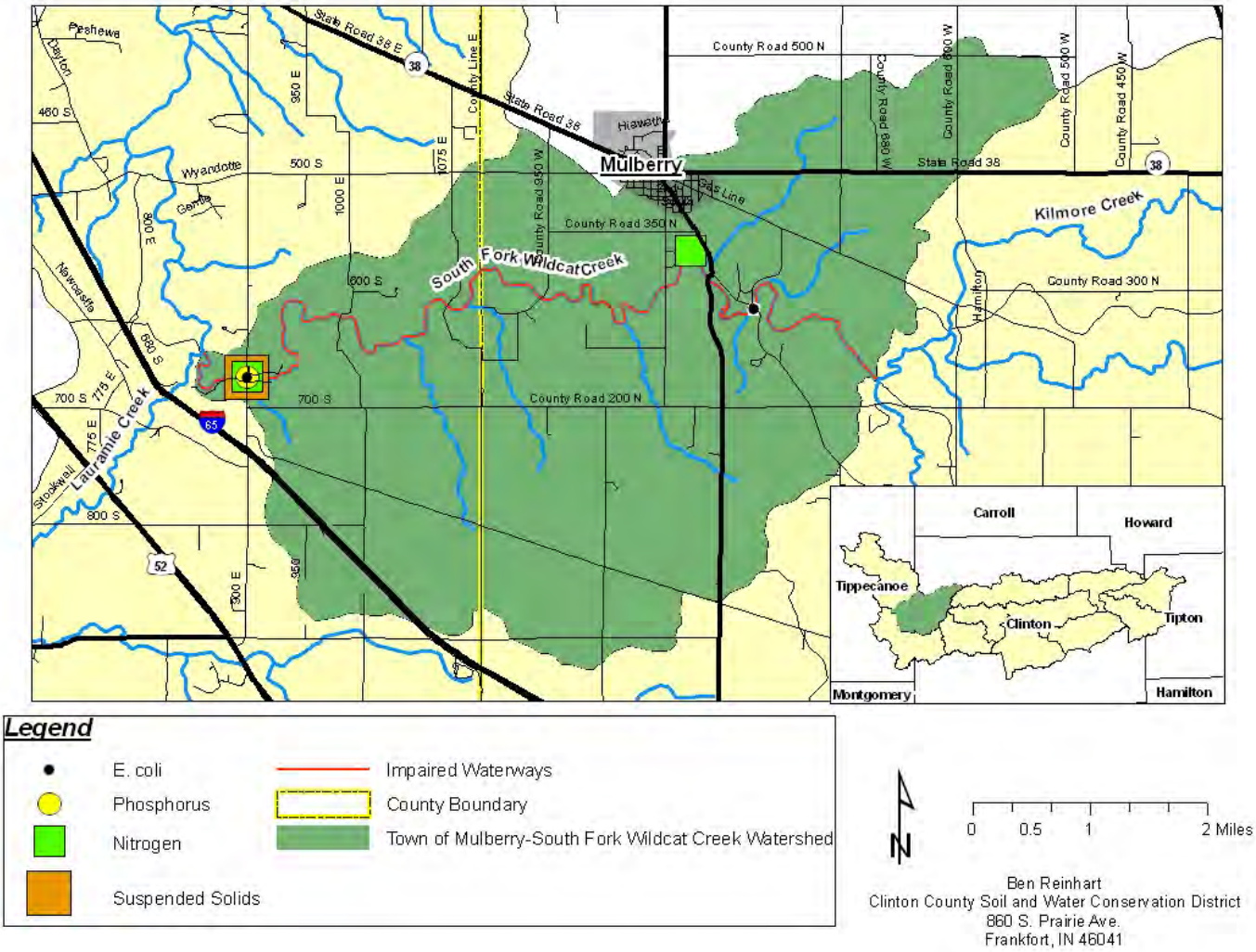

Figure 88. Town of Mulberry-South Fork Wildcat Creek Water Quality Impairments

5.0 REVIEW OF WATERSHED PROBLEMS AND CAUSES

5.1 SUMMARY OF WATER QUALITY

Total Suspended Solids (TSS)

Total Suspended Solids includes anything in the water column that can be filtered out (e.g. sediment, sewage, leaf litter or organic residues, algae, etc.). Many times sediment and other residues are carried away by water during storm events through surface runoff. To determine the potential of this surface runoff, each subwatershed was graded on the amount of Highly Erodible Land (HEL) and Potentially Highly Erodible Land (PHEL) which is based on soil type and land slope. When combining these two categories into an Erodibility Score for each subwatershed, HEL lands were weighted by a factor of two to assume a higher erosion risk. The Kilmore Creek subwatershed ranked first among all subwatersheds for erodible lands. This is also supported by the number of documented impairments for TSS from recent and historic water quality sampling (Figure 89).

