Headwaters Yellow River Watershed Management Plan

ARN: 305-5-9

Photo: Stream in the Milner Seltenright Ditch subwatershed with stream buffers and in-stream cover.

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Acronyms

CFO	Confined Feeding Operation
CFS	Cubic Feet per Second
CAFO	Concentrated Animal Feeding Operation
CSO	Combined Sewer Overflow
DNR	Department of Natural Resources
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
HUC	Hydrologic Unit Code
HSG	Hydrologic Soil Group
IDEM	Indiana Department of Environmental Management
KRBC	Kankakee River Basin Commission
LARE	Lake and River Enhancement
LID	Low-Impact Development
MACOG	Michiana Area Council of Government
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service
STORET	Storage and Retrieval
SWCD	Soil and Water Conservation District
TKN	Total Kjeldahl Nitrogen
KRBC	Kankakee River Basin Commission
TMDL	Total Maximum Daily Load
WMP	Watershed Management Plan
PCB	Polychlorinated biphenyls

1 Watershed Community Initiative

1.1 Introduction

In 2015 the Headwaters Yellow River Watershed project was initiated by the Marshall County Soil and Water Conservation District (SWCD). Funds were procured from the Indiana Department of Environmental Management (IDEM) 319 and Lake and River Enhancement (LARE) programs with further assistance from additional partners. The Marshall County SWCD was motivated to conduct a study of the watershed as the result of several water quality concerns related to multiple impaired waterbodies in the Headwaters Yellow River Watershed (Figure 1). Specifically the streams and lakes highlighted in Figure 1 are included in the IDEM 303(d) list of impaired waterbodies. Stream segments are listed most commonly for high *E. coli* concentrations but there are also a few stream segments listed for impaired biotic communities. The three lakes within the watershed, Pleasant Lake, Riddles Lake and Lake of the Woods, are listed for high phosphorus concentrations and Lake of the Woods is also listed for polychlorinated biphenyls (PCBs). The Headwaters Yellow River Watershed (10 Digit Hydrologic Code [HUC]: 0712000103) is located in north central Indiana and encompasses portions of Marshall, St. Joseph, Elkhart, and Kosciusko Counties. The Headwaters Yellow River Watershed is approximately 187,300 acres and is part of the Kankakee River watershed (HUC: 07120001). The mainstem of the Yellow River originates north of Bremen in St. Joseph County and flows southwest and eventually flows through Plymouth. The Yellow River continues to flow west and drains into the Kankakee River, near Knox. However, the Yellow River southwest of Plymouth is outside of the scope of the Headwaters Yellow River Watershed project. Populated areas of the watershed include Lakeville, La Paz, Plymouth, Bremen, and Nappanee (Figure 1). The subsequent sections that constitute the Watershed Management Plan for the Headwaters Yellow River Watershed have been intended to address the concerns of watershed stakeholders in a holistic manner.

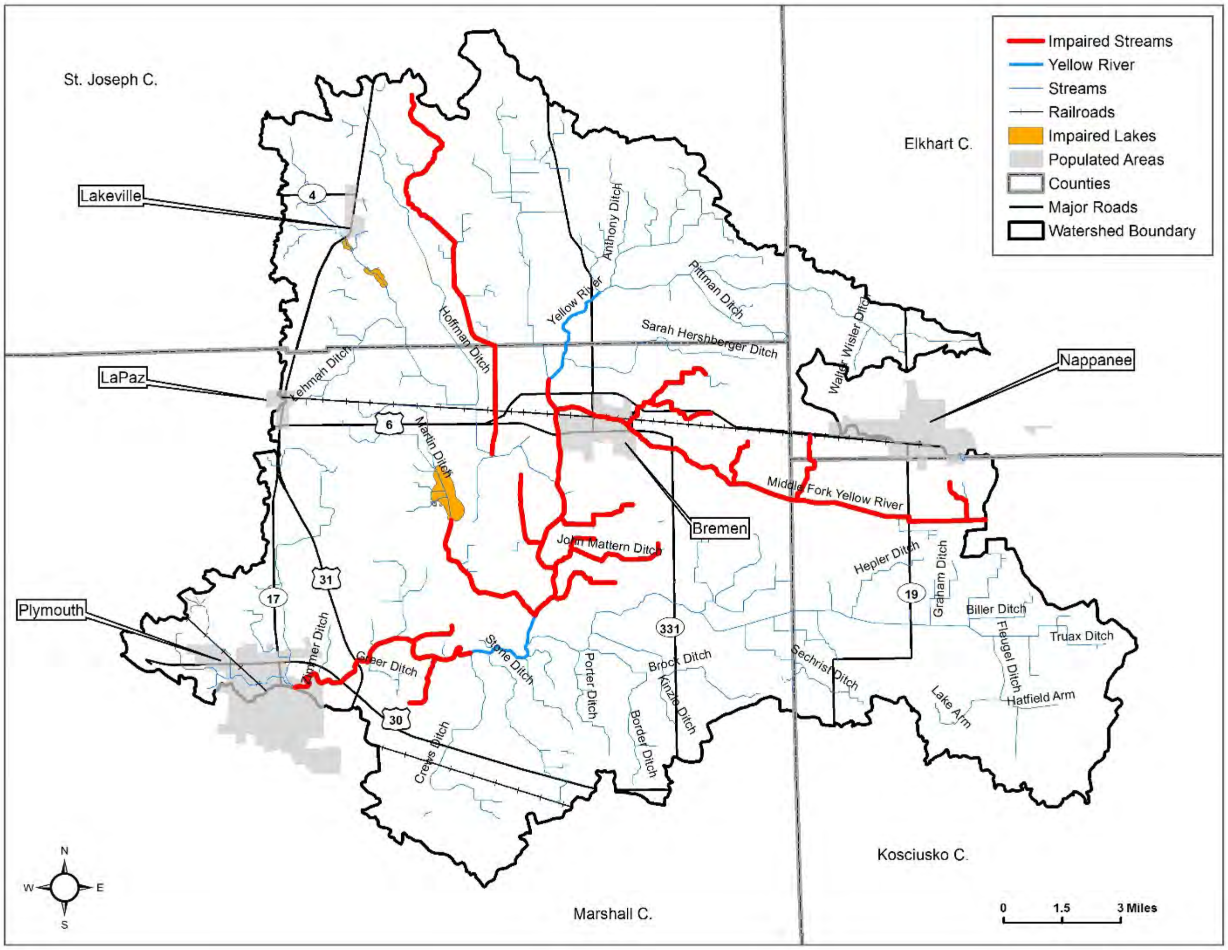
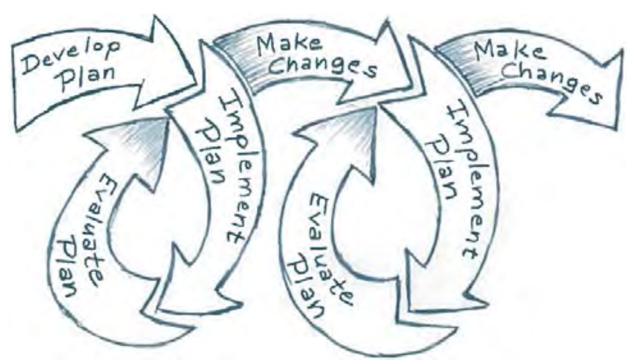


Figure 1. Location of the Headwaters Yellow River Watershed in Northern, Indiana.



A watershed is an area of land that drains to a common waterway, such as a stream, lake, estuary or wetland. Using a watershed approach to restore waterbodies addresses problems in a holistic manner and keeps local stakeholders involved in the management actions selected to solve problems in the watershed. This watershed management plan (WMP) for the Headwaters Yellow River Watershed describes the issues present in the watershed and the management actions necessary to remediate them. While the development of the Headwaters Yellow River WMP is a significant achievement, this document represents only a portion of the watershed planning process. In order to achieve the goals described in this WMP watershed stakeholders will need to continuously implement, evaluate, and adapt management actions in the watershed.

1.2 Stakeholder Concerns

A stakeholder concern is an issue or topic that a stakeholder believes is relevant to the watershed. During the first steering committee meeting for the Headwaters Yellow River Watershed Project in March of 2015, steering committee members identified topics of concern in the watershed. Many of the topics of concern were identified previously through an online survey that was distributed to watershed stakeholders in the first quarter of 2015. Table 1 presents a categorization of the concerns identified for the Headwaters Yellow River Watershed. The primary categories of concerns in the watershed are: natural resource quality, non-point source pollutant sources, and recreation opportunities. The primary concerns of the Marshall County SWCD included erosion, nutrient concentrations, *E. coli* concentrations, and recreation opportunities in the Headwaters Yellow River Watershed. These water quality concerns were further validated with the listing of Lake of the Woods, Pleasant Lake, Riddles Lake and 73 miles of streams in the watershed on the IDEM 303(d) list of impaired waterbodies. Streams were listed primarily for *E. coli* but also a few streams were listed for impaired biotic communities. All lakes were listed for phosphorus and Lake of the Woods is also listed for PCBs in fish tissue.

Table 1. Headwaters Yellow River Watershed Stakeholder Concerns

Category	Specific Concern
Natural Resource Quality	Stream water quality including nutrients, sediment, and *E. coli*
	Introduction of excess nutrients, sediment and *E. coli* to Lake of the Woods, Pleasant Lake, and Riddles Lake
	Limited habitat for aquatic organisms
	Introduction of Atrazine to the groundwater
Nonpoint Source Pollutant Sources	Stream bank erosion
	Failing septic systems throughout the watershed
	Direct discharges of wastewater from older homes
	Land applications of waste material
Recreational Opportunities	Management of the Yellow River for fisheries
	Limited boating access to the Yellow River
Miscellaneous	Debris and tree removal along the Yellow River
	Rural & urban drainage
	Rural & urban flooding

1.3 Steering Committee

The Headwaters Yellow River Watershed encompasses four counties and five populated areas. Therefore, stakeholders in the watershed come from a large geographic area that includes both rural and urban communities. The steering committee for the Headwaters Yellow River Watershed project was developed to address the concerns of stakeholders that were identified using an online survey. The steering committee members listed in Table 2 are representatives of governmental agencies, non-profit organizations, municipalities, educational institutions, and advocacy groups, with the knowledge and skills necessary to address the concerns expressed by watershed stakeholders in Table 1. Some of the Steering Committee members are landowners within the Headwaters Yellow River Watershed as well.

Table 2. List of the Headwaters Yellow River Watershed Steering Committee members and organizations.

Steering Committee Member	Agency/Organization
Jim Hess	Elkhart County SWCD
Debbie Palmer	Marshall County SWCD
Jeremy Cooper	St. Joseph County SWCD
John Lash	Kosciusko County SWCD
Larry Fisher	Marshall County Drainage Board
Matthew Longfellow	Marshall County Health Department
Madisson Heinl	Center for Lakes and Streams
Joe Skelton	Marshall County Lakes and Waters Council
Troy Manges	Natural Resources Conservation Service
Robert Yoder	Purdue University Cooperative Extension Service
Trend Weldy	Town of Bremen
Jody Melton	Kankakee River Basin Commission
Charlie Houin	Marshall County Farm Bureau

1.4 Mission Statement

During the first steering committee meeting on March 30th, 2015 the steering committee and additional watershed stakeholders in attendance discussed the mission of the Headwaters Yellow River Watershed project. The mission statement for the project was further modified until the following mission statement was agreed upon by the steering committee. Below is the mission statement developed for the Headwaters Yellow River Watershed Management Plan:

"To protect, restore, and enhance the surface and groundwater of the Headwaters Yellow River Watershed for future generations through education and the implementation of conservation practices."

2 Watershed Inventory Part I

2.1 Geology/Topography

The Headwaters Yellow River Watershed is located in north central Indiana (Figure 1), which was greatly influenced by the presence of the Wisconsin Glacier 70,000 years ago. The ice from the glacier was as thick as three miles in some places and ultimately extended just south of current day Indianapolis, Indiana (Wilson, 2008). The extreme weight of the glacier carved out bedrock from Canada and carried it southward through northern Indiana, where the debris was deposited (Wilson, 2008). As the glacier melted and began to retreat stratified drift was deposited creating a level plain called the Kankakee Outwash Plain (Wilson, 2008). The debris present in the outwash plain created fertile farmland throughout northern, Indiana. The advancing of the Wisconsin Glacier also influence the topography of northern, Indiana. As a result of the advance and retreat of the glacier the Headwaters Yellow River Watershed has limited topographical relief. The highest elevation in the watershed is approximately 920 feet and the lowest elevation in the watershed is approximately 810 feet (Figure 2). The Yellow River has an average gradient of 1.25 feet/mile along its relatively straight 22 stream miles.

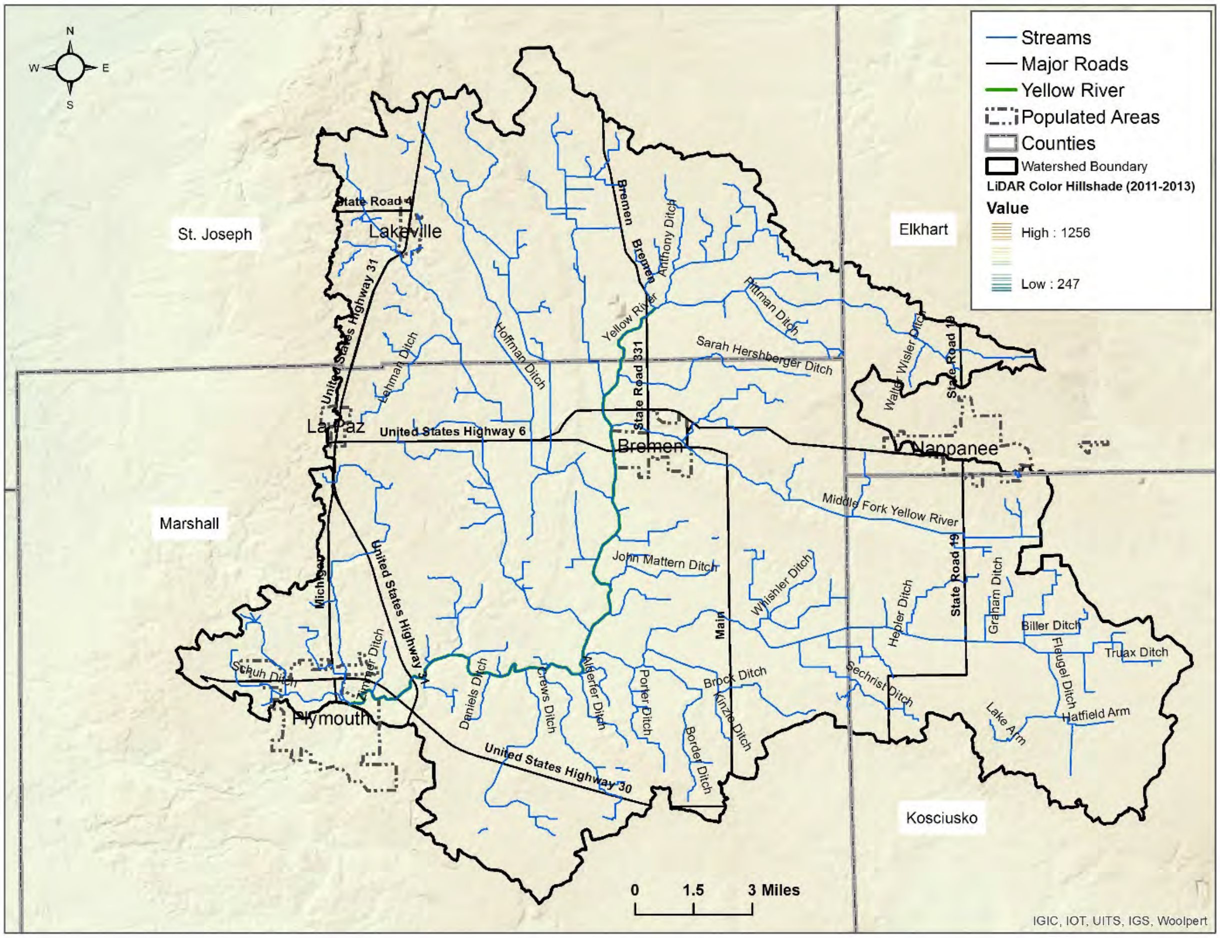


Figure 2. Headwaters Yellow River Watershed elevation map.

2.2 Hydrology

The Headwaters Yellow River Watershed (HUC: 0712000103) contains twelve subwatersheds across St. Joseph, Kosciusko, Elkhart, and Marshall Counties (Figure 3). The subwatershed of the Headwaters Yellow River Watershed include Armey Ditch (HUC: 071200010303), Dausman Ditch (HUC: 071200010308), Elmer Seltenright Ditch (HUC: 071200010311), Fleugel Ditch (HUC: 071200010306), Headwaters Stock Ditch (HUC: 071200010304), Kline Rouch Ditch (HUC: 071200010302), Lake of the Woods (HUC: 071200010309), Lateral Ditch No. 5 (HUC: 071200010301), Lemler Ditch (HUC: 071200010307), Milner Seltenright Ditch (HUC: 071200010312), Stone Ditch (HUC: 071200010310), and West Bunch Branch (HUC: 071200010305). Included in each of these subwatersheds is a network of streams, closed drains, lakes, and wetlands.

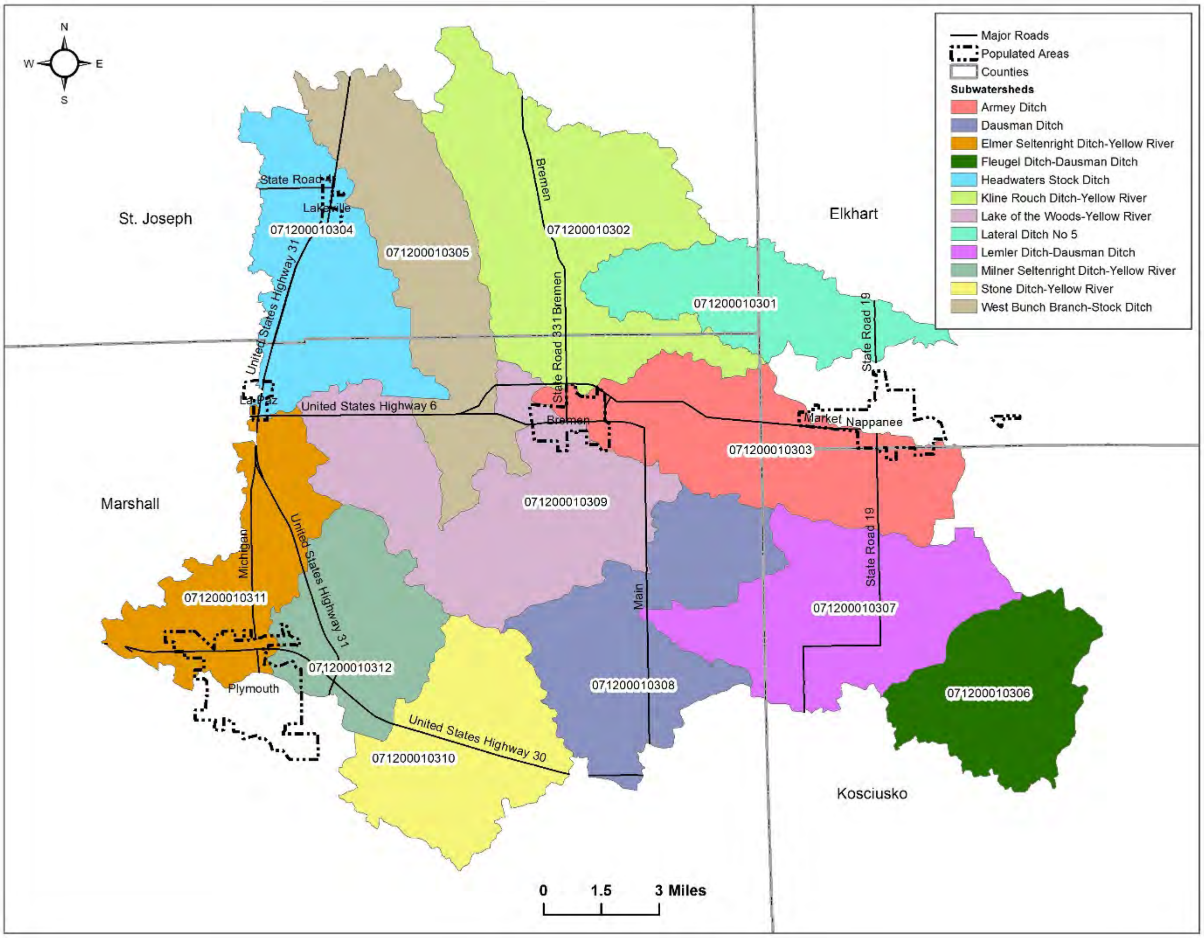


Figure 3. Headwaters Yellow River HUC 12 Subwatersheds.

The twelve subwatersheds combine to include a total of 335 miles of streams (open water drainages) and 154 miles of closed drains (tiles; Figure 4). All of these streams and closed drains shown in Figure 4 are regulated drains and subject to local drainage board management. Water from streams and closed drains ultimately drain to the Yellow River, which originates in southern St. Joseph County (Figure 4). The headwaters of the Yellow River flows four miles south, past the west side of Bremen. The river continues in a southwesterly direction for another fourteen miles until the river reaches Plymouth in central Marshall County (Figure 4). Portions of the Headwaters Yellow River Watershed are located in Elkhart and Kosciusko Counties; however the mainstem of the Yellow River flows only through St. Joseph and Marshall Counties. The streams and closed drains of the watershed are primarily utilized for drainage and irrigation purposes. However, the lower portion of the Yellow River in the watershed is utilized for angling despite limited access. In addition to lotic environments the Headwaters Yellow River contains numerous lentic environments.

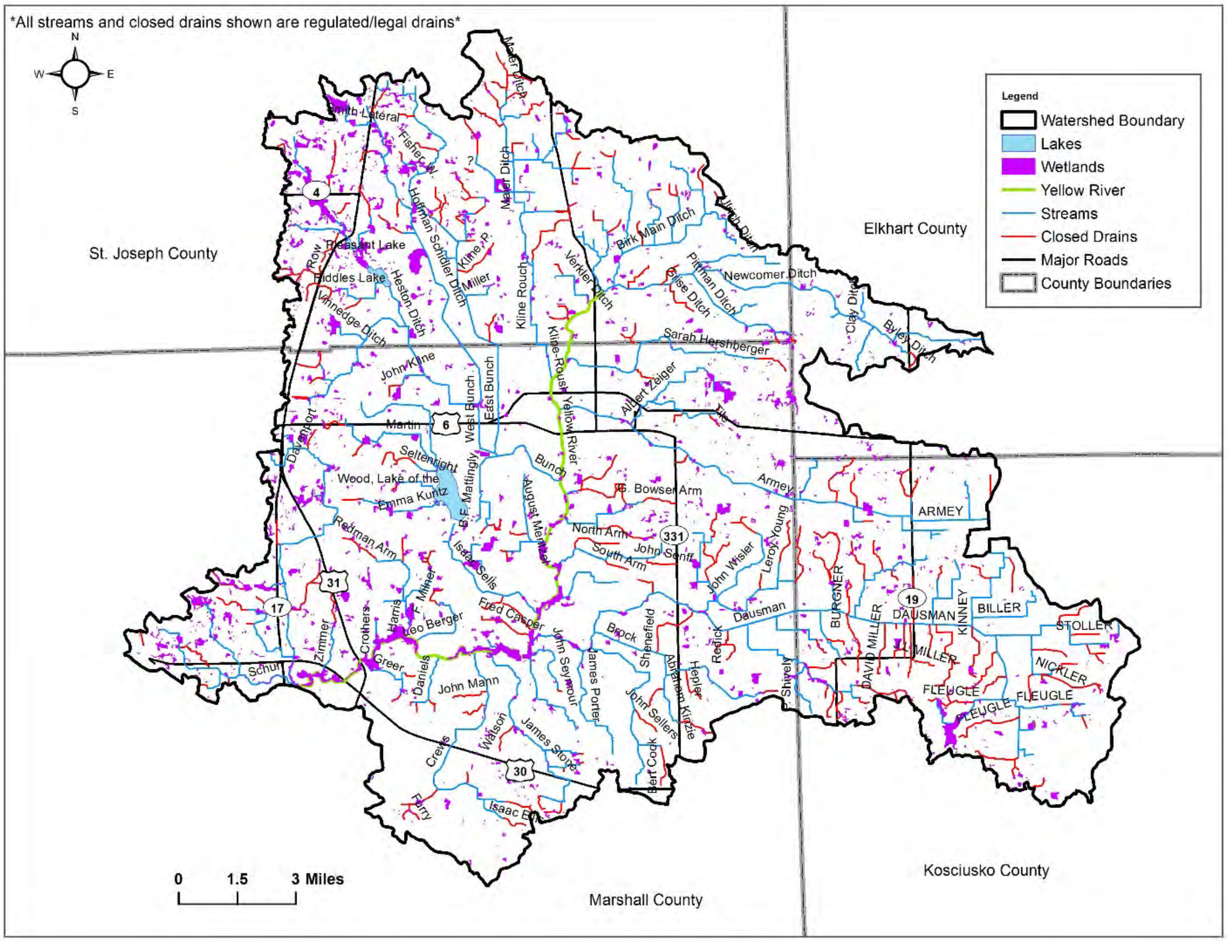


Figure 4. Waterbodies of the Headwaters Yellow River Watershed.

There are three primary lakes in the watershed including Pleasant Lake (24 acres), Riddles Lake (74 acres), and Lake of the Woods (420 acres) (Figure 4). Pleasant and Riddles Lakes are located in St. Joseph County near Lakeville. Pleasant Lake has a maximum depth of 39 feet (JFNew 2006a). Heston Ditch is the primary inlet to Pleasant Lake (JFNew 2006a). Riddles Lake has a maximum depth of 20 feet. Heston Ditch is also the primary inlet to Riddles Lakes (JFNew 2006a). Lake of the Woods is the largest lake in the watershed and is located in Marshall County southwest of Bremen. Lake of the Woods has a maximum depth of 47.9 feet (DJ Case and Associates 2005). There are five inlets to Lake of the Woods including William Forsythe Ditch, Martin Ditch, Seltenright Ditch, Bohmer Ditch, and Kuntz Ditch (DJ Case and Associates 2005). Each of these lakes is utilized by the public for multiple recreational activities including fishing, boating, and swimming.

The remainder of the lotic environments in the watershed includes wetlands ranging from 169 acres to less than 0.1 acres in size. Nearly 8,000 acres of small wetlands are scattered throughout the watershed, with an average size of 3.6 acres (Figure 4). The National Wetland Inventory data suggests that there were once an additional 1,895 wetlands totaling 1,358 acres present in the watershed that no longer exist. The largest existing wetland is a 169 acre wetland complex in the southern portion of the watershed, which is adjacent to the Yellow River upstream from Plymouth (Figure 4). Nearly all of the wetland ecosystems in the watershed are located on private land. It is likely that a portion of the wetlands on privately owned land are used by stakeholders for recreational activities such as waterfowl hunting. There is one protected wetland in the watershed located near Atwood in Kosciusko County. This is the location of the Glenwood Nature Preserve owned and managed by Acres Land Trust.

Seasonal changes result in significant variation in the discharge of the Yellow River. Historically, the spring months of March and April exhibit the greatest mean discharge (Figure 5). During these spring months the annual snowmelt combined with increasing precipitation results in dramatic increases in discharge over short periods of time. The peak discharge for the Yellow River was 5,390 cubic feet per second (cfs) in October of 1954. Conversely, the late summer months of August and September exhibit the lowest mean discharge (Figure 5). The dramatic increases in discharge that regularly occur in the Headwaters Yellow River Watershed pose flooding risks for residents of the watershed.

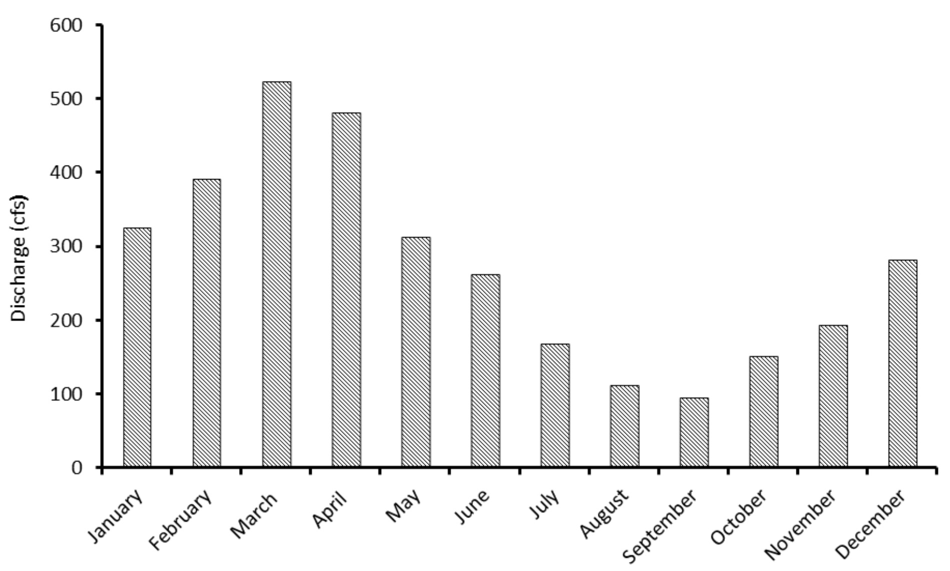


Figure 5. Mean (1948-2014) monthly discharge at USGS gauging station (05516500), located on the Yellow River in Plymouth, Indiana.

While flooding in the Headwaters Yellow River Watershed was not a primary area of concern to stakeholders, flooding concerns do exist in the watershed. Figure 6 displays areas of the watershed that have been determined to have a 0.2 to 1.0% chance of annual flooding. Approximately 7.0% or 13,285 acres of the Headwaters Yellow River Watershed are classified under this flooding category. Of the five populated areas in the watershed three do not appear to be located in floodplains including Lakeville, La Paz, and Nappanee (Figure 6). However, portions of Plymouth and Bremen are located in floodplains. Bremen has the potential to flood on the west side of town where the Yellow River flows past town and on the northeast side of town where Armey Ditch flows through town (Figure 6). Plymouth has the potential for flooding along the Yellow River and along Elmer Seltenright Ditch on the north side of town (Figure 6).

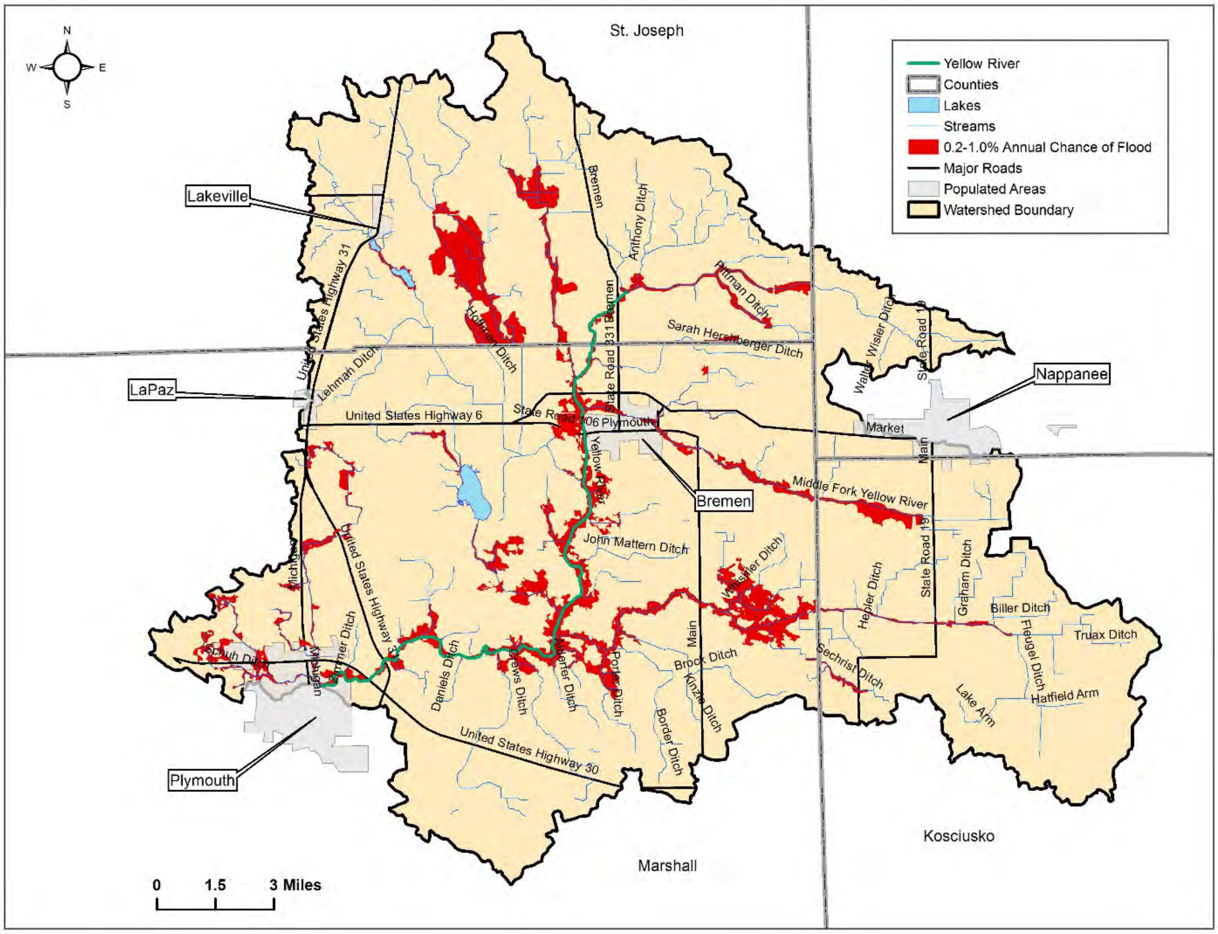


Figure 6. Headwaters Yellow River Flooding Areas.

Hydrologic modifications within the Headwaters Yellow River Watershed have been significant in regards to channelization of streams and construction of drainage ditches or installation of drainage tiles. Hydrologic modification for the purposes of increasing landscape drainage is a common practice in agriculturally dominated watersheds such as the Headwaters Yellow River Watershed. The modification of drainages within the watershed is shown well in Figure 4, as noted by the relatively straight flow paths of most drainages within the watershed. These hydrologic modification have also changed the extent of wetlands present within the watershed, resulting in fewer wetland acres than what would have been present historically. All three lakes in the watershed are natural; however, their water levels are maintained seasonally by outlet structures. The Headwaters Yellow River Watershed does not contain any dams or reservoirs.

2.3 Soils

The soil types present in a watershed greatly influence hydrologic processes. Soils have unique characteristics that influence infiltration rates, erosion, and hydrology. The Headwaters Yellow River Watershed contains a total of 175 soil associations, which are provided in Appendix A. Crosier loam (0-1% slopes) is the most common soil association, comprising 22% of the watershed followed by Brookston loam (0-1% slopes), comprising 14% of the watershed and Rensselaer loam (0-1% slopes) which accounts for 9.25% of the watershed (Appendix A). The remaining soil associations individually account for less than 7% of the watershed (Appendix A). Each of these soil associations have unique characteristics that influence watershed-scale processes.

Hydrologic soil groups (HSG's) are determined by the water transmitting soil layer with the lowest saturated hydraulic conductivity and depth to any layer that is more or less impermeable or depth of water table (United States Department of Agriculture 2007). The four HSG categories are A, B, C, and D soils. Soils in HSG A have the lowest runoff potential and transmit water freely through the soil, while soils in the remaining groups (B, C, and D) have increasing levels of runoff potential and decreasing water transition rates. The runoff potential and water transmission characteristics of each HSG are described in Table 3 and in the example scenario described immediately below Table 3 noted by an (*).

Table 3. Characteristics of the HSG's of the Headwaters Yellow River Watershed (United States Department of Agriculture 2007).

Hydrologic Soil Groups	Runoff Potential	Water Transmission Rate
A	Low	High
B	Moderately Low	Moderate
C	Moderately High	Low
D	High	Very Low

*If Group-D soils within 24 inches of the water table can be adequately drained they are assigned a dual HSG (A/D, B/D, and C/D). The first letter applies to the drained condition and second applies to the undrained condition.

The primary HSG's in the watershed are B/D (35%), followed by C/D (30%) and B (17%). There is only 1% of the watershed in the HSG C. The eastern portion of the watershed is dominated by B/D and C/D soils, while the western portion of the watershed has a greater portion of A, A/D, and B soils (Figure 7). HSG soil classification are closely linked to the location and quantity of hydric soils in the watershed.

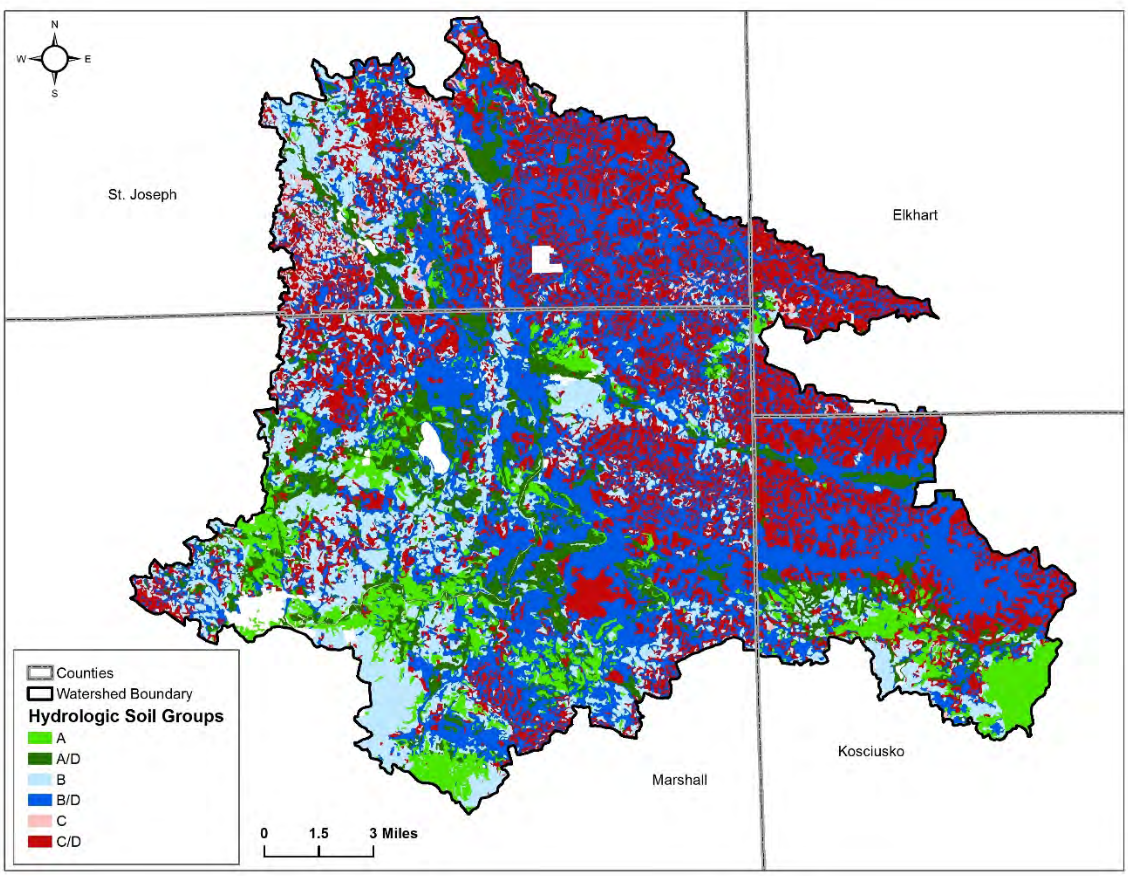


Figure 7. Headwaters Yellow River Watershed Hydrologic Soil Groups (HSG's).

Hydric soils are soils that form under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper part. The Headwaters Yellow River Watershed contains a combination of soils that are classified as all hydric, partially hydric, and not hydric. Partially hydric soils account for 58% of the watershed, followed by non-hydric at 30%, and all hydric at 12%. The southeastern portion of the watershed contains a significant portion of the hydric soils, while the southwest portion of the watershed contains a significant amount of not hydric soils (Figure 8). Partially hydric soils are scattered throughout the watershed, however they are particularly common in the northern portion of the watershed in the southeastern portion of St. Joseph County. (Figure 8).

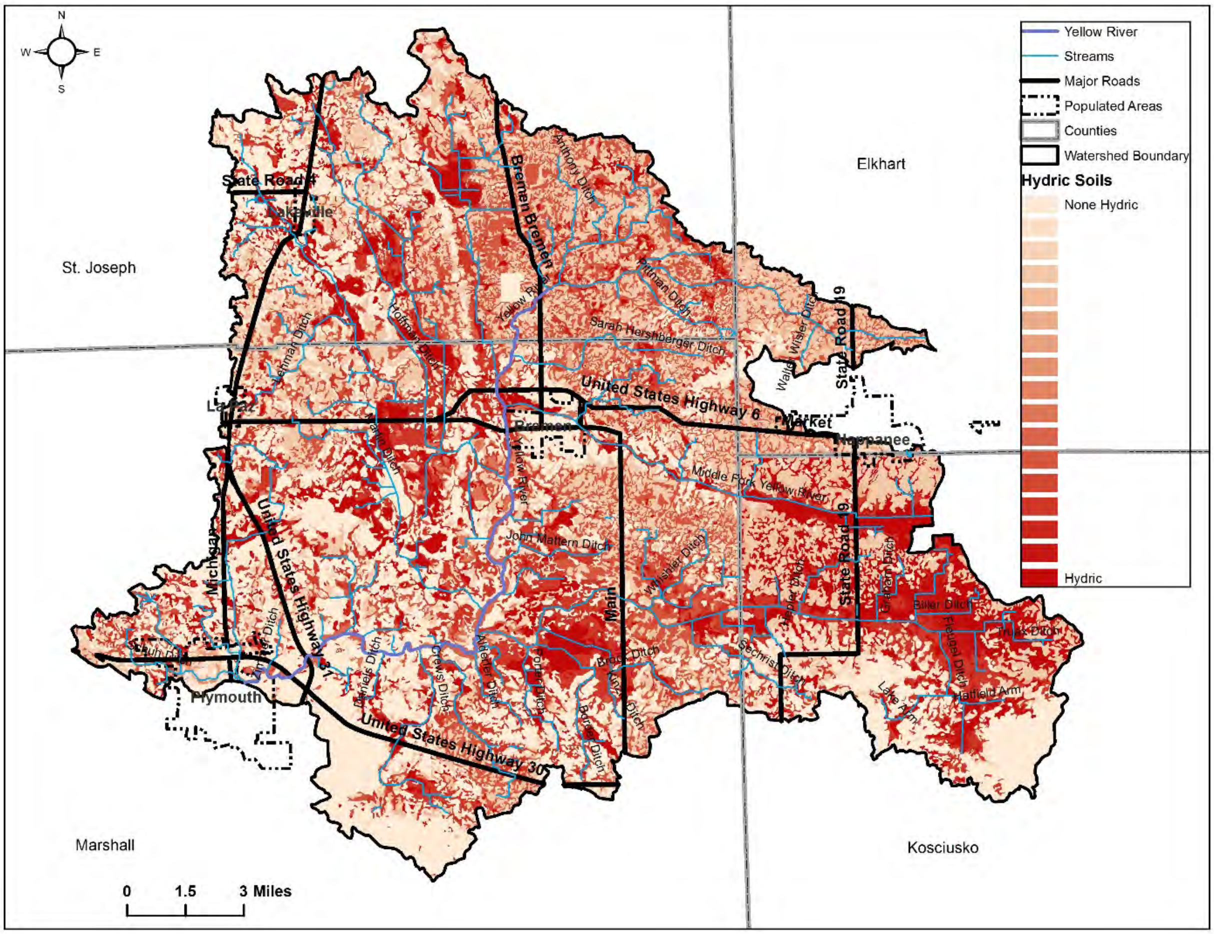


Figure 8. Headwaters Yellow River Watershed Hydric Soils.

Many of the soil types in the Headwaters Yellow River are more susceptible to erosion by wind and water. Identifying areas of the watershed that are more susceptible to erosion can assist with the prioritization of conservation efforts to limit soil loss in the Headwaters Yellow River Watershed. As a note, soils listed below that are referred as “severely susceptible to erosion” are synonymous to the designation “highly erodible soils.” Approximately 84% of the Headwaters Yellow River Watershed is slightly susceptible to erosion. The majority of the slightly erodible soils are located in the eastern portion of the watershed (Figure 9). It should be noted that the majority of the soils in the Kosciusko portion of the watershed are slightly erodible. Approximately 14% of the Headwaters Yellow River Watershed is moderately susceptible to erosion. The majority of the moderately erodible soils are located in St. Joseph and Marshall Counties, in the western portion of the watershed (Figure 9). Less than 1% of the soil in the watershed is severely susceptible to erosion. The soils classified as severely susceptible to erosion are scattered throughout Marshall and St. Joseph County (Figure 9).

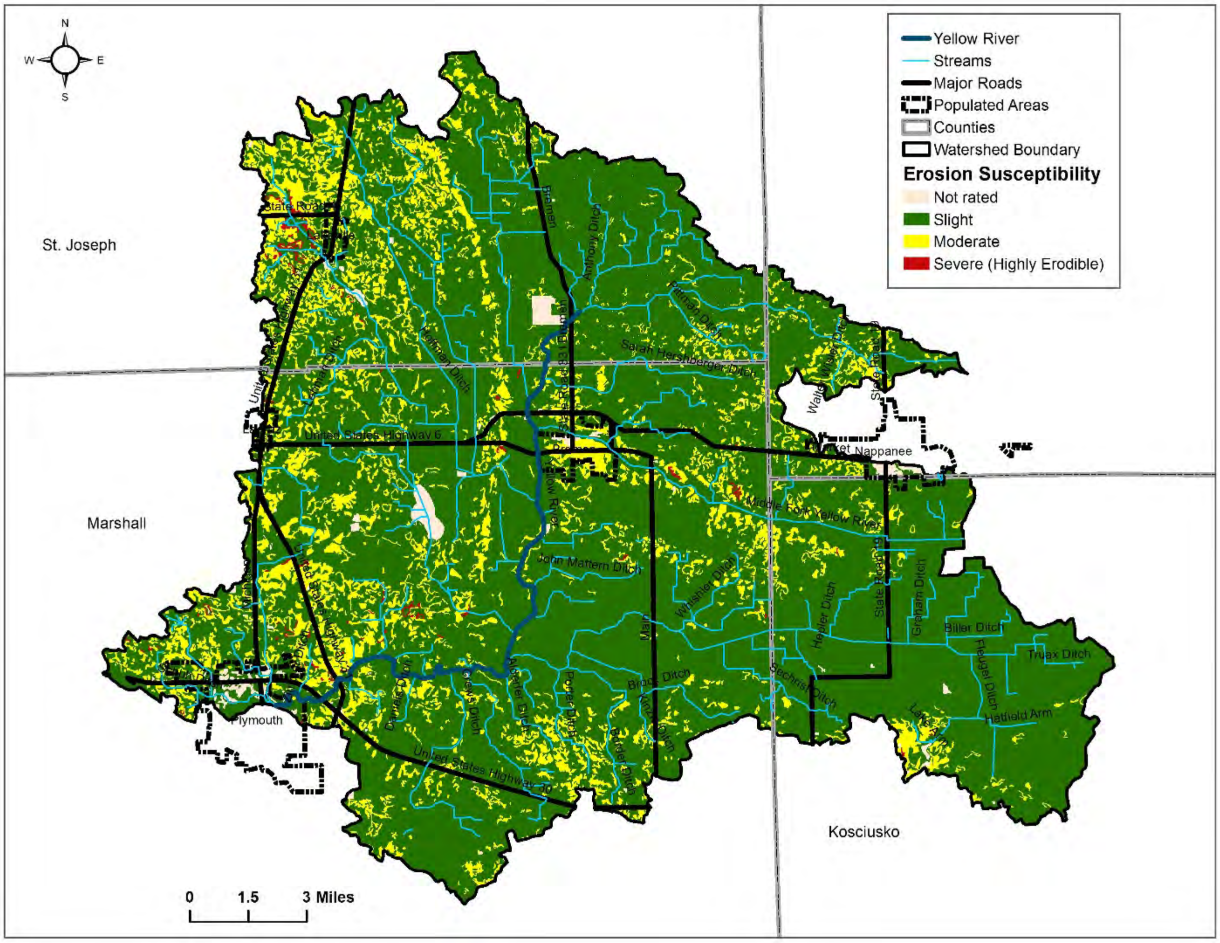


Figure 9. Headwaters Yellow River Watershed Soil Erosion Susceptibility.

