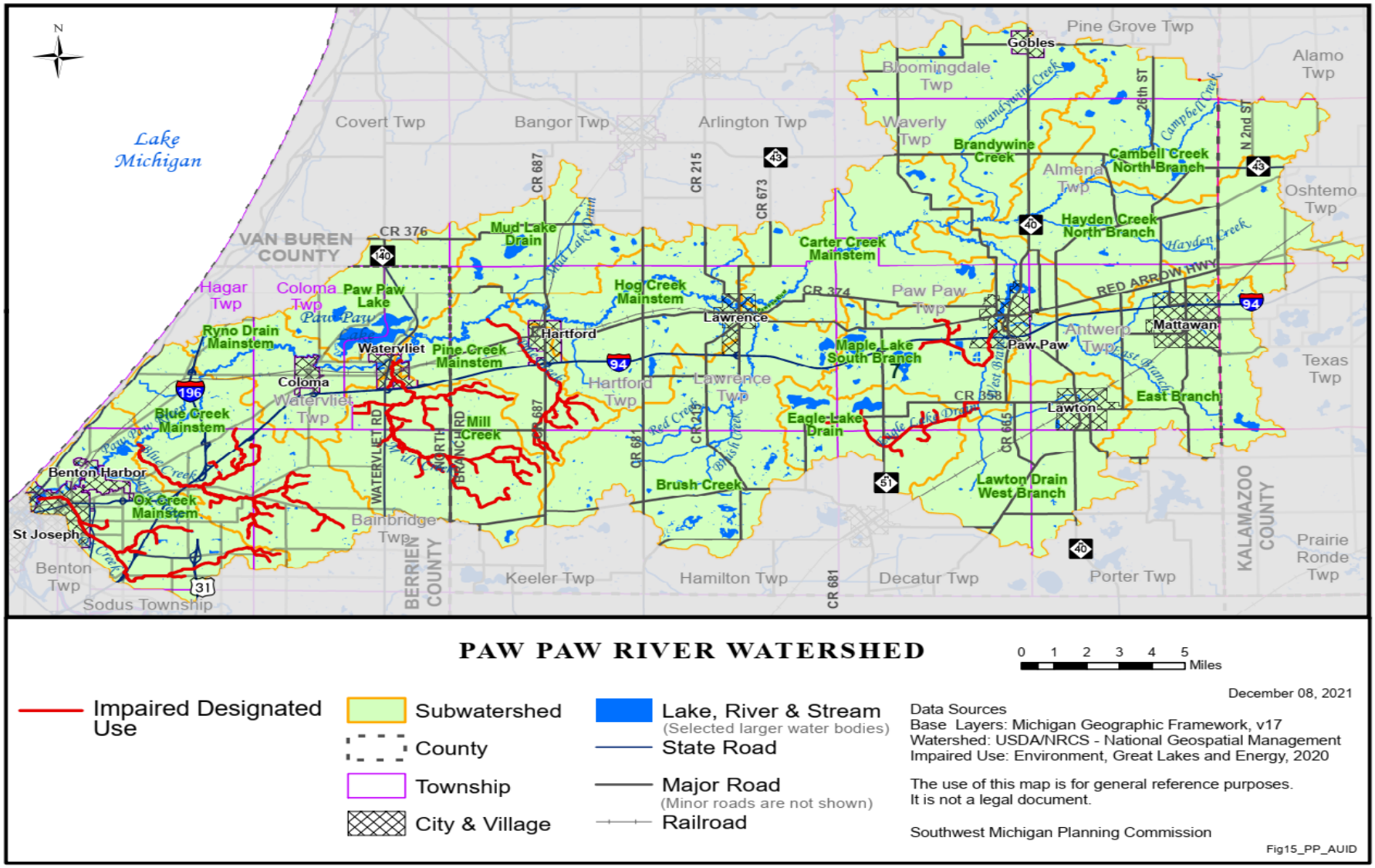


Table 16. Impaired Miles

Impaired Miles	Name
16.84258039	Ox Creek
19.03109258	Mill Creek
10.00641653	Eagle Lake
8.568834245	Pine Creek
14.93607165	Mill Creek
6.037263089	Maple Lake/South Branch
25.15352162	Blue Creek
4.160534549	Pine Creek

Table 17. TMDLs for Paw Paw River Watershed

Water Body	Pollutant	TMDL* Year
Ox Creek (summarized below)	Sedimentation/Siltation, Total Suspended Solids (TSS)	2018
Mill Creek (summarized below)	Escherichia coli (E. coli)	2009
Pine Creek (summarized below)	E. coli	2009
Blue Creek (summarized below)	E. coli	Statewide TMDL
Rush Lake	Mercury in Fish Tissue	2018
Van Auken Lake	Mercury in Fish Tissue	2018
Maple Lake	PCB in Fish Tissue	2013
Most PPRW Rivers/Streams/Lakes	PCB in Fish Tissue and Water Column and PCBs	2013

*A Total Maximum Daily Load (TMDL) is a calculation of the maximum amount of a pollutant a water body can receive and still meet applicable water quality standards.
Insert TMDL summaries for Ox, Pine and Mill, and Blue.

According to the 2020 Integrated Report, the following lakes are fully supporting Other Indigenous Aquatic Life and Wildlife: Paw Paw Lake (Berrien County), Paw Paw Lake (Kalamazoo County), Puterbaugh Lake, Shafer Lake, Hall Lake, Rush Lake, Van Auken Lake, Upper Reynolds Lake, School Section Lake, Maple Lake, Cora Lake, Brandywine Lake, Little Brandywine Lake, Ackley Lake, Three Mile Lake, Eagle Lake and Fish Lake. Both Wolf Lake and Paw Paw Lake (near Portage in Kalamazoo County) did not have sufficient information to determine if they meet the designated use of Coldwater Fishery.

Ox Creek

The purpose of the Ox Creek TMDL is to identify the appropriate actions to achieve the biological (macroinvertebrate) community targets that will result in Water Quality Standards attainment, specifically through reduction in total suspended solids (TSS) loadings from sources in the Ox Creek watershed. For Ox Creek, the impaired designated use is Other Indigenous Aquatic Life and Wildlife. The cause is other flow regime alterations, sedimentation / siltation, and solids (suspended / bedload). The sources are stream bank modifications / destabilization, impervious surface / parking lot

runoff, and urban runoff / storm sewers. The TSS target was set at 300 milligrams per liter (mg/L) as a daily maximum, which will protect aquatic life uses in Ox Creek.

Table 18 summarizes load reduction estimates. Implementation efforts should focus on erosion control in the upper portions of the Ox Creek watershed. Load reduction efforts in the lower portion of Ox Creek should focus on reducing storm water volumes delivered to the stream.

Table 18. Total Suspended Solids Estimation at Key Points in Ox Creek Watershed

Subwatershed		Load (tons/day)		Load Reduction
		Capacity	Existing	
A	*Yore – Stoeffer HW*	37.4	57	35%
B	*Upper Yore - Stoeffer*	45.5	518	91%
C	*Middle Yore - Stoeffer*	76.0	157	52%
D	*Lower Yore - Stoeffer*	90.0	180	50%
E	*Ox Headwaters*	45.2	87	48%
F	*Upper Ox*	147.8	160	8%
G	*Middle Ox*	163.4	266	38%
H	*Lower Ox*	181.8	197	7%
I	*Ox Outlet*	183.6	199	7%

Allocations fall into two categories: NPDES storm water Waste Load Allocation (WLA) (which includes MS4 and industrial storm water) and Load Allocation (LA) (which accounts for both nonpoint sources and background). The TMDL for Ox Creek established a Waste Load Allocation of 62.71 tons/day and a Load Allocation of 120.89 tons/day. There is a TSS Cumulative Loading Capacity of 183.6 tons/day. For the full TMDL document see Total Maximum Daily Load for Biota in Ox Creek.

Pine and Mill Creeks

Pine Creek (AUID: 040500012507-02, 040500012507-03) is 9.98 miles from the headwaters to the confluence with the Paw Paw River. The impaired designated use is Partial and Total Body Contact Recreation caused by E. coli.

Mill Creek (AUID: 040500012506-01) is 12.77 miles and the impaired designated use is Partial and Total Body Contact Recreation and caused by E. coli. Pine and Mill Creeks

were first placed on the Section 303(d) list in 2006 for the impairment of recreational uses due to exceedances of the E. coli WQS. Data collected by the Michigan Department of Environmental Quality (MDEQ) documented exceedances of the total and partial body contact WQS for E. coli at all sampling locations for both Pine and Mill Creeks during the months of July through September 2005. For this TMDL, the WQS of 130 E. coli per 100 mL as a 30-day geometric mean and 300 E. coli per 100 mL as a daily maximum to protect the total body contact designated use are the target levels for the TMDL reach from May 1 through October 31, and 1000 E. coli per 100 ml as a daily maximum year-round to protect the partial body contact designated use.

Possible sources of E. coli in Pine and Mill Creeks include runoff from pastureland and land application of manure, failing septic systems, illicit connections to storm sewers and drains, and inputs from wildlife. During certain weather conditions, the Hartford Dairy Concentrated Animal Feeding Operation (CAFO) (# MI0057562 - National Pollutant Discharge Elimination System (NPDES) permit) is a likely source of E. coli to Pine Creek. There are no CAFO permitted facilities in the Mill Creek watershed; however, the Hartford Dairy CAFO (MI0057562) does apply manure to some fields in the watershed.

This pathogen TMDL is concentration-based and the TMDL is equal to the total body contact target concentrations of 130 E. coli per 100 mL as a 30-day geometric mean and daily maximum of 300 E. coli per 100 mL in all portions of the TMDL reach for each month of the recreational season (May through October) and partial body contact target concentration of 1000 E. coli per 100 mL as a daily maximum year-round.

Because this TMDL is concentration-based, the total loading for this TMDL is equal to the total body contact WQS of 130 E. coli per 100 mL as a 30-day geometric mean and 300 E. coli per 100 mL as a daily maximum from May 1 to October 31, and partial body contact WQS of 1000 E. coli per 100 mL as a daily maximum year-round.

The WLA for the permits is equal to 130 E. coli per 100 mL as a 30-day average and 300 E. coli per 100 mL as a daily maximum from May 1 through October 31, and 1000 E. coli per 100 mL as a daily maximum year-round. For more information see EGLE – Total Maximum Daily Load for E. coli for Pine and Mill Creeks.

Blue Creek

Given the extent of the E. coli problem in Michigan's waters and the multitude of potential sources, a statewide approach was deemed more effective and efficient for addressing this issue. The Statewide E. coli TMDL, approved by the U.S. Environmental Protection Agency (U.S. EPA) in 2019, provides a general legal framework for reducing pollutant loads in areas where the E. coli Water Quality Standard (WQS) is exceeded. The goal is to meet the E. coli WQS and the total and partial body contact designated uses in each water body. Therefore, the numeric targets for all potential sources are equal to the total body and partial body contact WQS. The statewide daily targets are 300 E. coli per 100 milliliters (mL) from May to October and 1,000 E. coli per 100 mL the remainder of the year. An additional target is 130 E. coli per 100 mL as a 30-day

geometric mean from May to October. Blue Creek (AUID: 040500012508-01) is included in the statewide TMDL for E. coli and was first listed in 2008 as not meeting WQS. The creek exceeded the 30-day geometric mean 100%, it exceeded Total Body Contact 69% and Partial Body Contact 8%. The geometric mean for Blue Creek is 451 E. coli per 100 mL and the percent reduction is 33.5%. The E. coli sampling was conducted near Milburg and the suspected source is failing septic systems. More information see Michigan's Statewide E. coli Total Maximum Daily Load.

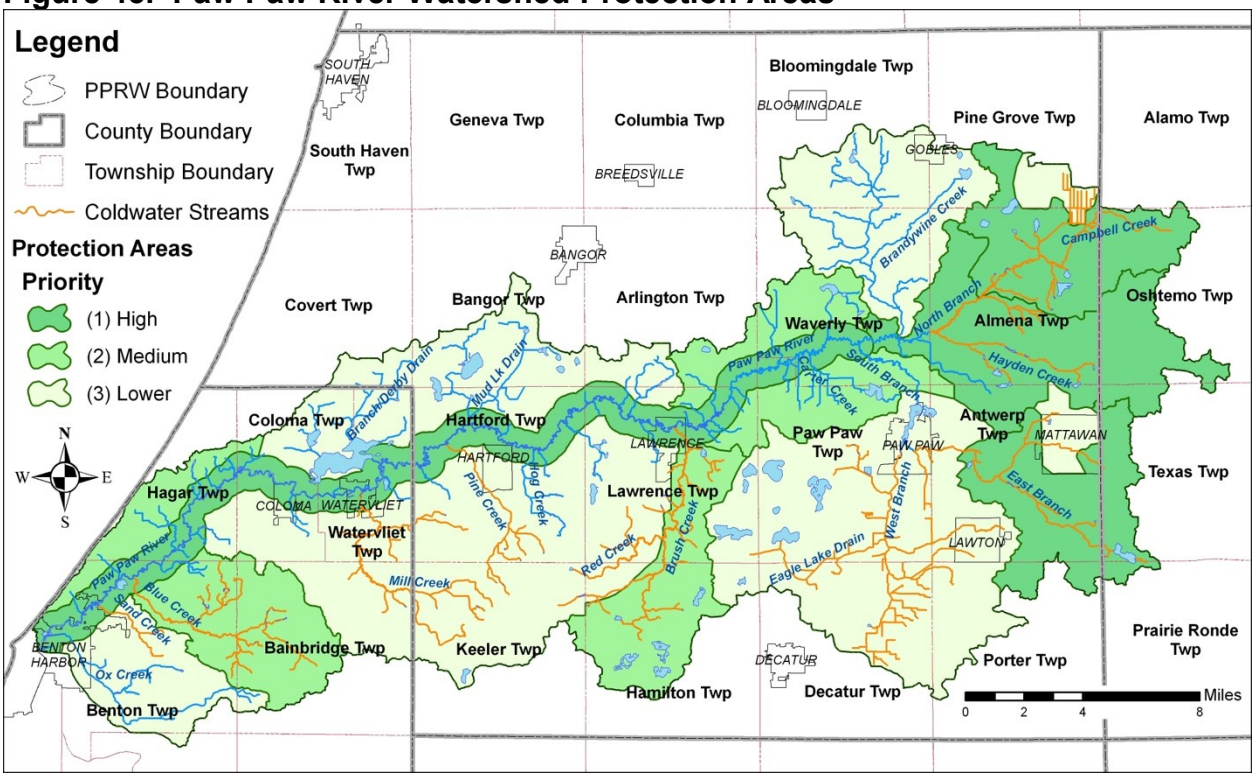
8 Prioritization - Areas, Pollutants, Sources

Priority areas were identified in the watershed based on lands that are contributing, or have the potential to contribute, a majority of the pollutants impacting water quality. By identifying priority areas, implementation can be targeted to the places where the most benefit can be achieved. Three different types of areas were prioritized in the PPRW – protection, agricultural management and urban management. Pollutants and sources of pollutants were also prioritized for each of the three areas.

8.1 Protection Areas

The prioritization of protection areas is based on the amount of natural land cover (habitat), groundwater recharge potential, intact wetland functions, the presence of high-quality water bodies and development pressure. The PPRW is prioritized into three categories for protection as shown in Figure 45. High priority protection areas are generally the Paw Paw River mainstem and the PPRW headwaters (North Branch and East Branch subwatersheds). Medium priority protection areas include the Blue Creek and Brush Creek subwatersheds, the southwestern half of Waverly Township and the area near Lake Michigan. The high and medium priority areas, if not preserved or at least managed properly, have the potential to contribute large amounts of pollution, as well as disrupt hydrologic patterns in the watershed. The remainder of the watershed is lower in priority for protection efforts, but since this analysis is at a landscape level, specific sites in the lower priority area may need just as much attention as the high and medium priority areas for maintaining long-term water quality in the watershed.

Figure 45. Paw Paw River Watershed Protection Areas



Protection Area Pollutants and Sources

In the protection areas the prioritization of pollutants and sources is based on their potential to threaten or impair water quality as development increases in these areas.

In the protection areas, the pollutants are prioritized as follows:

1. **Sediment** is a known pollutant causing impairments throughout the watershed. Construction sites in developing areas often contribute sediment to water bodies. Additional impervious surfaces alter hydrology leading to increased erosion and sedimentation.
2. **Nutrients** are currently a problem pollutant around lakes and urban areas. Nutrients are often attached to sediment. Stormwater runoff containing nutrients from lawns and golf courses is expected to increase with new development. Nutrients from additional septic systems could also be an issue with increased development in rural or suburban areas not served by municipal sewer.
3. **Temperature** is a concern because most coldwater streams are located in protection areas. With additional impervious surfaces and the removal of riparian buffers, the temperature of these streams could increase. Increased temperature could limit their ability to support coldwater fish.
4. **Bacteria and pathogens** are currently a suspected problem around lakes not served by municipal sewer systems. With increased development and additional septic systems in protection areas (especially in areas with soils not suitable for septic systems), bacteria and pathogens might become a more widespread problem.
5. **Pesticides** are suspected to become a problem with increased urbanization and the use of pesticides on lawns and golf courses.
6. **Oil, grease and metals** are not currently suspected to be a major problem in protection areas. The amount of oil, grease and metals is expected to increase with new development in these areas.

In the protection areas, the pollutant sources are prioritized as follows:

1. **Streambanks –** Increasing impervious surface in protection areas could alter hydrology and cause streambank erosion if runoff is not managed properly. Removal of the riparian corridor for waterfront development in protection areas could cause additional streambank erosion.
2. **Stormwater runoff –** Several priority pollutants could be delivered to protection area water bodies by stormwater runoff. With new development, stormwater runoff from construction sites and impervious surfaces is expected to increase in protection areas.
3. **Septage waste –** Failing septic systems are expected to become a problem with additional waterfront and suburban type development occurring in protection areas.
4. **Livestock –** There are several unrestricted livestock access sites within the protection areas; however, with increased residential development occurring in these areas, it is expected that livestock problems will become less of a concern.

8.2 Agricultural Management Areas

The prioritization of agricultural management areas is based on significant water body impairments, estimated pollutant loadings (SWAT model), amount of agriculture land cover and problems identified by EGLE staff, MDNR Fisheries staff, Van Buren County Drain Commissioner or through the volunteer inventory process. The PPRW is prioritized into three categories for agricultural management as shown in Figure 46. The high priority agricultural management areas are the Mill Creek, Pine Creek, Red Creek, Brandywine Creek and West Branch subwatersheds and the Mentha Flats area in the southeast corner of Pine Grove Township. The medium priority agricultural management areas generally cover the Branch & Derby Drain, Mud Lake Drain and Hog Creek subwatersheds as well as the upstream portions of Ox and Sand Creek. The high and medium priority areas are suspected to contain a majority of the agricultural related pollutant sources impairing or threatening water quality in the PPRW. The remainder of the watershed is in a lower priority level for agricultural management efforts. However, since this analysis is at a landscape scale, there may be agricultural sites in the lower priority area that need attention to improve water quality in the watershed.

Figure 46. Paw Paw River Watershed Agricultural Management Areas

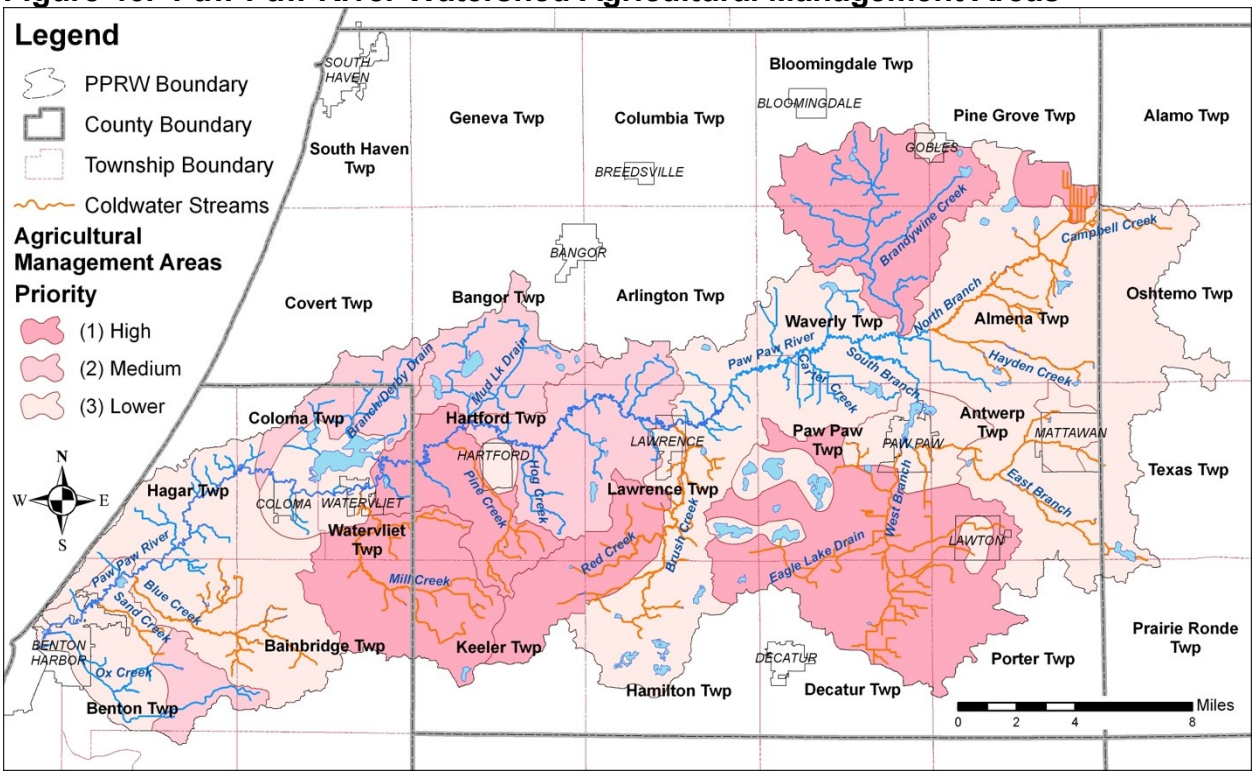


Figure 47. Paw Paw River Watershed Cropland

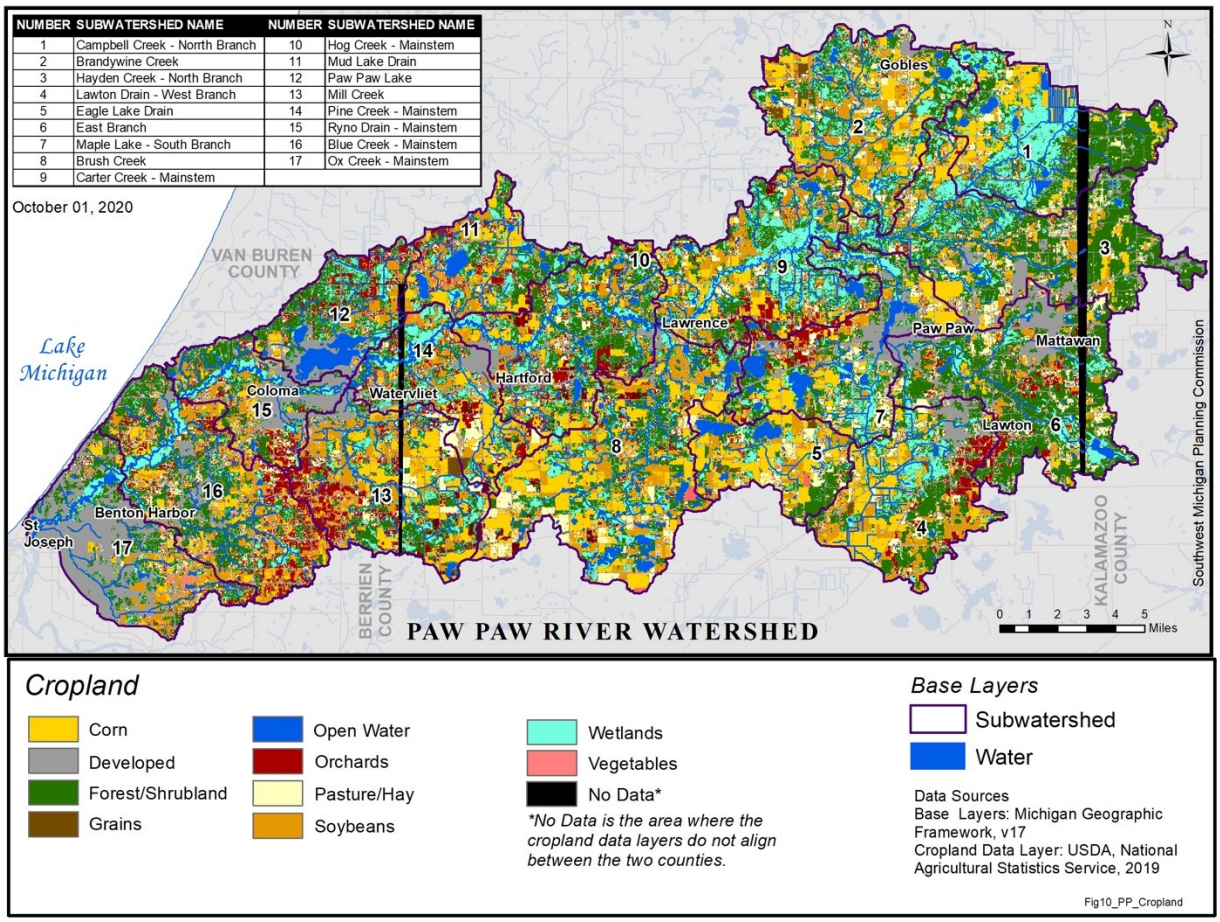


Table 19. Cropland Data Layer

CLASS	ACRES	PERCENT
Developed, High, Medium and Low	17,434	6.1%
Developed, Open Space	20,173	7.1%
Cropland	108,723	38.1%
Grassland/Pasture	13,041	4.6%
Forest	79,045	27.7%
Wetland	42,649	14.9%
Water	4,406	1.5%

Table 20. Highlights of the different crops

HIGHLIGHTS	ACRES
Corn	36,278
Hay	26,744
Soybean	18,632
Apples	6,346
Blueberries	6,251
Cherries	5,280
Grapes	5,188
Grains	2,135
Peppers	564

Agricultural Management Area Pollutants and Sources

In the agricultural management areas the prioritization of pollutants and sources is based on their suspected significance to impaired water quality in these areas.

In the agricultural management areas, the pollutants are prioritized as follows:

1. **Sediment** is a known pollutant throughout the watershed, especially in the agricultural areas. Sediment from agricultural runoff also carries nutrients like phosphorus and nitrogen. Biosurveys found sediment impairment occurring in all of the impaired streams in agricultural management areas.
2. **Bacteria and pathogens** are a known pollutant in two of the highest priority agricultural management area waterbodies, Mill and Pine Creeks. TMDLs are developed for these watersheds due to extremely high Escherichia coli (E. coli) levels. Blue Creek has high E. coli levels and is part of the statewide E. coli TMDL. Unrestricted livestock access sites have also been found in agricultural management areas.
3. **Nutrients** are a suspected pollutant in all of the agricultural management areas. In the West Branch, one of the highest priority agricultural management areas, nutrients are causing low dissolved oxygen levels.
4. **Pesticides** are suspected to be a problem in agricultural areas; however, no data was found to document their significance in the PPRW.
5. **Temperature** is a concern in agricultural management areas because the removal of tree cover along coldwater streams and drains can lead to increased water temperature. Temperature is also impacted by altered hydrology from increased drainage efficiency and soil compaction, because groundwater recharge is reduced.
6. **Oil, grease and metals** are a concern in agricultural areas because of the use and maintenance of farm equipment (tractors, irrigation pumps, etc.).

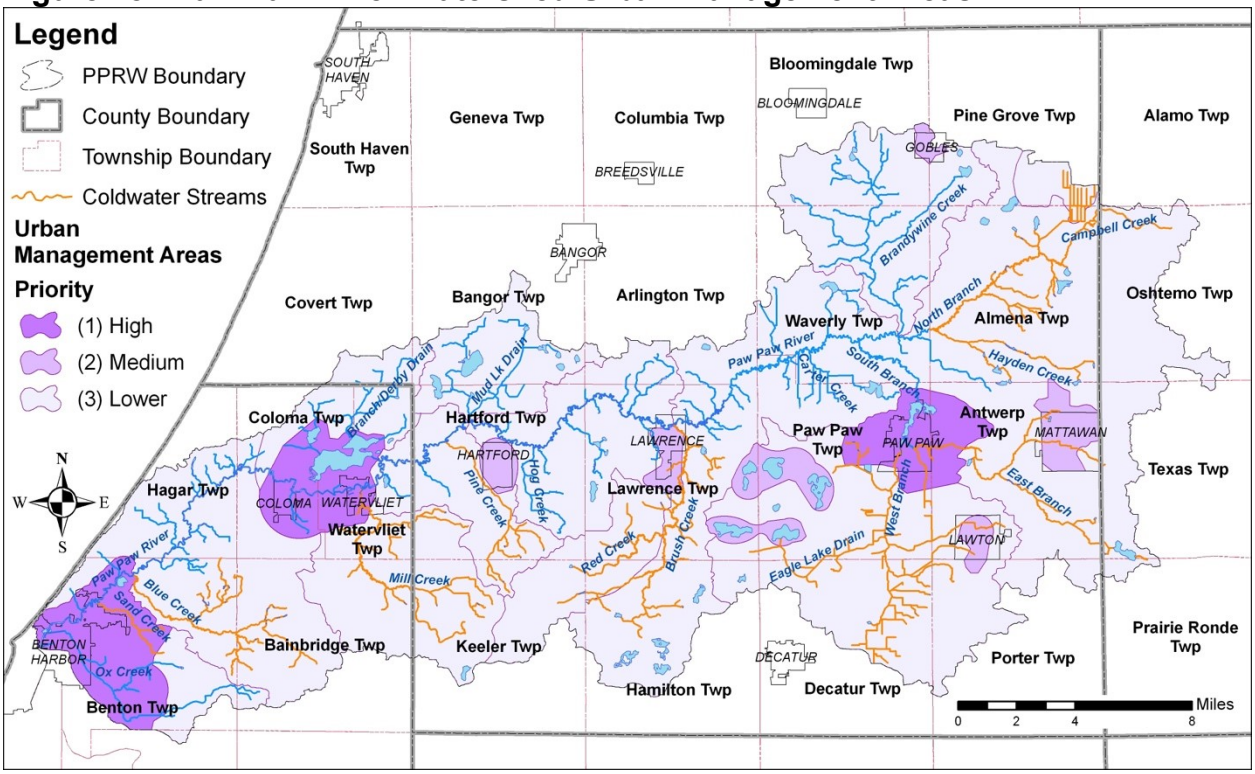
In the agricultural management areas, the pollutant sources are prioritized as follows:

1. **Streambanks –** Streambank erosion is a significant source of the highest priority pollutant (sediment). Streambank erosion was identified in biosurveys throughout the agricultural areas. In addition, recent fieldwork identified several streambank erosion sites on agricultural drains in the Paw Paw Lake (Berrien County) watershed.
2. **Livestock –** Two water bodies with a developed TMDL in agricultural management areas (Mill and Pine Creek) are being impacted by the application of livestock waste.
3. **Stormwater runoff –** Unmanaged runoff from agricultural lands can carry sediment, nutrients, bacteria and pathogens directly to surface water.
4. **Septage waste –** Failing septic systems and improper application or disposal of septage waste by septic haulers is a suspected source of nutrients, bacteria and pathogens in agricultural management areas. Failing septic systems are a suspected source of E. coli for Blue Creek.

8.3 Urban Management Areas

The prioritization of urban management areas is based on significant water body impairments, amount of urban land cover and problems identified by EGLE staff, MDNR Fisheries staff, Van Buren County Drain Commissioner or through the volunteer inventory process. The PPRW is prioritized into three categories for urban management as shown in Figure 48. The high priority urban management areas are the downstream portions of the Ox and Sand Creek subwatersheds, the Paw Paw Lake area and the Village of Paw Paw. Medium priority areas include the Villages of Lawrence, Lawton and Mattawan, the Cities of Gobles and Hartford and the area around Eagle, Three Mile, Cora, Reynolds and Christie lakes (between Lawrence and Paw Paw Villages). The high and medium priority areas are suspected to contain a majority of the urban related pollutant sources impairing or threatening water quality in the PPRW. The remainder of the watershed is in a lower priority level for urban management efforts. However, since this analysis is at a landscape scale, there may be places in the lower priority area that need attention to improve water quality in the watershed.

Figure 48. Paw Paw River Watershed Urban Management Areas



Urban Management Area Pollutants and Sources

In the urban management areas, the prioritization of pollutants and sources is based on their suspected significance to impaired water quality in these areas.

In the urban management areas, the pollutants are prioritized as follows:

1. **Sediment** is a known pollutant causing impairments in urban areas, especially in Benton Harbor (Ox Creek) and the Village of Paw Paw (Maple Lake).

2. **Nutrients** are a known pollutant in urban stormwater runoff. A study of Paw Paw Lake attributed low dissolved oxygen levels to excess nutrients. Nutrients are also suspected to be a problem in other developed lakes in the watershed.
3. **Oil, grease and metals** are a known pollutant in Ox Creek and are suspected to be causing impairments.
4. **Bacteria and pathogens** are suspected to be a problem in highly developed lake areas without municipal sewer (Eagle, Three Mile, Cora, Reynolds and Christie lakes).
5. **Temperature** is a concern because impervious surfaces in urban areas can cause increases in temperature; however, most coldwater streams in the PPRW are not located in urban areas.
6. **Pesticides** are a pollutant of concern in urban areas because of improper application on lawns and golf courses in these areas; however no data was found documenting their significance in the PPRW.

In the urban management areas, the pollutant sources are prioritized as follows:

1. **Stormwater runoff –** A majority of pollutants impairing or threatening designated uses in urban areas are found in stormwater runoff, which largely results from impervious surfaces.
2. **Streambanks –** Impervious surfaces in urban areas can alter hydrology, which causes streambank erosion.
3. **Septage waste –** Septic systems are suspected to be a source of bacteria and pathogens in lake areas lacking municipal sewer services. In addition, the failure of sewer system infrastructure in urban areas has also led to releases of untreated wastewater.

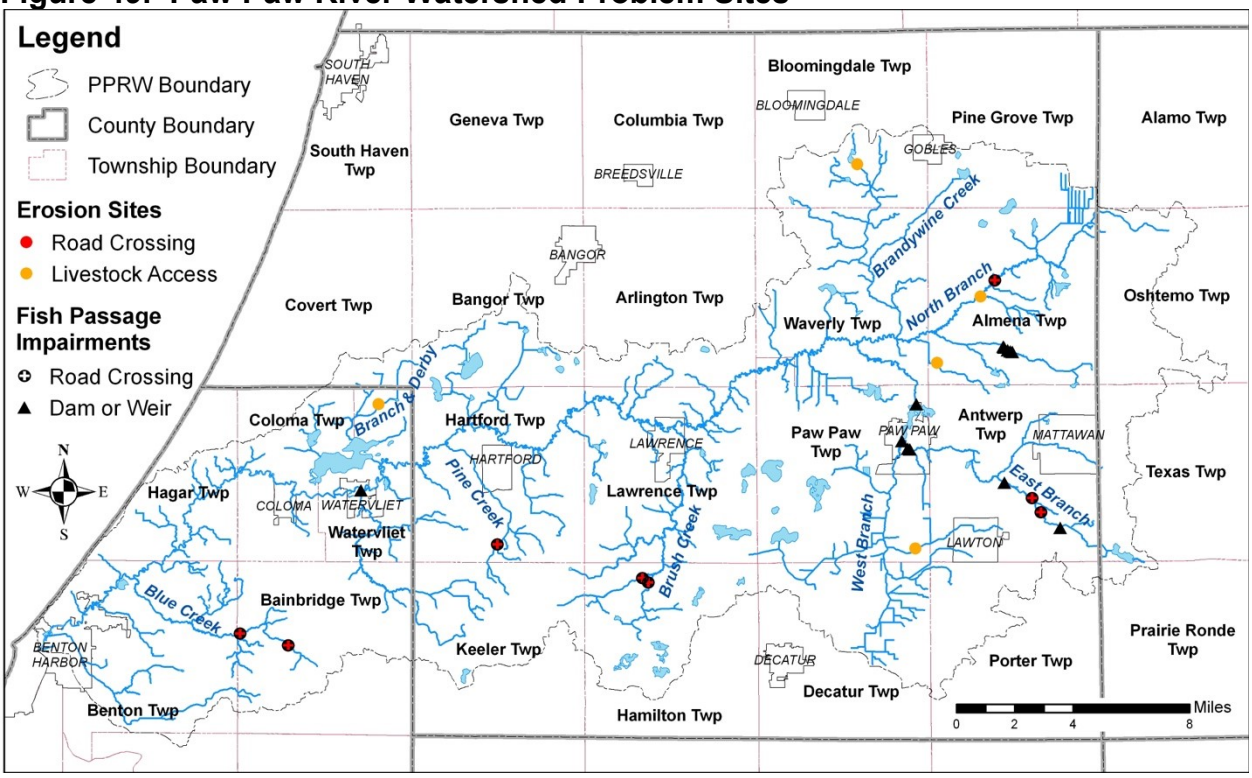
8.4 Problem Sites

Along with the priority areas, stakeholders identified several problem sites during the planning process that need attention. These sites included erosion sites, fish passage impairments and illegal wetland drainage or fill sites. A major problem site is located between Watervliet and Hartford along the Red Arrow Corridor, where a large wetland complex has been extensively ditched and drained altering the hydrology of the area.

Erosion and fish passage impairment sites are identified in Figure 49. Fish passage impairment sites result from a road crossing, dam or weir. An MDNR fisheries biologist identified the fish passage impairment sites. The fish passage sites may not be causing direct erosion problems but may be disrupting the natural flow regime of several tributaries in the watershed. Further, the low head dams and weirs found in the watershed can impact the movement of fish and other organisms and limit their ability to reach headwater areas for spawning and nursery areas.

Following the map is a description of each erosion site, which is due to either a problematic road/stream crossing or unrestricted livestock access to a stream. Volunteers identified several of the livestock access problem sites during the Volunteer Inventory process. At the livestock access problem sites, the streambanks are eroding, and most likely nutrients and bacteria/pathogens are entering the waterbodies.

Figure 49. Paw Paw River Watershed Problem Sites



Blue Creek
There are two known impaired road/stream crossings along Blue Creek, both on Territorial Road. The first crossing has a failing culvert that is undersized causing erosion and a shifting sand bedload on top of the fine gravel streambed. Stormwater runoff at the second crossing is causing erosion and variable flow rates. The undersized culverts at this crossing are impacting fish passage, flow and sand/woody debris transport.

Branch and Derby Drain
There is one known pasture with unrestricted livestock access on Branch & Derby Drain between M-140 and North Watervliet Rd.

Pine Creek
There is one known impaired road/stream crossing along Pine Creek at 64th Street causing sedimentation. The bottom of this box culvert is elevated above the streambed resulting in a semi-perched condition affecting channel morphology.

Brush Creek
There are two known impaired road/stream crossings in the Brush Creek watershed. The CR 215 road crossing of White Creek is preventing fish passage and causing modifications to stream morphology. The CR 215 crossing of Brush Creek is preventing fish passage and causing streambank erosion.

West Branch
There is one known unrestricted livestock access site in the West Branch watershed. Sheep were reported to have unrestricted access to Lawton Drain near CR 665.

East Branch
There are two known impaired road/stream crossings along the East Branch. The crossing at 26th Street has a culvert that is poorly aligned with the stream dimensions and as a result is preventing fish passage upstream and causing scouring downstream. The crossing at 63rd Avenue is undersized and perched preventing fish passage, creating scouring downstream and impounding water upstream.

North Branch
There is one known impaired road/stream crossing north of Whiskey Run on CR 653 causing severe streambank erosion. The culverts are poorly aligned and undersized restricting flows and creating modifications to the stream dimensions. There are two known sites where livestock have unrestricted access to streams within the North Branch watershed. One site is located on Ritter Creek at 30th Street and the other is on the Paw Paw and Allegan Road Drain at 45th Street.

Brandywine Creek
There is one known unrestricted livestock access site in the Brandywine Creek watershed. The site was found during the volunteer inventory on Martin Lake Drain at 18th Ave.

9 Goals and Objectives

Successful implementation of a watershed management plan is more likely to occur when the objectives are based on clearly defined goals. Goals can represent a long-term vision and also serve as guideposts established to keep everyone moving in the same direction and assess progress. Objectives are more specific actions that need to occur to achieve the stated goal. The goals and objectives for the PPRW address both water quality concerns and desired uses.

Successful implementation of a watershed management plan is more likely to occur when the objectives are based on clearly defined goals.

9.1 Goals for Designated Uses

The following two goals are related to restoring and protecting the designated uses of water bodies in the PPRW. Objectives for these goals are listed in the Action Plan (Table 22) as tasks to be implemented.

1. Prevent or reduce pollutants threatening or impairing water quality by sufficiently preserving or managing protection areas to meet designated uses.

2. Reduce pollutants threatening or impairing water quality in agricultural and urban management areas to meet designated uses.

9.2 Goals for Desired Uses

In addition to the Designated Uses established by state and federal water quality programs, stakeholders identified several Desired Uses for the PPRW. Desired uses are based on factors important to the watershed community. Desired uses may or may not have a direct impact on water quality. Table 21 lists the Desired Uses identified through public meetings, surveys and discussions with watershed stakeholders. The desired uses listed in Table 21 all have a direct or indirect impact on water quality.

Table 21. Paw Paw River Watershed Desired Uses

PPRW Desired Use	General Definition
Coordinated development	Promote and achieve the environmental and economic benefits of planned communities through coordinated land use planning and low impact development
Intact habitat for native and aquatic and terrestrial wildlife	Protect and enhance the habitats on which indigenous, threatened, and endangered species depend
Open Space and Agricultural Land	Develop a green infrastructure network consisting of natural, open and working lands to maintain a viable farming economy, maintain the rural character of communities, and maintain the natural ecosystem functions provided by woodlands, wetlands, and other natural areas
Groundwater Resources Protection	Protect groundwater recharge and wellhead areas from contamination and overdrafting
Appropriate recreational use and infrastructure	Establish water and non-motorized trails on or along appropriate sections of the Paw Paw River and its tributaries where desired and feasible while protecting natural features
Watershed monitoring efforts	Continue and increase monitoring efforts to better understand issues in the PPRW and to create baselines for future reference
Watershed Organization	Develop an organization to coordinate implementation of the watershed management plan

The following goals were developed to address the desired uses identified by stakeholders. Objectives for these goals are listed below.

1. Coordinated land use planning in the PPRW.

- Review local plans, ordinances and regulations addressing stormwater management, non-point source pollution and related water quality and natural resource issues
- Promote uniform set back requirements along lakes, streams, rivers and wetlands
- Develop model language for development standards and ordinances
- Develop resource maps for planning officials
- Gain local commitments to consider the watershed context in planning efforts and to recognize stormwater planning early in site planning and evaluation
- Conduct technical workshops and provide technical assistance throughout the watershed regarding the importance of coordinated watershed and land use planning
- Develop a communication plan targeting mayors, city managers, county administrators, governing bodies, planning commissioners, community development corporations, and neighborhoods about the importance of watershed and land use planning

2. Protected habitat for native aquatic and terrestrial wildlife

- Build support to include the Paw Paw River in Michigan's Natural Rivers Program
- Develop a community supported green infrastructure vision for the PPRW that includes natural and working lands
- Assist conservation organizations, local governments and landowners to preserve and manage wildlife habitat
- Minimize modification of sensitive habitat areas such as stream corridors
- Conduct on the ground habitat evaluations in high priority protection areas and in high quality water bodies

3. Protected groundwater resources

- Develop and implement community well head protection programs
- Continue to close abandoned wells
- Determine current and future amount of groundwater withdrawal and its potential impacts
- Develop strategies to prevent increased impervious surfaces in high recharge areas and to restore areas with high recharge potential, as appropriate

4. Improved recreation infrastructure along river while respecting natural features

- Encourage coordinated recreation planning that promotes sustainable uses of natural resources and protects the unique natural features of PPRW communities
- Incorporate bank stabilization efforts and BMPs at access sites to minimize the impact of foot traffic and erosion
- Educate private and commercial river users on the proper management of woody debris to improve navigability without impacting fish habitat or hydrology
- Build and maintain a trail/boardwalk system along appropriate sections of the river
- Remove litter and trash along banks
- Educate boaters about limiting the movement of invasive species

5. Continued/increased watershed monitoring efforts

- Partner with Drain Commissioners, MDEGLE, MDNR, tribal and federal agencies to develop and implement a monitoring strategy to examine the current quality of the river as well as to monitor changes over time
- Coordinate volunteer road/stream crossing riparian surveys to assess current conditions and monitor changes over time as well identify problem sites
- Develop a program for testing of private drinking water wells
- Encourage monitoring and potential regulation of commercial groundwater withdrawals

6. Continue to provide a sustainable organization (Two Rivers Coalition) to coordinate and implement the watershed management plan and to instill a sense of stewardship

- Identify a funding strategy that includes membership, governmental units, foundations and business support
- Hire staff to secure funding and implement the watershed management plan
- Develop a work plan for the organization

10 Implementation Strategies

This chapter provides a management strategy to protect and improve water quality in the PPRW. The management strategy prioritizes tasks to be implemented, identifies specific problem sites and lays out a detailed action plan for implementation. The strategy also includes an information and education plan and describes current efforts. The entire watershed should be monitored by EGLE. For more details see section 11.3.

10.1 Action Plan by Priority Area

Table 22 is a detailed action plan with structural, vegetative and managerial tasks, which address priority pollutants and their sources. This action plan should serve as a starting point for effective implementation. The items in the action plan should be reviewed annually and updated as conditions change in the watershed.

Table 22 is divided into three priority areas (protection, agricultural and urban) and specific sites, which are detailed later in this chapter and identified in Figure 26. For each priority area, specific tasks are listed. Each task addresses specific pollutants and sources as indicated. Since resources will probably not be available to implement all of the tasks at once, Table 22 provides a suggested timeframe for beginning implementation of each task. The implementation timeframe was based on the ranking of pollutants and sources for each priority area in Chapter 8. Prioritizing the tasks will allow resources to be allocated to the tasks that address the most important pollutants and sources first. The timeframe may be changed if resources or opportunities become available for earlier implementation. Table 22 also provides a cost estimate for each task and identifies the potential lead agency or individuals that need to take action. Potential partners, funding sources and programs are listed, which could assist with task implementation. Lastly, milestones and proposed evaluation methods are listed for each task.

Below is a list of structural, vegetative and managerial tasks to be implemented in the PPRW by priority area. The priority areas are meant to target implementation efforts where the most benefit can be achieved. However, implementing these tasks in other parts of the watershed may be necessary to achieve long-term water quality improvement and protection. The priority areas are based on the watershed protection and management area maps described in Chapter 8 (Figure 45, Figure 46, and Figure 48).

<u>Protection Area Tasks</u>

The following tasks should be focused in the high and medium priority protection areas as indicated in Figure 45.

Highest-priority tasks:

- Enact/improve water quality protection related ordinances (see Chapter 4.3 of this plan for recommendations on ordinances)
- Protect wetlands (see Landscape Level Wetland Functional Assessment report to determine priority sites for protection)

- Enact ordinances protecting riparian buffers
- Update inventory of road stream crossings and prioritize for improvements
- Identify and correct problem road/stream crossing sites (see Figure 49)

High-priority tasks:

- Protect sensitive lands and high priority wetlands (see Figure 37 for further refinement of priority lands by quarter-quarter section and Figure 17, Figure 18, Figure 19 for high priority wetlands)
- Improve and promote soil erosion and sedimentation practices and regulations (building construction site practices and regulations)

Medium-priority tasks:

- Improve zoning maps to locate high density or intensive uses in appropriate areas
- Identify and correct failing septic systems

Agricultural Area Tasks

The following tasks should be focused in the high and medium priority agricultural management areas as indicated in Figure 46.

Highest-priority tasks:

- Utilize alternative drain maintenance/ construction techniques (such as two stage ditch design, natural river restoration techniques – j-hooks, cross vanes, etc)
- Restore riparian buffers and stabilize eroding streambanks
- Restore and protect wetlands (see Landscape Level Wetland Functional Assessment to determine priority sites for restoration)
- Prevent/limit livestock access (fencing, crossings structures, alternative water sources) (see Figure 49)
- Install agricultural BMPs (filter strips, no-till, cover crops, grassed waterways, etc)
- Protect wetlands (see Landscape Level Wetland Functional Assessment report to determine priority sites for protection)
- Expand disposal options for agricultural chemicals
- Conduct additional E. coli monitoring in TMDL watersheds

High-priority tasks:

- Develop and implement manure management plans

Medium-priority tasks:

- Utilize soil testing to determine appropriate application rates for fertilizers and pesticides
- Utilize integrated pest management
- Construct secondary containment facilities for chemical/fuel handling areas
- Improve and/or enforce septage waste disposal regulations

Urban Area Tasks

The following tasks should be focused in the high and medium priority urban management areas as indicated in Figure 48.

Highest-priority tasks:

- Utilize stormwater best management practices (road/parking lot sweeping, stormceptors, rain gardens, constructed wetlands, vegetated swales, etc)

- Enact and improve stormwater and post construction control ordinances (see Low Impact Development for Michigan: A Design Guide for Implementers and Reviewers at www.swmpc.org/downloads/lidmanual.pdf or see model stormwater ordinance at www.swmpc.org/ordinances.asp)
- Identify and correct illicit connections or discharges to stormwater system
- Utilize best management practices for road maintenance (such as alternative de-icing methods)
- Enact a phosphorus lawn fertilizer ban

High-priority tasks:

- Increase or expand household hazardous waste disposal options
- Distribute spill kits

Medium-priority tasks:

- Properly maintain and design municipal sewer system infrastructure

10.2 Information and Education

The structural, vegetative and managerial tasks listed in the action plan (Table 22) are voluntary. Therefore, individuals, before they are motivated to action, will need to understand the watershed concerns and how their actions can play a role in protecting water quality. An Information and Education (I&E) plan was developed to offer a strategy for informing and motivating responsible parties to implement the tasks listed Table 22. The I&E plan provides goals and outlines the relationship between target audiences, watershed issues and outreach activities. The I&E plan was developed in cooperation with the Black River Watershed Project because both watersheds have similar issues. The benefits of partnering and sharing resources are clear with outreach activities. The Black and Paw Paw River Watershed Information and Education Plan can be found in Appendix 10.

10.3 Planning and Studies

In some areas, further study and investigation, as well as subwatershed planning may be needed before more specific recommendations can be made. For example, hydro geomorphology studies in the Ox Creek, West Branch/Eagle Lake Drain and Branch/Derby Drain subwatersheds would provide specific direction as to which BMPs would be best suited to improve water quality and hydrology problems in these water bodies. In the North and East Branch subwatersheds, an on the ground habitat evaluation of the land and waterbodies would be beneficial for targeting protection efforts.

Wetland restoration and protection activities are listed for both protection and agricultural management areas, therefore the implementation of these tasks could have a substantial effect on the long-term improvement and protection of water quality in the watershed. A targeted wetland restoration and protection project based on the Landscape Level Wetland Functional Assessment in conjunction with an educational campaign to landowners and municipal officials would be extremely helpful in advancing the wetland related tasks in the action plan. A few demonstration projects would be beneficial even in lower priority areas, because there has not been much wetland restoration work in the watershed.

10.4 Current Efforts

There are several opportunities to coordinate with and build upon existing local programs and projects. Below is a description of some key local initiatives that have developed during the planning phase of the PPRW project. Information on several other organizations and agencies working to improve and protect water quality over the years in the PPRW can be found in Appendix 11.

The Southwest Michigan Land Conservancy and The Nature Conservancy are coordinating protection efforts in the headwaters and along the mainstem. Sarett Nature Center is continuing to purchase lands along the mainstem and Blue Creek in the Benton Harbor area. After conducting a study to determine priority sources of sediment and nutrients, the Paw Paw Lake Foundation is working to develop implementation strategies. The Village of Paw Paw in partnership with the Van Buren County Drain Commissioner and the Maple Lake Association are coordinating efforts to better understand pollutant sources and causes in the Maple Lake Watershed.