Other subwatersheds that ranked highly included Dayton, Mulberry, Lauramie, Jenkins Ditch, and Spring Creek subwatersheds. These drainages, except for Spring Creek, also show recent and historic impairments for TSS. Based on current load estimates, all above mentioned subwatersheds except for Spring Creek and Lauramie Creek, have estimated load reductions from 45%-84% during high flow periods(Table 29). Load estimates for low flow periods currently meet water quality targets. The headwater drainages including, Stump Ditch, Shanty Creek, Swamp Creek, Talbert Ditch, and Prairie Creek ranked low in term of erodible lands but still show some historic TSS impairments. Current sampling in the Stump Ditch and Prairie Creek subwatersheds show both high and low flow TSS concentrations within our water quality targets. Current sampling results show that during high flows

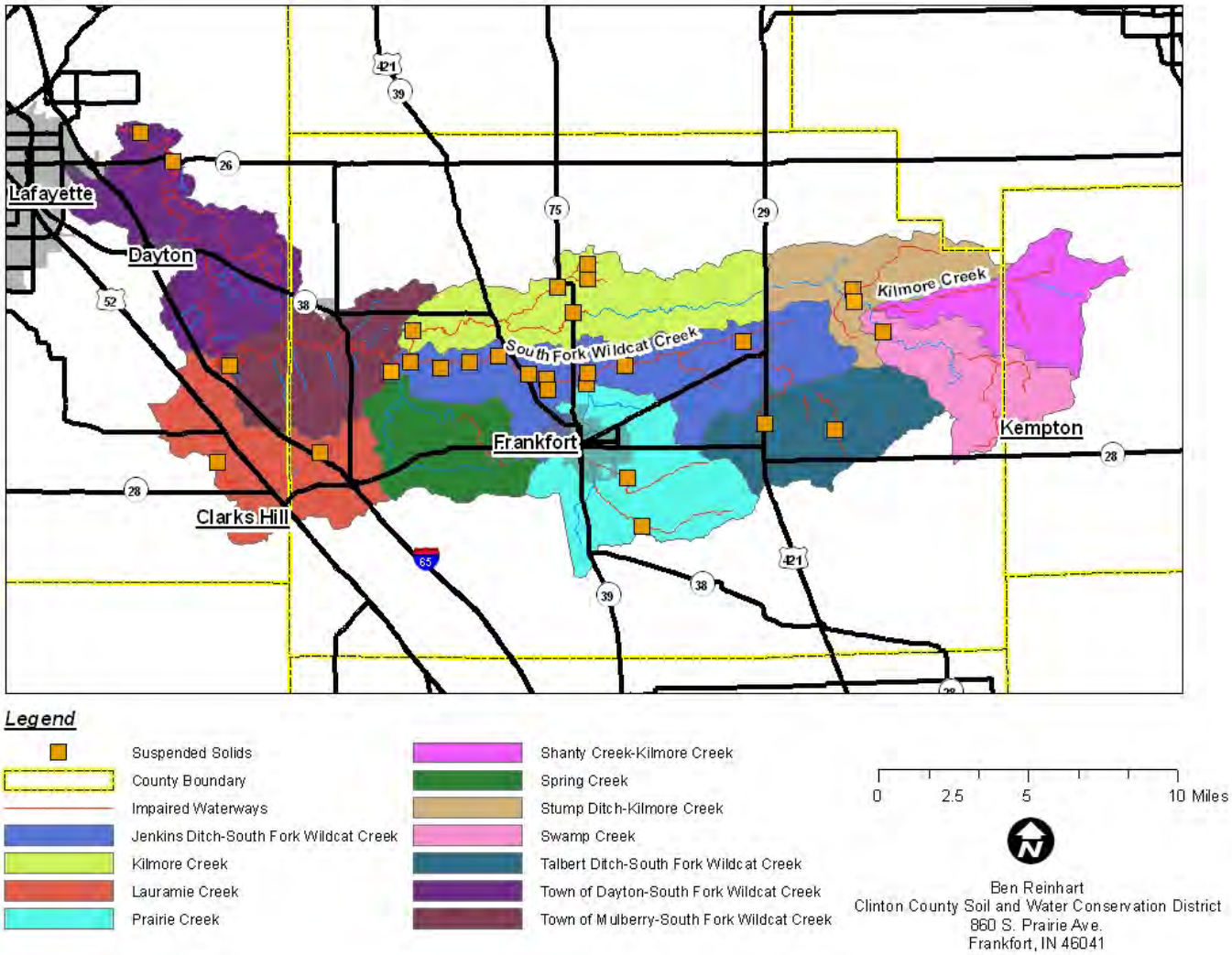

Figure 89. Total Suspended Solids Impairments for the South Fork Wildcat Creek Watershed

(i.e. wet weather periods) is when water quality standards are commonly being exceeded. Rural and urban surface runoff obviously plays a role in these loadings but streambank erosion has also been identified as a potential source of elevated TSS concentrations, especially during high flow, wet weather events. The Talbert Ditch subwatershed is the only headwater drainage area with a required load reduction for TSS (28% reduction, high flow periods only).

Nutrients