The majority of the land area in the Headwaters Yellow River Watershed is serviced by septic systems. Plymouth, Bremen, Nappanee, Lakeville, La Paz, and Lake of the Woods are only the portions of the watershed that are serviced by sewer systems. Therefore, an understanding of the location of soils with characteristics suitable or unsuitable for septic systems is necessary. Approximately 98% of the soils in the watershed are described as very limited for septic tank absorption fields, while only 1% are described as somewhat limited (Figure 10). Due to the widespread limitations in soil absorption for septic systems and the large number of rural residences in the watershed, septic tank design and maintenance should be an area of focus in the Headwaters Yellow River Watershed. There are no large unsewered communities located within the Headwaters Yellow River Watershed.

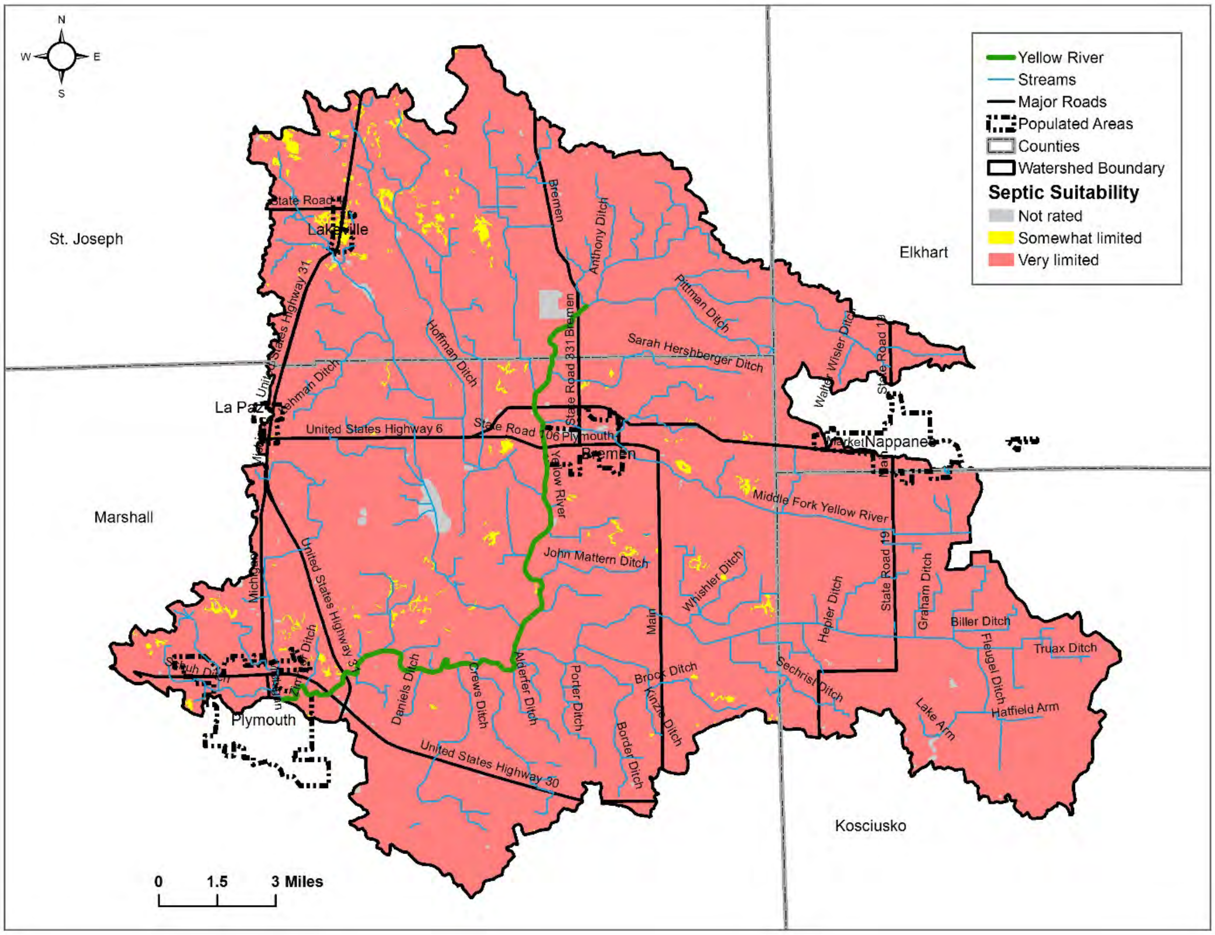


Figure 10. Headwaters Yellow River Watershed Septic Suitability.

2.4 Land Use

Landuse in the Headwaters Yellow River Watershed is dominated by agriculture. Cultivated cropland comprises the majority of the watershed followed by deciduous forest, developed open space, hay/pasture, low intensity development, and woody wetlands (Table 4).

Table 4. Percentage and acreage of each land use type in the Headwaters Yellow River Watershed.

Land use	% of Watershed	Acres
Open Water	0.4%	709
Developed, Open Space	5.4%	10,129
Developed, Low Intensity	2.1%	3,880
Developed, Medium Intensity	0.4%	830
Developed, High Intensity	0.3%	577
Barren Land	0.0%	90
Deciduous Forest	7.2%	13,468
Evergreen Forest	0.2%	367
Mixed Forest	0.0%	9
Shrub/Scrub	0.3%	511
Herbaceous	0.2%	345
Hay/Pasture	5.3%	9,903

Land use	% of Watershed	Acres
Cultivated Crops	76.0%	142,307
Woody Wetlands	2.0%	3,752
Emergent Herbaceous Wetlands	0.2%	423

The 2015 Natural Resource Conservation Service (NRCS) tillage transect survey suggests that approximately 19.5% of agricultural land dedicated to corn in the watershed was no-till and 49.3% of land dedicated to soybeans was no-till (Indiana State Department of Agriculture 2015). The primary areas of urban development are Plymouth, Bremen, Nappanee, La Paz, Lakeville, and Lake of the Woods (Figure 11). The remaining natural ecosystems in the watershed have been highly fragmented. Deciduous forest patches are isolated from each other and are commonly surrounded by a matrix of anthropomorphic land use such as development and row-crop agriculture (Figure 11).

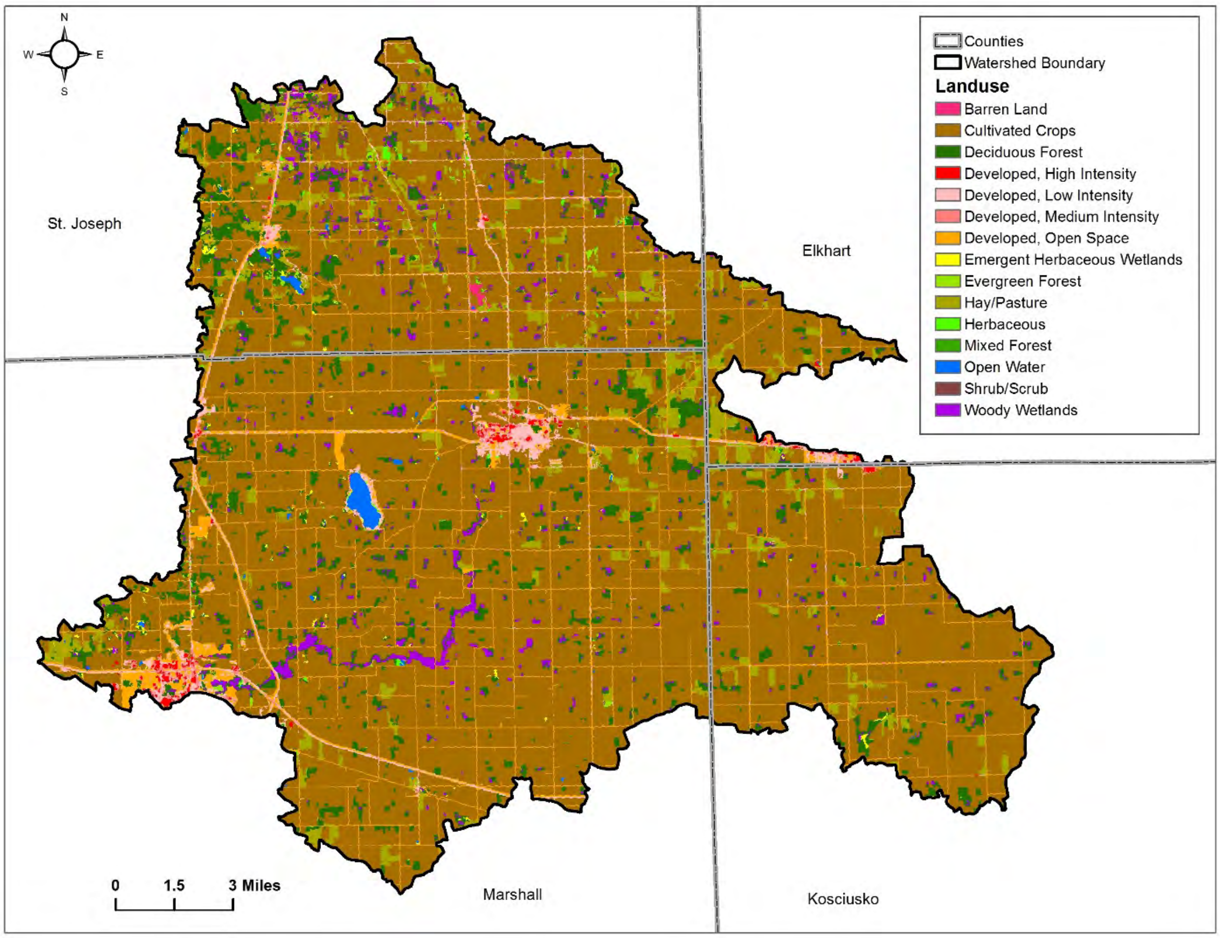


Figure 11. Headwaters Yellow River Watershed Landuse.

Deciduous forest fragments are scattered throughout the watershed, but many of the patches are concentrated along the western boundary of the watershed near Lakeville (Figure 11). Woody wetlands are concentrated largely along the mainstem of the Yellow River between Bremen and Plymouth, as well as the area east of Lakeville in St. Joseph County (Figure 11). The majority of the land in Headwaters Yellow River Watershed is privately owned. There are a total of 124 acres of public land in the watershed including Centennial Park (68 acres), Sunnyside Park (24 acres), Lake of the Woods Public Access Site (2 acres), Pleasant Lake Public Access Site (3 acres), and the Lakeville Bike Trail (27 acres) (Figure 12).

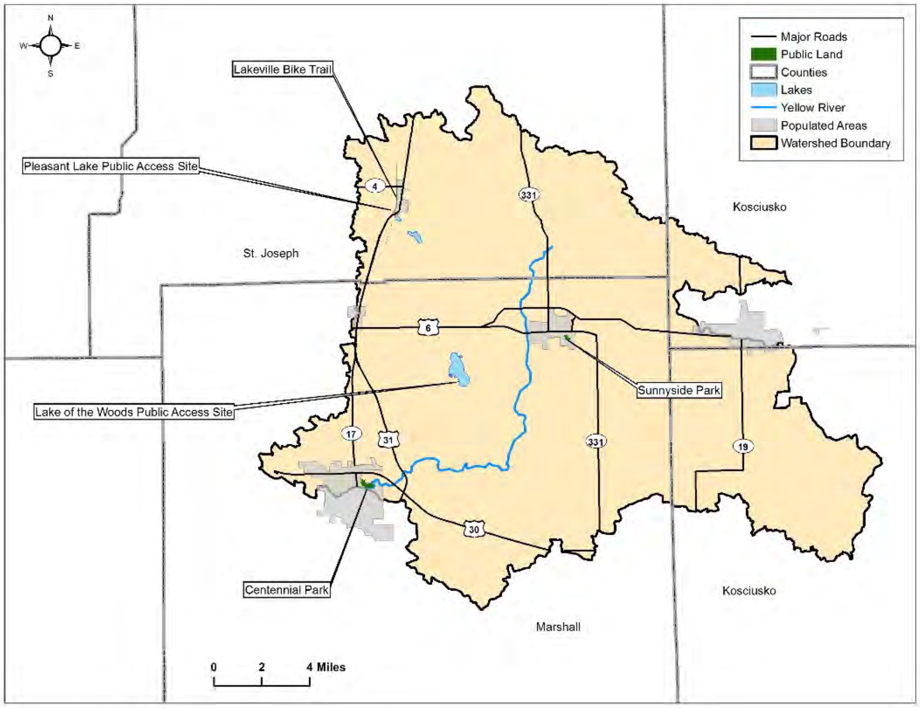


Figure 12. Public Land in the Headwaters Yellow River Watershed.

As landuse data shows, the Headwaters Yellow River Watershed has been altered by human activities significantly. This alteration of the landscape has resulted in changes of the interactions between forests, wetlands, streams, lakes and the general flow of water and nutrients through the various ecosystems contained within the watershed. These alterations can have an impact on water quality in a number of different ways. Significant landscape alterations such as the loss of wetland acres, the channelization of streams and the construction of drainage ditches and tiles have changed how water flows across the landscape resulting in a decreased ability of land to retain water thereby increasing overland flow and increasing general discharge levels within drainages. In general, precipitation that falls during a rain event or from snow melt reaches streams or drainage ditches more quickly and can have negative impacts on water quality by increasing streambank erosion, increased sediment and nutrient loading and decreased habitat quality for aquatic organisms through lower dissolved oxygen levels, sedimentation and unsuitable flow regimes. The loss of intact riparian habitat along streams is also of concern for water quality within the watershed. The loss of tree canopy cover along streams can increase water temperature and the stream edges that lack a vegetative buffer can have increased sediment and nutrient load, as well as increased streambank erosion. Streamside buffers are in important filter to overland flow as they help capture sediment and nutrients and provide habitat for organisms occupying these areas. Increases in nutrient and sediment loading are a concern to stakeholders within the watershed as it can have a negative affect the resources used by stakeholders. The primary categories of concerns expressed by stakeholders in the watershed are natural resource quality, non-point source pollutant sources, and recreation opportunities. Additional concerns expressed by stakeholders were rural and urban drainage and flooding, which is directly impacted by the interaction of various landuse practices within the watershed. It is important to note that the alterations described above have become a necessary means to use the land within the Headwaters Yellow River Watershed for production purposes and is therefore an integral component of the current landscape. For all stakeholders to benefit from the variety of resources available within the Headwater Yellow River Watershed, they must consider thoughtful development, landscape maintenance, planning, and soil/water conservation practices and preservation.

The use of fertilizer and pesticides for increased agricultural production is a common practice in the Headwaters Yellow River Watershed and the State of Indiana overall. The use of fertilizers and pesticides allow producers to maximize yields and if utilized in a responsible manner can have reduced negative impact on water quality. When fertilizer and pesticides are applied without consideration of weather conditions, application rates or excess nutrient and chemicals can be transported to waterways. Utilizing best management practices for fertilizer and pesticide application is advantageous to both producers and the natural environment as producers could save money on the amount of products applied and the natural environment benefits by reduced nutrient and chemical loading. The application of fertilizer is also a concern in urban environments for general landscaping needs. Developed landuse accounts for 8.2 percent of the Headwaters Yellow River Watershed and therefore should not be overlooked for impacts to water quality. Fertilizers applied to landscaped areas have the potential to reach waterbodies just as in rural landscapes. Fertilizers when possible should not be used for general landscaping should be avoided, but if used should be used in a responsible manner. If fertilizers are used, phosphorus free products are preferred.

Wildlife and pet waste can negatively impact water quality by increasing nutrient and E. coli loading. Areas where wildlife waste could be problem include the three lakes in the watershed, maintained areas such as those at parks and urban laws where pet waste can wash into storm drains and ultimately reach water resources.

2.5 Other Planning Efforts

There are numerous planning efforts that have taken place or are currently taking place in the Headwaters Yellow River Watershed. Figure 13 displays the location of each of the planning efforts in the watershed. In 2012 the Michiana Area Council of Governments (MACOG) sponsored a Watershed Management Plan (WMP) for the Heston-Stock Ditch subwatershed (Michiana Area Council of Governments 2012). The Heston-Stock Ditch subwatershed is located in the northwest portion of the Headwaters Yellow River Watershed (Figure 13). Lake of the Woods is the largest lake in Headwaters Yellow River Watershed and has been studied extensively (Figure 13). Lake of the Woods developed a diagnostic feasibility study in 1982 and a feasibility study in 1991 (Senft and Roberts 1982; Corporation Dynamac 1991). In 2005 the Kankakee River Basin Commission (KRBC) sponsored the completion of a WMP for Lake of the Woods in Marshall County (DJ Case and Associates 2005). Pleasant and Riddles Lakes, which are located in the northwest portion the Headwaters Yellow River Watershed had a watershed diagnostic study and sediment removal plan completed in 2006 (JFNew 2006a; JFNew 2006b). In addition to studies on the tributaries and lakes of the Yellow River, significant work has also been done on the mainstem of the Yellow River.

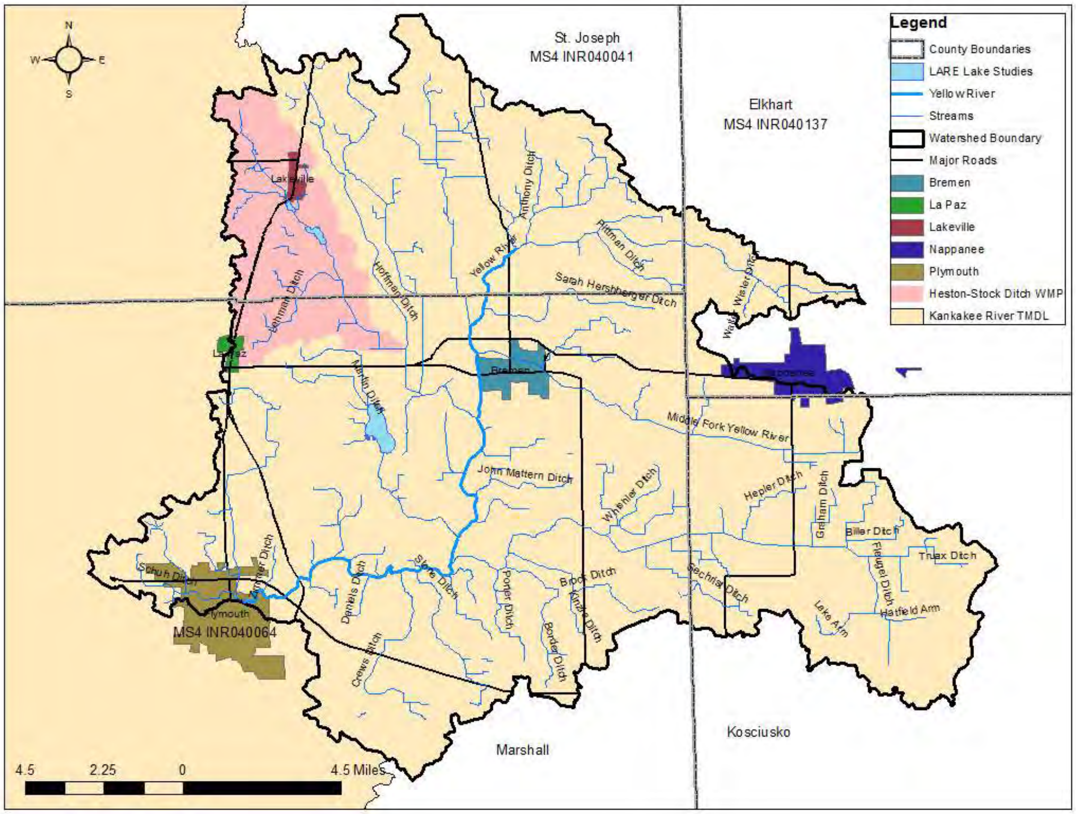


Figure 13. Planning Efforts in the Headwaters Yellow River Watershed.

A Total Maximum Daily Load (TMDL) Report was created for the Kankakee/Iroquois Watershed (Tetra Tech 2009), which includes the Yellow River watershed. The Kankakee River Basin Commission (KRBC) is also actively involved in the coordinating and planning of numerous ongoing conservation efforts in the Kankakee River Watershed. A Sediment Control Evaluation was prepared in 2012, which describes three areas of streambank erosion downstream of the Headwaters Yellow River Watershed in Starke County (Christopher B. Burke Engineering 2012). Lastly, fisheries surveys were conducted on the Yellow River by the Indiana Department of Natural Resources (DNR) in 1987, 1989, and 2005 (Price 2005). Relevant information provided in each of these planning efforts has been utilized throughout this WMP to describe the current and historical conditions of the watershed.

In addition to studies sponsored by local non-profits, many of the local governments in the watershed have developed plans that contain information relevant to the Headwaters Yellow River WMP. Each of the counties in the Headwaters Yellow River Watershed have County Comprehensive or Master Plans, which often contain sections regarding environmental objectives (Team Kosciusko County Area Plan Study 1996; Commissioners 2006; Marshall County 2013; HNTB and the St. Joseph County Area Plan Commission). Plymouth, which is the most populated municipality in watershed has a history of monitoring and planning projects to improve the water quality of the Yellow River. In 2002 the City of Plymouth prepared a study to monitor non-point source pollutants and explore ways to reduce pollutant inputs (Commonwealth Biomonitoring 2002). The City of Plymouth has also implemented practices to eliminate CSOs and reduce the frequency of overflows into the Yellow River. An examination was conducted in 2013 to monitor water quality following the implementation of these CSO improvements (Bright 2013). The Plymouth Park and Recreation Department received 2015 LARE funding to stabilize multiples areas of erosion along the Yellow River in Centennial Park. Lastly, in September of 2015, the Marshall County SWCD received an EPA Region 5 Wetland Program Development Grant to complete a Landscape-Level Wetland Functional Assessment (LLWFA) to develop a better understanding of the functional value of wetlands in the

Headwaters Yellow River watershed. The LLWFA assessment utilized the USFWS NWI 2016 dataset as the baseline data for the study. Tasks completed during the LLWFA study included the following: development of a NWI+ data base, LLWFA functional analysis of the NWI+ database, desktop review of NWI wetlands, targeted windshield survey of priority wetlands, overall functional wetland prioritization, and specific wetland restoration/enhancement site identification and conceptual plan development (Appendix B).

Construction and development are occurring within the Headwaters Yellow River Watershed but not at a rate which has caused concern to stakeholders. Construction and development sites which disturb greater than 1 acre of land need to follow an approved storm water pollution prevention plan (SWPPP), which is required by Rule 5. State and county personnel are responsible for reviewing the pollution prevention plans for Rule 5. There are no known areas in need of Rule 5 enforcement and or areas of unmanaged construction/sprawl located within the watershed at the time of the development of this plan.

In addition to controlling erosion and runoff at construction/development sites, Indiana also implements Municipal Separate Storm Sewer Systems (MS4s) to control stormwater runoff and prevention. Entities which have regulated MS4 programs in the Headwaters Yellow River Watershed include St. Joseph County (INR040041), Elkhart County (INR040137) and the City of Plymouth (INR040064; Figure 13). MS4s are required to develop and implement a Stormwater Quality Management Plan (SWQMP). The SWQMP is a comprehensive document that addresses stormwater quality, within the designated area, that includes methods and measureable goals. Components of the SWQMP include: public education and outreach; public participation and involvement; illicit discharge detection and elimination; construction site stormwater runoff control; post-construction stormwater runoff control; and municipal operations pollution prevention and good housekeeping.

2.6 Threatened and Endangered Species

The Indiana Department of Natural Resources has created a list of endangered, threatened, and rare species for each county in the state. An understanding of the endangered, threatened, and rare species is important to the watershed planning processes because of the potential to protect these species and the habitats they require. There are six endangered species, one threatened species, and four rare species in the Headwaters Yellow River Watershed (Table 5). The endangered species include the Yellow-headed blackbird (*Xanthocephalus xanthocephalus*), American Manna-grass (*Glyceria grandis*), Blanding's Turtle (*Emydoidea blandingii*), Kirtland's Snake (*Clonophis kirtlandii*), Thinleaf Sedge (*Carex sparganioides var. cephaloidea*), and Highbush-cranberry (*Viburnum opulus var. americanum*).

Photo: Blanding's Turtle (FWS 2015)

The Yellow-headed blackbird was documented near Plymouth where Highway 31 crosses the Yellow River. Yellow-headed blackbirds nest in marshes and forage in pastures (Sibley 2003). The American Manna-grass was documented near the Yellow River, south of Bremen and generally grows in shallow water areas such as wetlands (Gleason and Cronquist 1991). Both the Blanding's Turtle and Kirtland's Snake were documented near Lakeville in St. Joseph County. Blanding's Turtles prefer productive clean shallow water habitats (Ernst and Lovich 2009), while Kirkland's Snakes prefer open grassy areas on the edge of waterbodies (Ernst and Ernst 2003). Lastly, both the Thinleaf Sedge and Highbush-cranberry were documented near the Plymouth Airport in Marshall County. Thinleaf Sedge grows in dry woods and Highbush-cranberry grows in moist woods (Gleason and Cronquist 1991). The only high quality natural community in the watershed is a 40 acre circumneutral bog, located near Atwood in Kosciusko County. This is the location of the Glenwood Nature Preserve owned and managed by Acres Land Trust. The state threatened Slender Cotton-grass (*Eriophorum gracile*) is located in this circumneutral bog. The full listing of endangered, threatened, and rare species for the Headwaters Yellow River Watershed is provided in Table 5.

Table 5. Endangered, threatened and rare species in the Headwaters Yellow River Watershed (Indiana Department of Natural Resources 2015)**.**

Scientific Name	Common Name	State Status	Type
Tofieldia glutinosa	False Asphodel	SR	Vascular Plant
Xanthocephalus xanthocephalus	Yellow-headed Blackbird	SE	Bird
Platanthera orbiculata	Large Roundleaf Orchid	SX	Vascular Plant
Glyceria grandis	American Manna-grass	SE	Vascular Plant
Diervilla lonicera	Northern Bush-honeysuckle	SR	Vascular Plant
Taxidea taxus	American Badger	SSC	Mammal
Emydoidea blandingii	Blanding's Turtle	SE	Reptile
Panax trifolius	Dwarf Ginseng	WL	Vascular Plant
Pinus strobus	Eastern White Pine	SR	Vascular Plant
Gnaphalium macounii	Winged Cudweed	SX	Vascular Plant
Campeloma decisum	Pointed Campeloma	SSC	Mollusk Gastropod
Clonophis kirtlandii	Kirtland's Snake	SE	Reptile
Campeloma decisum	Pointed Campeloma	SSC	Mollusk Gastropod
Poa alsodes	Grove Meadow Grass	SR	Vascular Plant
Wetland - bog circumneutral	Circumneutral Bog	SG	High Quality Natural Community
Lymnaea stagnalis	Swamp Lymnaea	SSC	Mollusk Gastropod
Eriophorum gracile	Slender Cotton-grass	ST	Vascular Plant
Carex sparganioides var. cephaloidea	Thinleaf Sedge	SE	Vascular Plant
Viburnum opulus var. americanum	Highbush-cranberry	SE	Vascular Plant

SE = state endangered; ST = state threatened; SR = state rare; SSC = state species of special concern; SX = state extirpated; SG = state significant; WL = watch list

2.7 Watershed Inventory Part I Summary

The Headwaters Yellow River Watershed is an 187,300 acre watershed that has limited topographical relief as the result of the receding of the Wisconsin Glacier. The glacial events that occurred 70,000 years ago have also shaped the soil and hydrology of the watershed. The watershed contains significant amounts of partially hydric soils, which are scattered throughout the lower elevation areas of the watershed. Malfunctioning septic systems are likely present in the watershed considering 98% of the soils in the watershed are very limited for septic tank absorption fields. Therefore, failing septic systems should be considered a potential source of pathogens to the many streams in the watershed that are impaired for *E. coli*. In total, 73 miles of stream within the watershed are included on IDEM's list of impaired waterbodies. Most streams are listed for *E.* coli and a couple streams are listed for impaired biotic communities.

The topography of the watershed has formed twelve subwatersheds, each of which contains unique combinations of lentic and lotic habitats. The Headwaters Yellow River Watershed contains three primary lakes, all of which are on the IDEM list of impaired waterbodies, for phosphorus and Lake of the Woods is impaired for PCBs as well. As a result of these impairments each of these lakes has been extensively studied by local, state, and federal agencies in order to improve water quality. Streams of the watershed are largely fed by overland flow and the 154 miles of closed drains in the watershed. The extensive drain networks present in the watershed are a reflection of the dominance of agricultural and developed land uses in the watershed. Significant landscape alterations such as the loss of wetland acres, the channelization of streams and the construction of drainage ditches and tiles have changed how water flows across the landscape resulting in a decreased ability of the land to retain water thereby increasing overland flow and increasing general discharge levels within drainages. Flooding is a common occurrence in the watershed, especially during the spring months of March and April. Plymouth and Bremen are the primary urban areas in the watershed with flooding risks.

The land use of the watershed is dominated by row-crop agriculture, with limited use of no-till and cover crop practices relative to other Indiana counties. In 2015, approximately 14% of the row crop agricultural land dedicated to corn and 24% of the land dedicated to soybeans utilized no-till practices. Considering the widespread distribution of row-crop agricultural lands in the watershed significant opportunities exist to promote the use of no-till practices in the watershed. The increased use of no-till practices in the watershed would improve soil health and aide in the reduction of non-point source pollutants from row-crop agriculture. Natural ecosystems are rare in the Headwaters Yellow River Watershed and the majority of the natural ecosystems that remain in the watershed are not protected.

The most common natural ecosystems in the watershed are deciduous forest fragments and woody wetlands. However, there is one high quality natural area present in the watershed at the Glennwood Nature Preserve. This preserve is location of a circumneutral bog, which contains multiple rare plant species. Many of the remaining state endangered, threatened, and rare species have been observed in the watershed in proximity to the limited natural areas that remain in the watershed. Of the 187,300 acres of land in the watershed, only 124 acres (<1%) is publicly owned. Therefore, future efforts to address the concerns of the watershed will need to work closely and in cooperation with private landowners.

3 Watershed Inventory Part II

3.1 Water Quality Information

Water quality targets selected for the Headwater Yellow River watershed are aimed at providing good aquatic habitat quality to the organisms that live in and adjacent to the various drainages of the watershed and to provide suitable water quality to downstream resources. Water quality targets set for the Headwaters Yellow River are provided in Table 6.

Table 6. Water quality targets for measured parameters.

Parameter	Target	Reference
Ammonia	Range between 0.0075 mg/L and 0.2137 mg/L depending on temperature and pH	Indiana Administrative Code (327 IAC 2-1-6)
Atrazine	<3.0 µg/L	U.S. EPA Drinking water standard
Dissolved Oxygen	>4 mg/L and <12 mg/L	Indiana Administrative Code (327 IAC 2-1-6)
E. coli	<235 cfu (or MPN)/100mL Geo Mean <125 cfu/100mL	Indiana Administrative Code (327 IAC 2-1-6)
Nitrate+Nitrite	<1.5 mg/L (10 mg/L is the 327 IAC 2-1-6 standard for drinking water)	Dividing line between mesotrophic and eutrophic streams (Dodds, W.K. et al., 1998, Table 1, pg. 1459, and in EPA-822-B-00-002, p 27
pH	>6.5 and <9	Indiana Administrative Code (327 IAC 2-1-6)
TKN	<0.591 mg/L	U.S. EPA recommendation
Temperature	Monthly standard	Indiana Administrative Code (327 IAC 2-1-6)
Total Phosphorus	<0.30 mg/L	IDEM draft TMDL target
Total Suspended Solids (TSS)	<25 mg/L	Sediment in streams: sources, biological effects and control American Fisheries Society, Bethesda MD (Waters T.F., 1995)
Turbidity	10.4 NTU	U.S. EPA recommendation

Qualitative Habitat Evaluation Index (QHEI)	>51	Ohio EPA "Methods for Assessing Habitat in Flowing Waters Using the Qualitative Habitat Evaluation Index (QHEI) (June 2006) IDEM (2000)
Macroinvertebrate Index of Biotic Integrity (mIBI)	≥4	IDEM recommendation

Water samples, macroinvertebrate surveys, and habitat surveys were completed at 12 separate sampling locations in the Headwaters Yellow River Watershed from June 2015 through May 2016. Figure 14 and Table 7 provide the geographic location of each sample site in the watershed, what waterbody the site was located in and which subwatershed was represented by the sampling location. Water samples were collected from each sample site on a monthly basis during the sampling period. During the sampling period multiple stormflow and baseflow events were captured, providing a broad representation of the condition of each stream. Lastly, macroinvertebrate and habitat surveys were completed at each site in August 2015. The subsequent sections provide a summary of the water quality data as well as an analysis of the trends observed in the watershed. A more detailed report outlining the 12 month water quality sampling effort completed for the Headwaters Yellow River Watershed management plan can be found in Appendix C. Appendix C also contains the raw data obtained during the water quality, macroinvertebrate and habitat sampling.

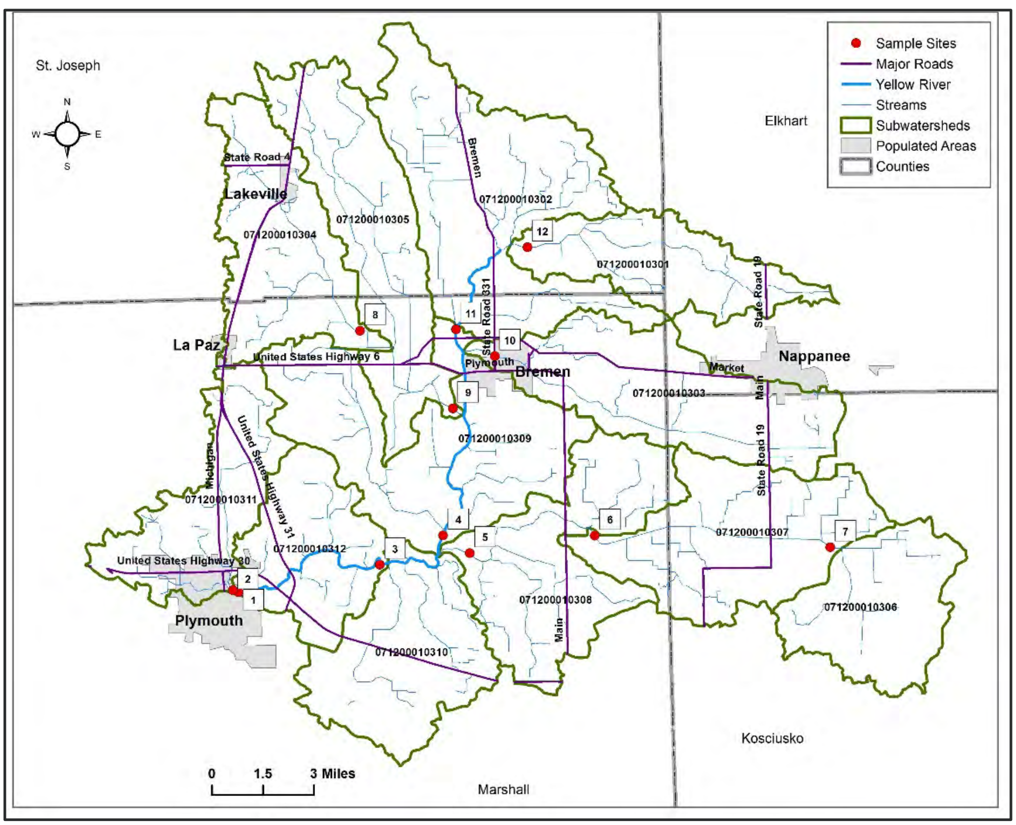


Figure 14. Location of sampling sites for the Headwaters Yellow River Watershed project (June 2015 – June 2016).

Table 7. Headwaters Yellow River Watershed sample site locations, coordinates, subwatersheds and descriptions.

Site ID	Physical Location and Watershed Location	Coordinates	Subwatershed Name	Subwatershed HUC
1	Randolph Dr – Yellow River	41.352961 -86.302878	Milner Seltenright Ditch-Yellow River	071200010312
2	Becknell Dr – Elmer Seltenright Ditch	41.353901 -86.306044	Elmer Seltenright Ditch-Yellow River	071200010311
3	8th Rd – Yellow River	41.364257 -86.222512	Stone Ditch-Yellow River	071200010310
4	7th Rd – Yellow River	41.376512 -86.186458	Lake of the Woods-Yellow River	071200010309
5	7B Rd – Dausman Ditch	41.368883 -86.171412	Dausman Ditch	071200010308
6	7th Rd – Dausman Ditch	41.375825 -86.100411	Lemler Ditch	071200010307
7	625 W – Dausman Ditch	41.369696 -85.966852	Fleugel Ditch	071200010306
8	1st Rd – Stock Ditch	41.464341 -86.232551	Headwaters Stock Ditch	071200010304
9	Grape Rd - Stock Ditch/Bunch Ditch	41.430768 -86.180228	West Bunch Branch-Stock Ditch	071200010305
10	SR 331 – Armey Ditch	41.452937 -86.156172	Armey Ditch	071200010303
11	1st Rd – Yellow River	41.464536 -86.177983	Kline Rouch Ditch-Yellow River	071200010302
12	Elm Rd – Lateral No. 5	41.499349 -86.13703	Lateral Ditch No. 5	071200010301

3.1.1 *E. coli*

The Indiana water quality standard for one grab sample per month of *E. coli* is 235 cfu/100mL. Average *E. coli* concentrations exceed this water quality standard at each sample site in the Headwaters Yellow River Watershed (Figure 15). Sample site #12 (Lateral Ditch No. 5 subwatershed) had the highest average *E. coli* concentration, while sample site #7 (Fleugel Ditch subwatershed) had the lowest average *E. coli* concentration (Figure 15). *E. coli* concentrations regularly exceeded 235 cfu/100mL during both stormflow and baseflow conditions. Approximately, 69% of all of the water samples collected in the watershed exceeded state standards for *E.coli* (Table 8).

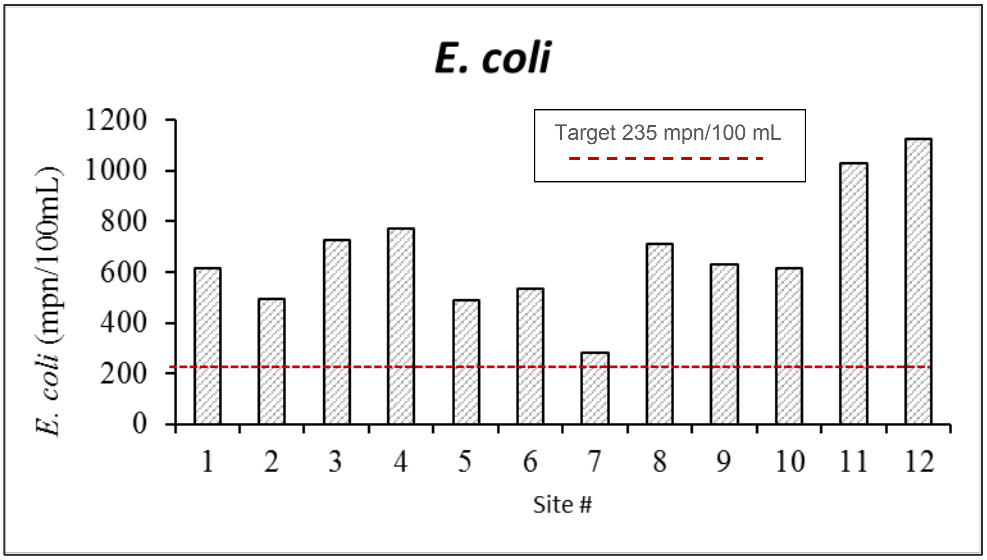


Figure 15. **Average *E. coli* concentration (mpn/100mL) for each sample location in the Headwater Yellow River watershed from June 2015 through May 2016.**

Table 8. **Target *E. coli* exceedance frequency by sample site taken from Headwaters Yellow River Watershed from June 2015 through May 2016.**

Sample Site	Target	Number of times exceeding Target	Percent of time exceeding Target	Sampled Range (mpn/100 mL)
1	235 mpn/100 mL	9/12	75%	135.4 – 2,419.6
2	235 mpn/100 mL	8/12	67%	46.4 – 2,417.6
3	235 mpn/100 mL	9/12	75%	156.5 – 2,419.6
4	235 mpn/100 mL	9/12	75%	146.7 – 2,419.6
5	235 mpn/100 mL	10/12	83%	131.7 – 1,413.6
6	235 mpn/100 mL	10/12	83%	101.9 – 1,732.9
7	235 mpn/100 mL	6/12	50%	29.2 – 816.4
8	235 mpn/100 mL	7/12	58%	38.4 – 2,419.6
9	235 mpn/100 mL	8/12	67%	40.8 – 2,419.6
10	235 mpn/100 mL	7/12	58%	84.4 – 2,419.6
11	235 mpn/100 mL	10/12	83%	164.3 – 2,419.6
12	235 mpn/100 mL	8/12	67%	82.3 – 2,419.6

As a result of the high *E. coli* concentrations that were observed during baseflow conditions, additional *E. coli* samples were collected on May 18th, 2016 and submitted for source tracking analysis. Source tracking samples were collected at three sample sites along the Yellow River. Sample sites included site #1 (Centennial Park off Randolph Drive, Plymouth), site #4 (7th Road, Marshall County), and site #11 (1st Road, Marshall County). One additional sample was collected from Lateral No. 5 at site #12 (Elm Road, St. Joseph County), which has a history of high *E. coli* concentrations. Samples collected from the Yellow River suggest that the primary source of *E. coli* to the Yellow River is human in origin (Figure 16). In fact, 80% of the *E. coli* at site #4 was human in origin (Figure 16). The sample collected from Lateral No. 5 suggests that the sources of *E. coli* to the stream are equally distributed between human and animal waste (Figure 16).

Figure 16. Source tracking of *E. coli* samples collected on May 18th, 2016. Red represents the percentage of *E. coli* from human sources and blue represents the percentage of *E. coli* from animal sources.

3.1.2 Nitrogen

Over the twelve month sampling period approximately 17% of all water samples collected in the watershed exceeded state water quality standards of 10 mg/L for nitrate-N+nitrite-N and 99% of all samples collected exceeded the target of 1.5 mg/L (Table 9). The highest average nitrate-N+nitrite-N concentration in the Headwaters Yellow River Watershed was observed at sample site #12, while the lowest average nitrate-N+nitrite-N concentration was observed at sample site #2 (Figure 17). The Dausman Ditch drainage (sample site #5, #6, and #7) had low average total phosphorus concentrations relative to other portions of the watershed, however nitrate-N+nitrite-N concentrations are relatively high (Figure 17).

Table 9. Target Nitrate + Nitrite exceedance frequency by sample site taken from Headwaters Yellow River Watershed from June 2015 through May 2016.

Sample Site	Target	Number of times exceeding Target	Percent of time exceeding Target	Sampled Range (mg/L)
1	1.5 mg/L 10 mg/L	12/12 0/12	100% 0%	3.27 – 9.48
2	1.5 mg/L 10 mg/L	11/12 0/12	92% 0%	1.29 – 3.27
3	1.5 mg/L 10 mg/L	12/12 0/12	100% 0%	3.35 – 9.01
4	1.5 mg/L 10 mg/L	12/12 0/12	100% 0%	3.49 – 8.30
5	1.5 mg/L 10 mg/L	12/12 3/12	100% 25%	3.08 – 12.80
6	1.5 mg/L 10 mg/L	12/12 5/12	100% 42%	3.74 – 14.00
7	1.5 mg/L 10 mg/L	12/12 5/12	100% 42%	3.08 – 13.60
8	1.5 mg/L 10 mg/L	12/12 0/12	100% 0%	1.87 – 5.48
9	1.5 mg/L 10 mg/L	12/12 0/12	100% 0%	2.59 – 7.36
10	1.5 mg/L 10 mg/L	12/12 0/12	100% 0%	2.14 – 9.59
11	1.5 mg/L 10 mg/L	12/12 5/12	100% 42%	5.88 – 12.80
12	1.5 mg/L 10 mg/L	12/12 6/12	100% 50%	3.01 – 15.30

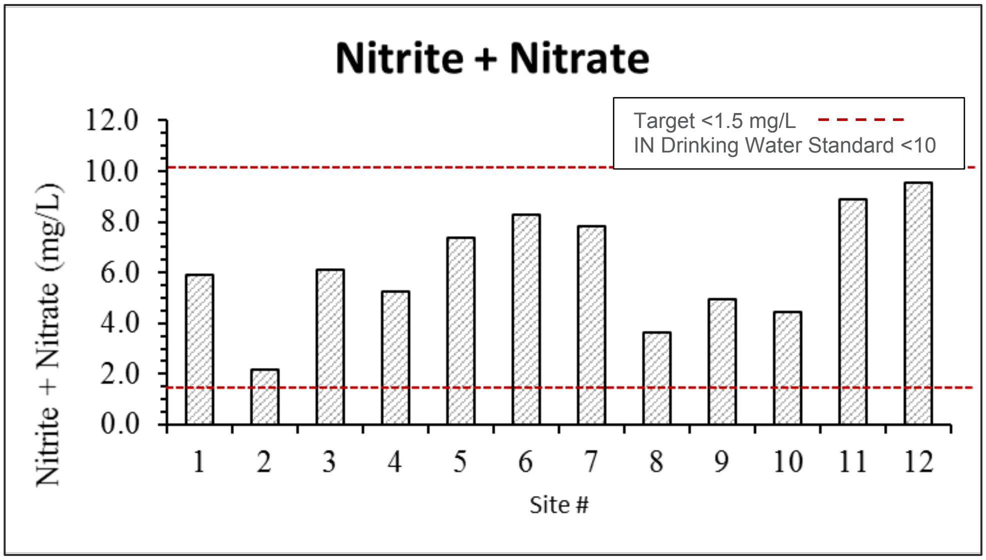


Figure 17. Average nitrate-N+nitrite-N concentration (mg/L) for each sample location in the Headwater Yellow River watershed from June 2015 through May 2016.