The Black River and Paw Paw River Watershed steering committees hosted sustainability workshops in May and June of 2008. At these workshops, the participants explored options available to ensure the watershed management plans are being implemented by a sustainable watershed organization. As a result of these meetings, a transition team formed to develop a new watershed organization to protect and improve the Paw Paw and Black River Watersheds called the **Two Rivers Coalition**: An alliance of the Black and Paw Paw River Watersheds. Over the next year, the group hopes to incorporate as a 501(c)3. Meanwhile the group will focus on a few efforts to protect and improve water quality such as promoting a phosphorus ban for lawn fertilizer in Allegan, Van Buren and Berrien Counties and attending township board and planning commission meetings to talk about water quality issues. The next step will be for the Two Rivers Coalition to partner with another organization such as the Van Buren Conservation District or the Southwest Michigan Land Conservancy to assist with watershed plan implementation.

There have been significant implementation activities since the development of the PPRW Management Plan. With assistance from SWMPC, VBCD, Freshwater Future and the Southwest Michigan Land Conservancy, the Two Rivers Coalition (TRC) was formed and received 501(c)(3) status. The Two Rivers Coalition, Van Buren Conservation District, Southwest Michigan Land Conservancy and Southwest Michigan Planning Commission have been conducted many implementation activities over the years. Also, several lake associations, in conjunction with the Michigan Lakes and Streams Association, have spent significant time and resources monitoring water quality in the watershed.

- In 2016 communities along the Paw Paw River began meeting to develop the Paw Paw River Water Trail. This is now one of the most successful water trails in southwest Michigan.
- Southwest Michigan Land Conservancy continues to protect land and wetlands in the watershed.

- Wetland restoration has been funded with 319 funds in the Paw Paw River Watershed.
- Municipalities have updated master plans and implemented zoning ordinances that are more protective of water quality and wetlands including building setbacks, buffer requirements and anti-keyholing ordinances.
- MSU-Extension has hosted educational activities, including Introduction to Lakes workshops
- The Van Buren Conservation District has worked with extensively with farmers in the Paw Paw River Watershed to incorporate BMPs such as cover crops, no-till and buffers to improve water quality.
- SWMPC and VBCD held a series of watershed workshops, including a Watershed Short Course, Introduction to Lakes workshop, and municipal summits on Low Impact Development Techniques and smart growth.
- VBCD and TRC host an annual river clean up and macro-invertebrate monitoring program in the Black and Paw Paw River Watersheds.
- In 2016, VBCD, the Van Buren Road Commission, SWMPC and TRC formed a partnership to conduct a pilot program for a road/stream crossing inventory in the Paw Paw River Watershed.
- SWMPC and Friends of the St. Joseph held a very successful wetland workshop for local officials in 2015 as part of an EPA Wetland Development Grant. Participants were from both the Paw Paw and Black River Watersheds.
- VBCD and the Van Buren County Drain Commissioner have successfully piloted a new drain assessment process in the South Branch of the Paw Paw River that provides landowners incentives to implement BMPs. The Drain Commissioner expects to expand this program in Van Buren County and there is interest with the incoming Berrien County Drain Commissioner.
- SWMPC has developed a management plan and a technical update for Ox Creek focusing on stormwater management best management practices for the Orchards Mall retail area. Please visit www.sustainoxcreek.org for more information.
- SWMPC and TRC have worked with the local municipalities along the Paw Paw River from Paw Paw to Benton Harbor to establish a water trail for canoeing and kayaking. The effort has been extremely popular, and the river is a destination for paddlers from near and far. For more information visit www.pawpawriverwatertrail.org or the Facebook page at www.facebook.com/PawPawRiverWaterTrail.

Figure 50. Paw Paw River Water Trail

Table 22. Paw Paw River Watershed Action Plan

Protection Areas (See Figure 45)	**High priority waterbodies – Paw Paw River mainstem, North Branch, East Branch, Hayden Creek, Campbell Creek** **Medium priority waterbodies – Blue Creek, Brush Creek, Carter Creek, South Branch**								
Task	**Pollutant**	**Source**	**Cause**	**Timeline**	**Potential Lead (Partners)**	**Estimated Cost**	**Potential Funding or Partner Programs**	**Milestones (after implementation begins)**	**Proposed Evaluation Method**
Enact/improve water quality protection related ordinances	Sediment	Streambanks	Increased flow fluctuations	Ongoing	Municipalities (SWMPC, MTA, MML)	$10,000/municipality	Municipalities, EGLE 319	By 2025: 3 municipalities By 2030: 7 municipalities By 2035: 13 municipalities	Number of ordinances enacted; Number of municipalities with ordinances
	Sediment, nutrients, pesticides, oil, grease, metals, temperature	Stormwater runoff – impervious surfaces and storm drains	Insufficient land use planning						
Protect wetlands	Sediment	Streambanks	Increased flow fluctuations	Ongoing	Landowners (SWMLC, TNC, Sarett Nature Center, DU)	$3,000-6,000/acre for purchase $3,000/conservation easement	EGLE 319, NAWCA grant, Ducks Unlimited	By 2025: 120 acres By 2030: 320 acres By 2035: 720 acres	Number of acres protected; Number of landowners protecting wetlands; Estimate pollutant loading reduction
Enact ordinances protecting riparian buffers	Sediment	Streambanks	Lack of riparian buffers	Ongoing	Municipalities (SWMPC, MTA, MML)	$2,500/municipality	Municipalities, EGLE 319	By 2025: 2 municipalities By 2030: 5 municipalities By 2035: 11 municipalities	Number of municipalities with ordinances
	Nutrients, pesticides	Stormwater runoff - lawns, parks, golf courses, agricultural lands							
Update inventory of road stream crossings and prioritize for improvements	Sediment	Streambanks	Lack of riparian buffers	Ongoing	Road Commission (Municipalities, SWMPC)	$5,000/agency	Road Commissions, Municipalities	By 2025: 2 road agencies By 2030: 5 road agencies By 2035: 8 road agencies	Number of road commissions and municipalities (road agencies) with improved standards enacted
Improve and promote soil erosion and sedimentation practices and regulations	Sediment	Stormwater runoff- road and building construction sites	Lack of soil erosion and sedimentation practices	Ongoing	Road Commission, Drain Commission	$5,000/agency	Road Commission, Drain Commissioner	By 2025: 1 agency By 2030: 3 agencies By 2035: 5 agencies	Number of agencies with improved practices and regulations adopted
Protect sensitive lands and high priority wetlands	Sediment, nutrients, pesticides, oil, grease, metals, temperature	Stormwater runoff – impervious surfaces and storm drains	Insufficient land use planning	Ongoing	SWMLC, TNC, Sarett Nature Center	$3,000-6,000/acre for purchase $3,000/conservation easement	Land Trusts, EGLE 319, private foundations	By 2025: 200 acres By 2030: 600 acres By 2035: 1400 acres	Number of acres protected; Estimate pollutant loading reduction
Improve zoning maps to locate high density or intensive uses in appropriate areas	Nutrients, bacteria/ pathogens	Septage waste	Insufficient site planning for locating septic systems	Ongoing	Municipalities (SWMPC)	$5,000/municipality	Municipalities	By 2025: 2 municipalities By 2030: 5 municipalities By 2035: 11 municipalities	Number of municipalities with improved zoning maps
Identify and correct failing septic systems	Nutrients, bacteria/ pathogens	Septage waste	Improper design or maintenance of septic systems	Ongoing	Landowners (Health Department)	$200-6,000/system	USDA Rural Development	By 2030: 5 systems By 2033: 13 systems By 2038: 28 systems	Number of systems identified and corrected; Estimate nutrient loading reduction

Agricultural Management Areas (See Figure 46)	High priority waterbodies- Eagle Lake Drain, Mill Creek, Pine Creek, Red Creek, Brandywine Creek, West Branch, North Branch headwaters Medium priority waterbodies - Branch & Derby Drain, Mud Lake Drain, Hog Creek, upstream portion of Ox Creek								
Task	**Pollutant**	**Source**	**Cause**	**Timeline**	**Potential Lead (Partners)**	**Estimated Cost**	**Potential Funding or Partner Programs**	**Milestones (after implementation begins)**	**Proposed Evaluation Method**
Utilize alternative drain maintenance/ construction techniques	Sediment	Streambanks	Increased flow fluctuations	Ongoing	Drain Commissioner (TNC)	$20/linear foot for tree revetments $7/lineal foot for woody debris mgt. $20/linear foot for 2 stage ditch $100-500/linear foot for jhooks and cross vanes	Drain Assessments, EGLE 319	By 2025: 2 projects By 2030: 3 projects By 2035: 5 projects	Number of miles of drain maintained or constructed with alternative techniques
Restore and protect wetlands	Sediment	Streambanks	Increased flow fluctuations	Ongoing	Landowners (NRCS, USFWS)	$1,000 – 2,000/acre	WRP. Partners for Wildlife, NAWCA, DU, National Fish and Wildlife Foundation, EGLE 319, Continuous CRP	By 2025: 80 acres By 2030: 180 acres By 2035: 240 acres	Number of acres restored; Number of landowners restoring wetlands; Estimate loading reduction
Install agricultural BMPs (filter strips, no-till, cover crops, grassed waterways, nutrient mgt, etc)	Sediment,	Streambanks	Increased flow fluctuations	Ongoing	Landowners (NRCS, Conservation Districts, TNC)	25% coverage in watershed with filter strips and conservation tillage $139,000	Farm Bill Programs, EGLE 319, Carbon Credit Program	By 2025: 5 landowners By 2030: 10 landowners By 2035: 15 landowners	Number of acres; Estimate sediment/nutrient loading reduction; Number of landowners
	Sediment, nutrients, temperature	Stormwater runoff -agricultural lands	Lack of BMPs						
Restore riparian buffers and stabilize eroding streambanks	Sediment	Streambanks	Lack of riparian buffers	Ongoing	Landowners (Drain Comm., Conservation Districts, NRCS)	$200-500/acre for restoration $200/ft for stabilization	Drain Assessments, EGLE 319, Farm Bill Programs, Carbon Credit Program	By 2025: 200 feet By 2030: 600 feet By 2035: 1400 feet	Linear feet of restoration/stabilization; Estimate pollutant loading reduction
	Nutrients, pesticides	Stormwater runoff - lawns, parks, golf courses, agricultural lands							
Protect wetlands	Sediment, nutrients, temperature	Stormwater runoff -agricultural lands	Loss of wetlands	Ongoing	Landowners (NRCS, USFWS, SWMLC, TNC, Sarett Nature Center)	$3,000-$6,000/acre for purchase $3,000 /conservation easement	EGLE 319, NAWCA grant, Ducks Unlimited, Wetland Reserve Program. Partners for Wildlife, Continuous CRP	By 2025: 20 acres By 2030: 80 acres By 2033: 180 acres	Number of acres protected; Number of landowners protecting wetlands; Estimate pollutant loading reduction
Expand disposal options for agricultural chemicals	Nutrients, pesticides	Stormwater runoff – lawns, parks, golf courses, agricultural lands	Improper storage/disposal of fertilizers and pesticides	Ongoing	MSUE	$15,000/year	MSUE, Michigan Dept of Agriculture	By 2025: increase by 2 days/sites By 2030: increase by 3 days/sites By 2033: increase by 5 days/sites	Number of disposal sites/days; Amount of chemicals collected
Develop and implement manure management plans	Nutrients, Bacteria/ pathogens	Livestock waste	Improper manure management	Ongoing	Landowners (NRCS, Conservation Districts)	$4,000- $10,000/plan (depends on the number of livestock)	Farm Bill Programs, Michigan Environmental Assurance Program	By 2025: 2 plans By 2026: 5 plans By 2031: 8 plans	Number of plans developed E. coli monitoring program
Utilize soil testing to determine appropriate application rates for fertilizers and pesticides	Nutrients, pesticides	Stormwater runoff – lawns, parks, golf courses, agricultural lands	Improper application or overuse of fertilizers and pesticides	Ongoing	Landowners (MSUE)	$3.85/acre/year for field crops $13.30/acre/year for specialty crops	Unknown	By 2030: 20 tests By 2033: 30 tests By 2038: 50 tests	Number of soil tests performed
Utilize integrated pest management	Nutrients, pesticides	Stormwater runoff – lawns, parks, golf courses, agricultural lands	Improper application or overuse of fertilizers and pesticides	Ongoing	Landowners (MSUE, NRCS)	$30/acre/year for field crops $120/acre/year for orchards $80/acre/year for vegetables	Unknown	By 2030: 5 landowners By 2033: 7 landowners By 2038: 10 landowners	Number of landowners utilizing IPM

Improve and/or enforce septage waste disposal regulations	Nutrients, bacteria/ pathogens	Septage waste	Improper disposal by waste haulers/ wastewater treatment plants	Ongoing	EGLE (MLSA, Tip of Mitt, MI Environmental Council)	N/A	EGLE	Unknown	Improved regulations enacted and enforced
Construct secondary containment facilities	Oil, grease, fuel	Stormwater runoff	Spills and leaks	Ongoing	Landowners (NRCS, Conservation Districts)	$4,000-32,000/facility	Groundwater Program	By 2030: 1 facility By 2033: 3 facilities By 2038: 5 facilities	Number of secondary containment facilities installed
Conduct additional E. coli monitoring in TMDL watersheds	Bacteria/ pathogens	Livestock waste; Septage waste	Manure management/spreading; Failing septic systems	Ongoing	EGLE	TBD	EGLE	By 2023 – 1 watershed; By 2024 – 1 watershed; By 2025 – 1 watershed	Number of watersheds monitored/year
Urban Management Areas (See Figure 48)			**High priority waterbodies –Sand Creek, Paw Paw Lake, Maple Lake, downstream portions of Paw Paw River mainstem, East Branch, Mill Creek, Ox Creek, West Branch Medium priority waterbodies –Eagle Lake, Three Mile Lake, Cora Lake, Reynolds Lake and Christie Lake, Mattawan Creek, Lawton Drain, downstream portion of Brush Creek**						
Task	**Pollutant**	**Source**	**Cause**	**Timeline**	**Potential Lead (Partners)**	**Estimated Cost**	**Potential Funding or Partner Programs**	**Milestones (after implementation begins)**	**Proposed Evaluation Method**
Utilize stormwater best management practices (road/parking lot sweeping, stormceptors, rain gardens, vegetated swales, constructed wetlands, wet/dry ponds, etc)	Sediment, nutrients, pesticides, oil, grease, metals, temperature	Stormwater runoff – impervious surfaces and storm drains	Lack of stormwater management	Ongoing	Municipalities, Drain Commissioner, Road Commission (SWMPC, MTA, MML)	Depends on practice Rain Garden - $5-40/ft2 Rain Barrel - $75 each Green Roof - $12-24/ft2 Bioswales – $0.05-2.50/ft2 Permeable paving- $1-5/ft2	Municipalities, EGLE 319	By 2025: 2 municipalities By 2030: 4 municipalities By 2035: 8 municipalities	Number of municipalities sweeping streets/parking lots and using other practices; Estimate pollutant loading reduction
	Sediment	Streambanks	Increased flow fluctuations						
Enact and improve stormwater and post construction control ordinances	Sediment, nutrients, pesticides, oil, grease, metals, temperature	Stormwater runoff – impervious surfaces and storm drains	Lack of stormwater management	Ongoing	Municipalities, Drain Commissioner, Road Commission (SWMPC, MTA, MML)	$5,000/municipality	Municipalities, EGLE 319	By 2025 – 2 municipalities By 2030 – 4 municipalities By 2035 – 8 municiplalities	Number of municipalities with ordinances enacted
Identify and correct illicit discharges or connections	Sediment, nutrients, pesticides, oil, grease, metals, temperature	Stormwater runoff – impervious surfaces and storm drains	Illicit connections or discharges	Ongoing	Drain Commissioner, Municipalities, Road Commission	$500 - $5,000/site	Drain Commissioner, Municipalities, Road Commission	By 2025: 3 sites By 2030: 5 sites By 2035: 8 sites	Number of connections or discharges identified and corrected
Utilize best management practices for road maintenance	Sediment, salt	Stormwater runoff – roads and parking lots	Improper road salt/sand application and snow disposal	Ongoing	Road Commission, Municipalities	$50-$1,000/practice	Road Commission, Municipalities	By 2025: 2 road agencies By 2030: 3 road agencies By 2035: 5 road agencies	Number of road agencies adopting improved practices; Estimate sediment loading reduction
Enact county –wide phosphorus fertilizer ban	Nutrients, pesticides	Stormwater runoff – lawns, parks, golf courses, agricultural lands	Improper application or overuse of fertilizers and pesticides	Ongoing	Counties (SWMPC, Conservation Districts, Health Department, Drain Commissioner, Two Rivers Coalition)	$2,000/county	Unknown	By 2030: 2 counties	Number of counties with bans (enacted in Van Buren County)
Increase or expand household hazardous waste disposal options	Nutrients, pesticides	Stormwater runoff – lawns, parks, golf courses, agricultural lands	Improper storage/disposal of hazardous materials	Ongoing	VB MSUE, Berrien County Resource Recovery, Kalamazoo County	$10,000/year	Counties, Municipalities, Private Sector	By 2025: increase by 2 days/sites By 2030: increase by 3 days/sites By 2035: increase by 5 days/sites	Number of disposal sites/days; Amount of waste collected
	Oil, grease, fuel	Stormwater runoff – impervious surfaces and storm drains							

Distribute spill kits	Oil, grease, fuel	Stormwater runoff – impervious surfaces and storm drains	Spills and leaks	Ongoing	Businesses (MSUE, Conservation Districts)	$200/kit	Groundwater Program	By 2025: 8 kits By 2030: 16 kits By 2035: 30 kits	Number of spill kits distributed
Proper maintenance and design of sewer system infrastructure	Nutrients, bacteria/ pathogens	Septage waste	Sewer system/ infrastructure failure	Ongoing	Municipalities	Depends on system needs	Municipalities, EGLE state revolving loans, USDA Rural Development	By 2030: 2 municipalities By 2033: 4 municipalities By 2038: 5 municipalities	Number of system improvements; Number of municipalities with regular system inspection
Specific Sites (See Figure 49)									
Prevent/limit livestock access (fencing, crossings structures, alternative water source)	Sediment	Streambanks	Lack of riparian buffers	Ongoing	Landowners (NRCS, Conservation Districts)	$2/ft for fencing $1,200 –3,600/crossing structure $500/water source	Farm Bill Programs, EGLE 319	By 2025: 2 sites By 2030: 4 sites By 2035: 8 sites	Number of sites corrected; Estimate sediment and nutrient loading reduction
	Nutrients	Livestock waste	Unrestricted livestock access						
Identify and correct problem road/stream crossing sites	Sediment	Streambanks	Improper design or maintenance of road/stream crossings	Ongoing	Road Commission	$5,000 - $15,000/site	Road Commission, EGLE 319, MDNR Inland Fisheries Grant	By 2025: 1 site By 2030: 3 sites By 2035: 6 sites	Number of sites corrected; Estimate sediment loading reduction

Table 23. Summary of Maple Lake Recommendations

Desired Condition	Short Term (1-4 years)	Long Term (5+ years)
Lake Depth and Access Navigability of the South Basin	• Participate in update of Paw Paw River Watershed plan	• Dredging • Drain Commission to investigate sediment trap • Develop a lake management plan that extends to upstream activities
Weed and Algae Reduction	• Signage about boat washing • Regular weed cutting • Chemical Treatments • Annual Drawdown (good for milfoil & starry stonewort) • Waterfowl management • Property owner education of lakefront practices • Treat for phragmites • Test burlap bags/barley bales	• Improve storm water management • Ultrasound technology for algae • Install a boat wash station at Sunset Park • Work with upstream landowners to reduce storm water run off • Support upstream wetland restoration
Lakeshore stability	• Continue to install natural shorelines • Promote natural shorelines • Remove invasive species growing on shoreline • Consider passage of waterfront overlay district	
Leverage natural resources toward economic development	• Upkeep of Maple Lake park facilities and launches • Support River Trail promotional efforts • Conduct study about economic impact of Maple Lake	• Seek canoe and kayak rental establishment

11 Evaluation

An evaluation process will determine if the plan implementation is effective and if improvements in water quality are being achieved. Measuring improvements and sharing results will increase community support for plan implementation. Since watersheds are extremely dynamic systems influenced by many factors, evaluation can be a difficult and expensive endeavor. As a result, different levels of evaluation are proposed to illustrate levels of success in the watershed. The level of evaluation and the methods utilized will largely be dependent on the formation of a sustainable watershed organization being able to carry out the proposed evaluation methods and on the amount of resources and funding available. Lastly, this Watershed Management Plan should be reviewed and updated periodically.

11.1 Knowledge and Awareness

The first level of evaluation is documenting a change in knowledge or increase in awareness. Measures and data collection for this level can take place in three specific ways:

1. A pre- and post-test of individuals at workshops focused on specific water quality issues in the PPRW. This should be an on-going activity.
2. The tracking of involvement in a local watershed group or increases in attendance at water quality workshops or other events. This should be an on-going activity.
3. A large-scale social survey effort of the PPRW population to understand individual watershed awareness and behaviors impacting water quality. Surveys are expensive, so this level of evaluation will not be able to happen until funding is secured.

Additional evaluation methods for measuring and tracking knowledge and awareness can be found in the Information and Education Plan for the Black and Paw Paw River Watersheds in Appendix 10.

11.2 Documenting Implementation

The second level of evaluation is BMP adoption or implementation. The measurement is mostly a documentation of successful implementation. The evaluation will involve identifying and tracking individuals, organizations and governmental units involved in implementing and adopting BMPs whether they be structural, vegetative or managerial. Data about the BMP implementation can be gathered simply through tracking the number of BMPs installed or adopted. This evaluation should be done annually.

Table 22 has milestones and specific evaluation methods proposed for measuring the progress of BMP implementation and improvements to water quality for each task in the PPRW action plan. The action plan should be reviewed at least annually to ensure progress is being made to meet the milestones. During the annual review, the action plan should be updated as tasks are completed, and as new tasks are identified.

11.3 Monitoring Water Quality

Another level of evaluation is documenting changes in water quality through monitoring. The monitoring of water quality is a very complex task, which involves gathering data from a number of sources. Periodic assessments of the water quality in the PPRW are conducted as part of federal and state water quality monitoring programs. Local efforts to monitor water quality include those of lake associations, drain commissioners and the Pokagon Band of Potawatomi Indians. Combining data gathered under these programs, with other periodic water quality assessments will provide a picture of water quality in the watershed. Four types of monitoring are proposed for the PPRW:

1. The volunteer inventory that was conducted during the plan development process could be repeated at the 200 plus sites throughout the watershed. The results could be compared to see if any problem areas have been improved or if any areas are worsening. This effort could be done by TRC volunteers with assistance from Conservation Districts and SWMPC staff.

It is recommended that the agricultural inventory conducted with this plan update could be repeated in the Mill and South Branch subwatersheds in five years to see if any improvements can be documented. This effort would address sediment, nutrients and dissolved oxygen. This effort could be done by TRC volunteers with assistance from Conservation Districts, SWMPC and EGLE staff.

Also, problems sites identified in the watershed-wide Animal Feeding Operation Inventory could be visited within five years to see if any improvements have happened. This effort would address sediment, nutrients and bacteria (E. coli). This effort could be done by TRC volunteers with assistance from Conservation Districts and SWMPC staff.

Lastly, stream habitat assessments utilizing the EPA Rapid Bio-assessment method is recommended every 3-5 years in high priority Agricultural and Urban Management Areas to address sediment, nutrients, dissolved oxygen and temperature. This effort could be done by TRC volunteers with assistance from Conservation Districts and EGLE staff.

2. Expanding Current Monitoring Efforts:

a. Benthic Monitoring can evaluate changes in the presence and type of aquatic life in the Paw Paw River and its tributaries to provide a general trend of water quality in the watershed. This monitoring can address sediment, nutrients, dissolved oxygen and temperature. This plan will rely on EGLE performing benthic monitoring in the watershed during its five-year rotating basin schedule. The Van Buren Conservation District, along with the Two Rivers Coalition, has been doing volunteer macro-invertebrate collections.

b. Thermal monitoring is of special importance for the coldwater streams in the PPRW. Routine monitoring of temperature regimes will help to evaluate if these coldwater streams are being protected with the BMPs that are being implemented in these subwatersheds. MDNR Fisheries Division sometimes conducts thermal monitoring.

c. Additional E. coli monitoring beyond EGLE's five-year rotating basin schedule is recommended for the subwatersheds with TMDLs (Blue, Pine and Mill Creeks). The documented levels of E. coli have been extremely high in these subwatersheds impairing partial and full-body contact. TRC has done some additional E. col monitoring.

11.4 Estimating Pollutant Load Reductions

The last level of evaluation is to estimate a reduction in pollutant loadings. A pollutant loading is a quantifiable amount of pollution that is being delivered to a water body. Pollutant load reductions can be calculated based on the ability of an installed BMP to reduce the targeted pollutant. Pollutant loading calculations are best used at specific sites where structural BMPs are installed and detailed data about the reduction of pollutants can be gathered. Specific pollutant load reduction calculations should be completed for structural BMPs when they are proposed and installed.

The PPRW plan is mostly focused on the preservation of water quality and habitat. However, there are pollution problems throughout the watershed. Pollutants of concern include sediment, nutrients (nitrogen and phosphorus), bacteria/pathogens (E. coli), pesticides, oil, grease, metals and temperature.

In Table 22, under the last column (proposed evaluation methods), pollutant loading reduction calculations are suggested for evaluating several tasks in the action plan. Specifically these tasks include: protecting and restoring wetlands and sensitive lands, correcting failing septic systems, installing agricultural BMPs (filter strips, no-till, cover crops, grassed waterways, nutrient mgt, etc), restoring riparian buffers and stabilizing streambanks, utilizing urban stormwater BMPs (road/parking lot sweeping, stormceptors, rain gardens, vegetated swales, constructed wetlands, wet/dry ponds, etc), correcting livestock access problem sites and correcting road/stream crossing problem sites. The other items in the action plan (Table 22) either deal with hydrological modifications or they are proactive and preventative measures. Estimating pollutant loads and load reductions for these types of practices is not feasible.

Appendix 12 presents estimates for pollutant loading and loading reductions for specific agricultural and urban stormwater BMPs implemented in the PPRW. The estimates were derived from modeling efforts which included the Soil and Water Assessment Tool (SWAT) and an empirical build-out model using the Long-term Hydrologic Impact Assessment model (L-THIA).

(SWAT) was utilized to estimate pollutant-loading reductions for sediment and nutrients with the installation of agricultural BMPs (such as no-till, filter strips, cover crops, fertilizer reduction and a combination of filter strips and no-till). The largest load reductions were realized from the combination of no-till and filter strips. Alone, filter strips provided the most water quality benefits, but are the most expensive to implement. No-till is the most cost-efficient BMP and large scale implementation of no-till would bring significant water quality benefits.

To address threatened and impaired designated uses, other than Partial and Total Body Contact (Coldwater Fishery, Warmwater Fishery and Other Indigenous Aquatic Life and Wildlife), in the priority agricultural areas, BMPs should be implemented in at least 75% of those areas. At this level of implementation, an estimated reduction of sediment by 65.3%, total phosphorus by 62.1% and total nitrogen by 60.8% needs to be realized at the mouth of the Paw Paw River.

An empirical model utilizing the Long-term Hydrologic Impact Assessment model (L-THIA) was utilized to estimate load reductions in high priority urban areas for sediment and nutrients with the installation of urban stormwater BMPs (such as wet retention ponds, dry detention ponds, vegetated swales, rain gardens and constructed wetlands). Table 24 presents some general treatment efficiencies for urban stormwater BMPs which were used as a baseline in the PPRW build-out empirical model.

Table 24. General Urban BMP Treatment Efficiencies

	TP	TSS
Wet retention pond	90%	90%
Dry detention pond	30%	90%
Vegetated swale	40%	80%
Rain garden [1]	100%	100%
Constructed wetland [2]	90%	90%

[1] Assuming rain gardens absorb all pollutants contained in the runoff captured.
[2] Assuming to be the same as wet retention ponds (Rouge River National Wet Weather Demonstration Project, 2001).

Among the five urban BMPs examined (wet retention ponds, dry detention ponds, vegetated swales, rain gardens, and constructed wetlands), wet retention ponds and constructed wetlands provide the greatest load reductions for TP and TSS while vegetative swales are the most cost-effective (lowest per pound cost of load reduction).

To address threatened and impaired designated uses, other than Partial and Total Body Contact (Coldwater Fishery, Warmwater Fishery and Other Indigenous Aquatic Life and Wildlife), in the priority urban areas, urban stormwater BMPs should be implemented on urban lands at a 50% treatment coverage for wet and dry retention ponds, vegetated swales and constructed wetlands and at a 15% treatment coverage for rain gardens. With those BMP implementation rates on urban lands, an estimated 1,500 pounds/year reduction in total phosphorus and a 60,000 pounds/year reduction in total suspended solids need to be realized in the PPRW. These reduction estimates were calculated by averaging the load reductions for each of the five urban stormwater BMPs modeled for the three urban subwatersheds of the PPRW. The three urban areas are 1) the Ox Creek Area (Benton Harbor/St Joseph); 2) the Paw Paw Lake Area (includes the townships of Coloma and Watervliet and the Cities of Watervliet and Coloma); and 3) the village of Paw Paw and Antwerp Township.

Based on the TMDL, the TSS target for Ox Creek is 300 mg/L as a daily maximum. The TMDL for Ox Creek established a Waste Load Allocation of 62.71 tons/day and a Load Allocation of 120.89 tons/day. There is a TSS Cumulative Loading Capacity of 183.6 tons/day. The reduction targets are based on subwatersheds vary between 7% and 91%.

To address the threatened and impaired use of Partial and Total Body Contact, BMPs must be implemented in agricultural, protection and urban areas to ensure all water bodies meet water quality standards for Escherichia coli (E. coli). For Total Body

Contact, E. coli levels need to be reduced to 130 E. coli per 100 milliliters (ml) water as a 30-day average and 300 E. coli per 100 ml water at any time during the time period of May 1 to October 1 to meet the water quality standard. For Partial Body Contact, E. coli levels need to be reduced to 1000 E. coli per 100 ml water to meet the water quality standard. These targets for E.coli are consistent with the TMDLs for Blue, Pine and Mill Creeks.

Currently, there are no loading estimates or reduction calculations for pesticides, oils, grease, metals and temperature for the PPRW.

Pollutant loading reductions have been estimated for each grant funded implementation project. See Appendix 14 for project fact sheets for information.

11.5 Evaluating the Watershed Management Plan

The watershed management plan should be reviewed and updated as needed. The Two Rivers Coalition: An alliance for the Black and Paw Paw River Watersheds should take the lead in the management and action plan review process. As general guidance, the review should at a minimum include the following updates:

- Land Cover (Chapter 2.4) – at a minimum every 10 years
- Demographics (Chapter 3.3) – with every new US Census
- Future Growth and Development (Chapter 3.4) – every 5-10 years
- Local Water Quality Protection Policies (Chapter 4.3 and 4.4) – every 3 years
- Water Quality Summary (Chapter 7) – every two years with the release of EGLE Integrated Reports
- Scheduled TMDLs (Table 17) – every two years with the release of EGLE Integrated Reports or when a TMDL is completed
- Prioritization of areas, pollutants and sources (Chapter 8) – every 5-10 years
- Goals and Objectives (Chapter 9) – every 5-10 years
- Implementation Strategy (Chapter 10) – review annually and update as needed

Appendix 1. Land Cover by Subwatershed

Entire Watershed and Subwatersheds 1-5 (WS = subwatershed)

Paw Paw River Watershed 2000 Land Cover												
	Entire PPRW		Subwatershed 1		Subwatershed 2		Subwatershed 3		Subwatershed 4		Subwatershed 5	
	% of PPRW	Acres	% of WS	Acres	% of WS	Acres	% of WS	Acres	% of WS	Acres	% of WS	Acres
Land Cover Category												
Low Intensity Urban	1.91%	5468	0.92%	159	0.97%	192	1.51%	360	1.23%	206	0.79%	77
High Intensity Urban	0.87%	2488	0.18%	31	0.28%	56	0.41%	98	0.57%	95	0.28%	27
Airports	0.08%	234	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0
Roads/Paved	4.12%	11775	2.32%	399	3.22%	635	2.95%	704	3.13%	524	2.57%	250
Total Urban	**6.99%**	**19965**	**3.42%**	**589**	**4.48%**	**883**	**4.87%**	**1162**	**4.92%**	**825**	**3.64%**	**354**
Non-vegetated Farmland	0.24%	680	0.10%	18	0.37%	73	0.14%	33	0.31%	52	0.09%	9
Row Crops	15.14%	43241	17.91%	3081	32.72%	6451	9.17%	2187	19.63%	3291	26.60%	2589
Forage Crops	21.99%	62789	11.96%	2058	20.77%	4096	25.86%	6167	26.05%	4367	30.61%	2979
Orchards/Vineyards/ Nursery	10.22%	29179	1.15%	198	1.76%	348	2.86%	683	8.42%	1411	7.88%	767
Total Agriculture	**47.59%**	**135889**	**31.13%**	**5355**	**55.62%**	**10968**	**38.04%**	**9070**	**54.40%**	**9121**	**65.18%**	**6344**
Upland Openland	9.75%	27848	9.91%	1705	8.97%	1768	12.67%	3020	9.19%	1541	4.98%	485
Upland Forest	20.02%	57184	28.87%	4967	16.16%	3186	31.58%	7530	19.66%	3297	14.80%	1440
Lowland Forest	8.23%	23501	15.06%	2591	7.62%	1502	7.00%	1670	8.54%	1432	4.20%	409
Wetland	6.09%	17383	10.78%	1854	6.50%	1281	5.65%	1347	3.15%	528	3.03%	295
Water	1.02%	2912	0.81%	140	0.55%	108	0.15%	36	0.05%	8	4.07%	396
Total Natural	**45.11%**	**128828**	**65.43%**	**11257**	**39.79%**	**7845**	**57.05%**	**13603**	**40.59%**	**6806**	**31.08%**	**3025**
Other/Unknown	**0.31%**	**886**	**0.02%**	**3**	**0.11%**	**22**	**0.04%**	**9**	**0.09%**	**15**	**0.10%**	**10**
Total Acres	**100.00%**	**285568**	**100.00%**	**17204**	**100.00%**	**19718**	**100.00%**	**23844**	**100.00%**	**16767**	**100.00%**	**9733**

Subwatersheds 6-11 (WS=subwatershed)

Paw Paw River Watershed 2000 Land Cover												
	Subwatershed 6		Subwatershed 7		Subwatershed 8		Subwatershed 9		Subwatershed 10		Subwatershed 11	
	% of WS	Acres	% of WS	Acres	% of WS	Acres	% of WS	Acres	% of WS	Acres	% of WS	Acres
Land Cover Category												
Low Intensity Urban	1.96%	425	2.32%	392	1.16%	306	0.56%	105	1.52%	273	1.01%	101
High Intensity Urban	1.10%	237	1.16%	196	0.41%	107	0.09%	17	0.59%	105	0.19%	19
Airports	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0
Roads/Paved	4.59%	994	5.21%	879	2.93%	771	2.41%	455	3.37%	604	2.70%	271
Total Urban	**7.65%**	**1656**	**8.69%**	**1467**	**4.50%**	**1184**	**3.05%**	**577**	**5.48%**	**982**	**3.89%**	**391**
Non-vegetated Farmland	0.15%	33	0.73%	124	0.28%	75	0.14%	27	0.15%	26	0.16%	16
Row Crops	4.87%	1054	14.81%	2500	20.83%	5483	16.53%	3126	15.08%	2700	26.58%	2670
Forage Crops	21.03%	4550	20.54%	3466	28.46%	7491	20.70%	3913	23.35%	4182	21.38%	2147
Orchards/Vineyards/ Nursery	8.81%	1907	9.04%	1525	7.10%	1869	8.62%	1630	9.28%	1662	5.40%	542
Total Agriculture	**34.87%**	**7544**	**45.13%**	**7615**	**56.68%**	**14918**	**45.99%**	**8696**	**47.86%**	**8570**	**53.51%**	**5375**
Upland Openland	13.23%	2863	8.54%	1441	7.42%	1952	8.65%	1635	9.38%	1680	7.22%	725
Upland Forest	33.65%	7281	18.30%	3088	15.44%	4064	18.42%	3482	20.47%	3665	16.69%	1676
Lowland Forest	5.59%	1210	8.82%	1489	7.87%	2072	10.72%	2027	9.15%	1638	8.66%	870
Wetland	4.33%	936	7.04%	1188	6.88%	1810	12.38%	2340	7.06%	1264	6.77%	680
Water	0.56%	122	3.29%	555	0.52%	137	0.78%	147	0.36%	65	3.16%	317
Total Natural	**57.37%**	**12412**	**45.99%**	**7761**	**38.12%**	**10035**	**50.94%**	**9631**	**46.42%**	**8312**	**42.49%**	**4268**
Other/Unknown	**0.11%**	**24**	**0.19%**	**32**	**0.70%**	**185**	**0.02%**	**3**	**0.25%**	**44**	**0.10%**	**10**
Total Acres	**100.00%**	**21636**	**100.00%**	**16875**	**100.00%**	**26322**	**100.00%**	**18907**	**100.00%**	**17908**	**100.00%**	**10044**

Subwatersheds 12-17 (WS = subwatershed)

Paw Paw River Watershed 2000 Land Cover												
	Subwatershed 12		Subwatershed 13		Subwatershed 14		Subwatershed 15		Subwatershed 16		Subwatershed 17	
	% of WS	Acres	% of WS	Acres	% of WS	Acres	% of WS	Acres	% of WS	Acres	% of WS	Acres
Land Cover Category												
Low Intensity Urban	3.54%	364	1.31%	242	2.17%	259	4.90%	477	2.26%	469	6.88%	1061
High Intensity Urban	0.62%	64	0.59%	109	0.74%	88	2.11%	205	0.60%	124	5.90%	910
Airports	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	1.52%	234
Roads/Paved	5.54%	569	3.22%	596	4.48%	536	6.66%	648	4.99%	1034	12.36%	1906
Total Urban	**9.70%**	**997**	**5.12%**	**947**	**7.38%**	**883**	**13.67%**	**1330**	**7.85%**	**1627**	**26.66%**	**4111**
Non-vegetated Farmland	0.09%	9	0.24%	44	0.18%	22	0.38%	37	0.13%	27	0.36%	55
Row Crops	8.98%	923	16.65%	3080	16.64%	1990	2.65%	258	5.25%	1087	5.00%	771
Forage Crops	19.31%	1985	24.79%	4586	21.44%	2564	18.08%	1760	19.23%	3984	16.17%	2494
Orchards/Vineyards/ Nursery	7.78%	800	24.12%	4462	16.73%	2000	23.16%	2254	27.75%	5750	8.89%	1371
Total Agriculture	**36.16%**	**3717**	**65.80%**	**12172**	**54.99%**	**6576**	**44.28%**	**4309**	**52.36%**	**10848**	**30.42%**	**4691**
Upland Openland	11.71%	1204	6.67%	1234	8.14%	973	10.73%	1044	11.06%	2291	14.83%	2287
Upland Forest	19.03%	1956	10.94%	2024	12.12%	1449	17.50%	1703	16.88%	3498	18.66%	2878
Lowland Forest	8.49%	873	6.60%	1221	10.79%	1290	9.09%	885	7.19%	1489	5.40%	833
Wetland	6.48%	666	4.64%	858	6.26%	748	4.25%	414	3.37%	698	3.09%	476
Water	8.32%	855	0.09%	17	0.00%	0	0.05%	5	0.00%	0	0.03%	4
Total Natural	**54.03%**	**5554**	**28.94%**	**5354**	**37.30%**	**4460**	**41.63%**	**4051**	**38.49%**	**7976**	**42.01%**	**6478**
Other/Unknown	**0.12%**	**12**	**0.14%**	**26**	**0.33%**	**39**	**0.43%**	**42**	**1.30%**	**269**	**0.91%**	**141**
Total Acres	**100.00%**	**10280**	**100.00%**	**18499**	**100.00%**	**11958**	**100.00%**	**9732**	**100.00%**	**20720**	**100.00%**	**15421**

Appendix 2. NPDES permits in the Paw Paw River Watershed

Current as of September 2021

Site Name	Permit Number	Permit Class	COC Permit Type	Issue Date	Expiration Date	Site Address	Site City	County	Site Type
305 Farms-Van Buren	MIR116243	NPDES Construction Storm Water Notice of Coverage (NOC)		9/17/2020	8/27/2021	Crandall Parkway	Lawrence	Van Buren	Construction Site
ANR Pipeline-US 31 Pipe Relocation-Benton Harbor	MIR116088	NPDES Construction Storm Water Notice of Coverage (NOC)		5/19/2020	4/24/2021	E Empire Ave & S Benton Center Rd	Benton Harbor	Berrien	Construction Site; Industrial
Benton Twp-Raw Water Pump Sta	MIG640264	NPDES Certificate of Coverage under General Permit (COC)	Wastewater Discharge from Potable Water Supply	6/8/2015	4/1/2020	1061 Rocky Gap Road	Benton Harbor	Berrien	Potable Water Facility
Brutsche Concrete-Benton Hbr	NEC157969	NPDES Industrial Storm Water No Exposure Certificate (NEC)		5/14/2020	5/14/2025	1108 South Crystal	Benton Harbor	Berrien	Industrial
MDNR-Wolf Lake Fish Hatchery	MI0035734	NPDES Individual Permit		9/30/2014	10/1/2017	34270 County Road 652	Mattawan	Van Buren	Fish Hatchery
Paw Paw WWTP	MI0021741	NPDES Individual Permit		10/31/2014	10/1/2017	38360 Paw Paw road	Paw Paw	Van Buren	Municipal Sanitary-Public
Lounsbury-New Home Construction-ML	MIR116197	NPDES Construction Storm Water Notice of Coverage (NOC)		8/18/2020	8/10/2021	51602 CR 653	Paw Paw	Van Buren	Construction Site
MPH/Lindberg Div of Thermal	NEC186752	NPDES Industrial Storm Water No Exposure Certificate (NEC)		8/15/2018	8/15/2023	3827 Riverside Road	Riverside	Berrien	Industrial
Benton Harbor WTP	MIG640258	NPDES Certificate of Coverage under General Permit (COC)	Wastewater Discharge from Potable Water Supply	5/19/2015	4/1/2020	601 North Ridgeway Drive	Saint Joseph	Berrien	Potable Water Facility
MDOT-I-196 from I-94 to N of M-63	MIR115132	NPDES Construction Storm Water Notice of Coverage (NOC)		6/18/2018	6/17/2023	I-196 from I-94 to north of M-63, Berrien & VanBuren Counties	Benton Harbor	Berrien	Construction Site
MDOT-I-94, US-31, I-94 BL, I-196, Design Build-Berrien Co	MIR116237	NPDES Construction Storm Water Notice of Coverage (NOC)		9/15/2020	9/14/2025	I-94, US-31 Design Build, Benton Twp, Berrien Co.	Benton Harbor	Berrien	Construction Site
MDOT-I-94, US-31, Design Bld 3, Tree Clearing-Berrien Co	MIR116259	NPDES Construction Storm Water Notice of Coverage (NOC)		9/28/2020	9/27/2025	I-94, US-31, Design Build 3, Tree Clearning, Berrien Co.	Benton Harbor	Berrien	Construction Site
AEP-Valley Area	MIR115084	NPDES Construction Storm Water Notice of		6/7/2018	5/21/2021	Hartford Substation	Hartford	Van Buren	Construction

Site Name	Permit Number	Permit Class	COC Permit Type	Issue Date	Expiration Date	Site Address	Site City	County	Site Type
Improvements		Coverage (NOC)				Beginning of Transmission Line			Site
AEP-Valley Area Improvements	MIR115112	NPDES Construction Storm Water Notice of Coverage (NOC)		6/7/2018	6/30/2022	Hartford Substation Beginning of Transmission Line	Hartford	Van Buren	Construction Site
AEP-Valley Area Improvements	MIR115206	NPDES Construction Storm Water Notice of Coverage (NOC)		7/17/2018	7/30/2022	Hartford Substation Beginning of Transmission Line	Hartford	Van Buren	Construction Site
AEP-Valley Area Improvements	MIR115218	NPDES Construction Storm Water Notice of Coverage (NOC)		7/27/2018	6/30/2022	Hartford Substation Beginning of Transmission Line	Hartford	Van Buren	Construction Site
AEP-Valley Area Improvements	MIR115956	NPDES Construction Storm Water Notice of Coverage (NOC)		2/12/2020	2/3/2021	Hartford Substation Beginning of Transmission Line	Hartford	Van Buren	Construction Site
Lawrence WWSL	MIG580107	NPDES Certificate of Coverage under General Permit (COC)	Wastewater Stabilization Lagoon	12/4/2019	4/1/2024	on North Paw Paw Street between Bangor Road and 51st Avenue	Lawrence	Van Buren	Municipal Sanitary-Public
MDOT-I-94-Van Buren Co	MIR115643	NPDES Construction Storm Water Notice of Coverage (NOC)		7/1/2019	6/30/2024	I-94, Cities of Hartford, Lawrence, Mattawan, Paw Paw, Van Buren Co.	Lawrence	Van Buren	Construction Site
Whirlpool-Benton Harbor Div	MIG081252	NPDES Certificate of Coverage under General Permit (COC)	Petroleum Contaminated Wastewater	11/8/2019	4/1/2020	151 Riverview Drive	Benton Harbor	Berrien	Groundwater Cleanup; Industrial
Primetals Technologies USA LLC	MIG250362	NPDES Certificate of Coverage under General Permit (COC)	Noncontact Cooling Water	9/25/2019	4/1/2023	470 North Paw Paw Avenue	Benton Harbor	Berrien	Industrial
New Products Corp	MIG250368	NPDES Certificate of Coverage under General Permit (COC)	Noncontact Cooling Water	8/7/2013	4/1/2018	448 North Shore Drive	Benton Harbor	Berrien	Industrial
Benton Harbor MS4-Berrien	MIG610243	NPDES Certificate of Coverage under General Permit (COC)	MS4 Watershed	11/17/2003	4/1/2008	200 E Wall St	Benton Harbor	Berrien	Municipal Separate Storm Sewer System
Benton Harbor CM	MIR116251	NPDES Construction Storm Water Notice of Coverage (NOC)		9/22/2020	6/19/2021	200 East Wall Street	Benton Harbor	Berrien	Contributing Municipality
Leco-Michigan	MIS310062	NPDES Certificate of	SW-Industrial CY3	11/30/2018	4/1/2023	1920 Yore Avenue	Benton Harbor	Berrien	Industrial

Site Name	Permit Number	Permit Class	COC Permit Type	Issue Date	Expiration Date	Site Address	Site City	County	Site Type
Ceramics Div		Coverage under General Permit (COC)							
Southwest Mich Reg Airport	MIS310078	NPDES Certificate of Coverage under General Permit (COC)	SW-Industrial CY3	8/23/2019	4/1/2023	1123 Territorial Road	Benton Harbor	Berrien	Industrial
GM-Brass-Aluminum Foundry-BH	MIS310106	NPDES Certificate of Coverage under General Permit (COC)	SW-Industrial CY3	11/6/2013	4/1/2018	200 West Wall Street	Benton Harbor	Berrien	Industrial
Mono Ceramics-Benton Harbor	MIS310114	NPDES Certificate of Coverage under General Permit (COC)	SW-Industrial CY3	11/9/2018	4/1/2023	2235 Pipestone Road	Benton Harbor	Berrien	Industrial
Worthington Armstrong Venture	MIS310118	NPDES Certificate of Coverage under General Permit (COC)	SW-Industrial CY3	5/10/2019	4/1/2023	745 Enterprise Way	Benton Harbor	Berrien	Industrial
JVIS Mfg-Ox Creek Fac	MIS310119	NPDES Certificate of Coverage under General Permit (COC)	SW-Industrial CY3	8/23/2019	4/1/2023	359 Territorial Road	Benton Harbor	Berrien	Industrial
JVIS Mfg-Crystal Ave Fac	MIS310127	NPDES Certificate of Coverage under General Permit (COC)	SW-Industrial CY3	8/23/2019	4/1/2023	1285 North Crystal Avenue	Benton Harbor	Berrien	Industrial
Old Europe Cheese Inc	MIS310204	NPDES Certificate of Coverage under General Permit (COC)	SW-Industrial CY3	11/30/2018	4/1/2023	1330 East Empire Avenue	Benton Harbor	Berrien	Industrial
Max Casting Co-Benton Harbor	MIS310242	NPDES Certificate of Coverage under General Permit (COC)	SW-Industrial CY3	8/23/2019	4/1/2023	116 Paw Paw Avenue	Benton Harbor	Berrien	Industrial
Champlain Specialty Metals Inc	MIS310255	NPDES Certificate of Coverage under General Permit (COC)	SW-Industrial CY3	11/9/2018	4/1/2023	2235 Dewey Avenue	Benton Harbor	Berrien	Industrial
Dawson Mfg-Benton Harbor	MIS310519	NPDES Certificate of Coverage under General Permit (COC)	SW-Industrial CY3	11/9/2018	4/1/2023	1042 North Crystal Avenue	Benton Harbor	Berrien	Industrial
Square Deal Auto-Benton Harbor	MIS310520	NPDES Certificate of Coverage under General Permit (COC)	SW-Industrial CY3	8/23/2019	4/1/2023	1091 Territorial Road	Benton Harbor	Berrien	Industrial
New Products Corp	MIS310611	NPDES Certificate of Coverage under	SW-Industrial CY3	11/9/2018	4/1/2023	448 North Shore Drive	Benton Harbor	Berrien	Industrial

Site Name	Permit Number	Permit Class	COC Permit Type	Issue Date	Expiration Date	Site Address	Site City	County	Site Type
		General Permit (COC)							
Aludyne West Michigan LLC-Benton Harbor	MIS310656	NPDES Certificate of Coverage under General Permit (COC)	SW-Industrial CY3	10/25/2018	4/1/2023	1320 Paw Paw Avenue	Benton Harbor	Berrien	IPP Industrial User; Industrial
Modar Inc-2200 Empire LLC	MIS310735	NPDES Certificate of Coverage under General Permit (COC)	SW-Industrial CY3	8/23/2019	4/1/2023	2200 East Empire Avenue	Benton Harbor	Berrien	IPP Industrial User; Industrial
Greg Orchards LLC	MIS310767	NPDES Certificate of Coverage under General Permit (COC)	SW-Industrial CY3	4/16/2020	4/1/2023	4949 N Branch Rd	Benton Harbor	Berrien	Industrial
Benton Metal Recycling	MIS320049	NPDES Certificate of Coverage under General Permit (COC)	SW-Containment CY3	2/15/2019	4/1/2023	1256 Milton Street	Benton Harbor	Berrien	Industrial
Primetals Technologies USA LLC	MIS320065	NPDES Certificate of Coverage under General Permit (COC)	SW-Containment CY3	11/30/2018	4/1/2023	470 North Paw Paw Avenue	Benton Harbor	Berrien	Industrial
Josh's Auto Parts	MISNPTD0002	No Potential to Discharge Determination Storm Water Industrial		11/20/2018	11/20/2023	2670 Territorial Rd.	Benton Harbor	Berrien	Industrial
Whirlpool-Benton Harbor Div	NEC186577	NPDES Industrial Storm Water No Exposure Certificate (NEC)		12/29/2016	12/28/2021	151 Riverview Drive	Benton Harbor	Berrien	Groundwater Cleanup; Industrial
K-O Products Co	NEC186578	NPDES Industrial Storm Water No Exposure Certificate (NEC)		1/24/2017	1/23/2022	1225 Milton Street	Benton Harbor	Berrien	Industrial
Ausco Products Inc.	NEC186669	NPDES Industrial Storm Water No Exposure Certificate (NEC)		12/11/2017	12/10/2022	2245 Pipestone Road	Benton Harbor	Berrien	IPP Industrial User; Industrial
Paw Paw Lake Area WWTP	MI0023779	NPDES Individual Permit		9/26/2018	10/1/2022	4689 DEFIELD RD	COLOMA	Berrien	Municipal Sanitary-Public
Menasha Packaging Co-Coloma	MIS310237	NPDES Certificate of Coverage under General Permit (COC)	SW-Industrial CY3	6/7/2019	4/1/2023	238 North West Street	Coloma	Berrien	Industrial
Coloma Frozen Foods	MISNPTD0003	No Potential to Discharge Determination Storm Water Industrial		7/8/2019	7/8/2024	4145 COLOMA RD	COLOMA	Berrien	Food Processor; Industrial
Hartford WWTP	MI0023094	NPDES Individual Permit		2/27/2020	10/1/2022	66460 56th Ave.	Hartford	Van Buren	Municipal Sanitary-

Site Name	Permit Number	Permit Class	COC Permit Type	Issue Date	Expiration Date	Site Address	Site City	County	Site Type
									Public
Red Arrow Dairy-CAFO	MIG010210	NPDES Certificate of Coverage under General Permit (COC)	CAFO	12/7/2016	4/1/2020	69444 County Road 687	Hartford	Van Buren	Concentrated Animal Feeding Operation
Lawton WWTP	MI0055514	NPDES Individual Permit		11/30/2018	10/1/2022	625 W. Union Street	Lawton	Van Buren	Municipal Sanitary-Public
Welch Foods Inc	MIG250385	NPDES Certificate of Coverage under General Permit (COC)	Noncontact Cooling Water	9/30/2019	4/1/2023	400 Walker Street	Lawton	Van Buren	Food Processor; Industrial
Welch Foods Inc	MIS310525	NPDES Certificate of Coverage under General Permit (COC)	SW-Industrial CY3	11/9/2018	4/1/2023	400 Walker Street	Lawton	Van Buren	Food Processor; Industrial
BASF Corp-Mattawan	NEC186432	NPDES Industrial Storm Water No Exposure Certificate (NEC)		6/6/2017	6/5/2022	23930 Concord Avenue	Mattawan	Van Buren	Industrial
Coca Cola-Paw Paw	MI0056367	NPDES Individual Permit		5/3/2017	10/1/2021	38279 Red Arrow Highway	Paw Paw	Van Buren	Industrial
St Julian Wine Company Inc	MIG250145	NPDES Certificate of Coverage under General Permit (COC)	Noncontact Cooling Water	3/5/2019	4/1/2023	716 South Kalamazoo Street	Paw Paw	Van Buren	IPP Industrial User; Industrial; Winery, Cidery, Brewery, Distillery
St Julian Wine Company Inc	MIS310061	NPDES Certificate of Coverage under General Permit (COC)	SW-Industrial CY3	10/25/2018	4/1/2023	716 South Kalamazoo Street	Paw Paw	Van Buren	IPP Industrial User; Industrial; Winery, Cidery, Brewery, Distillery
Knouse Foods Coop Inc-Paw Paw	MIS310631	NPDES Certificate of Coverage under General Permit (COC)	SW-Industrial CY3	6/7/2019	4/1/2023	815 South Kalamazoo Street	Paw Paw	Van Buren	Industrial
Orchard Hill LF-Watervliet	MI0058853	NPDES Individual Permit		5/3/2017	10/1/2020	3290 HENNESSEY RD	WATERVLIET	Berrien	Industrial

Site Name	Permit Number	Permit Class	COC Permit Type	Issue Date	Expiration Date	Site Address	Site City	County	Site Type
Berrien CDC-South Watervliet Drain #485	MIR116128	NPDES Construction Storm Water Notice of Coverage (NOC)		6/4/2020	6/3/2022	433 LUCINDA LN	WATERVLIET	Berrien	Construction Site
Pinecrest Ind-Lower Peninsula	MIG031002	NPDES Certificate of Coverage under General Permit (COC)	Nuisance Plant	5/23/2017	2/1/2022	various locations throughout the Lower Peninsula of Michigan	varies	Berrien	Pesticide
Indiana Mich Power Co ROW-Nuisance Plant	MIG031037	NPDES Certificate of Coverage under General Permit (COC)	Nuisance Plant	4/20/2017	2/1/2022	various locations within the Indiana MI Pwr Co Rights of Way	varies	Berrien	Pesticide
Berrien CDC-Weed and Algae	MIG031048	NPDES Certificate of Coverage under General Permit (COC)	Nuisance Plant	4/20/2017	2/1/2022	various locations throughout Berrien County	varies	Berrien	Pesticide

Appendix 3. Protection and Management Options for Private Lands

Land Protection Options

Land Protection Option	Description	Results	Income Tax Deduction ?*	Estate Tax Reduction ?*
Conservation easement	Legal agreement between a landowner and a land conservancy or government agency permanently limiting a property's uses.	Important features of the property protected by organization. Owner continues to own, use, live on land.	Yes	Yes
Outright land donation	Land is donated to the land conservancy.	Organization owns, manages, and protects land.	Yes	Yes
Donation of land by will	Land is specifically designated for donation to the land conservancy.	Organization owns, manages, and protects land.	No	Yes
Donation of remainder interest in land with reserved life estate	Personal residence or farm is donated to the land conservancy, but owner (or others designated) continue to live there, usually until death.	Organization owns remainder interest in the land, but owners (others) continue to live on and manage land during their lifetime subject to a conservation restriction.	Yes	Yes
Bargain sale of land	Land is sold to the land conservancy below fair market value. It provides cash, but may also reduce capital gains tax, and entitle you to an income tax deduction.	Organization owns, manages, and protects land.	Yes	Yes

*The amount of income/estate tax reduction depends on a number of factors. Please consult a professional tax and/or legal advisor. (Adapted from Conservation Options: A Landowner's Guide, Land Trust Alliance.)