Nutrients have long been identified as a pollutant of concern within the South Fork Wildcat Creek watershed. A number of areas have been targeted in the past, such as Lauramie Creek, Prairie Creek, and Swamp Creek subwatersheds, to determine the extent of nitrogen and phosphorus loading from various sources. As can be seen below there have been a number of impairments identified within these drainages as well as in the Jenkins Ditch, Kilmore Creek, and Spring Creek subwatersheds (Figure 90). Current sampling efforts show excessive Total Phosphorus levels within the Prairie Creek drainage during both high and low flow events. Also, the Jenkins Ditch subwatershed exceeds phosphorus water quality targets both upstream and downstream of the Prairie Creek outlet during high flow events. Ammonia has historically been measured downstream of potential sources of wastewater discharges. These areas have shown various impairments. Current sampling did not focus on measuring ammonia levels but rather measured nitrate-nitrite levels. At our target level of 10 mg/L, a drinking water standard for the State of Indiana, only one site within the Jenkins Ditch subwatershed exceeded this concentration which was during a wet weather event. Other drainage areas, except for Spring Creek and Lauramie Creek subwatersheds, showed average high flow concentrations approaching our target level while average low flow concentrations fell well below the target standard. Based on current water quality targets, the Jenkins Ditch drainage area is the only subwatershed with required load reductions