The sampled average ammonia concentrations were highest at Site 8 (Headwaters Stock Ditch watershed), followed by Site 11 (Kline Rouch watershed), Site 10 (Armey Ditch watershed) and Site 9 (West Bunch Branch – Stock Ditch watershed; Figure 18). Ammonia concentrations exceeded State Standards most frequently at Site 8/Headwaters Stock Ditch (nine times), followed by Site 11/Kline Rouch (five times), Site 9 West Bunch Branch – Stock Ditch (four times), Sites 10/Armey and 12/Lateral Number 5 (three times), and all other sites exceeded on only one occasion. The sampled average TKN concentrations exceeded the target of 0.591 at all sites except Site 2 and Site 12 which averaged 0.59 mg/L and 0.41 mg/L, respectively (Figure 19). All sites exceeded the TKN target a minimum of five times with those sites exceeding most frequently included Site 4/Lake of the Woods (11 times), Site 8/Headwaters Stock Ditch (10 times), Site 3/Stone Ditch (nine times), and Site 9/West Bunch Branch (eight times).

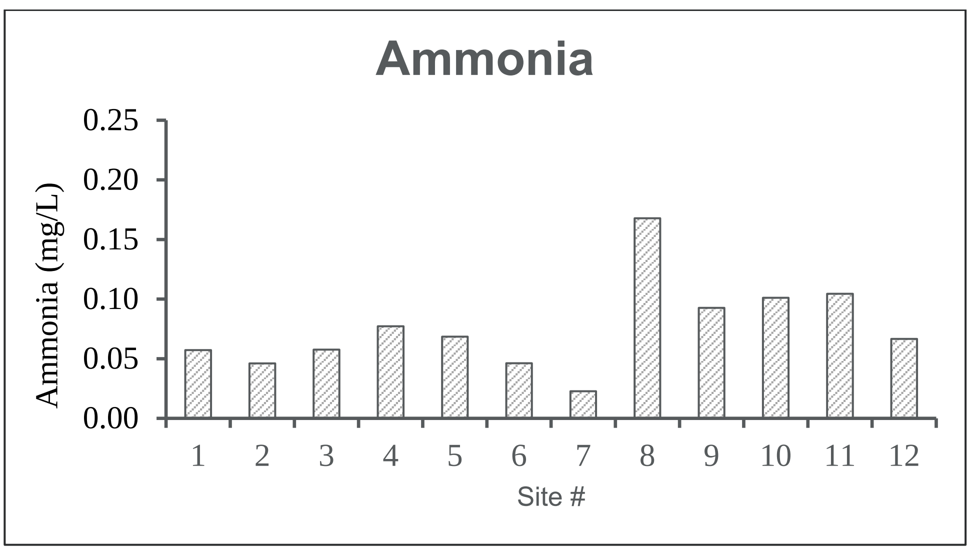


Figure 18. Average ammonia NH3 concentration (mg/L) for each sample location in the Headwater Yellow River watershed from June 2015 through May 2016.

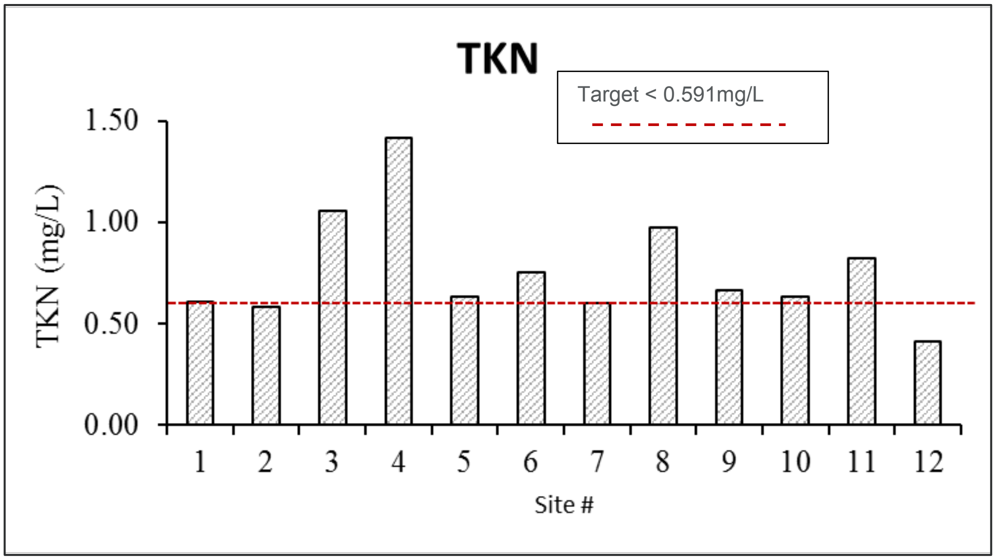


Figure 19. Average total Kjeldahl nitrogen (TKN) concentration (mg/L) for each sample location in the Headwater Yellow River watershed from June 2015 through May 2016.

3.1.3 Phosphorus

Over the twelve month sampling period approximately 32% of all water samples collected in the watershed exceeded the target value of 0.3 mg/L for phosphorus (Table 10). The highest average total phosphorus concentration in the Headwaters Yellow River Watershed was observed at sample site #12, while the lowest average total phosphorus concentration was observed at sample site #7 (Figure 20). The Dausman Ditch drainage (sample site #5, #6, and #7) had low average total phosphorus concentrations relative to other portions of the watershed (Figure 20).

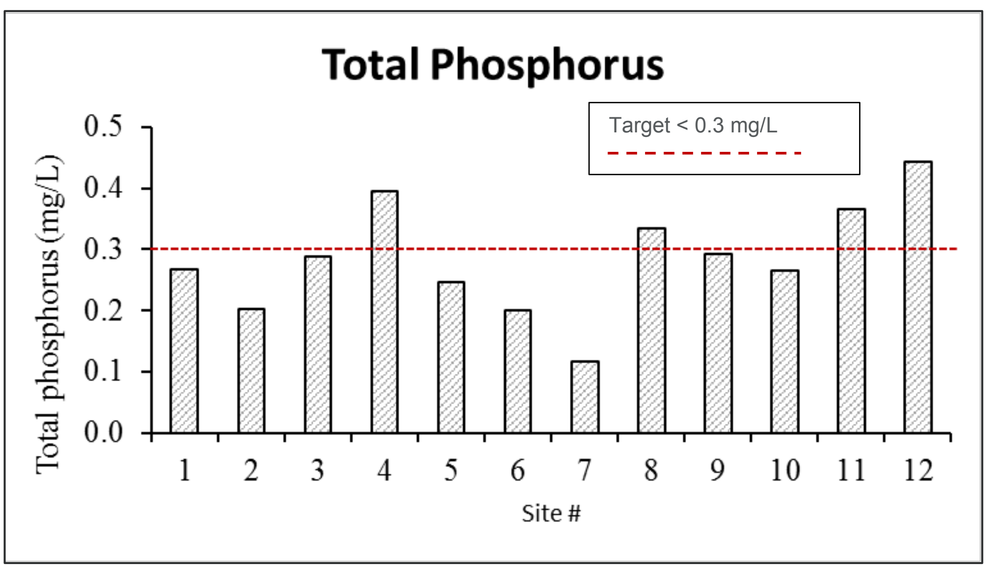


Figure 20. Average total phosphorus (TP) concentration (mg/L) for each sample location in the Headwater Yellow River watershed from June 2015 through May 2016.

Table 10. Target total phosphorus exceedance frequency by sample site taken from Headwaters Yellow River Watershed from June 2015 through May 2016

Sample Site	Target	Number of times exceeding Target	Percent of time exceeding Target	Sampled Range (mg/L)
1	0.3 mg/L	3/12	25%	0.150 – 0.498
2	0.3 mg/L	4/12	33%	0.076 – 0.379
3	0.3 mg/L	3/12	25%	0.153 – 0.460
4	0.3 mg/L	7/12	58%	0.153 – 0.976
5	0.3 mg/L	1/12	8%	0.030 – 1.500
6	0.3 mg/L	1/12	8%	0.061 – 1.130
7	0.3 mg/L	1/12	8%	0.030 – 0.488
8	0.3 mg/L	5/12	42%	0.150 – 0.860
9	0.3 mg/L	3/12	25%	0.132 – 0.865
10	0.3 mg/L	4/12	33%	0.125 – 0.548
11	0.3 mg/L	6/12	50%	0.100 – 0.849
12	0.3 mg/L	7/12	58%	0.131 – 1.120

3.1.4 Sediment

During the twelve month sampling period the average total suspended solids (TSS) concentration leaving the Headwaters Yellow River Watershed was 9.4 mg/L (Figure 21), as determined from Site 1, which is the downstream extent of the Yellow River in the Headwaters Yellow River Watershed. All sites average TSS concentrations were below the target level of 25 mg/L with the exception of Site 4 (Lake of the Woods-Yellow River watershed) and Site 9 (West Bunch Branch-Stock Ditch watershed; Table 11). Sampled TSS concentrations exceed the target of 25 mg/L approximately 14% of the time during the sampling period. The average TSS concentration is generally higher further upstream in the watershed, with higher average TSS concentrations at each of the sample sites (sample sites #3, #4, and #11) along the mainstem of the Yellow River (Figure 21). Sample sites #4 and #9 appear to be significant areas of the sediment contribution (Figure 21). However, the average TSS concentration for these sites may be skewed to temporary drainage maintenance activities that were taking place during some sampling events. This data also suggests that a high proportion of the sediment being transported from headwater drainages to the Yellow River drops out of the water column before reaching Plymouth. There are a large number of floodplain wetlands between Bremen and Plymouth that likely promote the removal of sediment during storm flow events (Figure 4 and Figure 11). The average turbidity at sample sites exceeded the target level of 10.4 NTU at all sites with the exception of Site 2 (Elmer Seltenright Ditch) and Site 7 (Fleugel Ditch-Dausman Ditch watershed; Figure 22).

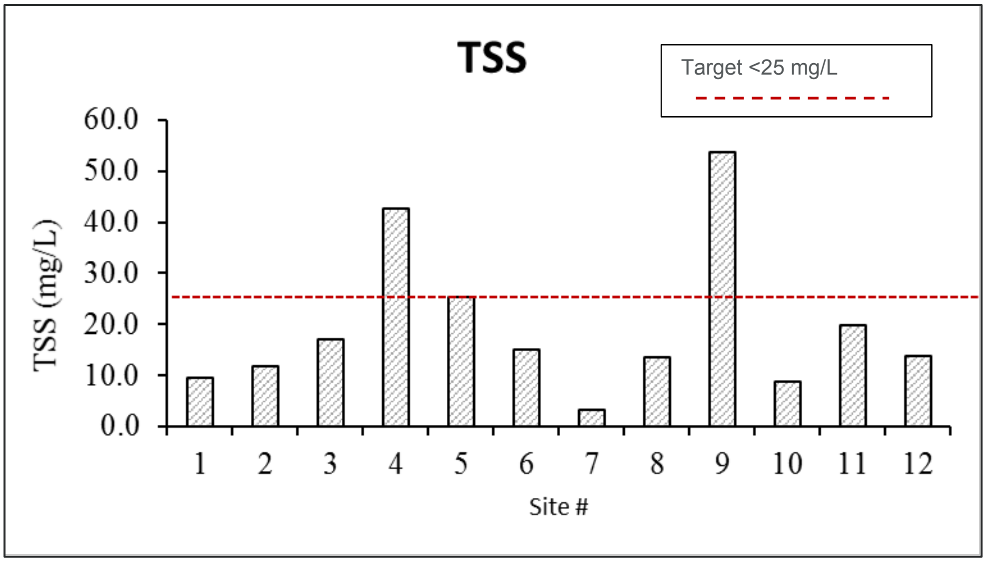


Figure 21. **Average total suspended solids (TSS) concentration (mg/L) for each sample location in the Headwater Yellow River watershed from June 2015 through May 2016.**

Table 11. **Target total suspended solids (TSS) exceedance frequency by sample site taken from Headwaters Yellow River Watershed from June 2015 through May 2016**

Sample Site	Target	Number of times exceeding Target	Percent of time exceeding Target	Sampled Range mg/L
1	25 mg/L	1/12	8%	1 - 45
2	25 mg/L	2/12	17%	1 - 43
3	25 mg/L	3/12	25%	2 - 68
4	25 mg/L	3/12	25%	1 - 274
5	25 mg/L	2/12	17%	1 - 201
6	25 mg/L	1/12	8%	1 - 111
7	25 mg/L	0/12	0%	1 - 16
8	25 mg/L	1/12	8%	2 - 67
9	25 mg/L	2/12	17%	1 - 435
10	25 mg/L	1/12	8%	1 - 36
11	25 mg/L	2/12	17%	1 - 153
12	25 mg/L	2/12	17%	1 - 54

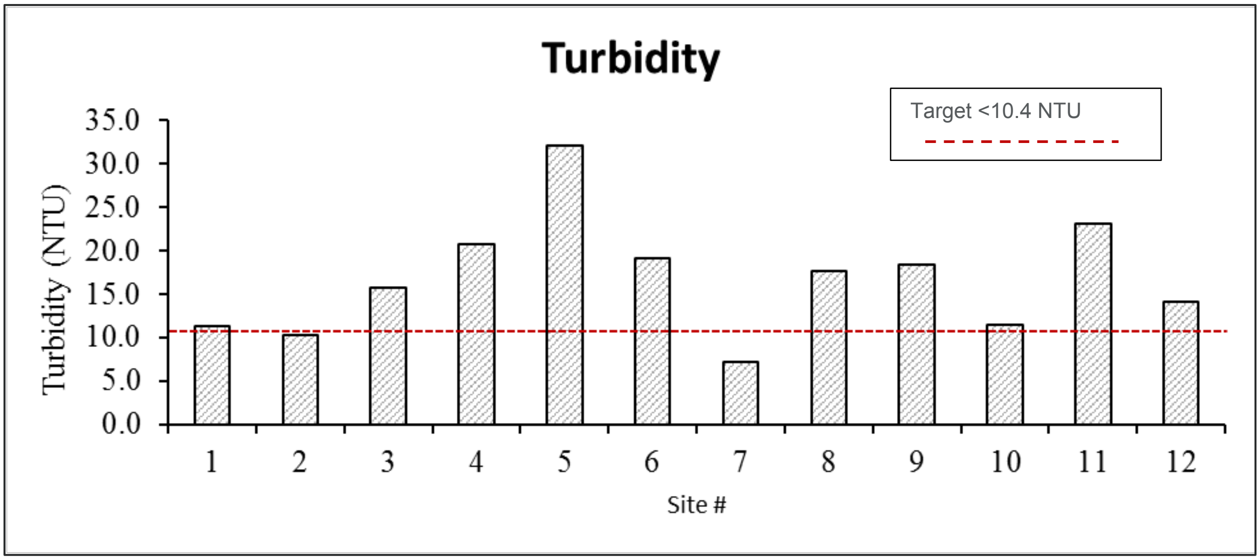


Figure 22. **Average turbidity concentration (NTU) for each sample location in the Headwater Yellow River watershed from June 2015 through May 2016.**

3.1.5 Atrazine

The average Atrazine concentration did not exceed the target level of 3.0 µg/L at any site and did not exceed the target level during any one sampling event (Figure 23).

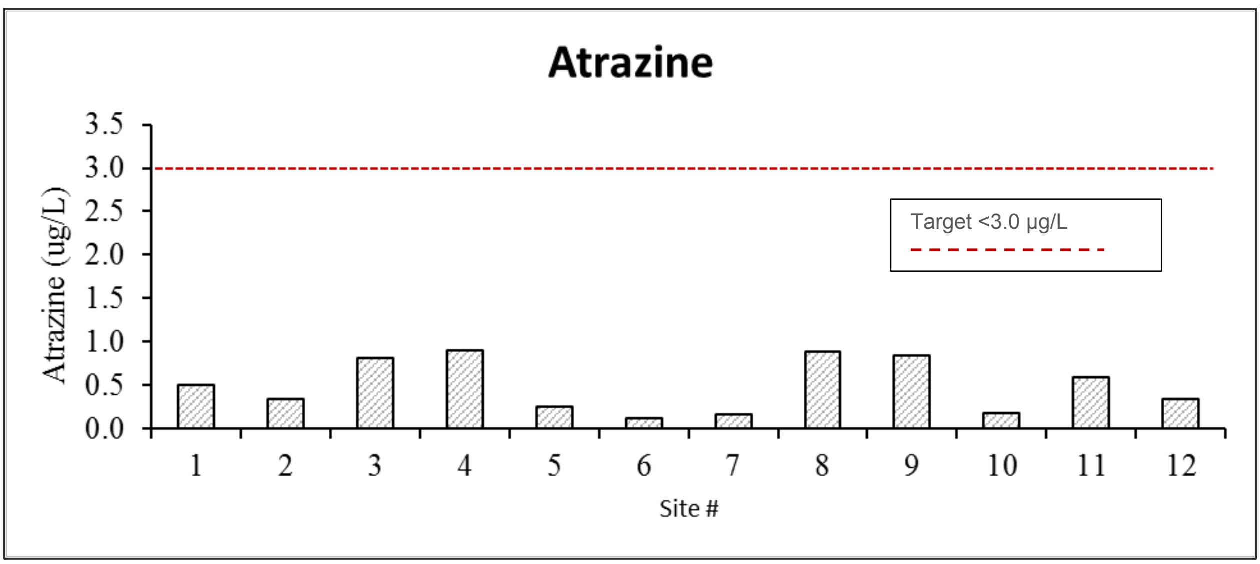


Figure 23. **Average Atrazine concentration (µg/L) for each sample location in the Headwater Yellow River watershed from June 2015 through May 2016.**

3.1.6 Macroinvertebrate (mIBI) and Habitat (QHEI)

Figure 24 describes the health of the macroinvertebrate community for each sample site using the mIBI. The mIBI is a biotic index that uses macroinvertebrate community structure as an indicator of stream impairment. Sample sites #1, #3, #4, #5, #6, and #9 scored between 4 and 6 on the mIBI indicating that each of these streams is slightly impaired (Figure 24). Sample sites #2, #7, #8, #10, #11, and #12 scored between 2 and 4 on the mIBI indicating that each of these streams is “moderately impaired” (Figure 24). There were no streams in the watershed that are categorized as “non-impaired” or “severely impaired” on the mIBI.

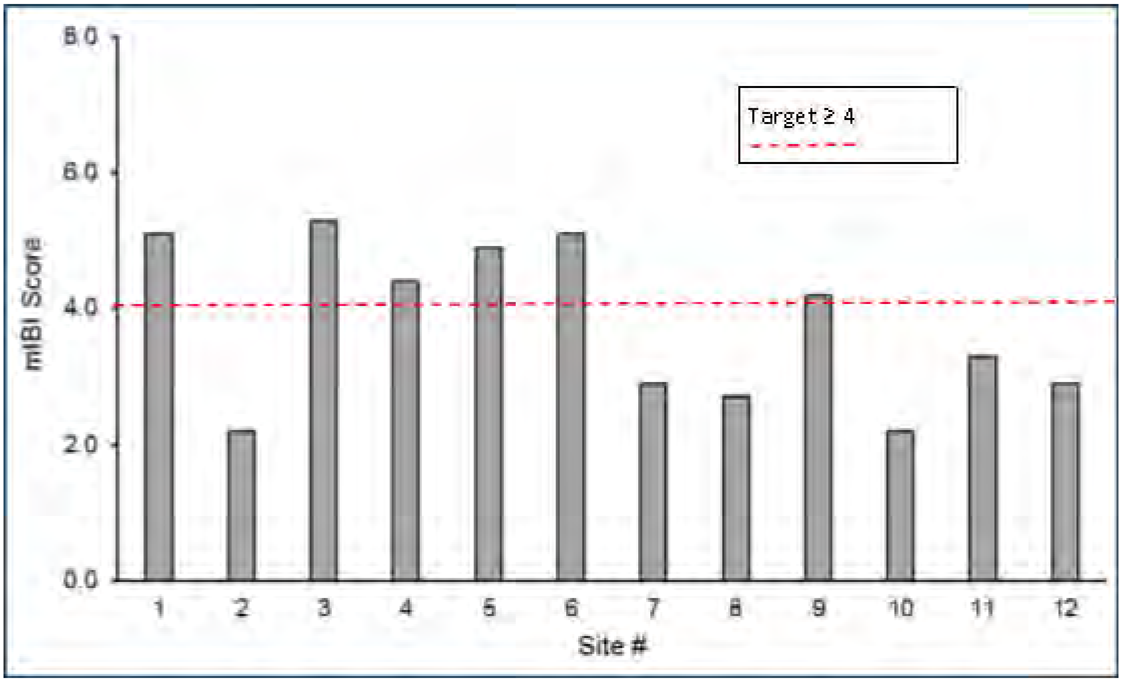


Figure 24. Comparison of mIBI scores for each sample site in the Headwaters Yellow River Watershed. Based on the IDEM mIBI protocol severely impaired streams have a score between 0 and 2, moderately impaired streams are between 2 and 4, slightly impaired streams are between 4 and 6, and non-impaired streams are between 6 and 8.

Figure 25 describes the available habitat at each sample site using the Qualitative Habitat Evaluation Index (QHEI). Sample site #2 had the highest QHEI score in the watershed and is categorized as having “good” habitat (Figure 25). Sample site #1, #3, #6, and #11 are the remaining samples sites categorized as having “good” habitat (Figure 25). Sample site #9 and #12 had QHEI scores between 43 and 54, which categorizes these sites as “fair” habitat (Figure 25). Sample site #4, #5, #7, #8, and #10 had QHEI scores between 30 and 42, which categorizes these sites as “poor” habitat (Figure 25). There were no streams in the watershed that scored in the “excellent” or “very poor” habitat category. The majority of the headwater streams in the watershed and the upper portion of the Yellow River lack riparian vegetation. Riparian corridors become more common along the lower portion of the Yellow River between Plymouth and 7th Road in Marshall County.

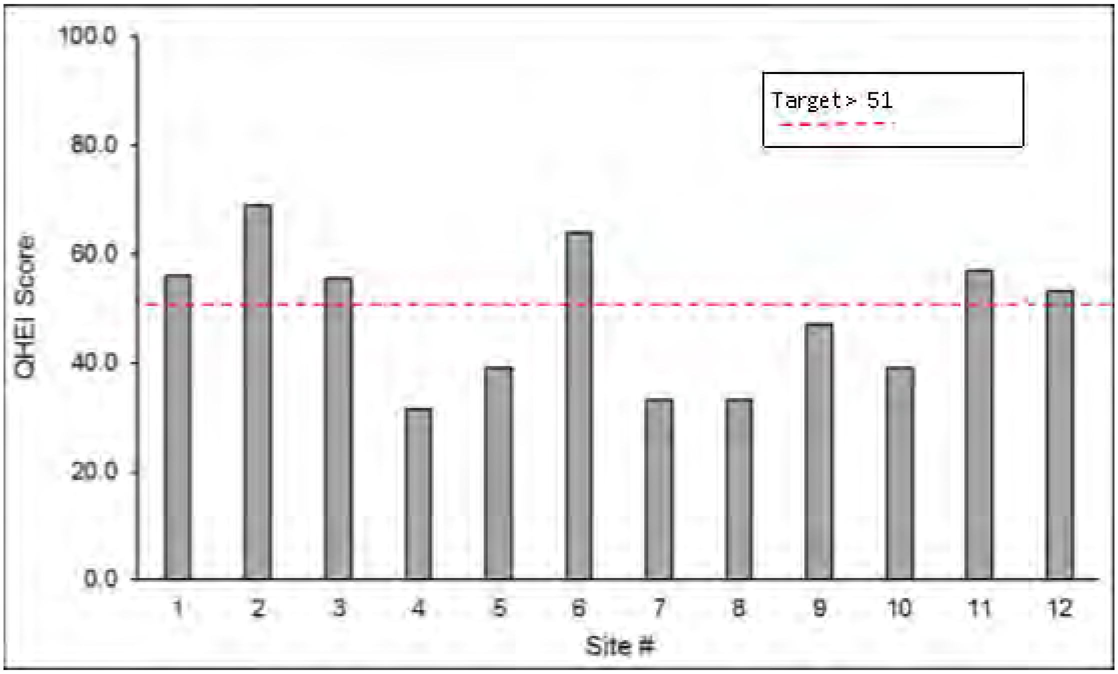


Figure 25. Comparison of QHEI scores for each sample site in the Headwaters Yellow River Watershed. Based on the QHEI protocol sites with scores <30 are very poor, 30 to 42 are poor, 43 to 54 are fair, 55 to 69 are good, and >70 are excellent.

3.2 HUC-12 Subwatersheds

The Headwaters Yellow River Watershed consists of twelve (HUC 12) subwatersheds. Figure 3 displays the location, name, and the twelve digit hydrologic unit code (HUC) for each subwatershed. In the subsequent sections the known watershed conditions as sampled during the 12 month sampling efforts from June 2015 through June 2016 and land use of each subwatershed are described. Included in this analysis for each subwatershed is data collected during a 2015 windshield survey. The windshield survey looked at 222 sites across the Headwaters Yellow River Watershed. The windshield survey was completed by driving to each of the 222 sites via car and observing the site from the road. At each site the degree of streambank erosion, channelization, stream buffers, and in-stream cover of each site was visually assessed. Streambank erosion, channelization, and stream buffers were evaluated on a scale ranging from 0 to 4. A score of "0" indicates that particular characteristic was not observed at the site. Score from 1 through 4 indicate incremental increases in the occurrence of the given characteristic. In-stream cover was evaluated on a scale ranging from 0 to 6, with a larger score indicating greater in-stream cover. The results of each characteristic were then averaged across the 222 sites that were surveyed in the Headwaters Yellow River Watershed. In the subsequent sections the average score for each characteristic in each subwatershed is compared and evaluated in relation to the Headwaters Yellow River Watershed as a whole. A summary of this data is displayed in Table 12.

Table 12. Summary of the subwatershed habitat analysis from the 2015 windshield survey (higher average indicate an increased occurrence for each parameter).

Subwatershed	Streambank Erosion	Channelization	Stream Buffers	In-stream Cover
Armey Ditch x̅	1.2	3.6	1.6	1.9
Dausman Ditch x̅	0.8	3.9	0.4	1.9
Elmer Seltenright Ditch x̅	0.8	3.2	2.0	3.1
Fleugel Ditch x̅	0.5	3.2	0.4	1.0
Headwaters Stock Ditch x̅	0.5	1.7	1.3	2.1
Kline Rouch Ditch x̅	0.5	2.9	1.2	2.9
Lake of the Woods x̅	0.9	3.4	0.8	2.0
Lateral Ditch No. 5 x̅	0.8	3.6	0.7	2.5
Lemler Ditch x̅	1.1	3.7	0.3	1.4
Milner Seltenright Ditch x̅	1.2	1.8	2.9	3.3
Stone Ditch x̅	0.7	2.5	1.1	2.4
West Bunch Branch x̅	0.7	3.2	0.7	2.1
Headwaters Yellow River Watershed Average	0.8	3.1	1.1	2.2

3.2.1 Armey Ditch (HUC: 071200010303)

The Armey Ditch subwatershed is located in the eastern portion of the Headwaters Yellow River Watershed and contains both urban and rural land uses. There are two urban areas in the Armey Ditch subwatershed including portions of Bremen and Nappanee (Figure 26). Developed land use accounts for 13.2% of the Armey Ditch subwatershed which is the second highest amount of developed space in the Headwaters Yellow River watershed. Numerous manufacturing facilities are present in Nappanee and Bremen, with the potential for increased development at this time. Currently there are no large scale industrial facility development projects occurring in the Armey Ditch subwatershed. Predominate land use in the Armey Ditch subwatershed is cultivated crops and accounts for 65.5% of the watershed. Another 11.5% of the land in the watershed is dedicated to hay/pasture. The portion of the watershed that contains forested, wetland, or herbaceous habitat is relatively small (Table 13). Current landuse trends do not indicate a shift in the dominate landuse proportions at this time.

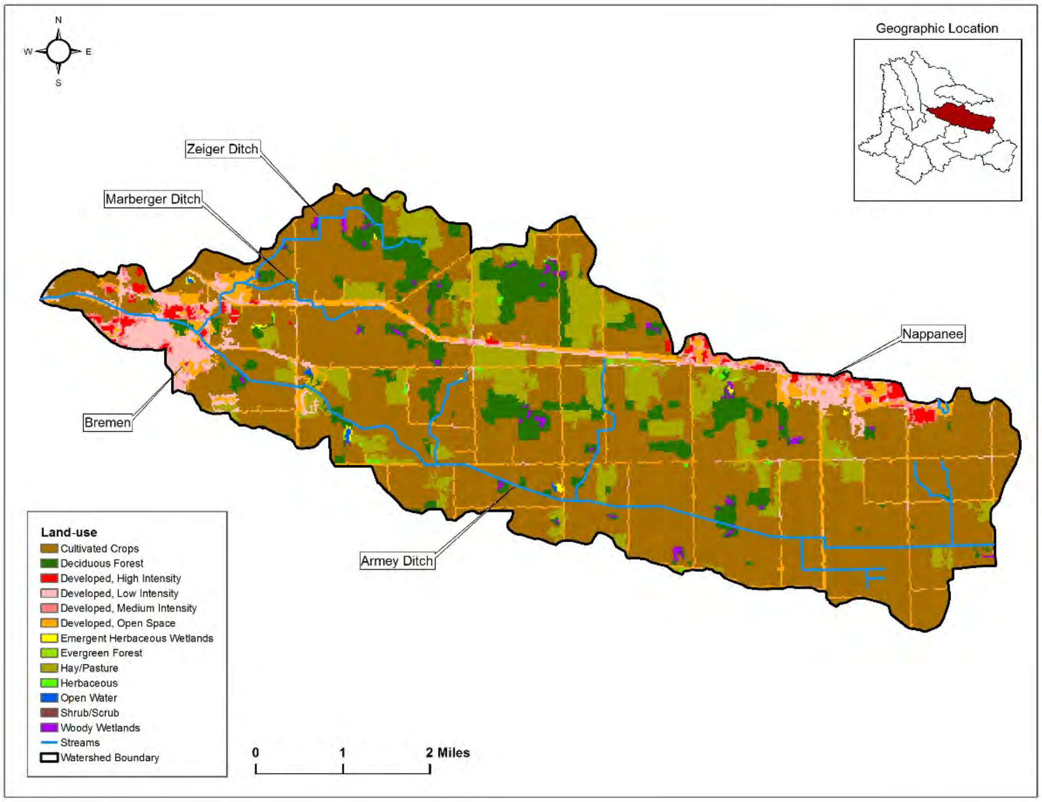


Figure 26. Armey Ditch subwatershed landuse.

Table 13. Percentage and acreage of each land use type in the Armey Ditch subwatershed (HUC: 071200010303).

Land use	% of Watershed	Acres
Open Water	0.1%	12
Developed, Open Space	6.1%	1,061
Developed, Low Intensity	4.6%	795
Developed, Medium Intensity	1.3%	225
Developed, High Intensity	1.1%	198
Deciduous Forest	8.8%	1,525
Evergreen Forest	0.1%	14
Shrub/Scrub	0.0%	6
Herbaceous	0.2%	26
Hay/Pasture	11.5%	1,988
Cultivated Crops	65.5%	11,335
Woody Wetlands	0.6%	99
Emergent Herbaceous Wetlands	0.1%	20

The Armey Ditch subwatershed contains 22 miles of streams and 6 miles of closed drains (Figure 27). There are multiples waterbodies with water quality concerns in the watershed, including. Approximately 22.2 miles of streams listed as impaired by IDEM as the result of high *E. coli* concentrations (Figure 27). Five water samples were collected from Armey Ditch in 2008, all of which exceeded the state standard for *E. coli* (Tetra Tech 2009). Based on the *E. coli* concentrations detected in 2008 an *E. coli* reduction of 89% would be needed for Armey Ditch to meet water quality standards (Tetra Tech 2009). EPA STORET (Storage and Retrieval) data (2000) for water samples collected from Armey Ditch in Bremen averaged 459.4 cfu/100 ml, which is above the state standard of 235 cfu/100ml.

Photo: Stream in the Armey Ditch subwatershed that has been channelized and contains no stream buffer.

The watershed contains one National Pollutant Discharge Elimination System (NPDES) facility in the northeast portion of the watershed, however this permit is now terminated (Figure 27). The watershed also contains one confined feeding operations (CFO), located south of Nappanee (Figure 27).

There were seventeen locations surveyed in the Armey Ditch subwatershed during the windshield survey (Figure 28). The results of the windshield survey indicate that many of the streams in the watershed have degraded habitat. Forty-one percent of the survey sites (7/17) were listed as having poor in-stream cover (Figure 28). Stream buffers were assessed to be absent on 8.15 miles (37%) of the approximately 22 miles of streams within the Armey Ditch subwatershed. Streambank erosion was listed as sever or very sever at 12% of the sites (7/17 sites; Figure 28). Direct livestock access to streams was not noted within the Armey Ditch subwatershed during the windshield survey. Overall, windshield survey results indicate that relative to the Headwaters Yellow River Watershed as a whole the streambank erosion in the Armey Ditch subwatershed is more prevalent, channelization is more prevalent, stream buffers are more prevalent, and in-stream cover is less prevalent (Table 12; Table 14).

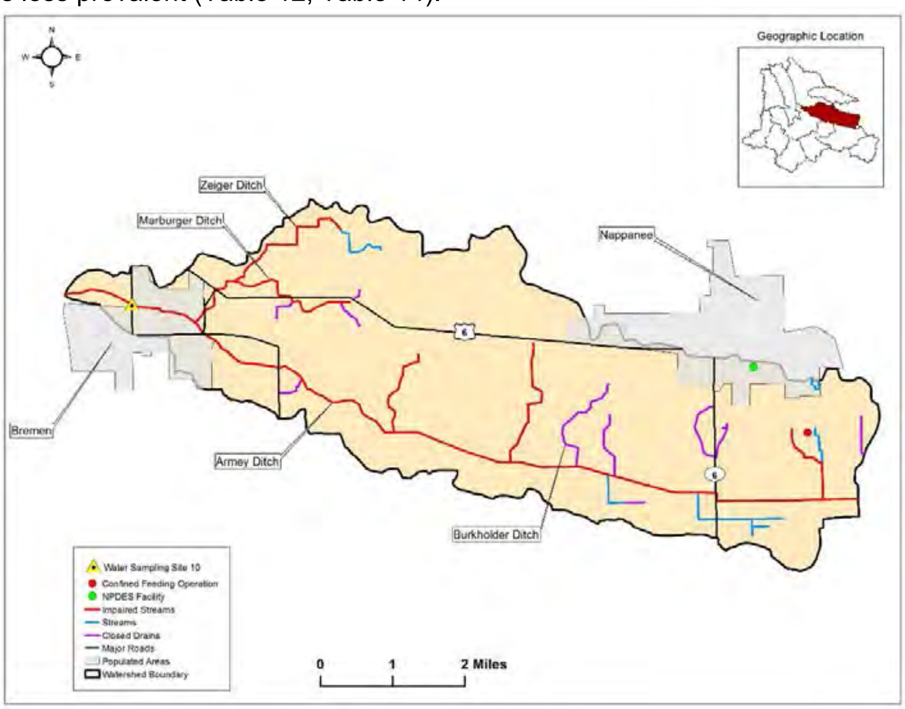


Figure 27. Armey Ditch subwatershed water quality information map.

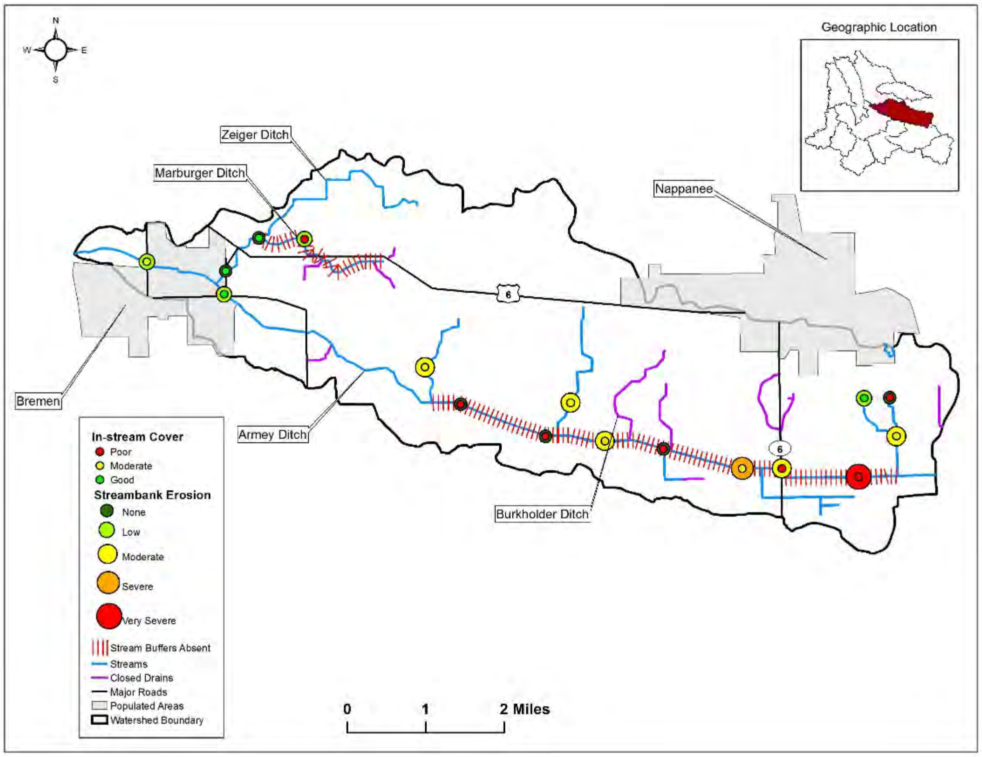


Figure 28. Armey Ditch subwatershed 2015 windshield survey sites and results.

Table 14. Results of the Armey Ditch subwatershed 2015 windshield survey.

Subwatershed	Streambank Erosion	Channelization	Stream Buffers	In-stream Cover
Armey Ditch $\bar{x}$	1.2	3.6	1.6	1.9
Headwaters Yellow River Watershed Average	0.8	3.1	1.1	2.2

Testing Site 10 was located in Armey Ditch and used to evaluate the overall water quality of the Armey Ditch subwatershed (Figure 27). Table 15 displays the mean values of sampled water quality parameters and the determined scores for biological and habitat assessments at Site 10 during the 12 month sampling period from June 2015 through May 2016. The mean E. coli concentration was 616 mpn/100mL, which exceeds the project target of 235 mpn/100mL and ranked as the eighth lowest mean between all sites (Figure 15). E. coli levels exceeded the project target 7 out of 12 events (58%) during the sampling period. Nitrate + Nitrite mean concentration was the tenth lowest of 12 sampling sites, and exceeded the project target during all sampling events and the Indiana State standard on zero occasions (Figure 17; Table 15). Site 10 had the third highest ammonia mean at 0.101 mg/L and exceeded Indiana State standards during three events (25%; Figure 18; Table 15). TSS concentrations only exceeded the project target during one event and overall TSS levels were the eleventh lowest between all sites. Total phosphorus concentrations exceeded the project target 33% of the time and overall was the eighth lowest between the 12 sites. The mean water quality parameters within project targets include total phosphorus, total suspended solids, Atrazine, pH and dissolved oxygen. Site 10 did not meet project targets for both habitat (QHEI) and biological (MIBI) assessments. A complete listing of water quality testing results from the 12 month sampling period can be found in Appendix C.

Table 15. Site 10 water quality analysis – Armey Ditch Subwatershed.

Parameter	Mean/Score	Unit	# of Times Does not Meet Target	% Does not Meet Target
Total Phosphorus	0.26	mg/L	4	33
Dissolved Phosphorus	0.15	mg/L	-	-
Nitrate + Nitrite	4.43	mg/L	1.5 mg/L 12	100
			10 mg/L 0	0
Ammonia	0.101	mg/L	3	25
TKN	0.64	mg/L	5	42
E. coli	616	mpn/100mL	7	58
Atrazine	0.17	µg/L	-	-
TSS	9	mg/L	1	8
Turbidity	11.45	NTU	4	33
Dissolved Oxygen	8.1	mg/L	0	0
pH	7.93	-	0	0
QHEI	39	-	Does not meet target	
MIBI	2.2	-	Does not meet target	

3.2.2 Dausman Ditch (HUC: 0712000105)

The Dausman Ditch subwatershed is located in the southern portion of the Headwaters Yellow River Watershed (Figure 29). The Dausman Ditch subwatershed has no populated areas and therefore has relatively little developed land (Table 16); however, agricultural land uses are common in the watershed. Water quality impacts from developed land or industrial faculties is not a concern within the Dausman Ditch subwatershed. Cultivated crops account for 86.5% of the watershed and hay/pasture account for 2.3% of the watershed. The portion of the watershed that contains forested, wetland, and additional natural habitats are relatively small (Table 15). Current landuse proportions are expected to remain consistent into the future and increased development from industrial facilities is not anticipated.

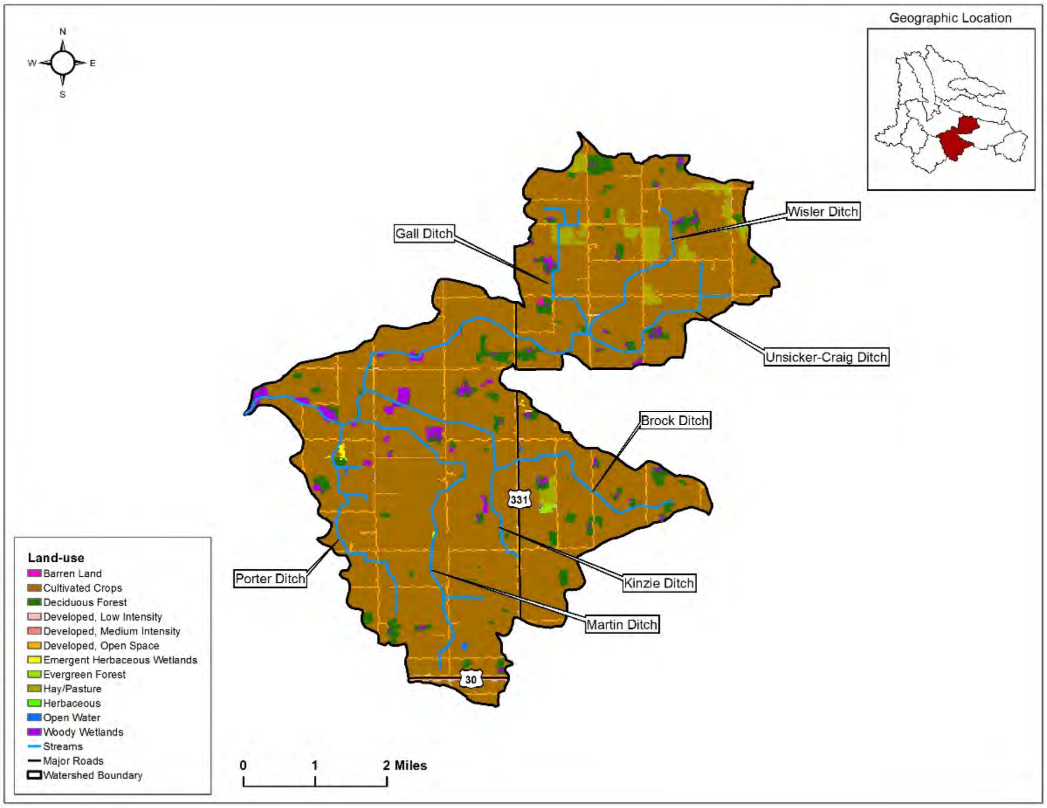


Figure 29. Dausman Ditch subwatershed landuse.

Table 16. Percentage and acreage of each land use type in the Dausman Ditch subwatershed (HUC: 0712000105).

Land use	% of Watershed	Acres
Open Water	0.1%	9
Developed, Open Space	4.6%	761
Developed, Low Intensity	0.4%	61
Developed, Medium Intensity	0.0%	1
Barren Land	0.0%	4
Deciduous Forest	4.3%	711
Evergreen Forest	0.1%	15
Herbaceous	0.0%	3
Hay/Pasture	2.3%	386
Cultivated Crops	86.5%	14,391
Woody Wetlands	1.7%	277
Emergent Herbaceous Wetlands	0.1%	17

The Dausman Ditch subwatershed contains approximately 25 miles of streams and 12 miles of closed drains (Figure 30). There are currently no streams in the Dausman Ditch subwatershed listed as impaired. There are also no NPDES facilities in the watershed. However, there are two CFO's located in the watershed. One CFO is located east of Martin Ditch near Highway 331 and the other is located near Kinzie Ditch (Figure 30). There were seventeen locations surveyed in the Dausman Ditch subwatershed during the windshield survey (Figure 31). The degree of streambank erosion in the Dausman Ditch subwatershed is equivalent to the average for the whole Headwaters Yellow River Watershed and there were no sites identified as having severe or very severe streambank erosion (Table 17; Figure 31). However, channelization is more prevalent, stream buffers are less prevalent and in-stream cover is less prevalent relative to the Headwaters Yellow River Watershed as a whole (Table 12;Table 17). In-stream cover was rated poor at 35% of the windshield survey sites (6/17) and stream buffers were estimated to be absent on 18.79 miles (75%) of the 25 miles of streams in the Dausman Ditch Subwatershed. There was one location where livestock were noted as having direct access to a stream (Figure 31).