This table was created by the Southwest Michigan Land Conservancy call (269) 324-1600 for more information.

Land Management Programs**

Land Management Option	Description	Agreement	Landowner reimbursement
Wildlife Habitat Incentive Program (WHIP)	Provides technical and financial assistance to promote wildlife habitat including corridor, riparian buffer and rare species habitat development	Contracts run for a minimum of 5 years and a maximum of 10 years.	Up to 75% of cost of improvements.
Wetland Reserve Program (WRP)	Assists in restoring active agricultural land to natural wetland condition.	Agreements can be 10-year, 30-year or perpetual.	Up to 75% of cost of improvements or 100% for permanent agreements.
Environmental Quality Incentives Program (EQIP)	Assists in restoring agricultural land to wildlife habitat.	Agreements can last 2-10 years.	Up to 75% of cost of improvements.

**These are just a few of many examples. For more information contact Van Buren Conservation District office at 269-657-4030 x5 or the Berrien Conservation District at (269) 471-9111.

Appendix 4. Water Quality Statement by Water Body

Designated uses of many water bodies in the PPRW are threatened or impaired due to habitat loss or fragmentation, rather than any specific pollutant. For the purposes of this summary we will limit the discussion to pollutant based impairments and threats. From a pollutant standpoint, water quality in the PPRW varies greatly from one water body to the next. The connection between which designated uses are being threatened or impaired; the pollutants causing the threat or impairment; the sources of the pollutants; and the causes related to those sources will be examined for individual water bodies in order to provide a detailed description of water quality throughout the watershed. Several sources of information* were used to determine the status of each step in this connection. If a designated use is not mentioned, either it was not assessed or there was not sufficient information to determine if the use was being met, threatened or impaired. Not all water bodies within the watershed were evaluated. Only water bodies with enough information to make a water quality statement are included in this summary.

*Information used: MDEQ 2006, 2008 and 2020 Integrated Reports; MDNR Fisheries Division staff input; MDNR Fisheries Reports; Spicer Study on Paw Paw Lake; TNC Agricultural Impact Study; TNC Floodplain Forest Study; Van Buren County Drain Commissioner input; MDEQ/EGLE Biosurvey Reports; PPRW Volunteer Inventory; MDEQ Road Stream Crossing Inventory, MDEQ Wetland Functional Analysis, MDEQ Flashiness Report

Paw Paw Mainstem

The Paw Paw Mainstem originates at the confluence of the North and South Branches and flows centrally through the watershed in a southwest direction to the St. Joseph River. The designated uses of Warmwater Fishery and Other Indigenous Aquatic Life and Wildlife are threatened due to known sedimentation. Nutrients and pesticides are also suspected to be threatening water quality. Streambanks are the only known source of sediment within the mainstem corridor. Agricultural lands, roads, building sites and impervious surfaces throughout the watershed are suspected to be contributing sediment, nutrients and pesticides.

Land cover along the Paw Paw Mainstem is predominantly natural. The floodplain forests, wetlands, and sand/gravel geology along the mainstem provide excellent habitat for a diverse assemblage of fish species. Land cover changes throughout the PPRW are the primary threat to the hydrology of the mainstem. Wetland loss, channel modification and increased runoff from urban and agricultural land without BMPs creates flow fluctuations and increased stream power. These hydrologic changes cause stream bank erosion and habitat modification resulting in adverse impacts to native biota. The Paw Paw River has relatively stable flows, but a study of historic streamflow data by EGLE suggests flashiness is increasing. Streams with more uniform flow throughout the year typically have more stable channel morphology and fish assemblages.

According to the 2020 Integrated Report, the Paw Paw Mainstem is meeting its designated use for Other Indigenous Aquatic Life and Wildlife, but it was not assessed for other designated uses. The Paw Paw Mainstem was sampled at eight locations in a biological survey conducted by the MDEQ (now EGLE) in 2006. According to the staff report, the riparian corridor was very complete with most stations having riparian zones that were more than 150 feet wide with a large amount and variety of vegetation. Although some bank erosion was evident at nearly every station, the river did not appear flashy and large woody debris was stable and extended into the active stream channel.

Coldwater Tributaries

Blue Creek

Blue Creek is a coldwater stream that joins the Paw Paw River in Benton Twp. Yellow Creek is the only significant tributary to Blue Creek. The designated uses of Coldwater Fishery and Other Indigenous Aquatic Life and Wildlife are threatened due to known sedimentation. The designated uses of Total and Partial Body Contact are impaired due to known bacteria and pathogens, as evidenced by the presence of Escherichia coli (E. coli). Nutrients, pesticides and increased water temperature are also suspected to be threatening water quality. Agricultural and developed lands are suspected sources of sediment, nutrients, pesticides and increased water temperature. Streambanks are a known source of sediment. Illicit discharges of wastewater are the primary suspected source of E. coli.

Land cover in the Blue Creek watershed is approximately 57% agricultural, 35% natural and 8% developed. Most of the natural riparian corridor along Blue Creek remains intact. According to the MDEQ Landscape Level Wetland Functional Assessment report, 82% of presettlement wetlands in the Blue Creek watershed remain intact. Many of these wetlands have a high significance for sediment and other particulate retention. Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) increase runoff allowing sediment, nutrients and pesticides to be transported directly to surface water with runoff from rain events. Developed lands and associated impervious surfaces also increase runoff. Without sufficient stormwater management practices, runoff from developed lands within the watershed will carry sediment, nutrients, oils, metals and chemicals directly to Blue Creek.

Increased runoff creates flow fluctuations and reduces groundwater infiltration, which affects base flow and water depth during periods of low flow. These hydrologic changes cause stream bank erosion, temperature fluctuations and habitat modification resulting in adverse impacts to native biota. Streams with more uniform flow throughout the year typically have more stable channel morphology and fish assemblages.

Failing and improperly designed road/stream crossings can cause fish passage impairment, bank erosion and other changes to channel morphology. There are two known impaired road/stream crossings along Blue Creek, both on Territorial Road. The first crossing has a failing culvert that is undersized causing erosion and a shifting sand bedload on top of the fine gravel streambed. Stormwater runoff at the second crossing

is causing erosion and variable flow rates. The undersized culverts at this crossing are impacting fish passage, flow and sand/woody debris transport.

According to the 2020 and 2008 Integrated Reports, Blue Creek was not assessed for its Coldwater Fishery designated use. It was found to be meeting its designated use for Other Indigenous Aquatic Life and Wildlife. Blue Creek is not meeting its designated use for Total and Partial Body Contact due to E. coli. Blue Creek is included in the statewide TMDL.

A biological survey conducted by the MDEQ in 2006 at Park Road rated the macroinvertebrate community acceptable. Habitat was rated excellent due to epifaunal substrate consisting of undercut banks, leaf packs and abundant woody debris. However, the report noted that the deposition of sand was evident. The biological survey conducted by the MDEQ in 2006 also includes information about elevated E. coli levels found in a strom drain discharging to Blue Creek downstream of Highland Avenue. According to the report, illicit discharges of wastewater from the community of Millburg in Benton Twp are the likely source of the E. coli. EGLE is working with the Berrien County Health Department to address this problem. In addition to the E. coli issue, a great deal of sedimentation has occurred in Blue Creek from a gully that formed along the streambank due to the stormwater discharges at this site.

Brush Creek

Brush Creek is a coldwater stream that joins the Paw Paw River in the Village of Lawrence. Its tributaries include Red Creek and White Creek. The designated uses of Coldwater Fishery and Other Indigenous Aquatic Life and Wildlife are threatened due to known sedimentation. Nutrients, pesticides and increased water temperature are also suspected to be threatening water quality. Agricultural lands are the primary suspected source of sediment, nutrients, pesticides and increased water temperature. Streambanks are a known source of sediment.

Land cover in the Brush Creek watershed is approximately 57% agricultural, 38% natural and only 4% developed. Although a large portion of the natural riparian corridor along Brush Creek remains intact, there is a lack of riparian buffers on many of the small agricultural ditches in the watershed. Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) allow sediment, nutrients and pesticides to be transported directly to surface water with runoff from rain events. According to the MDEQ Wetland Functional Assessment report, the Brush Creek watershed has only lost 28% of its presettlement wetlands. However, 45% of the wetlands with a high significance for streamflow maintenance and sediment and other particulate retention have been lost.

Wetland loss, channel modification and lack of BMPs cause increased runoff from agricultural lands. Increased runoff creates flow fluctuations and reduces groundwater infiltration, which affects base flow and water depth during periods of low flow. These hydrologic changes cause stream bank erosion, temperature fluctuations and habitat modification resulting in adverse impacts to native biota. Streams with more uniform

flow throughout the year typically have more stable channel morphology and fish assemblages.

Failing and improperly designed road/stream crossings can cause fish passage impairment, bank erosion and other changes to channel morphology. There are two known impaired road/stream crossings in the Brush Creek watershed. The CR 215 crossing of White Creek is preventing fish passage and causing modifications to stream morphology. The CR 215 crossing of Brush Creek is preventing fish passage and causing streambank erosion.

According to the 2020 and 2008 Integrated Report, Brush Creek was not assessed for its Coldwater Fishery designated use. For the 2020 Integrated Report, Brush, Red and White Creeks were found to not be supporting its designated use for Other Indigenous Aquatic Life and Wildlife due to mercury in the water column and was not assessed for Warm or Coldwater Fishery and insufficient information for Total and Partial Body Contact. A biological survey conducted by the MDEQ in 2006 at 63rd Street rated the macroinvertebrate community as acceptable. The habitat was rated good due to large woody debris, undercut banks and a small amount of gravel. However, the report noted that the substrate was dominated by sand, the banks were somewhat scoured and the stream appeared to be somewhat flashy.

Campbell Creek

Campbell Creek is a coldwater tributary of the North Branch. The designated uses of Coldwater Fishery and Other Indigenous Aquatic Life and Wildlife are threatened due to suspected sedimentation. Nutrients, pesticides and increased water temperature are also suspected to be threatening water quality. Suspected sources of sediment are agricultural lands and streambanks. Agricultural and developed lands are also a suspected source of nutrients, pesticides and increased water temperature.

The Campbell Creek watershed contains a tremendous amount of natural land cover including a very large wetland complex known as the Almena Swamp. According to the MDEQ Wetland Functional Assessment report, 66% of presettlement wetlands in the Campbell Creek watershed remain intact. Many of these wetlands have a high significance for streamflow maintenance and nutrient transformation. Small farms are scattered throughout this watershed and residential development is increasing. Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) increase runoff allowing sediment, nutrients and pesticides to be transported directly to surface water with runoff from rain events. Developed lands and associated impervious surfaces also increase runoff. Without sufficient stormwater management practices, runoff from developed lands within the watershed will carry sediment, nutrients, oils, metals and chemicals directly to Campbell Creek.

Increased runoff creates flow fluctuations and reduces groundwater infiltration, which affects base flow and water depth during periods of low flow. These hydrologic changes cause stream bank erosion, temperature fluctuations and habitat modification resulting

in adverse impacts to native biota. Streams with more uniform flow throughout the year typically have more stable channel morphology and fish assemblages.

According to the 2020 and 2008 Integrated Reports, Campbell Creek was not assessed for its Coldwater Fishery designated use. It was found to be meeting its designated use for Other Indigenous Aquatic Life and Wildlife and not assessed for Total and Partial Body Contact. A biological survey conducted by the MDEQ in 2006 at 28th Street rated the macroinvertebrate community at the high end of acceptable. Habitat was rated excellent, but a lack of cobble and gravel was evident. A biological survey conducted by the MDEQ in 1991 at Stevens Road reported that Campbell Creek demonstrated classic temperature and macroinvertebrate profiles of a cold headwater stream. The 1991 report stated that the water was well oxygenated with good instream habitat only modestly impacted by silt and sand deposition. Overall scores in 1991 indicated the stream was meeting its coldwater designated use.

Eagle Lake Drain

Eagle Lake Drain is a coldwater tributary of the West Branch. The designated uses of Coldwater Fishery and Other Indigenous Aquatic Life and Wildlife are impaired due to known sedimentation. Nutrients, pesticides and increased water temperature are also suspected to be threatening water quality. Suspected sources of sediment are agricultural lands and streambanks. Agricultural lands are also a suspected source of nutrients, pesticides and increased water temperature.

Land use in the Eagle Lake Drain Watershed is primarily agricultural. Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) allow sediment, nutrients and pesticides to be transported directly to surface water with wind and runoff from rain events. Increased runoff due to wetland loss, channel modification and lack of BMPs (buffer strips, no-till, cover crops, etc.) creates flow fluctuations and increased stream power. Increased runoff also reduces groundwater infiltration and decreases base flow and water depth during periods of low flow. These hydrologic changes cause stream bank erosion, temperature fluctuations and habitat modification resulting in adverse impacts to native biota. Streams with more uniform flow throughout the year typically have more stable channel morphology and fish assemblages.

In the 2020 Integrated Report, Eagle Lake Drain is not supporting its designated use for Other Indigenous Aquatic Life and Wildlife due to flow regime modification and other anthropogenic substrate. It is meeting its designated use for Coldwater Fishery based on dissolved oxygen measurements. Eagle Lake Drain was not assessed for Total and Partial Body Contact.

Biological surveys conducted by the MDEQ in 1991 and 1996 found the Coldwater Fishery designated use not being supported. In addition, the biological survey conducted by the MDEQ in 2006 rated the macroinvertebrate community poor and the habitat marginal at 42nd Street. Habitat was rated as marginal because woody debris was absent from the stream channel and there was very little substrate available for

colonization. Discussions with MDNR Fisheries Division staff suggest the coldwater fishery is being impaired by sediment laden agricultural runoff.

East Branch

The East Branch is a coldwater stream that joins the West Branch in the Village of Paw Paw. Its tributaries include Cook Drain, Mattawan Creek and Paw Paw Lake in Kalamazoo County. The designated uses of Coldwater Fishery and Other Indigenous Aquatic Life and Wildlife are threatened due to known sedimentation. Nutrients, pesticides and increased water temperature are also suspected to be threatening water quality. Streambanks are the only known source of sediment. Agricultural and developed lands are suspected sources of nutrients, pesticides and increased water temperature.

The East Branch has the highest groundwater inflow in the PPRW and therefore is more stable and less affected by major precipitation events. The natural riparian corridor along the stream remains mostly intact and this watershed contains an extensive area with high potential for groundwater recharge. This watershed also contains several large prairie fens, which are unique wetlands rich in species diversity.

The Village of Mattawan and a portion of the Village of Paw Paw are found within the East Branch watershed. Commercial and residential development is increasing rapidly in this area. Agricultural land cover in the East Branch watershed is dominated by orchards, vineyards and non-tilled forage crops. Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) increase runoff allowing sediment, nutrients and pesticides to be transported directly to surface water with runoff from rain events. Developed lands and associated impervious surfaces also increase runoff. Without sufficient stormwater management practices, runoff from developed lands within the watershed will carry sediment, nutrients, oils, metals and chemicals directly to the East Branch.

Flow fluctuations created by increased runoff reduce groundwater infiltration, which affects base flow and water depth during periods of low flow. These hydrologic changes also cause stream bank erosion, temperature fluctuations and habitat modification resulting in adverse impacts to native biota. Streams with more uniform flow throughout the year typically have more stable channel morphology and fish assemblages.

Failing and improperly designed road/stream crossings can cause fish passage impairment, bank erosion and other changes to channel morphology. There are two known impaired road/stream crossings along the East Branch. The crossing at 26th Street has a culvert that is poorly aligned with the stream dimensions and as a result is preventing fish passage upstream and causing scouring downstream. The crossing at 63rd Avenue is undersized and perched preventing fish passage, creating scouring downstream and impounding water upstream.

In the 2020 Integrated Report, the East Branch was listed as fully supporting Other Indigenous Aquatic Life and Wildlife. It was not assessed for Coldwater Fishery and

there was insufficient information for Partial and Total Body Contact. A biological survey conducted by the MDEQ in 2006 at 32nd Street rated both the macroinvertebrate community and habitat as excellent. However, the report noted that woody debris within the stream channel was at least 50% embedded, and the bottom substrate was dominated by sand. Two stations near the Village of Paw Paw were also surveyed in 2006. The macroinvertebrate communities were rated as acceptable and the habitats were rated as good at these sites.

The biological survey conducted by the MDEQ in 2006 also includes information on the possible effects of contaminated venting groundwater on the East Branch. Thomas Drain has been enclosed and functions as a city storm drain for the Village of Paw Paw. The drain meets the East Branch just downstream of the Gremps Street crossing and just upstream of the confluence with the West Branch. The drain historically has been thought to carry venting groundwater contaminated with trichloroethene from the Paw Paw Plating facility on Commercial Street. Water samples were collected from the storm drain itself and sediment samples were collected downstream and upstream of its confluence with the East Branch. Water quality standards were being met for all parameters analyzed. Sediment sample results from the downstream site exceeded sediment quality guidelines for several parameters and were much higher than the results from the upstream site. EGLE will continue to investigate the Paw Paw Plating site.

Hayden Creek

Hayden Creek is a coldwater tributary of the North Branch. The designated uses of Coldwater Fishery and Other Indigenous Aquatic Life and Wildlife are threatened due to suspected sedimentation. Nutrients, pesticides and increased water temperature are also suspected to be threatening water quality. Suspected sources of sediment are agricultural lands and streambanks. Agricultural and developed lands are also a suspected source of nutrients, pesticides and increased water temperature.

The natural riparian corridor along Hayden Creek remains mostly intact including a wide wetland zone in many areas. According to the MDEQ Wetland Functional Assessment report, the wetlands along Hayden Creek have a high significance for sediment and other particulate retention as well as fish, shellfish and other wildlife habitat. There is a considerable amount of agricultural land cover within the Hayden Creek watershed. Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) increase runoff allowing sediment, nutrients and pesticides to be transported directly to surface water with runoff from rain events. Developed lands and associated impervious surfaces also increase runoff. Without sufficient stormwater management practices, runoff from developed lands within the watershed will carry sediment, nutrients, oils, metals and chemicals directly to Hayden Creek.

Increased runoff creates flow fluctuations and reduces groundwater infiltration, which affects base flow and water depth during periods of low flow. These hydrologic changes cause stream bank erosion, temperature fluctuations and habitat modification resulting

in adverse impacts to native biota. Streams with more uniform flow throughout the year typically have more stable channel morphology and fish assemblages.

According to the 2020 and 2008 Integrated Reports, Hayden Creek was not assessed for its Coldwater Fishery designated use and was found to be meeting its designated use for Other Indigenous Aquatic Life and Wildlife. A biological survey conducted by the MDEQ in 2006 at 30th Street rated the macroinvertebrate community in the mid-range of excellent. Habitat was also rated excellent. The 2006 report notes that the banks appeared stable and although the substrate consisted entirely of sand, there was an excellent amount of pool variability and a mix of available cover including large woody debris and undercut banks. A biological survey conducted by the MDEQ in 1991 at 32nd Street found the stream to be somewhat limited by sand and silt deposition. It noted that insects commonly found in rocky or gravel riffle zones were absent. Although one trout was found during this survey, a number of warmwater fish were also found. The report noted that these warmwater species might be emigrants from Lime Lake or other small impoundments on Hayden Creek. Overall scores in 1991 indicated the stream was meeting its coldwater designated use.

Mill Creek

Mill Creek is a coldwater stream that meets the Paw Paw River in the City of Watervliet. The Total and Partial Body Contact designated uses are impaired due to known bacteria and pathogens (E. coli). The designated uses of Coldwater Fishery and Other Indigenous Aquatic Life and Wildlife are threatened due to known sedimentation. Nutrients, pesticides and increased water temperature are also suspected to be threatening water quality. Livestock and septic systems are the suspected sources of E. coli. Streambanks are a suspected source of sediment. Agricultural lands are a suspected source of sediment, nutrients, pesticides and increased water temperature.

Land use in the Mill Creek Watershed is primarily agricultural. Unrestricted livestock access to streams and improper management of manure causes bacteria and pathogens to enter surface water. There are no known unrestricted livestock access sites in the Mill Creek Watershed, but there are several farms with livestock. There is also a large amount of manure being applied to fields within the watershed. Improper management of manure is the primary suspected cause of E. coli in Mill Creek. Improperly designed or maintained septic systems are another suspected cause of E. coli.

Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) allow sediment, nutrients and pesticides to be transported directly to surface water with runoff from rain events. According to the MDEQ Wetland Functional Assessment report, 60% of the wetlands with a high significance for sediment and other particulate retention have been lost in the Mill Creek Watershed. Increased runoff due to wetland loss, channel modification and lack of BMPs creates flow fluctuations and increased stream power. Increased runoff also reduces groundwater infiltration and decreases base flow and water depth during periods of low flow. These hydrologic changes cause stream bank erosion, temperature fluctuations and habitat modification resulting in adverse impacts

to native biota. Streams with more uniform flow throughout the year typically have more stable channel morphology and fish assemblages.

In the 2020 Integrated Report, Mill Creek is listed as not supporting Partial and Total Body Contact due to E. coli. It was not assessed for Cold or Warmwater Fishery and it is fully supporting Other Indigenous Aquatic Life and Wildlife. A TMDL was developed in 2009.

A biological survey conducted by the MDEQ in 2006 at a site just upstream of Red Arrow Hwy rated the habitat as good due to a large amount of gravel and some woody debris, but also found evidence of flow fluctuations and sedimentation. A biological survey conducted by the MDEQ in 2005 rated the habitat at 67th Street as severely impaired. In addition to MDEQ reports, the SWAT model places the Mill Creek Watershed in the second highest category for sediment loading.

North Branch

The North Branch is designated as a coldwater stream above M-40. Coldwater tributaries of the North Branch include Campbell Creek, Hayden Creek, and Ritter Creek. The only significant warmwater tributary is Brandywine Creek and it joins the North Branch approximately 1.5 miles before the confluence of the North and South Branches. The designated uses of Coldwater Fishery and Other Indigenous Aquatic Life and Wildlife are threatened due to known sedimentation. The designated uses of Total and Partial Body Contact are threatened due to suspected bacteria and pathogens (E. coli). Nutrients, pesticides and increased water temperature are also suspected to be threatening water quality. Agricultural lands are the primary suspected source of sediment, nutrients, pesticides and increased water temperature. Streambanks are a known source of sediment. Livestock are the only known source of suspected E. coli.

The North Branch watershed includes a large historic wetland area known as the Mentha Flats, which has been severely channelized to facilitate vegetable production. This area and Brandywine Creek are suspected to be contributing the largest amounts of sediment to the North Branch. Land cover in the Mentha Flats area is 71% agricultural. Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) allow sediment, nutrients and pesticides to be transported directly to surface water with wind and runoff from rain events.

Failing and improperly designed road/stream crossings can cause fish passage impairment, bank erosion and other changes to channel morphology. There is one known impaired road/stream crossing north of Whiskey Run on CR 653 causing severe streambank erosion. The culverts are poorly aligned and undersized restricting flows and creating modifications to the stream dimensions. Unrestricted livestock access to streams also causes streambank erosion and allows bacteria and pathogens to enter surface water. There are two known sites where livestock have unrestricted access to streams within the North Branch watershed. One site is located on Ritter Creek at 30th Street and the other is on the Paw Paw and Allegan Road Drain at 45th Street.

Below the Mentha Flats, the North Branch flows through approximately 1,500 acres of wetland known as the Almena Swamp. According to the MDEQ Wetland Functional Assessment report, the coldwater portion of the North Branch Watershed has lost 40% of its presettlement wetlands. However, 94% of the wetlands with a high significance for sediment and other particulate retention still remain. Wetland loss, channel modification and lack of BMPs can increase runoff creating flow fluctuations and increased stream power. Increased runoff also reduces reduces groundwater infiltration, which affects base flow and water depth during periods of low flow. These hydrologic changes cause stream bank erosion, temperature fluctuations and habitat modification resulting in adverse impacts to native biota. Streams with more uniform flow throughout the year typically have more stable channel morphology and fish assemblages.

For the 2020 Integrated Report, the North Branch was fully supporting Other Indigenous Aquatic Life and Wildlife but was not assessed for Warm or Coldwater Fishery nor Total and Partial Body Contact. However, a biological survey conducted by the MDEQ in 2006 at 35 ½ Street rated the macroinvertebrate community in the mid-range of acceptable. Habitat was rated as good, but the riparian zone was noted to be impacted by the road running parallel and very close to the stream for several yards. The survey noted a lack of epifaunal substrate due to sand embedding most of the large woody debris.

Pine Creek

Pine Creek is a coldwater stream that meets the Paw Paw River near the City of Hartford. The designated uses of Coldwater Fishery and Other Indigenous Aquatic Life and Wildlife are impaired due to known sedimentation. The Total and Partial Body Contact designated uses are impaired due to known bacteria and pathogens (E. coli). Nutrients, pesticides and increased water temperature are also suspected to be threatening water quality. The only known source of sediment is streambanks. Livestock and septic systems are the suspected sources of E. coli. Agricultural lands are a suspected source of sediment, nutrients, pesticides and increased water temperature.

Land use in the Pine Creek Watershed is primarily agricultural. Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) allow sediment, nutrients and pesticides to be transported directly to surface water with runoff from rain events. Increased runoff due to lack of BMPs, wetland loss and channel modification, creates flow fluctuations and increased stream power. Increased runoff also reduces groundwater infiltration and decreases base flow and water depth during periods of low flow. These hydrologic changes cause stream bank erosion, temperature fluctuations and habitat modification resulting in adverse impacts to native biota. Streams with more uniform flow throughout the year typically have more stable channel morphology and fish assemblages.

Failing and improperly designed road/stream crossings can cause fish passage impairment, bank erosion and other changes to channel morphology. There is one

known impaired road/stream crossing at 64th Street causing sedimentation. The bottom of this box culvert is elevated above the streambed resulting in a semi-perched condition affecting channel morphology.

Unrestricted livestock access to streams and improper management of manure causes bacteria and pathogens to enter surface water. There are no known unrestricted livestock access sites in the Pine Creek Watershed, but there are several farms with livestock. There is also large amount of manure being applied to fields within the watershed. Improper management of manure is the primary suspected cause of E. coli in Pine Creek. Improperly designed or maintained septic systems are another suspected cause of E. coli.

In the 2020 Integrated Report, Pine Creek is listed as not supporting Partial and Total Body Contact due to E. coli and a TMDL was developed in 2009. Pine Creek is also not supporting its designated use for Coldwater Fishery and Other Indigenous Aquatic Life and Wildlife due to flow regime modification and other anthropogenic substrate. It is fully supporting Other Indigenous Aquatic Life and Wildlife upstream from 66th Avenue.

A biological survey conducted by the MDEQ in 2006 rated the macroinvertebrate community poor at Red Arrow Hwy. Habitat was rated as marginal because the substrate consisted entirely of sand with little pool variability. According to the staff report the stream appeared to experience severe flow fluctuations. In addition to MDEQ reports, the SWAT model places the Pine Creek Watershed in the second highest category for sediment loading.

Red Creek

Red Creek is a coldwater tributary of Brush Creek. The designated uses of Coldwater Fishery and Other Indigenous Aquatic Life and Wildlife are impaired due to known sedimentation. Nutrients, pesticides and increased water temperature are also suspected to be threatening water quality. The only known source of sediment is agricultural lands. Streambanks are a suspected source of sediment. Agricultural lands are a suspected source of nutrients, pesticides and increased water temperature.

Land use in the Red Creek Watershed is primarily agricultural. Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) are the primary source of sedimentation. They allow sediment, nutrients and pesticides to be transported to surface water with runoff from rain events. Increased runoff due to lack of BMPs, creates flow fluctuations and increased stream power. Increased runoff also reduces groundwater infiltration and decreases base flow and water depth during periods of low flow. These hydrologic changes cause stream bank erosion, temperature fluctuations and habitat modification resulting in adverse impacts to native biota. Streams with more uniform flow throughout the year typically have more stable channel morphology and fish assemblages.

According to the 2008 and 2020 Integrated Report, Red Creek was not assessed for its Coldwater Fishery designated use. For the 2020 Integrated Report, Brush, Red and

White Creeks were found to not be supporting its designated use for Other Indigenous Aquatic Life and Wildlife due to mercury in the water column and there was insufficient information for Total and Partial Body Contact.

A biological survey conducted by the MDEQ in 2006 rated the macroinvertebrate community as barely acceptable at 56th Street. The MDEQ staff report from biological surveys conducted in 1991 notes that habitat was significantly impacted by sediment deposition and poor stream bank vegetation producing unstable banks. Biological surveys conducted by the MDEQ in 1991 found the Coldwater Fishery designated use not being supported. In addition to MDEQ reports, the SWAT model places the Red Creek Watershed in the highest category for sediment loading. Discussions with MDNR Fisheries Division staff confirm that the coldwater fishery is being impaired by sediment laden agricultural runoff.

Sand Creek

Sand Creek is a coldwater stream that meets the Paw Paw River near Benton Harbor. The designated uses of Coldwater Fishery and Other Indigenous Aquatic Life and Wildlife are impaired due to known sedimentation. Streambank erosion is the primary suspected source of sediment. Increased water temperature, nutrients, pesticides, metals, oils and grease are also suspected to be impacting water quality. Developed lands are the only suspected source of these pollutants.

The Sand Creek Watershed contains a significant amount of urban land cover and associated impervious surfaces. Insufficient management of the stormwater runoff created by impervious surfaces leads to sedimentation, polluted runoff and altered hydrology. Increased runoff reduces groundwater infiltration causing decreased base flow and water depth during periods of low flow. Flow fluctuations, increased stream power and other hydrology changes cause stream bank erosion, habitat modification and adverse impacts to native biota. Streams with more uniform flow throughout the year typically have more stable channel morphology and fish assemblages. Increased water temperature can be caused by impervious surfaces (such as parking lots and rooftops), which may increase the temperature of water moving over them, and reduced water depth during low flow periods due to decreased base flow. Suspected causes of polluted runoff include improper application, storage, and disposal of fertilizers and pesticides by landowners. Poor vehicle maintenance and improper oil disposal are suspected causes of oil and grease in urban stormwater runoff.

In the 2020 Integrated Report, Sand Creek was not assessed for its Coldwater Fishery and Partial and Total Body Contact but was fully supporting the Other Indigenous Aquatic Life and Wildlife designated use. In the staff report of biological surveys conducted by the MDEQ in 2006, Sand Creek is considered a potential concern due to the possible addition of a large culvert to facilitate runway extension at the Southwest Michigan Regional Airport in Benton Harbor. The report notes that in 2004 the macroinvertebrate community was rated acceptable, but the fish community was rated poor. Discussions with MDNR Fisheries Division staff suggest the coldwater fishery is being impaired by sedimentation resulting from altered hydrology.

West Branch

The West Branch is a coldwater stream that joins the East Branch in the Village of Paw Paw. Its tributaries include Eagle Lake Drain, Lawton Drain, Gates Extension Drain and Three Mile Lake Drain. The designated uses of Coldwater Fishery and Other Indigenous Aquatic Life and Wildlife are impaired due to known sedimentation and low dissolved oxygen (DO) levels. The designated uses of Total and Partial Body Contact are threatened due to suspected bacteria and pathogens (E. coli). Nutrients, pesticides and increased water temperature are suspected to be threatening water quality. The only known source of sediment is streambanks. Agricultural lands are a suspected source of sediment, nutrients, pesticides and increased water temperature. Livestock are the only known source of suspected E. coli.

Land use in the West Branch Watershed is primarily agricultural. Presettlement land cover in the watershed was dominated by wetlands. According to the MDEQ Wetland Functional Assessment report, 57% of presettlement wetlands in the West Branch Watershed have been drained and converted to agricultural lands. Of those lost wetlands, 81% had a high significance for streamflow maintenance and 47% had a high significance for sediment and other particulate retention. Increased runoff due to wetland loss, channel modification and lack of BMPs (buffer strips, no-till, cover crops, etc.) creates flow fluctuations and increased stream power. Increased runoff also reduces groundwater infiltration and decreases base flow and water depth during periods of low flow. These hydrologic changes cause stream bank erosion, temperature fluctuations and habitat modification resulting in adverse impacts to native biota. Streams with more uniform flow throughout the year typically have more stable channel morphology and fish assemblages.

Unrestricted livestock access to streams causes streambank erosion and allows bacteria and pathogens to enter surface water. There is one known unrestricted sheep access site on Lawton Drain at CR 665. Agricultural lands without BMPs allow sediment, nutrients and pesticides to be transported directly to surface water with runoff from rain events. There are no known causes of low DO levels in the West Branch, but nutrients are often related to the impairment.

In the 2020 Integrated Report, the West Branch from Three Mile Lake Drain to the confluence to 60th Avenue including Three Mile Lake Drain is listed as not supporting coldwater fishery due to dissolved oxygen. It was supporting Other Indigenous Aquatic Life and Wildlife. The West Branch downstream to Three Mile Lake Drain is fully supporting Coldwater Fishery and Other Indigenous Aquatic Life and Wildlife. The West Branch upstream to 60th Avenue is fully supporting Other Indigenous Aquatic Life and Wildlife, but not assessed for Warm or Coldwater Fishery nor Total and Partial Body Contact.

A biological survey conducted by the MDEQ in 2006 rated the macroinvertebrate community at the low end of acceptable. Habitat was rated as marginal due to sedimentation and silt exceeding three feet in depth in some areas. In addition to MDEQ reports, the West Branch was identified in the TNC Agricultural Impact study as

a problem area. The Van Buren County Drain Commissioner and the Village of Paw Paw have identified the West Branch as the primary source of sediment problems in Briggs Pond and Maple Lake.

Warmwater Tributaries

Brandywine Creek

Brandywine Creek is a warmwater tributary of the North Branch. Its tributaries include the North Extension Drain and Martin Lake Drain. The designated use of Warmwater Fishery is impaired, and the designated use of Other Indigenous Aquatic Life and Wildlife is threatened due to known sedimentation. The designated uses of Total and Partial Body Contact are threatened due to suspected bacteria and pathogens (E. coli). Nutrients and pesticides are also suspected to be threatening water quality. Streambanks are the only known source of sediment. Livestock are the only known source of suspected E. coli. Agricultural lands are a suspected source of sediment, nutrients and pesticides.

Land cover in the Brandywine Creek Watershed is approximately 56% agricultural. Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) allow sediment, nutrients and pesticides to be transported directly to surface water with runoff from rain events. Unrestricted livestock access to streams causes streambank erosion and allows bacteria and pathogens to enter surface water. There is one known unrestricted livestock access site on Martin Lake Drain at 18th Ave.

According to the MDEQ Wetland Functional Assessment report, the Brandywine Creek Watershed has lost 61% of its wetlands with a high significance for streamflow maintenance. Wetland loss, channel modification and lack of BMPs create flow fluctuations and increased stream power. These hydrologic changes cause stream bank erosion and habitat modification resulting in adverse impacts to native biota.

In the 2020 Integrated Report, Brandywine Creek was fully supporting Other Indigneous Aquatic Life and Wildlife but was not assessed for Cold or Warmwater Fishery nor Total and Partial Body Contact.

However, a biological survey conducted by the MDEQ in 2006 rated the habitat as marginal because existing woody debris was deeply embedded by sediment. The survey also noted that the stream appeared flashy as evidenced by eroded streambanks. Brandywine Creek's designated use of Warmwater Fishery was not assessed in the 2008 Integrated Report. Biological surveys conducted by the MDEQ in 1991 found the fish populations acceptable but noted a significant lack of instream structure for fish cover.

In addition to MDEQ reports, Brandywine Creek was identified in the TNC Agricultural Impact study as an in-stream erosion problem area. Bank Erosion Hazard Index scores from the Volunteer Inventory were very high in this watershed. The Van Buren County Drain Commissioner identified Brandywine Creek and the North Extension Drain as high priorities for restoration due to sedimentation problems. Discussions with MDNR

Fisheries Division staff suggest the warmwater fishery is being impaired by sedimentation.

Branch & Derby Drain

Branch & Derby Drain is a warmwater stream that is the largest tributary of Paw Paw Lake. The designated uses of Warmwater Fishery and Other Indigenous Aquatic Life and Wildlife are threatened due to known sedimentation. The designated uses of Total and Partial Body Contact are threatened due to suspected bacteria and pathogens (E. coli). Nutrients and pesticides are also suspected to be threatening water quality. Agricultural lands are a suspected source of sediment, nutrients and pesticides. Streambanks are a suspected source of sediment. Livestock are the only known source of suspected E. coli.

Land use in the Branch & Derby Drain Watershed is primarily agricultural. Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) allow sediment, nutrients and pesticides to be transported directly to surface water with runoff from rain events. Unrestricted livestock access to streams causes streambank erosion and allows bacteria and pathogens to enter surface water. There is one known pasture with unrestricted livestock access on Branch & Derby Drain between M-140 and North Watervliet Rd. Wetland loss, channel modification and lack of BMPs create flow fluctuations and increased stream power. These hydrologic changes cause stream bank erosion and habitat modification resulting in adverse impacts to native biota. Streams with more uniform flow throughout the year typically have more stable channel morphology and fish assemblages.

According to the 2008 Integrated Report, Branch & Derby Drain was not assessed for the designated uses of Other Indigenous Aquatic Life and Wildlife or Warmwater Fishery. The Spicer Group conducted an assessment of the Branch & Derby Drain as part of a study of the Paw Paw Lake Watershed in 2007. According to the study, Branch & Derby Drain is the largest contributor of sediment to Paw Paw Lake. The unrestricted livestock access site between M-140 and North Watervliet Rd was discovered during this assessment.

Carter Creek

Carter Creek is a warmwater stream that meets the Paw Paw River northwest of the Village of Paw Paw in Waverly Twp. Brownwood Lake and a few county drains are the only significant tributaries. The designated uses of Warmwater Fishery and Other Indigenous Aquatic Life and Wildlife are threatened due to known sedimentation. Nutrients and pesticides are also suspected to be threatening water quality. Agricultural lands are a suspected source of sediment, nutrients and pesticides. Discharges from the Coca-Cola Paw Paw facility are a suspected source of nutrients.

Land cover in the Carter Creek Watershed is 58% natural, 38% agricultural and 4% urban. According to the MDEQ Wetland Functional Assessment report, 57% of the presettlement wetlands have been lost. Wetland loss, channel modification and lack of agricultural BMPs (buffer strips, no-till, cover crops, etc.) create flow fluctuations and

increased runoff. Increased runoff reduces groundwater infiltration, which affects base flow and water depth during periods of low flow. These hydrologic changes cause stream bank erosion and habitat modification resulting in adverse impacts to native biota. Agricultural lands without BMPs allow sediment, nutrients and pesticides to be transported directly to surface water with runoff from rain events.

According to the 2020 and 2008 Integrated Report, Carter Creek was not assessed for its Warmwater Fishery, Partial and Total Body Contact designated uses. It was found to be meeting its designated use for Other Indigenous Aquatic Life and Wildlife in 2008 and 2020. A biological survey conducted by the MDEQ in 2006 downstream of 47th Avenue rated the macroinvertebrate community as acceptable. However, the habitat was rated marginal, and the report noted that historic channel alterations were evident. More than 50% of the stream bottom was affected by sediment deposition, but the banks appeared stable. Large amounts of aquatic vegetation were present. The report notes that in July of 2001, MDEQ staff observed nuisance level algae conditions, but these conditions were not present in 2006. Increased flow was noticed compared to 2001. This increase may be attributed to the discharge from the Coca-Cola Paw Paw facility, which began in 2002.

Hog Creek

Hog Creek is a warmwater stream that meets the Paw Paw River just east of the City of Hartford. The designated uses of Warmwater Fishery and Other Indigenous Aquatic Life and Wildlife are threatened due to known sedimentation. Nutrients and pesticides are also suspected to be threatening water quality. Streambanks are the only known sources of sediment. Agricultural lands are a suspected source of sediment, nutrients and pesticides.

Land use in the Hog Creek Watershed is primarily agricultural. Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) allow sediment, nutrients and pesticides to be transported directly to surface water with runoff from rain events. According to the MDEQ Wetland Functional Assessment report, the Hog Creek Watershed has lost 85% of its wetlands with a high significance for sediment and other particulate retention. Wetland loss, channel modification and lack of BMPs create flow fluctuations and increased stream power. These hydrologic changes cause stream bank erosion and habitat modification resulting in adverse impacts to native biota. Streams with more uniform flow throughout the year typically have more stable channel morphology and fish assemblages.

According to the 2020 Integrated Report, Hog Creek is fully supporting its designated use for Other Indigenous Aquatic Life and Wildlife, but its designated use for Warmwater Fishery and Total and Partial Body Contact was not assessed. A biological survey conducted by the MDEQ in 2006 at Red Arrow Hwy rated the habitat marginal and the macroinvertebrate community as acceptable but noted that the banks were scoured up to three feet above the water surface suggesting the stream is somewhat flashy.

Mud Lake Drain

Mud Lake Drain is a warmwater stream that meets the Paw Paw River north of the City of Hartford. The designated use of Warmwater Fishery is impaired, and the designated use of Other Indigenous Aquatic Life and Wildlife is threatened due to known sedimentation. Nutrients are also suspected to be threatening water quality. Suspected sources of sediment are agricultural lands and streambanks. Agricultural lands are the suspected source of nutrients.

Land use in the Mud Lake Drain Watershed is primarily agricultural. Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) allow sediment and nutrients to be transported to surface water with runoff from rain events. Increased runoff, due to the lack of BMPs, wetland loss and channel modification, creates flow fluctuations and increased stream power. These hydrologic changes cause stream bank erosion and habitat modification resulting in adverse impacts to native biota. Streams with more uniform flow throughout the year typically have more stable channel morphology and fish assemblages. According to the MDEQ Wetland Functional Assessment report, the Mud Lake Drain Watershed has lost 42% of its wetlands with a high significance for streamflow maintenance and 81% of its wetlands with a high significance for fish and shellfish habitat.

For the 2020 Integrated Report, Mud Lake Drain was fully supporting Other Indigenous Aquatic Life and Wildlife and not assessed for Total and Partial Body Contact, Warmwater Fishery and Coldwater Fishery. A biological survey conducted by the MDEQ in 2006 at 52nd Street noted that 70% of the stream bottom was affected by sand deposition. MDNR Fisheries Division staff reported that Mud Lake Drain has lost two fish species.

Ox Creek

Ox Creek is a warmwater stream that joins the Paw Paw River in Benton Harbor. The designated uses of Warmwater Fishery and Other Indigenous Aquatic Life and Wildlife are impaired due to known sedimentation, metals, oils and grease. Nutrients, pesticides and contaminated sediment are also suspected to be impacting water quality. Developed lands are a suspected source of these pollutants. Streambanks are a suspected source of sediment. Agricultural lands in the headwaters of the stream are another suspected source of sediment, as well as nutrients and pesticides. Heavy metals and organic compounds have been found in Ox Creek. Historic industrial practices are a known source of these pollutants.

The Ox Creek Watershed contains the most urbanized portion of the PPRW, with over 2000 acres of impervious surface. Insufficient management of the stormwater runoff created by impervious surfaces leads to sedimentation, polluted runoff and altered hydrology. Flow fluctuations, increased stream power and other hydrology changes cause stream bank erosion, habitat modification and adverse impacts to native biota. Streams with more uniform flow throughout the year typically have more stable channel morphology and more stable fish assemblages. Flow fluctuations can also affect environmental conditions, such as water temperature and chemistry. Suspected causes

of polluted runoff include improper application, storage, and disposal of fertilizers and pesticides by landowners. Poor vehicle maintenance and improper oil disposal are suspected causes of oils and grease in urban stormwater runoff. Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) allow sediment, nutrients and pesticides to be transported directly to surface water with runoff from rain events.

In the 2020 Integrated Report, Ox Creek is not supporting Other Indigenous Aquatic Life and Wildlife due to flow regime modification, sedimentation/siltation and total suspended solids. There is insufficient information if Ox Creek is meeting the Warmwater Fishery designated use and the following uses were not assessed: Coldwater Fishery and Total and Partial Body Contact. A TMDL has been developed and a separate watershed management plan and technical update was developed that focused on stormwater best management practices in the Orchards Mall retail district area.

Sediment samples taken in 2006 by EGLE indicated that levels of lead, zinc and several polycyclic aromatic hydrocarbons exceeded sediment quality guidelines. Biological surveys conducted by the MDEQ in 2006 rated the macroinvertebrate community poor at 2 of 3 survey locations. Habitat was rated as marginal at one location due to a lack of epifaunal substrate and heavy deposits of sand. The fish community was rated at the low end of acceptable at Meadowbrook Rd., the only location sampled for fish and the most upstream survey station on Ox Creek. The fish community further downstream is more affected by high stormwater flows and altered hydrology.

South Branch

The South Branch is designated as a warmwater stream originating at the confluence of the East and West Branches in the Village of Paw. Approximately 5 miles downstream of Maple Lake, the South Branch joins the North Branch to become the Paw Paw River Mainstem. The designated uses of Warmwater Fishery and Other Indigenous Aquatic Life and Wildlife are threatened due to known sedimentation. Nutrients, pesticides, metals, oils and grease are also suspected to be threatening water quality. Agricultural lands are a suspected source of sediment, nutrients and pesticides. Streambanks are the primary suspected source of sediment. Urban stormwater runoff from the Village of Paw Paw is a suspected source of nutrients, pesticides, metals, oils and grease.

Land cover in the South Branch Watershed below the confluence of the East and West branches is 49% natural, 40% agricultural and 11% urban. According to the MDEQ Wetland Functional Assessment report, 75% of the presettlement wetlands remain intact. The Village of Paw Paw contains most of the urban land cover and associated impervious surfaces in the South Branch Watershed. Insufficient management of stormwater runoff created by impervious surfaces leads to sedimentation and polluted runoff. Suspected causes of polluted runoff include improper application, storage, and disposal of fertilizers and pesticides by landowners. Poor vehicle maintenance and improper oil disposal are suspected causes of metals, oil and grease in urban stormwater runoff.

The West Branch is the largest tributary to the South Branch and its watershed is predominantly agricultural. Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) allow sediment, nutrients and pesticides to be transported directly to surface water with runoff from rain events. Wetland loss, channel modification and lack of BMPs create flow fluctuations in the West Branch and its tributaries. These hydrologic changes cause stream bank erosion and allow sediment and nutrients to be transported to Maple Lake in suspension.

Most of the sediment from urban stormwater runoff and the West Branch is trapped by Maple Lake, but nutrients, pesticides and other pollutants can move through the lake to the South Branch. Although Maple Lake serves as a sediment trap, the lack of suspended sediment in the water below the lake can actually lead to increased bank erosion along the South Branch. Water devoid of suspended sediment has an enhanced ability to cause streambank erosion.

According to the 2020 Integrated Report, the South Branch was not assessed for its Warmwater Fishery designated use. It was found to be meeting its designated use for Other Indigenous Aquatic Life and Wildlife. A biological survey conducted by the MDEQ in 2006 at 3750th Avenue rated the macroinvertebrate community as acceptable. The habitat was rated good, but the report noted that very little substrate was available for colonization. The pool substrate was dominated by silt, and there were several deep deposits of silt.

Lakes

According to the 2020 Integrated Report, the following lakes are fully supporting Other Indigenous Aquatic Life and Wildlife: Paw Paw Lake (Berrien County), Paw Paw Lake (Kalamazoo County), Puterbaugh Lake, Shafer Lake ,Hall Lake, Rush Lake, Van Auken Lake, Upper Reynolds Lake, School Section Lake, Maple Lake, Cora Lake, Brandywine Lake, Little Brandywine Lake, Ackley Lake, Three Mile Lake, Eagle Lake and Fish Lake. Both Wolf Lake and Paw Paw Lake (near Portage in Kalamazoo County) did not have sufficient information to determine if they meet the designated use of Coldwater Fishery.