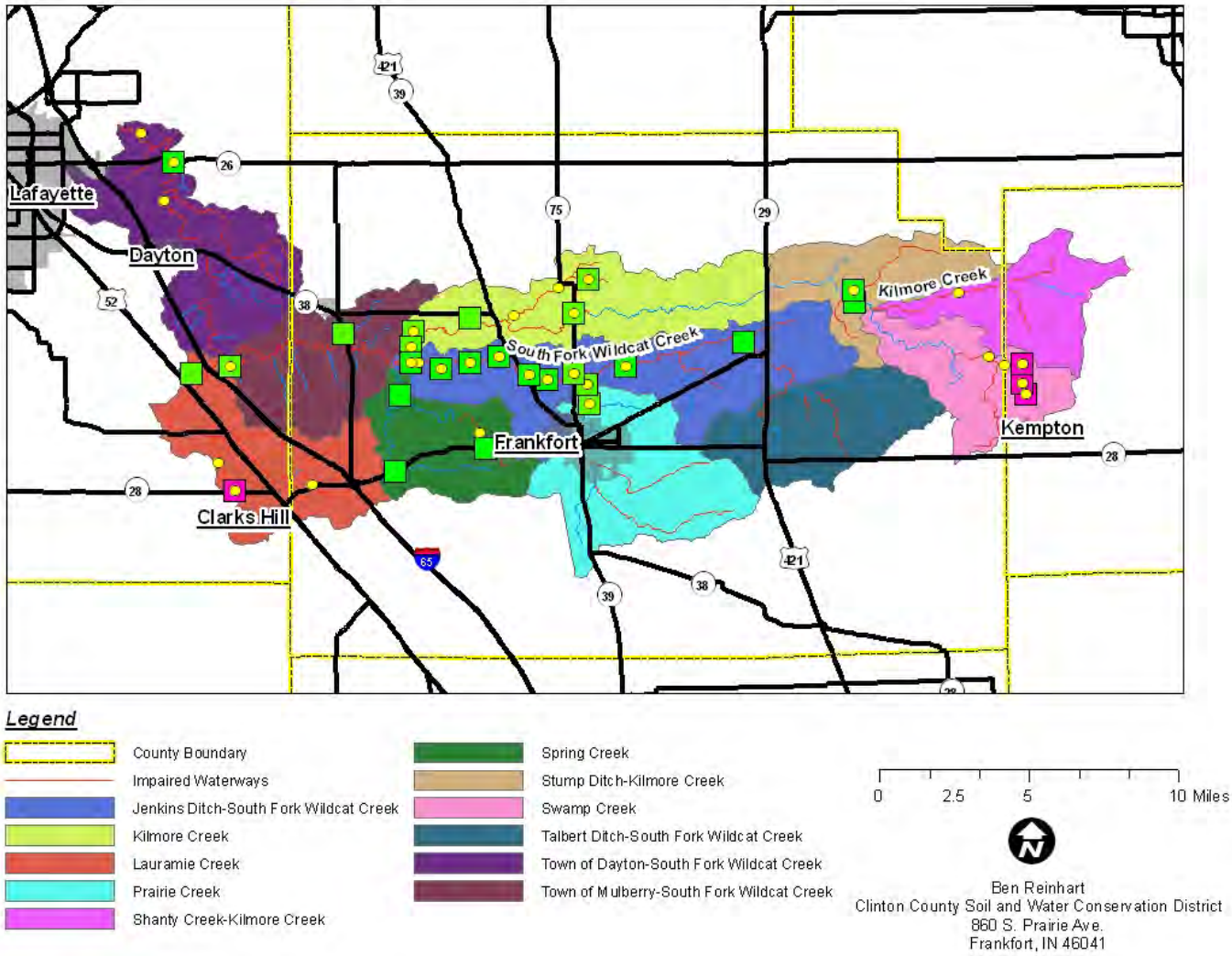

Figure 90. Nutrient Impairments for the South Fork Wildcat Creek Watershed

for nitrate-nitrite (4%, high flow periods only). The Jenkins Ditch subwatershed, as well as the Town of Dayton subwatershed, has load reductions for Total Phosphorus of 12% and 35%, respectively, for high flow periods. The Prairie Creek Subwatershed has estimated load reductions for both high flow (27%) and low flow (75%) periods.

Bacteria and Pathogens

Along with nutrients, *E. coli* has been a historically important parameter for water quality in the South Fork Wildcat Creek watershed (Figure 91). Past areas that have been specifically focused on include the Swamp Creek, Lauramie Creek, and Spring Creek subwatersheds as well as areas around the Blinn Ditch and Boyle's Ditch drainages. Current sampling has shown that the highest averages during both high and low flow periods can be found in the Jenkins Ditch, Prairie Creek, Lauramie Creek, and Stump Ditch subwatersheds. The Jenkins Ditch, Prairie Creek, Kilmore Creek, Spring Creek, and Lauramie Creek