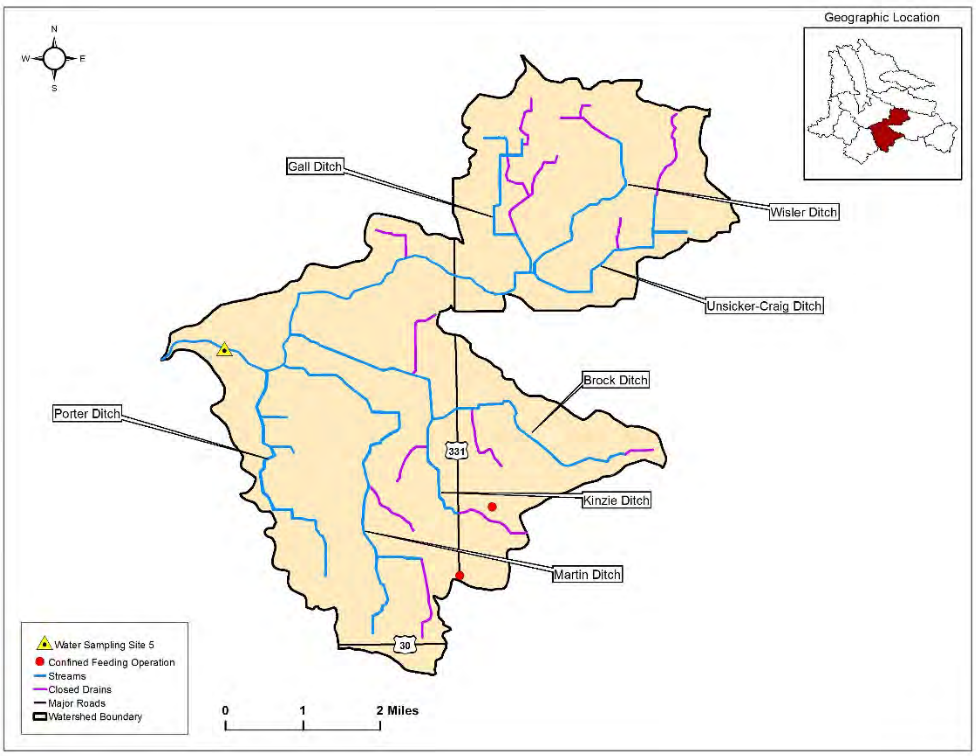


Figure 30. Dausman Ditch subwatershed water quality information map.

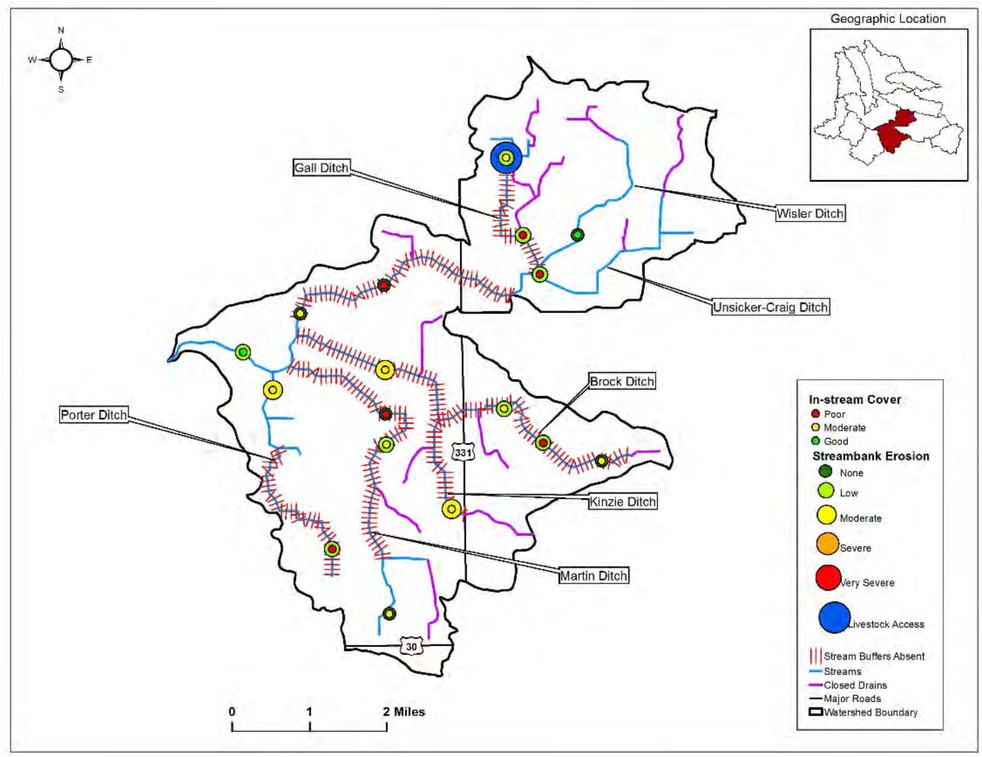


Figure. 31. Results of the Dausman Ditch subwatershed 2015 windshield survey.

Table 17. Results of the Dausman Ditch subwatershed 2015 windshield survey.

Subwatershed	Streambank Erosion	Channelization	Stream Buffers	In-stream Cover
Dausman Ditch x̅	0.8	3.9	0.4	1.9
Headwaters Yellow River Watershed Average	0.8	3.1	1.1	2.2

Testing Site 5 was located in Dausman Ditch and used to evaluate the overall water quality of the Dausman Ditch subwatershed (Figure 30). Table 18 displays the mean values of sampled water quality parameters and the determined scores for biological and habitat assessments at Site 5 during the 12 month sampling period from June 2015 through May 2016. The mean E. coli concentration was 489 mpn/100mL and exceeds the Indiana State standard of 235 mpn/100mL. E. coli levels exceeded the Indiana standard 83% of the time (10/12) and the mean E. coli concentration was the second lowest between all sites. Total phosphorus mean concentration was 0.25 mg/L ranking as the ninth lowest between all sites and was within the project target (Figure 20). Total phosphorus project target concentration was exceeded only one time during the 12 month sampling period. TSS mean concentration was the third highest between all sites (Figure 20) and exceeded the project target during two sampling events (Table 18). TSS mean value was impacted by a high concentration in February 2016, as was the situation at numerous others sites during that sampling event. The mean turbidity value was 32.16 NTU and ranked as the highest mean between all sites. Turbidity samples exceeded the project target 42% of the time over the twelve month sampling period. The mean water quality parameters meeting the project target include total phosphorus, Atrazine, TSS, dissolved oxygen and pH. The MIBI assessment meet target biological levels however the QHEI habitat assessment was below the project target. A complete listing of water quality testing results from the 12 month sampling period can be found in Appendix C.

Table 18. Site 5 water quality analysis – Dausman Ditch subwatershed.

Parameter	Mean/Score	Unit	# of Times Does not Meet Target	% Does not Meet Target
Total Phosphorus	0.25	mg/L	1	8
Dissolved Phosphorus	0.11	mg/L	-	-
Nitrate + Nitrite	7.37	mg/L	1.5 mg/L 12	100
			10 mg/L 3	25
Ammonia	0.069	mg/L	1	8
TKN	0.63	mg/L	5	42
E. coli	489	mpn/100mL	10	83
Atrazine	0.25	µg/L	-	-
TSS	25	mg/L	2	17
Turbidity	32.16	NTU	5	42
Dissolved Oxygen	9.1	mg/L	0	0
pH	8.09	-	0	0
QHEI	39	-	Does not meet target	
MIBI	4.9	-	Meets target	

3.2.3

3.2.4 Elmer Seltenright Ditch (HUC: 071200010311)

The Elmer Seltenright Ditch subwatershed is located in the southwestern portion of the Headwaters Yellow River Watershed (Figure 32). The subwatershed contains a significant portion of Plymouth, which is the largest town in the Headwaters Yellow River Watershed. Therefore, developed land accounts for a significant portion of the subwatershed at 22.7%. Increases in developed land is expected in the future from both residential and industrial developments and responsible development strategies should be focus for future watershed management efforts. While development of the Elmer Seltenright Ditch subwatershed is greater than any other subwatershed, agricultural land use still dominates. Cultivated crops account for 59.1% of the watershed and hay/pasture account for another 4.5% of the watershed. The portion of the watershed that contains forested, herbaceous, and wetland habitats are relatively small (Table 19).

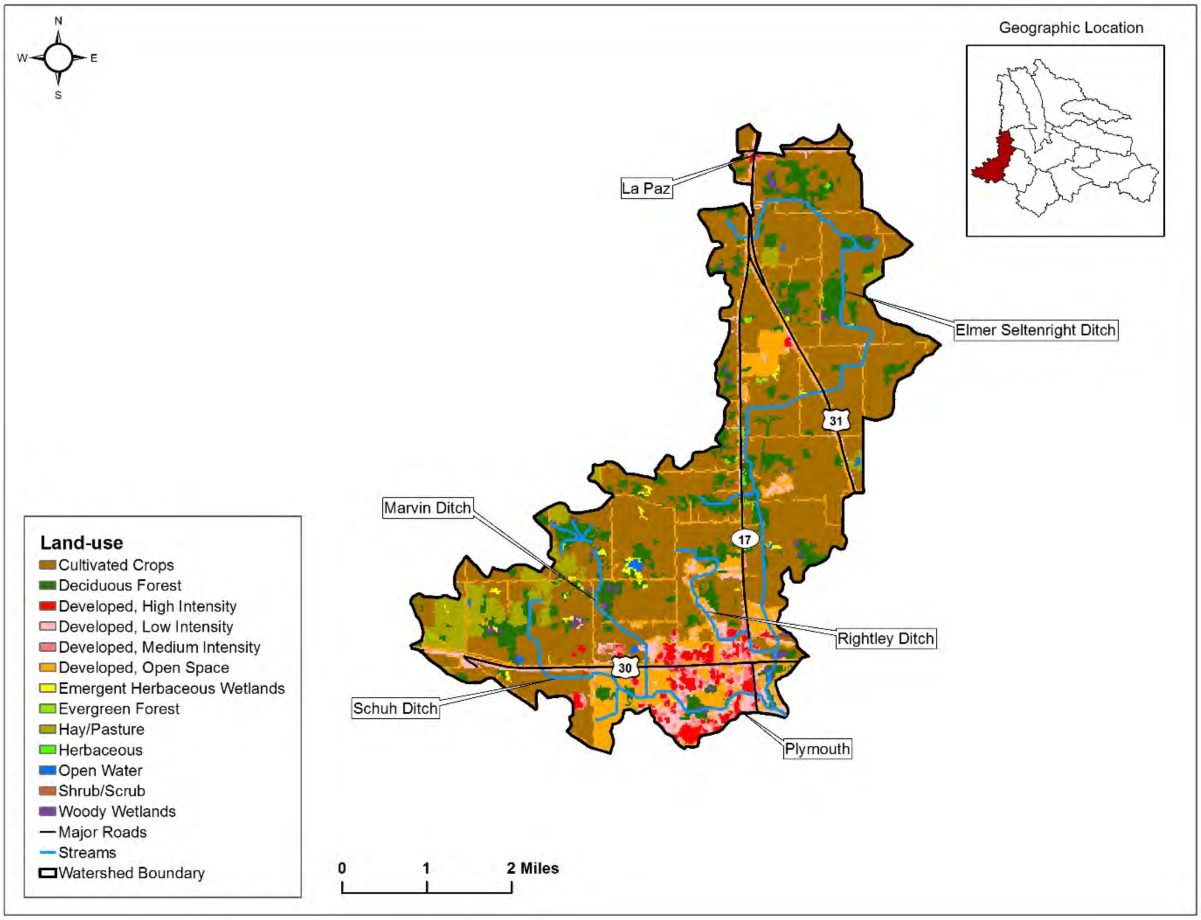


Figure 32. Elmer Seltenright Ditch subwatershed landuse.

Table 19. Percentage and acreage of each land use type in the Elmer Seltenright Ditch subwatershed (HUC: 071200010311).

Land use	% of Watershed	Acres
Open Water	0.3%	30
Developed, Open Space	12.5%	1,475
Developed, Low Intensity	5.7%	668
Developed, Medium Intensity	2.4%	277
Developed, High Intensity	2.1%	253
Deciduous Forest	11.7%	1,374
Evergreen Forest	0.2%	21
Shrub/Scrub	0.0%	1
Herbaceous	0.1%	14
Hay/Pasture	4.5%	528
Cultivated Crops	59.1%	6,955
Woody Wetlands	0.9%	101
Emergent Herbaceous Wetlands	0.6%	75

The Elmer Seltenright Ditch subwatershed contains approximately 22 miles of streams and 8 miles of closed drains, none of which are listed as impaired (Figure 33). There is one NPDES facility located in the Elmer Seltenright Ditch subwatershed, which is located in the northern portion of the subwatershed near Elmer Seltenright Ditch (Figure 33). This facility is the site of the municipal wastewater treatment plant for the Town of La Paz (Figure 33). A review of the NPDES facility compliance history indicates there are no current violations and the last violation occurred in July of 2014. There are no CFO's located in the Elmer Seltenright Ditch subwatershed. There were fifteen locations surveyed in the Elmer Seltenright Ditch subwatershed during the windshield survey (Figure 34). Relative to all other subwatershed in the Headwaters Yellow River Watershed the degree of streambank erosion is equivalent, channelization is more prevalent, stream buffers are more prevalent, and in-stream cover is more prevalent in the Elmer Seltenright Ditch (Table 12; Table 20). In-stream cover was identified as poor at 20% of the sites (3/15), one site was listed as having severe or very severe streambank erosion and direct livestock access to stream was not observed. Stream buffers were estimated to be absent on nine miles (41%) of the 22 miles of streams within the watershed.

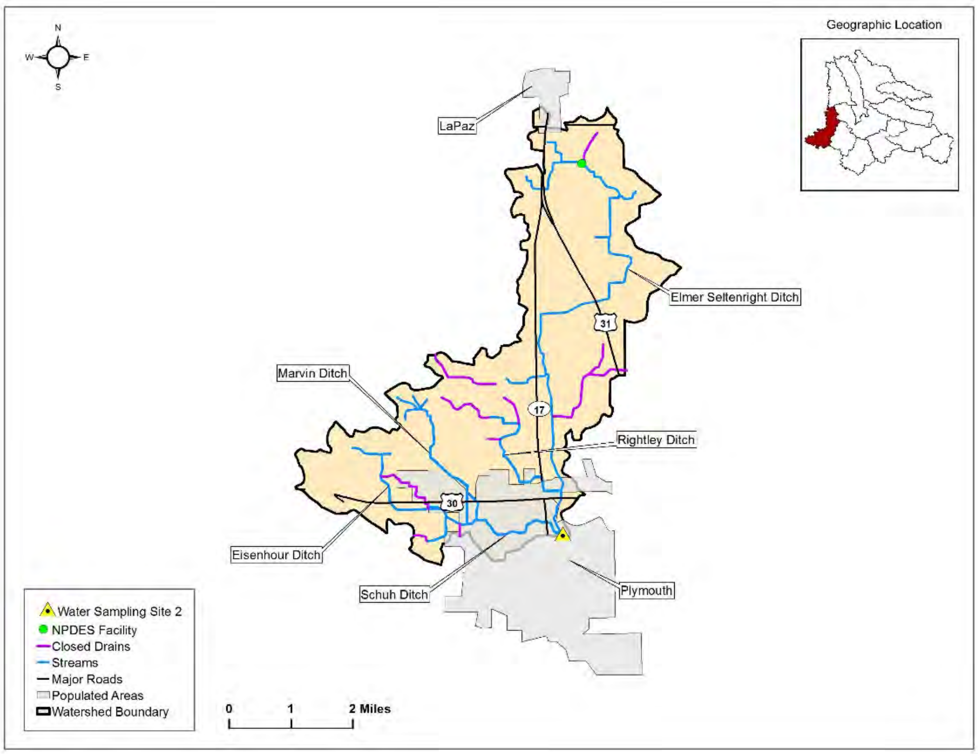


Figure 33. Elmer Seltenright Ditch subwatershed water quality information map.

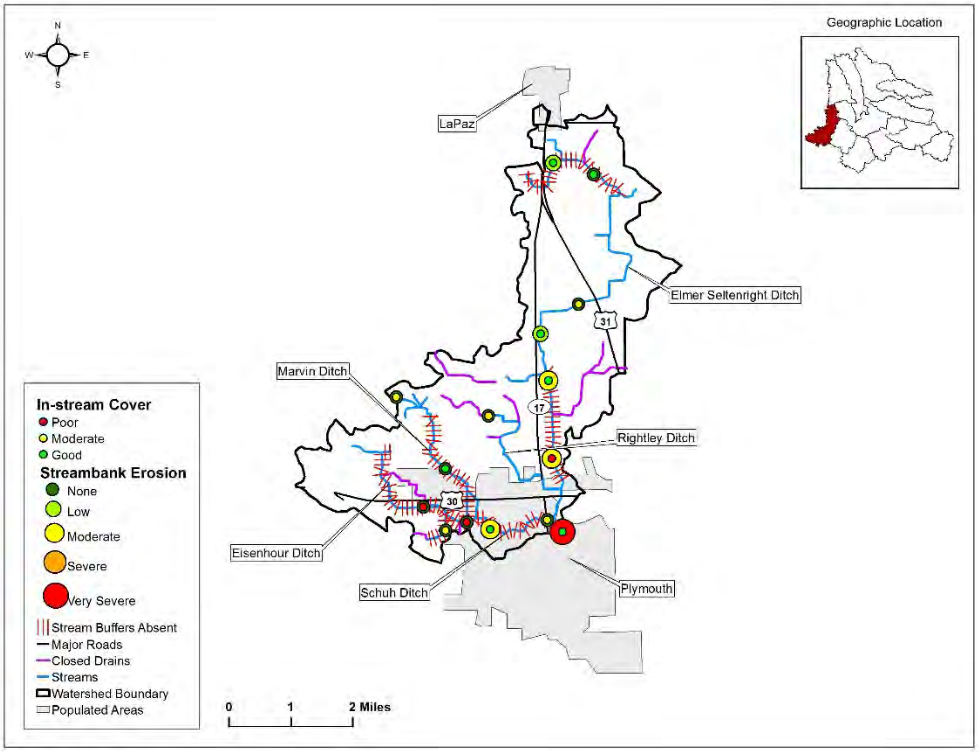


Figure 34. Elmer Seltenright Ditch subwatershed 2015 windshield survey sites and results.

Table 20. Results of the Elmer Seltenright Ditch subwatershed 2015 windshield survey.

Subwatershed	Streambank Erosion	Channelization	Stream Buffers	In-stream Cover
Elmer Seltenright Ditch $\bar{x}$	0.8	3.2	2.0	3.1
Headwaters Yellow River Watershed Average	0.8	3.1	1.1	2.2

Testing Site 2 was located in Elmer Seltenright Ditch and used to evaluate the overall water quality of the Elmer Seltenright Ditch subwatershed (Figure 33). Table 20 displays the mean values of sampled water quality parameters and the determined scores for biological and habitat assessments at Site 2 during the 12 month sampling period from June 2015 through May 2016. The mean E. coli concentration at Site 2 was 497 mpn/100mL and exceeds the Indiana State standard of 235 mpn/100mL. The State standard was exceeded 67% (8/12) of the time during the 12 month sampling period. E. coli mean at Site 2 was ranked as third lowest between all sites (Figure 15). Total phosphorus mean concentration of 0.20 was within the project target and ranked as the third lowest between all sites (Figure 20). Nitrate+Nitrite mean of 2.15 mg/L was the lowest mean between all sites, however, it still does not meet the project target concentration of <1.5 mg/L. TKN mean concentration was 0.59 mg/L and was one of only three sites mean that met the project target of <0.591 mg/L (Figure 19). The measured mean water quality parameters that meet project targets include total phosphorus, TKN, Atrazine, TSS, Turbidity, dissolved oxygen and pH. The biological assessment using the MIBI did not meet the project target and tied as the lowest score between all sites. Conversely, the QHEI habitat assessment meet the project target value and was the highest score between all sites. A complete listing of water quality testing results from the 12 month sampling period can be found in Appendix C.

Table 21. Site 2 water quality analysis – Elmer Seltenright Ditch subwatershed.

Parameter	Mean/Score	Unit	# of Times Does not Meet Target	% Does not Meet Target
Total Phosphorus	0.20	mg/L	4	33
Dissolved Phosphorus	0.14	mg/L	-	-
Nitrate + Nitrite	2.15	mg/L	1.5 mg/L 11	92
			10 mg/L 0	0
Ammonia	0.046	mg/L	1	8
TKN	0.59	mg/L	6	50
E. coli	497	mpn/100mL	8	67
Atrazine	0.34	µg/L	-	-
TSS	12	mg/L	2	17
Turbidity	10.29	NTU	4	33
Dissolved Oxygen	9.27	mg/L	0	0
pH	8.09	-	0	0
QHEI	69	-	Meets target	
MIBI	2.2	-	Does not meet target	

3.2.1 Fleugel Ditch (HUC: 071200010306)

The Fleugel Ditch subwatershed is located in the southeastern portion of the Headwaters Yellow River Watershed (Figure 35). The Fleugel Ditch subwatershed contains no large populated areas and is dominated by cultivated crops. Cultivated crops account for 85.3% of the watershed. The remainder of the watershed is divided between deciduous forest, open space, hay/pasture, wood wetlands, emergent herbaceous wetlands, low intensity development, open water, evergreen forest, medium intensity development, herbaceous, and high intensity development (Table 22). It should be noted that the one high quality natural community in the Headwaters Yellow River Watershed, which is a circumneutral bog owned by Acres Land Trust is located south of Lake Arm Ditch (Figure 35). This circumneutral bog is surrounded by woody wetlands and deciduous forest to form the Glenwood Nature Preserve. Overall current landuse trends are expected to remain consistent within the watershed.

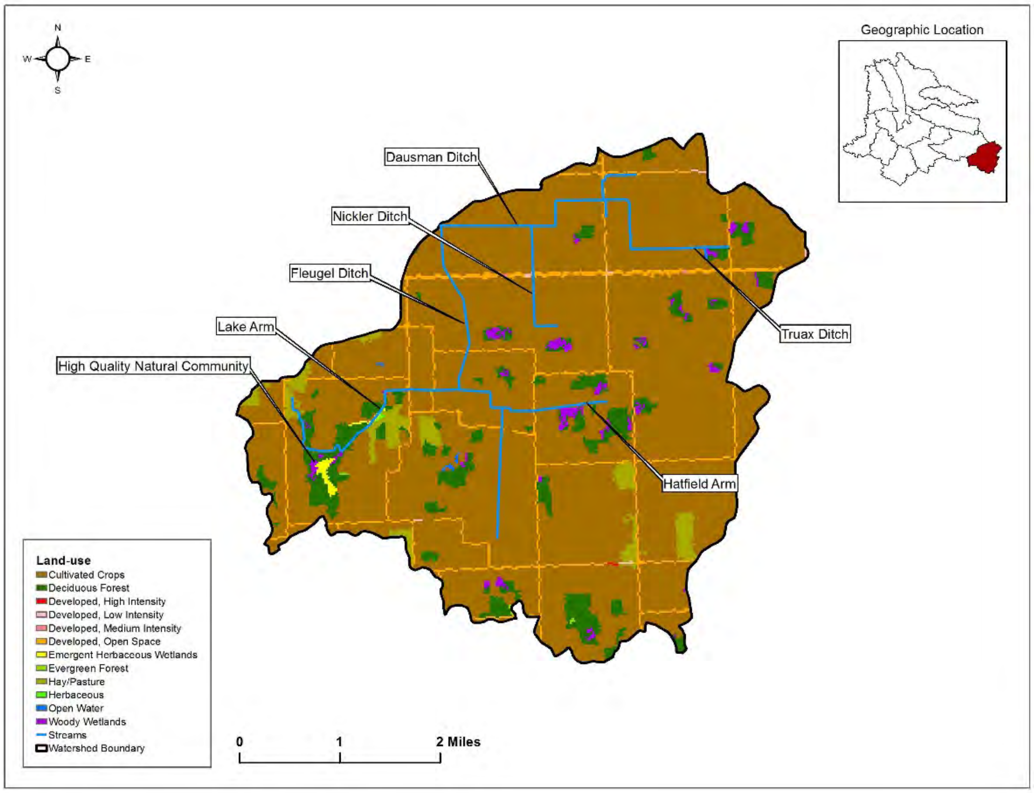


Figure 35. Fleugel Ditch subwatershed landuse.

Table 22. Percentage and acreage of each land use type in the Fleugel Ditch subwatershed (HUC: 071200010306).

Land use	% of Watershed	Acres
Open Water	0.0%	6
Developed, Open Space	3.9%	450
Developed, Low Intensity	0.1%	9
Developed, Medium Intensity	0.0%	2
Developed, High Intensity	0.0%	1
Deciduous Forest	6.6%	758
Evergreen Forest	0.0%	4
Herbaceous	0.0%	2
Hay/Pasture	2.7%	309
Cultivated Crops	85.3%	9,758
Woody Wetlands	1.0%	117
Emergent Herbaceous Wetlands	0.2%	27

The Fleugel Ditch subwatershed contains approximately 16 miles of streams and 17 miles of closed drains, none of which are currently listed as impaired (Figure 36). There are no NPDES facilities located in the watershed. However, there are two CFO's located in the Fleugel Ditch subwatershed (Figure 36). Both CFO's are located east of Truax Ditch in the northern portion of the subwatershed (Figure 36). There were thirteen locations surveyed in the Fleugel Ditch subwatershed during the windshield survey (Figure 37). Relative to the Headwaters Yellow River Watershed as a whole the degree of streambank erosion is less prevalent, channelization is more prevalent, stream buffers are less prevalent, and in-stream cover is less prevalent in the Fleugel Ditch subwatershed (Table 12; Table 23). In-stream cover was listed as poor at 69% (9/13) of the sites, one site contained severe or very severe streambank erosion and buffers were estimated to be absent on 6.9 miles (43%) of the 16 miles of streams in the watershed. Two locations were identified as having livestock access to streams (Figure 36).

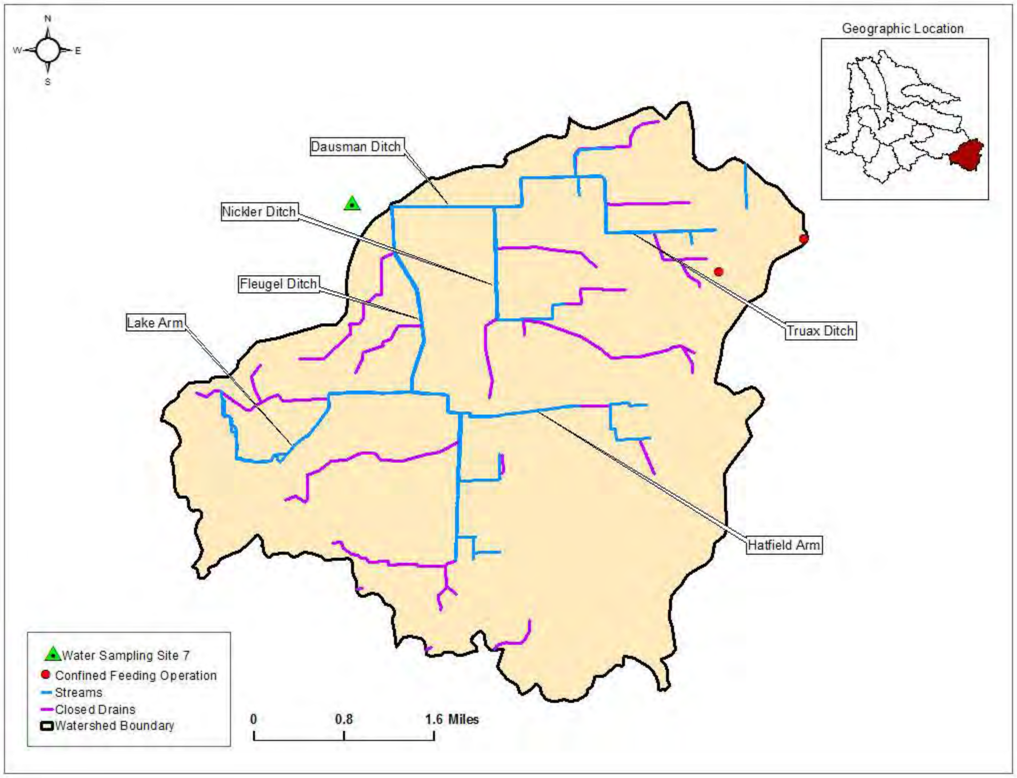


Figure 36. Fleugel Ditch subwatershed water quality information map.

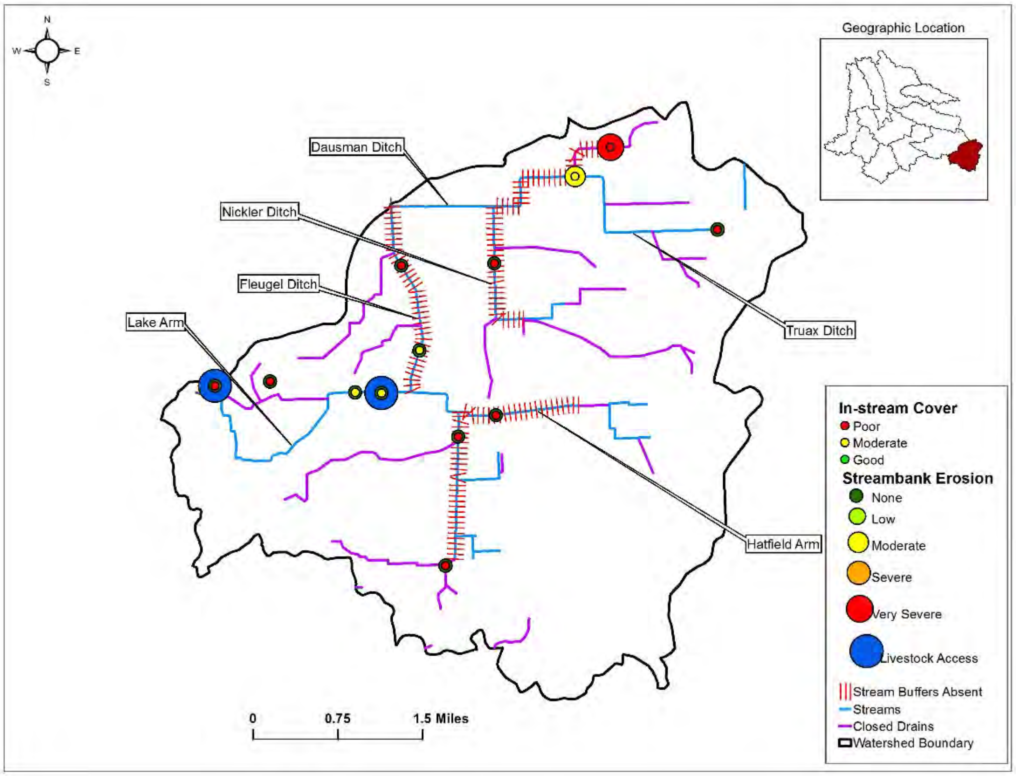


Figure 37. Fleugel Ditch subwatershed 2015 windshield survey sites and results.

Table 23. Results of the Fleugel Ditch subwatershed 2015 windshield survey.

Subwatershed	Streambank Erosion	Channelization	Stream Buffers	In-stream Cover
Fleugel Ditch $\bar{x}$	0.5	3.2	0.4	1.0
Headwaters Yellow River Watershed Average	0.8	3.1	1.1	2.2

Testing Site 7 was located in Dausman Ditch and used to evaluate the overall water quality of the Fleugel Ditch subwatershed (Figure 36). Table 24 displays the mean values of sampled water quality parameters and the determined scores for biological and habitat assessments at Site 7 during the 12 month sampling period from June 2015 through May 2016. Site 7 in general had the majority of the lowest mean concentrations of sampled parameters between all sites. Site 7 mean concentrations' ranked as the lowest included total phosphorus, ammonia, turbidity, E. coli, TSS, and dissolved phosphorus. The mean parameter assessed to be higher included nitrate+nitrite. Overall Site 7 was the fourth highest nitrate+nitrite mean at 7.83 mg/L. Nitrate+nitrite exceed the project target on 100% of the samples and exceeded Indiana State standards on five occasions. The E. coli concentration mean was 281 mpn/100 mL and exceeds the Indiana State standard of 235 mpn/100 mL. E. coli concentrations exceeded the State standard on 50% of the samples. The mean concentrations meeting project targets levels include total phosphorus, turbidity, atrazine, TSS, TKN, dissolved oxygen and pH. The assessed MIBI and QHEI at Site 7 was below project targets. A complete listing of water quality testing results from the 12 month sampling period can be found in Appendix C.

Table 24. Site 7 water quality analysis – Fleugel Ditch subwatershed.

Parameter	Mean/Score	Unit	# of Times Does not Meet Target	% Does not Meet Target
Total Phosphorus	0.12	mg/L	1	8
Dissolved Phosphorus	0.08	mg/L	-	-
Nitrate + Nitrite	7.83	mg/L	1.5 mg/L 12	100
			10 mg/L 5	42
Ammonia	0.023	mg/L	1	8
TKN	0.60	mg/L	6	50
E. coli	281	mpn/100mL	6	50
Atrazine	0.16	µg/L	-	-
TSS	3	mg/L	0	0
Turbidity	7.13	NTU	1	8
Dissolved Oxygen	9.76	mg/L	0	0
pH	8.03	-	0	0
QHEI	33	-	Does not meet target	
MIBI	2.9	-	Does not meet target	

3.2.2 Headwaters Stock Ditch (HUC: 071200010304)

The Headwaters Stock Ditch subwatershed is located in the northwestern portion of the Headwaters Yellow River Watershed. La Paz and Lakeville are located in this watershed and account for approximately 2.8% of the watershed (Figure 38). The primary land use in the watershed is cultivated crops accounting for 66.0% of the watershed. The remainder of the watershed is divided among deciduous forest, hay/pasture, emergent herbaceous wetlands, woody wetlands, evergreen forest, and herbaceous land uses (Table 25). Land use in the watershed remains similar to the land use that is described in the Headwaters Stock Ditch WMP. However, the conversion of Highway 31 to an interstate has since been completed which creates localized drainage modifications and additional road crossing not previously present. Excluding the Highway 31 project, land use proportions in the future are suggested to remain similar to current conditions. Industrial development is not anticipated to increase within the watershed.

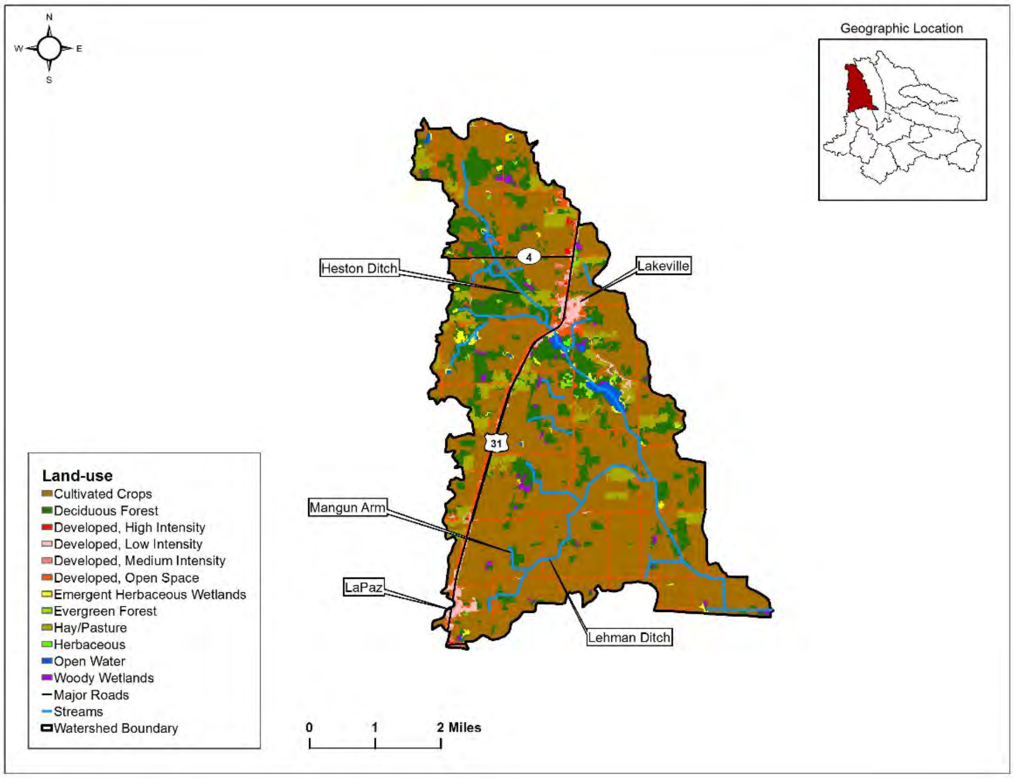


Figure 38. Headwaters Stock Ditch subwatershed landuse.

Table 25. Percentage and acreage of each land use type in the Headwaters Stock Ditch subwatershed (HUC: 071200010304).

Land use	% of Watershed	Acres
Open Water	0.9%	131
Developed, Open Space	5.7%	831
Developed, Low Intensity	2.3%	334
Developed, Medium Intensity	0.4%	59
Developed, High Intensity	0.1%	18
Deciduous Forest	16.2%	2,358
Evergreen Forest	0.4%	52
Herbaceous	0.2%	23
Hay/Pasture	6.2%	900
Cultivated Crops	66.0%	9,583
Woody Wetlands	0.8%	122
Emergent Herbaceous Wetlands	0.8%	117

The Headwaters Stock Ditch subwatershed contains approximately 23 miles of streams and 9 miles of closed drains, none of which are currently listed as impaired. There are two NPDES facilities located in the southern portion of the watershed (Figure 39). One of the facilities is associated with a gas station and is compliance to date and has not any violations in the last 12 quarters. The other facility was associated with a pipeline but the permit has been terminated. There are no CFO's in the Headwaters Stock Ditch subwatershed. There were seventeen locations surveyed in the Headwaters Stock Ditch subwatershed during the windshield survey (Figure 40). Relative to the Headwaters Yellow River Watershed as a whole the degree of streambank erosion is less prevalent, channelization is less prevalent, stream buffers are more prevalent, and in-stream cover is less prevalent in the Headwater Stock Ditch subwatershed (Table 12; Table 26). During the windshield tour 35% (6/17) of the sites were listed as having poor in-stream habitat, no sites had identified severe or very severe erosion and stream buffers were estimated to be absent on 7.6 miles (33%) of the 23 miles of streams in the watershed (Figure 40). Direct access by livestock to streams was not observed during the windshield survey.

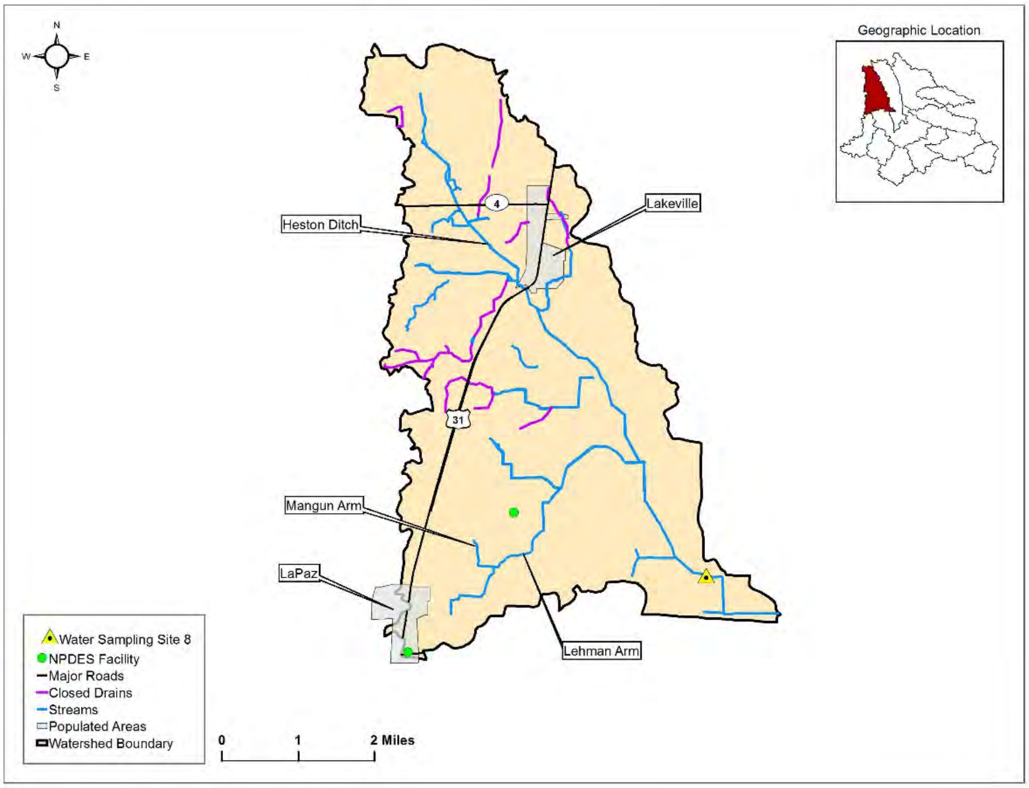


Figure 39. Headwaters Stock Ditch subwatershed water quality information map.

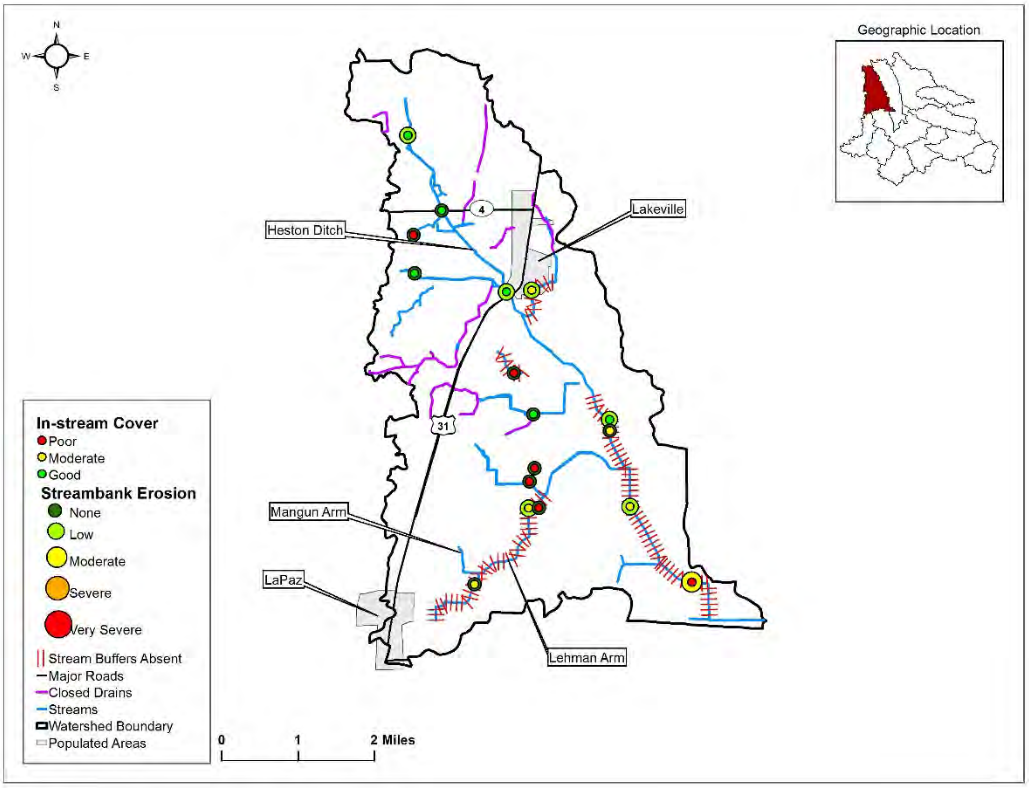


Figure 40. Headwaters Stock Ditch subwatershed 2015 windshield survey sites and results.

Table 26. Results of the Headwaters Stock Ditch subwatershed 2015 windshield survey.

Subwatershed	Streambank Erosion	Channelization	Stream Buffers	In-stream Cover
Headwaters Stock Ditch x̅	0.5	1.7	1.3	2.1
Headwaters Yellow River Watershed Average	0.8	3.1	1.1	2.2

In 2012 a Watershed Management Plan (WMP) was developed by the Michiana Area Council of Governments (MACOG) for the Headwaters Stock Ditch subwatershed, which conducted a windshield survey and collected twelve months of water quality monitoring data. The watershed MACOG WMP was locally funded effort and was not developed into an IDEM approved WMP. MACOG's windshield survey identified livestock access to waterbodies, eroded streambanks, lack of stream buffers, lack of cover crops, and existing residences on septic system limited soils as areas of concern. The water quality monitoring program also found that phosphorus, nitrate, *E. coli*, total suspended solid (TSS) loads exceeded target loads (Michiana Area Council of Governments 2012). Based on this data MACOG identified Heston Ditch upstream of Pleasant Lake, Ward Ditch, Shidler Ditch, Heston Ditch between Pleasant and Riddles Lakes, and Walters Ditch as critical areas of the Headwater Stock Ditch subwatershed.

The Headwaters Stock Ditch subwatershed contains both Pleasant and Riddles Lakes. Pleasant and Riddles Lakes are 29 acre and 77 acre lakes, respectively. Both lakes are located south of Lakeville in St. Joseph County. In 2006 a watershed diagnostic study was completed for these two lakes to describe the condition of the watershed, identify potential problems, and make prioritized recommendations. The collection of water samples from tributaries during this study revealed that Bunch Ditch and Walters Ditch were contributing high concentrations of *E. coli*, phosphorus, and nitrogen to the lakes (JFNew 2006a).

Testing Site 8 was located in Stock Ditch and used to evaluate the overall water quality of the Headwaters Stock Ditch subwatershed (Figure 39). Table 27 displays the mean values of sampled water quality parameters and the determined scores for biological and habitat assessments at Site 8 during the 12 month sampling period from June 2015 through May 2016. The mean E. coli concentration at Site 8 was 713 mpn/100 mL which exceeds the Indiana State standard. E. coli concentrations exceeded State Standards during 58% (7/12) of the sampled events and overall Site 8 had the fifth highest E. coli mean between all sites. Total phosphorus mean concentration was 0.33 which exceeds the project target and was the fourth highest mean between sites (Figure 20). Total phosphorus exceeded the project target during 42% of sampling events. Ammonia mean at Site 8 was the highest between all sites at 0.168 mg/L and exceeded Indiana State standards during 75% (9/12) of sampling events. While ammonia concentrations were high nitrate+nitrite concentrations were the second lowest between all sites. Nitrate+nitrite mean concentration was 3.63 mg/L and exceeded the project target 100% of the time. The Indiana State standard for Nitrate+Nitrite was not exceeded during any event. TKN mean was the third highest observed between sites and exceeded the project target during 83% (10/12) of sampling events. Site 8 mean concentrations that meet project target levels include atrazine, TSS, dissolved oxygen and pH. Both habitat and biological assessments at Site 8 do not meet target levels. A complete listing of water quality testing results from the 12 month sampling period can be found in Appendix C.

Table 27. Site 8 water quality analysis – Headwaters Stock Ditch subwatershed.

Parameter	Mean/Score	Unit	# of Times Does not Meet Target		% Does not Meet Target
Total Phosphorus	0.33	mg/L	5		42
Dissolved Phosphorus	0.21	mg/L	-		-
Nitrate + Nitrite	3.63	mg/L	1.5 mg/L	12	100
			10 mg/L	0	0
Ammonia	0.168	mg/L	9		75
TKN	0.98	mg/L	10		83
E. coli	713	mpn/100mL	7		58
Atrazine	0.88	µg/L	-		-
TSS	14	mg/L	1		8
Turbidity	17.72	NTU	6		50
Dissolved Oxygen	7.01	mg/L	2		17
pH	7.74	-	1		8
QHEI	33	-	Does not meet target		
MIBI	2.7	-	Does not meet target		

3.2.3 Kline Rouch Ditch (HUC: 071200010302)

The land use of the Kline Rouch Ditch is dominated by cultivated crops, which accounts for 75.5% of the watershed. Hay/Pasture land use also accounts for a large part of the watershed with 8.5%. There are no populated areas in the watershed, therefore only 6.7% of the land in the watershed is developed (Figure 41). The remainder of the watershed contains limited natural land use types such as open water, deciduous forest, evergreen forest, mixed forest, shrub/scrub, herbaceous, woody wetlands, and emergent herbaceous wetlands (Table 28). Industrial development is not a concern within the watershed and it is suggested current land use proportions will remain consistent into the future.