Maple Lake

Maple Lake is a man made impoundment of the East and West Branches of the Paw Paw River. The designated use of Warmwater Fishery is threatened due to known sedimentation. The designated use of Other Indigenous Aquatic Life and Wildlife is threatened by sediment and suspected nutrients. Pesticides, metals, oils and grease are also suspected to be impacting water quality. Suspected sources of sediment are streambanks and agricultural lands in the West Branch Watershed. Agricultural lands are a suspected source of nutrients and pesticides. Urban stormwater runoff from the Village of Paw Paw is a suspected source of nutrients, sediment, pesticides, metals, oils and grease.

The Village of Paw Paw contains the largest amount of urban land cover and associated impervious surfaces in the Maple Lake Watershed. Insufficient management of the stormwater runoff created by impervious surfaces leads to sedimentation and polluted

runoff. Suspected causes of polluted runoff include improper application, storage, and disposal of fertilizers and pesticides by landowners. Poor vehicle maintenance and improper oil disposal are suspected causes of metals, oil and grease in urban stormwater runoff. Polluted runoff and increased nutrient levels lower dissolved oxygen (DO) in the water column.

The West Branch is the largest tributary to Maple Lake and its watershed is predominantly agricultural. Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) allow sediment, nutrients and pesticides to be transported directly to surface water with runoff from rain events. Wetland loss, channel modification and lack of BMPs create flow fluctuations and increased stream power in the West Branch and its tributaries. These hydrologic changes cause stream bank erosion and allow sediment and nutrients to be transported to Maple Lake in suspension. The sediment and nutrients accumulate in the lake resulting in lowered DO levels and habitat modification with adverse impacts to native biota.

According to the 2008 and 2020 Integrated Reports, Maple Lake is meeting its designated use for Other Aquatic Life and Wildlife. For the 2018 and 2020 Integrated Report, warmwater fishery and total and partial body contact were not assessed. Increasing sediment, nutrients and weed growth is altering the lake's habitat and chemistry. Lake levels were lowered during the fall of 2007 to facilitate repair of the dam. Lower water levels revealed the extent of sedimentation and weed growth. The Village of Paw Paw is working with the Van Buren County Drain Commissioner to determine how they can restore Maple Lake and protect it from further sedimentation and weed growth.

Paw Paw Lake

Paw Paw Lake is the largest lake in Berrien County and the largest lake in the PPRW. The designated use of Warmwater Fishery is threatened due to known low dissolved oxygen (DO) levels. The designated use of Other Indigenous Aquatic Life and Wildlife is threatened by known sediment and nutrients. Pesticides, metals, oils and grease are also suspected to be impacting water quality. Developed lands are a suspected source of nutrients, sediment, pesticides, metals, oils and grease. Agricultural lands in the headwaters of the lake are a suspected source of nutrients, sediment and pesticides. Tributary streambanks are another suspected source of sediment.

The area immediately adjacent to Paw Paw Lake contains a significant amount of urban land cover and associated impervious surfaces. Insufficient management of the stormwater runoff created by impervious surfaces leads to sedimentation and polluted runoff. Suspected causes of polluted runoff include improper application, storage, and disposal of fertilizers and pesticides by land owners. Polluted runoff and increased nutrient levels lower Dissolved Oxygen in the water column. Poor vehicle maintenance and improper oil disposal are suspected causes of metals, oil and grease in urban stormwater runoff.

Land cover in the headwaters of the Paw Paw Lake Watershed is predominantly agricultural. Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) allow sediment, nutrients and pesticides to be transported directly to surface water with runoff from rain events. Wetland loss, channel modification and lack of BMPs create flow fluctuations and increased stream power in Paw Paw Lake tributaries. These hydrologic changes cause stream bank erosion and allow sediment and nutrients to be transported to the lake in suspension. The sediment and nutrients accumulate in the lake resulting in lowered DO levels and habitat modification with adverse impacts to native biota.

According to the 2020 Integrated Report, Paw Paw Lake is meeting its designated use for Other Indigenous Aquatic Life and Wildlife and not assessed for any other designated uses. Habitat has been severely impaired by increased armoring of the shoreline (sea walls, sheet piling and rip-rap). The Spicer Group conducted a study of Paw Paw Lake and its watershed in 2007. According to the study, low Dissolved Oxygen levels are impairing the water quality of the lake. Accumulating nutrients (phosphorus & nitrogen) and organic material on the lake bottom is using up the available oxygen in the water column. Discussions with MDNR Fisheries Division staff confirm the fishery is impaired.

Appendix 5. Rare Species in the Paw Paw River Watershed

Scientific Name	Common Name	Federal Status	State Status	Type
Accipiter gentiles	Northern Goshawk		SC	Animal
Acris crepitans blanchardi	Blanchard's Cricket Frog		SC	Animal
Agrimonia rostellata	Beaked Agrimony		SC	Plant
Ambystoma opacum	Marbled Salamander		T	Animal
Ammodramus henslowii	Henslow's Sparrow		T	Animal
Ammodramus savannarum	Grasshopper Sparrow		SC	Animal
Amorpha canescens	Leadplant		SC	Plant
Aristida tuberculosa	Beach Three-awned Grass		T	Plant
Asclepias purpurascens	Purple Milkweed		SC	Plant
Astragalus canadensis	Canadian Milk-vetch		T	Plant
Baptisia lactea	White or Prairie False Indigo		SC	Plant
Bartonia paniculata	Panicled Screw-stem		T	Plant
Berula erecta	Cut-leaved Water-parsnip		T	Plant
Bog				Community
Cacalia plantaginea	Prairie Indian-plantain		SC	Plant
Calamagrostis stricta	Narrow-leaved Reedgrass		T	Plant
Carex seorsa	Sedge		T	Plant
Carex squarrosa	Sedge		SC	Plant
Cistothorus palustris	Marsh Wren		SC	Animal
Clemmys guttata	Spotted Turtle		T	Animal
Clonophis kirtlandii	Kirtland's Snake		E	Animal
Coastal plain marsh	Infertile Pond/marsh, Great Lakes Type			Community
Coreopsis palmata	Prairie Coreopsis		T	Plant
Cypripedium candidum	White Lady-slipper		T	Plant
Dalea purpurea	Purple Prairie-clover		X	Plant
Dendroica cerulea	Cerulean Warbler		SC	Animal
Dryopteris celsa	Log Fern		T	Plant
Elaphe obsoleta obsoleta	Black Rat Snake		SC	Animal
Emys blandingii	Blanding's Turtle		SC	Animal
Eryngium yuccifolium	Rattlesnake-master		T	Plant
Filipendula rubra	Queen-of-the-prairie		T	Plant
Fuirena squarrosa	Umbrella-grass		T	Plant
Galearis spectabilis	Showy Orchis		T	Plant
Great Blue Heron Rookery	Great Blue Heron Rookery			Other

Scientific Name	Common Name	Federal Status	State Status	Type
Great lakes marsh				Community
Gymnocladus dioicus	Kentucky Coffee-tree		SC	Plant
Hemicarpha micrantha	Dwarf-bulrush		SC	Plant
Hibiscus moscheutos	Swamp Rose-mallow		SC	Plant
Hydrastis canadensis	Goldenseal		T	Plant
Jeffersonia diphylla	Twinleaf		SC	Plant
Juncus scirpoides	Scirpus-like Rush		T	Plant
Kuhnia eupatorioides	False Boneset		SC	Plant
Lepisosteus oculatus	Spotted Gar		SC	Animal
Lepyronia angulifera	Angular Spittlebug		SC	Animal
Lepyronia gibbosa	Great Plains Spittlebug		T	Animal
Liparis liliifolia	Purple Twayblade		SC	Plant
Ludwigia alternifolia	Seedbox		SC	Plant
Mesic sand prairie	Moist Sand Prairie, Midwest Type			Community
Mesodon elevatus	Proud Globe		SC	Animal
Microtus ochrogaster	Prairie Vole		E	Animal
Neonympha mitchellii mitchellii	Mitchell's Satyr	LE	E	Animal
Nicrophorus americanus	American Burying Beetle	LE	E	Animal
Oak barrens	Barrens, Central Midwest Type			Community
Panax quinquefolius	Ginseng		T	Plant
Panicum leibergii	Leiberg's Panic-grass		T	Plant
Panicum verrucosum	Warty Panic-grass		T	Plant
Platanthera ciliaris	Orange or Yellow Fringed Orchid		T	Plant
Polygala cruciata	Cross-leaved Milkwort		SC	Plant
Pomatiopsis cincinnatiensis	Brown Walker		SC	Animal
Populus heterophylla	Swamp or Black Cottonwood		E	Plant
Potamogeton bicupulatus	Waterthread Pondweed		T	Plant
Prairie fen	Alkaline Shrub/herb Fen, Midwest Type			Community
Protonotaria citrea	Prothonotary Warbler		SC	Animal
Psilocarya scirpoides	Bald-rush		T	Plant
Pycnanthemum verticillatum	Whorled Mountain-mint		SC	Plant
Rallus elegans	King Rail		E	Animal
Rhexia virginica	Meadow-beauty		SC	Plant
Rhynchospora macrostachya	Tall Beak-rush		SC	Plant
Sabatia angularis	Rose-pink		T	Plant

Scientific Name	Common Name	Federal Status	State Status	Type
Scleria pauciflora	Few-flowered Nut-rush		E	Plant
Scleria reticularis	Netted Nut-rush		T	Plant
Silphium integrifolium	Rosinweed		T	Plant
Sistrurus catenatus	Eastern Massasauga	C	SC	Animal
Southern floodplain forest				Community
Sporobolus heterolepis	Prairie Dropseed		SC	Plant
Stellaria crassifolia	Fleshy Stitchwort		T	Plant
Terrapene carolina Carolina	Eastern Box Turtle		SC	Animal

LE: Listed Endangered SC: Special Concern T: Threatened
C: Candidate for federal status under the Endangered Species Act of 1998
E: Endangered X: Probably Extirpated
Source: Michigan Natural Features Inventory, 2006

Appendix 6. Steering Committee Participants (2008)

First Name	Last Name	Representing*	# of Steering Committee Meetings Attended
Chris	Bauer	EGLE	13
Bob	Becker	Paw Paw Lake	2
Calli	Berg	Coloma Watervliet Economic Development Corporation	1
Tricia	Bizoukas	Van Buren Conservation District	1
Jack	Bley	Landowner	2
Gaye	Blind	Berrien County Conservation District	10
Craig	Burns	The Nature Conservancy	2
Beth	Clawson	Van Buren MSU Extension	5
Marcy	Colclough	Southwest Michigan Planning Commission	16
Geoff	Cripe	Southwest Michigan Land Conservancy	4
Pete	DeBoer	Southwest Michigan Land Conservancy	10
Sue	DeVries	The Nature Conservancy	13
Dave	Diget	Landowner	5
Carl	Druskovich	Hamilton Twp	1
Chuck	Eckenstahler	Public Consulting Team	3
Nancy	Edwards	Landowner	9
Andrew	Fang	Kieser & Associates	1
Chad	Fizzel	EGLE	1
Dave	Foerster	Van Buren County Farmland Preservation Board	14
Dave	Fongers	EGLE	1
John	Fraser	Southwest Michigan Land Conservancy	1
Erin	Fuller	Black River Watershed Project	3
Kelly	Dissette	Van Buren MSU Extension	5
Lou	Gibson	Paw Paw Lake	5
Charles	Goodrich	Hamilton Twp	5
Cameron	Guenther	Kieser & Associates	1
Brian	Gunderman	Michigan Department of Natural Resources	1
Bob	Harvey	Village of Paw Paw	9
Anne	Hendrix	Berrien County Drain Commission	1
Matt	Herbert	The Nature Conservancy	1
Lawrence	Hummel	Van Buren County Road Commission	1
Val	Janowski	Pokagon Band of Potawatomi Indians	1
Frank	Jurenka	Paw Paw Lake	3
Linda	Kerr	Texas Twp	1
Jean	Ketchum	Landowner	1
Mark	Kieser	Kieser & Associates	2
Julia	Kirkwood	EGLE	10
John	Lauck	Van Buren County Planning Commission	3
William	Lawson Jr.	Hamilton Twp Planning Commission	2

First Name	Last Name	Representing*	# of Steering Committee Meetings Attended
John	Legge	The Nature Conservancy	6
Tamara	Lipsey	Michigan Department of Environmental Quality	1
Amy	Lockhart	Van Buren Conservation District	9
Don	Main	Landowner	6
MaDonna	Martin	Hartford Twp	1
Kyle	Mead	Van Buren Conservation District	1
Matt	Meersman	Southwest Michigan Planning Commission	14
Jon	Mills	Van Buren Conservation District	1
Chuck	Nelson	Sarett Nature Center	8
Pat	Nelson	Little Paw Paw Lake	1
Larry	Nielsen	Village of Paw Paw	2
Jeff	Noel	Whirlpool Corporation	1
Joe	Parman	Van Buren County Drain Commission	9
Mark	Parrish	Pokagon Band of Potawatomi Indians	10
Steve	Petersen	Hamilton Twp Planning Commission	13
Lisa	Phillips	Porter Twp	1
Laurence	Picq	Kieser & Associates	12
Steven	Rigoni	Michigan Avenue Academy	1
Daniel	Ruzick	Antwerp Twp	2
Darrin	Schaer	Landowner	4
Ken	Schaut	Village of Lawrence	2
Sharon	Schmuhl	Michigan Agri-Women	1
Bonnie	Schultz	Michigan Agri-Women	1
Amy	Seitz	Southwest Michigan Planning Commission	1
Connie	Selles	Almena Twp	1
Del	Sipes	Paw Paw Lake	8
John	Small	Village of Paw Paw	2
Kregg	Smith	Michigan Department of Natural Resources	2
Gary	Soper	Benton Twp	4
Jeff	Spoelstra	Kieser & Associates	2
Joe	Stepich	Paw Paw Lake	3
Doug	Stiles	Almena Twp Supervisor	13
Gary	Stock	Landowner	13
Jo	Taylor	Landowner	1
Ted	Thar	Van Buren County	1
Jeannine	Totzke	Berrien County Drain Commission	1
Peter	Vincent	EGLE	8
Mindy	Walker	Sarett Nature Center	8
Emily	Wilke	Southwest Michigan Land Conservancy	1
Rob	Zbiciak	EGLE	10

*The representation of steering committee members is self declared and may have changed from when it was recorded in the meeting records.

Appendix 7. Stakeholder Concerns

Urban/Urbanizing Related

- Wetland Filling (Wal-Mart, Crystal Ave., Harbor Shores Project, etc.)
- Soil Erosion and Sedimentation from Urban Development
- Polluted Urban Stormwater Runoff (roads, parking lots, etc.)
- Fertilizer and Chemical Runoff from Lawns
- Faulty Sewer and Septic Systems
- Fragmentation/Urban Development
- Hartford - Watervliet Area Development Corridor
- Loss of Natural Lake Shoreline to Sea Walls and Rip Rap
- Fisheries Habitat Fragmentation from Road/Stream Crossings (especially in Blue Creek and East Branch)
- Head Cuts Starting to Form on Blue Creek from Undersized or Misaligned Culverts on Road/Stream Crossings
- Impact of Road Improvements and Possible Tree Removal Along Trout Stream on 38th Ave. in Almena Twp.

Agricultural Related

- Impact of Confined Animal Feeding Operation (CAFO) in Hartford Area
- Soil Erosion and Sedimentation from Cropland
- Lack of buffers on tributaries
- Chemical and Fertilizer Runoff from Cropland
- Livestock Waste and Livestock Access to Streams
- Historic Contributions of Sediment to Brush Creek from Agricultural Practices Along Red Creek (recovery is being monitored by MDNR)
- Groundwater Contamination in Coloma Township
- Vegetable production and soil erosion concerns (Cucumbers, tomatoes and jalapeño peppers are grown in unique ways, which make prevention of soil erosion difficult. Tomatoes and peppers are grown in mounds of soil. Cucumbers grow in short vines that spread across the ground with little root structure. After the cucumbers are harvested, the vines die leaving soils exposed. Winter cover crops are rarely planted to protect soils.)

Industrial Related

- Groundwater Contamination from K&L Avenue Landfill in Kalamazoo County
- Hartford Superfund Site
- Coca Cola/Minute Maid Effluent Discharge
- Ox Creek Groundwater Venting
- Groundwater Withdrawals for Commercial Bottling
- Aircraft Components Superfund Site – Benton Harbor

Conservation Related

- Preserve the Connected Forested Floodplain Corridor
- Protection of Groundwater Recharge Areas
- Protection and Identification of Endangered Species Habitat
- Invasive or Non-native Species Competing with Natives
- MDNR Natural River Designation

Recreation Related

- Watercraft on Waterways (gas, oil, wave action, etc.)
- Lack of Public Access to River
- Negative Impact of Increased Recreation on Natural Resources

General Concerns

- Plant and Algae Growth in Area Lakes
- Canada Geese Population
- Sedimentation of Maple Lake and Paw Paw Lake
- In-Channel Erosion and Sediment Load
- Pesticide/Herbicide Use by Paw Paw Public Schools
- Ecoli Impairment of Pine/Mill Creeks

Appendix 8. Paw Paw River Watershed Related Studies

Title	Year of Pub.	Author	Agency Sponsor	Report ID/#
State of Michigan 1955 report on water resource conditions and uses in the Paw Paw River basin	1955	Michigan Water Resources Commission	MDEQ	MI/DEQ/SWQ-96/100
Bottom fauna survey, Paw Paw River, Watervliet to Benton Harbor, Berrien County, Michigan, July 10-11, 1958	1958	Fetterolf, C.M.	MDEQ	Report # 000550
Self purification study, Paw Paw River, Watervliet to Benton Harbor	1960		MDEQ	Report # 025430
Water resource conditions and uses in the Paw Paw River basin (revised 1964)	1964		MDEQ	Report # 025435
Water Resource Conditions and Uses in the Paw Paw River Basin	1964	Michigan Water Resources Commission		
Comments on Glaser, Crandall Company's proposed use of the East Branch Paw Paw River for waste disposal	1966	Fetterolf, C.M.	MDEQ	Report # 022571
Physical Characteristics of the Paw Paw Basin	1969		MDEQ	MI/DEQ/SWQ-99/026
Biological and Sediment Oil Survey of Ox Creek, Benton Harbor, MI	1976		MDEQ	Report # 002910
Water Quality at Selected Stations on Streams in the Kalamazoo, Paw Paw, Black and Macatawa River Basins in Southwestern Michigan	1976	Sylvester, S.	MDEQ	Report # 022850
A Water and Land Resource Plan for the Kalamazoo-Black-Macatawa-Paw Paw Rivers Basin	1977		USDA	
Report of toxicity evaluations conducted with well water from International Research and Development Corporation, VanBuren County, Mattawan, MI	1978	Bohan, J.E.	MDEQ	MI/DNR/SWQ-91/167
Report of a 48-hour acute toxicity screening test conducted on effluent, Duwel Metal Products, all outfall No. 800023, VanBuren County, Hartford, MI	1979	Lee, L	MDEQ	MI/DNR/SWQ-91/258
Report of a toxicity screening test conducted on wastewater of International Research and Development Corporation, Vanburen County, Mattawan, MI	1979	Bohan, J.E.	MDEQ	MI/DNR/SWQ-91/168
Report of toxicity evaluations conducted on process wastewater of Auto Specialties Company, Riverside Castings Division, Berrien County, Benton Harbor, MI	1979	Bohan, J.E.	MDEQ	MI/DNR/SWQ-92/095

Title	Year of Pub.	Author	Agency Sponsor	Report ID/#
Reports of a toxicity evaluation conducted on wastewaters discharged by Auto Specialties Manufacturing Company, St. Joseph, MI	1979	White, B.	MDEQ	MI/DNR/SWQ-92/096
Sediment and Water Survey to Determine influences by Michigan Standard Alloy - Aluminum Division's (Benton Harbor) Operations on the Paw Paw River	1979	Wuycheck, J.	MDEQ	Report # 065130
Stream Assessment of the Paw Paw River in the Vicinity of Automotive Specialties and Whirlpool Corporation	1979	Creal, W.	MDEQ	Report # 003490
Biological Assessment of Pine Creek, Vicinity of Hartford, Van Buren County	1980	Creal, W.	MDEQ	Report # 003710
Report of a toxicity evaluation conducted at the Duwel Products, Inc., outfall 800155 (000), VanBuren County, Hartford, MI	1980	Lee, L	MDEQ	MI/DNR/SWQ-91/261
Report of an invertebrate toxicity screening test conducted with effluent from International Research and Development Corporation, all outfalls No. 800030, Van Buren County, Mattawan, MI	1980	Swanson, J.	MDEQ	MI/DNR/SWQ-91/169
Chemical and biological Investigations of the East & West Branches of the Paw Paw River & Maple Ackley Lakes, Vicinity of Paw Paw, Van Buren County	1982	Creal, W.	MDEQ	Report # 004070
Macroinvertebrate Survey of the Paw Paw River, Vicinity of Watervliet Paper Company	1982	Creal, W.	MDEQ	Report # 004060
Report of an on-site toxicity evaluation at Watervliet Paper Company, facility No. 110091, NPDES permit No. MI0000817, Berrien County, Watervliet, MI, November 1981	1982	White, B.	MDEQ	MI/DNR/SWQ-92/180
Report of an on-site toxicity evaluation at Watervliet Paper Company,facility No. 110091, NPDES Permit No. MI0000817, Berrien County, Watervliet, MI, June-July 1982	1982	White, B.	MDEQ	MI/DNR/SWQ-92/181
Toxicity evaluation of effluent discharged by Auto Specialties Corporation, Hartford, MI	1984	Hull, C.	MDEQ	MI/DNR/SWQ-91/280
Hydrology and Land Use in Van Buren County, MI	1984	Cummings, T.R.; Twenter, F.R.; Holtschlag, D.J.	USGS, Van Buren County, MDNR, MDA	
Michigan Tributaries of the St. Joseph River Basin Report	1985		USDA, Soil Cons. Services	

Title	Year of Pub.	Author	Agency Sponsor	Report ID/#
Acute toxicity assessment of Duwell Products, Inc., dechlorinated effluent, Hartford, MI	1987	Hering, C.M.	MDEQ	MI/DNR/SWQ-91/260
Site Visit at Lawton Drain, Van Buren County	1987		MDEQ	Report # 025660
Southwestern Michigan Commission Water Quality Sampling of the St. Joseph River and Its Tributaries	1988	Fishbeck, Thompson, Carr & Huber, Inc.		
Aquatic toxicity assessment of Watervliet Paper Company 001 effluent, Watervliet, Michigan	1988	Dimond, W.F.	MDEQ	MI/DNR/SWQ-88/068
Biological Survey of Lawton Drain in the Vicinity of Welch Foods, Inc., Van Buren County, Michigan	1989	Hull, C.	MDEQ	MI/DNR/SWQ-89/038
Water Quality Investigation for St. Joseph River System	1989	Fishbeck, Thompson, Carr & Huber, Inc.		
Acute toxicity assessment of Paw Paw Lake area WWTP 001 effluent, Coloma, Michigan	1990	Dimond, W.F.	MDEQ	MI/DNR/SWQ-90/139
Acute toxicity assessment of Paw Paw WWTP 001 effluent, Paw Paw, Michigan	1990	Dimond, W.F.	MDEQ	MI/DNR/SWQ-90/138
Acute toxicity assessment of Hoffman Die Cast Corp. outfall 002 effluent, Benton Harbor, MI	1991	Dimond, W.F.	MDEQ	MI/DNR/SWQ-91/225
Fisheries Survey of the Paw Paw River Basin	1991	Dexter, J.L.	MDNR–Fisheries Division	Report # 91-2
MDNR Status of the Fishery Resource Report: East Branch Paw Paw River (and Mattawan Creek)	1991	Dexter, J.L.	MDNR–Fisheries Division	Report # 91-16
Biological Survey of Pine Creek, Van Buren County, Michigan	1992	Heaton, S.	MDEQ	MI/DNR/SWQ-92/272
MDNR Status of the Fishery Resource Report: Campbell Creek	1992	Dexter, J.L.	MDNR–Fisheries Division	Report # 92-3
Biological Survey of the Paw Paw River between Coloma and Paw Paw Roads	1992	Schaddlelee, L.	TNC	
Paw Paw River Trail – Preliminary Conceptual Plan	1993		CWAEDC	

Title	Year of Pub.	Author	Agency Sponsor	Report ID/#
MDNR Status of the Fishery Resource Report: Maple Lake	1993	Dexter, J.L.	MDNR–Fisheries Division	Report # 93-5
Acute toxicity assessment of Fletcher Paper Company, Watervliet, Michigan, Outfall 001 effluent, NPDES Permit No. MI0000817	1994	Butler, D.	MDEQ	MI/DNR/SWQ-94/069
Biological survey of Blue Creek, Yellow Creek and Pipestone Creek, Berrien County, MI	1995	Heaton, S.	MDEQ	MI/DNR/SWQ-95/032
Biological Survey of Sand Creek, Berrien County, MI	1995	Heaton, S.	MDEQ	MI/DNR/SWQ-95/030
Carrying capacity analysis of Paw Paw Lake	1995		Paw Paw Lake Assoc.	
Protecting the Groundwater of Van Buren County: A Blueprint for Action	1995	Houseman, L.; Kirby, M.J; Hughes, L.D.	Van Buren Cons. District, EPA, MDEQ	
Paw Paw Lake Chemical Monitoring Project Final Project Report	1998	Kirby, M.J.	Paw Paw Lake Assoc. & Foundation	
Biological Survey of the Paw Paw River and Selected Tributaries in Van Buren County	1999	Cooper, J.	MDEQ	MI/DEQ/SWQ-99/017
Biological Surveys of Selected Tributaries in the Paw Paw River Watershed in Van Buren County	1999	Cooper, J.	MDEQ	MI/DEQ/SWQ-99/158
St. Joseph River Assessment	1999	Wesley, J.; Duffy, J.	MDNR–Fisheries Division	
MDNR Status of the Fishery Resource Report: East Branch Paw Paw River	2000	Dexter, J.L.	MDNR–Fisheries Division	Report # 2000-4
MDNR Status of the Fishery Resource Report: Maple Lake	2000	Dexter, J.L.	MDNR–Fisheries Division	Report # 2000-10
The St. Joseph River Basin: Water-Related People, Activities, and Things that Influenced the History of the Region	2001	St. Joseph River Basin Commission		

Title	Year of Pub.	Author	Agency Sponsor	Report ID/#
Paw Paw River Development Corridor	2002	The Abonmarche Group	CWAEDC	
A Biological Survey of the North and South Branches of the Paw Paw River and Selected Tributaries	2002	Rockafellow, D.	MDEQ	MI/DEQ/SWQ-02/062
A Biological Survey of the Paw Paw River and Selected Tributaries	2002	Rockafellow, D.	MDEQ	MI/DEQ/SWQ-02/063
Site ecological summary for Lower Paw Paw River	2002	Hyde, D.A.; Padkus, J.J.	MNFI	
Paw Paw River Watershed Conservation Area Plan	2002		TNC	
Final Draft Souce Water Assessment Report for the City of Benton Harbor Water Supply	2002		USGS, MDEQ	MI Source Water Assmnt Report 18
The Brach-Derby Toll Gate Project “An in-depth feasibility study”	2003	Progressive AE	Paw Paw Lake Foundation	
NPL Fact sheets for Michigan: Burrows Sanitation	2003		EPA – Region 5	EPA ID# MID980410617
St. Joseph River Watershed Management Plan	2005	DeGraves, A.	Friends of the St. Joe River Assoc.	
Mill Creek Water Survey	2005	Wesley, J.; Markham, S.	MDNR– Fisheries Division	
St. Joseph River Sediment Transport Modeling Study	2005	W.F. Baird & Assoc.	U.S. Army Corps of Engineers	
A Biological and Water Chemistry Survey of Mill and Pine Creeks in the Vicinity of the Hartford Dairy Concentrated Animal Feeding Operation	2006	Walterhouse, M.	MDEQ	MI/DEQ/WB-06/035
Big Paw Paw Lake, Water Quality Studies 2004-2005	2006	Fusilier, W.E.; Fusilier, B.	Paw Paw Lake Foundation	

Title	Year of Pub.	Author	Agency Sponsor	Report ID/#
Little Paw Paw Lake, Water Quality Studies 1992-2005	2006	Fusilier, W.E.; Fusilier, B.	Paw Paw Lake Foundation	
Stream Power Analysis of the Paw Paw River Watershed	2007	Applied Ecological Services	Great Lakes Protection Fund	

The following studies and reports were completed for the 2008 Paw Paw River Watershed Planning Project and can be found at www.swmpc.org/pprw_studies.asp.

Title	Year of Pub.	Author	Agency Sponsor
Ecologically Similar Subwatersheds of the Paw Paw River	2008	Kregg Smith	Michigan Department of Natural Resources
Prioritization of Floodplain Forest Areas on the Paw Paw River	2007	John Legge	The Nature Conservancy
Volunteer Inventory of the Paw Paw River Watershed	2008	Matt Meersman	Southwest Michigan Planning Commission
Assessing Cumulative Loss of Wetland Functions in the Paw Paw River Watershed Using Enhanced National Wetlands Inventory Data	2007	Chad Fizzell	Michigan Department of Environmental Quality
Agricultural Insult Areas in the Paw Paw River Watershed	2008	Matt Meersman and Craig Burns	The Nature Conservancy and Southwest Michigan Planning Commission
Modeling of Agricultural BMP Scenarios in the Paw Paw River Watershed using the Soil and Water Assessment Tool (SWAT)	2008	Kieser & Associates	Kieser & Associates
Urban Build Out and Stormwater BMP Analysis in the Paw Paw River Watershed	2008	Kieser & Associates	Kieser & Associates
Critical Areas for Preservation in the Paw Paw River Watershed	2008	Southwest Michigan Land Conservancy	Southwest Michigan Land Conservancy
PPRW Preservation Area Model	2008	Matt Meersman	Southwest Michigan Planning Commission
PPRW Agricultural Area Model	2008	Matt Meersman	Southwest Michigan Planning Commission

Title	Year of Pub.	Author	Agency Sponsor
PPRW Urban/Developing Model	2008	Matt Meersman	Southwest Michigan Planning Commission
Information and Education Plan for the Black and Paw Paw River Watersheds	2008	Southwest Michigan Planning Commission and Van Burn Conservation District	Southwest Michigan Planning Commission and Van Burn Conservation District
Municipal Planning and Water Quality in the Paw Paw River Watershed – Local Plan Reviews	2008	Southwest Michigan Planning Commission	Southwest Michigan Planning Commission

Appendix 9. Common Pollutants, Sources and Water Quality Standards

Sources of water pollution are broken down into two categories: point source pollution and nonpoint source pollution. Point source pollution is the release of a discharge from a pipe, outfall or other direct input into a body of water. Common examples of point source pollution are factories and wastewater treatment facilities. Facilities with point source pollution discharges are required to obtain a National Pollutant Discharge Elimination System (NPDES) permit to ensure compliance with water quality standards under the Clean Water Act. They are also required to report to EGLE on a regular basis. This process assists in the restoration of degraded water bodies and drinking water supplies.

Sixty percent of water pollution is from non-point source pollution. Polluted runoff is caused when rain, snowmelt, or wind carries pollutants off the land and into water bodies. Roads, parking lots, driveways, farms, home lawns, golf courses, storm sewers, and businesses collectively contribute to nonpoint source pollution.

Nonpoint source pollution, also known as polluted runoff, is not as easily identified. It is often overlooked because it can be a less visible form of pollution. Polluted runoff is caused when rain, snowmelt, or wind carries pollutants off the land and into water bodies. Roads, parking lots, driveways, farms, home lawns, golf courses, storm sewers, and businesses collectively contribute to nonpoint source pollution.

The State of Michigan's Part 4 Rules (of Part 31, Water Resources Protection, of Act 451 of 1994) specify water quality standards, which shall be met in all waters of the state. Common water pollutants and related water quality standards are described below. Note that not all water quality pollutants have water quality standards established.

Sediment

Sediment is soil, sand, and minerals that can take the form of bedload, suspended or dissolved material. Sediment harms aquatic wildlife by altering the natural streambed and increasing the turbidity of the water, making it "cloudy". Sedimentation may result in gill damage and suffocation of fish, as well as having a negative impact on spawning habitat. Increased turbidity from sediment affects light penetration resulting in changes in oxygen concentrations and water temperature that could affect aquatic wildlife. Sediment can also affect water levels by filling in the stream bottom, causing water levels to rise. Lakes, ponds and wetland areas can be greatly altered by sedimentation. Other pollutants, such as phosphorus and metals, can bind themselves to the finer sediment particles. Sedimentation provides a path for these pollutants to enter the waterway or water body.

Removing trees and building close to the river's edge can cause bank erosion.

Related water quality standards

Total Suspended Solids (TSS) - Rule 50 of the Michigan Water Quality Standards (Part 4 of Act 451) states that waters of the state shall not have any of the following unnatural physical properties in quantities which are or may become injurious to any designated use: turbidity, color, oil films, floating solids, foam, settleable solids, suspended solids, and deposits. This kind of rule, which does not establish a numeric level, is known as a "narrative standard." Most people consider water with a TSS concentration less than 20 mg/l to be clear. Water with TSS levels between 40 and 80 mg/l tends to appear cloudy, while water with concentrations over 150 mg/l usually appears dirty. The nature of the particles that comprise the suspended solids may cause these numbers to vary.

Nutrients

Although certain nutrients are required by aquatic plants in order to survive, an overabundance can be detrimental to the aquatic ecosystem. Nitrogen and phosphorus are generally available in limited supply in an unaltered watershed but can quickly become abundant in a watershed with agricultural and urban development. In abundance, nitrogen and phosphorus accelerate the natural aging process of a water body and allow exotic species to better compete with native plants. Wastewater treatment plants and combined sewer overflows are the most common point sources of nutrients. Nonpoint sources of nutrients include fertilizers and organic waste carried within water runoff. Excessive nutrients increase weed and algae growth impacting recreational use on the water body. Decomposition of the increased weeds and algae lowers dissolved oxygen levels resulting in a negative impact on aquatic wildlife and fish populations.

Nitrogen and phosphorus are generally available in limited supply in an unaltered watershed but can quickly become abundant in a watershed with agricultural and urban development.

Related water quality standards

Phosphorus - Rule 60 of the Michigan Water Quality Standards (Part 4 of Act 451) limits phosphorus concentrations in point source discharges to 1 mg/l of total phosphorus as a monthly average. The rule states that other limits may be placed in permits when deemed necessary. The rule also requires that nutrients be limited as necessary to prevent excessive growth of aquatic plants, fungi or bacteria, which could impair designated uses of the surface water.

Dissolved Oxygen - Rule 64 of the Michigan Water Quality Standards (Part 4 of Act 451) includes minimum concentrations of dissolved oxygen, which must be met in surface waters of the state. This rule states that surface waters designated as coldwater fisheries must meet a minimum dissolved oxygen standard of 7 mg/l, while surface waters protected for warmwater fish and aquatic life must meet a minimum dissolved oxygen standard of 5 mg/l.

Temperature/Flow

Removal of streambank vegetation decreases the shading of a water body, which can lead to an increase in temperature. Impounded areas can also have a higher water temperature relative to a free-flowing stream. Heated runoff from impervious surfaces

and cooling water from industrial processes can alter the normal temperature range of a waterway. Surges of heated water during rainstorms can shock and stress aquatic wildlife, which are adapted to "normal" temperature conditions. Increased areas of impervious surfaces, such as parking lots and driveways, and reduced infiltration from other land use types, such as lawns and bare ground, leads to an increase in runoff. Increased runoff reduces groundwater recharge and leads to highly variable flow patterns. These flow patterns can alter stream morphology and increase the possibility of flooding downstream.

Increased areas of impervious surfaces, such as parking lots and driveways, and reduced infiltration from other land use types, such as lawns and bare ground, leads to an increase in runoff. Increased runoff reduces groundwater recharge and leads to highly variable flow patterns.

Related water quality standards

Temperature - Rules 69 through 75 of the Michigan Water Quality Standards (Part 4 of Act 451) specify temperature standards which must be met in the Great Lakes and connecting waters, inland lakes, and rivers, streams and impoundments. The rules state that the Great Lakes and connecting waters and inland lakes shall not receive a heat load which increases the temperature of the receiving water more than 3 degrees Fahrenheit above the existing natural water temperature (after mixing with the receiving water). Rivers, streams and impoundments shall not receive a heat load, which increases the temperature of the receiving water more than 2 degrees Fahrenheit for coldwater fisheries, and 5 degrees Fahrenheit for warmwater fisheries. These waters shall not receive a heat load, which increases the temperature of the receiving water above monthly maximum temperatures (after mixing). Monthly maximum temperatures for each water body or grouping of water bodies are listed in the rules. The rules state that inland lakes shall not receive a heat load, which would increase the temperature of the hypolimnion (the dense, cooler layer of water at the bottom of a lake) or decrease its volume. Further provisions protect migrating salmon populations, stating that warmwater rivers and inland lakes serving as principal migratory routes shall not receive a heat load which may adversely affect salmonid migration.

<u>Bacteria/Pathogens</u>

Bacteria are among the simplest, smallest, and most abundant organisms on earth. While the vast majority of bacteria are not harmful, certain types of bacteria cause disease in humans and animals. Concerns about bacterial contamination of surface waters led to the development of analytical methods to measure the presence of waterborne bacteria. Since 1880, coliform bacteria have been used to assess the quality of water and the likelihood of pathogens being present. Combined sewer overflows in urban areas and failing septic systems in residential or rural areas can contribute large numbers of coliforms and other bacteria to surface water and groundwater. Agricultural sources of bacteria include livestock excrement from barnyards, pastures, rangelands, feedlots, and uncontrolled manure storage areas. Stormwater runoff from residential, rural and urban areas can transport waste material from domestic pets and wildlife into surface waters. Land application of manure and

Bacteria from both human and animal sources can cause disease in humans.

sewage sludge can also result in water contamination. Bacteria from both human and animal sources can cause disease in humans.

Related water quality standards

Bacteria - Rule 62 of the Michigan Water Quality Standards (Part 4 of Act 451) limits the concentration of microorganisms in surface waters of the state and surface water discharges. Waters of the state, which are protected for total body contact recreation, must meet limits of 130 Escherichia coli (E. coli) per 100 milliliters (ml) water as a 30-day average and 300 E. coli per 100 ml water at any time. The total body contact recreation standard only applies from May 1 to October 1. The limit for waters of the state, which are protected for partial body contact recreation, is 1000 E. coli per 100 ml water. Discharges containing treated or untreated human sewage shall not contain more than 200 fecal coliform bacteria per 100 ml water as a monthly average and 400 fecal coliform bacteria per 100 ml water as a 7-day average. For infectious organisms which are not addressed by Rule 62, EGLE has the authority to set limits on a case-by-case basis to assure that designated uses are protected.

Chemical Pollutants

Chemical pollutants such as gasoline and oil can enter surface water through runoff from roads and parking lots, or from boating. Other sources can be approved processes such as permitted application of herbicides to inland lakes to prevent the growth of aquatic nuisance plants. Other chemical pollutants consist of pesticides and herbicide runoff from commercial, agricultural, municipal or residential uses. Impacts of chemical pollutants vary widely with the chemical.

Related water quality standards

pH - Rule 53 of the Michigan Water Quality Standards (Part 4 of Act 451) states that the hydrogen ion concentration expressed as pH shall be maintained within the range of 6.5 to 9.0 in all waters of the state.

Appendix 10. Education Plan: Black & Paw Paw River Watersheds

Introduction

The Black River Watershed and Paw Paw River Watershed Information & Education (I&E) Plan was formulated through the efforts of the joint information & education sub-committee. This sub-committee consisted of members from both watershed Steering Committees. The purpose of the plan is to provide a framework to inform and motivate the various stakeholders, residents and other decision makers within the Black River and Paw Paw River watersheds to take appropriate actions to protect water quality. This working document will also provide a starting point for organizations within the watersheds looking to provide educational opportunities or outreach efforts.

The geography of the Black River and Paw Paw River watersheds lend themselves to a partnership approach, which has been a focal point for all information and education efforts to date within the watersheds. With both watersheds sharing multiple municipal boundaries as well as many similar water quality concerns, a partnership approach to education and outreach enables both watershed projects to maximize their resources and effectively reach a larger audience than could be accomplished alone.

Information & Education Goal

The I&E plan will help to achieve the watershed management goals by increasing the involvement of the community in watershed protection efforts through awareness, education and action. The watershed community can become involved only if they are informed of the issues and are provided information and opportunities to participate.

The I&E plan lists specific tasks to be completed. These tasks will increase the general awareness of watersheds and water quality issues for all audiences, educate target audiences on specific issues and motivate target audiences to implement practices to improve and protect water quality. These practices may include homeowner activities such as reducing fertilizer use, maintaining septic systems, installing a rain garden or maintaining stream buffers. Practices for governmental units or officials may include incorporating watershed protection language into master plans and zoning ordinances, reducing the amount of salt used for deicing and utilizing low impact development techniques on public property.

Target Audiences

The level of understanding of watershed concepts and management, the concerns, values and level of enthusiasm can all vary between different audience groups. Recognizing differences between groups of target audiences is critical to achieving success through education and outreach efforts. Educational messages may need to be tailored to effectively reach different audiences. It is important to understand key motivators of each target audience to establish messages that will persuade them to adopt behaviors or practices to protect and improve water quality. The table below lists

and describes the major target audiences for the Paw Paw and Black River Watersheds and specific messages and activities that could be used to reach each audience.

Target Audiences	Description of Audience	General Message Ideas	Potential Activities
Businesses	This audience includes businesses engaging in activities that can impact water quality such as lawn care companies, landscapers, car washes, etc.	Clean water helps to ensure a high quality of life that attracts workers and other businesses.	Workshops and presentations Brochures/flyers/fact sheets One-on-one contact
Developers / Builders / Engineers	This audience includes developers, builders and engineers.	Water quality impacts property values.	Newsletter articles Workshops and presentations Watershed tours Brochures/flyers/fact sheets Trainings
Farmers	This audience includes both agricultural landowners and those renting agricultural lands and farming them.	Protecting water quality is a long-term investment by saving money by decreasing inputs (fuel, fertilizer)	Workshops and presentations Brochures/flyers/fact sheets One-on-one contact Watershed tours Newsletter articles
Government Officials and Employees	This audience includes elected (board and council members) and appointed (planning commissions and zoning board of appeals) officials of cities, townships, villages and the county. This audience also includes the drain commission and road commission staff. It also includes state and federal elected officials.	Water quality impacts economic growth potential. Water quality impacts property values and the tax revenue generated in my community to support essential services. Clean drinking water protects public health.	One-on-one contact Trainings Workshops and presentations Brochures/flyers/fact sheets Watershed tours Educational videos Watershed Management Plan User Guide
Kids / Students	This audience includes any child living or going to school in the watershed.	Clean water is important for humans and wildlife. We all depend on water.	Student stream monitoring Teacher training workshops Curriculum Educational videos
Property Owners	This audience includes any property owner in the watershed.	Water quality impacts my property value and my health.	PSAs and press releases Display/materials at festivals Workshops and presentations Watershed Tours Tax/utility bill inserts Website/YouTube video Workshops and presentations Brochures/flyers/fact sheets One-on-one contact "Entering the watershed" signs
Riparian Property Owners	This audience includes those property owners that own land along a river, stream, drain or lake.	Water quality impacts my property value and my health.	Newsletter articles Door knob hangers One-on-one contact Videos Workshops and presentations
Recreational Users	This audience includes any person who engages in recreational activities.	Water quality is important for enjoying recreational activities.	Website/YouTube video Kiosks Newsletter articles Brochures/flyers/fact sheets

Watershed Issues

To begin formulating education and outreach strategies, it is important to identify the major issues, which need to be addressed to improve and protect water quality. The priority issues for the Black and Paw Paw River Watersheds are described below. Each of these issues relate back to the goals and actions in the Watershed Management Plans for the Black and Paw Paw Rivers.

Each issue is tied to pollutants of concern in the watersheds. For each issue, the audience(s) will need to not only understand the issue, but also the solutions or actions needed to protect or improve water quality. For each major issue, priority target audiences have been identified. The priority audiences were selected because of their influence or ability to take actions, which would improve or protect water quality.

1. Watershed Awareness

The Paw Paw and Black River Watersheds both have unique natural resources, but also have significant problems with water quality. Watershed residents need to understand that their every day activities affect the quality of those resources. All watershed audiences need to be made aware of the priority pollutants and their sources and causes in each of the watersheds. Lastly, education efforts should, whenever possible, offer audiences solutions to improve and protect water quality.

One effective way to increase general watershed awareness is through recreational activities. These activities can help instill a sense of stewardship of the resources needed to enjoy the activities. Rivers, lakes and streams can provide many enjoyable recreational activities such as fishing, paddling, boating and swimming. It is important for recreational users to understand and appreciate the natural resources within the watershed and to gain a level of knowledge about the protection of those natural resources. Water trails and public access to water bodies can ensure that the public is offered an opportunity to enjoy and recreate on the water resources within the watersheds.

Priority Target Audiences: All , with focus on kids/students

Major Pollutants of Concern: sediment, nutrients, bacteria and pathogens, temperature, oil, grease and metals, pesticides

Priority Area: Entire watershed

2. Land Use Change

Land use change can disrupt the natural hydrologic cycle in a watershed. Natural vegetation, such as forest cover, usually has high infiltration capacity and low runoff rates. Whereas, urbanized land cover has impervious areas (buildings, parking lots, roads) and networks of ditches, pipes and storm sewer, which augment natural drainage patterns. Impervious surfaces reduce infiltration and the recharge of groundwater while increasing the amount of runoff. Local governmental officials and builders/developers need to understand the water quality benefits of smart growth, low

impact development, open space and farmland preservation and protection of wetlands, floodplains and riparian areas.

Current and past wetland loss in both urban and agricultural areas is a major concern in both the Paw Paw and Black River Watersheds. The loss of wetlands result in disrupted hydrology and degraded water quality. Further, many agricultural areas have been drained with extensive ditching to move water off the land quickly. While this helps with food production in these areas, water quality suffers. The high flow amounts and velocity can cause increased streambank erosion and sediment delivery. Educational efforts should target drain commissioners and farmers to better understand the water quality benefits of ditch naturalization techniques and the need for wetland protection and restoration.

Priority Target Audiences: Farmers, Governmental Officials and Employees, Developers/Builders/Engineers

Major Pollutant of Concern: sediment

Priority Area: Paw Paw River Watershed High and Medium Priority Protection Areas

3. Stormwater Runoff

Stormwater runoff is caused when rain, snowmelt or wind carries pollutants off the land and into water bodies. Education efforts should increase awareness of stormwater pollutants, sources and causes, especially the impacts of impervious (paved or built) surfaces and their role in delivering water and pollutants to water bodies. Everyday homeowner and business actions are often the source and cause of stormwater pollution. These activities include lawn care practices, household hazardous waste and oil disposal, pet waste disposal and car and equipment care. Local government activities impacting stormwater runoff include land use planning, road and parking lot maintenance and construction, lawn care practices, oversight of construction sites and identification and correction of illicit discharges and connections.

Educational efforts should target property owners and businesses about the many best practices that can decrease the amount of water and pollutants coming from their property. In addition, local governmental units can be encouraged to implement low impact development and smart growth techniques in their plans and zoning ordinances. Local governments can also be encouraged to enact regulations such as a stormwater ordinance and a phosphorus ban for non-agricultural fertilizer use. Educational efforts can also promote municipal operations and maintenance best practices, which are important for reducing polluted runoff. These include best practices for road and parking lot construction and maintenance, lawn care and vehicle maintenance.

Priority Target Audiences: Property Owners, Builders/Developers/Engineers, Businesses, Governmental Officials and Employees

Major Pollutants of Concern: sediment, nutrients, bacteria and pathogens, temperature, oil, grease and metals, pesticides

Priority Area: Paw Paw River Watershed High and Medium Priority Urban Management Areas

4. Natural Resources Management and Preservation

Preserving land and managing natural resources is crucial for effective watershed management. Preservation and management of open space, wetlands, farmland and other natural features helps to reduce the amount of stormwater runoff entering water bodies, preserve natural ecosystems, endangered species as well as the services that the natural systems provide to us such as filtering drinking water and retaining storm water.

Invasive species, both aquatic and terrestrial; pose a threat to water quality and biodiversity in both watersheds. Education efforts should focus on identification and control techniques as well as the prevention of additional invasive species. Education efforts should also encourage the use of native Michigan plants for landscaping, wildlife habitat and other uses.

Recreational activities can often have a negative impact on sensitive areas. It may be necessary to understand carrying capacities for boats on lakes and rivers. In sensitive areas, there may be a need to limit recreational activities to ensure water quality and natural resources are protected. In addition, best management practices should be utilized to limit the impacts of recreational use on water and other natural resources. BMPs could include proper woody debris management for clearing rivers for navigation and installing and maintaining proper access sites to rivers and streams for fishing and canoeing.

Education efforts should instill a sense of understanding and appreciation for natural features. Property owners, developers and local governmental officials and employees need to be presented with options for preservation and management of natural resources. Educational efforts promoting smart growth, low impact and open space development and green infrastructure should target local government officials and employees and builders, developers and engineers.

Priority Target Audiences: Property Owners, Governmental Officials and Employees, Recreational Groups/Users, Developers/Builders/Engineers

Major Pollutants of Concern: sediment, temperature

Priority Area: Paw Paw River Watershed High and Medium Priority Protection Areas

5. Agricultural Runoff

Agricultural lands cover most of the area in the Black and Paw Paw River Watersheds, If not properly managed, runoff from agricultural lands can impact the watershed by delivering pollutants such as sediment and nutrients. Education efforts should seek to help audiences understand the impacts of agricultural runoff. A key concept is the need to reduce soil erosion from agricultural lands. It is also important to understand that soil particles also carry nutrients and chemicals to water bodies. There are many best management practices for addressing soil erosion from agricultural lands. Best management practices include conservation tillage, filter strips, cover crops, grassed waterways, ditch naturalization and wetland restoration.

> Erosion is an intrinsic natural process, but in many places it is increased by human land use. A certain amount of erosion is natural and, in fact, healthy. Excessive erosion, however, does cause problems, such as sedimentation of streams and lakes, ecosystem damage and outright loss of soil. Soil erosion on agricultural fields can be caused by water, wind and tillage practices. Soil loss, and its associated impacts, is of great concern to farmers.

Drain maintenance activities, which often remove vegetation from riparian areas, contribute to soil erosion problems in agricultural areas. Drain maintenance projects should ensure as much riparian vegetation is left intact as possible and replace the vegetation with native grasses, shrubs and trees if it needs to be removed. Another major concern is manure being applied to fields in the watershed especially fields with drain tiles, which connect to ditches and streams. For nutrients and bacteria and pathogens, agricultural best management practices include methane digesters, manure and/or nutrient management, restricting livestock access to water bodies, wetland restoration and soil testing. Lastly, for pesticide concerns, best management practices include organic production and integrated pest management techniques. Cost share and technical assistance programs are available to assist agricultural landowners in implementing many of these practices.

Priority Target Audiences: Farmers

Major Pollutants of Concern: sediment, nutrients, bacteria and pathogens, pesticides

Priority Area: Paw Paw River Watershed High and Medium Priority Agricultural Management Areas

6. Septage Waste

Septage waste is both an urban and rural issue. In more rural areas and around lakes, failing or incorrectly installed septic systems impact water quality by adding excess nutrients, bacteria or other pollutants to the system. Education activities should seek to educate audiences about the impacts of septic systems on water quality. Proper maintenance of septic systems is a key practice for homeowners. Educational efforts should also target governmental units to encourage them to enact point of sale septic system inspection ordinances and to plan and zone for higher density development only in areas served by municipal sewer systems.

For urban areas, the proper operation and maintenance of municipal sewer infrastructure is necessary for protecting water quality. There is a widespread problem with aging infrastructure in urban areas, with some sewer systems dating over 100 years. Municipalities must ensure that combined sewer overflow events and other untreated releases of septage waste do not impact water quality. Educational efforts should target municipal officials and employees to encourage planning for adequate capacity, management, operation, and maintenance of sewer collection and treatment systems.