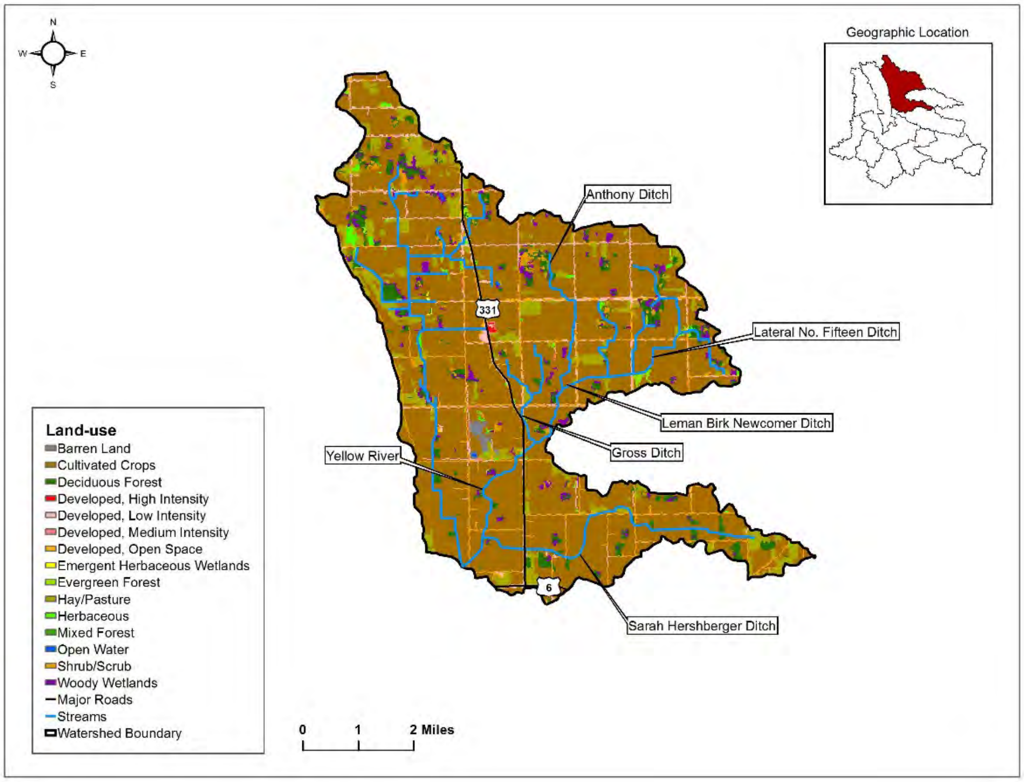


Figure 41. Kline Rouch subwatershed landuse.

Table 28. Percentage and acreage of each land use type in the Kline Rouch Ditch subwatershed (HUC: 071200010302).

Land use	% of Watershed	Acres
Open Water	0.1%	12
Developed, Open Space	3.4%	808
Developed, Low Intensity	3.0%	711
Developed, Medium Intensity	0.3%	76
Developed, High Intensity	0.0%	11
Barren Land	0.4%	86
Deciduous Forest	4.4%	1,052
Evergreen Forest	0.4%	85
Mixed Forest	0.0%	5
Shrub/Scrub	1.0%	228
Herbaceous	0.6%	147
Hay/Pasture	8.5%	2,024
Cultivated Crops	75.5%	18,029
Woody Wetlands	2.5%	588
Emergent Herbaceous Wetlands	0.0%	10

The Kline Rouch Ditch subwatershed contains approximately 75 miles of streams and 17 miles of closed drains, none of which are currently listed as impaired. The watershed contains two NPDES permitted facilities (Figure 42). One facility is the Madison Elementary School water treatment plant. The plant is in compliance currently and has three minor violations in the last 12 quarters, with the last violation in September 2016. Minor violations were for total recoverable iron. The other NPDES facility is the Wyatt wastewater treatment plant. The plant is currently in compliance but has had violations in seven of the last

12 quarters. All violations were minor with the exception of one major. Violations ranged from exceeding values for ammonia, TSS, biological oxygen demand (BOD), and E. coli. One CAFO and two CFO's are located in the Kline Rouch Ditch subwatershed (Figure 42). The CAFO is located in the northern portion of the watershed (Figure 42). The CFO's is located south of Gross Ditch near Highway 331 and the other is located north of Gross Ditch near Highway 331. There were twenty-eight locations surveyed in the Kline Rouch Ditch subwatershed during the windshield survey (Figure 43). Relative to the Headwaters Yellow River Watershed as a whole the degree of streambank erosion is less prevalent, channelization is less prevalent, stream buffers are more prevalent, and in-stream cover is more prevalent in the Kline Rouch Ditch subwatershed (Table 12; Table 29). In-stream cover was described as poor at 14% (4/28) of the sites, no sites were listed as having severe or very severe streambank erosion and stream buffers were estimated to be absent along 15.4 miles (21%) of the 75 miles streams in the watershed. No sites were listed as having livestock access to streams.

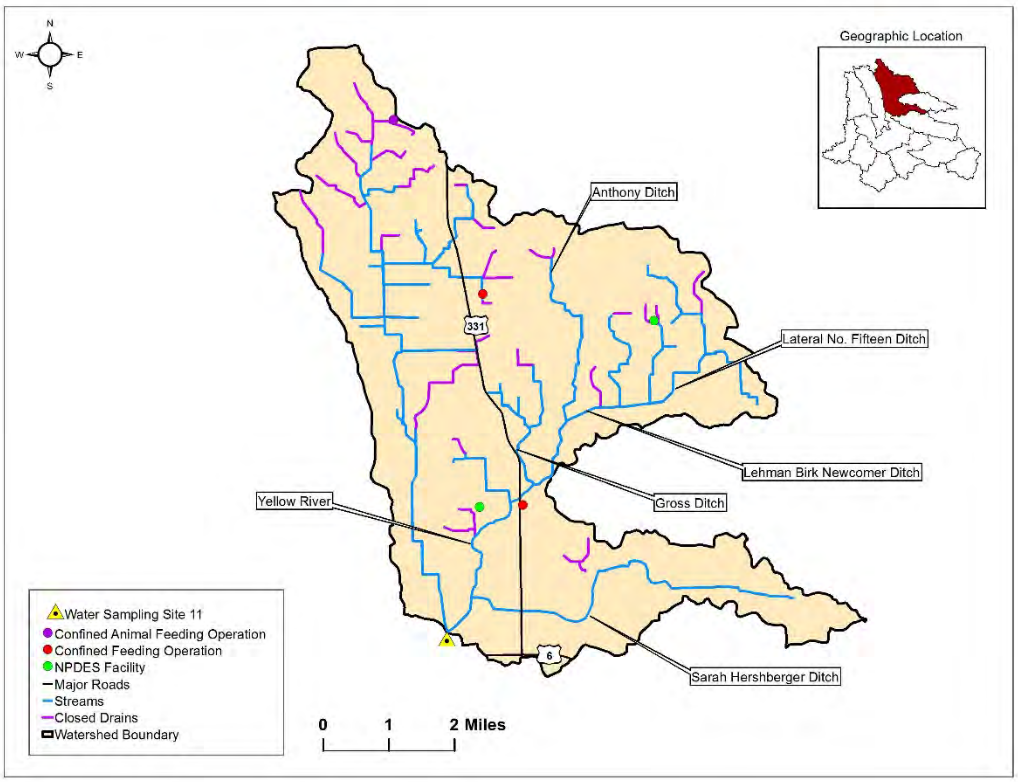


Figure 42. Kline Rouch subwatershed water quality information map.

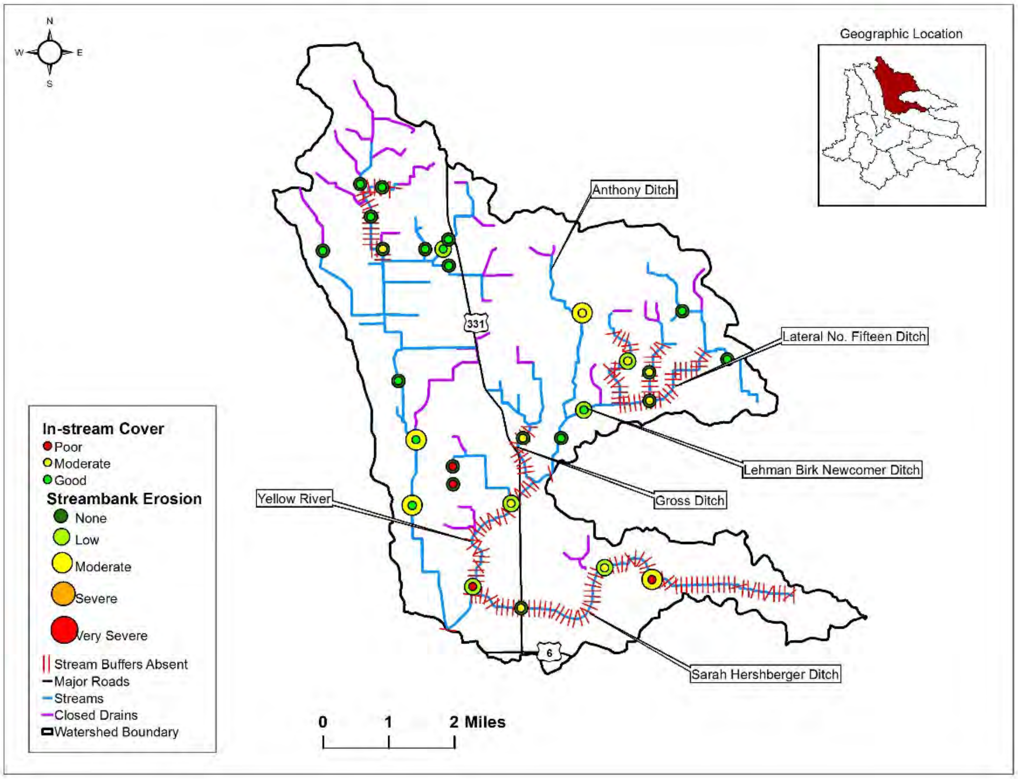


Figure 43. Kline Rouch subwatershed 2015 windshield survey sites and results.

Table 29. Results of the Kline Rouch subwatershed 2015 windshield survey.

Subwatershed	Streambank Erosion	Channelization	Stream Buffers	In-stream Cover
Kline Rouch Ditch x̄	0.5	2.9	1.2	2.9
Headwaters Yellow River Watershed Average	0.8	3.1	1.1	2.2

Testing Site 11 was located in the Yellow River and used to evaluate the overall water quality of the Headwaters Stock Ditch subwatershed (Figure 42). Table 30 displays the mean values of sampled water quality parameters and the determined scores for biological and habitat assessments at Site 11 during the 12 month sampling period from June 2015 through May 2016. Overall, many of the mean water quality concentrations were high compared to other subwatersheds. Site 11 did not contain the highest mean concentrations for any parameters tested but did have the second highest mean concentration for ammonia, nitrate+nitrite, turbidity, E. coli and dissolved phosphorus. The E. coli mean concentration was 1,029 mpn/100 mL and exceeds the Indiana State Standard. E. coli levels exceeded the state standard during 10 of 12 events (83%). Site 11 was one of four sites sampled in May 2016 for source tracking of E. coli samples for percent human vs percent animal. The results indicated human waste was the source for 53% of the E. coli bacterium while animal waste accounted for the remaining 47%. Similar results were observed at two of the other sites (Site 1 within Milner Seltenright subwatershed and Site 12 Lateral Ditch No. 5 subwatershed), while Site 4 located within the Lake of the Woods subwatershed had 80% human and 20% animal (Figure 16). Ammonia mean concentration was 0.105 mg/L and exceeded Indiana State standards during five sampling events. Turbidity mean concentration was 23.13 NTU and exceeded the project target during 25% of the events. Dissolved phosphorus mean concentration was 0.27 mg/L and total phosphorus mean was 0.37 mg/L which exceeds the project target. Nitrate+nitrite concentrations were high with the mean being 8.90 mg/L. Nitrate+nitrite concentrations exceeded the project target of 1.5 mg/L, 100% of the time and exceeded the Indiana State standard of 10 mg/L on five occasions. The water quality parameters mean concentrations within project targets include atrazine, TSS, dissolved oxygen and pH. Site 11 had the third best QHEI score at 57 and meets the project target, however, biological assessment with MIBI does not meet the project target. A complete listing of water quality testing results from the 12 month sampling period can be found in Appendix C.

Table 30. Site 11 water quality analysis – Kline Rouch subwatershed.

Parameter	Mean/Score	Unit	# of Times Does not Meet Target	% Does not Meet Target
Total Phosphorus	0.37	mg/L	6	50
Dissolved Phosphorus	0.27	mg/L	-	-
Nitrate + Nitrite	8.90	mg/L	1.5 mg/L 12	100
			10 mg/L 5	42
Ammonia	0.105	mg/L	5	42
TKN	0.82	mg/L	7	58
E. coli	1,029	mpn/100mL	10	83
Atrazine	0.60	µg/L	-	-
TSS	20	mg/L	2	17
Turbidity	23.13	NTU	3	25
Dissolved Oxygen	8.01	mg/L	0	0
pH	7.90	-	0	0
QHEI	57	-	Meets target	
MIBI	3.3	-	Does not meet target	

3.2.1 Lake of the Woods (HUC: 071200010309)

The Lake of the Woods subwatershed land use is dominated by cultivated crops, which account for 77.8% of the watershed. Deciduous forest is the second most prevalent land use, which accounts for 7.3% of the watershed. The Lake of the Woods subwatershed does contain the southwest portion of Bremen, which is the second most populated urban area in Headwaters Yellow River Watershed (Figure 44). There is also a reasonable degree of development in the Lake of the Woods subwatershed along Lake of the Woods, which is the largest lake in the Headwaters Yellow River Watershed. Current development around Lake of the Woods is not expected to change into the future however increases in industrial and residential development on the west side of Bremen is possible. The land draining into Lake of the Woods is primarily agricultural (DJ Case and Associates 2005). The remaining distribution of land uses in the Lake of the Woods subwatershed is described in Table 31.

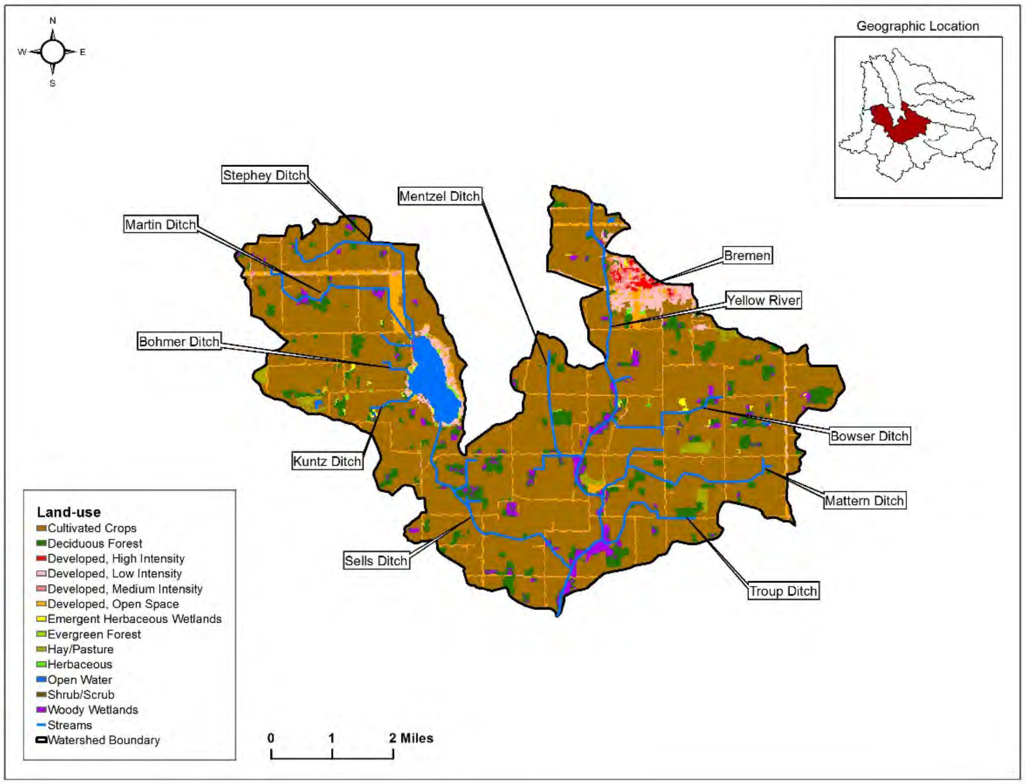


Figure 44. Lake of the Woods subwatershed landuse.

Table 31. Percentage and acreage of each land use type in the Lake of the Woods subwatershed (HUC: 071200010309).

Land use	% of Watershed	Acres
Open Water	2.0	438
Developed, Open Space	5.6	1,221
Developed, Low Intensity	2.3	508
Developed, Medium Intensity	0.5	105
Developed, High Intensity	0.3	71
Deciduous Forest	7.3	1,598
Evergreen Forest	0.1	12
Shrub/Scrub	0.0	6
Herbaceous	0.1	27
Hay/Pasture	1.0	220
Cultivated Crops	77.8	16,943
Woody Wetlands	2.6	557
Emergent Herbaceous Wetlands	0.3	68

The Lake of the Woods subwatershed contains approximately 29 miles of streams and 17 miles of closed drains, with 21.6 miles of streams listed as impaired for *E. coli* (Figure 45). During a 2009 TMDL report for the Kankakee/Iroquois watershed all five of the water samples collected from the Yellow River in the Lake of the Woods subwatershed exceeded state standards and an 87% reduction in *E. coli* concentrations would be needed to meet water quality standards (Tetra Tech 2009). Lake of the Woods is the largest lake in the Headwaters Yellow River Watershed at approximately 395 acres. Lake of the Woods is currently listed as impaired by IDEM for both phosphorus and polychlorinated biphenyls (PCB's) in fish tissue.

There are two NPDES permitted facilities and no CFO's in the Lake of the Woods subwatershed (Figure 45). One of these NPDES facilities was a privately owned facility, with a terminated permit. The second NPDES facility is the Bremen Wastewater Treatment Plant, which is located in the northwest portion of Bremen. The facility is currently in compliance and has violations in eight of the last 12 quarters. All violations were minor and included exceedances for mercury, pH and ammonia. The last violation occurred in March 2017. There were twenty-seven locations surveyed in the Lake of the Woods subwatershed during the windshield survey (Figure 46). Relative to the Headwaters Yellow River Watershed as a whole the degree of streambank erosion is more prevalent, channelization is more prevalent, stream buffers are less prevalent, and in-stream cover is less prevalent in the Lake of the Woods subwatershed (Table 12; Table 32). During the windshield tour in-stream cover was rated poor at 52% (14/27) of sites, no sites were listed as having severe or very severe streambank erosion and stream buffers were estimated to be absent on 17.7 miles (61%) of the 29 miles of streams in the watershed (Figure 46). Direct access of livestock to streams was not observed during the windshield survey.

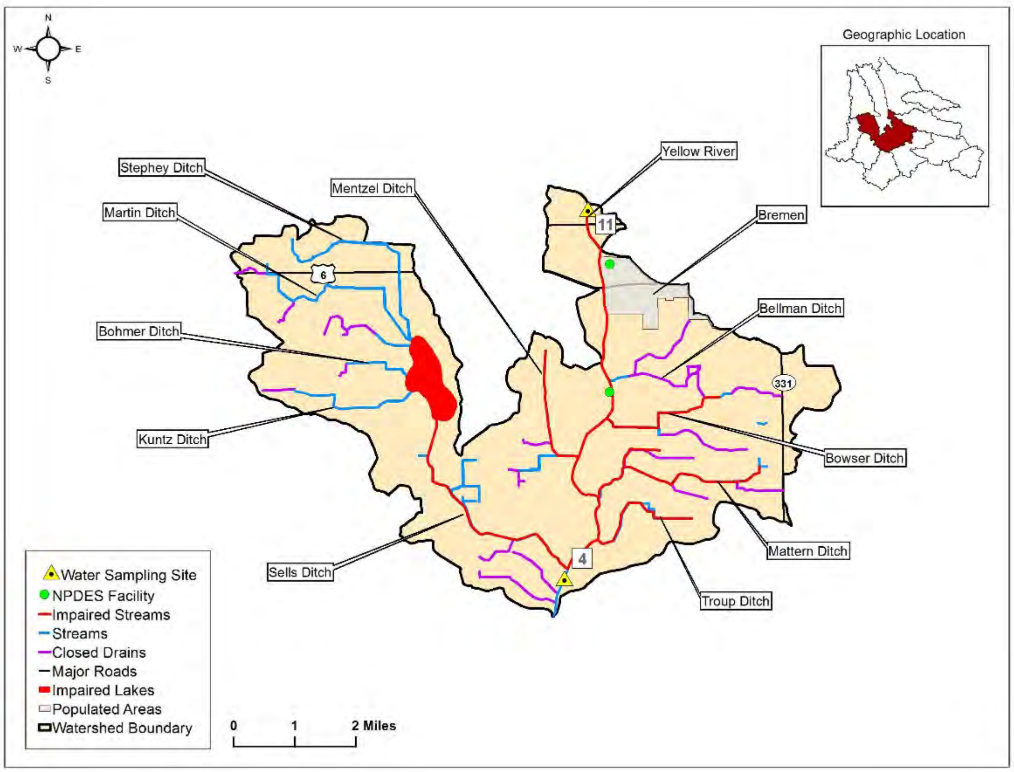


Figure 45. Lakes of the Woods subwatershed water quality information map.

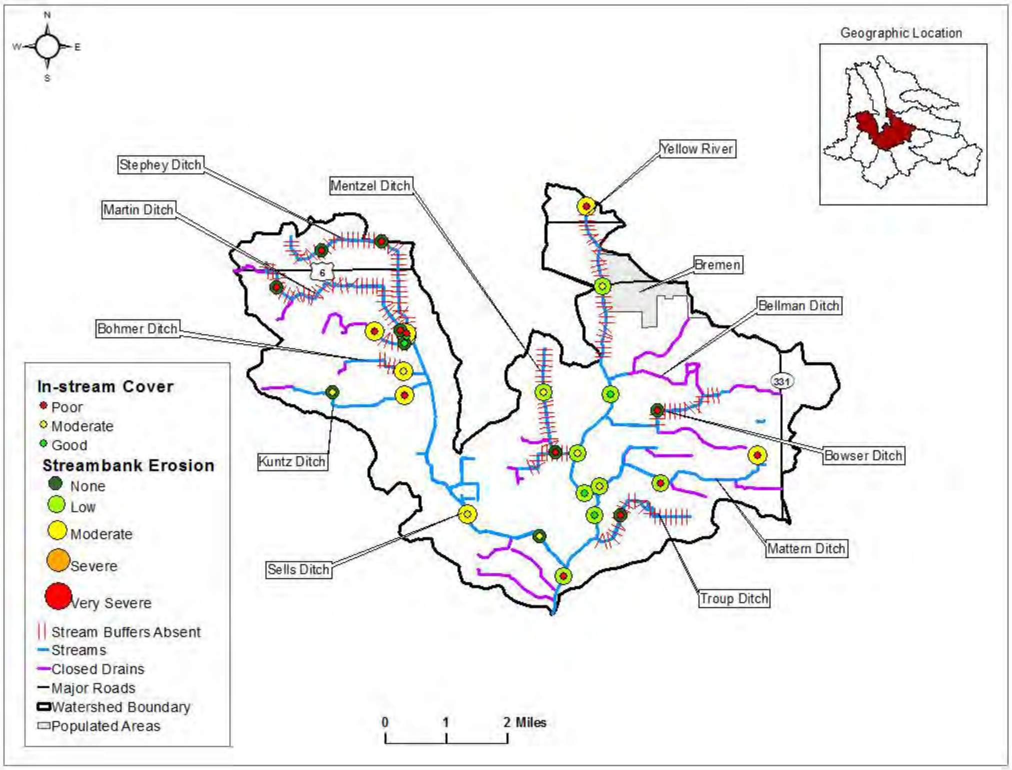


Figure 46. Lake of the Woods subwatershed 2015 windshield survey sites and results.

Table 32. Results of the Lake of the Woods subwatershed 2015 windshield survey.

Subwatershed	Streambank Erosion	Channelization	Stream Buffers	In-stream Cover
Lake of the Woods x̅	0.9	3.4	0.8	2.0
Headwaters Yellow River Watershed Average	0.8	3.1	1.1	2.2

In 2005 a watershed diagnostic study was completed for Lake of the Woods. The study found that over the past three decades Lake of the Woods has demonstrated average to below average water quality compared to most other natural lakes in Indiana (DJ Case and Associates 2005). While *E. coli* concentrations were below the typical statewide average (645 CFU/100mL), water samples regularly exceeded water quality standards. IDEM water samples of Bohmer, Kuntz, public access ditch, Martin Ditch, and Seltenright Ditch all exceeded water quality standards for *E. coli* (DJ Case and Associates 2005). However, water samples collected at Inlet Ditch #1, Stephey Ditch, and Isaac Sells Ditch met water quality standard for *E. coli* (DJ Case and Associates 2005). During the development of the Lake of the Woods diagnostic study community leaders identified erosion/sediment control, hydrology/drainage, nutrient loading, long-term watershed management planning, and channel maintenance as the primary water quality issues in the watershed.

Testing Site 4 was located in the Yellow River and used to evaluate the overall water quality of the Lake of the Woods subwatershed (Figure 45). Table 33 displays the mean values of sampled water quality parameters and the determined scores for biological and habitat assessments at Site 4 during the 12 month sampling period from June 2015 through May 2016. Site 4 mean concentrations for the sampled water quality parameters ranked consistently in the top three highest for the following parameters total phosphorus (#2), turbidity (#3), E. coli (#3), TSS (#2), dissolved phosphorus (#3), and TKN (#1). The E. coli mean concentration was 773 mpn/100 mL and exceeds the Indiana State standard. E. coli sampled exceeded the State standard 75% of the time. Site 4, was one of four sites sampled in May 2016 for source tracking of E. coli bacteria. Results of the source tracking indicated the main source of E. coli was human accounting for 80% of the sample while animal sources were 20% (Figure 16). This was the highest human percentage determined between the four sites and the three other sites were approximately split evenly between human and animal sources (Figure 16). Total phosphorus mean concentration was 0.39 mg/L and exceeds the project target of 0.3 mg/L. Total phosphorus samples exceeded the project target concentration on 58% (7/12) of the samples. TSS mean concentration was 43 mg/L and exceeds the project target. TSS concentrations exceeded the project target 25% (3/12) of the time. TKN mean at Site 4 was the highest observed between all site and was 1.41, which exceeds the project target of 0.591 mg/L. TKN samples exceeded the project target concentration on all but one sampling event. The mean water quality parameters meeting project targets include atrazine, dissolved oxygen and pH. Habitat assessment using the QHEI indicates the Site 4 does not meet project target however biological assessment with the MIBI does meet the project target. A complete listing of water quality testing results from the 12 month sampling period can be found in Appendix C.

Table 33. Site 4 water quality analysis – Lake of the Woods subwatershed.

Parameter	Mean/Score	Unit	# of Times Does not Meet Target	% Does not Meet Target
Total Phosphorus	0.39	mg/L	7	58
Dissolved Phosphorus	0.25	mg/L	-	-
Nitrate + Nitrite	5.27	mg/L	1.5 mg/L 12	100
			10 mg/L 0	0
Ammonia	0.077	mg/L	1	8
TKN	1.41	mg/L	11	92
E. coli	773	mpn/100mL	9	75
Atrazine	0.89	µg/L	-	-
TSS	43	mg/L	3	25
Turbidity	20.69	NTU	7	58
Dissolved Oxygen	8.71	mg/L	0	0
pH	8.11	-	0	0
QHEI	31.5	-	Does not meet target	
MIBI	4.4	-	Meets target	

3.2.2 Lateral Ditch No. 5 (HUC: 071200010301)

The most common land use in the Lateral Ditch No. 5 subwatershed is cultivated crops, which account for 78.2% of the watershed (Figure 47). The second most common land use is hay/pasture, accounting for 10.5% of the watershed. There are no urban areas in the Lateral Ditch No. 5 subwatershed, which has limited developed land uses to less than 6.0% of the subwatershed. The most common natural habitat is deciduous forest followed by woody wetlands, evergreen forest, shrub/scrub, and herbaceous habitats (Table 34). Industrial development is not a concern within the Lateral Ditch No. 5 subwatershed and current land use percentages are suggested to remain consistent into the future.

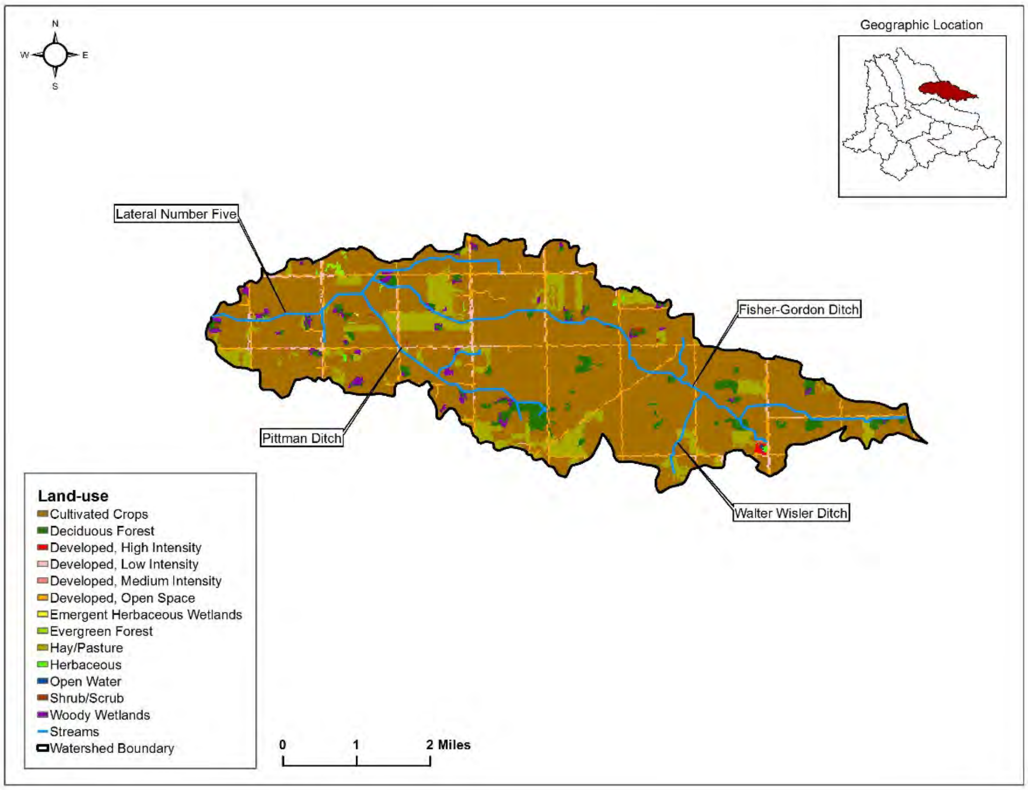


Figure 47. Lateral Ditch No. 5 subwatershed landuse.

Table 34. Percentage and acreage of each land use type in the Lateral Ditch No. 5 subwatershed (HUC: 071200010301).

Land use	% of Watershed	Acres
Open Water	0.0%	2
Developed, Open Space	4.1%	443
Developed, Low Intensity	1.2%	134
Developed, Medium Intensity	0.0%	5
Developed, High Intensity	0.1%	9
Deciduous Forest	4.0%	427
Evergreen Forest	0.2%	21
Shrub/Scrub	0.2%	24
Herbaceous	0.1%	10
Hay/Pasture	10.5%	1130
Cultivated Crops	78.2%	8424
Woody Wetlands	1.3%	143
Emergent Herbaceous Wetlands	0.0%	1

The Lateral Ditch No. 5 subwatershed contains approximately 20.3 miles of streams and 3.1 miles of closed drains, none of which are currently listed as impaired. The watershed contains one NPDES permitted facility and three CFO's (Figure 48). The NPDES facility and two of the CFO's are located near Lateral Number No. 5 and the other CFO is located near Pittman Ditch (Figure 48). The NPDES facility permit is no longer active. There were seventeen locations surveyed in the Lateral Ditch No. 5 subwatershed during the windshield survey (Figure 49). Relative to the Headwaters Yellow River Watershed as a whole the degree of streambank erosion is equivalent, channelization is more prevalent, stream buffers are less prevalent and in-stream cover is more prevalent in the Lateral Ditch No. 5 subwatershed (Table 12; Table 35). During the windshield survey in-stream habitat was rated as poor at 12% (2/17) of sites, no sites were identified as having severe or very severe streambank erosion and stream buffers were absent along 14.7 miles (72%) of the 20.3 miles of streams in the watershed (Figure 49). Direct access of livestock to streams was not observed during the survey.

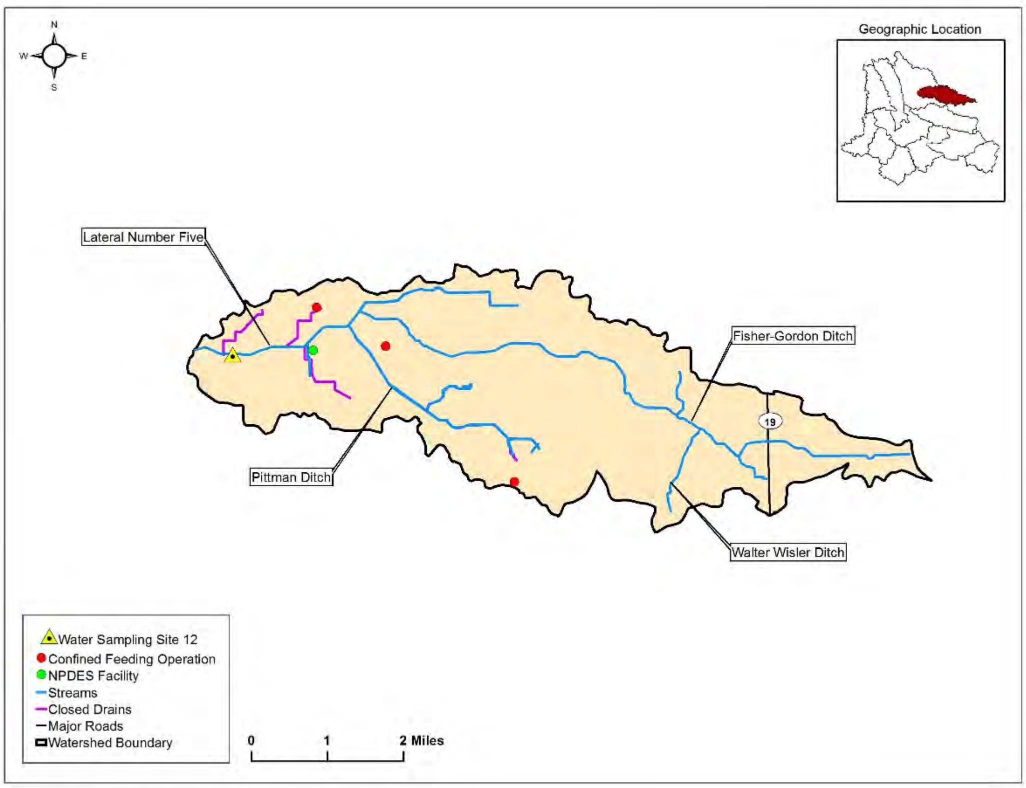


Figure 48. Lateral Ditch No. 5 subwatershed water quality information map.

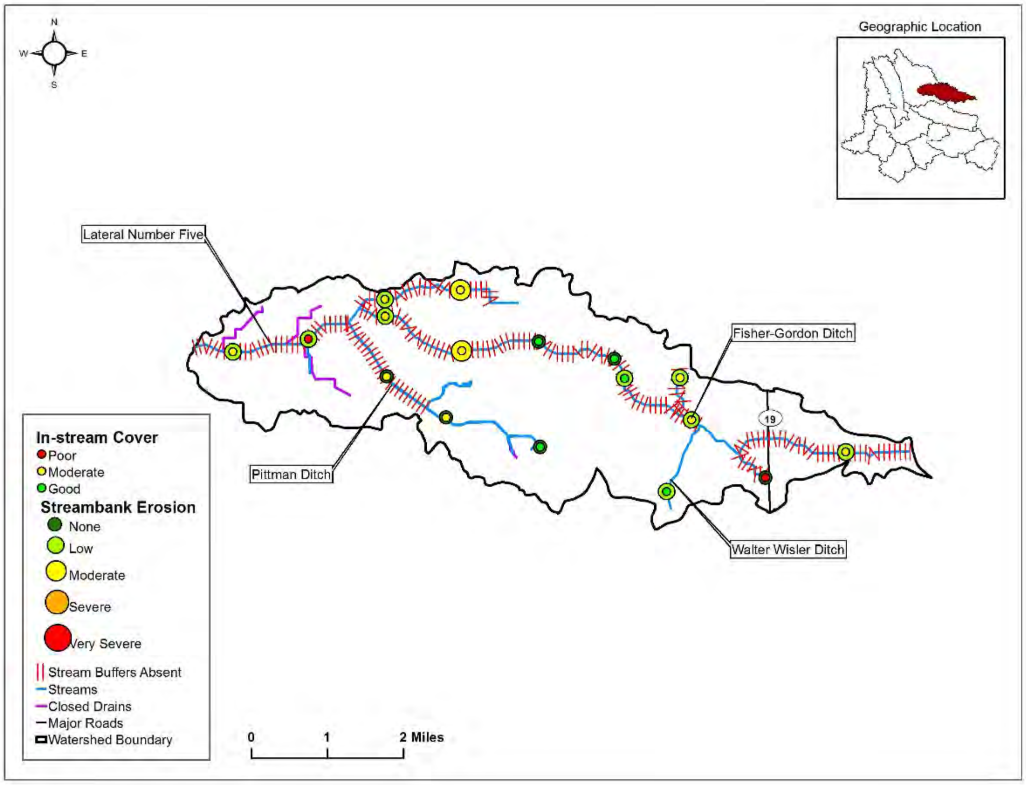


Figure 49. **Lateral Ditch No. 5 subwatershed 2015 windshield survey sites and results.**

Table 35. **Results of the Lateral Ditch No. 5 subwatershed 2015 windshield survey.**

Subwatershed	Streambank Erosion	Channelization	Stream Buffers	In-stream Cover
Lateral Ditch No. 5 $\bar{x}$	0.8	3.6	0.7	2.5
Headwaters Yellow River Watershed Average	0.8	3.1	1.1	2.2

Testing Site 12 was located in Lateral Ditch No. 5 and used to evaluate the overall water quality of the Lateral Ditch No. 5 subwatershed (Figure 48). Table 36 displays the mean values of sampled water quality parameters and the determined scores for biological and habitat assessments at Site 12 during the 12 month sampling period from June 2015 through May 2016. Site 12 had the highest mean concentration between all sites for the following parameters: total phosphorus, nitrate+nitrite, E. coli and dissolved phosphorus. Total phosphorus mean concentration was 0.44 mg/L and exceeds the project target. Total phosphorus samples exceeded the project target 58% of time. Nitrate+nitrite mean concentration was 9.57 mg/L and exceeds the project target of <1.5 mg/L by a significant amount and almost exceeds the Indiana State standard of 10 mg/L. The E. coli mean concentration was 1,127 mpn/100 mL and exceeds the Indiana State standard of 235 mpn/100 mL. E. coli samples exceeded the State standards during 67% (8/12) of events. Site 12 was one of four sites included in E. coli source tracking analysis in May 2016, investigating contributions from human and animal sources. Results of the E. coli source tracking indicated humans and animals contributed equally to E. coli levels at Site 12 with each accounting for 50% of the sample (Figure 16). Site 12 had the lowest mean TKN concentration at 0.41 mg/L. TKN samples exceeded the project target 42% (5/12) of the time. The mean parameter concentrations meeting project targets include atrazine, TSS, TKN, dissolved oxygen and pH. Habitat assessment with the QHEI meets the project target of >51 but the MIBI biological assessment does not meet the project target of ≥4. A complete listing of water quality testing results from the 12 month sampling period can be found in Appendix C.

Table 36. Site 12 water quality analysis – Lateral Ditch No. 5 subwatershed.

Parameter	Mean/Score	Unit	# of Times Does not Meet Target	% Does not Meet Target
Total Phosphorus	0.44	mg/L	7	58
Dissolved Phosphorus	0.35	mg/L	-	-
Nitrate + Nitrite	9.57	mg/L	1.5 mg/L 12	100
			10 mg/L 6	50
Ammonia	0.067	mg/L	3	25
TKN	0.41	mg/L	5	42
E. coli	1,127	mpn/100mL	8	67
Atrazine	0.34	µg/L	-	-
TSS	14	mg/L	2	17
Turbidity	14.12	NTU	4	33
Dissolved Oxygen	9.2	mg/L	0	0
pH	7.95	-	0	0
QHEI	53	-	Meets target	
MIBI	2.9	-	Does not meet target	

3.2.1 Lemler Ditch (HUC: 071200010307)

The Lemler Ditch subwatershed is dominated by cultivated crops, which account for 86.8% of the watershed. The second most common land use in the watershed is developed-open space, which primarily consists of roads (Figure 50). There are no urban areas in the Lemler Ditch subwatershed, therefore developed land use is limited to low density development (Table 37). The primary natural habitats in the subwatershed are deciduous forest and wood wetlands, which combine for less than 5.0% of the subwatershed (Table 37). Industrial development is not a concern within the watershed and current land use percentages are expected to remain consistent into the future.

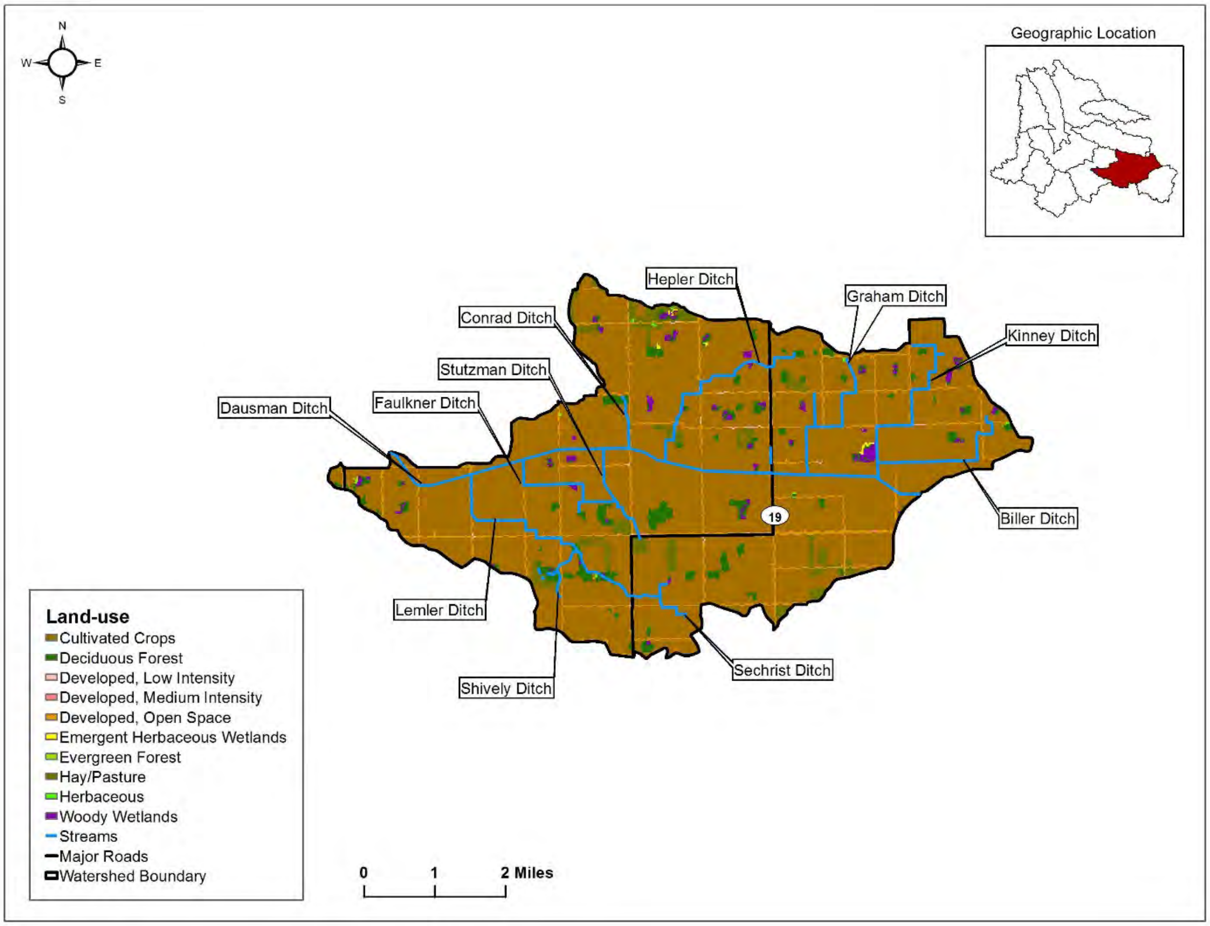


Figure 50. Lemler Ditch subwatershed landuse.

Table 37. Percentage and acreage of each land use type in the Lemler Ditch subwatershed (HUC: 071200010307).

Land use	% of Watershed	Acres
Developed, Open Space	4.5%	786
Developed, Low Intensity	0.3%	45
Developed, Medium Intensity	0.0%	3
Deciduous Forest	3.6%	630
Evergreen Forest	0.0%	6
Herbaceous	0.0%	8
Hay/Pasture	3.5%	610
Cultivated Crops	86.8%	15,025
Woody Wetlands	1.1%	184
Emergent Herbaceous Wetlands	0.1%	12

The Lemler Ditch subwatershed contains approximately 29 miles of streams and 29 miles of closed drains, none of which are currently listed as impaired (Figure 51). The watershed contains no NPDES permitted facilities and one CFO (Figure 51). The CFO is located near the headwaters of Shively Ditch in the southern portion of the subwatershed (Figure 51). There were twenty-four locations surveyed in the Lemler Ditch subwatershed during the windshield survey (Figure 52). Relative to all the Headwaters Yellow River Watershed as a whole the degree of streambank erosion is more prevalent, channelization is more prevalent, stream buffers are less prevalent, and in-stream cover is less prevalent in the Lemler Ditch subwatershed (Table 12; Table 38). In-stream was documented as poor at 58% (14/24) of sites, four sites (17%) were identified as having severe or very severe streambank erosion and stream buffers were estimated to be absent on 22.6 miles (78%) of the 29 miles of streams in the watershed (Figure 52). One location was noted for having livestock access to the stream (Figure 52).