Priority Target Audiences: Governmental Officials and Employees, Riparian Property Owners

Major Pollutants of Concern: bacteria and pathogens, nutrients

Priority Area: Paw Paw River Watershed High and Medium Priority Urban Management Areas and E. coli TMDL watersheds (Pine and Mill Creek watersheds)

Distribution Formats

Because of the differences between target audiences, it will sometimes be necessary to utilize multiple formats to successfully get the intended message across. Distribution methods include the media, newsletters and direct mailings, email lists and websites, and passive distribution of printed materials. Below is a brief description of each format with some suggestions on specific outlets or methods.

1. Media

Local media is a key tool for outreach to several audience groups. The more often an audience sees or hears information about watershed topics, the more familiar they will become and the more likely they will be to use the information in their daily lives. Keeping the message out in front through press releases and public service announcements is essential to the success of education and outreach efforts.

Newspapers include: the Herald Palladium, the Kalamazoo Gazette (including the Hometown Gazette), the Courier Leader, the Bangor Reminder, the South Haven Tribune, the South Bend Tribune, the Decatur Republican, the Tri-City Record, Michigan Farm News and the Farmer's Exchange.

Radio outlets include WMUK, WCSY, WKZO, WBCT, Michigan Farm Radio Network , WKMI – Kalamazoo, WDOW – Dowagiac

Television outlets include WWMT Channel 3, WOOD Channel 8, WZZM Channel 13, WGVU Channel 35 and WXMI FOX Channel 17.

2. Newsletters and other direct mailings

Several municipalities, governmental agencies, utilities, County offices and non-profit organizations send out newsletters or other mailings which may be coordinated with

various outreach efforts such as fact sheets or “Did you Know” messages. Currently identified mailings include Van Buren County Drain Office, Village and City utility bills, Van Buren, Allegan and Berrien County Farm Bureau newsletters, USDA Farm Service Agency newsletters, Van Buren, Allegan and Berrien Conservation District newsletters, Sarett Nature Center, The Southwest Michigan Land Conservancy newsletters, MSUE, Southwest Michigan Planning Commission newsletters and The Stewardship Network.

3. E-Mail lists and Websites:

The Van Buren Conservation District and the Southwest Michigan Planning Commission maintain active websites and email lists which can be used to reach residents of the watersheds as well as elected officials and businesses. As part of the Information and Education plan, other organizations should be encouraged to supply watershed related educational materials through their websites where appropriate. Enviro-mich provides an opportunity to advertise events and workshops to a large audience. Enviro-mich is a list serve for those in Michigan interested in environmental issues.

4. Passive Distribution:

This method relies on the target audience picking up a brochure, fact sheet, or other information. This can occur by placing materials at businesses, libraries, township/city/village halls and community festivals and events, An example would be to place information on reducing fertilizer use at a store that sells fertilizer.

Plan Administration and Implementation

An information and education implementation strategy is laid out for the Black and Paw Paw River Watersheds in the table found at the end of this report. This table lists specific tasks or activities, a potential lead agency and partners, timeframe, milestones and costs to educate target audiences for each watershed issue.

Roles and Responsibilities

The Southwest Michigan Planning Commission and the Van Buren Conservation District will continue to oversee the implementation of the Information and Education Plan as well as make adjustments to the plan when necessary. An Information & Education committee will meet as needed to advise on educational efforts.

There are efforts underway to establish a non-profit organization called the Two Rivers Coalition to implement the watershed plans for the Black and Paw Paw River Watersheds. Once this group is established, it may be most appropriate for this organization to oversee the implementation of the I&E Plan and convene the I&E committee.

Existing Efforts

It is important to understand current education efforts being offered or resources that are available for use or adaptation in the Paw Paw and Black River Watersheds. In some cases, existing efforts may need additional advertisement or updating to more effectively transmit their intended message. A few existing efforts that could be

supplemented or utilized in the Paw Paw and Black River Watersheds are described below.

MSU Extension sponsors a Citizen Planner Course each year in Southwest Michigan. The target audiences for this course are municipal and planning officials as well as citizens. Topics presented during each course include various land use planning topics and techniques.

The Stewardship Network, Sarett Nature Center, Conservation Districts, Southwest Michigan Planning Commission, MSUE and lake associations periodically host educational workshops related to watershed and water quality topics.

The Southwest Michigan Planning Commission provides educational resources about stormwater and water quality to Berrien and Cass County Phase II communities. These resources are available on the Internet at www.swmpc.org/pep_materials.asp and could easily be adapted for use in the Black and Paw Paw River Watersheds.

The St. Joseph River Basin has produced a DVD about septic systems that could be distributed in the Black and Paw Paw River Watersheds.

The Southeast Michigan Council of Governments is facilitating a committee to develop a Statewide Low Impact Development manual, which will be extremely useful for educating and implementing LID.

Priorities

Project priorities will be established to direct resources to the areas that will gain the most benefit from the designated outreach activity. These priorities should be re-evaluated over time by the Education & Outreach sub-committee and changed as necessary.

Highest priority activities include:

- Activities that promote or build on existing efforts and expand partnerships with neighboring watershed projects, municipalities, conservation organizations and other entities.
- Activities that promote general awareness and understanding of watershed concepts and project goals.
- Activities that leverage external funding from local, state or federal sources.
- Activities that lead to actions (especially those in the watershed management plan), which help to improve and/or protect water quality.

Evaluation

Ultimately, evaluation should show if water quality is being improved or protected in the watershed due to education efforts being implemented. Since watersheds are dynamic systems, this can be difficult to accomplish. For the education efforts, one level of evaluation is documenting a change in knowledge or increase in awareness and participation. Measures and data collection for this level can take place in three specific ways:

1. A large-scale social survey effort to understand individual watershed awareness and behaviors impacting water quality.
2. A pre- and post-test of individuals at workshops focused on specific water quality issues in the PPRW.
3. The tracking of involvement in a local watershed group or increases in attendance at water quality workshops or other events.

Additional levels of evaluation, which estimate pollutant loading reductions and measure water quality improvements through monitoring, are explained in the Paw Paw River Watershed Management Plan in Chapter 11 Evaluation.

Information and Education Strategy for the Black and Paw Paw River Watersheds

Issue	Priority Target Audience*	Activity	Potential lead agency	Potential partners	Timeline** (milestone)	Evaluation	Costs
Watershed awareness	All	Produce and distribute 3- 4 public service announcements/press releases per year	VBCD, BCD	SWMPC, MSUE, TRC	current - on-going (3-4 PSAs/year)	number of news articles	5 hours staff time/press release
		Maintain a website that makes watershed information easily available to the public	TRC	VBCD, SWMPC	current - on-going	website traffic - number of hits monthly	$20 per month hosting fees + 20 hours staff time/month
		Develop 4 videos for website (stories about watershed protection/management - Farmer, Landowner, Municipal Official, etc.)	TRC	SWMLC, TNC, VBCD, SWMPC	short-term (2 videos/ year)	website traffic - number of hits monthly	$600/video for production 100 hours staff time/video
		Create a display and participate in 2-3 community festivals/year	TRC	VBCD, SWMPC	current - on-going (2-3 festivals/ year)	number of participants	$200 per event + 30 hours staff time to develop
		Develop and install "Entering the watershed" signs at watershed boundaries	Road Commission	TRC	long-term (5 signs/ year)	number of installed signs	$200 per sign for printing and installation
	Kids/ Students	Develop a student stream monitoring program	VBISD	VBCD, Math & Science Center (Allegan ISD)	long-term (1 school/ year)	number of schools participating in program	$1500 for program materials (nets, waders, etc) + 20 hours/month staff time
		Plan and offer 1 teacher training workshop/year	VBCD	VBISD	long-term (1 training/ year)	attendance at workshop and incorporation of watershed topics into curriculum	$200/workshop + 40 hours staff time/year
		Distribute curriculum materials on watersheds and water quality to teachers (use materials from Great Lakes Alliance)	VBISD	VBCD, Math & Science Center	medium-term (4 schools/ year)	number of schools incorporating curriculum materials	$200/school + 60 hours staff time
Land Use Change	Drain Commission	Meet one-on-one with drain commissioners to discuss alternative drain maintenance methods and ditch naturalization techniques and stormwater standards/ordinance	VBCD, SWMPC	TRC, Drain Commissioner	medium-term (3 commissioners/year)	miles of County Drains converted and improvements in stormwater standards	80 hours staff time
		Promote trainings being offered that relate to drain maintenance and construction methods that protect water quality	TRC	Drain Commissioner, VBCD, SWMPC	short-term (1 training/ year)	improvements in drain maintenance and construction practices, reduced sediment	5 hours staff time/training

Issue	Priority Target Audience*	Activity	Potential lead agency	Potential partners	Timeline** (milestone)	Evaluation	Costs
Agricultural runoff and Land Use Change	Farmers	Produce and distribute brochures/flyers/fact sheets to farmers about best management practices, cost share programs, wetland protection/restoration opportunities	VBCD	MSUE, Drain Commissioner, VBCD, NRCS	short-term (2 printed pieces/year)	number of practices installed, amount of Farm Bill $ spent in the watershed, reduction in pollutants	$1500 per direct mailing + 30 hours staff time/distribution
		Plan and host at least 1 workshop per year and host a tour/field site visit at least every 2-3 years addressing agricultural runoff, best management practices, wetland protection and restoration	VBCD, BCD, ACD	MSUE, NRCS	current - on-going (1 workshop/ year and 1 tour/2-3 years)	number of attendees and evaluations completed	$200-$600/workshop + 80 hours/year
		Develop and provide 1 newsletter article per year to Farm Bureau or other agencies on agricultural BMPs and wetland restoration/protection	MSUE, VBCD	NRCS	short-term (1 article/ year)	number of readers (circulation of publication)	10 hours/year
		Contact farmers in TMDL areas on a one-on-one basis to discuss best management practices and wetland restoration and distribute printed materials	VBCD	NRCS, MSUE, Drain Commissioner	medium-term (15-20 farmers/ year)	number of practices installed, reduction of pollutants	$400 printing + 400 hours staff time
Land use change, stormwater runoff and natural resource management and preservation	Government units-officials	Promote trainings being offered on water quality, land use planning and LID	TRC	VBCD, MSUE, SWMPC	current - on-going (2 trainings/ year)	increase in use of LID techniques	5 hours staff time/training
		Promote the adoption of a county-wide phosphorus ban in Van Buren and Berrien Counties and assist with educational efforts in Berrien, Van Buren and Allegan counties	TRC	Lake Assoc, Drain Commissioner, VBCD, SWMPC, ACD	current - on-going (1 adoption/ year)	adoption of ordinance	$1000 (printing materials) + 120 hours staff time
		Plan and host at least 1 workshop or summit per year on land use and water quality related issues and to share successes in watershed protection efforts and host a watershed tour every 2-3 years focusing on low impact development.	SWMPC	MSUE, VBCD, Planning Commission	long-term (1 workshop/ year and 1 tour/2-3 years)	incorporation of watershed topics into land use planning	$600/year + 80 hours staff time
		Produce and distribute a Watershed Management Plan user guide	TRC	VBCD, SWMPC	short-term (1 user guide/ year)	number of guides distributed or requested	200 hours staff time +$800 printing
		Produce and distribute brochures/flyers/fact sheets on land use and water quality, low impact development, smart growth, green infrastructure etc.	SWMPC	VBCD, MSUE, TRC, SWMLC	current - on-going (2 printed pieces/year)	increased use of LID practices	$800/printing & postage 80 staff hours/item
		Work one-on-one with planning commissions to improve plans and zoning ordinances for water quality protection ordinances, smart growth and low impact development and green infrastructure	SWMPC	VBCD, TRC.	current - on-going (3 municipalities/year)	number of improvements to plans and ordinances	200 hours staff time/municipality

Issue	Priority Target Audience*	Activity	Potential lead agency	Potential partners	Timeline** (milestone)	Evaluation	Costs
Land use change, stormwater runoff and natural resource management and preservation	Developers/ builders/ engineers	Develop and distribute newsletter articles and brochures, flyers and fact sheets on low impact development to SW Michigan realtor and builders associations	SWMPC	SWMHBA, SWMAR	medium-term (1 printed piece/year)	increased use of LID practices	30 hours staff time/item
		Plan and host a watershed tour to showcase LID every 2-3 years	TRC	VBCD, MSUE, SWMPC	medium-term (1 tour/2-3 years)	tour attendance and evaluations	100 hours/event + $50/person
		Promote statewide LID manual and trainings offered	SWMPC	SWMHBA / SWMAR	short-term (1 training/ year)	attendance at trainings	80 hours staff time
Stormwater runoff and natural resource management and preservation	Property owners	Print and distribute fact sheets from SWMPC's stormwater campaign at www.swmpc.org/water.asp	TRC	SWMPC, VBCD	current - on-going (50 fact sheets/year)	number distributed	$300 printing/postage 20 hours staff time
		Install storm drain markers and place door knob hangers to educate residents about stormwater runoff	VBCD, BCD	Lake Associations, TRC	current - on-going (2 municipalities/year)	number installed	40 hours staff time to coordinate volunteers
		Produce a direct mailing on land protection options - focus on property owners in high priority protection areas and high priority wetland protection/restoration areas	SWMLC	Land Preservation Board, VBCD, BCD, SWMPC	short-term (1mailing/ 2-3 years)	increased landowner interest in land preservation options	$1000/printing and postage + 100 hours staff time
		Host workshops/tours for property owners in high priority protection areas	SWMLC	VBCD, BCD, TRC, SWMPC	short-term (1 tour/ 2-3 years)	attendance and evaluations completed	$100-$500/workshop + 80 staff hours
		Distribute printed materials on what can be done to protect water quality and on land protection options for private landowners in tax or utility bills	County and Townships	SWMLC, VBCD, BCD, SWMLC, TRC	long-term (1 mailing/ year)	number of mailings	$300 printing/postage 40 hours staff time
Stormwater runoff	Government units- employees	Promote trainings on municipal operations (including road maintenance and construction) and best management practices to protect water quality	Drain Commissioner Municipalities	Road Commission, VBCD, SWMPC	medium-term (1 training/ year)	number of governmental employees attending trainings	20 hours/training opportunity
		Distribute brochures/flyers/fact sheets about municipal operations and road construction and maintenance best practices for water quality	Road Commission, Municipalities	SWMPC	medium-term (1 printed piece/year)	number adopting watershed friendly practices	$150/item printing and postage + 20 hours staff time/item

Issue	Priority Target Audience*	Activity	Potential lead agency	Potential partners	Timeline** (milestone)	Evaluation	Costs
Stormwater runoff	Businesses	Give presentations at local business gatherings about what businesses can do to protect water quality	VBCD	MSUE, Drain Commissioner	medium-term (1 presentation/ year)	number of business adopting watershed friendly practices	40 hours staff time/presentation
		Distribute brochures/flyers/fact sheets about business operations best practices for water quality - focus on lawn care companies	MSUE	VBCD	medium-term (1 distribution/ year	number of business adopting watershed friendly practices	$200-$500 printing/postage 30 hours staff time/item
Natural resource management and preservation	Recreation groups/users	Develop and install kiosks at parks along the rivers about water quality and natural features	Municipalities	BSHWTA, VBCD, SWMPC, Sarett Nature Center, TRC	medium-term (1 kiosk/ 2 years)	number of kiosks installed	$1,000/kiosk + 120 hours staff time/kiosk
		Develop water trails, public access sites and walking trails along the river	Municipalities	BSHWTA, Sarett Nature Center, SWMPC, Road Commission	long-term (1access site/ 2-3 years)	number of access sites; use of trails	$100/mile for water trail $1,000-$8,000/access site
		Develop and distribute 1 newsletter article per year for recreation groups	VBCD	BSHWTA, Lake Associations SWMLC	medium-term (1 article/ year)	number of readers (circulation of publication)	10 hours staff time/article
Septage waste	Riparian property owners	Develop 1 newsletter article per year for lake associations to utilize in their newsletters	VBCD	Health Dept, MSUE, SWMPC	medium-term (1 article/ year)	number of readers (circulation of publication)	10 hours staff time/article
		Develop and work with lake associations to distribute door knob hangers about septic system maintenance	Lake Assoc.	VBCD, TRC	medium-term (2 lakes/year)	number of households in distribution area	$0.50each printing + 100 hours staff time/lake association
		Encourage lake association members to meet with lake owners on a one-on-one basis to discuss septic system maintenance	Lake Assoc.	VBCD, MSUE	medium-term (2 lakes/year)	improved septic maintenance and reduced pollutants	3 hours/household
		Obtain and distribute a video on septic systems and water quality to Lake Associations (video available from St. Joseph River Basin Commission)	Lake Assoc.	SWMPC, St Joe River Basin Commission	medium-term (3 lakes/year)	improved septic maintenance and reduced pollutants	100 hours staff time
	Government unit-employees	Promote trainings about municipal sewer infrastructure planning and management	TRC	VBCD, SWMPC, Health Dept.	medium-term (1 training/ year)	number of municipal officials and employees attending trainings	10 hours/training

Issue	Priority Target Audience*	Activity	Potential lead agency	Potential partners	Timeline** (milestone)	Evaluation	Costs
Septage waste	Government units-officials	Develop and distribute brochures/flyers/fact sheets about the impacts of failing septic systems and what local governments can do	VBCD	MSUE, Health Dept, TRC	medium-term (1distribution/ 4 years)	increased number of septic related ordinances	$400 printing/postage 80 hours staff time
		Obtain and distribute a video on septic systems and water quality to governmental units (video available from St. Joseph River Basin Commission)	SWMPC	St. Joe Basin Commission, VBCD, MSUE	medium-term (5 governmental units/year)	number of municipalities receiving video	100 hours staff time
		Work one-on-one with planning commissions to improve plans and zoning ordinances relating to septic systems	SWMPC	VBCD, MSUE	current - on-going (3 municipalities/year)	increased number of septic related ordinances	80 hours/municipality

*Note: Primary audiences are listed; there may be additional audiences that could benefit as well
** short-term - within one year; medium-term - within 2-3 years; long-term - within 4-6 years

Acronyms
ACD: Allegan Conservation District
BCD: Berrien Conservation District
BSHWTA" Bangor-South Haven Heritage Water Trail Association
MSUE: Michigan State University Extension
NRCS: Natural Resources Conservation Service
SWMAR: Southwest Michigan Association of Realtors
SWMHBA: Southwest Michigan Home Builder's Association
SWMLC: Southwest Michigan Land Conservancy
SWMPC: Southwest Michigan Planning Commission
TNC: The Nature Conservancy
TRC: Two Rivers Coalition: An Alliance for the Black and Paw Paw River Watersheds
VBCD: Van Buren Conservation District
VBISD: Van Buren Intermediate School District

Appendix 11. Past Efforts in the PPRW

The Van Buren Conservation District worked with several teachers and opportunities exist with Gobles, Lawton, Lawrence, Hartford and Mattawan schools to do water quality/macro-invertebrate monitoring with schools.

The Village of Mattawan applied for a grant to install plantings along Mattawan Creek and to monitor water quality.

The VBISD owns 35 acres in Lawrence along Brush Creek, which is being developed as an outdoor education center. The VBISD is working on curriculum and plans to open this center up to all Van Buren County schools for learning opportunities.

The Red Arrow Corridor Group has conducted an economic development study. This group involves the municipalities along Red Arrow (and the Paw Paw River) from Coloma to Mattawan. The study indicated that the Paw Paw River is a under utilized asset to the local economies of these small towns. The study also recognized the need to protect the natural areas and small town atmospheres. Van Buren County Economic Development led this effort.

As a result of the Red Arrow economic study, the Paw Paw River sub-committee was formed. This group hosted a municipal summit on November 3, 2003. The summit was organized by SWMPC and TNC. The group is interested in increasing Protection, Education and Awareness of the Paw Paw River. (The PEA plan!)

Partners including the MDNR, TNC, SWMPC and Berrien County, are working to remove the Watervliet dam on the Paw Paw River. In 2008, a USFWS grant was secured and TNC has applied for an MDNR Inland Fisheries Grant.

In 2004, SWMPC helped Watervliet secure a grant from Great Lakes Basin to install an Urban Stormwater BMP Demonstration Site along the Paw Paw River off M-140. A porous pavement parking lot, rain garden, riparian buffer and interpretative signs have been installed.

In 2004, SWMPC worked with Watervliet and Coloma Cities on a Cool Cities grant application. The main focus of the grant was on the Paw Paw River (connecting the two cities with a water heritage trail and connecting the downtowns with the river). This grant was not awarded.

SWMPC organized a Watershed Short Course offered in Berrien County in the spring of 2005. The targeted audience included the Galien, St. Joseph and Paw Paw River Watersheds. (This course was partly funded by SWMPC, MSUE and the Galien River Watershed 319 grant.)

TNC has designated the Paw Paw River Watershed as a target area for preservation. TNC created a poster that showcases the different habitats in the Paw Paw River Watershed. It also recognizes the river corridor and headwaters as priority conservation areas.

Over 1,800 acres in the watershed are protected or managed by the Sarett Nature Center, SWMLC, TNC and Michigan DNR.

SWMLC owns a preserve along the river corridor.

SWMLC is partnering with TNC to plan for the preservation of ecologically diverse areas in the watershed.

SWMLC is partnering with Sarett Nature Center and fostering protection efforts in the western part of the watershed.

FOTSJR Assoc. has developed a watershed management plan for the entire St. Joseph River Watershed, which includes the Paw Paw River Watershed. The Plan has identified the Paw Paw River as a high priority preservation area.

In 1991, the Van Buren Conservation District completed a groundwater study in the Paw Paw River Watershed.

The VBCD worked with Partners for Fish and Wildlife to restore 300 acres of wetland in the watershed owned by the VBCD.

The Maple Lake Association and the Village of Paw Paw continually dredge Maple Lake and Briggs Pond. There is interest to better understand the source of sediment and implement BMPs upstream to address the problem.

In 2007, the Paw Paw Lake Foundation hired Spicer Group to study pollutants, causes and sources in Paw Paw Lake.

Benton Harbor area is included in Phase II for stormwater regulations. Because the Phase II program affects less than 1/3 of the Paw Paw River Watershed, the watershed is still eligible for 319 funding.

The Pokagon Band is doing water quality monitoring in the PPRW near Hartford and is developing a land use plan for its property.

Van Buren County Planning Commission is pursuing a ban on the use of phosphorus fertilizer. The Paw Paw Lake Association is pushing for a similar ban in Berrien County.

The Village of Paw Paw, and others, have supported the inclusion of the the west branch between Michigan Avenue and 60th Street to the south as part of the Gates Drain. This would put the management of the total Gates Drain under one agency which

would work with all parties to implement best management practices. As of this date, a Board of Determiners had approved the extension of the Gates Drain but a group has filed circuit court action in opposition.

The Maple Lake Association and the Village of Paw Paw are interested in learning more about weed management and the re-establishment of a fishery in Maple Lake. Such is now primarily pan fish where other species had been found.

Appendix 12. Pollutant Load Estimates and Reductions

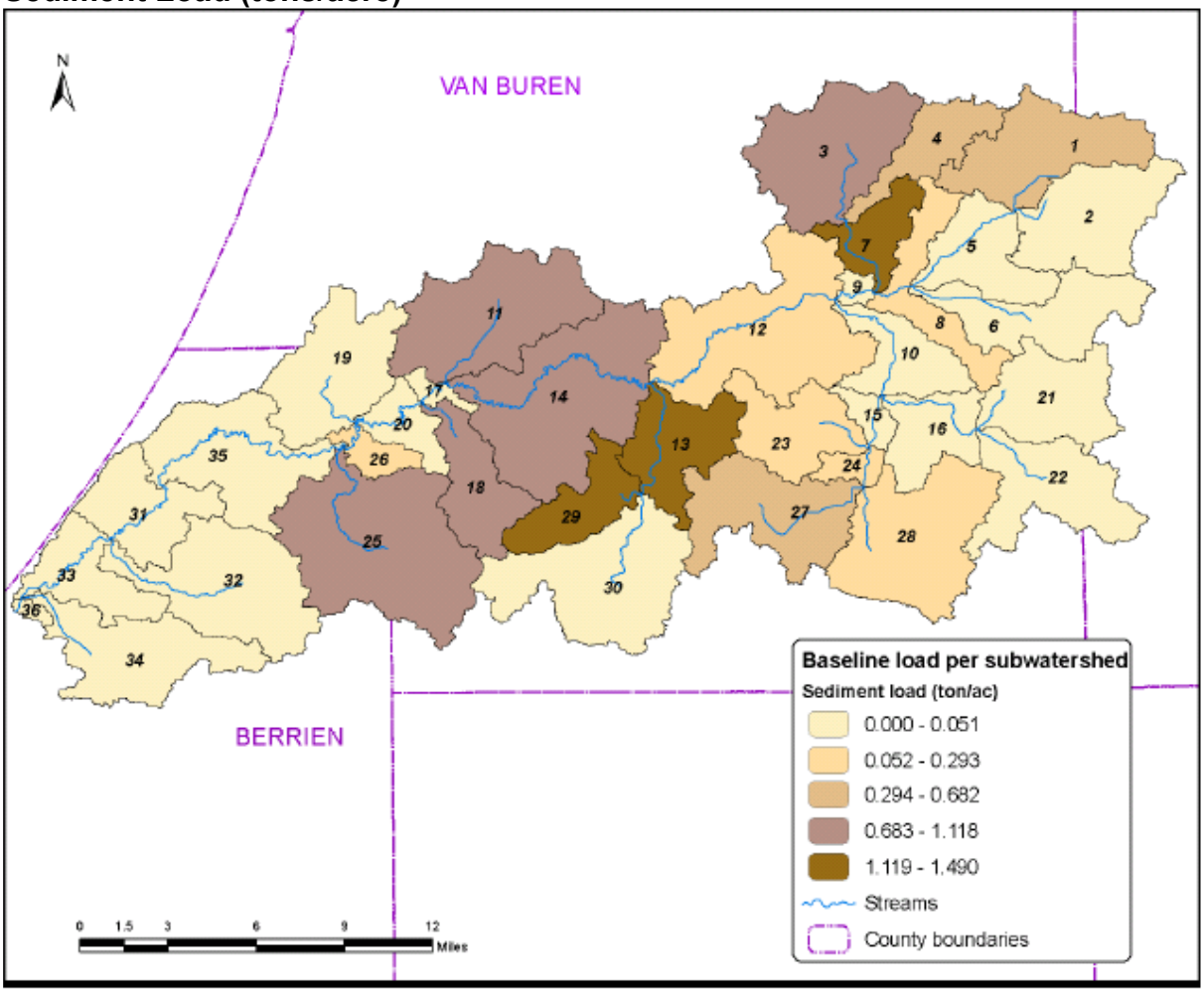
A pollutant loading is a quantifiable amount of pollution that is being delivered to a water body. Pollutant load reductions can be calculated based on the ability of an installed BMP to reduce the targeted pollutant. For this plan, the Soil and Water Assessment Tool (SWAT) was utilized to estimate pollutant-loading reductions for sediment and nutrients with the installation of agricultural BMPs (such as no-till, filter strips, cover crops, fertilizer reduction and a combination of filter strips and no-till). An empirical model utilizing the Long-term Hydrologic Impact Assessment model (L-THIA) was utilized to estimate load reductions in high priority urban areas for sediment and nutrients with the installation of urban stormwater BMPs (such as wet retention ponds, dry detention ponds, vegetated swales, rain gardens and constructed wetlands). Below is a summary of the results of these two modeling efforts. The full reports can be found online at:
www.swmpc.org/downloads/pprw_swat_report.pdf
www.swmpc.org/downloads/pprw_buildout_report.pdf.

SWAT Modeling

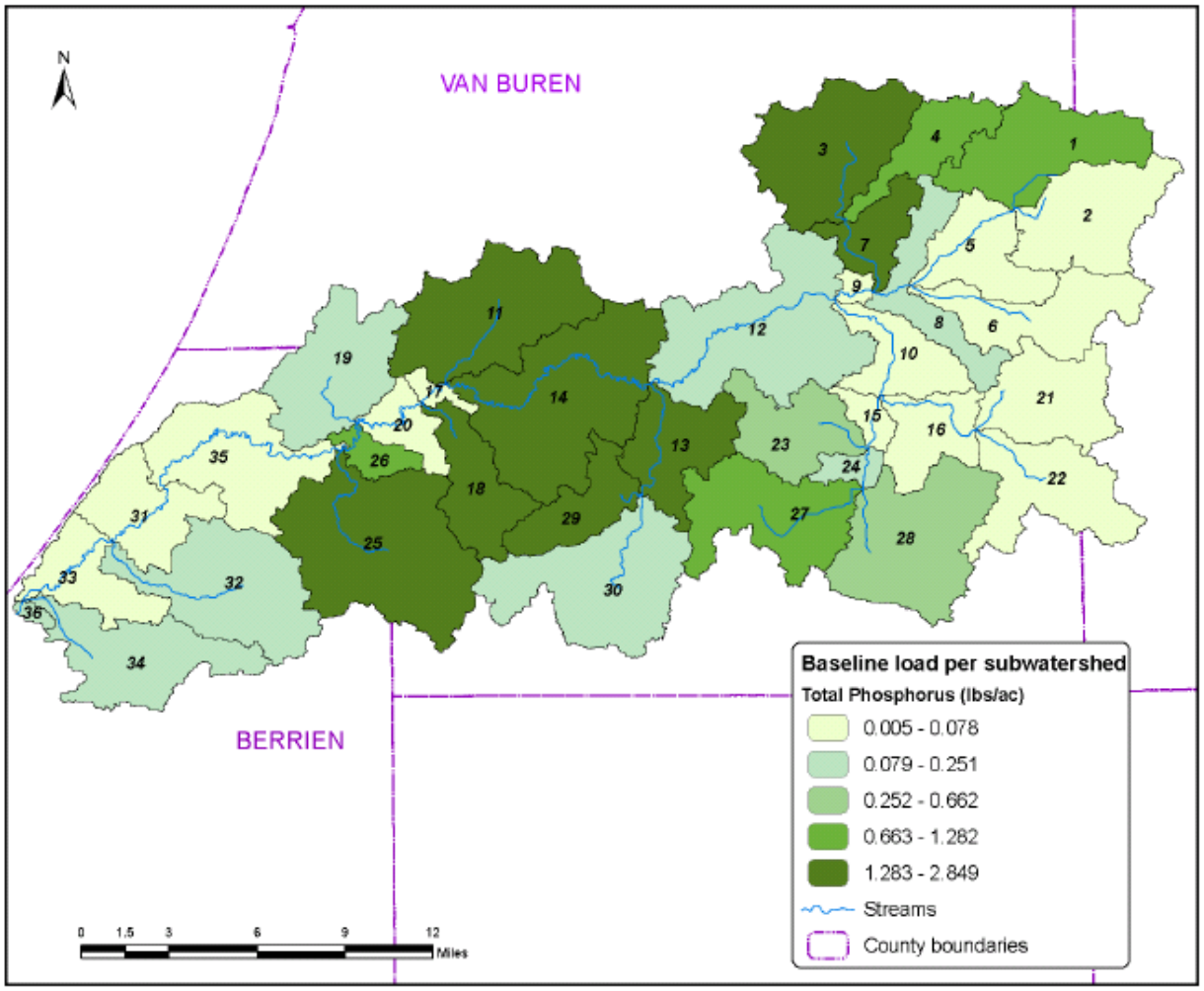
The US EPA supports the use of water quality models to satisfy the load quantification requirements in the development of a watershed management plan (US EPA, 2005). In part, the US EPA developed "BASINS" (Better Assessment Science Integrating point and Nonpoint Sources), a multipurpose analytical tool that integrates environmental databases and water quality models in a geographic information systems (GIS) framework. The Soil and Water Assessment Tool (SWAT), one of the models included in BASINS 3.1, was selected for this study due to its ability to simulate agricultural best management practices. Further, SWAT was chosen to build on existing efforts and to be consistent with the St. Joseph River Watershed Management Plan, which also utilized SWAT.

SWAT modeling was utilized to estimate the pollutant loads of total nitrogen, total phosphorus and sediment in 36 sub-basins of the PPRW. SWAT was also used to predict load reductions under selected agricultural best management practices (BMP) scenarios in selected sub-basins. The baseline average annual pollutant loadings were calculated for year 1997-2004 (excluding 2000 because of missing precipitation data) for 36 sub basins. The results for the pollutant loading are shown in the following figures.

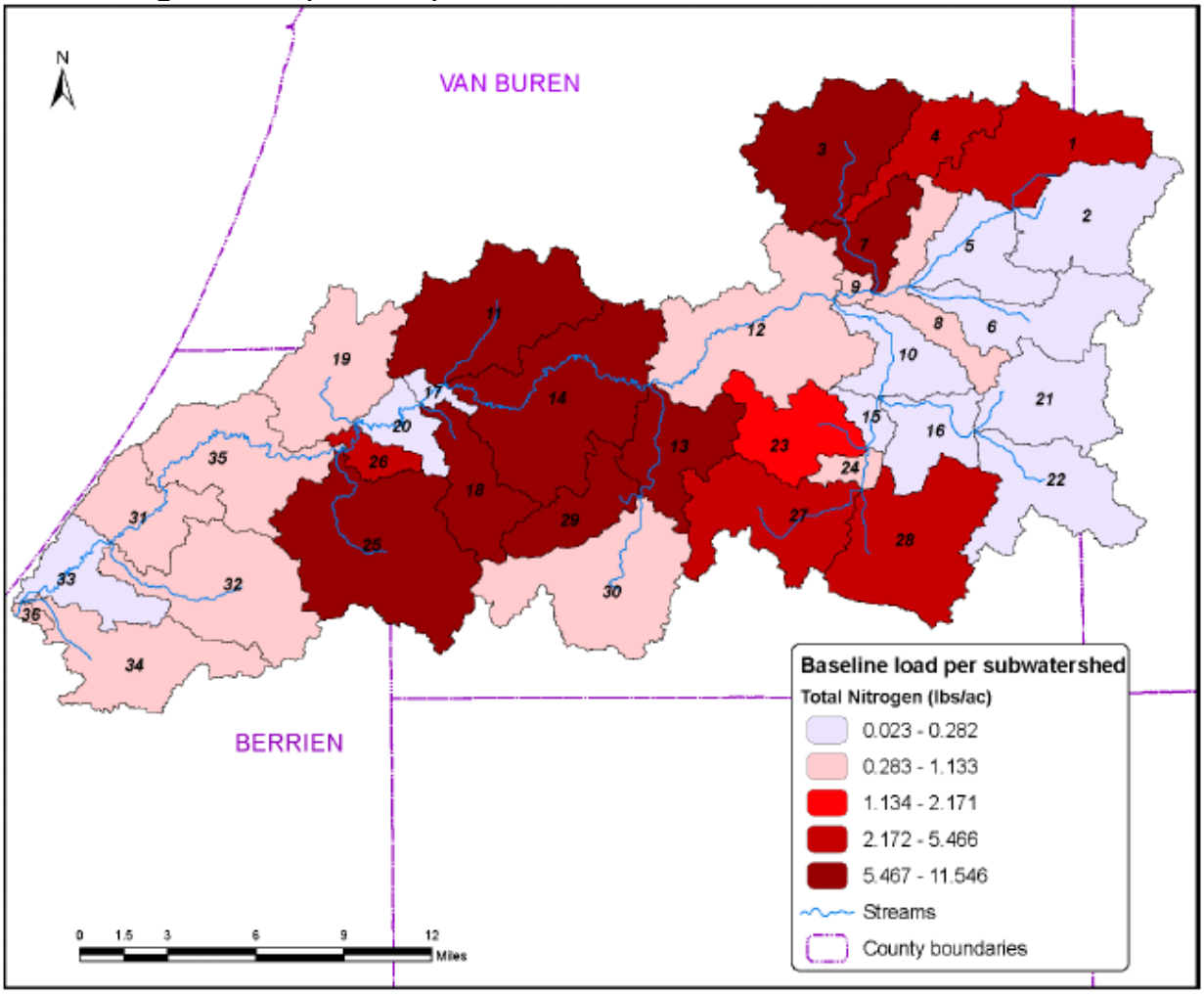
Sediment Load (tons/acre)



Total Phosphorus Load (lbs/acre)

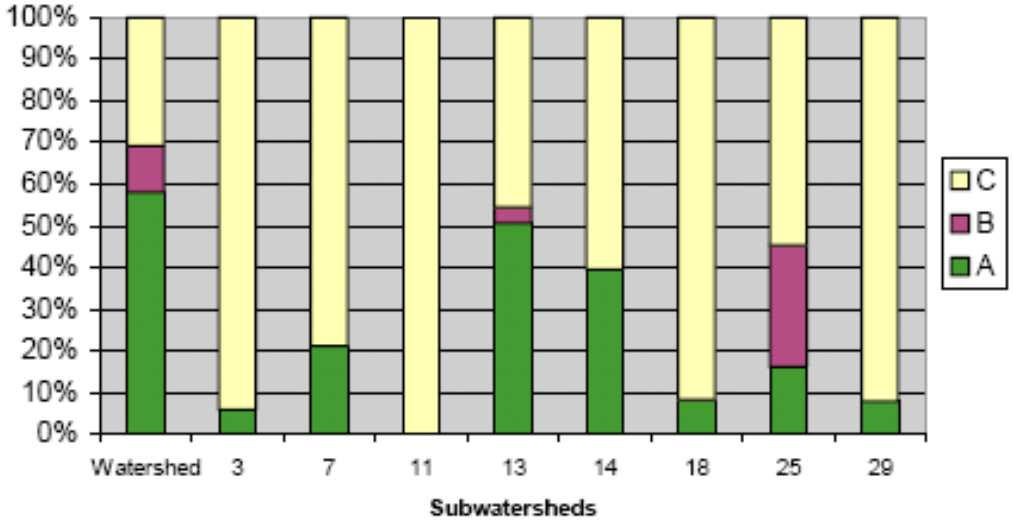


Total Nitrogen Load (lbs/acre)

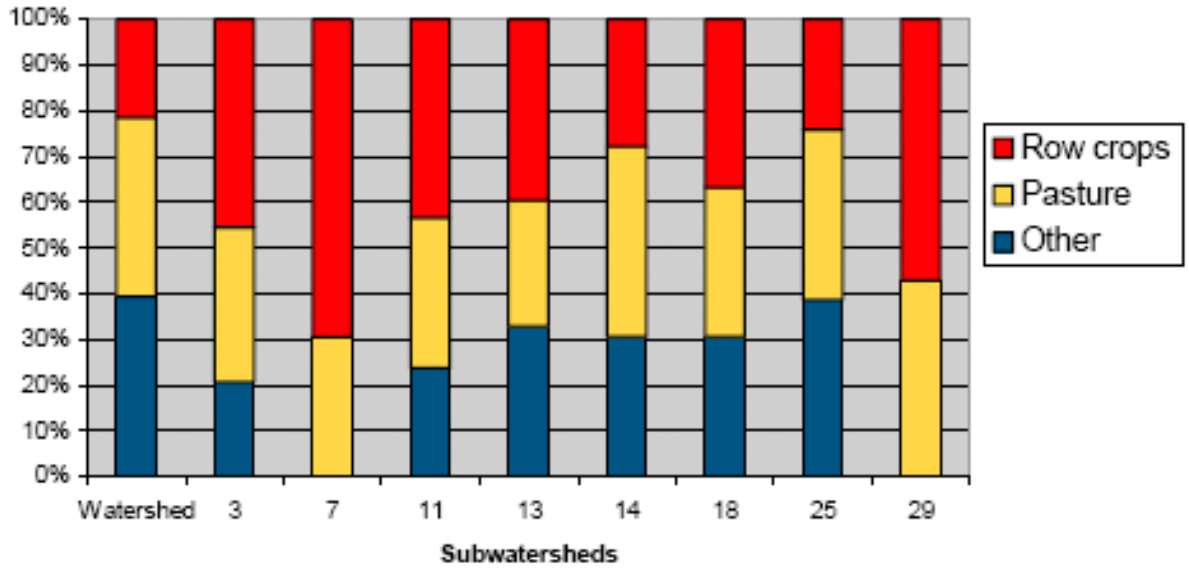


Model results indicate that the highest loading subwatersheds have a large proportion of silty clay loam soils, with a slow infiltration rate and higher runoff potential (hydrologic soil group C). These subwatersheds also have a higher proportion of agricultural land use, in particular row crops. See figures below.

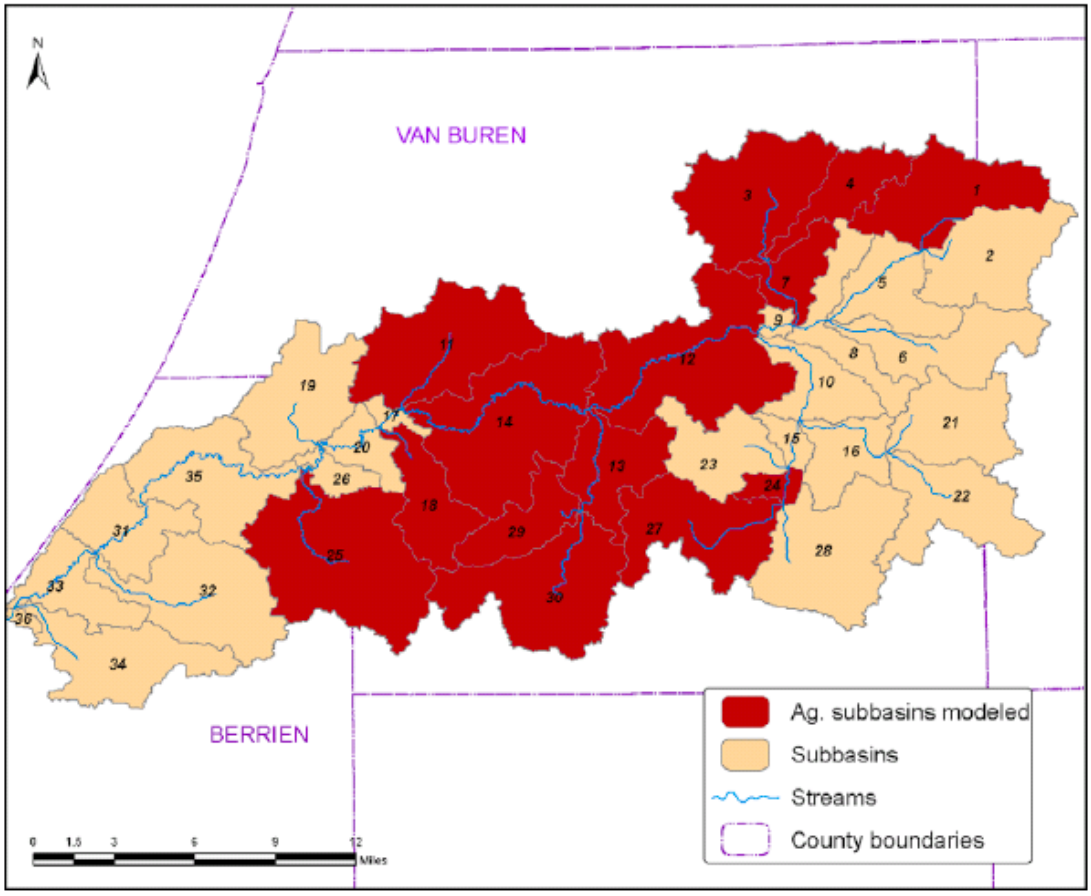
Proportion of hydrologic soil groups (A-C) in highest loading subwatersheds compared to the watershed average.



Proportion of land use in highest loading subwatersheds compared to the watershed average.



Agricultural Sub-basins Modeled in BMP Scenarios



The loading reductions from the implementation of agricultural best management practices were calculated as a percent reduction at the mouth of the Paw Paw River. The following table shows the loading reductions for agricultural practices being applied to 25%, 50% and 75% of the selected agricultural area respectively.

Percent Pollutant Loading Reduction for Selected Agricultural BMPs

	Implementation rate (% of selected agricultural area)		
	25%	***50%***	***75%***
Sediment			
No-till[a]	13	33.1	49.8
Filterstrip[b]	19.8	34.6	42.9
Cover crop[c]	7.8	18.5	23.9
Fertilizer reduction[d]	0	0.9	1.1
Combo[e]	22.5	39.5	65.3
Total Phosphorus			
No-till	11.1	25.1	41.7
Filterstrip	23.1	35.8	44.4
Cover crop	10.5	21.1	26.3
Fertilizer reduction	0.6	1.4	1.7
Combo	23.7	40.3	62.1
Total Nitrogen			
No-till	11	24.9	41.1
Filterstrip	21.7	34.4	43.2
Cover crop	10.1	21.4	27.2
Fertilizer reduction	0.7	1.5	1.9
Combo	22.9	39.2	60.8

[a] No-till for corn
[b] 30-ft edge-of-field filter strip
[c] Rye cover crop during winter
[d] Fertilizer application rate reduction of 25%
[e] Combination of filter strips and no-till

In conclusion, the SWAT modeling was coarsely calibrated for the Paw Paw River watershed given the limited availability of monitoring data. The model was used to simulate baseline-loading conditions for TP, TN, and sediments and analyzed the impact of five agricultural best management practices on water quality.

Among the four individual agricultural BMPs simulated, no-till emerged as the most cost-efficient BMP at all implementation rates due to its low per acre implementation cost ($3.23/ac/yr). Large-scale implementation for this BMP would bring significant water quality benefits. Filter strips may represent the most expensive BMP to install but

they provide the largest sediment and nutrient load reductions, and are second to no-till when considering cost-effectiveness. A small-scale implementation of filter strips would represent the best option given increasing cost with diminishing returns at higher application rates. This result suggests that **preservation of existing stream buffers should be a high priority for the watershed.** The combined BMP scenario (no-till and filter strips) provided the largest load reductions in all scenarios. However, it was shown that effectiveness gains will be diminished when more than one BMP is implemented on top of one another. Finally, it must be noted that filter strip and no-till BMPs (as modeled in the combination scenario) will not consistently improve water quality under all streamflow conditions as they do not have an impact on sediment loads under high flows, and they have minimal benefit on TP and TN loads under low flow conditions.

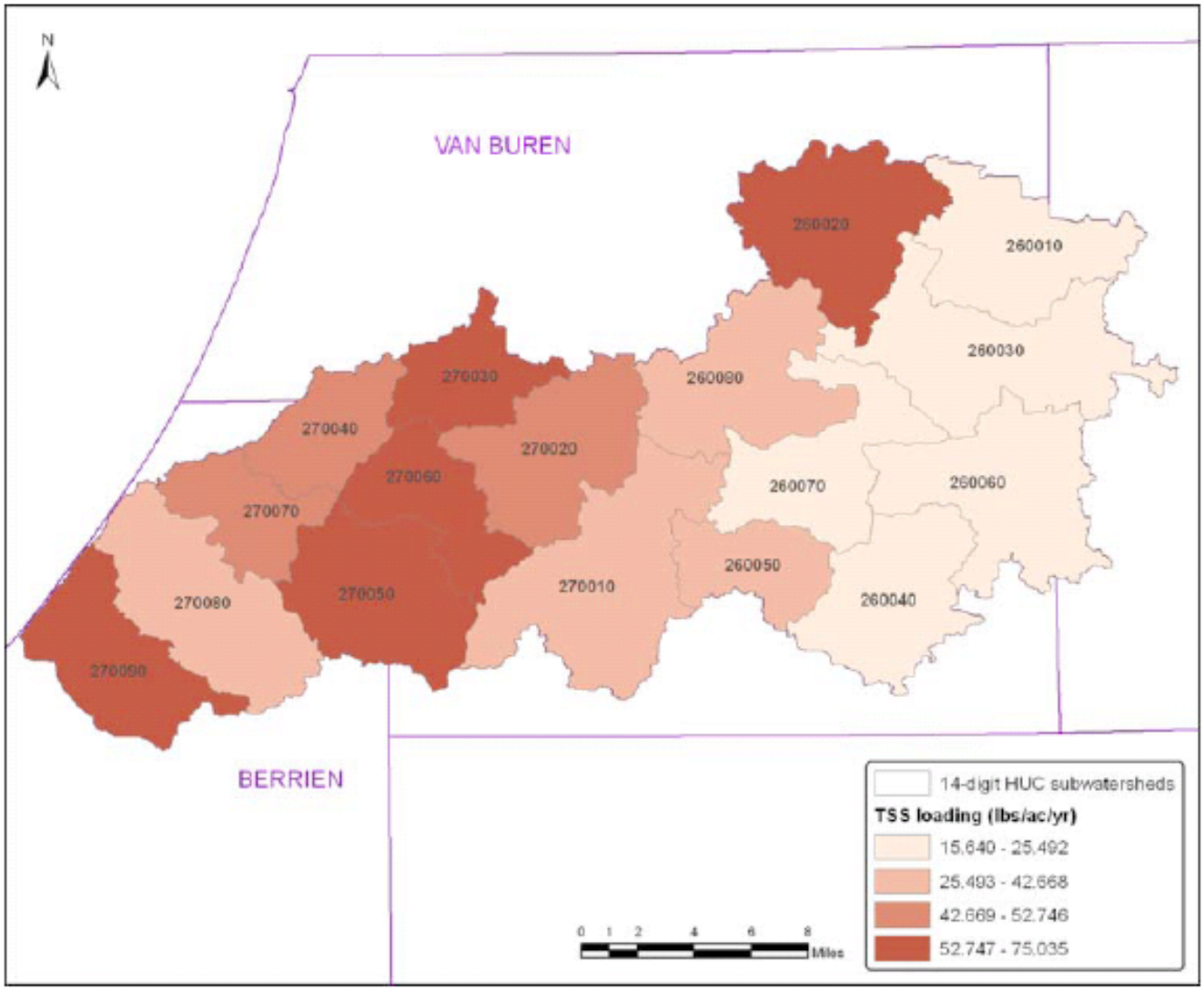
This study summarizes the impact of agricultural BMPs on pollutant and sediment loads at the mouth of the watershed. However, BMP load reductions could also be quantified for specific subwatersheds to identify the potential for local water quality improvement provided local monitoring data were available to support robust calibration.

Build-out Modeling

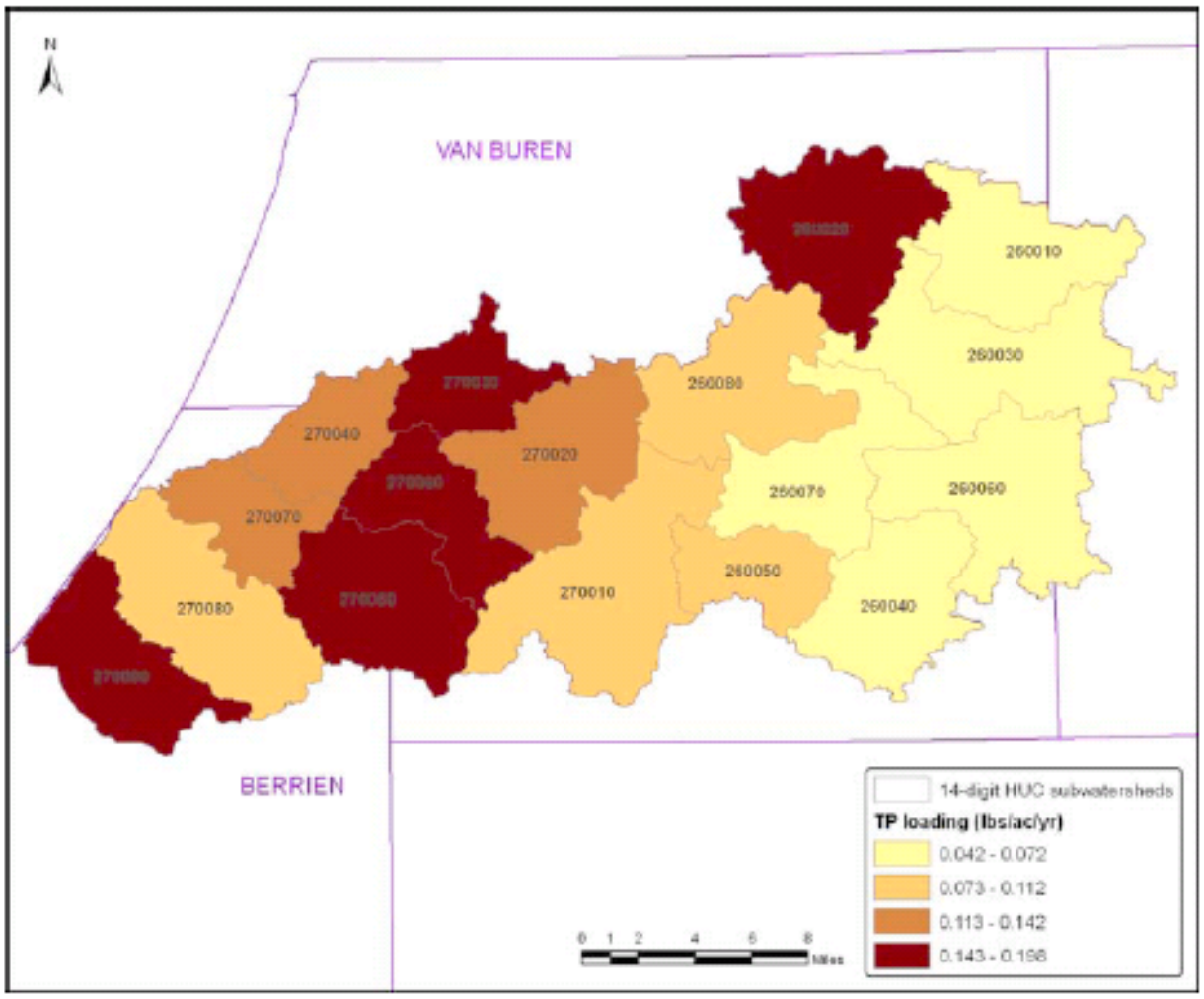
A simple empirical approach, similar to the one used in the St Joseph Watershed Management Plan was used to calculate nonpoint source pollutant loads and estimate the impact of stormwater BMPs. Pollutant loads and runoff volumes were calculated using average runoff depth values produced by the Long-term Hydrologic Impact Assessment model (L-THIA), and available pollutant event mean concentration values. Hypothetical build-out scenarios were based on local future land use plans to estimate the impact of urban development on water quality and quantity. The impact and cost-effectiveness of five common stormwater best management practices were also modeled to support land use planning in the Paw Paw River Watershed. The report is available online at www.swmpc.org/downloads/pprw_buildout_report.pdf. Below is a summary of the findings.

Pollutant loadings for sediment, total phosphorous, total nitrogen and runoff volume were calculated for current conditions and build-out scenarios. The following figures show the sediment, total phosphorous, total nitrogen and runoff volume for each of the seventeen 14-digit HUC subwatersheds at baseline conditions.

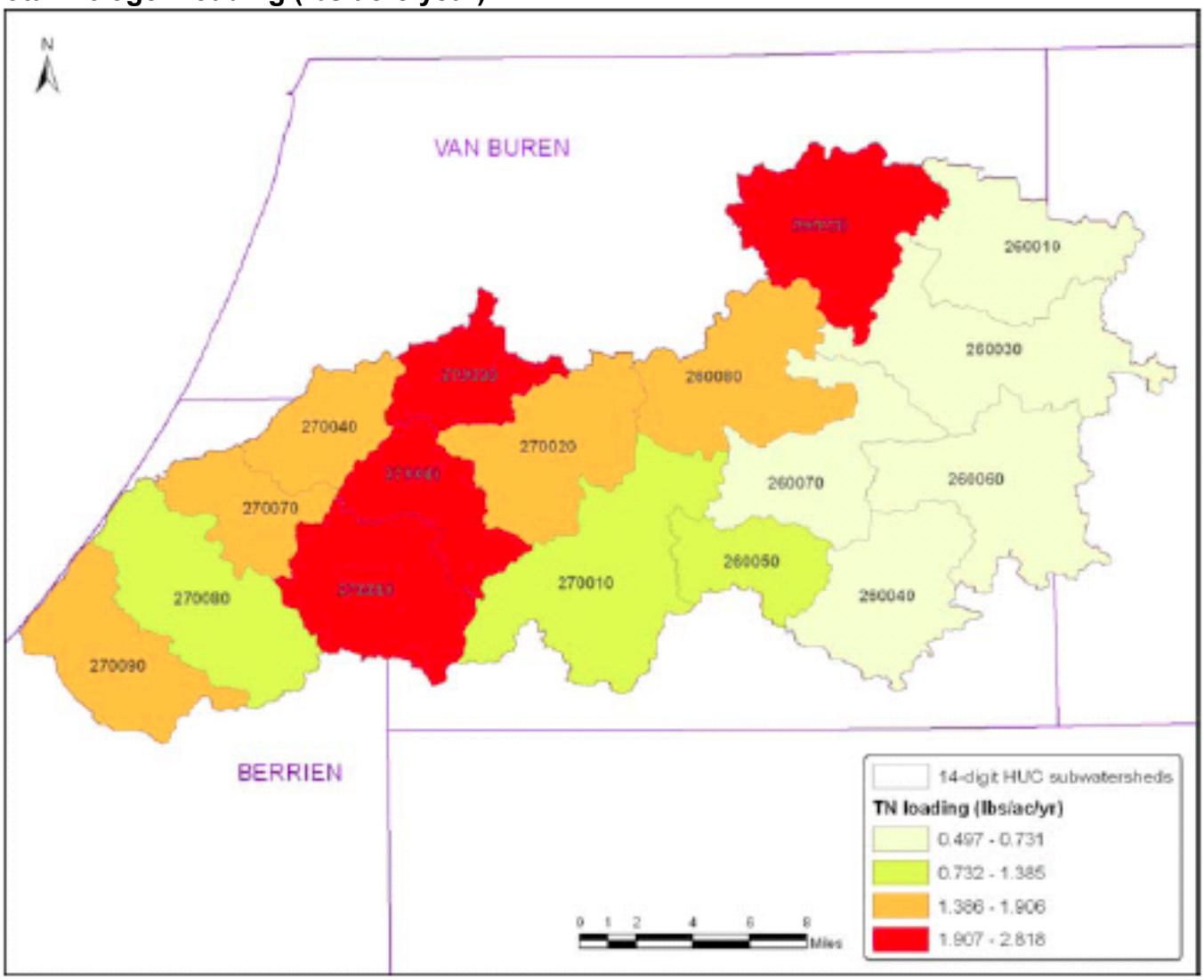
Total Suspended Solids loading (lbs/acre/year)



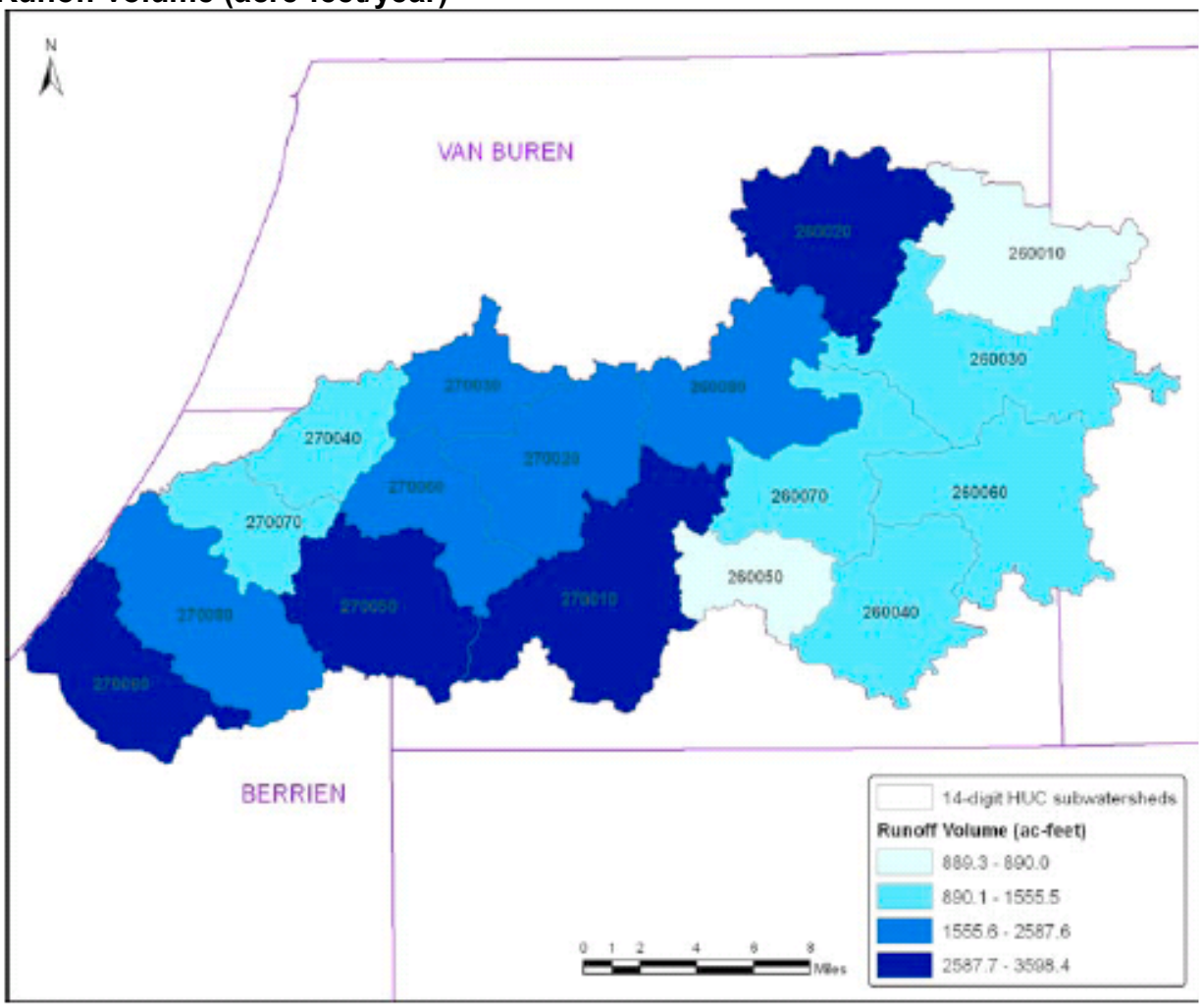
Total Phosphorus loading (lbs/acre/year)



Total nitrogen loading (lbs/acre/year)



Runoff volume (acre-feet/year)



To calculate pollutant-loading reductions, best management practices were applied to the highest priority urban areas in the watershed defined as follows:

- Ox Creek Area: corresponds to subwatershed 270090 (Benton Harbor/St Joseph).
- Paw Paw Lake Area (includes the townships of Coloma and Watervliet and the Cities of Watervliet and Coloma)
- The village of Paw Paw and Antwerp Township.

The following tables from the final report show the pollutant load reductions for total phosphorus and total suspended solids with the installation of five different BMPs in the high priority urban areas. The tables also show the costs to implement these BMPs in relation to the amount of pollutants reduced.

Table 9: Wet retention pond pollutant treatment costs with a 50% treatment coverage of urban lands.

	Pond Volume	Pond Area [1]	TP Load Reduction	TSS Load Reduction	Capital Cost [2]	30-year Annualized Cost [3]	TP Load Reduction Cost	TSS Load Reduction Cost
Urban Center	ft^3	acre	lbs/yr	lbs/yr	$	$/yr	$/lbs/yr	$/lbs/yr
Ox Creek Area (Benton Harbor)	749,559	3.4	1,086	358,988	730,820	64,147	59	0.18
Paw Paw Lake Area (Watervliet/Coloma)	432,260	2.0	827	260,349	421,454	36,992	45	0.14
Antwerp Twp/Village of Paw Paw	375,987	1.7	529	174,787	366,588	32,177	61	0.18
Total/Average	*1,557,807*	*7*	*2,441*	*794,124*	*1,518,862*	*133,316*	*55*	*0.17*

[1] Ponds are assumed to have an average depth of 5 feet.
[2] Construction cost + design and permits.
[3] Assuming a 5% interest rate and including a $4,152/acre/year maintenance cost.

Table 10: Dry detention pond pollutant treatment costs with a 50% treatment coverage of urban lands.

	Pond Volume	Pond Area [1]	TP Load Reduction	TSS Load Reduction	Capital Cost [2]	30-year Annualized Cost [3]	TP Load Reduction Cost	TSS Load Reduction Cost
Urban Center	ft^3	acre	lbs/yr	lbs/yr	$	$/yr	$/lbs/yr	$/lbs/yr
Ox Creek Area (Benton Harbor)	749,559	3.4	362	199,438	584,656	38,033	151	0.27
Paw Paw Lake Area (Watervliet/Coloma)	432,260	2.0	276	144,639	337,163	21,933	114	0.22
Antwerp Twp/Village of Paw Paw	375,987	1.7	176	97,104	293,270	19,078	156	0.28
Total/Average	*1,557,807*	*7*	*814*	*441,180*	*1,215,089*	*79,043*	*140*	*0.26*

[1] Ponds are assumed to have an average depth of 5 feet.
[2] Construction cost + design and permits.
[3] Assuming a 5% interest rate and including a $4,825/acre/year maintenance cost.

Table 11: Vegetated swale pollutant treatment costs with a 50% treatment coverage of urban lands.

	Area [1]	TP Load Reduction	TSS Load Reduction	Capital Cost [2]	30-year Annualized Cost [3]	TP load Reduction Cost	TSS Load Reduction Cost
Urban Center	acre	lbs/yr	lbs/yr	$	$/yr	$/lbs/yr	$/lbs/yr
Ox Creek Area (Benton Harbor)	15.0	483	319,101	196,498	25,882	54	0.08
Paw Paw Lake Area (Watervliet/Coloma)	9.7	367	231,422	126,293	16,635	45	0.07
Antwerp Twp/Village of Paw Paw	9.2	235	155,366	120,672	15,895	68	0.10
Total/Average	*34*	*1,085*	*705,888*	*443,462*	*58,412*	*56*	*0.09*

[1] Total area of vegetated swales in the subwatershed. Assuming for every 5 acre of drainage area, an 8×200 sq ft swale is needed.
[2] Construction cost
[3] Assuming a 5% interest rate and including a $0.02/sq ft/yr maintenance cost.

Table 12: Rain garden pollutant treatment costs with a 15% treatment coverage of urban lands

	Area [1]	TP Load Reduction	TSS Load Reduction	Capital Cost [2]	30-year Annualized Cost [3]	TP load Reduction Cost	TSS Load Reduction Cost
Urban Center	acre	lbs/yr	lbs/yr	$	$/yr	$/lbs/yr	$/lbs/yr
Ox Creek Area (Benton Harbor)	80.9	362	119,663	38,758,220	2,521,270	6,967	21.07
Paw Paw Lake Area (Watervliet/Coloma)	46.1	276	86,783	22,103,183	1,437,839	5,218	16.57
Antwerp Twp/Village of Paw Paw	48.8	176	58,262	23,360,056	1,519,600	8,624	26.08
Total/Average	*176*	*814*	*264,708*	*84,221,459*	*5,478,709*	*6,936*	*21.24*

[1] Total area of rain gardens in the subwatershed. Assuming rain garden area of 19% of the drainage area, which in turn is assumed to be 15% of impervious urban lands.
[2] Construction cost.
[3] Assuming a 5% interest rate

Table 13: Constructed wetland treatment costs with a 50% treatment coverage of urban lands.

	Area [1]	TP Load Reduction	TSS Load Reduction	Capital Cost [2]	30-year Annualized Cost [3]	TP load Reduction Cost	TSS Load Reduction Cost
Urban enter	acre	lbs/yr	lbs/yr	$	$/yr	$/lbs/yr	$/lbs/yr
Ox Creek Area (Benton Harbor)	141.9	1,086	358,988	7,237,334	591,420	545	1.65
Paw Paw Lake Area (Watervliet/Coloma)	80.9	827	260,349	4,127,334	337,277	408	1.30
Antwerp Twp/Village of Paw Paw	85.5	529	174,787	4,362,030	356,456	674	2.04
Total/Average	*308*	*2,441*	*794,124*	*15,726,697*	*1,285,153*	*542*	*1.66*

[1] Total area of constructed wetlands in the subwatershed. Assuming constructed wetlands to have 10% of the impervious drainage area.
[2] Construction cost + design and permits.
[3] Assuming a 5% interest rate and including a $850 /acre/year maintenance cost.

Among the five urban BMPs examined (wet retention ponds, dry detention ponds, vegetated swales, rain gardens, and constructed wetlands), wet retention ponds and constructed wetlands provide the greatest load reductions for TP and TSS while vegetative swales are the most cost-effective (lowest per pound cost of load reduction). Cautions should be taken, however, in interpreting these results due to the uncertainties in design parameters of vegetative swales and rain gardens. Other considerations should be evaluated, including limitations of vegetated swales and rain gardens for runoff flow reduction, and the feasibility of installing the required acreage in residential or high-density urban areas.

The modeling results clearly indicate that urban land uses (in particular transportation) contribute disproportionately high loads of TP, TN and TSS when compared to the fraction of the area they occupy. In fact, urban areas contribute greater than 50% of TP load in all three subwatersheds modeled for BMPs, but only occupy between 9 to 26% of the total acreage. Specifically in the St Joseph/Benton Harbor subwatershed (the most urban of the three), transportation uses account for 66% of the TP load and only 12% of the acreage. **It is clear that treatment of urban stormwater runoff is crucial for reducing TP and TSS loadings in these urbanized subwatersheds.**

Overall the model shows, under the current land use **urban stormwater runoff is the largest source of nutrient and sediment loads in urban subwatersheds**. In addition, the analysis of a hypothetical 25% build-out scenario showed that urban subwatersheds would experience the greatest increase in pollutant loads and runoff volume. Therefore, it is important to control this source of loading if water quality in the Paw Paw River Watershed is to be maintained or improved.

Appendix 13. Paw Paw River Watershed Strategic Land Conservation Plan

This plan was created as part of the Paw Paw and Black River Watershed Plan Updates, funded through the Department of Environment, Great Lakes and Energy through Section 205(j) of the Federal Clean Water Act.
This NPS Pollution Control project has been funded wholly or in part through the Michigan Department of Environment, Great Lakes, and Energy's Nonpoint Source Program by the United States Environmental Protection Agency under assistance agreement #2017-0105 to Southwest Michigan Planning Commission for the Paw Paw and Black River Watershed Plan Updates project. The contents of the document do not necessarily reflect the views and policies of the United States Environmental Protection Agency or the Department of Environment, Great Lakes, and Energy, nor does the mention of trade names or commercial products constitute endorsement or recommendation for use.
By Hilary Hunt, Southwest Michigan Land Conservancy
Written for Marcy Hamilton, Southwest Michigan Planning Commission
June 2020

Section I: Overview and Scope of Project

This Land Conservation Plan represents the latest iteration in a multi-decade history of shared priorities and goals between the Southwest Michigan Land Conservancy (SWMLC) and the Southwest Michigan Planning Commission (SWMPC). Together, SWMLC and SWMPC have partnered to identify high quality natural land across these two watersheds that would benefit from permanent protection. For this project, these high quality areas are places where land has a disproportionate ability to affect water quality—for example, land adjacent or proximal to water bodies, or land with hydric soils. This project is a component of the much larger Watershed Management Plan update, developed by SWMPC in 2020, which identify the status of and threats to the Paw Paw and Black River Watersheds. Because protected natural land is a major component in what maintains or improves the health of a watershed, SWMLC's expertise in identifying high quality areas worthy of protection can be a great benefit to the conservation of the overall watershed. The more natural land conserved (pervious surface) in a watershed, the better for water quality and river health. Conversely, when natural land is converted to other uses, water quality may worsen.

In fall 2019, SWMPC and SWMLC staff met with a group of stakeholders to generate ideas for this project, particularly asking the attendees to share the characteristics of land that they see as highly impactful on water quality. The stakeholders put forward many helpful ideas, which shaped the model described below in Section III. After receiving input from stakeholders, SWMLC and SWMPC staff put together the model, which was rendered spatially in Geographic Information Systems (GIS) software by geographers at the Upjohn Center for Geographic Change at Western Michigan University (WMU). In February 2020, SWMLC staff aggregated the addresses and names of landowners who own the highest quality parcels (as identified through the GIS modeling) within these two watersheds and invited them to community events in their respective areas, with the hopes of making new connections and finding new leads for future land conservation projects. See Appendix C for a list of landowners who received communications regarding their property as part of this project. In March 2020, staff met some of these landowners through planned outreach events (one of which had to be canceled due to the coronavirus pandemic), and also received communications from landowners who were not able to attend but were nevertheless interested in protecting their land. Over the next few years, SWMLC staff will be working on completing the land deals that came out of these events.

Section II: The Watershed

The Paw Paw River Watershed is located in Southwest Michigan as adjacent sub-watersheds of the larger Lake Michigan watershed. The Paw Paw River Watershed contains 446 square miles of land. The watershed is dominated by its eponymous river, but both watersheds also contain hundreds of smaller streams, creeks, lakes, and drains, which are also important to overall watershed health.

The Paw Paw River Watershed is particularly important from a conservation perspective, because a large amount of the watershed is still undeveloped, and

because five endangered species make their home in the watershed[1].. Despite agricultural uses, housing development, and other events, there is plenty of high quality land left to protect in the watershed. The respective future will depend in part on how much of this land we are able to keep natural and under protection.

Section III: Stakeholders' Input

To begin identifying high quality parcels and areas for protection, SWMPC and SWMLC staff convened stakeholders from across both watersheds to discuss the future of land protection in the two watersheds. The goal of this meeting was to select what kinds of inputs needed to go into the spatial modeling that would identify high quality land in the watersheds. The assembled stakeholders who provided input represent a wide variety of disciplines, hail from all three counties, and work in different sectors. The stakeholders who met are the following: Marcy Hamilton (SWMPC), Hilary Hunt (SWMLC), Kevin Haight (Two Rivers Coalition), Nancy Carpenter (Berrien County Conservation District), Erin Fuller (Van Buren Conservation District), Pete Vincent (Michigan Department of Environment, Great Lakes and Energy), Grant Poole, Kyle Boon and Jennifer Kanine (Pokagon Band of Potawatomi, Department of Natural Resources), and Brian Talsma (Allegan Conservation District). To identify high quality areas and parcels, the stakeholders used their collective knowledge to select landscape features that make a given area of land important to water quality.

Several landscape features came up as priorities or general precepts for our approach, with the intention that these features would help identify high priority parcels. We prioritized the protection of the following: Type 1&2 cold water streams, natural land cover, adjacency and proximity to protected lands, lakes greater than five acres, adjacency and proximity to water features (rivers, streams, lakes, drains), acreage of wetlands, groundwater recharge areas, bigger parcels and habitat areas are better than smaller.

Section IV: Building the Model

With these priorities in mind, SWMPC and SWMLC staff met with WMU geographers to translate these priorities and precepts into quantifiable values, and then convert those values into a spatial representation of the two watersheds' landscapes. The model that resulted from these priorities is below in Table 1. The mapping results that came from this model are pictured below in Figure 1. Initially, the plan was to use the same model for both watersheds. However, when the maps were completed, we found that the model worked well for the Black River Watershed, but that the Paw Paw River Watershed required a different model.

Fortunately, there was another regional mapping project occurring at the same time, SWMLC's Strategic Climate Resilience Land Conservation Plan, in which the organization is identifying land that is most likely to be resilient to the effects of climate change, with the goal of conserving these places. Although the funds associated with this grant had been spent by that time that we found this issue, we were able to ask the WMU geographers to run the Water Quality component of the resilience mapping as a

[1] Two Rivers Coalition, 2008. Paw Paw River Watershed Management Plan.

single layer in place of the original Paw Paw River Watershed model, giving us Table 1 and Figure 1. As a result, the two models and the resulting maps are slightly different from each other, but are based on the same values and perform the same function: identifying land that has an outsize impact on protecting nearby water quality. The tables below used many diverse data sources, layers, and shapefiles to churn out the maps of high quality areas for protection. The datasets and dataset sources are listed in Appendix A, along with the geographer's abbreviated descriptions of the steps they followed to create the maps and process these datasets.

Table 1: *Criteria used for identifying priority areas for land conservation (Paw Paw River Watershed)*

Target	Category	Type	Category Max	Type Max	Value Description
Water Quality	Wetland	% of hexagon that is wetland	200	100	0-100 continuous
		Physical components of Wetland Functionality		100	0-100 continuous
	Surface Water (without drains)	Presence	300	100	Present/Absent
		Feet of frontage on surface water		100	Continuous
		Protect forested first order streams: First order streams that are adjacent to 3 forested land cover classes, including forested wetlands		100	Present/Absent
	Groundwater	Recharge	200	100	0-100 continuous
		DRASTIC		100	0-100 continuous
	Forest Cover	Merge all three forested 2016 LULC classes, directly proximal to water body.	100	100	Present/Absent
		Potential Max Value	**800**		

Section IV: Results from Spatial Modeling of High Quality Sites for Land Protection

Creating models like the ones above is useful because they can give us new information in an easily understandable way; in this case, through the maps shown in Figure 1. Following the methods described in Appendix A under "Processing", the geographers obtained the maps shown in Figure 1. The map is a visual representation of the model above in Table 1. In Figure 1, the units in the Paw Paw River Watershed are quarter-mile hexagons, which are not based on parcels, and therefore have no minimum size. Thus, every part of the land is scored.

There are positives and negatives to both models. The Paw Paw River Watershed parcel data allows Conservancy staff to easily prioritize landowners with whom they would like to work, while the Black River Watershed map requires more effort to identify individual parcels. On the other hand, for the Black River Watershed all areas of land score equally without regard for property boundaries, which means that there is no statistical bias towards larger properties. However, both methods serve the purposes for this project, which is for the models to identify areas of land that are worthy of protection, with the goal of protecting water bodies and water resources.

Many of the results from the modeling are consistent with existing conservation priorities: in general, the highest quality areas are along bodies of water, with the very best land areas located at the headwaters of streams and rivers. In general, areas with more acres of wetland and more functionality within those wetlands also rank highly. Below, see the detailed breakdown of high quality sites for land protection. See Appendix B for watershed maps that include labels corresponding to the high quality sites below.

High Quality Sites for Land Protection in the Paw Paw River Watershed

Site 1: Lower Branch Paw Paw River (Benton Harbor to Coloma)

From the city limits of Benton Harbor all the way northeast to Coloma, the Paw Paw River is at its best—wide and wild floodplain forest and emergent marsh, much of which has been protected through the work of the Sarett Nature Center and the Southwest Michigan Land Conservancy. This riparian corridor is well-known as a site for migratory and breeding bird habitat, as well as documented populations of the federally-endangered Mitchell's satyr butterfly and the Eastern Massasauga rattlesnake, along with other listed species and species of special concern.

Conservation properties held by SWMLC in this area include the following, listed more-or-less from south to north: Sarett's Brown Sanctuary Conservation Easement (CE) (280 acres), Sarett CE (164 acres), Smith Nature Trust CE (300 acres), Nelson Family West CE (87.73 acres), Nelson Family East CE (71.78 acres), and Sarett's Blacks Woods CE (33 acres). Five of these properties are owned by the Sarett Nature Center, but have received additional protection as conservation easements held by SWMLC. These properties are in addition to the several hundred other acres owned by the Sarett Nature Center. As previously discussed, these large blocks of intact habitat are what has the greatest regional impact for preserving biodiversity. Accordingly, continuing to protect more land in this area will remain a priority for SWMLC.

Site 2: Mainstem from Watervliet to Hartford

From Coloma to Watervliet, the Paw Paw is more highly impacted by urbanization and residential development, with many small lot sizes and urban landscaping. However, east of Watervliet, there is more high quality land with more potential for conservation, especially on the northern bank of the river. SWMLC's 71.5-acre Robert Heuser Memorial CE is located to the south of this area, protecting 2,600 feet of frontage on Shafer Lake Creek, which is a tributary of the Paw Paw River.

Site 3: Brush Creek

The Brush Creek corridor, located south of Lawrence, is another high quality area ripe for conservation work. As a tributary of the Paw Paw, it has the potential to have a large impact on water quality in the mainstem. Brush Creek is also significant given its status as a coldwater stream, providing important aquatic habitat for species sensitive to changes in water temperature and dissolved oxygen. As with most of the high quality areas identified in this analysis, runoff from agricultural activities remains a threat to the healthy, native floodplain forests that line its banks. To the east of Brush Creek, SWMLC has protected the 82.5-acre Bonamego Woods CE and the 87.4-acre

Bonamego Farms CE. At the furthest southern extent of Brush Creek, its headwaters also have many high quality areas, some of which has been protected by the Michigan Nature Association's Hamilton Township Coastal Plain Marsh Preserve on School Lake and the surrounding areas, particularly Pine Lake, which has a largely undeveloped shoreline. These areas, which include much of the northwest quadrant of rural Hamilton Township, are ripe for further conservation.

Site 4: Mainstem Northwest of Lawrence
Our model also identified high quality land northwest of Lawrence, along the mainstem of the Paw Paw River. This area was not identified in previous analyses, which makes it an interesting finding. When looking at the National Wetlands Inventory layer in GIS, there are some large tracts of undisturbed floodplain forest along these stretches of the river, so perhaps this is what led to the model identifying this area as high quality. Given that SWMLC staff have spent little time ground-truthing the results in this area, this remains an area for further exploration.

Site 5: Mainstem Basin
North of Paw Paw is the confluence of many of the Paw Paw River's tributaries as they join the mainstem, and the confluence of the North Branch and the South Branch as it comes out of Maple Lake. These winding, wild floodplains that line the meanders in the river and creeks have been and remain a very high priority for SWMLC's conservation efforts. We consider this area of waters coming together a biodiversity hub for the entire region, given the amount of conserved land and high likelihood of future conservation success. Staff have frequently sited rare species in this beautiful, intact floodplain, including the Prothonotary warbler and the Cerulean warbler. Properties protected in this region include: Sora Meadows Preserve (65 acres), the Eureka! CE (341.7 acres), the Jazz CE (55.9 acres), the Paw Paw River Preserve (258 acres), and the Dayton-Willard Wildlife Preserve (41 acres). This area will remain a very important priority for SWMLC in the years to come.

Site 6: East Branch Paw Paw River
Another area that has received a good deal of conservation attention is the East Branch of the Paw Paw River, which joins the West Branch just south of Maple Lake to join the mainstem. Given the very high amount of biodiversity and excellent water quality in this area, the Nature Conservancy (TNC) made this area a high priority of theirs in the early 2000s, completing several conservation projects including the Paw Paw Prairie Preserve West, several conservation easements, and Paw Paw Prairie Preserve East at the furthest east extent of the river, just on the border of Kalamazoo and Van Buren counties. SWMLC has also done work in this area, completing the 51.9-acre Farris CE adjacent to the TNC CEs. This area is home to breeding populations of box turtles and other rare fauna due to its high quality habitat, which includes prairie fens, upland oak barrens and more. This area remains a priority for multiple organizations, and SWMLC has several imminent land deals nearby.

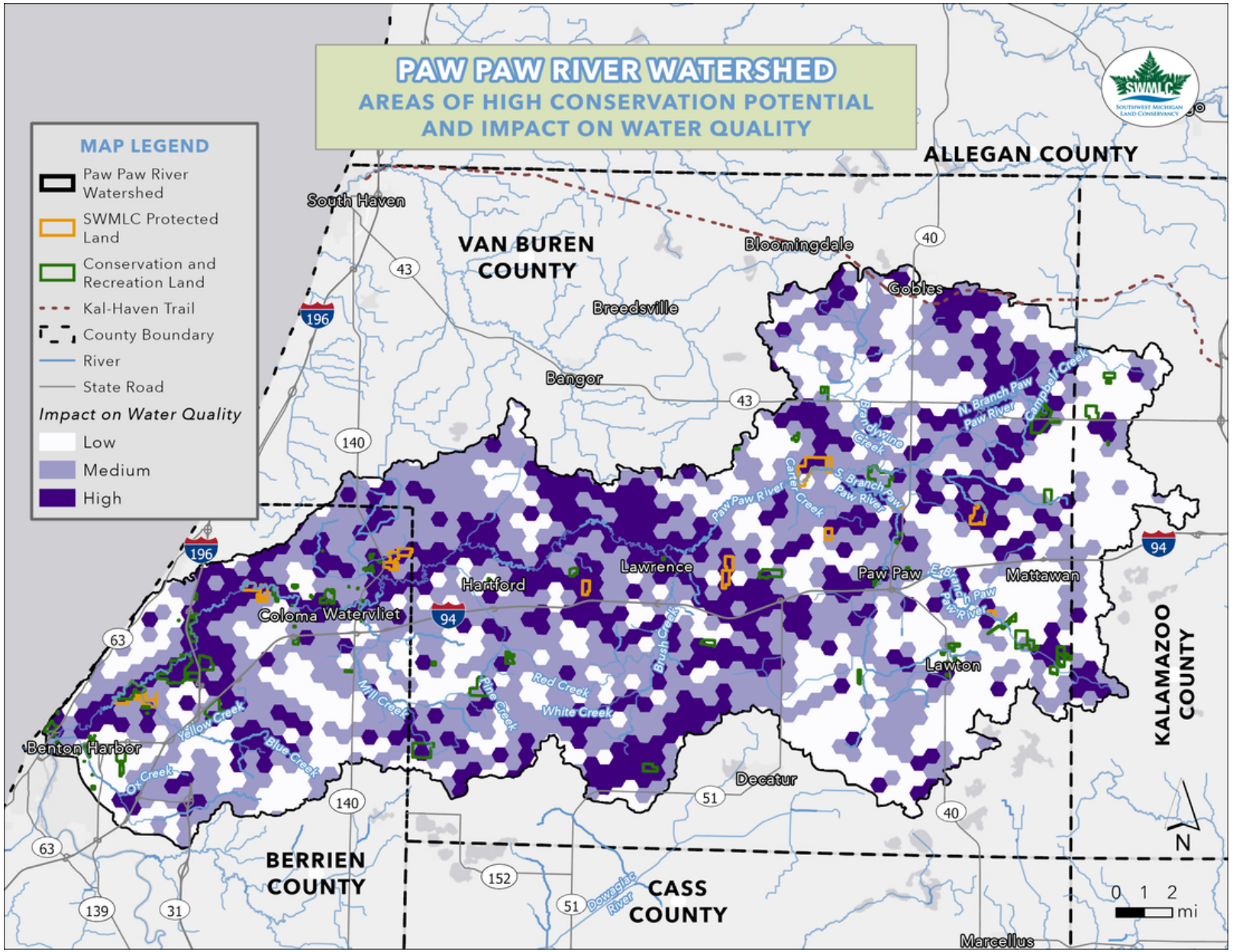
Site 7: Headwaters Area near Lime Lake

Development pressure in and around the Mattawan area is currently very high, and we are seeing a great deal of conversion from farmland to suburban developments. However, some of the Paw Paw River's most important headwaters are located just northwest of Mattawan near Lime Lake, putting conservationists in a race against time to protect these wetlands and neighboring upland areas. This area is home to some of the highest quality prairie fens in Southwest Michigan, several imperiled species (Mitchell's satyr, Eastern Massasauga rattlesnake), high quality natural communities, and outsize regional importance for groundwater recharge areas. SWMLC's 189.87-acre Portman Nature Preserve is the crown jewel of this area, protecting an astounding amount of biodiversity and serving as an anchor for the headwaters. Clearly, this area will remain a priority for SWMLC and its partners over the years and decades to come. Several nearby properties have potential as future conservation acquisitions.

Site 8: Campbell Creek and North Branch Headwaters

Another high priority headwaters area is located just north of Site 6. Known as the Almena Swamp, this wild and wonderfully biodiverse floodplain forest serves as the starting place for the North Branch Paw Paw River. In these extensive wetlands, the nascent North Branch is fed by Campbell Creek as well as other smaller, unnamed creeks. The Michigan Department of Natural Resources owns Wolf Lake State Fish Hatchery, which protects the shores of Wolf Lake and acres of forest surrounding it. This area is quite rural, with large tracts of property owned by individuals as well as public hunting area and managed woodland owned by Almena Township. This area is some of the wildest, wettest and largely undevelopable area in SWMLC's service area, and land protection staff is active in several acquisition projects in this area.

Figure 1: Results from Paw Paw River Watershed mapping, obtained using model in Table 1



Section V: Conclusion

When looking holistically across the entire basin of both the Paw Paw River Watershed and the Black River Watershed, it quickly becomes apparent that there is a great deal of land left to protect. Frankly, this can be an overwhelming prospect when faced with the tens of thousands of acres still in need of protection. Over the past 28 years, SWMLC has protected over 17,000 acres of land, and looks forward to continuing that legacy. However, with such a large service area (the nine counties of Southwest Michigan), it can be challenging to remain strategic about new acquisitions. Participating in projects like this Water Quality Management Plan can be extremely helpful for clarifying priorities and deciding which areas to approach first, based on level of threat from conversion to other uses and urgency for conservation.

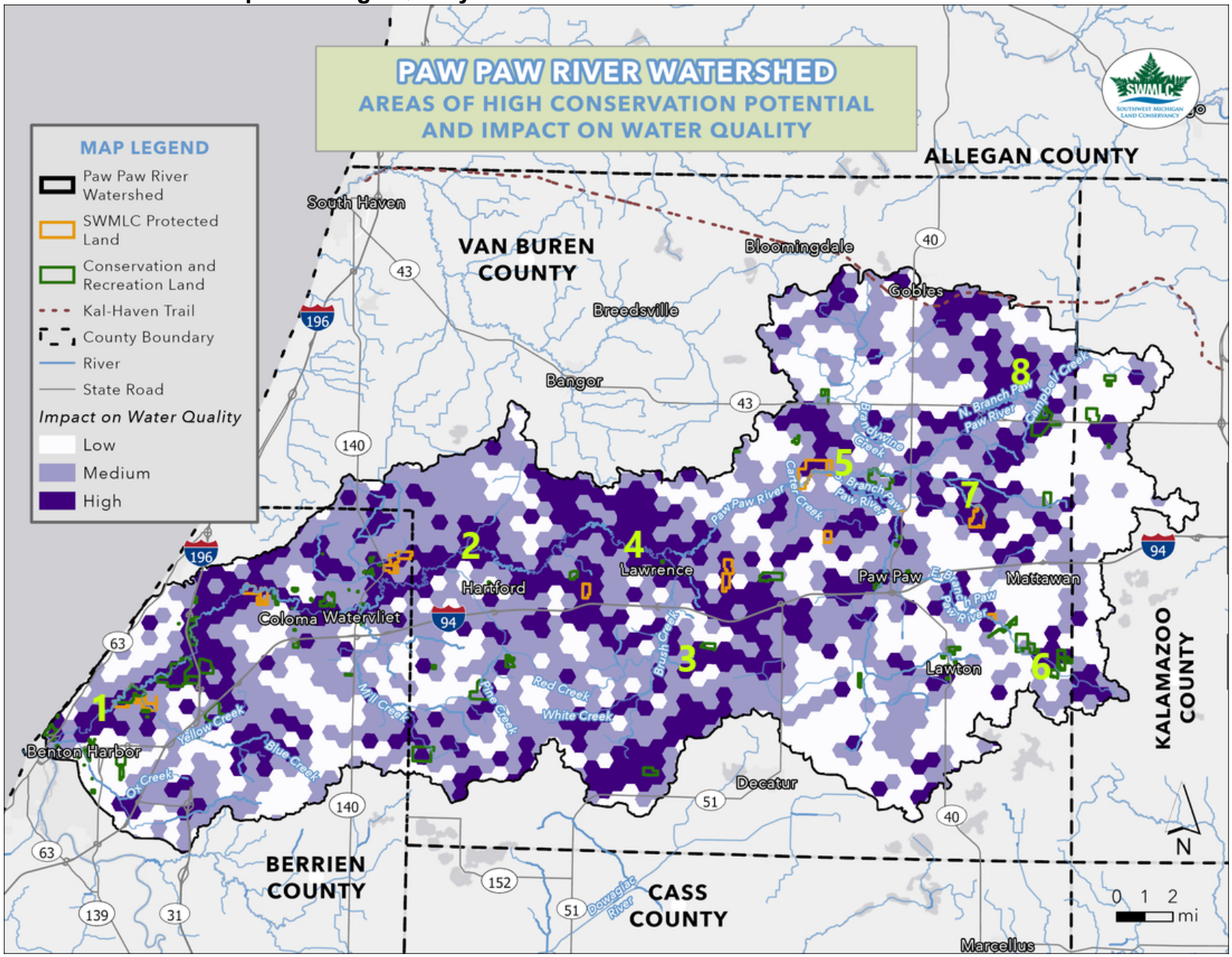
Through this project, SWMLC staff were able to identify high quality sites for land protection in both watersheds, and begin the process of building relationships with the landowners who own property in these priority areas. Many thousands of acres of land will be protected more effectively as a result of this Strategic Conservation Plan.

Appendix A: Data Layers and Processing

Data Layers for Table 1 and Figure 1 – Paw Paw River Watershed:
Wetlands, Wetland Functionality – National Wetland Inventory, MCGI
Lakes – Michigan Lake Polygons, MCGI
Streams – Michigan Hydro, MCGI
Floodplains – Floodplains, MCGI
LULC – 2016 Land Use Land Cover, MRCL
Watershed Boundary – MCGI
Parcels – Van Buren, Berrien, Kalamazoo
Groundwater – DRASTIC

Processing for Table 1 and Figure 1 – Paw Paw River Watershed:
Generate ¼ mile hexagon tessellations and assign Grid IDs
Vector Layer extraction for category features
Various data from Michigan Open Data, MNFI, and NWI
Vector to Raster
Reclassify and Rescale by function for set category values
LULC data reclassified (non-urban & non-ag, forested wetlands, and all forested types)
Rescale continuous data using linear function
Reclassify for Present/Absent data
Overlay and Proximity
Find intersection of feature
Adjoining wetland types, Forest Covered Streams, and Water Bodies
Zonal Statistics
Tabulate Intersection
Feet of Frontage of Surface water, percent wetland
Map Algebra
Z-score smoothing for TNC “Landscape Diversity”
Based off mean and stand deviation from both ecoregions
Add all raster rescale and reclassified layers for each target
Zonal Statistics
All statistics calculated for each hexagon

Appendix B: Watershed Maps with High Quality Sites Labeled



Appendix C: Landowners of High Quality Parcels (Received Mailing as Part of this Project)

Paw Paw River Watershed Landowners

First Name	Last Name	Mailing Address	City
David C.	Adent	41 SUNSET TR	OGDEN DUNES, IN 46368
Juanita	Arndt	52937 CR 365	LAWRENCE, MI 49064
Mary E.	Arnold	23690 44TH AVE	MATTAWAN, MI 49071
Marc W.	Baiers	66258 90TH AVE	HARTFORD, MI 49057
Mark R.	Baldwin	81255 68TH ST	WATERVLIET, MI 49098
Tracy	Balles	57850 WOODBERRY LN	MUSKEGO, WI 53150
Bruce C. & Elizabeth A.	Bauer	69001 CR 687	HARTFORD, MI 49057
Nancy A.	Baumgartner	3404 SOUTH 1ST STREET	KALAMAZOO, MI 49009
MICHAEL C JR	BEAUPRE	68960 CR 215	LAWRENCE, MI 49064
William	Beeching	49864 54TH ST	LAWRENCE, MI 49064
Norma & Gilberto	Benavides	52290 TERRITORIAL RD	DECATUR, MI 49045
Wesley J.	Bender	226 CAMERON AVE	LOCKPORT, IL 60441
Russel K.	Berryman	77099 33RD ST	LAWTON, MI 49065
Kenny & Gayla	Bess	68795 RED ARROW HWY	HARTFORD, MI 49057
William	Beyer	33365 72ND AVE	LAWTON, MI 49065
Robert J. and Alice L.	Bilton	8621 HILL RD	WATERVLIET, MI 49098
Harlan & Pamela	Birk	31 N CLARK ST	CHICAGO, IL 60602
Ann Marie	Bland	44756 64TH AVE	PAW PAW, MI 49079
David & Cathy	Block	38959 36 1/2 ST	PAW PAW, MI 49079
PETER J & TERRI J	Bogdan	9320 E DIVISION	KNOX, IN 46534
Scott	Boguta	36767 32ND ST	PAW PAW, MI 49079
Daniel J. SR & Patricia	Bohle	51960 CR 681	LAWRENCE, MI 49064
Louis A.	Bonamego	57979 48TH ST	LAWRENCE, MI 49064
John D.	Bontrager	10138 CR 18	MIDDLEBURY, IN 46540
Eloise M.	Boothby	25731 M 40 HWY	GOBLES, MI 49055
Randy L.	Boothby	47482 33RD ST	PAW PAW, MI 49079
Peter J. & Christine M.	Bourgeois	5438 GLEN HARBOR	KALAMAZOO, MI 49009
Mary E.	Bower	46911 24TH ST	MATTAWAN, MI 49071
Wayne	Breece	7492 RIVER RD	FLUSHING, MI 48433
Louie C. & Betty J.	Breeding	1616 N DRAKE	KALAMAZOO, MI 49006
Susan A.	Brennan	26531 DRAPE RD	LAWTON, MI 49065
John P	Bright	11259 OAKLAND DR	SCHOOLCRAFT, MI 49087
John R.	Brinton	PO BOX 447	LAWTON, MI 49065
Charles T.	Broderick	2996 MAPLE LN	BENTON HARBOR, MI 49022
Donald W.	Bush Senior	4980 TERRITORIAL RD	BENTON HARBOR, MI 49022
Robert J.	Byrd	71375 IRONWOOD DR	NILES, MI 49120

Brian J. & Candice B.	Cady	55038 M 51 WEST	DECATUR, MI 49045
Joel & Brooke	Camp	70601 26TH ST	LAWTON, MI 49065
Frank & Melissa	Caron	43910 30TH ST	PAW PAW, MI 49079
Alfred J. & Linda D.	Chabot	3290 CHABOT RD	BENTON HARBOR, MI 49022
Wendy & Karen	Christians & Farrow	321 SHEFFIELD CIR	PALM HARBOR, FL 34683
Thomas P. & Liane	Churney & Lazzari	35780 36TH AVE	PAW PAW, MI 49079
Michael A.	Clark	62843 70TH ST	WATERVLIET, MI 49098
Cordon J & Gladis L.	Clemens	51895 59 1/2 ST	HARTFORD, MI 49057
David	Coleman	28575 29TH ST	PAW PAW, MI 49079
Robert A. & Kristen T.	Colgren	42108 CR 215	LAWRENCE, MI 49064
Matthew R.	Cooper	43445 CR 374	PAW PAW, MI 49079
JAMES A & JILL	Copeand	78118 M 40 HWY	LAWTON, MI 49065
Ronald	Crafton	31664 FISH HATCHERY RD	KALAMAZOO, MI 49009
Robert G. & Noreen A.	Cramer	68333 CR 652	LAWTON, MI 49065
Anthony	Dacoba	827 S LAGRAVE ST	PAW PAW, MI 49079
Andrea	Dalton	20078 BRANDYWINE DR	GOBLES, MI 49055
George & Stephanie	Daniels	78059 67TH ST	HARTFORD, MI 49057
Robert J. & Salesk	Depierre	7410 OAKSTONE DRIVE	CLARKSTON, MI 48348
Joseph & Joan	Dick	74469 51ST ST	DECATURE, MI 49045
James R. & Lisa M.	Dietrich Trustees	24789 WISE RD	GOBLES, MI 49055
David K.	Diget	32180 25TH ST	MATTAWAN, MI 49071
Gregory H. & Susan K.	Doll	27701 CR 354	LAWTON, MI 49065
JAMES R & CHARLENE	Drake	64990 51ST ST	LAWRENCE, MI 49064
SIDNEY JOSEPH & BEVERLY J	EARLS	55606 BUTCHER RD	LAWRENCE, MI 49064
Elijah E.	Essar II	76386 56TH ST	DECATUR, MI 49045
Derrick A. & Monica R.	Fisher	69019 80TH AVE	WATERVLIET, MI 49098
Geraldine	Fleetwood	47315 48TH AVE	LAWRENCE, MI 49065
Kathleen S.	Flynn	3233 ESTATES DR	ST JOSEPH, MI 49085
Thomas J. SR & Rosemary	Fogarty	2814 RED ARROW HWY	BENTON HARBOR, MI 49022
Robert E.	Fouts	416 W ELM ST	WHEATON, IL 60189
John & Joan	Frank	59760 60TH ST	HARTFORD, MI 49057
Roman P. & Joann	Gajewzki	5536 RIVERSIDE RD	COLOMA, MI 49038
Kevin L.	Gardner	50792 48TH ST	LAWRENCE, MI 49064
Ida J.	Gaul	1798 POPULAR PATH	STEVESVILLE, MI 49127
Albert	Geresy	27700 44TH AVE	MATTAWAN, MI 49071
Gary L.	Gibson	6963 N 32ND ST	RICHLAND, MI 49083

William G.	Gillard	7278 PAW PAW AVE	WATERVLIET, MI 49098
Howard R. & Shirey M.	Ginter	5389 E C AVE	RICHLAND, MI 49083
Lawrence L.	Glidden	44262 46TH AVE	PAW PAW, MI 49079
Lawrence R. & Annette R.	Glista	54947 44TH AVE	LAWRENCE, MI 49064
Luis	Godines	51433 63RD AVE	LAWRENCE, MI, 49064
Harriet, Cassie & Tessie	Golomb	PO BOX 545	COLOMA, MI 49038
David & Jeannie	Goodwin	42900 CR 665	PAW PAW, MI 49079
Michael P. & Joyce D.	Grabbe	26069 RED ARROW HWY	MATTAWAN, MI 49071
Adam	Gregory	51560 63RD AVE	LAWRENCE, MI 49064
Bernard F.	Grgurich	PO BOX 115	LAWTON, MI 49065
THOMAS E & LUCILLE F	GRIFFITHS	28044 49TH AVE	MATTAWAN, MI 49071
Travis & Katie	Grimwood	10276 WEST TU AVE	LAWTON, MI 49065
Edwin & Joyce	Gustafson	55055 70TH ST	HARTFORD, MI 49057
James & Jenny	Guzinski & Grunberg	8814 WEST H AVENUE	KALAMAZOO, MI 49009
Carl & Kathleen	Haas	60903 TERRITORIAL RD	LAWRENCE, MI 49064
HAROLD & MELINDA	Haight	61158 48TH AVE	HARTFORD, MI 49057
Lillian C.	Hall	2506 BLUFFWOOD DR W	INDIANAPOLIS, IN 46228
Ronald L. & Rebecca	Hamming	18122 36TH ST	GOBLES, MI 49055
Leroy P. & Dianne M.	Haney	45067 60TH ST	LAWRENCE, MI 49064
Bryan	Hanson	51178 40TH AVE	BANGOR, MI 49013
Nicole & Scott	Hassle	28230 ELM ST	DOWAGIAC, MI 49047
Timothy	Hazard	17002 CR 653	GOBLES, MI 49055
Charles D. II & Jan A.	Hazzard	80045 55TH ST	DECATUR, MI 49045
Adam & Lauren	Healy	48548 60TH AVE	LAWRENCE, MI 49064
Caryle	Heintzman	30297 CR 388	GOBLES, MI 49055
Dorothy	Hemenway	95231 52ND ST	DECATUR, MI 49045
Robert G. & Amy L.	Hendrickson	5961 JOHNSON RD	COLOMA, MI 49038
Barnard H. & Jacqueline M.	Hiler	545 S ARENT RD	WATERVLIET, MI 49098
Jon B. & Diane F.	Hinkelman	2201 NORTH M 140	WATERVLIET, MI 49098
Matthew L. & Margret A.	Hochstetler	8160 W 1050 NORTH	NAPPANEE, IN 46550
Randy A. & Kathryn A.	Hoevenaar	23999 66TH AVE	MATTAWAN, MI 49071
Margaret J.	Holfinger	2062 YORKTOWN DRIVE	ANN ARBOR, MI 48105
Jeff & Linda	Hunter	319 S 23RD ST	CHESTERTON, IN 46304
David W. & Shirley I.	Hurley	28252 20TH AVE	GOBLES, MI 49055
Jack A. & Susan A. & Tona R	Imbordino & Scott	3017 JOHNSON RD LOT 39	STEVESVILLE, MI 49127
Peter & Sandra	Johnson	60614 RED ARROW HWY	HARTFORD, MI 49057
Gary E.	Jones	43198 56TH AVE	PAW PAW, MI 49079
Robert F. & Deborah A.	Jones	81280 6TH ST	WATERVLIET, MI 49098