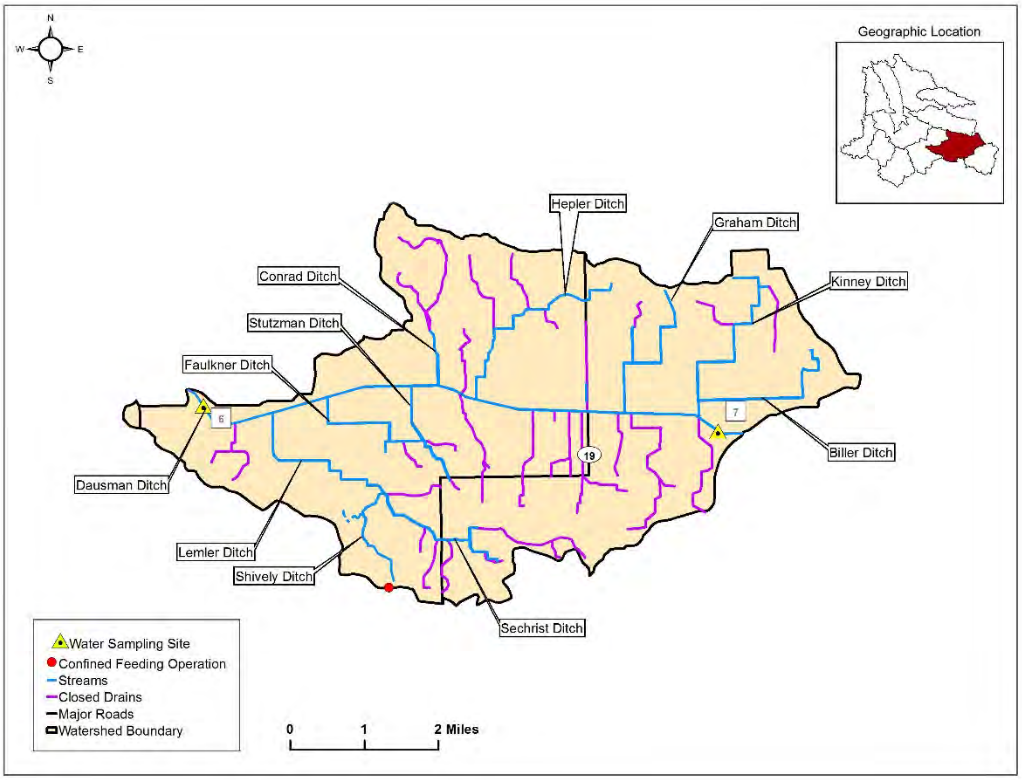


Figure 51. Lemler Ditch subwatershed water quality information map.

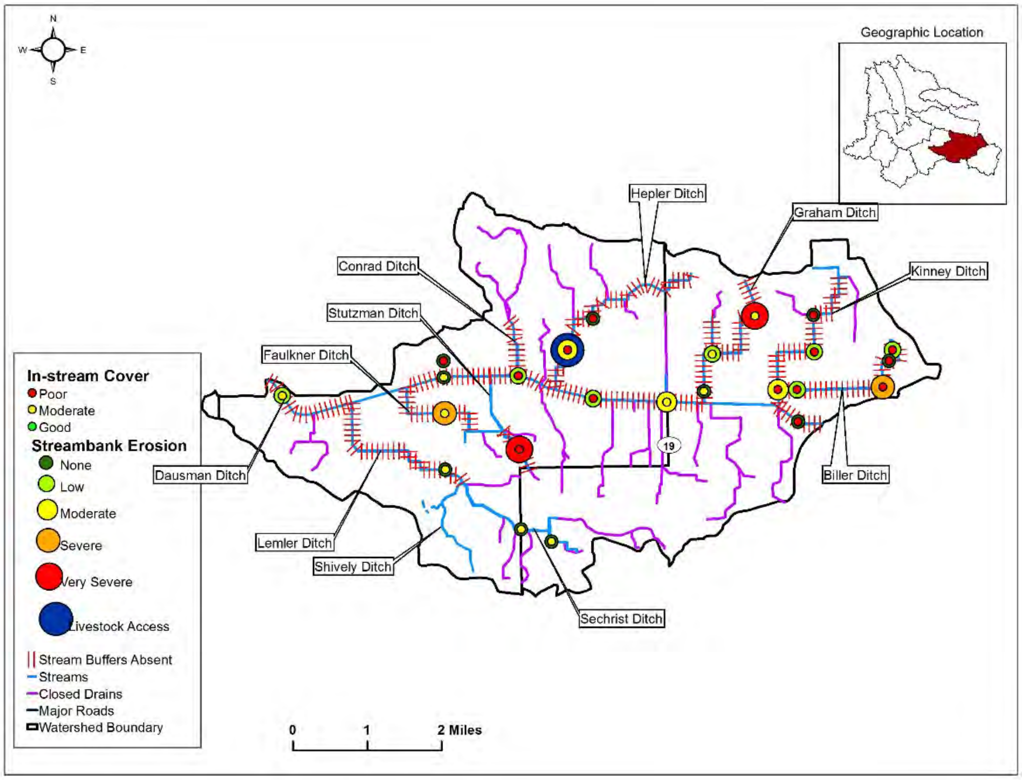


Figure 52. Lemler Ditch subwatershed 2015 windshield survey sites and results.

Table 38. Results of the Lemler Ditch subwatershed 2015 windshield survey.

Subwatershed	Streambank Erosion	Channelization	Stream Buffers	In-stream Cover
Lemler Ditch x̅	1.1	3.7	0.3	1.4
Headwaters Yellow River Watershed Average	0.8	3.1	1.1	2.2

Testing Site 6 was located in Dausman Ditch and used to evaluate the overall water quality of the Lemler Ditch subwatershed (Figure 51). Table 39 displays the mean values of sampled water quality parameters and the determined scores for biological and habitat assessments at Site 6 during the 12 month sampling period from June 2015 through May 2016. Site 6 mean water quality parameter concentrations usually ranked in the middle of sampled sites or had some of the lowest concentrations. Total phosphorus and dissolved phosphorus mean concentrations were the second lowest between sites and ammonia mean concentration was third lowest. Total phosphorus mean concentration was 0.20 mg/L and meets the project target. Total phosphorus samples exceeded the project target on only one occasion. Nitrate+Nitrite mean concentration was the third highest between all sites at 8.29 mg/L and exceeds the project target (Figure 19). Nitrate+Nitrite concentrations exceeded the project target of <1.5 mg/L 100% of the time and exceeded Indiana State standard of 10 mg/L on 42% of samples. The E. coli mean concentration was 533 mpn/100 mL which is the fourth lowest between all sites however it does exceed the Indiana State standard. E. coli samples exceeded the State standard on 83% (10/12) of samples. The mean parameter concentrations that met project targets include total phosphorus, atrazine, TSS, dissolved oxygen and pH. At Site 6 both the habitat and biological assessments met project target values. Site 6 is one of only three sites sampled that meet both the QHEI and MIBI project targets, with the other Sites being Site 1 (Milner Seltenright Ditch subwatershed) and Site 3 (Stone Ditch subwatershed). A complete listing of water quality testing results from the 12 month sampling period can be found in Appendix C.

Table 39. Site 6 water quality analysis – Lemler Ditch subwatershed.

Parameter	Mean/Score	Unit	# of Times Does not Meet Target		% Does not Meet Target
Total Phosphorus	0.20	mg/L	1		8
Dissolved Phosphorus	0.10	mg/L	-		-
Nitrate + Nitrite	8.29	mg/L	1.5 mg/L	12	100
			10 mg/L	5	42
Ammonia	0.046	mg/L	1		8
TKN	0.76	mg/L	7		58
E. coli	533	mpn/100mL	10		83
Atrazine	0.12	µg/L	-		-
TSS	15	mg/L	1		8
Turbidity	19.06	NTU	2		17
Dissolved Oxygen	9.66	mg/L	0		0
pH	8.03	-	0		0
QHEI	64	-	Meets target		
MIBI	5.1	-	Meets target		

3.2.1 Milner Seltenright Ditch (HUC: 071200010312)

The most common land use in the Milner Seltenright Ditch subwatershed is cultivated crops, which account for 74.3% of the watershed. The second most common land use in the watershed is developed-open space, which accounts for 7.6% of the watershed (Table 40). Developed land uses are relatively common in the Milner Seltenright Ditch subwatershed as the result of the City of Plymouth in the southwest portion of the subwatershed (Figure 53). The Milner Seltenright Ditch subwatershed also has a significant amount of deciduous forest and woody wetlands (Figure 53). Woody wetlands are largely concentrated along the mainstem of the Yellow River in the central portion of the Milner Seltenright Ditch subwatershed. Industrial and residential development in and around Plymouth are expected to increase into the future and will have an impact on future land use percentages. Thoughtful development with regard to stormwater management should be a priority in developing areas of the watershed.

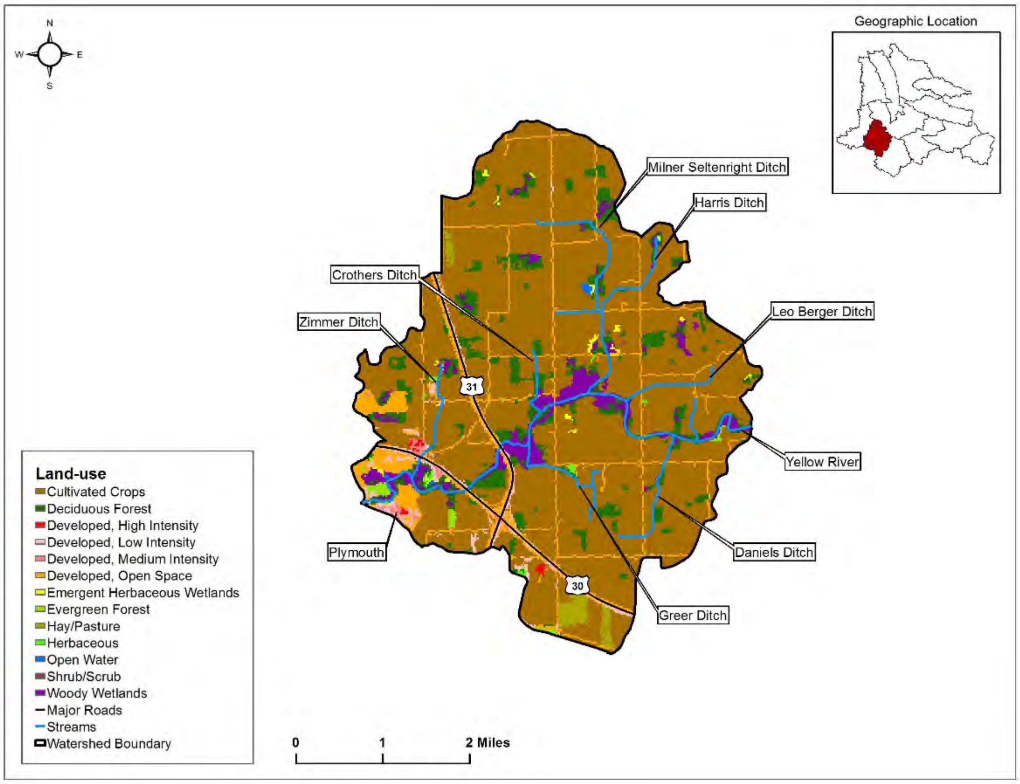


Figure 53. Milner Seltenright Ditch subwatershed landuse.

Table 40. Percentage and acreage of each land use type in the Milner Seltenright Ditch subwatershed (HUC: 071200010312).

Land use	% of Watershed	Acres
Open Water	0.1%	13
Developed, Open Space	7.6%	839
Developed, Low Intensity	2.4%	261
Developed, Medium Intensity	0.5%	54
Developed, High Intensity	0.1%	15
Deciduous Forest	8.3%	913
Evergreen Forest	0.4%	45
Shrub/Scrub	0.0%	4
Herbaceous	0.2%	24
Hay/Pasture	1.1%	121
Cultivated Crops	74.3%	8,208
Woody Wetlands	4.6%	505
Emergent Herbaceous Wetlands	0.3%	39

The Milner Seltenright Ditch subwatershed contains approximately 13 miles of streams and 5 miles of closed drains. Of the 13 miles of open drains 9.3 miles are currently listed as impaired for *E. coli* (Figure 54). All five of the water samples collected in 2008 for the Kankakee/Iroquois TMDL report exceed water quality standards for *E. coli* and concentrations would need to be reduced by 85% to meet water quality standards (Tetra Tech 2009).

Photo: Stream in the Milner Seltenright Ditch subwatershed with stream buffers and in-stream cover.

The watershed contains no NPDES permitted facilities or CFO's (Figure 54). There were fourteen locations surveyed in the Milner Seltenright Ditch subwatershed during the windshield survey (Figure 55). Relative to the Headwaters Yellow River Watershed as a whole the degree of streambank erosion is more prevalent, channelization is less prevalent, stream buffers are more prevalent and in-stream cover is more prevalent in the Milner Seltenright Ditch subwatershed (Table 12; Table 41). In-stream cover was assessed to be poor at one of the windshield survey sites, three sites were listed as having severe or very severe streambank erosion and stream buffers were estimated to be absent along 2.3 miles (18%) of the 13 miles of stream in the Milner Seltenright Ditch subwatershed (Figure 55). There no instances observed of livestock with direct access to streams.

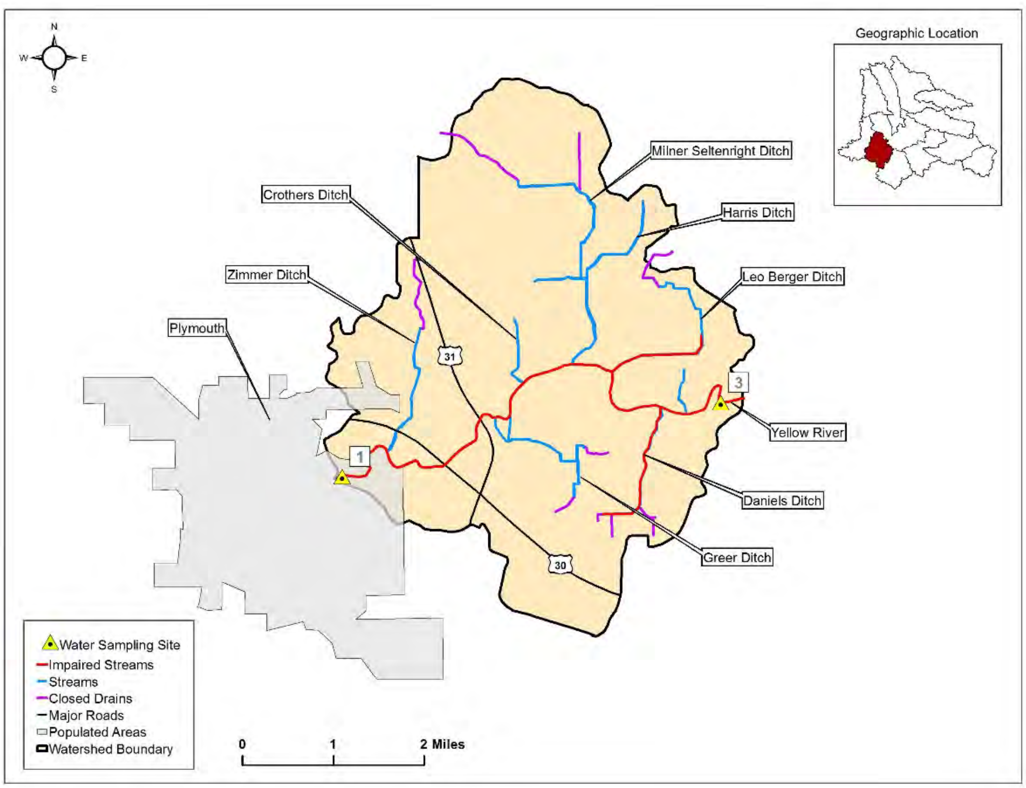


Figure 54. Milner Seltenright Ditch subwatershed water quality information map.

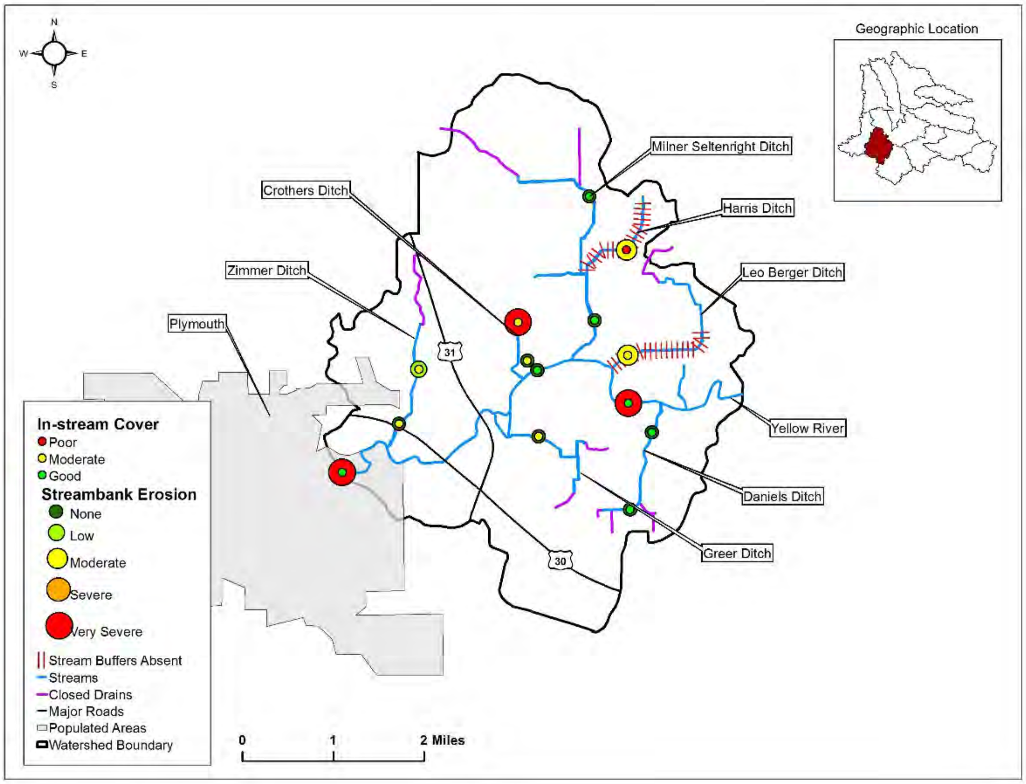


Figure 55. Milner Seltenright Ditch subwatershed 2015 windshield survey sites and results.

Table 41. Results of the Milner Seltenright Ditch subwatershed 2015 windshield survey.

Subwatershed	Streambank Erosion	Channelization	Stream Buffers	In-stream Cover
Milner Seltenright Ditch x̅	1.2	1.8	2.9	3.3
Headwaters Yellow River Watershed Average	0.8	3.1	1.1	2.2

Testing Site 1 was located in the Yellow River and used to evaluate the overall water quality of the Milner Seltenright Ditch subwatershed (Figure 56). Table 42 displays the mean values of sampled water quality parameters and the determined scores for biological and habitat assessments at Site 1 during the 12 month sampling period from June 2015 through May 2016. Overall, mean values determined for Site 1 are usually associated with in the middle range of values between all sites; however, Site 1 means for turbidity and TSS rank as the third lowest between all sites. Site 1 turbidity concentrations exceeded the project target 42% of the time and overall the mean of 11.34 NTU does exceed the project target of 10.4 NTU. TSS concentrations exceeded the project target on only one occasion and the overall mean was 9 which is meets the project target. E. coli mean concentration at Site 1 was 613 mpn/100 mL and exceeds the Indiana State standard. E. coli samples exceeded the State standard 75% (9/12) of the time. Site 1 was one of four sites sampled in May 2016 for source tracking of E. coli for percent human vs percent animal. Results of the sources tracking analysis indicated humans accounted for 53% while animals accounted for 47% (Figure 16). This was consistent with two of the other samples included in the E. coli source tracking analysis (Site 11 and Site 12; Figure 16). The total phosphorus mean concentration was 0.27 and meets the project target. Total phosphorus samples exceeded the project target 25% of the time. Both the habitat and biological assessments at Site 1 meet the project target values. Site 1 had a MIBI value of 5.1 which was the second highest between all sites. Site 1 was one of only three sites that met project target values for both habitat and biological assessments. A complete listing of water quality testing results from the 12 month sampling period can be found in Appendix C.

Table 42. Site 1 water quality analysis – Milner Seltenright Ditch subwatershed.

Parameter	Mean/Score	Unit	# of Times Does not Meet Target	% Does not Meet Target
Total Phosphorus	0.27	mg/L	3	25
Dissolved Phosphorus	0.20	mg/L	-	-
Nitrate + Nitrite	5.91	mg/L	1.5 mg/L 12	100
			10 mg/L 0	0
Ammonia	0.057	mg/L	1	8
TKN	0.61	mg/L	7	58
E. coli	613	mpn/100mL	9	75
Atrazine	0.51	µg/L	-	-
TSS	9	mg/L	1	8
Turbidity	11.34	NTU	5	42
Dissolved Oxygen	8.31	mg/L	0	0
pH	8.06	-	0	0
QHEI	56	-	Meets target	
MIBI	5.1	-	Meets target	

3.2.1 <u>Stone Ditch (HUC: 071200010310)</u>

The most common land use in the Stone Ditch subwatershed is cultivated crops, which account for 82.5% of the subwatershed. The second most common land use in the Stone Ditch subwatershed is deciduous forest, which accounts for 5.2% of the watershed. There is also 5.1% of the watershed containing developed-open space. The remainder of the watershed is evenly distributed amongst the land uses described in Table 43, however it should be noted that the woody wetlands located in the Stone Ditch subwatershed are concentrated along the mainstem of the Yellow River in the northern portion of the watershed (Figure 56). Industrial development is not a concern in the Stone Ditch subwatershed and current land use percentages are expected to remain similar into the future.

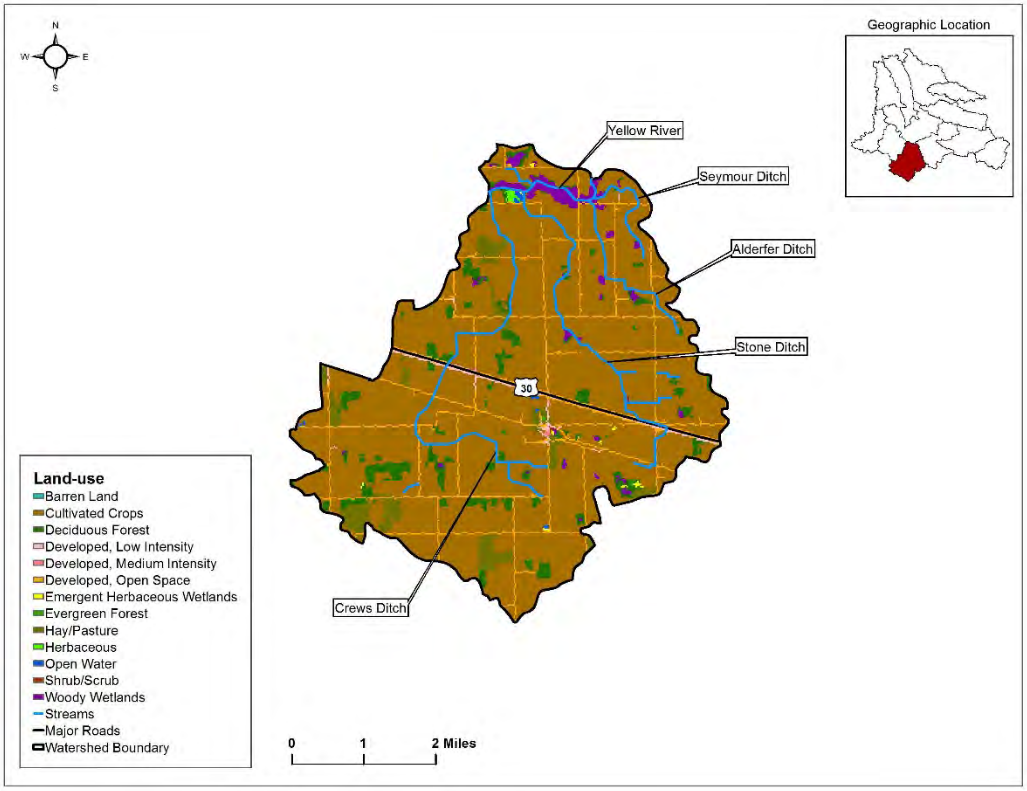


Figure 56. Stone Ditch subwatershed landuse.

Table 43. Percentage and acreage of each land use type in the Stone Ditch subwatershed (HUC: 071200010310).

Land use	% of Watershed	Acres
Open Water	0.1%	19
Developed, Open Space	5.1%	725
Developed, Low Intensity	1.0%	137
Developed, Medium Intensity	0.1%	7
Barren Land	0.0%	0
Deciduous Forest	5.2%	742
Evergreen Forest	0.1%	8
Shrub/Scrub	0.0%	3
Herbaceous	0.1%	14
Hay/Pasture	3.8%	541
Cultivated Crops	82.5%	11,739
Woody Wetlands	2.0%	286
Emergent Herbaceous Wetlands	0.1%	14

The Stone Ditch subwatershed contains approximately 20 miles of streams and 8 miles of closed drains, none of which are currently listed as impaired (Figure 57). The watershed contains no NPDES permitted facilities, however there is one CFO located near the intersection of Stone Ditch and Highway 30 (Figure 57). There were twenty-four locations surveyed in the Stone Ditch subwatershed during the windshield survey (Figure 58). Relative to the Headwaters Yellow River Watershed as a whole the degree of streambank erosion is less prevalent, channelization is less prevalent, stream buffers are more prevalent, and in-stream cover is more prevalent in the Stone Ditch subwatershed (Table 12; Table 44). During the watershed windshield survey in-stream cover was listed as poor at 17% (4/24) of the sites, no sites were identified as having severe of very severe streambank erosion and stream buffers were estimated to be absent along 15.1 miles (75%) of the 20 miles of streams within the watershed (Figure 58). There no sites identified during the windshield survey that had direct livestock access to streams.

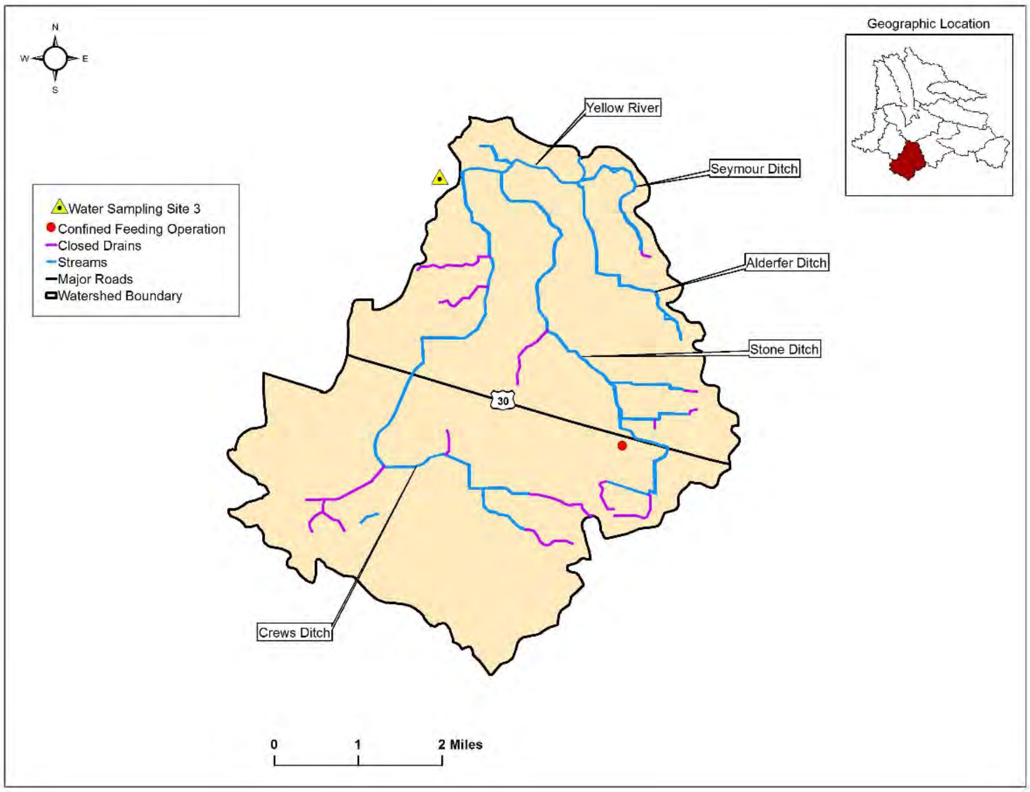


Figure 57. Stone Ditch subwatershed water quality information map.

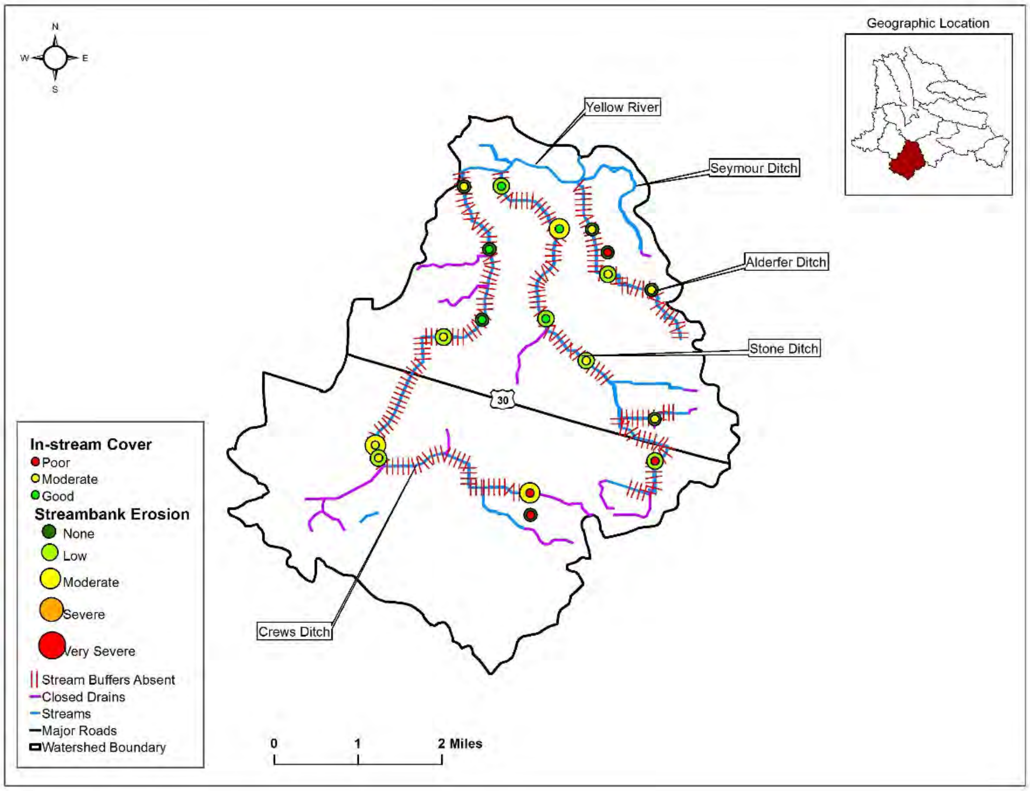


Figure 58. Stone Ditch subwatershed 2015 windshield survey sites and results.

Table 44. Results of the Stone Ditch subwatershed 2015 windshield survey.

Subwatershed	Streambank Erosion	Channelization	Stream Buffers	In-stream Cover
Stone Ditch x̅	0.7	2.5	1.1	2.4
Headwaters Yellow River Watershed Average	0.8	3.1	1.1	2.2

Testing Site 3 was located in the Yellow River and used to evaluate the overall water quality of the Stone Ditch subwatershed (Figure 57). Table 45 displays the mean values of sampled water quality parameters and the determined scores for biological and habitat assessments at Site 3 during the 12 month sampling period from June 2015 through May 2016. Overall, mean water quality parameter results fall within the middle portion of the range between all sites. The exception to this is for TKN which Site 3 had a mean concentration of 1.06 mg/L and ranked as the second highest between all sites. TKN mean exceeds the project target value and overall TKN exceeded the target concentration 75% of the time. The mean E. coli concentration was 729 mpn/100 mL and exceeds the Indiana State standard. E. coli concentrations exceeded the State standard on 75% of samples. Total phosphorous mean concentration was 0.29 mg/L and ranked as the fifth highest between all sits (Figure 20). The total phosphorus mean meets the project target of <0.3 mg/L and overall total phosphorus samples exceeded the project target on 25% of the samples. Mean water quality parameter concentrations that meet project targets include total phosphorus, atrazine, TSS, dissolved oxygen and pH. The biological assessment using the MIBI was 5.3 and was the highest score between all sites and meets the project target. Habitat assessment using the QHEI was 55.5 and meets the project target. Site 3 is one of only three sites that meets project targets for both QHEI and MIBI. A complete listing of water quality testing results from the 12 month sampling period can be found in Appendix C.

Table 45. Site 3 water quality analysis – Stone Ditch subwatershed.

Parameter	Mean/Score	Unit	# of Times Does not Meet Target	% Does not Meet Target
Total Phosphorus	0.29	mg/L	3	25
Dissolved Phosphorus	0.19	mg/L	-	-
Nitrate + Nitrite	6.13	mg/L	1.5 mg/L 12	100
			10 mg/L 0	0
Ammonia	0.058	mg/L	1	8
TKN	1.06	mg/L	9	75
E. coli	729	mpn/100mL	9	75
Atrazine	0.82	µg/L	-	-
TSS	17	mg/L	3	25
Turbidity	15.70	NTU	5	42
Dissolved Oxygen	7.4	mg/L	0	0
pH	8.0	-	0	0
QHEI	55.5	-	Meets target	
MIBI	5.3	-	Meets target	

3.2.1 West Bunch Branch (HUC: 071200010305)

The most common land use in the West Bunch Branch subwatershed is cultivated crops, which account for 71.8% of the watershed. The second most common land use in the watershed is deciduous forest, accounting for 8.3% of the watershed. Hay/pasture is also relatively common in the watershed, accounting for 6.9% of the watershed (Table 46). While the total land area of woody wetlands in the West Bunch Branch subwatershed is not large, there are a large number of small woody wetlands scattered throughout the northern portion of the watershed (Figure 59). The West Bunch Branch subwatershed does not contain any urban areas and industrial development is not a concern within the watershed. Current land use percentages are expected to remain comparable into the future.

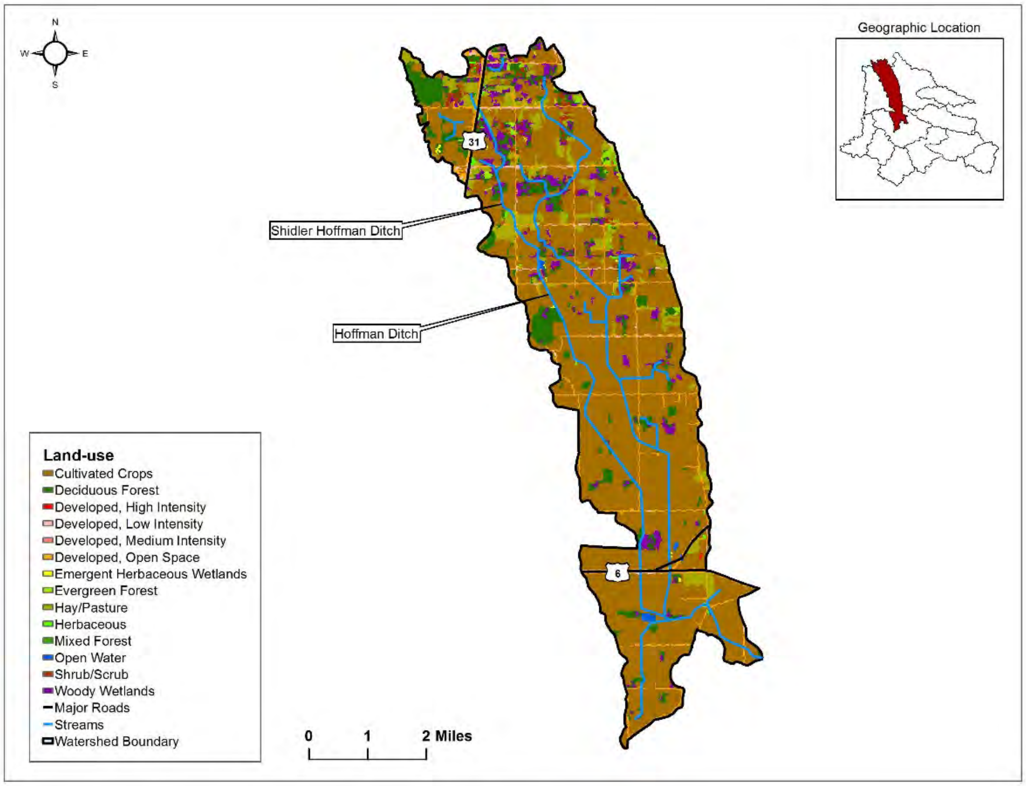


Figure 59. West Bunch Branch subwatershed landuse.

Table 46. Percentage and acreage of each land use type in the West Bunch Branch subwatershed (HUC: 071200010305).

Land use	% of Watershed	Acres
Open Water	0.2	38
Developed, Open Space	4.4	736
Developed, Low Intensity	1.3	219
Developed, Medium Intensity	0.1	15
Developed, High Intensity	0.0	2
Deciduous Forest	8.3	1,388
Evergreen Forest	0.5	84
Mixed Forest	0.0	4
Shrub/Scrub	1.4	239
Herbaceous	0.3	48
Hay/Pasture	6.9	1154
Cultivated Crops	71.8	12,010
Woody Wetlands	4.6	775
Emergent Herbaceous Wetlands	0.1	24

The West Bunch Branch subwatershed contains approximately 33.9 miles of streams and 8.9 miles of closed drains, 11.2 miles of which are currently listed as impaired for *E. coli* and/or impaired biotic communities. All five of the water samples collected in 2008 for the Kankakee/Iroquois TMDL report from West Bunch Branch exceeded state standards for *E. coli* and concentrations would need to be reduced by 87% to meet water quality standards (Tetra Tech 2009).The one NPDES facility in the West Bunch Branch subwatershed is the Lake of the Woods Regional Sewer District. A review of the facility reporting records indicates there have been two minor violations within the last 12 quarters. Violations were for TSS and pH, with most recent violation occurring in March of 2017. The facility is currently in compliance. There are no CFO's in the West Bunch Branch subwatershed (Figure 60). There were fifteen locations surveyed in the West Bunch Branch subwatershed during the windshield survey (Figure 61). Relative to the Headwaters Yellow River Watershed as a whole the degree of streambank erosion is less prevalent, channelization is more prevalent, stream buffers are less prevalent, and in-stream cover is less prevalent in the West Bunch Branch subwatershed (Table 12; Table 47). During the windshield survey in-stream habitat was report as poor at six sites (40%), two sites (13%) were listed as having severe or very severe streambank erosion and stream buffers were estimated to be absent along 12 miles (35%) of the 33.9 miles of streams in the watershed (Figure 61). Livestock were not observed with direct access to streams throughout the watershed.

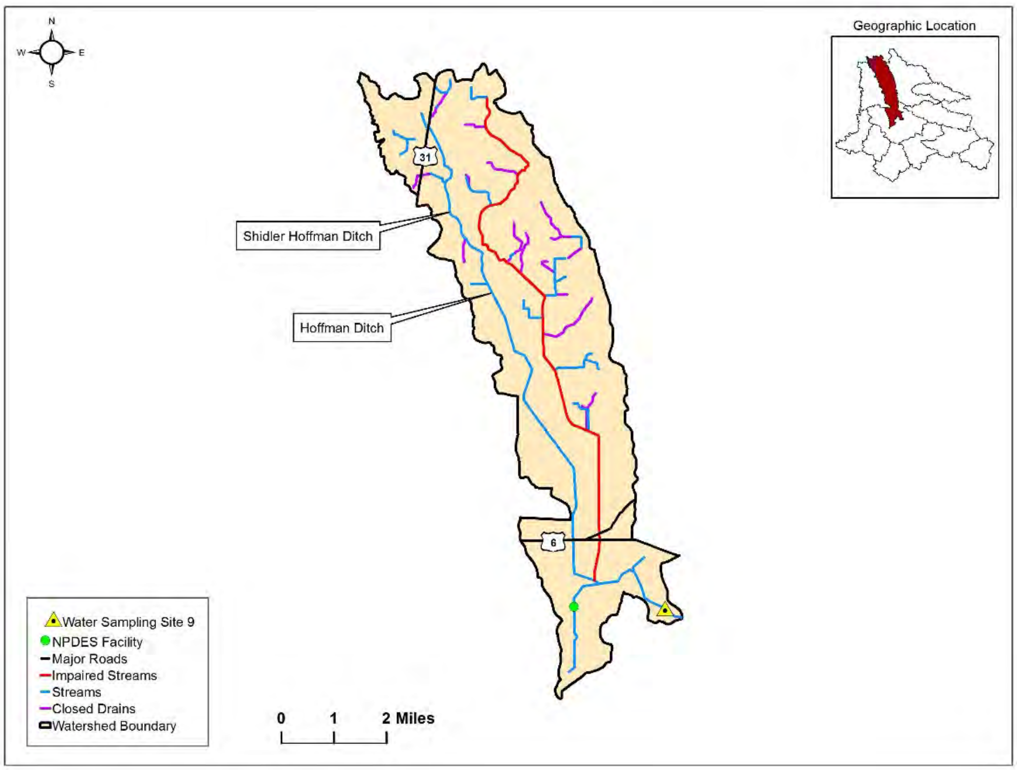


Figure 60. West Bunch Branch subwatershed water quality information map.

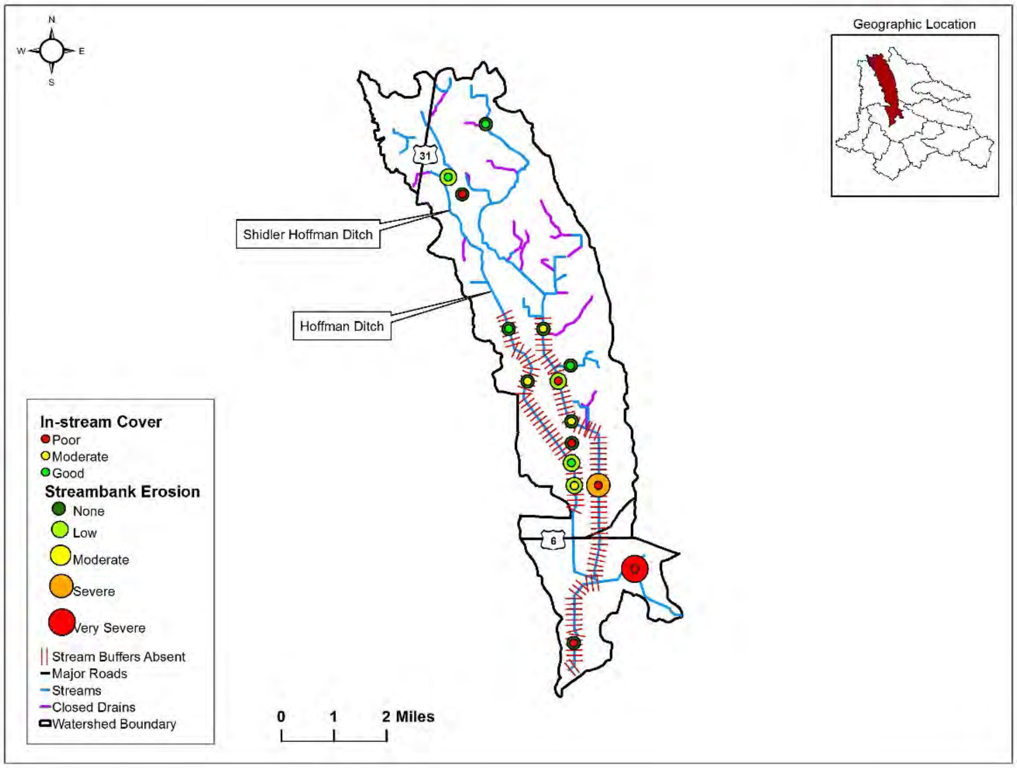


Figure 61. West Bunch Branch subwatershed 2015 windshield survey sites and results.

Table 47. Results of the West Bunch Branch subwatershed 2015 windshield survey.

Subwatershed	Streambank Erosion	Channelization	Stream Buffers	In-stream Cover
West Bunch Branch x̄	0.7	3.2	0.7	2.1
Headwaters Yellow River Watershed Average	0.8	3.1	1.1	2.2

Testing Site 9 was located in Stock/Bunch Ditch and used to evaluate the overall water quality of the Stock Ditch subwatershed (Figure 62). Table 48 displays the mean values of sampled water quality parameters and the determined scores for biological and habitat assessments at Site 9 during the 12 month sampling period from June 2015 through May 2016. The majority of mean water quality parameters at Site 9 were within the middle range of means between all sites. The exception to this is TSS which the mean concentration was 54 mg/L and was the highest average between all sites (Figure 21). TSS samples exceeded the project target during two events and were very high concentrations with one being 435 mg/L and the other at 144 mg/L. The E. coli mean concentration was 632 mpn/100 mL and exceeds the Indiana State standard. E. coli samples exceeded the State standard 58% (7/12/) of the time. Total phosphorus mean concentration was 0.29 mg/L and meets the project target. Total phosphorus samples exceeded the project target 25% (3/12) of the time. Nitrate+Nitrite mean concentration was 4.96 mg/L and was the fourth lowest between all sites. Nitrate+nitrite mean concentration exceeds the project target of <1.5 mg/L. Nitrate+nitrite samples did not exceed the Indiana State standard of 10 mg/L during any sampling event. The mean water quality parameter concentrations that meet project target values include total phosphorus, atrazine, dissolved oxygen and pH. Site 9 did meet the target value for biological assessment using the

MIBI, but did not meet the habitat QHEI project target. A complete listing of water quality testing results from the 12 month sampling period can be found in Appendix C.

Table 48. Site 9 water quality analysis – West Bunch Branch subwatershed.

Parameter	Mean/Score	Unit	# of Times Does not Meet Target		% Does not Meet Target
Total Phosphorus	0.29	mg/L	3		25
Dissolved Phosphorus	0.18	mg/L	-		-
Nitrate + Nitrite	4.96	mg/L	1.5 mg/L	12	100
			10 mg/L	0	0
Ammonia	0.093	mg/L	4		33
TKN	0.67	mg/L	8		67
E. coli	632	mpn/100mL	7		58
Atrazine	0.84	µg/L	-		-
TSS	54	mg/L	2		17
Turbidity	18.41	NTU	5		42
Dissolved Oxygen	8.62	mg/L	1		8
pH	8.0	-	0		0
QHEI	47	-	Does not meet target		
MIBI	4.2	-	Meets target		

3.3 Watershed Inventory Part II Summary

Windshield survey data, land use data, and data from previous studies suggest that there are differences in habitat and water quality conditions between the subwatersheds that constitute the Headwaters Yellow River Watershed (Figure 62). The watershed is mostly rural and the largest city is the watershed is Plymouth at approximately 10,000 residents. Other population centers in the watershed include Bremen, LaPaz, Lakeville and the very western portion of Nappanee. Industrial development is the greatest within Plymouth and Bremen and are the areas with likely increases in development into the future. Industrial or residential development in these areas should be responsibly planned and stormwater management best management practices implemented as applicable. The predominate land use in the Headwaters Yellow River watershed is cultivated crops at 76%, followed by deciduous forest 7.2%. The collective percent of developed land use types accounts for 8.2% of the watershed.

Based on the information collected during the windshield survey the Stone Ditch and Kline Rouch Ditch subwatersheds have better than average existing conditions than other subwatersheds in the Headwaters Yellow River Watershed. Both of these subwatersheds had below average streambank erosion, below average channelization, above average stream buffers, and above average in-stream cover (Table 12). The land use distribution of these two subwatershed is similar with approximately 85% of the land in each subwatershed dedicated to agriculture, 6.0% developed, and 8.0-9.0% natural ecosystems. In addition to the Kline Rouch Ditch and Stone Ditch subwatersheds there are other subwatersheds with positive attributes. The Headwaters Stock Ditch subwatershed contains the largest percentage of natural ecosystems and has the lowest average stream channelization average of any other subwatershed.

Results of the windshield survey which investigated 222 sites across the watershed listed in-stream habitat as poor at 76 sites (34%; Figure 62). During the windshield survey most streambank erosion was classified as moderate or low and only 6% (13/222) of sites were listed as having severe or very severe erosion (Figure 62). Streams that lack adequate buffers was a common occurrence throughout the watershed (Figure 62). Stream buffers were estimated to be absent along approximately 153 miles (46%) of the 335 miles of streams in the watershed (Figure 62).

Based on the information collected during the windshield survey the Lake of the Woods and Lemler Ditch subwatersheds appear to have the greatest degree of habitat degradation in the Headwaters Yellow River Watershed. Both Lake of the Woods and Lemler Ditch subwatershed have above average streambank erosion, above average channelization, below average stream buffers, and below average in-stream cover (Table 12). Stream impairments are also common in the Lake of the Woods subwatershed, with nearly 22 miles of impaired streams in the subwatershed (Figure 62). Lemler Ditch subwatershed contains the highest percentage of agricultural land uses and the lowest percentage of natural ecosystems than any other subwatershed. As a result of the land use distribution the Lemler Ditch subwatershed has fewer stream buffers found in the subwatershed than any other area of the Headwaters Yellow River Watershed. Despite the widespread degradation of streams and adjacent ecosystems in the Lemler Ditch subwatershed there are currently no impaired streams in the subwatershed.

The water quality data collected from June 2015 through May 2016 in the Headwaters Yellow River Watershed demonstrates that there are spatial differences in the contribution of nutrients, *E. coli*, and sediment to the Yellow River. Overall, four sampling sites had mean total phosphorous concentrations above the project target of 0.3 mg/L (Figure 62). These sites included Site 12 (Lateral Ditch No. 5 subwatershed), Site 11 (Kline-Rouch Ditch subwatershed), Site 8 (Headwaters Stock Ditch subwatershed) and Site 4 (Lake of the Woods subwatershed). Mean TSS concentrations from sample sites was within project target value at all but two sites, Site 9 (West Bunch Branch subwatershed) and Site 4. TSS project target concentrations were exceeded greater than 25% of the time (3 or more events) at only two sites, Site 3 (Stone Ditch subwatershed) and Site 4 (Figure 62). The export of nutrients to the Yellow River appears to be influenced partially by the soils of the watershed. Hydric soils are common in Dausman Ditch, Lemler Ditch, and Fleugel Ditch subwatersheds (sample site #5, #6, and #7). Each of these subwatersheds had relatively high nitrate-N+nitrite-N concentrations and relatively low concentrations of total phosphorus. This suggests that the Dausman Ditch, Lemler Ditch, and Fleugel Ditch subwatersheds are exporting greater quantities of nitrogen via subsurface flow. The remainder of the watershed contains less hydric soil, therefore greater quantities of phosphorus are exported to the Yellow River via erosion. This is supported by relatively low TSS concentrations in areas of the watershed dominated by hydric soils and relatively high TSS concentrations in areas of the watershed with little hydric soil.

E. coli concentrations are the primary cause of stream impairment in the watershed and water samples collected from June 2015 through May 2016 suggest that *E. coli* concentrations exceed state water quality standards throughout the watershed. While *E. coli* concentrations regularly exceed state water quality standard at all sample sites, the northeastern portion of the watershed appears to have the highest concentrations. The Lateral Ditch No. 5 subwatershed had both the highest average concentration of total phosphorus and *E. coli*. This suggests that fecal contamination is a significant source of *E. coli* and phosphorus to the Lateral Ditch No. 5 subwatershed. Source tracking samples collected during the spring of 2016 demonstrate that human and animal fecal waste are sources of *E. coli* and phosphorus to Lateral Ditch No. 5 and the Headwaters Yellow River Watershed as a whole. Therefore, the increased implementation of agricultural BMPs and improved human waste treatment practices will need to be addressed to reduce *E. coli* concentrations.

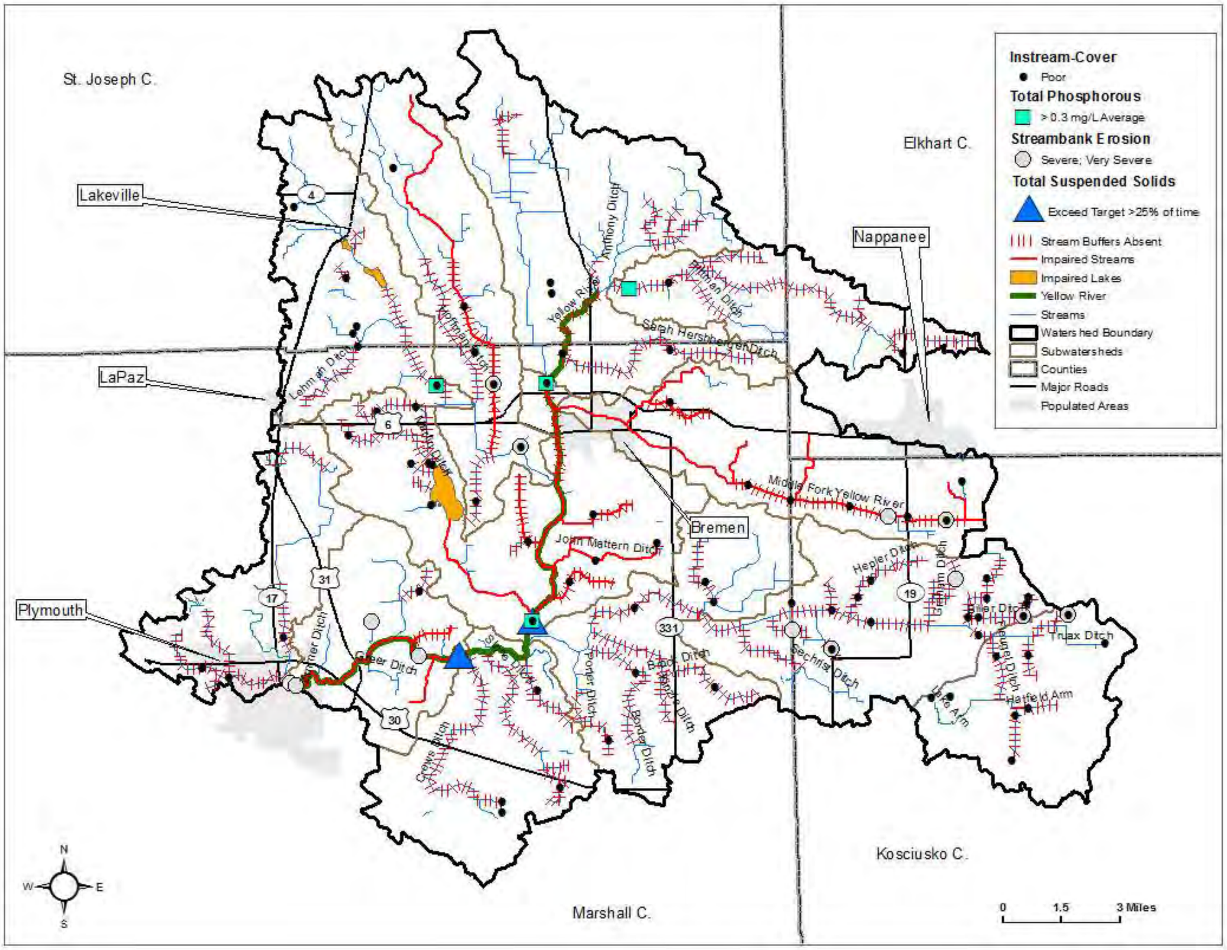


Figure 62. Headwaters Yellow River Watershed inventory summary map.

3.4 Analysis of Stakeholder Concerns

There are a number of stakeholder concerns that were described in Section 1.2 that are supported by data described in Section 3.1 and 3.2. One of the primary stakeholder concerns that was identified is the introduction of non-point source pollutants to the streams and lakes of the Headwaters Yellow River Watershed, which is supported by the listing of numerous waterbodies on the IDEM 303(d) list of impaired waterbodies and water quality data. The most common cause of impairment in the watershed is *E. coli* concentrations that exceed state standards. However, there are also waterbodies in the watershed that are impaired for PCB's and excess phosphorus. There have also been multiple LARE Lake diagnostic studies, LARE Watershed Diagnostic Studies, and additional agency water samples that support the concern that non-point source pollution is a water quality concern in the watershed. Therefore, addressing non-point source pollution in the streams and lakes of the Headwaters Yellow River Watershed was determined to be an area of focus (Table 49).

The watershed inventory also provides significant insights regarding the habitat conditions that exist in the watershed. Headwaters Yellow River Watershed stakeholders have concerns related to the limited aquatic habitat for aquatic organisms, which is supported by data collected during the windshield survey. The windshield survey demonstrates that in-stream cover and riparian vegetation is lacking in streams throughout the watershed. Stakeholders also expressed concerns regarding the removal of trees along the

Yellow River, which is supported by observances during the windshield survey. Lastly, stakeholders expressed concerns of streambank erosion in the watershed, which was commonly observed during the windshield survey. Due to the ecosystem interactions between in-stream cover, riparian vegetation, streambank erosion, and water quality, addressing each of these concerns is believed to be an area of focus (Table 49)

As a result of the documented *E. coli* concentrations in the watershed, stakeholders expressed concerns related to the introduction of human and animal waste into streams. The introduction of human waste into streams through failing septic systems, direct discharges from homes, and land application of waste is a concern of stakeholders in the watershed. Previous planning efforts in the watershed suggest that failing septic systems should be a concern in the watershed. The Kankakee/Iroquois Watershed TMDL Report (Tetra Tech 2009) lists failing septic systems as a potential unregulated non-point source of *E.coli* in the watershed and multiple other existing WMPs (JFNew 2006a; Michiana Area Council of Governments 2012) suggest significant portions of the watershed contain soils that are not conducive to septic systems. Stakeholders also expressed concerns that there may be homes in the watershed directly discharging human waste into streams. There is no existing data to suggest that direct discharges from homes is contributing human waste into streams, however water quality data suggests that direct discharges may be present in the watershed. Lastly, watershed stakeholders expressed concerns regarding potential introduction of land applied waste material. This concern is supported by data provided in the Kankakee/Iroquois Watershed TMDL Report (Tetra Tech 2009). The potential introduction of waste material to streams via land application, failing septic systems, or direct discharges is an area of concern due to pervasive *E. coli* impairment in the watershed (Table 49).

Another common concern among Headwaters Yellow River Watershed stakeholders is the drainage and flooding of both urban and rural areas of the watershed. This concern is supported by the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) database, which demonstrates that there are approximately 13,285 acres of land that have a 0.2-1.0% annual chance of flooding. The primary areas of flooding are located adjacent to the Yellow River or major tributaries of the Yellow River. Areas of flooding in the watershed impact both agricultural and urban land uses. The western portion of Bremen and the northern portion of Plymouth are the primary urban areas of the watershed that are impacted by flooding in the watershed. Land uses in Bremen with the potential to flood include developed land, deciduous forest, and cultivated crops. Land uses in Plymouth with the potential to flood include developed land, deciduous forest, evergreen forest, and cultivated crops. It should be noted that flooding is also a legitimate concern to the southern portion of Plymouth and waterbodies downstream of the Headwaters Yellow River Watershed. While drainage and flooding concerns in the watershed are reasonable the steering committee chose not to focus on these concerns (Table 49).

The last category of concerns expressed by watershed stakeholders were the recreational opportunities in relation to the Yellow River. Stakeholders expressed concerns that the lack of public access sites to the Yellow River are limiting the recreational use of the river. This concern is supported by the watershed inventory, because recreational access to the Yellow River is limited to a small canoe launch in Centennial Park. Larger public access sites in the watershed are located at Lake of the Woods, Pleasant Lake, and Riddles Lake. There were also concerns regarding the fisheries management of the Yellow River, which is not supported by evidence. In fact the Indiana DNR Division of Fisheries has conducted multiples fisheries surveys of the Yellow River and have recommended addressing non-point sources pollution problems to improve the fishery (Price 2005). Based on the fisheries recommendations and goals of the steering committee these two concerns will not be an area of focus in the WMP.

Table 49. Analysis of the Stakeholder Concerns for the Headwaters Yellow River Watershed.

Concern	Supported by Data?	Evidence	Quantifiable?	Area of Focus
Stream water quality including nutrients, sediment, and *E. coli*	Yes	303(d) listed streams Water Quality Data	Yes	Yes
Introduction of excess nutrients, sediment and *E. coli* to Lake of the Woods, Pleasant Lake, and Riddles Lake	Yes	303(d) listed lakes	Yes	Yes
Limited habitat for aquatic organisms	Yes	Windshield survey documented poor in-stream cover at 76 of 222 sites (34%). QHEI scores at 6 of the 12 2015/2016 water sampling sites had score below target value of 51.	Yes	Yes
Introduction of Atrazine to the groundwater	No	Water Quality Data	Yes	No
Stream bank erosion	Yes	Windshield survey documented widespread streambank erosion. Erosion listed as severe or very severe at 13 of 222 sites (6%). Erosion listed as moderate at 35 of 222 sites (16%).	Yes	Yes
Failing septic systems throughout the watershed	Yes	(DJ Case and Associates 2005; Tetra Tech 2009; Michiana Area Council of Governments 2012)	Yes	Yes
Direct discharges of wastewater from older homes	No	May 2016 E. coli source tracking samples indicated humans were 50% or greater of E. coli contribution.	No	Yes
Land applications of waste material	Yes	(Tetra Tech 2009)	Yes	Yes
Management of the Yellow River for fisheries	No	DNR Sampling & Management	Yes	No
Limited boating access to the Yellow River	Yes	There are no public access sites on the Yellow River in the watershed.	Yes	No

Concern	Supported by Data?	Evidence	Quantifiable?	Area of Focus
Debris and tree removal along the Yellow River	Yes	Windshield survey documented limited riparian vegetation	Yes	Yes
Rural & urban drainage	Yes	Channelization and subsurface tile drainage is abundant in watershed. 335 miles of open streams and 154 miles of closed drains in the watershed.	No	No
Rural & urban flooding	Yes	13,285 acres of land with 0.2-1.0% probability of annual flooding	Yes	No

4 Identifying Problems and Causes

For the purposes of this WMP a "problem" is defined as an issue that exists due to one or more concerns. Therefore, problems build on concerns by formally stating a condition or action that need to be changed, improved, or further investigated. Table 50 describes the concerns of focus that were reviewed in Section 3. The problem related to the introduction of non-point source pollutants to the lakes and streams of the watershed is that many of these pollutants have resulted in the impairment of waterbodies. The concerns regarding failing septic systems, direct discharges of wastewater, and land applications of waste material are all a problem due to the prevalence of *E. coli* concentrations that exceed state water quality standards in the watershed. The concerns regarding limited habitat for aquatic organisms and vegetation removal along the Yellow River have resulted in reduced QHEI scores. Lastly, concerns regarding stream bank erosion are a problem due to the sediment and nutrient loads that exceed targets.

Table 50. List of the Concerns and the Problems Related to each Concern.

Concern(s)	Problem
Stream water quality including nutrients, sediment, and *E. coli*	Multiple stream segments in the watershed are listed as impaired on IDEMs' 303(d) list. 2015/2016 water sampling indicated nutrient, sediment and E. coli levels exceeded the project target during numerous sampling events and overall mean concentrations exceed project targets at some sites.
Introduction of excess nutrients, sediment and *E. coli* to Lake of the Woods, Pleasant Lake, and Riddles Lake	Multiple lakes in the watershed are listed as impaired on IDEM's 303(d) list.
Limited habitat for aquatic organisms	Streams have limited riparian and in-stream vegetation.
Streambank erosion	Sediment from streambank erosion is contributing to sediment and nutrient loads that exceed targets.
Failing septic systems throughout the watershed	Multiple stream segments in the watershed are listed as impaired on IDEMs' 303(d) list.
Direct discharges of wastewater from older homes	Multiple stream segments in the watershed are listed as impaired on IDEMs' 303(d) list.

Land applications of waste material	Multiple stream segments in the watershed are listed as impaired on IDEMs' 303(d) list. Streams have excess phosphorous and nitrogen levels.
Debris and tree removal along the Yellow River	Streams have limited riparian and in-stream vegetation.

Each of the problems described in Table 50 has a corresponding cause, which is defined in the form of a specific pollutant parameter and shown in Table 51. The most common problem in the Headwaters Yellow River Watershed is the impairment of streams, which is caused by *E. coli* concentrations that exceed the 235 CFU/100mL single sample water quality standard (Indiana Administrative Code (327 IAC 2-1.5-8)). Pleasant Lake, Riddles Lake, and Lake of the Woods are each listed as impaired lakes, which is caused by phosphorus concentrations that exceed the 0.3 mg/L water quality standard (Indiana Administrative Code (327 IAC 2-1.5-8)). Streams in the Headwaters Yellow River Watershed have impacted water quality which is shown in the mIBI scores displayed in Figure 24 and there is limited instream habitat and limited riparian and in-stream vegetation, which is demonstrated by QHEI scores that are below the target scores that are shown in Figure 25. Sediment from streambank erosion is contributing to sediment and nutrient loads that exceed targets as the result of TSS concentrations that exceed the group's goal of 25.0 mg/L.

Table 51. List of the Causes for each of the Problems in the Headwaters Yellow River Watershed.

Problem	Potential Cause(s)
Multiple stream segments in the watershed are listed as impaired on IDEMs' 303(d) list.	*E. coli* concentrations exceed the water quality standard of 235 CFU/100mL in a single sample.
Multiple lakes in the watershed are listed as impaired on IDEM's 303(d) list.	Phosphorus concentrations the exceed water quality standard of 0.3 mg/L.
Streams have limited riparian and in-stream vegetation.	QHEI scores are below the group's target score at six of the 12 sample sites from 2015/2016. Windshield survey listed 76 of 222 sites as poor in-stream habitat.
Sediment from streambank erosion is contributing to sediment and nutrient loads that exceed targets.	TSS concentrations in streams exceed the group's goal of 25.0 mg/L.
Streams have excess phosphorus and nitrogen levels.	Mean concentrations of water samples from 2015/2016 sampling exceeded the project target for Nitrate+Nitrite at all 12 sites. Mean total phosphorus concentrations exceed the project target of 0.3 mg/L at four of 12 sites.

5 Identifying Sources and Calculating Loads

Table 52. Potential pollutant sources per problem.

Problem	Potential Cause(s)	Potential Source(s)
Multiple stream segments in the watershed are listed as impaired on IDEMs' 303(d) list.	*E. coli* concentrations exceed the water quality standard of 235 CFU/100mL in a single sample.	Watershed is mainly rural and most homes utilize a septic system. Approximately 98% of the soils in the watershed are described as very limited for septic tank absorption fields, while only 1% are described as somewhat limited.
Multiple lakes in the watershed are listed as impaired on IDEM's 303(d) list.	Phosphorus concentrations the exceed water quality standard of 0.3 mg/L.	Application of lawn fertilizer by lake residents. Excess sediment and nutrient loading from inlet streams from the Headwaters Stock Ditch and Lake of the Woods subwatersheds. 2015/2016 water sampling mean concentration for total phosphorous exceeds target of 0.3 mg/L in Headwaters Stock Ditch and Lake of the Woods subwatersheds.
Streams have limited riparian and in-stream vegetation.	QHEI scores are below the group's target score at six of the 12 sample sites from 2015/2016. Windshield survey listed 76 of 222 sites as poor in-stream habitat.	Headwaters Yellow River watershed land use is dominated by cultivated crops at 76% (142,307 acres), and therefore streams have been channelized and riparian buffers lost over a significant amount of area. Stream buffers absent from 46% of watershed.
Sediment from streambank erosion is contributing to sediment and nutrient loads that exceed targets.	TSS concentrations in streams exceed the group's goal of 25.0 mg/L.	Streambank erosion listed as moderate to very severe at 24% of sites across Headwaters Yellow River watershed during 2015 windshield survey. Armey Ditch, Milner Seltenright Ditch and Lemler Ditch had highest streambank erosion score during windshield survey.
Streams have excess nutrient levels.	Mean concentrations of water samples from 2015/2016 sampling exceeded the project target for Nitrate+Nitrite at all 12 sites. Mean total phosphorus concentrations exceed the project target of 0.3 mg/L at four of 12 sites.	Agricultural application of fertilizer. Cultivated crops account for 76% of land use. Urban runoff potential source for nutrient loading. Developed land accounts for 8% of land use.

Pollutant loading rates discussed for each of the subwatersheds are expressed as the maximum load per day as determined from the twelve month water sampling effort conducted from June 2015 through May 2016. Loading rates are determined by multiplying the concentration of the sampled parameter by the measured discharge during the sampling event. All parameter loading rates are expressed as pounds per day (lbs/day) with the exception of *E. coli* which is reported as most probable number per day (mpn/day). *E. coli* must be reported in this way because laboratory analysis looks at *E. coli* in terms of number of bacteria not the mass of bacteria.

As displayed in Table 53 through Table 56 each subwatershed is represented by one of the sampling sites used during the twelve month sampling effort. It is important to note that some of the water sampling sites ultimately include water volumes from other subwatersheds, such as locations sampled within the Yellow River or drainages that are present in numerous subwatersheds (Figure 14 and Table 7). Those subwatershed loading calculations which do not have impacts from other subwatersheds and therefore are completely representative of the listed subwatershed include Armey Ditch (Site 10), Elmer Seltenright Ditch (Site 2), Fleugel Ditch (Site 7), Headwaters Stock Ditch (Site 8) and Lateral Ditch No. 5 (Site 12). The subwatersheds which are represented by samples taken from within the Yellow River and therefore include water volumes from upstream sources outside of the listed subwatershed include Kline Rouch Ditch (Site 11), Lakes of the Woods (Site 4), Stone Ditch (Site 3) and Milner Seltenright Ditch (Site 1). The most downstream sampling site on the Yellow River and within the Headwaters Yellow River Watershed is located at sampling Site 1, listed as Milner Seltenright Ditch (Figure 14). This location therefore represents the overall water quality conditions exiting the Headwaters Yellow River Watershed.

5.1 E. coli

5.1.1 Potential Sources

E. coli concentrations throughout the Headwaters Yellow River Watershed have historically exceeded state water quality standards and are a central cause of stream impairment in the watershed. In total, 64.3 miles of streams within the Headwaters Yellow River Watershed are designated as impaired for E. coli on Indiana's 303(d) list of impaired waters. Water samples collected from 2015 through 2016 had high *E. coli* concentrations during both base and stormflow events, suggesting there are both point source and non-point sources of *E. coli* to streams of the Headwaters Yellow River Watershed. The TMDL Report for the Kankakee/Iroquois Watershed has described both point source (permitted facilities) and potential non-point sources of *E. coli* in the Headwaters Yellow River Watershed (Tetra Tech 2009). The TMDL report outlined the following potential sources for E. coli from point source and non-point sources: CSO's, failing septic systems, CFO's, CAFO's, pastureland, and wildlife (Tetra Tech 2009). This study found no bacterial discharge violations from any of the NPDES facilities in the Headwaters Yellow River Watershed (Tetra Tech 2009). Previous water quality monitoring studies of the Yellow River in Plymouth have documented improvements to water quality following the implementation of Plymouth's CSO operational plan (Bright 2013). In addition to municipal wastewater treatment plants there are a significant number of residences outside of urban areas that have septic systems.

Septic systems are designed to collect and store sewage in a concrete, fiberglass, or polyethylene tank (USEPA 2015). Solid wastes will collect and settle to the bottom of the tank, after which beneficial bacterial breakdown the solids (USEPA 2015). Liquid waste is transferred from the tank to an absorption field where the liquids are absorbed and filtered by the underlying layers of soil. Soils have unique characteristics and the most important characteristic when considering the design of a septic system is the transmission rate of the soil. Septic systems that are built in unsuitable soils have the potential to leak sewage into nearby streams (USEPA 2015). As described in Section 2.3 the majority of the soils of the Headwaters Yellow River Watershed are very limited for septic tank absorption fields. In addition to soil limitations the Headwaters Yellow River Watershed in general is a rural environment and therefore has a significant number of residences that are outside of municipal sewer districts and utilize septic systems. Plymouth, Bremen, Nappanee, Lakeville, La Paz, and Lake of the Woods are only the portions of the watershed that are serviced by sewer systems, which account for less than 10 percent of the land cover in the Headwaters Yellow River Watershed. Considering both the soil limitations and the density of septic systems in the watershed, the introduction of bacteria to surface waters is likely. During May of 2016 water samples from site number 1, 4, 11, and 12 were analyzed to determine *E. coli* sources. These water samples demonstrate that humans are a larger source of *E. coli* than previously anticipated (Figure 3-15). While there are numerous parcels in the Headwaters Yellow River likely containing septic systems, those parcels that are closest to streams pose the greatest contamination risk (Sowah et al. 2014) The high *E. coli* concentrations observed between 2015 and 2016 during baseflow events combined with the source tracking data suggests that septic systems may be a large source of *E. coli* to streams throughout the watershed; however, there are additional potential sources of *E. coli*.

In addition to human sewage, livestock waste can be a significant source of *E. coli* if managed improperly. There are approximately 9,911 acres of pastureland in the Headwaters Yellow River. The Kline Rouch Ditch subwatershed contains more pastureland than any other subwatershed, with 2,024 acres (Figure 41). If livestock are pastured directly adjacent to streams without riparian buffers waste material is likely to runoff into the stream during precipitation events. The presence of riparian buffers is essential to the prevention of manure runoff into stream, because they have been shown to reduce fecal coliform concentrations by 99% (Sullivan et al. 2007). Riparian buffers reduce *E. coli* concentrations through physical and chemical absorption within the soil profile (Sullivan et al. 2007). Livestock manure may also enter streams if livestock have direct access to the stream. While the direct access of animals to streams is believed to be uncommon in the Headwaters Yellow River Watershed, there were a couple observances during the windshield survey.

Another potential source of *E. coli* into streams of the Headwaters Yellow River Watershed are CFO's and CAFO's. CFO's and CAFO's contain large numbers of animals in a confined area, which excrete large amounts of waste material. Despite regulation of these facilities accidental spills and over-application of manure to fields can enter receiving streams (Centner 2010). Because animals raised in these facilities are warm blooded their waste contains many bacterial species including *E. coli* (Burkholder et al. 2007). The Headwaters Yellow River Watershed contains eleven CFO's and one CAFO. The eastern portion of the watershed contains the greatest concentration of CFO/CAFO's, while none are present in the western portion of the watershed. The location of each CFO/CAFO is displayed in Section 3.2.

While livestock can be a significant source of *E. coli* to waterbodies, there are additional animal sources. The remaining potential sources of *E. coli* to the watershed are wildlife and domestic pet waste runoff. Like any other watershed the Headwaters Yellow River Watershed contains a diverse community of warm-blooded wildlife that contribute waste and *E. coli* to waterbodies. However, the pollution contribution of wildlife is generally believed to be less severe because wildlife are not concentrated or limited to one area in close proximity to waterbodies. The last potential source of *E. coli* to the Headwaters Yellow River Watershed is domesticated pet waste. Domesticated pet waste can contribute *E. coli* to waterbodies following precipitation events. Domesticated pet waste is common in urban areas simply because of the increased population. Therefore, urban areas of the watershed are likely the areas of the watershed with the greatest contribution of domesticated pet waste to waterbodies. The introduction of domestic pet waste to waterbodies in urban areas can be reduced by properly disposing of pet waste and through the implementation of low-impact development (LID) practices.

5.1.2 Loading

Each of the twelve subwatersheds in the Headwaters Yellow River Watershed exceeded the state water quality standard for *E. coli* concentration of 235 MPN/100mL. Table 53 describes the maximum *E. coli* load that was observed during twelve months of water sampling and the reductions that will be needed in each subwatershed to reach target maximum loads. Reductions needed to meet target *E. coli* loads range from 33% to 90% (Table 53). The reductions described in Table 53 closely resemble reductions that were called for in both the Heston-Stock Ditch Watershed Management Plan (Michiana Area Council of Governments 2012) and the Kankakee River Watershed TMDL Report (85-93%) (Tetra Tech 2009).

Table 53. Maximum *E. coli* load (mpn/day) observed from June 2015 through May 2016, target load (mpn/day), and necessary load reduction (mpn/day) for each subwatershed of the Headwaters Yellow River Watershed.

Subwatershed Water Sampling Site ()	Maximum Load (mpn/day)	Target Maximum Load (mpn/day)	Reduction (mpn/day)	% Reduction
Armey Ditch (Site 10)	4.1×10^{12}	4.0×10^{11}	3.7×10^{12}	90%
Dausman Ditch (Site 5)	3.2×10^{12}	5.4×10^{11}	2.7×10^{12}	83%
Elmer Seltenright Ditch (Site 2)	1.1×10^{12}	1.0×10^{11}	1.0×10^{12}	90%
Fleugel Ditch (Site 7)	1.2×10^{11}	8.0×10^{10}	4.0×10^{10}	33%
Headwaters Stock Ditch (Site 8)	5.4×10^{12}	5.3×10^{11}	4.8×10^{12}	89% 87.6% (Michiana Area Council of Governments 2012)
Kline Rouch Ditch (Site 11)	8.1×10^{12}	7.9×10^{11}	7.3×10^{12}	90%
Lake of the Woods (Site 4)	3.3×10^{13}	3.2×10^{12}	2.9×10^{13}	88%
Lateral Ditch No. 5 (Site 12)	2.2×10^{12}	2.1×10^{11}	1.9×10^{12}	86%
Lemler Ditch (Site 6)	3.6×10^{12}	4.9×10^{11}	3.1×10^{12}	86%
Milner Seltenright Ditch (Site 1)	6.0×10^{13}	5.8×10^{12}	5.4×10^{13}	90%
Stone Ditch (Site 3)	3.3×10^{13}	4.5×10^{12}	2.9×10^{13}	88%
West Bunch Branch Ditch (Site 9)	4.3×10^{12}	7.1×10^{11}	3.5×10^{12}	81%

5.2 Nitrogen

5.2.1 Potential Sources

Water samples collected in 2015 and 2016 suggest that all portions of the Headwaters Yellow River Watershed receive excess nitrogen from multiple land uses which is evident by the sampled mean nitrate-nitrite concentration shown in Figure 17 and how target concentrations were exceeded during numerous sampling events (Table 9). Sources of nitrogen into waterbodies include agricultural practices, soil erosion, urban stormwater runoff, wastewater, and lawn fertilizers.

Agricultural practices can introduce excess nitrogen to surface waters if they are not managed properly. In addition to being a source of E. coli and bacteria, livestock waste also contains nitrogen. Nitrogen-based compounds like ammonia and nitrogen oxides are also a common source of nitrogen from fertilizer application. Nitrogen from livestock waste and nitrogen compounds enters surface waters via surface runoff and subsurface drainage following precipitation events. Therefore, the application of manure and nitrogen-based compounds for fertilizers to fields should be done in the proper amount, at the right time of year, using the correct method.

In developed portions of the watershed stormwater runoff is an area of concern. Water that would typically infiltrate through the soil is now forced to runoff hard surfaces such as buildings, parking lots, and roads. Ultimately the water enters a network of storm drains carrying with it pollutants such a nitrogen which can be bound to sediment, vegetation, debris or excess fertilizer from turf grass applications. When stormwater runoff is transported via traditional urban stormwater drainage systems there are insufficient opportunities for the filtration and removal of nitrogen. Stormwater runoff is a potential source of nitrogen in the Headwaters Yellow River Watershed primarily in Plymouth, Bremen, La Paz, Lakeville, and Nappanee.

Human waste contains nutrients such as nitrogen and can enter surface waters in both sewered and septic serviced areas. Populated areas of the Headwaters Yellow River Watershed that are serviced by municipal sewers include Plymouth, Bremen, La Paz, and Lakeville. Municipal sewers can be a potential source of nitrogen to surface waters when sewage is treated improperly or discharged directly to streams during CSO events. While a significant number of people live in populated areas of the watershed there are also a significant number of residences that treat sewage using septic systems. Studies have shown that septic systems can discharge to the subsurface after which nitrogen is transported to surface waters (Iverson et al. 2015). Septic systems are likely a source of nitrogen to streams of the Headwaters Yellow River Watershed considering the soil conditions described in Section 2.3 and the number of rural residences present in the watershed.

The dominant land cover type in urban areas are generally turf grass, which regularly receives fertilizer applications from residents. Lawn fertilizers generally contain nitrogen, phosphorus, and potassium. When applied improperly, lawn fertilizers can become a significant source of nitrogen to waterbodies in urban watersheds. Previous studies have documented residential lawn fertilizer application rates that are comparable to agricultural and golf course applications (Law, Band, and Grove 2004). Therefore, the nitrogen budget for subwatersheds with populated areas such as Plymouth, Bremen, La Paz, Lakeville, and Nappanee is likely influenced by applications of lawn fertilizers.

5.2.2 Loading

Table 54 describes the maximum nitrate-N+ nitrite-N load that was observed during twelve months of water sampling and the reductions that will be needed in each subwatershed to reach the water quality target load of 1.5 mg/L and the drinking water standard of 10 mg/L. The target water quality concentration for the Headwaters Yellow River WMP is 1.5 mg/L, however, the Indiana drinking water standard is included in this analysis since the standard was exceeded within some of the subwatersheds. Of the twelve subwatersheds in the Headwaters Yellow River Watershed there were five that exceeded the Indiana State drinking water quality standard of 10 mg/L for nitrate-N + nitrite-N (Table 54). The subwatersheds include

Dausman Ditch, Fleugel Ditch, Lemler Ditch, Kline Rouch Ditch, and Lateral Ditch No. 5 subwatersheds (Table 54). All subwatersheds exceeded the 1.5 mg/L target maximum daily loading value (Table 54). Reductions needed to meet the target of 1.5 mg/L nitrate-N + nitrite-N loads for the range from 73% to 90%. Reductions needed to meet the target of State drinking water standard of 10 mg/L ranged from 22% to 33%.

Table 54. Maximum nitrate + nitrite load (lbs/day) observed from June 2015 through May 2016, target load (lbs/day), and necessary load reduction (lbs/day) for each subwatershed of the Headwaters Yellow River Watershed.

Subwatershed Water Sampling Site ()	Maximum Load (lbs/day)	Target Maximum Load (lbs/day) 1.5 mg/L Target / 10.0 mg/L Indiana Drinking Water Standard	Reduction (lbs/day) 1.5 mg/L Target / 10.0 mg/L Indiana Drinking Water Standard	% Reduction 1.5 mg/L Target / 10.0 mg/L Indiana Drinking Water Standard
Armey Ditch (Site 10)	3,619	566	3,053	84%
		3,773	-	-
Dausman Ditch (Site 5)	15,732	1,844	13,888	88%
		12,290	3,442	22%
Elmer Seltenright Ditch (Site 2)	652	299	353	54%
		1,994	-	-
Fleugel Ditch (Site 7)	1,026	113	913	89%
		755	271	26%
Headwaters Stock Ditch (Site 8)	2,718	744	1974	73%
		4,959	-	-
Kline Rouch Ditch (Site 11)	9,867	1,156	8,711	88%
		7,708	2,159	22%
Lake of the Woods (Site 4)	25,234	4,560	20,674	82%
		30,402	-	-
Lateral Ditch No. 5 (Site 12)	2,992	299	2,693	90%
		1,994	998	33%
Lemler Ditch (Site 6)	9,282	995	8,287	89%
		6,630	2,652	29%

Subwatershed Water Sampling Site ()	Maximum Load (lbs/day)	Target Maximum Load (lbs/day) 1.5 mg/L Target	Reduction (lbs/day) 1.5 mg/L Target	% Reduction 1.5 mg/L Target
		10.0 mg/L Indiana Drinking Water Standard	10.0 mg/L Indiana Drinking Water Standard	10.0 mg/L Indiana Drinking Water Standard
Milner Seltenright Ditch (Site 1)	51,970	8,223	43,747	84%
		54,821	-	-
Stone Ditch (Site 3)	38,369	6,388	31,981	83%
		42,585	-	-
West Bunch Branch Ditch (Site 9)	4,880	995	3,885	80%
		6,630	-	-

5.3 Phosphorus Sources

5.3.1 Potential Sources

Water sampling in the Headwaters Yellow River Watershed demonstrated excess phosphorus is a problem in many portions of the watershed (Table 10 and Figure 20). Each of the land uses in the watershed is believed to be a source of phosphorus. The STEPL model suggests the largest contributor of phosphorus to the Yellow River watershed is cropland at 83%. Phosphorus loss from cropland is closely linked to soil loss; therefore, phosphorus contributions from cropland are primarily a result of sheet erosion, rill erosion, gully erosion, and streambank erosion. In 2015 approximately 14% of the row crop agricultural land dedicated to corn and 24% of the land dedicated to soybeans utilized no-till practices. Considering the widespread distribution of cultivated crops in the watershed (76%), significant opportunities exist to promote the use of no-till practices in the watershed. During water sampling of the watershed approximately 36% of the phosphorus in the Yellow River was bound to sediment particles, suggesting that soil erosion is a significant contributor of phosphorus. While nitrogen is the primary nutrient exported via subsurface drainage tile, both soluble and total phosphorus is exported via subsurface drainage tile (Smith et al. 2015). Therefore, the contributions of phosphorus via subsurface drainage should not be neglected.

Streambank erosion from both urban and rural land uses has the potential to contribute phosphorus to the watershed. During the windshield tour 6% (13) of the 222 sites assessed were listed as having severe or very severe streambank erosion, while another 16% (35) of sites had moderate streambank erosion. The degree to which streambank erosion is contributing phosphorus to the watershed is unclear. However, the windshield survey of the Headwaters Yellow River Watershed indicates that streambank erosion is present and likely contributing to the phosphorus load. Again, approximately 36% of the phosphorus in the Yellow River was bound to sediment. This suggests that soil erosion is a significant source of phosphorus to the system. This sediment bound phosphorus is likely the result of both upland erosion and streambank erosion.

The Headwaters Yellow River Watershed contains 9,903 acres of pastureland that is used primarily for cattle and horses. When the appropriate conservation practices are implemented on pastureland the runoff of animal waste from pastureland can be minimized. However, pastureland can be a significant source of phosphorus if pastured animals are allowed to directly enter streams. This contributes phosphorus to streams in two ways. First, the animal waste that directly enters the stream is rich in phosphorus. Secondly, pastured animals that are allowed to directly enter streams breakdown streambanks and promote phosphorus loss via erosion.

As discussed in Section 5.2.1 stormwater runoff in developed areas of the watershed are potential sources of nutrients including nitrogen and phosphorus. Traditional stormwater drainage systems do not adequately allow for the removal of dissolved or sediment bound phosphorus. A major source of dissolved phosphorus into urban stormwater is lawn fertilizer runoff. Lawn fertilizers are a potential source of phosphorus in urban areas when applied inappropriately. Plymouth, Bremen, Lakeville, La Paz, and Nappanee are the primary urban areas of the watershed potentially contributing phosphorus via stormwater runoff.

In addition to the contribution of coliform bacteria and nitrogen, septic systems and CSO's have the potential to contribute phosphorus to surface waters. While septic systems are estimated to constitute a small portion of the annual phosphorus load to the Yellow River, septic systems have the potential to be significant source of phosphorus during low flow periods (Macintosh et al. 2011; Withers, Jarvie, and Stoate 2011). Water samples collected during base flow conditions exceeded the IDEM recommendation for total phosphorus in multiple streams, which indicates septic systems may be contributing phosphorus to these streams. This is supported by the source tracking samples that are described in Section 5.1. A large portion of the phosphorus contributed by septic systems is soluble reactive phosphorus, which is the form of phosphorus that is used by algae and macrophytes (Withers, Jarvie, and Stoate 2011). Municipal sewers are a potential source of phosphorus to surface waters primarily during stormflow conditions when waste is discharged directly to streams during CSO events.

5.3.2 Loading

All of the subwatersheds in the Headwaters Yellow River Watershed exceeded the water quality targets for total phosphorus. Table 55 describes the maximum total phosphorus load that was observed during twelve months of water sampling and the reductions that will be needed in each subwatershed to reach target loads utilizing the project target maximum concentration of 0.3 mg/L. Reductions needed to meet target total phosphorus loads range from 10% to 80% (Table 55).

Table 55. Maximum total phosphorus load (lbs/day) observed from June 2015 through May 2016, target load (lbs/day), and necessary load reduction (lbs/day) for each subwatershed of the Headwaters Yellow River Watershed.

Subwatershed Water Sampling Site ()	Maximum Load (lbs/day)	Target Maximum Load (lbs/day)	Reduction (lbs/day)	% Reduction
Armey Ditch (Site 10)	207	113	94	45%
Dausman Ditch (Site 5)	760	152	608	80%
Elmer Seltenright Ditch (Site 2)	67	60	7	10%
Fleugel Ditch (Site 7)	13	8	5	39%
Headwaters Stock Ditch (Site 8)	259	149	110	42% 72.0% (Michiana Area Council of Governments 2012)
Kline Rouch Ditch (Site 11)	627	222	405	65%
Lake of the Woods (Site 4)	1,356	912	444	33%
Lateral Ditch No. 5 (Site 12)	122	60	62	51%
Lemler Ditch (Site 6)	524	139	385	74%
Milner Seltenright Ditch (Site 1)	2,730	1,645	1,085	40%
Stone Ditch (Site 3)	1,959	1,278	681	35%
West Bunch Branch Ditch (Site 9)	355	199	156	44%

5.4 Sediment

5.4.1 Potential Sources

Water samples collected between 2015 and 2016 suggest that sediment is a pollutant of concern in many portions of the Headwaters Yellow River Watershed (Table 11 and Figure 21). The introduction of sediment to streams can cause a variety of issues including the introduction of phosphorus, which can increase algal blooms and eutrophication (Lamba, Karthikeyan, and Thompson 2014). The primary sources of sediment in watersheds dominated by agricultural land uses are agriculture and streambank erosion (Lamba, Karthikeyan, and Thompson 2014). The relative contribution of these two sediment sources is dependent on the percentage of the watershed dedicated to agriculture. In watersheds dominated by agricultural land uses (row-crop and pasture) agriculture is the greatest contributor of sediment to streams (Lamba et al. 2015). However, streambank erosion contribution increases as the proportion of land dedicated to other land uses such as deciduous forest increases (Lamba et al. 2015). This land use and sediment contribution relationship is important to identifying the sources of sediment in different portions of the Headwaters Yellow River Watershed. Figure 63 displays the land use distribution for each subwatershed in the Headwaters Yellow River Watershed.

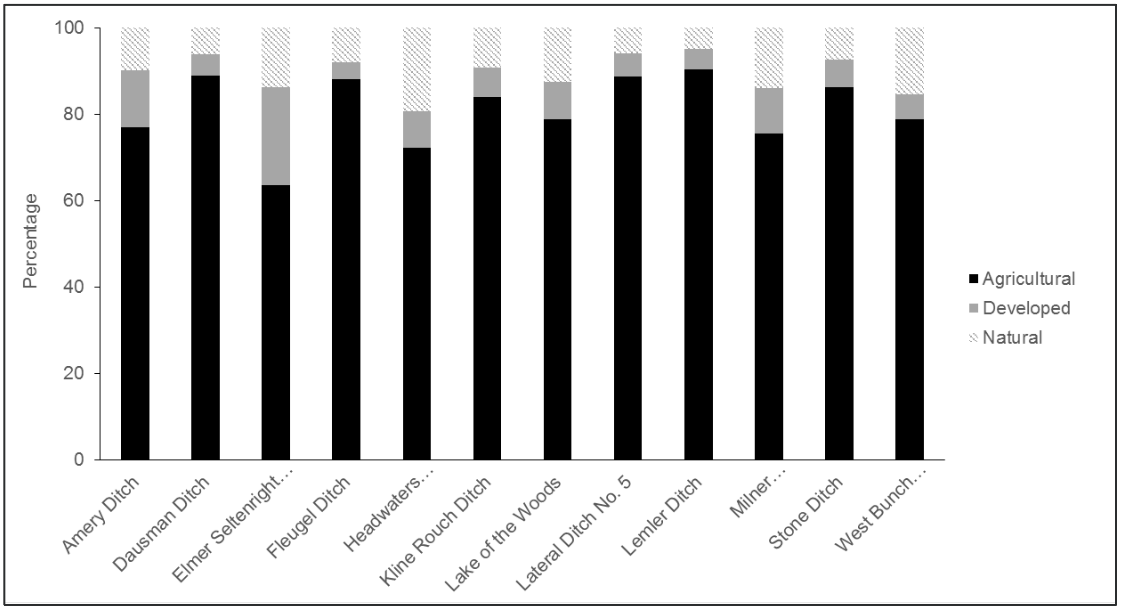


Figure 63. Percentage of agricultural, developed, and natural land uses for each subwatershed of the Headwaters Yellow River Watershed.

5.4.2 Loading

Table 56 describes the maximum TSS load that was observed during twelve months of water sampling and the reductions that will be needed in each subwatershed to reach target loads based on the project target maximum concentration of 25 mg/L. Of the twelve subwatersheds in the Headwaters Yellow River Watershed only two did not exceeded water quality targets for TSS. Those subwatersheds that did not exceed targets were Armey Ditch and Fleugel Ditch. Reductions needed to meet target TSS loads range from 19% to 94% (Table 56).