Frederick A. III & Louise Ann	Jorn	14745 HORSESHOE TRACE	West Palm, FL 33414
John G. & Diane J.	Julian	41385 WAUKEENAH DR	PAW PAW, MI 49079
Kevin & Nancy	Jusick	215 PARK AVE	PARCHMENT, MI 49004
John G. & Deborah L.	Kamer	2670 WOLF RD	EAU CLAIR, MI 49111
Timothy J.	Karmon	6294 W MAIN ST	KALAMAZOO, MI 49009
Timothy F.	Keller	69400 CR 215	LAWRENCE, MI 49064
John R.	Kelly	38332 CR 380	BLOOMINGDALE, MI 49026
Kenneth & Sheri	Kendal	15079 CR 653	GOBLES, MI 49055
Jason & Abigail	Kidd	35348 30TH ST	PAW PAW, MI 49079
Joel L.	Kienzle	9458 DWIGHT BOYER RD	WATERVLIET, MI 49098
Adam A.	Kietzer	8625 TERRITORIAL RD	BENTON HARBOR, MI 49022
KEVIN R & KAREN T	Kissinger	82198 67TH ST	HARTFORD, MI 49057
John L. & Sandra J.	Klein	22594 CONCORD AVE	MATTAWAN, MI 49071
Margaret	Kleinschmidt	26597 RED ARROW HWY	MATTAWAN, MI 49071
Dennis L.	Knuth	2159 MAPLE LANE	BENTON HARBOR, MI 49022
Kimberly	Kocek	856 WEST NEWPORT, APT 2	CHICAGO, IL 60657
Brian S.	Krajewski	23133 66TH AVE	MATTAWAN, MI 49071
Michael	Krieglstein	147 S ELLYN AVE	GLEN ELLYN, IL 60137
Gregory J.	Krikke	77460 55TH ST	DECATUR, MI 49045
Dariusz	Kulach	6478 CLYMER RD	COLOMA, MI 49038
Marc & Babbetta S.	Lakatos	5754 MARTIN RD	NORTON SHORES, MI 49441
Leo & Joyce	Lanphear	45039 43 1/2 ST	PAW PAW, MI 49079
Alton J. & Deborah	Laupp	49408 CHURCHILL ST	MATTAWAN, MI 49071
DONALD A	LAURIAN	35847 30TH ST	PAW PAW, MI 49079
James	Laveglia	44125 76TH AVE	DECATUR, MI 49045
Robert W.	Leet	36235 44TH AVE	PAW PAW, MI 49079
Robert A. & Juanita J.	Lembrecht	3221 M 140	WATERVLIET, MI 49098
Derek M.	Lietzau	73603 CR 215	DECATUR, MI 49045
Evie M. & Scott Sherman	Longshore	33108 36TH AVE	PAW PAW, MI 49079
Robert J. & Rosemary	Lucker	2150 ZOSCHKE RD	BENTON HARBOR, MI 49022
John & Melissa	Macyauski	52936 50TH ST	LAWRENCE, MI 49064
Carl D.	Manning	213 PAW PAW ST	PAW PAW, MI 49079
Steve & Sheri	Manning	27136 CR 375	PAW PAW, MI 49079
Paul W.	Manstrom	806 NORTHHAMPTON	KALAMAZOO, MI 49006
James P.	Marcelletti	49679 CR 665	PAW PAW, MI 49079
Nelu & Dorina	Marcus	9024 LINDER AVE	MORTON, IL 60053

Mary	Marko	82721 CR 215	DECATUR, MI 49045
Harlan	Maurer	2912 CALLENDER CT	KALAMAZOO, MI 49008
Richard & Chad	Maxam	134 AMPEY RD	PAW PAW, MI 49079
Mathew & Sarah	Mcdaid & Lynn	39219 32ND ST	PAW PAW, MI 49079
JAMES & BRENDA	MCGRUDER	PO BOX 339	PAW PAW, MI 49079
Calvin Stewart	Meabon	29583 38TH AVE	PAW PAW, MI 49079
Henry J. & Patsy J.	Meachum	64091 41ST ST	PAW PAW, MI 49079
Richard L.	Minter	30897 CR 653	GOBLES, MI 49055
Thomas	Mitchell	PO BOX 362	STEVESVILLE, MI 49127
Timothy Mark	Mizwicki	82802 67TH ST	HARTFORD, MI 49057
Russel E. & Cleora I	Mohney	3500 VANDERBILT AVE	PORTAGE, MI 49002
John	Mollitor	25321 M 43 HWY	MATTAWAN, MI 49071
Roger W. & Patricia M.	Molter	6808 TERRITORIAL RD	BENTON HARBOR, MI 49022
Maurice E. Jr	Mortimore	34022 81ST AVE	DECATUR, MI 49045
THOMAS T & TARA L	MOTYCKA	PO BOX 74	LAWTON, MI 49065
Todd Richard & Kelly	Munting	66901 OAK RIDGE DR	LAWTON, MI 49065
Gregory J. & Daniel & Suzanne	Myers & Arnosky	1811 RIVERSIDE RD	BENTON HARBOR, MI 49022
Carolyn L.	Nielson	30945 56TH AVE	PAW PAW, MI 49079
Michael & Kristen	Noack	PO BOX 636	COLOMA, MI 49038
GEORGE W & HELEN M	Noffke	3669 KERLIKOWSKE RD	COLOMA, MI 49039
Donald G. & Beverly	Ocker	38721 CR 652	MATTAWAN, MI 49071
Richard & Jill	Oppenlander	26940 CR 354	LAWTON, MI 49065
Mary Armstrong	Overholt	10435 S VAN KAL	MATTAWAN, MI 49071
Ruth A.	Owsiany	33117 CR 665	PAW PAW, MI 49079
Shaun L. & Angel D.	Parish	42620 85TH AVE	DECATUR, MI 49045
Charles L.	Pater	7932 LAKEWOOD DR S	COLOMA, MI 49038
Kelly F.	Patrick	16506 39 1/2 ST	BLOOMINGDALE, MI 49026
George SR & Ramona	Pera	PO BOX 746	LAWRENCE, MI 49064
Juan & Elvira	Perez	73075 CR 376	COVERT, MI 49043
Ryan & Sondra	Pero	45736 52ND ST	LAWRENCE, MI 49064
Josephine	Perry	50510 62ND ST	HARTFORD, MI 49057
Nancy & Carol	Peters	172 E 61ST ST	NEW YORK, NY 10065
Eddie W. & Sylvia J.	Petersheim	20548 CR 200	MOUNT VICTORY, OH 43340
Stephan E.	Peterson	74560 CR 215	DECATURE, MI 49045
Thomas Jr. & Cierra	Pfoftenhaur	5677 WILSON RD	COLOMA, MI 49038
Thomas C. & Carol S.	Pillars	43760 40TH ST	PAW PAW, MI 49079
Mathew L.	Pingel	71902 52ND ST	LAWRENCE, MI 49064
Trever & Angela	Portenga	4920 SADLER DR	WATERVLIET, MI 49098

Russel & Peggy E.	Pusilo	1041 DARTMOUTH DR	BARLETT, IL 60103
Richard	Rajkovich	70300 22ND ST	MATTAWAN, MI49071
Charles E.	Randall	300 WHITE OAK RD	LAWTON, MI 49065
Clifford	Ransler	304 ORCHARD CIR	GOBLES, MI 49055
Gredon & Cheral	Reinoehl	58009 CR 653	PAW PAW, MI 49079
Ruby Jane	Renfer	58611 CR 215	LAWRENCE, MI 49064
THOMAS M & LINDA	REYNNELLS	50930 RED ARROW HWY	LAWRENCE, MI 49064
Thomas & Candice	Rigny	20959 WISE RD	GOBLES, MI 49055
Linda & Gerald	Rininger	47962 27TH ST	MATTAWAN, MI 49071
Shirly A. & Linda & AJ	Ritter	11415 MADERA DR SW	LAKEWOOD, WA 98499
Susan K.	Rockenbach	17968 27TH ST	GOBLES, MI 49055
ROBERT & SUSAN	Rozankovich	2559 HUNTERS WOODS	KALAMAZOO, MI 49048
EDWARD G & CYNTHIA M	RUOFF	1848 SKYLER DRIVE	KALAMAZOO, MI 49008
DAVID L JR & CAROL L	SAGER	42549 32ND ST	PAW PAW, MI 49079
James G. & Karen	Sanborn	51560 63RD AVE	LAWRENCE, MI 49064
LOREN D & SHIRLEY E	SANDERS	25407 6TH AVE	GOBLES, MI 49055
Randal S.	Sarabyn	68638 CR 362	WATERVLIET, MI 49098
Thomas & Deborah	Schauer	808 N PAW PAW ST	LAWRENCE, MI 49064
Tim F. & Deborah A.	Scheu	27490 DRAPE RD	LAWTON, MI 49065
Leslie W.	Schmuhl	3668 KERLIKOWSKE RD	COLOMA, MI 49038
Diana & John	Schneider	32184 FISH HATCHERY RD	KALAMAZOO, MI 49009
Lynn	Scholten	418 103RD AVE	PLAINWELL, MI 49080
Rudolph J.	Schroeder	9289 WEST L AVENUE	KALAMAZOO, MI 49009
Kevin & Mary Nye E.	Schuhknecht	3154 KERLIKOWSKE RD	COLOMA, MI, 49038
Harold G.	Schuitmaker	60202 30TH ST	LAWTON, MI 49065
Donald E. & Jacquelein K.	Schultz	2657 RED ARROW HWY	BENTON HARBOR, MI 49022
Gerald & Joan E.	Seifer	27316 31ST ST	GOBLES, MI 49055
Kevin & Carol	Selvidge	223 MAIN ST	LAWRENCE, MI 49064
James K.	Shadow	PO BOX 176	PAW PAW, MI 49079
Vere Jr. & Linda	Shindeldecker	429 E LINDEN	HARTFORD, MI 49057
Clyde	Siewart	28755 CR 388	GOBLES, MI 49055
Jereme & Sarah	Smith	67267 CR 652	LAWTON, MI 49065
Mary A.	Smith	8474 WEST ML AVENUE	KALAMAZOO, MI 49009
Scott & Kathleen	Smith	67200 51ST ST	LAWRENCE, MI 49064
James & Oren JR	Snell	11400 2ND AVE	OTSEGO, MI 49078
Robert E.	Somsel	PO BOX 127	OSHTEMO, MI 49077
David D. & Constance M.	Sons	33992 FREDERICK ST	PAW PAW, MI 49079
Delores	Spears	3303 GARY WAY UNIT #308	GILBERT, AZ 85234
Mary	Spiech	47063 CR 665	PAW PAW, MI 49079

Aristos	Spugios	7971 KIERNAN AVE	MODESTO, CA 95358
Cinda Lou	Stevens	52285 72ND AVE	LAWRENCE, MI 49064
Thomas Jr. & Priscilla	Swiat	PO BOX 302	SCHOOLCRAFT, MI 49087
Paul	Szekley	69783 CR 652	LAWTON, MI 49065
Steven	Talsma	57001 BUTCHER RD	LAWRENCE, MI 49064
John & Janet L.	Tangeman	66977 BRAY BROOK	LAWRENCE, MI 49064
Stephan B. & Scott B.	Tatter	2825 RAYNOLDS DR	WINSTON SALEM, NC 27104
Martin A D	Teresko	68357 RED ARROW HWY	HARTFORD, MI 49079
Michael J & Wanda M.	Thomas	4000 THAR RD	COLOMA, MI 49038
Fred	Triquet	42701 CR 653	PAW PAW, MI 49079
Kirt M. & Sharon K.	Ullig	1009 BROOKFIELD DR	ST JOSEPH, MI 49085
BIRNEY	VANDERBOEGH	409 EDGEWATER DN PKWY	ST JOSEPH, MI 49085
Randy & Marietta	Vandermay	29482 37TH ST	PAW PAW, MI 49079
Robert	Venable	50268 CR 681	LAWRENCE, MI 49064
Jesus & Andres	Vera	4420 TERRITORIAL RD	BENTON HARBOR, MI 49022
Michael	Verburg	65030 CR 652	MATTAWAN, MI 49071
Ron E. & Dorothy J.	Verleger	26789 63RD AVE	LAWTON, MI 49065
Ronald & Dorothy	Verleger	26789 63RD AVE	LAWTON, MI 49065
Harley W. & Ruth Ann	Vollrath	31715 30TH ST	PAW PAW, MI 49079
Michael Victor	Vorick	37231 FISH HATCHERY RD	MATTAWAN, MI 49071
Edwin J.	Walko	63828 40TH ST	PAW PAW, MI 49079
Gerhard	Weilandt	4521 N BEACON ST	CHICAGO, IL 60640
CRAIG J & DEBRA L	Wenke	26959 28TH AVE	GOBLES, MI 49055
Alice Jean	Wescott	18761 27TH ST	GOBLES, MI 49055
George R	Wheatly	55636 42ND AVE	LAWRENCE, MI 49064
Shannon L. & Donna L.	Whelche	4191 THAR RD	COLOMA, MI 49038
MARK	WIELINGA	46284 BROADWAY	BLOOMINGDALE, MI 49026
Collier S.	Wiese	79282 56TH ST	DECATUR, MI 49045
Ferrin & Mary	Williams	54660 CR 687	HARTFORD, MI 49057
Guy A. & Christine M.	Williamson	24066 CR 375	MATTAWAN, MI 49071
Cecile D. & Diane Ra	Wismer	106 AUSTIN DR	HARTFORD, MI 49057
Larry & Virginia	Withrow	1346 N CRYSTAL AVE	BENTON HARBOR, MI 49022
Fred	Woodhams	4873 E Y AVE	VICKSBURG, MI 49097
Frederick Paul	Woodhams	27070 CR 653	GOBLES, MI 49055
Pricilla Lynn	Woodhams	26701 44TH AVE	MATTAWAN, MI 49071
Richard F.	Woodhams	46472 27TH ST	MATTAWAN, MI 49071

Edouard & Janice	Wu	331 E NIAGARA AVE	SCHAUMBURG, IL 60193
Richard J.	Yarbrough	32923 M 40 HWY	PAW PAW, MI 49079
Taryn J.	Yore	6055 N WATERVLIET RD	WATERVLIET, MI 49098
Dale	Zimmerle	36711 82ND ST	DECATUR, MI 49045
54TH STREET ACRES LLC		319 N MONTCLAIR AVE	GLEN ELLYN, IL 60137
Allen Louis & Irma Charlotte Krieger Rev Trust		8575 HILL RD	WATERVLIET, MI 49098
Almena Township		42125 CR 653	PAW PAW, MI 49079
ALTON C WENDZEL REVC LIVING TRUST		8645 DANNEFFEL RD	WATERVLIET, MI 49098
Andrew D. Blodgett Trust		399 14TH ST	SCHOOLCRAFT, MI 49087
ANNLY TSUO YUN YING MORRISON TRUST		4685 NUTMEG DR	YPSILANTI, MI 48197
Barbara Fritz Trustee		37988 CR 388	GOBLES, MI 49055
Bert C. & Geraldine M. Kruse Trustees		1906 ROOSEVELT	YPSILANTI, MI 48197
Chilla Family Trust		37971 CR 380	GOBLES, MI 49055
Chinodin		58620 SINK RD	DOWAGIAC, MI 49047
City of Benton Harbor		200 E WALL ST	BENTON HARBOR, MI 49022
David G Badiner Trustee		27326 CR 364	MATTAWAN, MI 49071
David B. Kruse Trust		PO BOX 438	PAW PAW, MI 49079
DEE F HICKMOTT TRUST		43184 PARKHURST DR	DECATUR, MI 49045
Donald L. Hinds & Takane Trustees		1249 E CROOKED LAKE DR	KALAMAZOO, MI 49009
Dorothy Jacob Trustee		4024 N CAMPBELL AVE	CHICAGO, IL 60657
DOROTHY MARIE TALANDA TRUSTEE		6093 HORIZON HEIGHTS	KALAMAZOO, MI 49009
Douglas R. Greenman Trustee		6 HEATHERWOOD	IRVINE, CA 92620
Em Bury LLC		4329 RIVERSIDE RD	COLOMA, MI 49038
ENDERS REAL ESTATE INVESTMENTS		7119 DEANS HILL RD	BERRIEN CENTER, MI 49102
Fetzer Institute		9292 WEST KL AVENUE	KALAMAZOO, MI 49009
Fifth Level Hospitality INC		4183 TRADEWIND DR NE	ROCKFORD, MI 49341
Fiskars Family Trust		1340 WHISPERING TRL	BENTON HARBOR, MI 49022
Frances A. Little Trustee		4415 DUKE ST STE 1E	KALAMAZOO, MI 49008
FRANCES A. SPECHT TRUSTEE		48 PARADISE LAKE DR	LAKE PLACID, FL 33852
Galles Family Trust		2012 WICKWIRE RD	BENTON HARBOR, MI 49022
Gary A. & Delora J. Dolezan Trustees		5095 N M 140 HWY	WATERVLIET, MI 49098
GAYE M KELLY TRUSTEE		32454 42ND AVE	PAW PAW, MI 49079
HAGAR SHORES ENTERPRISES LLC		5228 LAWN AVE	WESTERN SPRINGS, IL 60558
HANSON COLD STORAGE CO		2900 SOUTH STATE STREET	ST JOSEPH, MI 49085
HARTFORD LEASING & CONSULTING		PO BOX 187	LAWRENCE, MI 49064

HASSLE INVESTMENTS LLC	28230 ELM ST	DOWAGIAC, MI 49047
HAYBUCK FARM LLC	132 DUNKLEY AVE U1	SOUTH HAVEN, MI 49090
HBC PROPERTIES INC	PO BOX 907	LAWTON, MI 49065
Helen R. Braamse Trust	105 PAUL AVE	BENTON HARBOR, MI 49022
HUCKABA HOMES LLC	2305 M 139	BENTON HARBOR, MI 49022
Ilse M. Erickson Trust	3532 BESSEMER RD	COLOMA, MI 49038
IRENE M KOWALCZYK TRUST	460 DU PAHZE	NAPERVILLE, IL 60565
James & Marilyn Endres Trust	9037 WEST G AVENUE	KALAMAZOO, MI 49009
JAMES A & MARY M HOOD TRUSTEES	PO BOX 1	PAW PAW, MI 49079
Jean K. Mumford Trustee	6717 LEISURE WAY DR SE	CALEDONIA, MI 49316
JEFFREY F & NANCY M YOUNG TRUSTEES	6926 HAYWARD DR	VICKSBURG, MI 49097
JENNIFER ANN SCHWAB TRUST	56660 56TH ST	LAWRENCE, MI 49064
JM & C DALY INVESTMENTS LLC	5265 HUNTWICK RD	KALAMAZOO, MI 49009
JOHN A BLEY JR TRUSTEE	30571 29TH ST	GOBLES, MI 49055
John E. Fetzer Institute	9292 W KL AVE	KALAMAZOO, MI 49009
JOHN P NELSON REVOCABLE TRUST	76319 11TH AVE	SOUTH HAVEN, MI 49090
John V. Salay Living Trust	300 WINDYCREST DR	ANN ARBOR, MI 48105
Jon L. Stryker Trustee	645 MADISON AVE STE 610	NEW YORK, NY 10022
Kenneth N. Beach Trustee	35839 37TH ST	PAW PAW, MI 49079
KENNETH P & KIM J THOMPSON TRUSTEES	69922 52ND ST	LAWRENCE, MI 49064
Kevin & Sheri Van Dam	9727 W FG AVE	KALAMAZOO, MI 49009
KOLASSA NORBERT ESTATE	28843 M 40 HWY	PAW PAW, MI 49079
KRAKLAU CARL RAYMOND TRUST	9129 NORTH BRANCH RD	WATERVLIET, MI 49098
KUKI GENEVIEVE LIVING TRUST OF	311 RED FOX RUN	WALLACE, NC 28466
LEDUC BROS LLC	37146 30TH ST	PAW PAW, MI 49079
Lentz Family Trust	5164 SPRING HILL RD	COLOMA, MI 49038
Lisowski's Lake Assosiation	9019 W DE AVE	KALAMAZOO, MI 49009
Louis & Karen Koprolces Trust	10553 W S AVE	MATTAWAN, MI 49071
Mary Purnel Trustee	PO BOX 187	BENTON HARBOR, MI 49022
MASSEY VERNABELLE TRUST	29484 48TH AVE	PAW PAW, MI 49079
MASTRI FAMILY TRUST	2250 KERLIKOWSKE RD	BENTON HARBOR, MI 49022
MAVERICK & GREYSONS FARM LLC	1701 SW SAN ANTONIO DR	PALM CITY, FL 34990
MEACHUM PROPERTIES LLC	60930 52ND AVE	HARTFORD, MI 49057
Methner Farms of Southwest	10464 WILDWOOD DR	RICHLAND, MI 49083
MICHAEL J CHARBONEAU TRUSTEE	64683 77TH AVE	HARTFORD, MI 49057
Michael J. Calay Trustee	521 S LA GRAVE ST	PAW PAW, MI 49079

MICHELE BARTON TRUSTEE	3049 FRESNO LANE	HOMEWOOD, IL 60430
Michigan Department of Transportation	PO BOX 30050	LANSING, MI 48909
MITCHELL FAMILY LIMITED	2614 W JOHN BEERS RD	STEVENSVILLE, MI 49127
MITCHELL FAMILY LIMITED PARTNERSHIP	PO BOX 362	STEVENSVILLE, MI 49127
MITCHELL FAMILY LIMITED PARTNERSHIP	3384 CLAWSON RD	DOWAGIAC, MI 49047
MJ&M HOLDINGS LLC	32673 RED ARROW HWY	PAW PAW, MI 49079
MJMC AG PROPERTIES LLC	7519 FOREST BEACH RD	WATERVLIET, MI 49098
Nancy F Frost Trust	10435 WEST S AVE	MATTAWAN, MI 49071
Northwestern Berrien County Sanitation Authority	SMALLIDGE RD	BENTON HARBOR, MI 49022
OXFORD COURT HOLDINGS LLC	2015 SPRING ROAD STE 200	OAK BROOK, IL 60523
Patsy Ann Cantrell Trustee	39511 CR 380	BLOOMINGDALE, MI 49026
PAUL JOSEPH & DIXIE M SCHAUER TRUST	39558 CR 665	PAW PAW, MI 49079
PAW PAW CONSERVATION CLUB	PO BOX 342	PAW PAW, MI 49079
PHILLIPS & ASSOCIATES INC	PO BOX 36	RIVERSIDE, MI 49084
PIKE LUMBER CO INC	PO BOX 247	AKRON, IN 46910
POINT O WOODS GOLF & COUNTRY CLUB	1516 ROSLIN RD	BENTON HARBOR, MI 49022
POKAGON BAND OF POTAWATOMI	PO BOX 180	DOWAGIAC, MI 49047
RAVINE VIEW ESTATES MHC LLC	3084 NEWPORT CT	TROY, MI 48084
RENAISSANCE LAND DEVELOPMENT COMPANY LLC	38 W WALL ST	BENTON HARBOR, MI 49022
Richard Callen Jr. Trust	7564 W N AVE	KALAMAZOO, MI 49009
Richard J. Cipri Trust	49463 RED ARROW HWY	LAWRENCE, MI 49064
Rjsk Rentals LLC	PO BOX 332	COLOMA, MI 49038
ROSCHEK LIVING TRUST	8110 W ML AVE	KALAMAZOO, MI 49009
ROTH CREEKSIDE LLC	5875 LT PAW PAW LAKE RD	COLOMA, MI 49038
RYAN FRANCIS TRUSTEE	58951 CR 652	MATTAWAN, MI 49071
Sam & Karli Aiello Family Rev Trust	16552 W MCDONALD DR	LOCKPORT, IL 60441
Sarett Nature Center	2300 N BENTON CNTR RD	BENTON HARBOR, MI 49022
Scott D & Martha J Larson Trustees	PO BOX 306	GOBLES, MI 49055
Scott Remington	22732 44TH ST	BLOOMINGDALE, MI 49026
SOUTHERN MICHIGAN COLD STORAGE	2900 SOUTH STATE STREET	ST JOSEPH, MI 49085
STARKS INVESTMENT LLC	2650 NILES RD	ST JOSEPH, MI 49085
TAYLOR WAYNE TRUST	1301 KATHY ST	VAN WERT, OH 45891
The Kolosowsky Family Trust	5864 N COUNTY LINE RD	WATERVLIET, MI 49098
Thomas E. & Judy A. Esman Trustees	986 SOUTH SHORE DR	PORTAGE, MI 49002

Thomas Fleetwood Trustee	25512 CR 665	BLOOMINGDALE, MI 49026
THOMAS L & ARDIS M WESTON TRUSTEES	55654 CR 360	DECATUR, MI 49045
Thomas M Miller Trustee	828 N MARION ST	OAK PARK, IL 60302
Timothy Vandervest Trust	1756 NORTH 3RD STREET	KALAMAZOO, MI 49009
TRADITIONS DEVELOPMENT LLC	27772 CR 358	LAWTON, MI 49065
TREE FROG FARMS LLC	3208 BRONSON BVLD	KALAMAZOO, MI 49001
Twenty Eighth Street Panthers	260 NINETEENTH ST	SANTA MONICA, CA 90402
VAN BUREN SOIL AND WATER	1035 E MICHIGAN AVE	PAW PAW, MI 49079
VERNE R TRUSTEE LA DIEKEMA	34598 CR 655	PAW PAW, MI 49079
Watervliet Charter Township	4959 M 140	WATERVLIET, MI 49098
WESLEY D VANNIMAN TRUSTEE	22621 64TH AVE	MATTAWAN, MI 49071
WHITE CREEK CAMP LLC	8685 AMMERMAN DR	COMSTOCK PARK, MI 49321
WILDERNESS HABITAT FOUNDATION	4873 E Y AVE	VICKSBURG, MI 49097
William C. McCormick Trust	5782 RIVERSIDE RD	COLOMA, MI 49038
WILLIAM H WOODMAN TRUSTEE	62467 M 51 HWY	PAW PAW, MI 49079
WINDY PINES DEVELOPMENT LLC	46554 BROADWAY	BLOOMINGDALE, MI 49026

Appendix 14. Project Fact Sheets for Grant Funded Implementation Projects – re: pollutant loading reductions

Michigan's Nonpoint Source Program

Federal Clean Water Act Section 319 Grant
2009-0061

Van Buren Conservation District
Telephone: (269) 657-4030
Fax: (269) 657-4925
Email: erin.fuller@mi.nacdnet.net

Paw Paw & Black Rivers Wetland Protection and Restoration

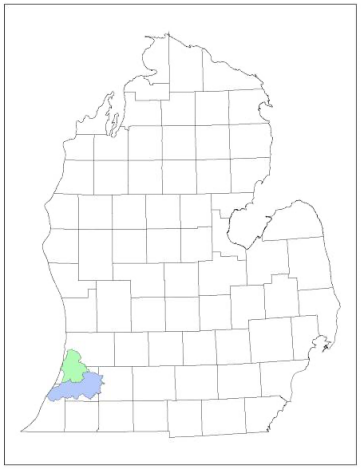
October 2009 through April 2013

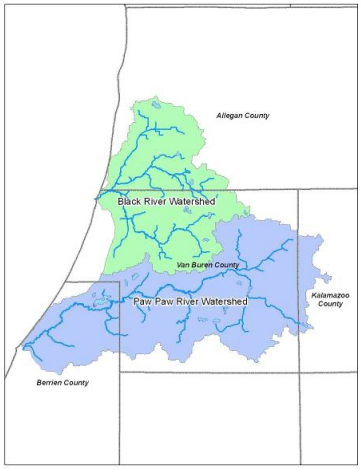
This project builds off watershed management plans for the Paw Paw and Black River Watersheds, in which wetland protection and restoration was identified as key pieces in improving water quality in our watersheds. The project had three main focus areas:

- Wetland Protection: Grant funds and local match were used to permanently protect 874 acres (418.6 of which are existing wetlands).
- Wetland Restoration: 6.4 acres of land that had been drained in the past were restored to wetland conditions with grant funds. Project partners restored an additional 63 acres of wetland.
- Outreach & Education: Brochures, letters and other outreach materials were developed and distributed to educate landowners and municipalities about the importance of preserving and restoring wetlands. A variety of workshops and field days were also held.

Grant Amount: $698,917.15
Match Funds: $723,654.05

Total Amount: $1,422,571.20





Best Management Practices:

- Conservation easements on 5 separate properties
- 874 acres permanently protected (418.6 of which are wetlands)
- 69.4 acres restored to wetland

Annual Load Reduction/Prevention:

- Total suspended solids: 120,512 pounds/year
- Phosphorus: 138.3 pounds/year
- Nitrogen: 2,234.2 pounds/year

I&E Activities:

- Mailed letters/brochures to top 300 wetland landowners
- Held 8 workshops for landowners and municipal officials
- Held 20+ meetings with municipal officials
- Created a GIS-based wetland prioritization model
- Developed educational video clips
- Installed educational signage

Partners involved:

- Southwest Michigan Land Conservancy
- Two Rivers Coalition
- Van Buren County Drain Commissioner
- Van Buren Co. Road Commission
- Landowners
- Ducks Unlimited
- US Fish & Wildlife Service
- Sarett Nature Center
- Harbor Shores
- Revolution Designs
- Southwest Michigan Planning Commission
- And more!

April 2013

Michigan's Nonpoint Source Program

Federal Clean Water Act
Section 319/CMINPS Grant
#2012-0033

"A Village to Discover"

Village of Paw Paw
Telephone: 269-657-3148
Fax: 269-657-7544
Email: l.nielsen@pawpaw.net

Improving Water Quality in the South Branch Watershed

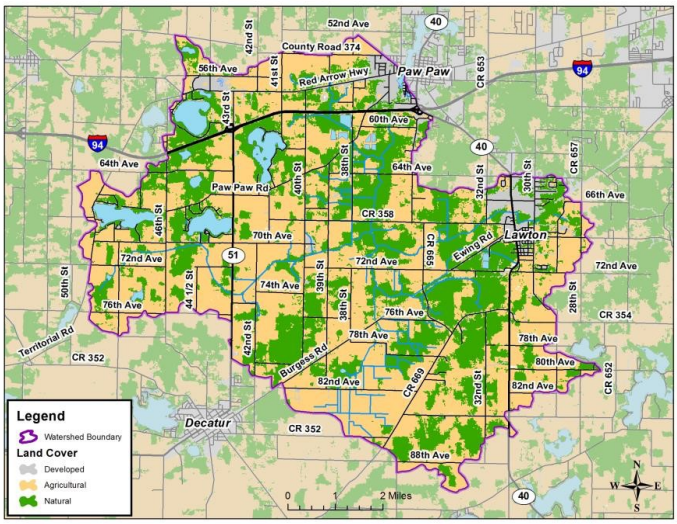
October 1, 2013 – September 30, 2016

This innovative project is in the headwaters of the Paw Paw River Watershed in Van Buren County. The South Branch Watershed contains 37,500 acres, with 64% of that in agricultural use. South Branch and Eagle Lake Drains are listed in the Integrated Report as impaired by sediment and nutrients from bank erosion and agricultural runoff. Traditional Farm Bill programs, a drain assessment reduction program and a special pilot payment program (financed by the Village of Paw Paw) were offered to farmers to incentivize the adoption of management practices that reduced polluted runoff. Practices included cover crops, no-till and wetland restoration.

Social monitoring was conducted to understand the opportunities and challenges with farmers adopting new management practices. The Van Buren Conservation District implemented an education campaign along with one-on-one assistance to farmers to encourage adoption of agricultural best management practices.

Grant Amount: $278,400
Match Funds: $163,000

Total Amount: $441,400



Best Management Practices:

- 2,422 acres of cover crops
- 690 acres converted to no-till
- 382 acres converted to reduced till
- 22.2 acres of wetland restoration
- 22-acre conservation easement
- 11 Crop-A-Systs
- 1 MAEAP verification completed/5 started

Annual Load Reductions:

- 570 tons of sediment
- 668 pounds of phosphorus
- 1,383 pounds of nitrogen

I&E Activities:

- One-on-One Technical Assistance
- Field Days
- Mailings
- Press Releases
- Brochures
- Newsletters

Partners involved:

- Maple Lake Association
- Southwest Michigan Planning Commission
- Two Rivers Coalition
- Van Buren Conservation District
- Van Buren County Drain Office
- Van Buren County Farm Bureau

September 30, 2016

Michigan's Nonpoint Source Program

Federal Clean Water Act Section 319/CMINPS Grant
2015-0040

Southwest Michigan Land Conservancy
Telephone: (269) 324-1600
Email: cmdargitz@swmlc.org

Paw Paw Priority Wetland Riparian Conservation

August 1, 2015 through December 31, 2018

The Paw Paw River Watershed, located in southwest Michigan, is part of the greater St. Joseph River Watershed and includes a combination of natural, agricultural, and urban land uses. To protect high quality natural areas and help restore areas of Ox Creek impaired by sediment and flow regime alterations this project built on strategic partnerships targeting limited resources. The project had four main focus areas, including permanently protecting 582 acres and 7 miles of stream frontage, implementing a rain garden in a highly urbanized area, developing a technical update to the Paw Paw River Watershed Management Plan highlighting green infrastructure priorities in the Orchards Mall area of Ox Creek, and providing education and outreach materials about wetland restoration/preservation and agricultural best management practices to landowners.

Grant Amount: $600,000.00
Match Funds: $798,000.00

Total Amount: $1,398,000.00

Best Management Practices:

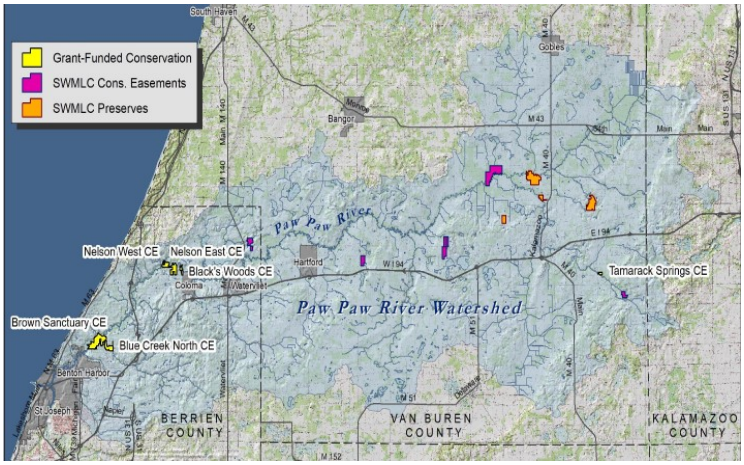
- Conservation easements on 6 separate properties permanently protecting 7.2 linear miles of frontage on the Paw Paw River and it's tributaries, 334 acres of wetland, and 582 total acres.
- One rain garden treating over 4,000 cubic feet of urban runoff.

Annual Load Reduction/Prevention:

- Sediment: 60 tons
- Phosphorus: 222.8 lbs
- Nitrogen: 1,806.1 lbs

I&E Activities:

- Mailed letters/brochures to priority agricultural landowner/producers
- Held 3 field days/workshops for agricultural landowners
- Developed presentation display board highlighting target areas and best management practices
- Held follow-up visits with over 35 land owners, securing 3 MAEAP verifications



Partners involved:

- Southwest Michigan Land Conservancy
- Two Rivers Coalition
- Berrien Conservation District
- Private Landowners
- Wightman Associates
- Sarett Nature Center
- Southwest Michigan Planning Commission
- And more!

Appendix 15. Ox Creek Technical Update and Ox Creek Watershed Management Plan

Ox Creek Technical Update

Ox Creek Watershed Management Plan

Appendix 16. Agricultural Inventory Quality Assurance Project Plan

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Paw Paw and Black River Watersheds Agricultural Inventory Quality Assurance Project Plan

Paw Paw and Black River
Watershed Management Plan Updates
Tracking Number: #2017-0105

Southwest Michigan Planning Commission
May 6, 2019

Signatures/Approvals:

Prepared By: Nancy Carpenter Date: 5/10/19
Nancy Carpenter, Berrien Conservation District

Prepared By: Marcy Hamilton Date: 5/10/19
Marcy Hamilton, Southwest Michigan Planning Commission

For the Grantee: _____ Date: 5/13/19
K. John Egelhaaf, Southwest Michigan Planning Commission

Reviewed By: _____ Date: _____
Alyssa Riley, Ph.D., Monitoring Coordinator, EGLE

For the State: _____ Date: _____
Robert Day, Unit Supervisor, EGLE

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This project was funded in part by the United States Environmental Protection Agency (USEPA) under assistance agreement OOE24910 to the Michigan Department of Environment, Great Lakes and Energy (EGLE). The contents of this document do not necessarily reflect the views and policies of the USEPA, nor does the USEPA endorse trade names or recommend the use of commercial products mentioned in this document.

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I. Project Description and Summary

With support from the Michigan Department of Environment, Great Lakes, and Energy (EGLE), the Southwest Michigan Planning Commission (SWMPC) will conduct an inventory of targeted subwatersheds in the Paw Paw River (040500012509), and Black River (04050002) Watersheds located in Allegan, Berrien and Van Buren Counties, Michigan.

The **Black River Watershed** (BRW) is located in Allegan and Van Buren Counties with three main branches converging and flowing into Lake Michigan at South Haven. The watershed encompasses approximately 183,680 acres and is primarily agricultural with roughly 57.4% of the land cover being agricultural, 32.9% forested upland, 6.7% wetland, 1.5% water and 1.2% developed. The **Paw Paw River** flows westward through Kalamazoo, Van Buren, and Berrien Counties before joining the St. Joseph River and emptying into Lake Michigan at Benton Harbor. The Paw Paw River Watershed (PPRW) encompasses approximately 285,000 acres and with 7% urban, 47% agriculture and 45% natural (14% wetlands, 30% uplands and1% water).

Staff from the Berrien County Conservation District (BCCD), Southwest Michigan Planning Commission and the Van Buren Conservation District (VBCD) along with volunteers from Two Rivers Coalition (TRC) will complete windshield surveys in targeted sub watersheds to document tillage practices, crops planted, crop residue, and existing best management practices on cropland. In addition to documenting cropland practices, staff and volunteers will also make observations of animal feeding operations (AFOs), noting if site conditions are such that polluted runoff could be impacting surface waters. All observations will be made from accessible roadways while driving the watershed. All fields and sites visible from roadways will be included in the survey.

This inventory will be done as part of the Paw Paw River and Black River Watershed Management Plan Update Project (#2017- 0105) to identify agriculture-based causes and sources of nonpoint source pollution. Information collected during the survey will assist in updating the nine-element approved watershed management plans for the Black and Paw Paw River Watersheds.

II. Study Objectives

The purpose of this study is to obtain an understanding of general management practices used in the watersheds, 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.

Results and recommendations stemming from the collected data will be used to assist in the updates of the nine-element approved watershed management plans, including:

- Identification of critical areas and prioritization of sites for future outreach and best management practice implementation efforts.

- Recommendations for best management practices to address specific sources of pollutants.
- Loading calculations and targets for future pollutant reductions.

12 III. Study Design

The basis for this inventory process was originally developed by EGLE's Nonpoint Source Program. Prior to the start of the inventory, several initial steps were completed to prepare the SWMPC and partners for field data collection. The SWMPC will use the tools to collect information during windshield surveys in portions of the Paw Paw and Black River Watersheds.

12.1 Preparatory Steps: Desktop Analysis and Map Production

Aerial photographs of four 12-digit HUC sub watersheds targeted in the Paw Paw and Black River Watersheds will be examined and maps created outlining all individual crop fields as well as animal feeding operations within those sub watersheds. This task will be completed by BCCD staff with the assistance of SWMPC.

Sub watersheds of interest will be overlaid with the HUC 12 sub watershed boundary to clearly delineate the area included in the inventory. Using best professional judgement, every individual field visible from aerial photographs will be identified within the sub watershed and field boundaries will be digitized in a geographic information system (GIS). Aerial photographs with high (0.3 meters) resolution will be used to get the best level of detail for each site.

Data layers for surface water bodies, areas where concentration animal feeding operation (CAFO) manure could potentially be applied, and the local road network system will be added to the GIS. These additional data layers provide information that can help further refine what fields are high priorities based on their potential to contribute nonpoint source pollutants to surface waters. Orienting the printed sub watershed map during windshield surveys is made much easier with inclusion of the road network as well.

Fields bordering a surface water body, without buffers, and those that potentially have CAFO manure applied are of particular interest. These fields could be high priority areas to promote best management practices because field conditions are such that nonpoint source pollutants have a high potential to reach surface waters unabated during runoff events.

While identifying field boundaries, an AFO identification guidance document **(Appendix A)** will be used to help identify potential· AFOs sites. The AFO aerial review inventory will be conducted for the entire Paw Paw and Black River Watersheds. These AFO sites will be marked and included in the GIS in a separate data layer. AFOs identified as having potential runoff issues will be designated for follow-up visits during windshield surveys.

Final printed maps of the sub watersheds will be created for use during the windshield survey. These maps will note the sub watershed boundary, individual field numbers, field boundaries, surface waters, road network, and AFOs identified for further follow up.

12.2 Target Areas

The two targeted sub watersheds in the Paw Paw River Watershed for this inventory include the South Branch (HUC040500012507),and Mill Creek (HUC 040500012506). These sub watersheds were selected as targeted sub watersheds because all have land uses dominated by agriculture and are suspected to contain a majority of the agricultural related pollutant sources impairing or threatening water quality in the PPRW. (see Figure 1 below for a map of the watershed and the targeted sub watersheds highlighted.) Based on the 303(d) list in the 2016 Integrated Report, Mill Creek is listed as impaired for Partial and Total Body Contact Recreation. South Branch is also impaired for Partial and Total Body Contact Recreation, as well as impaired for Cold Water Fisheries and Other Indigenous Aquatic Life and Wildlife. Data collected during this inventory could help identify potential sources and causes of these impairments. Based on the success of this inventory, future efforts could replicate this process in other sub watersheds to provide a more complete understanding of agricultural practices used throughout the entire watershed.

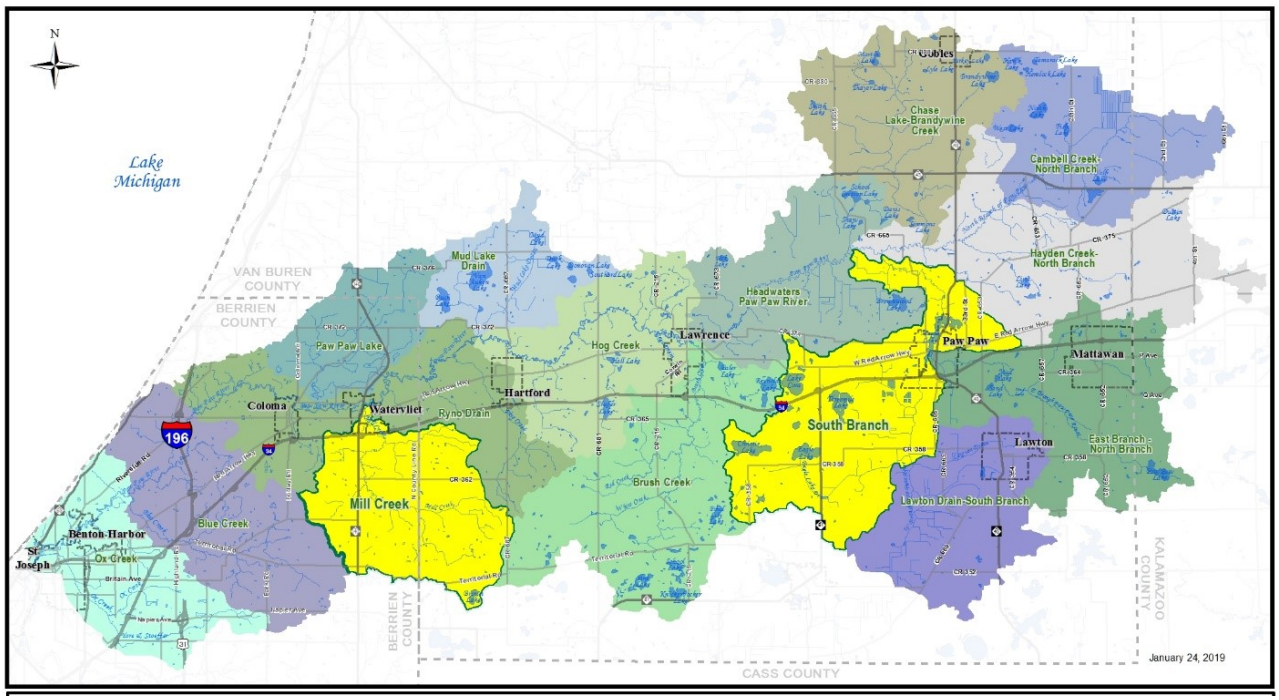

Figure 1: Paw Paw River Watershed. Subwatersheds targeted in this agricultural inventory are shaded in yellow.

The two targeted sub watersheds in the Black River Watershed for this inventory include the North Branch (HUC 040500020202), and the Great Bear Lake Drain (HUC 040500020206). These sub watersheds were selected as targeted sub watersheds because all have land uses dominated by agriculture and are suspected to contain significant agricultural related pollutant sources impairing or threatening water quality in the BRW. (see Figure 2 below for a map of the watershed and the targeted sub watersheds highlighted.) Based on the 303(d) list in the 2016 Integrated Report, North Branch is not listed as impaired. Great Bear Lake Drain is listed as impaired for Other Indigenous Aquatic Life and Wildlife.

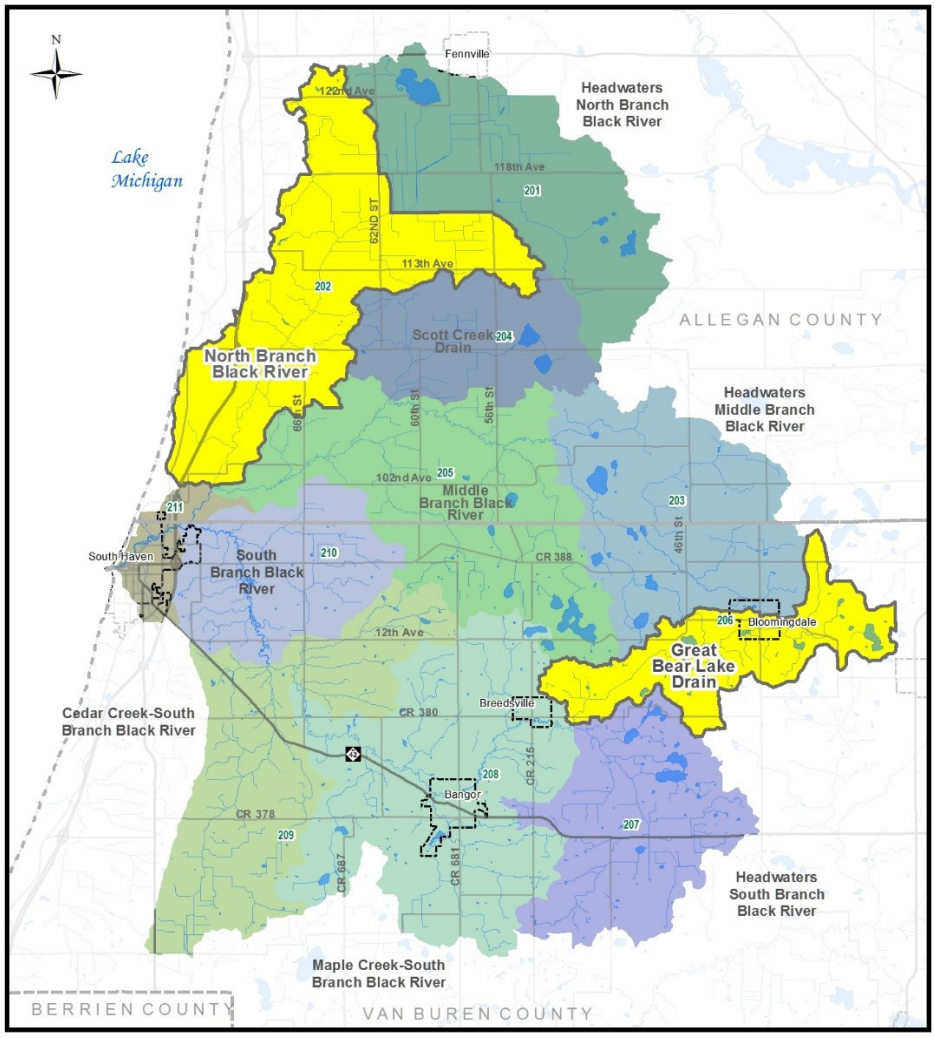

Figure 2. Black River Watershed (targeted sub watersheds are highlighted in yellow).

This agricultural tillage inventory will be focused on these four targeted sub watersheds, and AFO identification portion will be completed for the entire Paw Paw River and Black River Watersheds. The AFO identification portion is much less time consuming and the timeframe when data can be collected is much longer compared to the tillage and

residue portions of the inventory. This will allow staff and volunteers enough time to complete the AFO portion.

12.3 Data Collection

Berrien County Conservation District, Southwest Michigan Planning Commission and Van Buren Conservation District staff along with volunteers from Two Rivers Coalition will be responsible for conducting windshield surveys and collecting necessary data. Staff from these groups have attended a training presentation by EGLE (both classroom and in-field) to learn in detail the purpose of the inventory, what data will be collected, and the proper methods and procedures for collecting data. In combination with BCCD and VBCD staff's solid foundation and understanding of agriculture, including knowledge of different crops and practices commonly used in the region, the expertise gained through this training will ensure the staff can successfully complete the inventory, and if needed, train new staff in this process. BCCD, SWMPC, VBCD, and TRC will be equipped to make all necessary observations and collect all necessary data.

All data will be collected while driving the watershed during windshield surveys and recorded on field data sheets (see **Appendices B and C** for example data sheets used during desktop analysis and windshield surveys). Observations will be made from vehicles traveling on accessible roadways. Maps will be made available for staff before inventories begin, helping to self-orient during windshield surveys.

Windshield surveys will be completed by crews of two to four individuals. A crew of three to four crew members is recommended to capture data in the most efficient and effective manner. One crew member will be responsible for driving during the windshield survey. In order to collect the most accurate data possible, the driver may need to drive at a slow pace and/or make temporary stops on road shoulders, so observations of field conditions can be made. The driver will maintain acute awareness of their surroundings while driving to maintain the safety of all crew members conducting the windshield survey and all others on the road. Because crew members will at times be driving at slower than typical speeds or may need to pull *off* onto the road shoulder, being extremely vigilant of the surrounding terrain and traffic is extremely important during the survey. Using hazard lights when driving at slow speeds or when making frequent stops is encouraged.

A second crew member, the field observer, will be responsible for two major tasks; 1) using the map provided to navigate and determine what field is being observed at any time and 2) making observations of field conditions and communicating these observations to the data recorder. Because this is the most demanding task, it may be beneficial to have two field observers. Fields on both side of a two-lane road can be captured this way, making the survey faster and more efficient.

Another crew member, the data recorder, will be responsible for recording observations made by the field observer(s), onto field data sheets.

12.4 Windshield Surveys

Four separate windshield surveys will be completed to collect data representative of two agricultural years (fall tillage and spring residue).

A fall tillage survey will be completed to collect information from croplands, specifically the crop that was last planted, the type of tillage used after harvest of that crop, planting of a winter crop, and the presence or absence of any existing cover crops, filter strips, grassed waterways, or tile risers.

Based on the crop residue remaining on fields, the previous planted crop will be documented in the appropriate column on the data sheet. Categories include corn, corn silage, soybean, wheat, and hay. Should other crops be present, they will be noted and a new category added to the data sheet key. If a fall crop has been planted, (most typically wheat) this will also be noted. A column is also included in the datasheet to record the presence or absence of cover crops. The timing of harvest (early normal, late), planting (early, normal, late), general soil condition (wet, average, dry), and the beginning and end dates of each survey will also be documented. Other observations will be recorded in the "comments" column of the data sheet.

The different categories of tillage practices expected include plowed, chisel plowed, mulch tilled (including vertical till, disc till and field cultivator till), planted, wheat (planted to wheat with no-till planting method), no tillage done, and strip till.

When conducting windshield surveys, crew members may find that data cannot be collected from every field; some fields may not be visible from roadways or may have been missed during the survey. Several categories exist to document such fields, including fields that are "skipped" (because they were not visible), “pasture", developed (fields that have been converted to residential or commercial use), or “not a field”. If the crop cannot be identified by the reside remaining on the field at the time of the inventory, it can be labeled as “unknown”.

A spring residue survey will also be completed to collect data on the planted crop and the percentage of crop residue remaining on fields after planting.
Based on Natural Resources Conservation Service (NRCS) guidance, at least 30 percent crop residue is needed on cropland fields in order to reduce erosion to tolerate soil loss levels for crop production. Crop residue left on fields after harvest not only is beneficial for reducing soil loss, but also protects water quality. Residue helps hold soil in place, especially during snow melt and spring rain events, preventing sediment and nutrient loss that would occur if soil was left bare and exposed. This guidance was used to create categories for observed crop residue remaining on fields: zero percent residue, less than 30 percent residue, greater than 30 percent residue, planted with a no-till method, and not planted yet (if the field has not been planted at the time of the inventory). Data collectors will use best professional judgement during windshield surveys to make accurate observations regarding percent residue on cropland fields.

The presence of manure application and field tiles should be noted in the "Notes" column should they be observed. Photographs documenting residue percentage on fields can be found at the following NRCS reference document https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_042684.pdf While these photographs were taken while standing on fields, it provides general guidance on the amount of residue that falls under each category included in this inventory.

12.5 AFO Evaluation

Aerial photographs will be reviewed to identify AFOs that have the potential to contribute nonpoint source pollutants to surface waters in the Paw Paw and Black River Watersheds. These sites will be added to the GIS as a separate data layer and included on the printed map staff and volunteers will use during windshield surveys. Staff will include these sites in the windshield survey and evaluate them for potential nonpoint source issues that cannot easily be confirmed through aerial photography review. Additional observations, including potential number and type of livestock, will be documented in the AFO Field Data Sheet (See Appendix B)

12.6 Timing of Windshield Surveys

The time period that tillage and residue data can be collected via windshield survey is limited and is highly dependent on weather; the amount of precipitation received, and field visibility (snow cover, vegetation cover). Because these factors can vary on a year-to-year basis, so does the precise time frame when windshield surveys should be conducted. A description of the general time frame and conditions required for data collection is listed below for each survey type.

Fall Tillage Survey

Fall tillage information can be collected at two distinct times; either in late fall or early spring. If collecting information in late fall, the timing of the windshield survey will occur after most fall tillage has been completed, but before snow accumulation obscures visibility of field conditions. In a typical year, the best time to collect this data is late November to early December. However, if the amount of precipitation received in the fall is relatively high, landowners may be forced to wait to conduct fall tillage until field conditions improve, pushing the timing of a tillage survey into the next year.

If an early spring timeframe is selected for the fall tillage data collection, the timing of the windshield survey will occur after snow cover has melted away, but before any spring tillage has occurred (typically late March to early April). If spring tillage has already occurred, it is not possible to collect information reflecting the tillage practices used the previous fall.

Spring Residue Survey

Windshield surveys to collect spring residue data will be conducted after that season's crops have been planted, but before crops have grown enough to obstruct the view of crop residue remaining on fields. In a typical year, the general time frame spring residue data can be collected is late May to early June. The timing of crop planting will depend on temperature and precipitation received, which could push this time window earlier or later. If temperatures rise earlier in the year, the timing of planting could also be

accelerated. Particularly wet conditions could push the time window for planting back further.

12.7 Iterations

By collecting two fall tillage surveys and two spring residue surveys, a robust data set representative of two full calendar years can be used to analyze and make recommendations providing a more accurate understanding of the management practices used in the watershed.

12.8 Timetable

Fall Tillage Survey Data Collection Time Frame: After crops have been harvested and most fall tillage has been completed, but before snow obscures view of tillage.

Spring Residue Survey Data Collection Time Frame: After crops are planted, but before vegetation grows to the extent where you can no longer see field residue.

The following is the anticipated timetable for the windshield surveys.

Task	Timeframe	Staff (lead)
Digitize fields	Spring 2019	BCCD
Fall Tillage Survey	Spring 2019	BCCD
Spring Residue Survey	June – July 2019	BCCD
Fall Tillage Survey	Fall 2019/Spring 2020	BCCD
Spring Residue Survey	June 2020	BCCD

12.9 Data Gaps

It is possible that data collection will not be possible for all fields and sites. Fields may be too far from roadways to been seen clearly, new development may have altered the land use on sites, or fields could be taken out of production completely. The field data sheet key notes how these fields will be documented. During data analysis, the number of fields skipped or where data could not be collected will be used, so it is important that these fields are correctly categorized.

13 IV. Field Procedures and Trainings

EGLE provided staff with a training presentation detailing the inventory process. This presentation entailed detailed descriptions of what data will be collected during each survey, the appropriate timing of each survey, how to transfer observations made during windshield surveys to the field data sheet, and an overview of how the data will be compiled and analyzed to develop recommendations for future implementation efforts. In addition, EGLE staff will accompany BCCD/VBCD/TRC during the first iteration of the fall tillage and spring residue inventories to ensure observations made by BCCD/VBCD/TRC are representative of the parameters detailed in the training presentations.

14 V. Quality Control Procedures

To ensure that observations made during windshield surveys are both precise and accurate, staff and volunteers will take photographs of different field conditions observed during the first fall tillage and spring residue surveys. Photographs will clearly depict crops, tillage practices, and the amount of residue on the fields selected for photo-certification. The field number in each photograph will be noted and a completed data sheet shared so that observations made by data collectors can be reviewed and confirmed by EGLE or Van Buren Conservation District staff. After review, if recorded observations do not look to be representative of field conditions seen in photographs, EGLE or VBCD staff will accompany on the next windshield survey and provide in-the-field instruction to provide better guidance for collecting data.

BCCD staff will review all data sheets after completion of each survey to ensure all fields and sites are accounted for during the windshield survey. If any inconsistencies are found, the field number and observation will be highlighted. Aerial photographs of the fields in questions will be reviewed to see if issues can be rectified. Data will be shared with EGLE staff for review as well. EGLE staff will meet with BBCD/VBCD/TRC staff to discuss any inconsistencies or other questions as an additional data quality check.

14.1 Data Analysis and Interpretations

Data analysis will begin once data has been transferred from physical field data sheets to an excel spreadsheet. After data is transferred from physical data sheets to the excel spreadsheet, crew members will perform quality control to ensure the data transfer is complete and accurate. The crew member that transferred the data to the spreadsheet will provide the populated excel spreadsheet to a different crew member who will do a random check of 10% of the entries to ensure data was copied correctly. This spreadsheet will then be imported into the GIS and joined to the field boundary shapefile so that information can be queried and spatially described.

Sites will be highlighted as a priority based on several factors, including the tillage practice, percentage of crop residue, and proximity to surface water bodies. "Priority" areas are those that have a high likelihood of contributing nonpoint source pollutants to surface waters during runoff events based on the field conditions present and its proximity to surface water bodies. More intensive fall tillage practices reduce the amount of crop residue on field surfaces during the winter and early spring. This reduction in crop residue increases the potential for soil erosion, and the delivery of sediment and nutrients to surface waters during storm events and snow melt events. Plowing is the most intensive tillage practice followed by chisel plowing. Depending on the crop that was planted on a field previously, little to no residue could be left after these tillage practices are implemented, especially if the vegetation of the observed previous crop is not very hearty (e.g., soybeans). Less intensive practices such as mulch till, strip till, planting a winter wheat crop or no tillage at all, result in more crop residue left on the field and less nutrients reaching surface waters.

Depending on the crop that was planted, even sites where less intensive tillage practices were used, could still have little to no residue left. Fields that were observed to have zero or less than 30 percent residue during spring residue surveys, that are in

proximity of a surface water body, and that have no buffer between fields and surface water bodies will be a priority for future best management practice implementation efforts due to the increased likelihood that runoff events could transfer sediment and nutrients unabated to surface waters. Similarly, AFOs falling into the "high priority" category outlined in **Appendix A** will be highlighted for future best management practice implementation efforts. Maps depicting priority sites will be produced with a brief summary explaining the analysis that was completed.

15 VI. Data Reporting

Data will be collected during windshield surveys by BCCD, SWMPC and VBCD staff and TRC volunteers with experience and knowledge of agricultural crops and practices. Information will be recorded on hard copies of field data sheets and then transferred into an excel spreadsheet. Staff will then import data included in the data sheet to the geographic information system environment.

Data collected will be analyzed and maps with priority areas for future implementation efforts and outreach will be created and included in the Watershed Management Plan Updates. A brief summary of the analysis completed will be included in the plan updates as well.

16 Appendices

16.1 Appendix A Animal Feeding Operations Guidance/Methodology
Animal Feeding Operations Inventory

Purpose
Animal feeding operations (AFOs) are potentially significant contributors of nonpoint source (NPS) pollutants. This paper outlines an approach for cataloging, evaluating, and prioritizing AFOs within a Geographic Information System (GIS), for inclusion in a nine-element watershed management plan. This paper only looks at the AFO itself and not at the land application of manure.

The primary objective of an AFO inventory is to establish a prioritized list of locations, which stakeholders can use to systematically contact landowners about the incorporation of best management practices (BMPs) within their operation. The incorporation and systematic response to specific information within a watershed management plan allows stakeholders to develop implementation proposals that are more competitive.

Recommended Data Layers
The evaluation of AFOs within a watershed should always begin with a desktop analysis. The compilation of the following data layers is recommended when identifying AFOs within the planning area:

- Subwatershed Boundaries - the United State Geologic Survey (USGS) has created a nested set of watersheds for the entire country known as the hydrologic unit codes (HUCs). The twelve digits HUCs are the smallest unit in this cataloging system and are referred to as a subwatershed. Subwatersheds typically range in size from 10,000 to 40,000 acres. The location of AFOs should be compiled at the subwatershed level.
- Aerial Photographs - High resolution imagery (<1 ft. resolution) is critical in identifying and preliminarily evaluating the condition of an AFO. ArcMap provides good medium and high resolution aerial photographs. Aerial photographs are accessed within ArcMap in the following location: file>add data> add base maps. Medium resolution aerial photographs are activated at scales from 1:54,000 to 1:3,001 and are good for initial identification of AFOs. High resolution aerial images are activated at a 1:3,000 scale or less, and provide for a detailed evaluation of the site.
  High resolution photographs can also be obtained using the SIGGIS street view and birds eye add in tool bar. This tool provides high resolution aerial and bird's eye view photographs by simply clicking on the desired location in the ArcMap environment. A pop-up box with the image will appear. This tool should be used in tandem with the previously mentioned images, because point locations cannot be added onto the images derived from the SIGGIS tool. The tool provides the same images, with the advantage of a faster loading rate than ArcMap. The SIGGIS add in tool can be downloaded from the following location:
  http://www.arcgis.com/home/item.html?id=cb1bd2804d0f42d2b903952c2d781170
  Information on how to create a shapefile in ArcMap for the identified AFOs is explained in Appendix D.
- Confined Animal Feed Operations (CAFOs) – Facilities that house a large number of animals or are found to be a significant contributor of pollutants are required to obtain a National Pollution Discharge Elimination System (NPDES) permit from Michigan's Department of EGLE. The number of animals needed to qualify as a large operation depends on the type of animal housed at the facility, see Appendix A. Locational information is required as part of the permit, therefore all CAFOs within the

subwatershed can and should be mapped. CAFOs locations can be obtained using EGLE's MiWaters Site Map Explorer at: https://miwaters.deq.state.mi.us/nsite/. Click on the filter tab and select "Concentrated Animal Feeding Operation" under "Site Type". Then zoom in to the area of interest. Pink dots indicate CAFO locations. If there is a number in the pink dot this indicates more than one CAFO is located in this area. Zoom in further to get the exact location of the CAFOs.

- Waterbodies - An important step in this process is to identify what sites are in proximity to waterbodies. It is important to consider the potential impacts these facilities have on the different type of aquatic systems within a watershed. Shapefiles identifying the rivers, wetlands and lakes within the planning area should be incorporated into this process. Proximity to waterbodies should be included as part of the AFOs spatial datasets attribute table.
- Road Network - The road network within the planning area is needed. Maps with the location of the AFOs are printed and used to navigate the subwatershed during the windshield survey.
- Public Land Survey (Sections) - Using a grid overlay is optional, but recommended as it provides a way of systematically moving through a subwatershed. This is particularly important if the identification of AFOs can't be completed in one session. Sections are approximately 640 acres and are recommended as the grid overlay but, other grids systems can certainly be used.
- Topographic Data- elevation data of all AFOs should be evaluated, with particular attention paid to facilities in proximity to waterbodies. Contours or digital elevation models (DEMs) can be used. It is important to understand the direction water is likely flowing when runoff occurs on the site and how that runoff maybe impacting water quality.

Indicators of Animal Operations

AFOs can be easily identified using aerial photographs. The following section discusses some of the distinguishing characteristics that help to identify an AFO. These characteristics are interrelated and should be used as in conjunction with each other when evaluating if an operation is an AFO.

Manure Storage Structures

Animals produce waste and larger AFOs collect animal waste in manure storage structures. Manure storage structures are typically square or rectangular in shape (Figure 1), although older structures can be circular and elevated (Figure 2).

Manure storage structures typically appear to be holding a dark or turbid fluid but sometime may appear empty. Although manure storage structures are a very distinct feature, some AFOs have manure storage beneath the structures that house the animals. Similarly, smaller AFOs will not have manure storage structures, but will have areas where the manure is piled. Therefore, this feature may not be present on all AFOs.

Figure 1. A typical small manure storage structure

Figure 2. An older empty circular manure storage structure

Building Types

AFOs are typically long linear white buildings of varying sizes, depending on the number of animals they are housing. Figure 3 shows a larger AFO. It is also important to consider the kind of animal that may be present. The presence of the ring in Figure 4 indicates that horses are likely kept at this facility.

Figure 3. Larger operation with typical white structures of an AFO.

Figure 4. A small horse facility with a discernable exercise ring.

Feedlots/Bare Earth Areas

The presence of animals can result in the loss of ground vegetation. Patches of bare earth are a characteristic of AFOs (Figures 5 and 6).

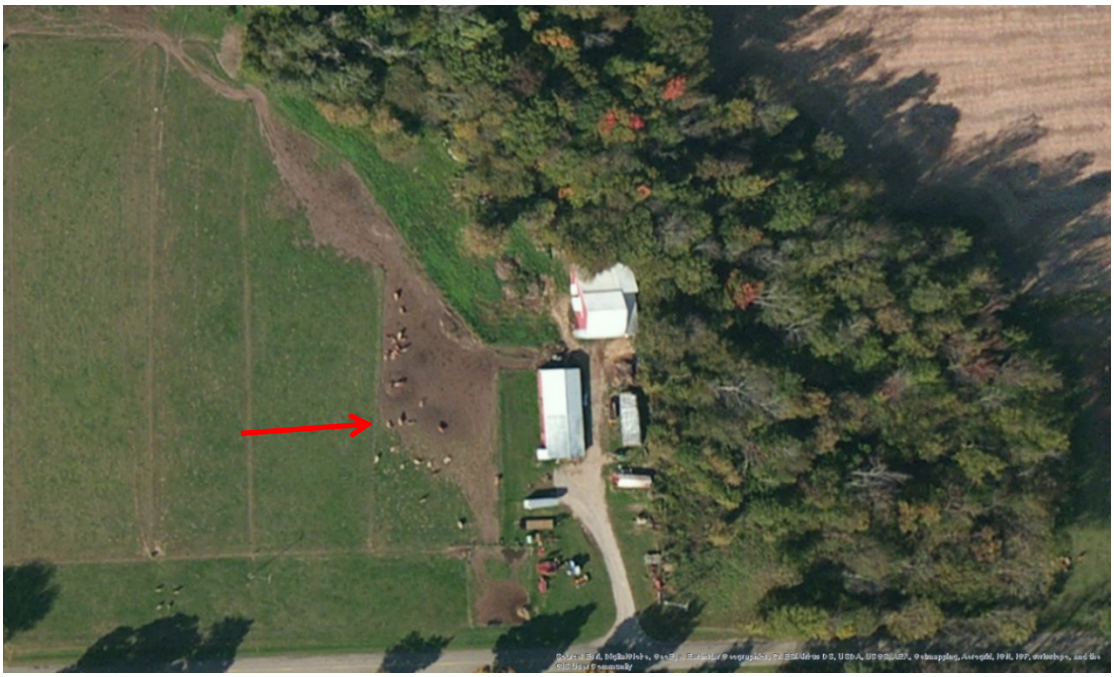

Figure 5. Patches of bare earth.

Figure 6. Patches of bare earth area associated with AFO.

Feed Storage

There are three characteristic feed storage structures found on AFOs: bagged silage, silos, and silage bunkers. Bagged silage are typically long white tube like structures but can also be rectangular in shape (Figure 7). Silos are the classic tall cylindrical structures associated with agricultural operations (Figure 7).

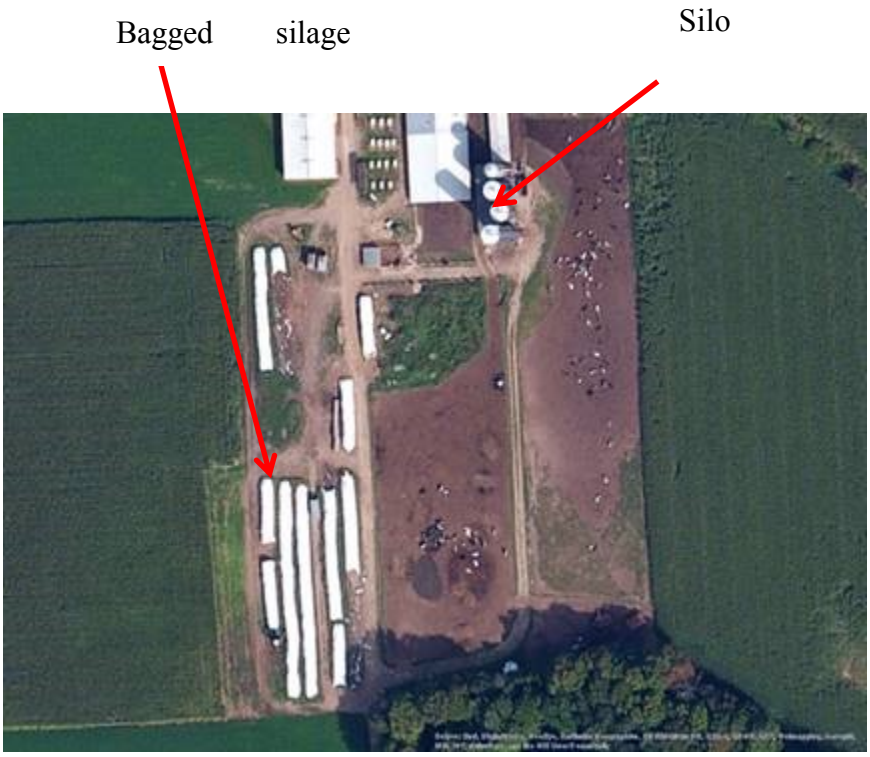

Figure 7. Typical form of bagged silage bales and silos on an AFO.

Silage Bunker

Figure 8. Example of the foil like appearance of a silage bunker.

Depending on the angle of the sun, the surface of a silage bunker can take on a tin foil like appearance (Figure 8). Another way of distinguishing silage bunkers are a series of circles, which are car tires piled on top to help keep the material covering the feed in place (Figure 17).

Feeder Stations

Feed for animals are often placed in feeder stations. Figure 9 shows several feeder stations out in a feedlot. An indicator typically associated with feeder stations is patches of bare earth. In a pasture setting, feeder stations are often moved around, and the bare earth areas have a distinct circular and/or rectangular pattern (Figure 10).

Figure 9. Feeder stations in feedlot

Figure 10. Feeder station outlines in pasture

Identification of Potential Sources of NPS Pollutants within AFOs

While reviewing aerial photographs for evidence of potential animal feeding operations you can also begin to identify sources of nonpoint source pollutants that have the potential to impact water quality. The items listed below should be considered when attempting to locate sources of nonpoint source pollutants at animal feeding operations:

- Proximity to water body
  - The closer a potential source is to a water body, the likelihood of it impacting water quality usually increases. The areas adjacent to water bodies and the connected upland area should be reviewed with an especially close eye.
  - Are there areas of bare, disturbed soil along surface waters? Does the stream channel become overly wide relative to other areas upstream and downstream at these sites? These could be areas where animals have direct access to surface water (It's possible some aerials might even show animals accessing the stream at the time the picture was taken).
  - Look for signs of fencing or other barriers that would indicate animals are not allowed direct access to streams.

Figure 11: Arrows indicate areas of bare soil where animals may have access to the stream. Banks appear disturbed.

- Review the features that indicate the site is an animal feeding operation. Look for any obvious drainage pathways near feed lots, pasture areas, silos, bunkers, or other impervious surfaces to surface water.

Figure 12: Arrows indicate natural drainage path from a feedlot area through a field to surface water.

Figure 13: Disturbed areas show temporary locations for animal feeding. Arrow indicates drainage flow path from feeding area, potentially transporting nutrients and pathogens to surface water.

- Manure Storage
    - Search the site for potential manure storage infrastructure, including above ground storage structures and earthen manure storage structures.
        - Above ground storage structures are often tall, circular structures (Depending on the lighting in the aerial photograph, you may be able to judge how full the structure is, which could give insight on the number of animals present). Are there any drainage pathways nearby leading to surface waters?

Figure 14: Arrow indicates above ground manure storage structure.

        - Earthen manure storage structure are lined, pond-like structures. Are they located close to surface water bodies?

Figure 15: Arrow indicates earthen manure storage structure.

- If there are no signs of storage structures, look for areas where equipment have frequented (bare soil) or other sectioned-off areas where manure piles could be kept. Piles might be visible from aerials.

- Silage Storage
  - Search the site for bunkers or silos. If these are in close proximity to water bodies or there are obvious drainage pathways leading to surface waters these could be sources.

Figure 16: Arrow indicates silos, potential sources of nutrients

Figure 17: Orange arrows indicate silage storage bunkers. Blue arrows show cows in close proximity to stream.

- Look at the site as a whole. Do buildings and equipment appear to be in good condition? Are things neat and orderly? Review the general management practices in place. If things overall look disorganized, there could be problems.

Prioritization

Using evidence collected during review of aerial photographs, sites can be prioritized based on the likelihood that water quality is being negatively impacted. The type of animal operation, the size of the operation, and the management practices being utilized at AFOs can be used to determine how severe that impact may be and what sites should be referred for further follow-up (site visit, drive by during windshield survey).

Type

Below are examples of different types of animal feeding operations including dairy, beef, poultry, swine, and hobby farms. Characteristics of each are noted, as well as the size.

- **Dairy**

Figure 18: Dairy operation

Characteristics that indicate this is a potential dairy operation include:

- Presence of a circular storage structure for liquid manure
- Silos for storing feed
- Red arrow indicates milking parlor structure with direct road access for trucks
- Top of the image shows hutches for calves
- Limited pasture area
- *Based on the size and number of structures, this operation is categorized as “Medium”

- **Beef**

Figure 19: Potential beef operation

Characteristics that indicate this is a potential beef operation include:

- No obvious milking parlor building
- No obvious liquid manure storage structures
- Larger areas for pasture
- *Based on the size of structures, this is categorized as a “Small” beef operation

- **Poultry:**

Figure 20: Poultry operation

Characteristics that indicate this is a potential poultry operation include:

- Fans lining the outside of long building with nearby dust/feather piles (see red arrow)
- Long buildings are connected to a more central building for processing. Easy road access as well (see blue arrow)
- *Based on the size and number of structures present this operation would be categorized as “Large”

- **Swine**

Figure 21: Swine operation (with visible manure storage structure)

Characteristics that indicate this is a potential swine operation include:

- Presence of circular manure storage structure (for slurry manure)
- Red arrow indicates feeders positioned at end of buildings
- Blue arrow indicates fans (without dust piles nearby)
- No on-site processing building
- Easy truck access.
- Based on the size and number of structures present this operation would be categorized as “Medium”

Example 2 below has no additional manure storage, but still has all other above characteristics.

Figure 22: Potential swine operation (without visible manure storage structure).

- **Hobby (horse, miscellaneous)**

Figure 23: Potential hobby farm (sheep)

Characteristics that indicate this is a potential hobby farm operation include:
- Pasture area
- No sizable structures for storing manure
- No sizable structures to house animals

Size

Large, medium, and small classifications are based on the numbers provided below, which are the regulatory definitions of large, medium, and small CAFOs.

- Large
- Medium
- Small

Size	**Dairy**	**Beef**
Small	60-150	30-60
Medium	151-500	61-100
Large	CAFO	>100
Poultry	Barn Size (determine from aerial imagery)	

Swine	Barn Size (determine from aerial imagery)
Hobby	specify type, estimate of number of each

Storage

- How is manure and silage being stored? Is it sufficient?

Maintenance

Orderly vs disorganized

High Priority

- Any size dairy or beef operations in close proximity to water bodies with:
  - Observable drainage pathways leading to surface waters from identified sources
  - No manure storage found, or,
  - Storage is lacking, or otherwise disorganized
- Operations with potential livestock access issues

Medium Priority

- Hobby farms with:
  - Potential access issues
  - Observable drainage pathways leading to surface waters from identified sources
- Any size or type AFO with manure storage structures near water body, but no strong evidence of water quality impacts observable via aerials.

Low Priority

- Any size or type AFO not near observable connection to water body.

AFO Field Check Methodology

Once aerial photograph identification and prioritization of animal feeding operations has been completed a field check should be perform to determine if the information gathered and conclusions made are accurate. The intent of the field check is not to do an on the ground inspection of every site but to drive by the identified sites and check the potential sources that can be observed either from the road or from within an adjacent stream. Reprioritization might be necessary based on the information gathered while performing the field check. Appendix B has an example of a field data sheet that could be used to collect the necessary data. At least two people should perform the field check. This allows one person to drive and another to make observations. However, it might be beneficial to have a third person to navigate. Prior to performing the field check the most efficient route to the sites should be identified.

Confirming Potential Sources

Proximity to water body

- Confirm the presence or absence of nearby water bodies identified on aerial photographs. If a water body has been identified adjacent to the site walk the water body to identify potential sources of pollutants and review the information from the Animal Feeding Operation (AFO) Aerial Photography Review Checklist (see Appendix B for checklist) and make changes as necessary. This includes

identifying if there is a vegetated buffer between the operation and the surface water which could help reduce pollutant impacts in a run off event. If the water has an odor, sheen, or distinct color change it is probable that there is a pollutant source nearby. Potential sources of pollutants that can be observed from the surface water include:

- Evidence of livestock access such as disturbed soil along the banks and widening of the stream. Also look for fences or other barriers that would restrict cattle access.
- Pipes directly discharging to the surface water or run off paths from the operation into the surface water.

- If there are road side ditches adjacent to the site, follow them and determine if they have a surface water connection. Review the information from the Animal Feeding Operation (AFO) Aerial Photography Review Checklist (see Appendix B for checklist) and make changes as necessary.

Type

- Determine or confirm if the operation is dairy, beef, swine, poultry, or hobby/horse.

Size

- Confirm the size of the operation. Are there new buildings that are not on the aerials?

Storage

- How are manure, and silage being stored? Is silage covered?

Maintenance and storage

- To the best of your ability from what you can see from the road document the overall cleanliness and organization of the site.
    - Note if buildings and equipment appear to be maintained.

Reprioritization

Once the field check has been completed use this additional information and determine if the sites have been prioritized correctly or if they need to be reprioritized based on the prioritization methodology.

16.2 Appendix B AFO Aerial Photography Review Checklist and AFO Field Data Sheet and Key

Animal Feeding Operation (AFO) Aerial Photography Review Checklist

Data sheet to catalog field characteristics observed during aerial imagery review. Review of aerial imagery should occur before windshield survey work begins.

Field #	Next to Waterbody?	Filter Strip Present?	Grassed Waterway Needed?	CAFO manure applied?	Tile-Riser Present?	AFO?	AFO Site Number

AFO Observations Field Data Sheet

*Fill in the first 5 columns when reviewing aerial photographs to identify AFOs; make additional comments or revise notes from desktop analysis when verifying information in the field

Watershed: **Date Collected:**

HUC #	AFO Site #	Animal Type	Manure Storage Issues Visible?	Runoff Pathways Visible?	Number of Animals	Comments
		DCow /Bcow /P / SW / H	Yes No	Yes No		
		DCow /Bcow /P / SW / H	Yes No	Yes No		
		DCow /Bcow /P / SW / H	Yes No	Yes No		

Key for AFO Field Data Sheet

KEY		
Animal Type		
Dairy cow	DCow	
Beef cow	BCow	
Poultry	P	
Swine	SW	
Hobby	H	
Number of Animals		
Dairy		
60-150		
151-500		
CAFO		
Beef		
30-60		
61-100		
>100		
Poultry	Barn Size (determine from aerial imagery)	
Swine	Barn Size (determine from aerial imagery)	
Hobby		
	specify type, estimate of number of each	
Runoff Visible?	**Pathways**	**Manure Storage Issues?**
Yes or No		Yes or No
Describe		Describe

16.3 Appendix C. Fall Tillage and Spring Residue Field Data Sheets and Key

Use the following data sheet to document fall tillage and spring residue data during windshield surveys. **Fall Tillage Survey Data Collection Time Frame:** After crops have been harvested and most fall tillage has been completed, but before snow obscures view of tillage. **Spring Residue Survey Data Collection Time Frame:** After crops are planted, but before vegetation grows to the extent where you can no longer see field residue.

General weather conditions: Wet, average or dry year? Late or early harvest?							
SubWatershed							Date Collected:
Field #	Previous Crop 18	Fall Tillage 18	Fall Planted Crop 18	Cover Crop 18	Spring Residue 19	Crop 19	Notes
	C / CS / S / W / H / U	N / CP / P / ST / MT / PT	Wheat	Yes / No	NT / G / L / O / NP	C / CS / S / W / H / U	
	C / CS / S / W / H / U	N / CP / P / ST / MT / PT	Wheat	Yes / No	NT / G / L / O / NP	C / CS / S / W / H / U	
	C / CS / S / W / H / U	N / CP / P / ST / MT / PT	Wheat	Yes / No	NT / G / L / O / NP	C / CS / S / W / H / U	
	C / CS / S / W / H / U	N / CP / P / ST / MT / PT	Wheat	Yes / No	NT / G / L / O / NP	C / CS / S / W / H / U	
	C / CS / S / W / H / U	N / CP / P / ST / MT / PT	Wheat	Yes / No	NT / G / L / O / NP	C / CS / S / W / H / U	
	C / CS / S / W / H / U	N / CP / P / ST / MT / PT	Wheat	Yes / No	NT / G / L / O / NP	C / CS / S / W / H / U	
	C / CS / S / W / H / U	N / CP / P / ST / MT / PT	Wheat	Yes / No	NT / G / L / O / NP	C / CS / S / W / H / U	
	C / CS / S / W / H / U	N / CP / P / ST / MT / PT	Wheat	Yes / No	NT / G / L / O / NP	C / CS / S / W / H / U	
	C / CS / S / W / H / U	N / CP / P / ST / MT / PT	Wheat	Yes / No	NT / G / L / O / NP	C / CS / S / W / H / U	
	C / CS / S / W / H / U	N / CP / P / ST / MT / PT	Wheat	Yes / No	NT / G / L / O / NP	C / CS / S / W / H / U	

Key for Tillage and Residue Field Data Sheet

FALL TIILAGE INVENTORY

Previous Crop

C	Corn
S	Soybean
W	Wheat
H	Hay
CS	Corn Silage
U	Unknown
*** others, as observed**	Sugar beets, vegetables, orchard, dry beans, sod, oats
Developed	Field is no longer farmed, and is being developed (residential, commercial)
Not a Field	If a grass field is harvested for feed, label as "Hay"; If not, "Not a Field"
Pasture	Field is not farmed, but appears to be utilized for livestock
Skipped	Field was landlocked, not visible from road; no tillage/residue data recorded

Fall Tillage

N	No Tillage Done
CP	Chisel Plowed
P	Plowed
ST	Strip Till
MT	Mulch Till
PT	Planted, Wheat/Cover Crop

Fall Planted Crop	Cover Crop
Wheat	Yes *After Spring residue survey, review data to check whether fields with a fall planted crop are a cover crop or will be harvested for grain

SPRING RESIDUE INVENTORY

NT	No-Till
G	greater than 30% residue
L	less than 30% residue
0	0% residue

Previous Crop

C	Corn
S	Soybean
W	Wheat
H	Hay
CS	Corn Silage
U	Unknown
*** others, as observed**	Sugar beets, vegetables, orchard, dry beans, sod, oats
Developed	Field is no longer farmed, and is being developed (residential, commercial)
Not a Field	If a grass field is harvested for feed, label as "Hay"; If not, "Not a Field"
Pasture	Field is not farmed, but appears to be utilized for livestock
Skipped	Field was landlocked, not visible from road; no tillage/residue data recorded
Manure?	Yes or No
Tile?	Yes or No

Condition and Date Information Sheet

Subwatershed: Mill Creek (PP)

Investigators:

Season	Harvest (early/normal/late)	Planting (early/normal/late)	Soil (wet/normal/dry)	Survey start date	Survey end date
Fall 2018					
Spring 2019					
Fall 2019					
Spring 2020					

Subwatershed: South Branch (PP)

Investigators:

Season	Harvest (early/normal/late)	Planting (early/normal/late)	Soil (wet/normal/dry)	Survey start date	Survey end date
Fall 2018					
Spring 2019					
Fall 2019					
Spring 2020					

Subwatershed: North Branch (Black)

Investigators:

Season	Harvest (early/normal/late)	Planting (early/normal/late)	Soil (wet/normal/dry)	Survey start date	Survey end date
Fall 2018					
Spring 2019					
Fall 2019					
Spring 2020					

Subwatershed: Great Bear Lake Drain (Black)

Investigators:

Season	Harvest (early/normal/late)	Planting (early/normal/late)	Soil (wet/normal/dry)	Survey start date	Survey end date
Fall 2018					
Spring 2019					
Fall 2019					
Spring 2020					

Do not need to fill in gray boxes

16.4 Appendix D: Creating An Empty Shapefile

The AFOs you identify will be stored within a geographic information system (GIS). This section outlines how to create and populate a shapefile within ESRI's ArcMap environment.

The first step is to create an empty shapefile within ArcCatalog. To create an empty shapefile launch ArcCatalog. In ArcCatalog navigate to the folder where the shapefile will be saved. In that folder right click on the mouse, go to new, and select shapefile (Figure 1).

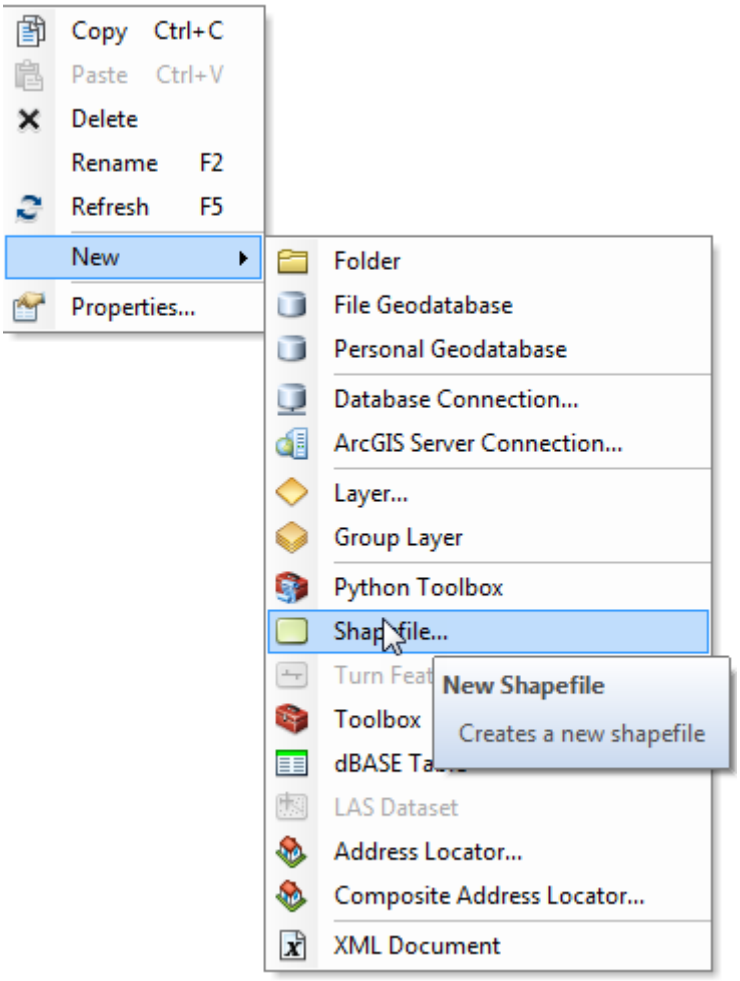

Figure 1. Creating a New Shapefile

The create new shapefile box will popup, name the file (Figure 2). Suggested naming convention is the HUC 12 number being investigated followed by AFO Inventory. Make sure the feature type is set to point.

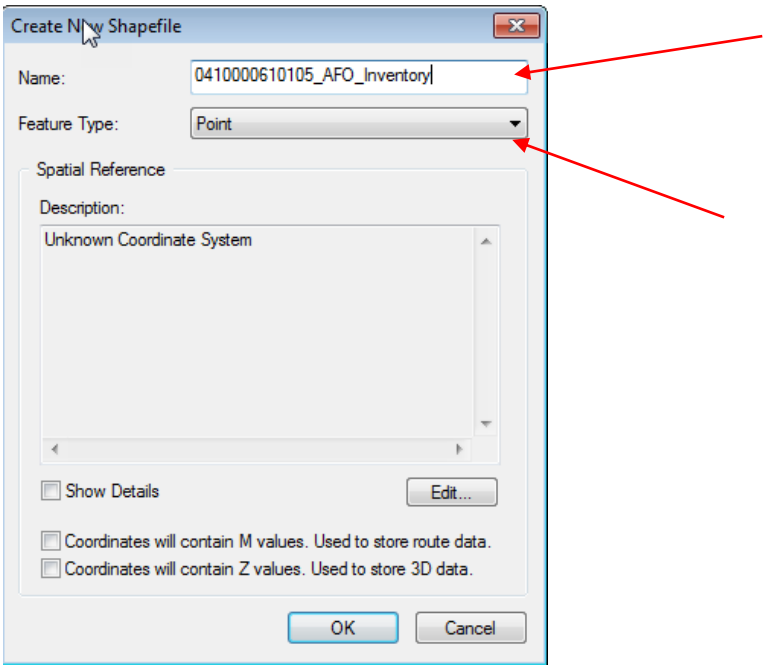

Figure 2. Naming a Shapefile

The next step is to select the coordinate system of the shapefile. Press the edit button and double click on the Projected Coordinates Systems file. Navigate to the state system folder and in that folder find the NAD 1983 Michigan Georef (Meters) projection, click on it, then hit ok (Figure 3). Once back to the create a new shapefile box hit ok.

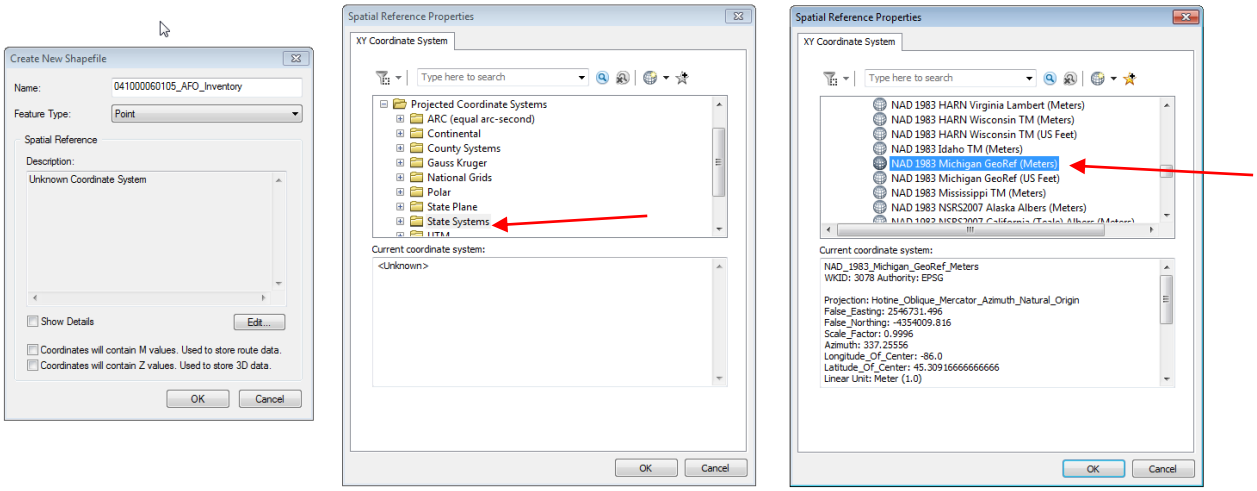

Figure 3. Spatial Reference Properties

Now launch ArcMap and add the empty shapefile you just created and aerial imagery, see above. To being populating the shapefile you must be in edit mode. This is done by adding the edit toolbar: customize>toolbars> select editor (Figure 4).

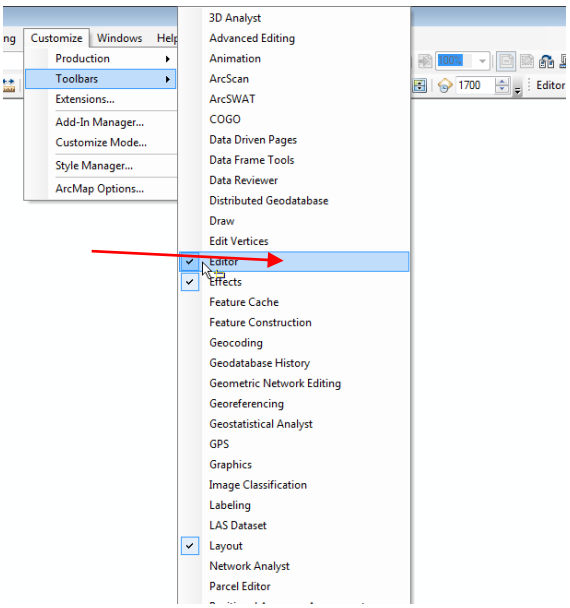

Figure 4. Adding Editor Toolbar

Go to the edit toolbar and select start editing (Figure 5).

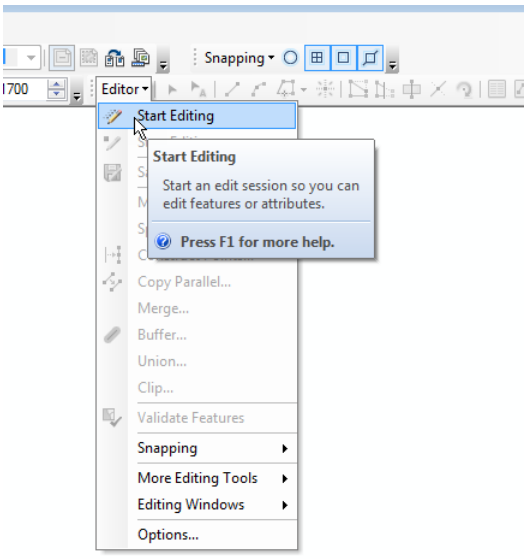

Figure 5. Start Editing a Shapefile

A new window will pop up and select the empty shapefile you just created and hit OK (Figure 6).

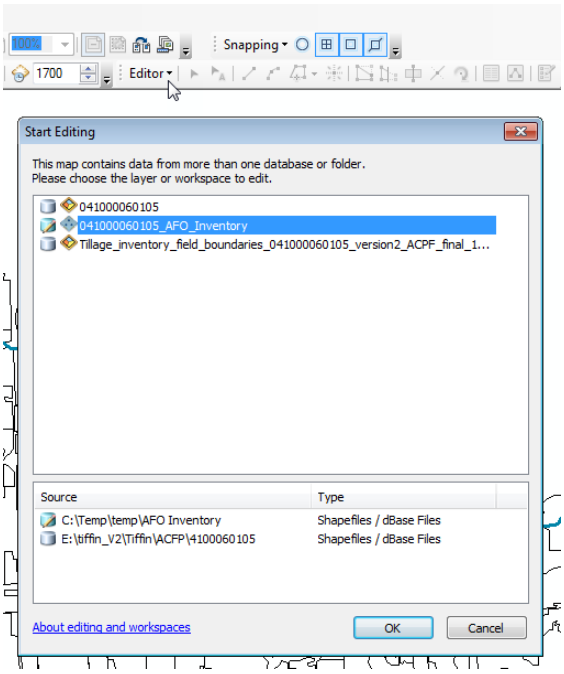

Figure 6. Selecting Shapefile to Start Editing

From here go back to the edit toolbar and select the edit window and select create a new feature (Figure 7).

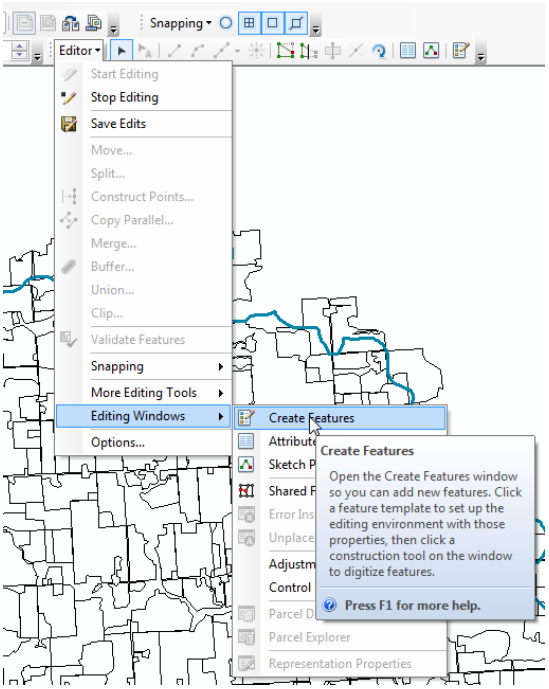

Figure 7. Create Features in Shapefile

On the right side of the Arc Map screen a create feature box will appear. Select your file in the create feature box and select point in the construction tool box (Figure 8).

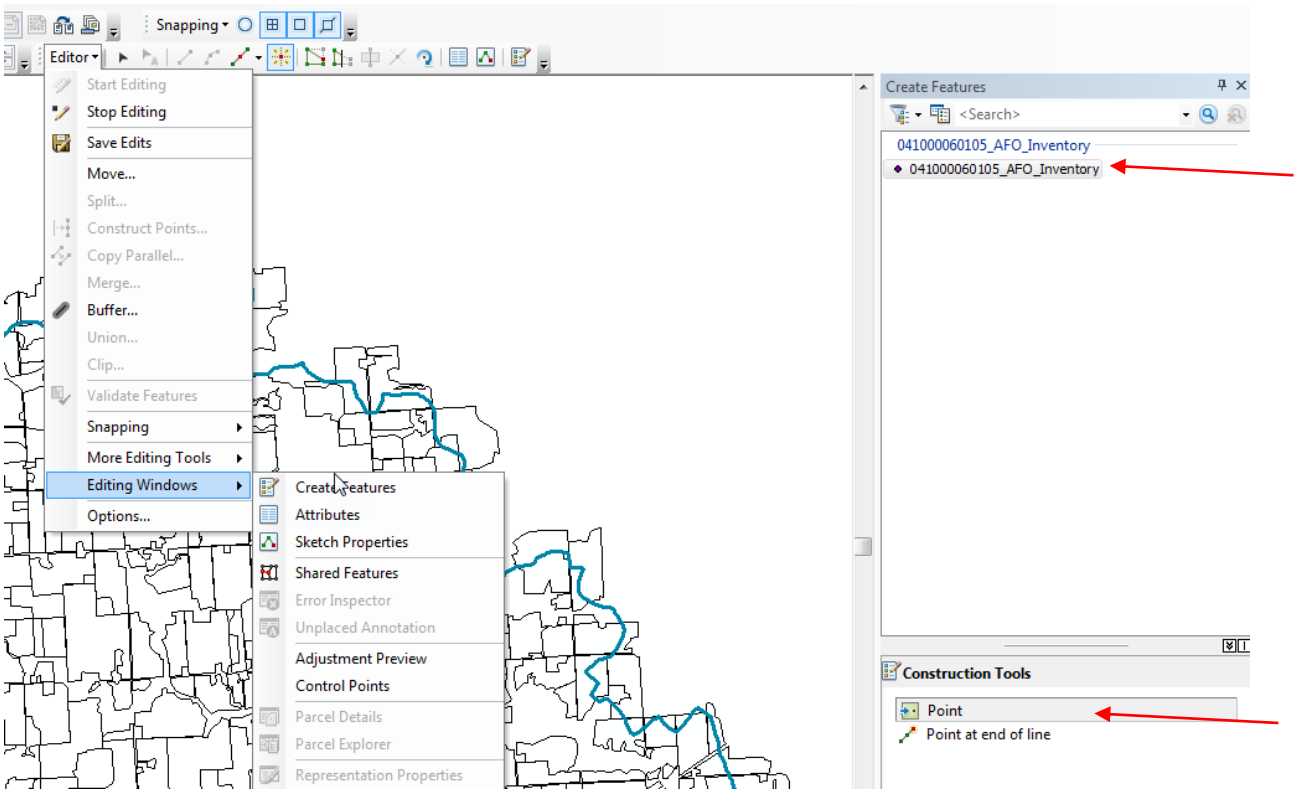

Figure 8. Select Shapefile to Add New Feature

You can now start adding points where AFOs are located by left clicking your mouse. If a point is put down in error it can be immediately deleted by hitting the delete button. If you want to move a point this can be done by selecting the edit tool on the edit tool bar (Figure 9).

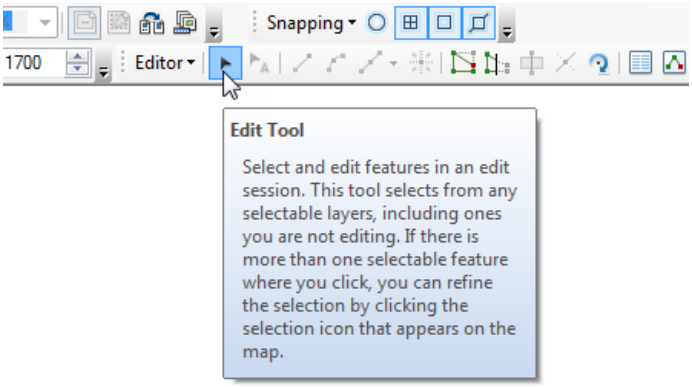

Figure 9. Adding Feature

Left click on the mouse to select the point or hold the left click down and draw a box around the point to select it. Once the point is selected put the cursor arrow directly over the point, left click the mouse holding it down, and move the point to where you want to locate it.

Point should be located in approximately the center of the facility. Once all AFOs are identified go back to the edit toolbar and select save edits and then select stop editing (Figure 10).

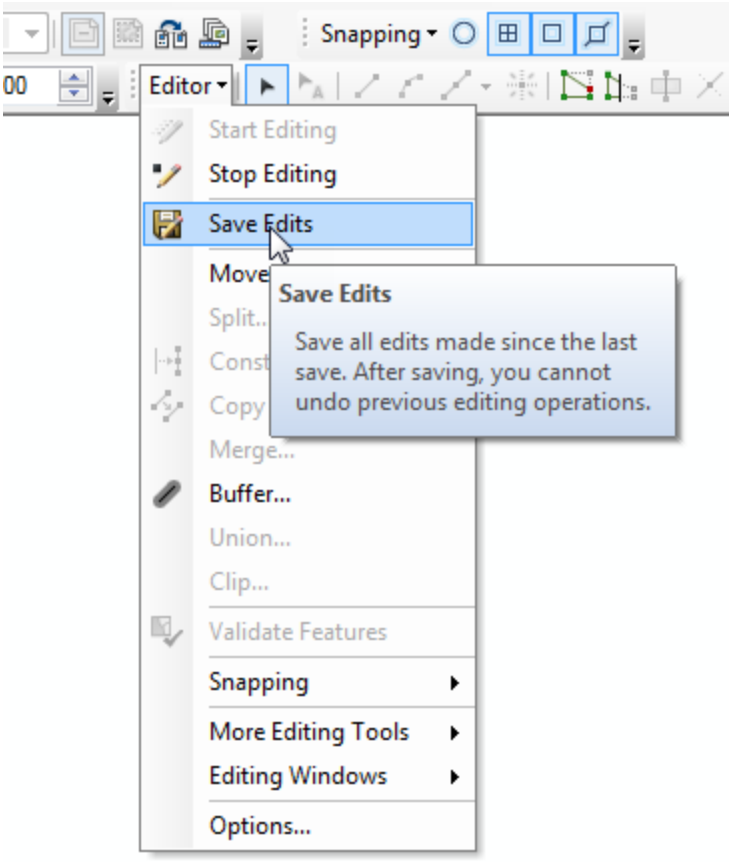

Figure 10. Saving Edits