Table 56. Maximum TSS load (lbs/day) observed from June 2015 through May 2016, target maximum load (lbs/day), and necessary load reduction (lbs/day) for each subwatershed of the Headwaters Yellow River Watershed.

Subwatershed	Maximum Load (lbs/day)	Target Maximum Load (lbs/day)	Reduction (lbs/day)	% Reduction
Armey Ditch (Site 10)	9,433	9,433	-	-
Dausman Ditch (Site 5)	101,848	12,668	89,180	88%
Elmer Seltenright Ditch (Site 2)	4,636	2,695	1,941	42%
Fleugel Ditch (Site 7)	431	674	-	-
Headwaters Stock Ditch (Site 8)	7,946	2,965	4,981	63% (51% Michiana Area Council of Governments 2012)
Kline Rouch Ditch (Site 11)	112,990	18,462	94,528	84%
Lake of the Woods (Site 4)	833,023	76,006	757,017	91%
Lateral Ditch No. 5 (Site 12)	10,571	4,986	5,585	53%
Lemler Ditch (Site 6)	51,457	11,590	39,867	76%
Milner Seltenright Ditch (Site 1)	246,695	137,053	109,642	44%
Stone Ditch (Site 3)	132,013	106,462	25,551	19%
West Bunch Branch Ditch (Site 9)	288,417	16,576	271,841	94%

6 Goals

Following the collection of twelve months of water quality and habitat data the Headwaters Yellow River Watershed steering committee developed goals for the improvement of the watershed. The goals described below will be used in the future to evaluate success and guide the adaptive watershed planning process. For the purposes of calculating the required load reductions for nutrient, sediment and E. coli based goals, water sampling Site 1 located within the Yellow River was used. Site 1 was chosen because it is the most downstream sampling point and represents the overall water quality exiting the Headwaters Yellow River Watershed. Additionally, nutrient, sediment and E. coli goal reduction amounts are expressed as a maximum daily loading value.

6.1 Goal Statements

6.1.1 Watershed Planning

Problem Statement: There is no central planning organization to promote the restoration of the Yellow River Watershed.

Goal #1: Develop a central planning organization within five years to implement the WMP.

Goal #1 Indicator: Establishment of a planning organization separate from the Marshall County SWCD whose goal is to achieve the goals outlined in the WMP. The planning organization can be composed of SWCD members but should not solely be the responsibility of the Marshall County SWCD who initiated the development of the Headwaters Yellow River WMP.

6.1.2 *E. coli*

Problem Statement: *E. coli* concentrations exceed the state water quality standard of 235 cfu/100mL in the headwaters of the Yellow River.

Goal #2: We want to reduce the maximum daily *E. coli* load of 6.0 x 10^{13} mpn/day to 5.8 x 10^{12} mpn/day (a 90% reduction) in 15 years. This would meet the Kankakee/Iroquois River TMDL designation (Tetra Tech 2009).

- Decrease maximum daily *E. coli* loading by 30% in 5 years – 1.8 x 10^{13}
- Decrease maximum daily *E. coli* loading by 60% in 10 years – 3.6 x 10^{13}
- Decrease maximum daily *E. coli* loading by 90% in 15 years – 5.4 x 10^{13}

Goal # 2 Indicator: Public outreach and educational events focused at improving the overall importance of septic system maintenance monitoring should be held annually. Water sampling will be completed to determine *E. coli* levels at the 5, 10 and 15 year intervals. Ideally a minimum of one baseflow and one stormflow event should be captured during each sampling year.

6.1.3 Phosphorus

Problem Statement: Total phosphorus concentrations in the headwaters of the Yellow River exceed the state TMDL target of 0.3 mg/L. Lake of the Woods, Pleasant Lake, and Riddles Lake are listed as impaired for phosphorus.

Goal #3: We want to reduce the watershed maximum daily total phosphorus load of 2,730 lbs/day to 1,645 lbs/day (a 40% reduction) within 15 years.

- Decrease maximum daily total phosphorus loading by 15% in 5 years – 410 lbs/day
- Decrease maximum daily total phosphorus loading by 30% in 10 years – 819 lbs/day
- Decrease maximum daily total phosphorus loading by 40% in 15 years – 1,092 lbs/day

Goal # 3 Indicator: Water sampling will be completed to determine total phosphorus levels at the 5, 10 and 15 year intervals. Ideally a minimum of one baseflow and one stormflow event should be captured during each sampling year. Phosphorus reduction can also be estimated by reviewing the annual trends of cropland utilizing reduced tillage and cover crop practices and implementation of other best management practices that would reduce sediment/nutrient loading.

6.1.4 Nitrogen

Problem Statement: Nitrate-N + Nitrite-N concentrations exceed the target maximum concentration of 1.5 mg/L.

Goal #4: We want to reduce the watersheds maximum daily nitrate-N+nitrite-N load of 51,197 lbs/day to 8,223 lbs/day (an 84% reduction) within 15 years.

- Decrease maximum daily nitrate-nitrite loading by 30% in 5 years – 15,591 lbs/day
- Decrease maximum daily nitrate-nitrite loading by 60% in 10 years – 31,182 lbs/day
- Decrease maximum daily nitrate-nitrite loading by 85% in 15 years – 44,175 lbs/day

Goal #4 Indicator: Water sampling will be completed to determine nitrate-nitrite levels at the 5, 10 and 15 year intervals. Ideally a minimum of one baseflow and one stormflow event should be captured during each sampling year. Nitrogen reductions could also be estimated by tracking implementation of best management practices throughout the watershed.

6.1.5 Sediment

Problem Statement: TSS concentrations exceed 25 mg/L in the headwaters of the Yellow River watershed.

Goal #5: We want to reduce the watershed maximum daily TSS load of 246,695 lbs/day to 137,053 lbs/day (a 44% reduction) in 15 years.

- Decrease maximum daily TSS loading by 15% in 5 years – 37,004 lbs/day
- Decrease maximum daily TSS loading by 30% in 10 years – 74,009 lbs/day
- Decrease maximum daily TSS loading by 45% in 15 years – 111,013 lbs/day

Goal #5 Indicator: Water sampling will be completed to determine TSS levels at the 5, 10 and 15 year intervals. Ideally a minimum of one baseflow and one stormflow event should be captured during each sampling year. Sediment reductions could also be estimated by tracking implementation of best management practices throughout the watershed.

6.1.6 Habitat

Problem Statement: Streams in the watershed have “poor” (score 30-42) habitat according to the QHEI.

Goal #6: Improve QHEI scores of streams to “fair” (score 43-54) in 10 years and “good” (55-69) in 20 years.

Goal #6 Indicator: Stream habitat will be assessed using the QHEI method at previously sampled sites at the 10 and 20 year intervals.

6.1.7 Education

Problem Statement: There has been limited education and outreach related to the Headwaters of the Yellow River.

Goal #7: Develop and complete annual educational/outreach programs for the Headwaters Yellow River Watershed.

- Complete one educational/outreach program each of the first four years.
- Complete two or more educational/outreach program each year starting by year five.

Goal #7 Indicator: The education goal will be assessed by the number of education events held each year. Surveys of program attendees can also be completed to track the awareness of the public to the Headwaters Yellow River Watershed issues and proposed solutions to the problems.

7 Identifying Critical Areas

Critical areas are areas where WMP implementation can remediate non-point source pollution in order to improve water quality conditions. Water quality, habitat, and windshield survey data suggests that each of the twelve (HUC-12) subwatersheds of the Headwaters Yellow River Watershed have qualities that do not align with the goals described in Section 6. However, there are some subwatersheds that contribute disproportionally to the water quality issues of the Headwaters Yellow River Watershed. Therefore, select subwatersheds have been identified as a high or medium priority critical areas (Figure 64). This prioritization of critical areas should maximize the benefits of future management actions.

High Priority critical areas include: Armey Ditch (071200010303), Headwaters Stock Ditch (071200010304), West Bunch Branch Ditch (071200010305), Lake of the Woods (071200010309), Lateral Ditch No. 5 (071200010301) and Kline Rouch Ditch (071200010302) subwatersheds (Figure 64). These subwatersheds were listed as high priority critical areas because of the following documented issues:

- Lateral Ditch No. 5 (071200010301) –
  - Highest average *E. coli* concentration between all sites sampled during the 12 month sampling period (Figure 15).
  - Highest average Nitrate+Nitrite concentration between all sites sample during the 12 month sampling period (Figure 17).
  - Average total phosphorus concentration exceeds the project target value (highest overall; Figure 20).
  - Contained the fifth lowest mIBI score between all sites sampled during the 12 month sampling period (Figure 24) and is below project target value.
- Kline Rouch Ditch (071200010302)
  - Second highest average *E. coli* concentration between all sites sampled during the 12 month sampling period (Figure 15).
  - Second highest average Nitrate+Nitrite concentration between all sites sampled during the 12 month sampling period (Figure 17).
  - Average total phosphorus concentration exceed the project target value (third highest overall; Figure 20).
  - mIBI score was below the project target value (Figure 24).
- Armey Ditch (071200010303)
  - Contained the lowest mIBI score between all sites sampled during the project water sampling period (Figure 24) and is below project target value.
  - QHEI score was below the project target level (Figure 25).
  - All streams are included on the 303(d) list for *E. coli* impairments (22.2 miles)
  - Overall, windshield survey results indicate that relative to the Headwaters Yellow River watershed as a whole, streambank erosion in the Armey Ditch subwatershed is more prevalent, channelization is more prevalent and in-stream cover is less prevalent (Table 12, Table 14).

- West Bunch Branch (071200010305)
  - Highest average TSS concentration between all sites sampled during the project water sampling period (Figure 21).
  - QHEI score was below the project target level (Figure 25).
  - Contains 11.2 miles of stream which are included on the 303(d) list of impaired waterbodies for *E. coli* and/or impaired biotic communities.
  - Relative to the Headwaters Yellow River watershed as a whole, windshield survey results indicate stream buffers are less prevalent and in-stream cover is less prevalent (Table 12; Table 47).
- Headwaters Stock Ditch (071200010304)
  - Average total phosphorus concentration exceeds the project target value (fourth highest overall; Figure 20).
  - Fifth highest average E. coli concentration between all sites sampled during the project water sampling period (Figure 15).
  - QHEI was below the project target level (Figure 25).
  - mIBI was the third lowest between all sites sampled during the project water sampling period (Figure 24).
  - Contains two lakes on the 303(d) list for impairments due to high total phosphorus concentrations, Pleasant Lake and Riddles Lake.
- Lake of the Woods (071200010309)
  - Second highest average TSS concentration between all sites sampled during the project water sampling period (Figure 21) and exceeds project target value.
  - Third highest average *E. coli* concentration between all sites sampled during the project water sampling period (Figure 15).
  - Average total phosphorus concentration exceeds the project target value (second highest overall; Figure 20).
  - Contains Lake of the Woods which is included on the 303(d) list for pollutants total phosphorus and fish consumption advisory for PCBs.
  - Contains 21.6 miles of stream listed on the 303(d) list for *E. coli* impairments.
  - QHEI score was below the project target level (Figure 25).

Medium priority critical areas of the watershed include Milner Seltenright Ditch (071200010312), Dausman Ditch (071200010308), and Stone Ditch (071200010310) subwatersheds (Figure 64). These subwatersheds were listed as medium priority critical areas because they contained less parameters which exceeded project targets however there are still documented problems within the subwatersheds.

- Milner Seltenright Ditch (071200010312)
  - Contains 9.3 miles of streams included on the 303(d) list of impaired waterbodies for high *E. coli* levels.
  - Includes the Town of Plymouth which is the largest town in the Headwaters Yellow River watershed, which could provide opportunities for urban BMP implementations discussed in Section 8.1.
  - Contains some quality floodplain habitat along the Yellow River which could be included Riparian Buffer BMP discussed more in Section 8.1 and discussed in the LLWFA report in Appendix B.
- Stone Ditch (071200010310)
  - Fourth highest average *E. coli* concentration between all sites sampled during the project water sampling period (Figure 15).
  - Average total phosphorus concentration exceeded the project target value (fifth highest overall; Figure 20)
- Dausman Ditch (071200010308)
  - Third highest average TSS concentration between all sites sampled during the project water sampling period (Figure 21) and is equal to the project target value of 25 mg/L.
  - Fifth highest average Nitrate+Nitrite concentration between all sites sampled during the project water sampling period (Figure 17).
  - QHEI score was below the project target level (Figure 25).

The subwatersheds not listed as critical and defined as low priority include Elmer Seltenright Ditch (071200010311), Lemler Ditch (071200010307) and Fleugel Ditch (071200010306; Figure 64). These watershed were not considered critical because they had some of the lowest average TSS, total phosphorus and *E. coli* concentrations observed during the 12 month sampling period respectively, and do not contain any listed waterbodies (Figures 21, Figure 20, Figure 15).

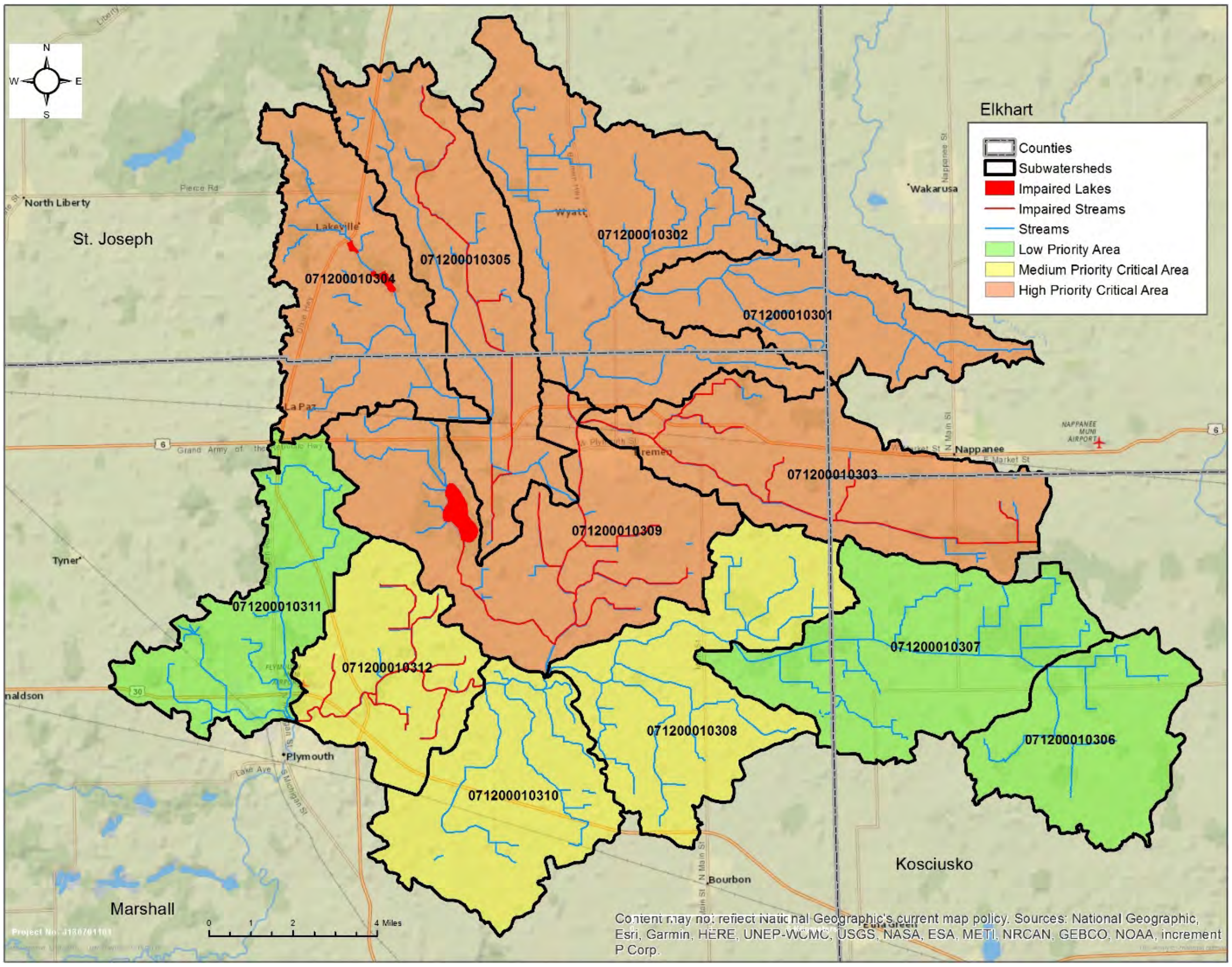


Figure 64. High and medium priority critical areas and low priority areas of the Headwaters Yellow River Watershed.

8 Management Measures

8.1 Recommended Management Measures

There are several BMPs and management measure that can be implemented in order to reduce non-point source pollutants in surface waters and address the concerns of watershed stakeholders. The following section describes the BMPs and management measures recommended to address the goals described in Section 6. The recommended BMPs and management measures have been chosen to address identified issues in the critical areas and are generally acceptable to landowners in the watershed based on feedback received during the steering committee meetings. Recommendations are also dependent on the geographic scale of the problem in the watershed and the magnitude of the issue in different portions of the watershed. Therefore, recommendations for the reduction of a non-point source pollutant may be different for the watershed as a whole, compared to a smaller subsets of the watershed. Section 4 describes the problems and potential causes of each problem.

The majority of the land use in the Headwaters Yellow River Watershed is agricultural and the landform is generally uniform; therefore, there are many agricultural BMPs that are recommended throughout the watershed (Table 57). The implementation of the BMPs listed in Table 57 will be prioritized based on numerous factors such as:

- Location within a high or medium priority critical area.
- Landowner interest and buy-in.
- Funding sources.
- Location of potential project(s) to be installed near or in connection with other BMP applications to create a conservation cropping system.
- Locations with direct boundary to a waterway or wetland.
- If the project would be the first installed measure within a defined area.

BMP implementation preference will be targeted within the high priority critical areas of the watershed during the initial implementation of this WMP as significant target pollutant loading rates and 303(d) listed waterways are located within these areas. BMP installation preference would be given to high priority critical areas over medium priority critical areas; however, each potential project will be reviewed prior to implementation to determine the best use of funding sources and overall water quality impact. For example, if funding sources are limited and only one project could be installed between a site in the high priority critical area and medium priority critical area, the medium priority area may be chosen over the high priority are if the medium area is located directly next to a waterway and could be combined with other BMPs for a more comprehensive conservation cropping system. Additionally, site selection or prioritization may be determined by modeling estimates of pollutant reductions, such that the site with the greatest reduction in pollutant loading could be chosen. The selection of which BMP to be installed at a site will be dependent on numerous factors such as:

- Landowner goals and cost-share.
- Land use, soils, wetland or waterway resources.
- Feasibility of construction (both cost and construction process).
- Overall water quality impacts.

Since limited land management work has occurred in the Headwaters Yellow River watershed, the initial implementation of the WMP will be focused on thoughtful BMP implementation in critical areas and developing a culture of land management aimed at improving water quality both for waterways within the watershed and to receiving downstream watersheds. Throughout the critical areas of the Headwaters Yellow River watershed there are hundreds of sites that could benefit from any number of BMP implementations. It will be the goal of the initial implementation of the WMP to connect willing landowners with implementation resources to get projects in the ground.

Table 57. Recommended agricultural BMPs or management measures applicable throughout the Headwaters Yellow River watershed and prioritized for High Priority Critical areas of the watershed.

BMP or Management Measure	NRCS Practice Standard	Description	Targeted Pollutants, watershed characteristic	Target Subwatersheds
Cover Crops	Practice Code: 340	Grasses, legumes, and forbs planted for seasonal vegetative cover.	Phosphorus, sediment, nitrogen application rates	**High Priority:** Lateral Ditch No. 5 071200010301 Kline Rouch Ditch-Yellow River 071200010302 Armey Ditch 071200010303 Headwaters Stock Ditch 071200010304 West Bunch Branch-Stock Ditch 071200010305 Lake of the Woods-Yellow River 071200010309 **Medium Priority:** Stone Ditch 071200010310 Milner Seltenright Ditch-Yellow River 071200010312 Dausman Ditch 0712000308
Filter Strips	Practice Code: 393	A strip or area of herbaceous vegetation that removes contaminants from overland flow.	Sediment, phosphorus	
Grassed Waterways	Practice Code: 412	A shaped or graded channel that is established with suitable vegetation to convey surface water at a non-erosive velocity using a broad and shallow cross section to a stable outlet.	Sediment, phosphorus	
Conservation Tillage: No-till, reduced till	Practice Code: 329, 345	Limiting soil disturbance to manage the amount, orientation and distribution of crop and plant residue on the soil surface year around.	Sediment, phosphorus, nitrogen	
Nutrient Management	Practice Code: 590	Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments.	Nitrogen, phosphorus	
Riparian Buffers	Practice Code: 390 391	An area predominantly trees and/or shrubs or grasses, sedges located adjacent to and up-gradient from watercourses or water bodies.	Sediment, phosphorus, Improve riparian and aquatic habitats	
Streambank Protection	Practice Code: 580	Treatment(s) used to stabilize and protect banks of streams or constructed channels, and shorelines of lakes, reservoirs, or estuaries.	Sediment, phosphorus, improve riparian and aquatic habitats	

BMP or Management Measure	NRCS Practice Standard	Description	Targeted Pollutants, watershed characteristic	Target Subwatersheds
Wetland Restoration, Creation, or Enhancement	Practice Code: 657, 658, 659	Restoring hydrology to drained wetlands, enhancing the plant community in existing wetlands, or creating new wetlands.	Phosphorus, nitrogen, sediment, improve available wetland habitat	
Septic System Care and Maintenance	NA	Septic systems should be pumped and inspected every 3-5 years. Replacement of failing systems as necessary.	*E. coli*	
Open Channels	Practice Code: 582	Water management, wildlife habitat, two-stage ditch	Reduce sediment, phosphorus and nitrogen loading. Streambank stabilization	

As previously described in Section 2.7 no-till farming practices and cover crop utilization in portions of the watershed are low relative to neighboring areas, which suggests that there are significant opportunities to promote and increase the future utilization of these practices. No-till farming practices have been shown to reduce soil erosion and sediment bound phosphorus to surface waters (Uri, Atwood, and Sanabria 1998). The benefits of cover crops vary based on the species that is used, however cover crops generally reduce soil erosion and nitrate leaching from row-crop agricultural land (Snapp et al. 2005). When no-till farming and cover crops are continuously combined together into a conservation cropping system additional soil benefits are obtained including reduced soil compaction, improved soil structure, increased organic matter, and increased available nitrogen. The promotion and incentivization of these agricultural practices will be the single most critical action needed to accomplish phosphorus (Goal #3), nitrogen (Goal #4), and sediment (Goal #5) reduction goals, and can be applied to all subwatersheds with, preference given to critical areas.

There appears to be spatial differences in the concentration and loading of nitrogen and phosphorus from different portions of the Headwaters Yellow River Watershed, likely as a result of soil characteristics. Therefore, the selection of specific cover crops and/or the development of nutrient management plans based on site specific conditions is recommended. For example, the Dausman Ditch drainage, which includes the Dausman Ditch, Fleugel Ditch, and Lemler Ditch subwatersheds contain poorly drained soils that export significant quantities of nitrogen and limited phosphorus. However, the remainder of the subwatersheds contains soils that promote the surface runoff of phosphorus and limited nitrogen. Due to these differences producers should work with their local SWCD and NRCS staff to select cover crop species and develop nutrient management plans that work within their management strategy while also reduce nutrient loss to surface waters. High priority critical areas had the highest nitrate concentrations sampled throughout the watershed and are important areas to implement nutrient management plans. Nutrient management plans can be implemented as individual projects where other BMPs are not being utilized but preference will be given if these plans can be combined with other BMPs on the same property as part of a conservation cropping system.

The installation of filter strips, riparian forested buffers, and grassed waterways are another group of agricultural BMPs that can be applied throughout the Headwaters Yellow River watershed to reduce the runoff of nutrients and sediment to receiving streams. Each of these BMPs function in a similar fashion by establishing vegetation which removes nutrients via plant uptake. The establishment of vegetation also prevents the mobilization of sediments and sediment bound nutrients. Combining riparian buffers with streambank protection measures is desirable as this could help promote improved stream habitat. Specifically, as shown in Figure 62, there are numerous locations within the critical areas where stream buffer absence and severe bank erosion are present together. Sites such as these would be desirable locations to utilize the combination of riparian buffers and streambank protection. As noted during the windshield survey, stream buffers are absent along many miles of waterways and there is no one subwatershed which contains adequate stream buffers throughout. The use of these BMPs should be promoted throughout the watershed and prioritized for implementation in the high priority critical areas of the watershed. These BMPs should be combined with other treatment methods such as no-till and cover crop, to implement conservation cropping systems if appropriate. The implementation of these BMPs will help address Goals 3 (phosphorus), Goal 4 (nitrogen), Goal 5 (sediment) and Goal 6 (stream habitat).

As described in Section 5 coliform bacteria is a wide spread problem in the Headwaters Yellow River Watershed. Source tracking samples revealed that a significant portion of the fecal contamination in the watershed is from human sources. This was true even at samples sites upstream of the nearest waste water treatment facility outfall, suggesting that individual septic systems issues are the source of the *E. coli* problem in the watershed. Funds will be sought out and used for educating and encouraging residents to maintain and repair septic systems. Septic system education and funding efforts will be directed first to high priority critical areas but efforts will also be applied in medium priority critical areas if opportunities are available. Medium priority critical areas are important for *E. coli* reduction efforts, as 303(d) listed streams for *E. coli* are located throughout the watershed (Figure 1). Septic education and maintenance efforts will address Goal 2 (*E. coli*).

Despite the prevalence of agricultural land uses in the watershed, urban areas of the watershed can greatly impact water quality. The implementation of any urban BMP practice is applicable within the primary urban areas of the Headwater Yellow River watershed which include Plymouth, Bremen, La Paz, Lakeville, and Nappanee. The targeted subwatersheds for urban BMP implementation include: Elmer Seltenright Ditch (071200010311), Milner Seltenright Ditch (071200010312), Armey Ditch (071200010303), Lake of the Woods (071200010309) and Headwaters Stock Ditch (071200010304). The majority of these practices are designed to capture, detain, and slowly release stormwater and will further reduce non-point source pollution to the surface waters of the watershed. Recommended practices for urban areas of the watershed include but are not limited to rain gardens, rain barrels, detention basins, pervious pavement, bioswales and pet waste management. Future urban BMP implementation would be prioritized to those subwatersheds listed as high priority critical area, however, urban BMP projects could be completed in a medium priority area and non-critical area watershed depending on funding sources for a project and the availability of similar projects within critical areas. Urban BMP implementation will help address numerous goals of the WMP including Goals 2-5.

In summary, the BMPs most anticipated for implementation include cover crops and no-till. Cover crops and no-till have the greatest potential impact for lowering key pollutants such as sediment and phosphorus loading to waterways throughout the watershed. Cover cropping and no-till BMPs are becoming more popular with producers in the relative area of the Headwaters Yellow River watershed and the applicable knowledge of implementation can be discussed between producers more readily. Pairing the use of cover crops and no-till with some of the other BMPs listed above will drive future water quality improvements. Production fields that combine numerous BMPs will be the most efficient at reducing pollutants from those lands. Where possible, implementation funds will be prioritized to support conservation cropping systems.

For example, the use of riparian buffers and filter strips, paired with streambank stabilization and a nutrient management plan addresses numerous goals of the WMP.

8.2 Anticipated Load Reductions

Table 58 and 59 describes the anticipated load reductions from the BMP practices discussed in Section 8.1 for the displayed unit/amount of BMP implemented. Table 58 and 59 pollutant reduction estimates do not represent the amount of BMP implementation needed to reach all goals outlined in Section 6, but rather represent the initial goal of implementation efforts set by the steering committee and further described in Section 9 Action Register. The amounts presented in Tables 58 and 59 and Section 9 Action Register are to be considered for implementation within the high priority critical areas of the watershed with no set amount per critical area watershed. Future water sampling efforts and WMP evaluations to track water quality improvement progress will help guide adaptive management decisions to where specific BMP implementation efforts should be modified, expanded etc. Section 10 provides a more detailed description of adaptive management procedures and tracking of progress. The discussed BMP implementation amounts in Tables 58 and 59, and in the Action Registers will be a collective goal for the critical areas of the watershed. The exception to this would be for cover crop and no-till which discusses implementation across the entire Headwaters Yellow River watershed; however, implementation efforts will be prioritized to the high priority critical areas.

The increased utilization of no-till and cover crops practices will be a critical component of the restoration of the watershed. Increasing the use of no-till farming to 50% across the watershed would remove the greatest quantity of nutrients and sediment (Table 58). Cover crop utilization across 30% of the watershed will also remove significant quantities of nutrients and sediment (Table 58). Many of the remaining BMPs that have been recommended provide limited watershed scale nutrient and sediment reduction benefits; however, these BMPs will be critical components of actions needed to accomplish habitat restoration goals. For example, the nonpoint source pollution reductions obtained from installing riparian buffers and streambank restoration are orders of magnitude less than the combined benefits of no-till and cover crops. However, these practices will provide improved instream habitat, riparian vegetation, and reduce *E. coli* loads. There are currently no models available that can accurately predict the reduction in *E. coli* loads resulting from BMP practices. However, the water quality data described in Section 5 suggests that proper septic system maintenance can be a primary driver for reducing *E. coli* loading in the Headwaters Yellow River Watershed.

Table 58. Anticipated load reductions for each recommended agricultural BMP or other general management measure applicable to Critical Areas in the Headwaters Yellow River Watershed.

BMP or Management Measure	Estimated Load Reduction for each BMP			Targeted Subwatersheds
	Nitrogen	Phosphorus	Sediment	
50% No-till utilization*	58,734 lbs/yr	11,195 lbs/yr	3,202 tons/yr	**High Priority:** Lateral Ditch No. 5 071200010301 Kline Rouch Ditch-Yellow River 071200010302
30% Cover crop utilization*	38,632 lbs/yr	8,793 lbs/yr	1,383 tons/yr	
Riparian Buffers (66 acres along the Yellow River)*	104 lbs/yr	20 lbs/yr	5.7 tons/yr	

Wetland Creation (50 acres)*	50 lbs/yr	20 lbs/yr	6 tons/yr	Armey Ditch 071200010303 Headwaters Stock Ditch 071200010304 West Bunch Branch-Stock Ditch 071200010305 Lake of the Woods-Yellow River 071200010309 **Medium Priority:** Milner Seltenright Ditch-Yellow River 071200010312 Dausman Ditch 071200010308 Stone Ditch-Yellow River 071200010310
Grassed Waterways (60 acres)*	148 lbs/yr	33 lbs/yr	6 tons/yr	
Filter Strips (120 acres)*	298 lbs/yr	65 lbs/yr	12 tons/yr	
Nutrient Management** **(per acre)**	4 lbs/yr	0.7 lbs/yr	NA	
Streambank Protection/Restoration (120 acres)*	322 lbs/yr	68 lbs/yr	14 tons/yr	
Septic System Care and Maintenance (1 system)	55 lbs/yr	6.5 lbs/yr	NA	
Streambank Stabilization per (500 ft)***	40 lbs/yr	20 lbs/yr	20 tons/yr	
Two-Stage Ditch	N/A But estimated at 17% reduction^	N/A But estimated at 33% reduction^	N/A But estimated at 38% reduction^	

Sources:
*Spreadsheet Tool for Estimating Pollutant Load (STEPL)
**NRCS Practice Coad 590
***Region 5 Model

^Estimates taken from supporting document about benefits of two-stage ditches accessed off the Indiana Nature Conservancy website. Reductions are based on parameter concentrations upstream and downstream of installed two-stage ditch reach. https://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/indiana/howwework/twostage-with-charts.pdf

Table 59. Anticipated load reductions for each of the recommended urban BMPs applicable to Critical Areas in the Headwaters Yellow River Watershed.

BMP or Management Measure	Amount	Estimated Load Reduction for each BMP			Targeted Subwatersheds
		Nitrogen	Phosphorus	Sediment	
Rain Garden	1 unit	12.6 lbs/yr	1.8 lbs/yr	1.4 tons/yr	**High Priority Areas:** Armey Ditch 071200010303 Lake of the Woods-Yellow River 071200010309 Headwaters Stock Ditch 0712000304 **Medium Priority:** Milner Seltenright Ditch-Yellow River 071200010312 **Low Priority:** Elmer Seltenright Ditch-Yellow River 0712000311
Detention Basin	1 unit	5.6 lbs/yr	0.1 lbs/yr	0.1 tons/yr	
Rain Barrel	1 unit	0.8 lbs/yr	0.2 lbs/yr	0.2 tons/yr	
Pervious Pavement	1 acre	47.9 lbs/yr	4.5 lbs/yr	1 ton/yr	
Bioswale	1 acre	14.9 lbs/yr	3.3 lbs/yr	1.4 ton/yr	
Pet Waste Management	-	NA	NA	NA	

Source: Region 5 Model.

8.3 Assistance

Many federal, state, and local agencies provide funding assistance for the implementation of several of the management measured described in Section 8.1. Different funding agencies and grant programs support different management practices and have varying goals, eligibility requirements, and cost-share requirements. Table 60 provides a list of potential assistance programs that correspond to the recommend management measures for the agricultural portions of the Headwaters Yellow River Watershed.

Table 60. List of available technical and funding resources for agricultural producers.

Agency	Program	Overview	Assistance
USDA	Wetland Reserve Program	A voluntary program that provides landowners with financial incentives to restore and protect wetlands in exchange for retiring marginal agricultural land.	Permanent Easement 30-year Easement Restoration Cost-Share Agreement
USDA	Conservation Reserve Program	Voluntary program that offers long-term rental payments and cost-share assistance to establish long-term, resource-conserving cover on environmentally sensitive cropland or, in some cases, marginal pastureland.	50% of the cost of establishing a CRP practice.
USDA	Farmable Wetlands Program	Designed to restore previously farmed wetlands and wetland buffer to improve both vegetation and water flow.	Annual rental payments for a 10- to 15-year period. Upfront CRP signing incentive payment of $100 per acre. Practice incentive payment equal to 40 percent of the eligible costs of installing the practice.
USDA	Conservation Reserve Enhancement Program	The Conservation Reserve Enhancement Program (CREP) is an offshoot of the Conservation Reserve Program (CRP), targets high-priority conservation issues identified by local, state, or tribal governments or non-governmental organizations. In exchange for removing environmentally sensitive land from production and introducing conservation practices, farmers, ranchers, and agricultural land owners are paid an annual rental rate.	Annual rental payments for a 10- to 15-year period.
USDA	Environmental Quality Incentives Program	The Environmental Quality Incentives Program (EQIP) is a voluntary program that provides financial and technical assistance to agricultural producers to plan	Payments are made on completed practices or activities identified in an EQIP contract that meet NRCS standards.

Agency	Program	Overview	Assistance
		and implement conservation practices that improve soil, water, plant, animal, air and related natural resources on agricultural land and non-industrial private forestland.	
IDEM	Nonpoint Source Implementation Grants (319 Program)	Nonpoint source pollution reduction projects can be used to protect water resource areas and the general water resources in a watershed by implementing BMPs.	Organizations are usually required to provide 40% of the total project cost.
IDNR	Lake and River Enhancement Program (LARE)	Engineering Design/Build Projects Engineering Feasibility Studies	LARE will provides funds for 80% of the total project cost.
USFWS	North American Wetlands Conservation Act Grants Program	Provides matching grants to carry out wetlands conservation projects in the United States for the long-term protection of wetland/upland habitats on which waterfowl and other migratory birds depend.	Project Grants - $50,000 to $1,000,000 1:1 non-federal cost - share
EPA	Five-Star and Urban Waters Restoration Program	Seeks to develop nation-wide-community stewardship of local natural resources, preserving these resources for future generations and enhancing habitat for local wildlife. Projects seek to address water quality issues in priority watersheds, such as erosion due to unstable streambanks, pollution from stormwater runoff, and degraded shorelines caused by development.	Grants - $20,000 to $50,000 1:1 non-federal cost - share

9 Action Register & Schedule

Section 8 describes in detail the recommend management measures and the corresponding anticipated load reductions. The proposed management measures will require different technical assistance, financial cost, and time. The following section describes the resources needed to implement the management recommendations for the Headwaters Yellow River Watershed and describes those efforts to be implemented within the critical areas of the watershed, with the exception of educational efforts which would occur throughout the watershed. Also, included is the schedule and milestone for the completion of each objective, the estimated cost to complete each management recommendation, and potential organizations that can could be partners to complete projects or provide technical assistance for each objective (Table 61).

Table 61. Action Register for the Headwaters Yellow River Watershed (page 9-114 through 10-119).

Goal	Objective	Target Audience	Milestones	Cost	Potential Partners/ Technical Assistance
Watershed Planning and Education: Develop a central planning organization to implement the WMP. Develop and complete annual educational/outreach programs for the watershed	Establish a Headwaters Yellow River Watershed group	Producers Landowners, Residents, and County Agencies	Establish a watershed group within five years	$2,000	SWCD County Drainage Board IDNR Municipalities Consultants
	Develop publications to promote recreational use of the river		Develop a publication within two years highlighting recreational opportunities within the Yellow River	$2,000	
	Install educational signage throughout the community		Install two information signs by year five. Install four information signs by year 10	$10,000/ $2,500 per sign	

Goal	Objective	Target Audience	Milestones	Cost	Potential Partners/ Technical Assistance
Watershed planning and education continued…	Develop publications to promote agricultural and urban BMPs		By end of year two create one publication for agricultural BMPs and one publication for urban BMPs	$2,000	
The overall goal is to reduce *E.coli* concentrations throughout the watershed not only to meet state water quality standards but to have impaired stream segments delisted. We want to reduce the maximum daily E. coli loading by 90% (reduce from 6.0 x 10^{13} mpn/day to 5.8 x 10^{12} mpn/day)	Educate and promote proper septic system maintenance	Landowners, Residents and County Agencies	Hold workshop biannually on proper septic maintenance for landowners in the watershed	$3,000/ 2 year cycle	SWCD IDEM County Health Departments IDNR Consultants
	Seek outside sources of funding for data collection on progress monitoring of *E. coli* levels in the watershed		Complete water sampling at ten sites within the watershed every five years. Collect minimum of one baseflow and one stormflow event at each site.	$2,000/ 5 year cycle	
The current maximum daily load of nitrate-nitrite is 51,197 lbs/day and the current maximum daily load of total phosphorus is 2,730 lbs/day. The load reductions needed to reach target maximum daily loading levels are 8,223 lbs/day for nitrate-nitrite (84% reduction) and 1,645 lbs/day for total phosphorus (40% reduction)	Educate and promote installation of BMPs through field days and workshops	Producers Landowners, Residents, and County Agencies	Hold 1 field day/workshop annually	$5,000	SWCD US Fish and Wildlife IDEM IDNR Municipalities NRCS Consultants
	Educate and promote proper nutrient management		Develop a publication within one year on nutrient management. Hold workshop every two years.	$5,000/ 2 year cycle	

Goal	Objective	Target Audience	Milestones	Cost	Potential Partners/ Technical Assistance
Nitrate-nitrite and phosphorus loading reduction continued…	Provide financial assistance to farmers for the development and implementation of nutrient management plans		Implement two nutrient management plans annually*	$10,000	
	Educate landowners on the importance of wetlands for water quality and restore wetland habitat in the watershed		Complete one wetland restoration project every 5 years. Complete an educational field day after each wetland project**	$25,000-$100,000/ 5 year cycle	
	Promote installation of urban BMPs to residents and urban planners/officials		Hold 1 workshop on urban BMPs every two years.	$5,000	
			Install one urban BMP every two years (rain garden, detention basin, pervious pavement, bioswale)*	$5,000-$50,000/ 2 year cycle	

Goal	Objective	Target Audience	Milestones	Cost	Potential Partners/ Technical Assistance
Nitrate-nitrite and phosphorus loading reduction continued…	Monitor Phosphorus and Nitrogen levels in the watershed		Complete water sampling at ten sites within the watershed every five years. Collect minimum of one baseflow and one stormflow event at each of the ten sites.	$3,500/ 5 year cycle	
	Educate landowners on the importance streambank protection/ restoration		Preserve 60 acres for streambank protection/ restoration every ten years*	$200,000/ 120 acres total	
The current maximum daily load of sediment is 246,695 lbs/day. The load reduction needed to reach target maximum daily loading levels is 137,053 lbs/day (44% reduction).	Provide financial assistance to producers for planting cover crops	Producers Landowners, Residents, and County Agencies	Increase watershed use of cover crops to 20% (28,500 acres) in five years and 30% (42,700 acres) in ten years.	$750,800	NRCS County Surveyor SWCD IDNR IDEM Municipalities Consultants
	Educate landowners on the importance of two-stage ditches for water quality and provide financial assistance to landowners to construct two-stage-ditches		Construct 1,000 feet of two-stage ditch every five years. (Construct total of 3,000 feet of two-stage ditch in 15 years)*	$255,000	

Goal	Objective	Target Audience	Milestones	Cost	Potential Partners/ Technical Assistance
Sediment loading reduction continued…	Provide financial assistance to producers to implement no-till		Increase watershed use of no-till to 40% (57,000 acres) in ten years and 50% (71,000 acres) in 15 years.	$641,500	
	Seek outside sources of funding for streambank stabilization projects		Stabilize 100 feet of streambank every year*	$15,000	
	Monitor TSS levels in the watershed		Complete TSS sampling at ten sites within the watershed every five years. Collect minimum of one baseflow and one stormflow event at each of the ten sites.	$2,000/ 5 year cycle	
	Educate landowners on importance of grassed waterways		Install four acres of grassed waterways annually*	$196,500/60 acres total	
Streams in the watershed have poor to fair habitat quality for aquatic organisms. The target is to have the majority of streams with fair to good habitat quality (QHEI scores of 43-69)	Educate the public about what organisms live in the streams of the watershed and how their populations are assessed	Landowners, Residents and County Agencies	Complete one field day/workshop on stream biology every five years	$5,000/ 5 year cycle	Schools IDNR SWCD IDEM NRCS Consultants

Goal	Objective	Target Audience	Milestones	Cost	Potential Partners/ Technical Assistance
	Provide financial assistance to promote establishment or preservation of riparian buffers		Preserve or establish five acres of streamside buffers or riparian habitat annually*	$118,000/ 75 acres total	

*Targeted to High Priority Critical Areas (Figure 64)

**LLWFA Report (Appendix B)

10 Tracking Effectiveness

The Marshall County SWCD is planning to submit for 319 implementation funding in 2018 which would allow for a cost-share program to install BMPs and provide financial assistance for an educational outreach program. Should funding be awarded, the SWCD will begin to implement the WMP and the goal set by the Marshall County SWCD would be to hire a watershed coordinator to further implement the plan. The watershed coordinator would be in charge of developing a Headwaters Leadership group as described in Goal 1, Section 6, and assist with guiding the implementation efforts. Having an individual committed to working on the various aspects of an implementation grant was determined critical by the steering committee and Marshall County SWCD. Having a central organization and individual who can lead landowner discussion/relations, hold educational events and develop educational materials, as well as complete the necessary grant reporting requirements will be key. Implementation efforts will be focused on the high priority critical areas of the watershed with installation of BMPs to take place first in the high priority critical areas. Educational efforts however will be available to all stakeholders in the watershed and will be important for developing a culture of responsible land management focused on improving water quality. While BMP implementation efforts will be focused on high priority critical areas, any landowner/project leads determined by the Marshall County SWCD, watershed coordinator or leadership group, located in the three medium priority critical areas and three non-critical subwatersheds will be documented and if applicable the project guided to local County SWCD or NRCS staff that could assist. In order to achieve the goals described in this WMP watershed stakeholders will need to continuously adapt efforts in the watershed. While the development of the Headwaters Yellow River WMP is a significant achievement, this document represents only a portion of the watershed planning process. A critical part of the watershed planning process is the ability to accurately track the completion of objectives over time.

Accurate tracking of progress will allow stakeholders the ability to track which objectives have been accomplished, therefore allowing a greater allocation of time and resources to objectives that have not yet been accomplished. As objectives are completed the management measures can then be adapted if the goals described in Section 6 are not achieved by the existing management measures. Table 62 lists the tracking strategies that will be used to document changes to water quality, educational outreach and BMP implementation across the watershed.

Table 62. Strategies for tracking goals and effectiveness of implementation.

Tracking Strategy	Frequency	Total Estimated Cost	Partners	Technical Assistance
BMP Load Reductions	Continuous	NA	SWCDs and NRCS	Partners Staff
Water Monitoring	Every 5 years	$7,500	SWCDs, IDNR, IDEM, new watershed group	Consultants
Attendance at Workshop/Field Days	Yearly	NA	SWCDs or new watershed group	NA
Number of Educational Publications	Yearly	NA	SWCDs or new watershed group	NA

The Marshall County SWCD and designated watershed coordinator will be responsible for managing the data acquired during the tracking process. Records of implemented BMP projects will be tracked by the Marshall County SWCD and estimated load reductions for each BMP documented. To track water quality data in the watershed, the goal is to complete water sampling every five years. Water sampling is recommended at a minimum of ten sites and should include at a minimum of one base flow and one storm flow sampling event at each site for that year. The ten sites should be the same sites sampled during the development of this WMP (all sites with exception of 2, 6, and 7) and should be taken from each of the nine critical area subwatersheds, with an extra sampling site location to be determined at the time when sampling is approved/planned. Parameters to be collected will include total phosphorus, nitrate, nitrite, TSS, *E. coli* and discharge. The cost estimate outlined in Table 62 includes sampling for the listed parameters at ten sites during one storm flow and one base flow event. Analysis of the water quality data will be used to see if certain critical area subwatersheds are showing noticeable signs of improvement from installed BMP efforts and educational efforts. The adaptive management process will consider the ability to get BMPs installed around the critical areas and determine if public educational events are being utilized by stakeholders. If certain critical subwatersheds are showing signs of improvement while others are not, it will be the responsibility of the Marshall County SWCD, watershed coordinator and leadership group to adjust implementation efforts accordingly. Potential management adjustments could be changing educational outreach formats (time of year event occurs, publication format electronic or paper, event notification process, event locations, type of event i.e. field days vs indoor seminars), types of BMP implemented (which BMPs are more receptive to landowners), and focusing landowner outreach efforts to subwatersheds with minimal BMP installation projects or working off successful projects in areas with significant landowner buy-in. Overall the implementation of the WMP will be an evolving effort with set reviews of management efforts approximately every five years.

Publications produced and attendance at workshops or field day will be tracked by the Marshall County SWCD, watershed coordinator and developed Headwaters Yellow River watershed leadership group. The Marshall County SWCD maintains a website http://www.marshallcountyswcd.org/ that will provide updates on water quality sampling efforts, any associated WMP updates and be a source for meeting and educational outreach event dates.

The Marshall County SWCD or newly developed watershed group will re-evaluate the Headwaters Yellow River WMP every five years following the results of the water sampling effort.

Currently the Marshall County SWCD will be responsible for maintaining all records for the project. Marshall County SWCD – 2903 Gary Drive, Plymouth, IN 46563 – (574) 936-2024 ext. 3.

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