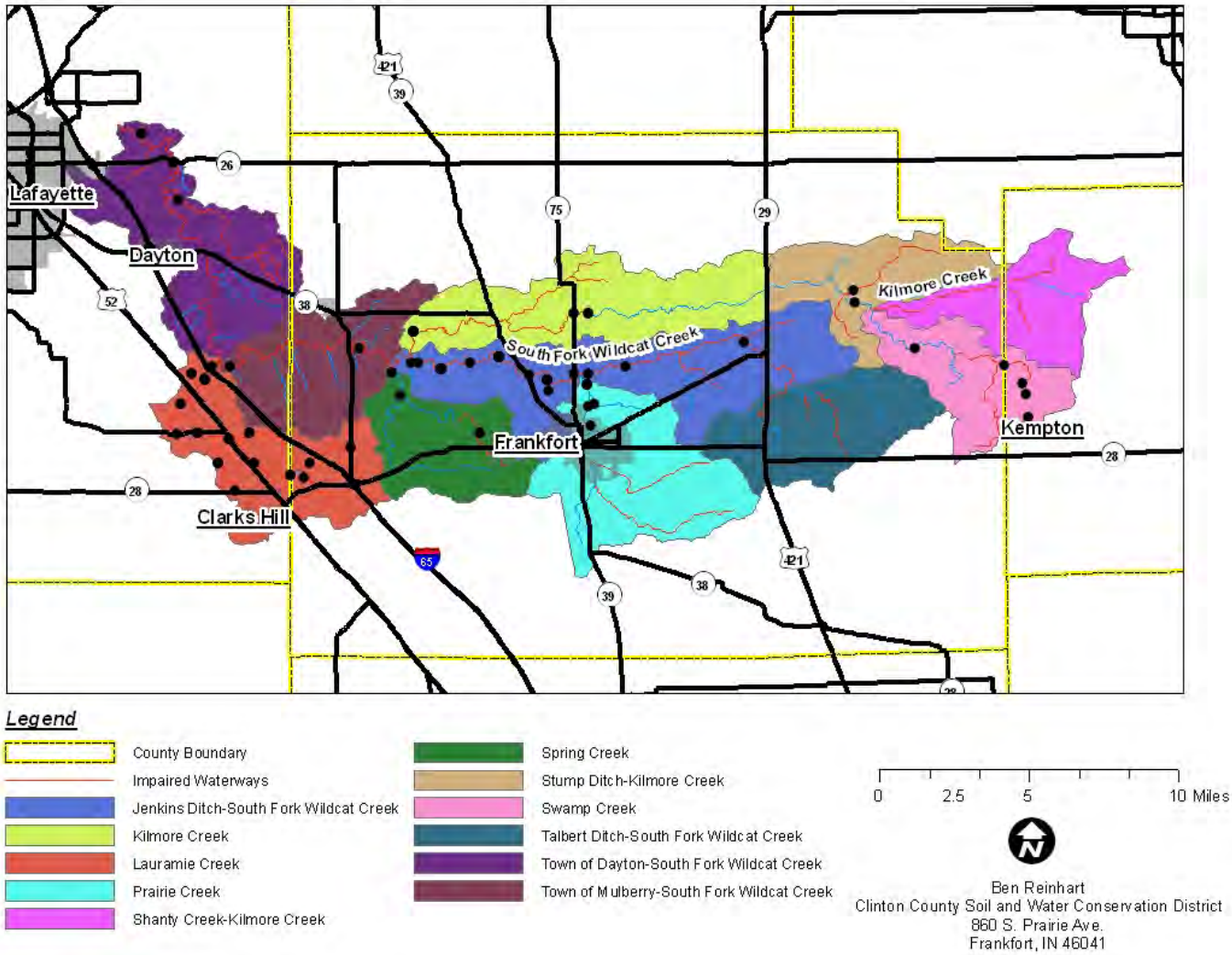

Figure 91. E.coli Impairments for the South Fork Wildcat Creek Watershed

drainage areas have estimated load reductions for both high and low flow periods. Low flow period reductions range from 39% in the Jenkins Ditch drainage to 66% in the Prairie Creek drainage. However, all subwatersheds within the South Fork Wildcat Creek Watershed have load reductions estimated at 61% or more for *E. coli* during high flow periods. Past documented impairments in the Spring Creek

subwatershed will hopefully improve given the new utilities and infrastructure expansion occurring around the Town of Jefferson. Also, current talks are progressing regarding potential wastewater strategies for the Town of Kempton which has historically struggled with wastewater discharges.

Habitat and Biology

Indices and other measures of habitat quality and biological communities have been routinely sampled as part of recent and historic water quality projects (Figure 92). Generally, impaired sites have been documented in headwater drainage areas while the main, downstream channels of the South Fork Wildcat Creek and Kilmore Creek have supported high quality habitat and biology. During current sampling, locations within the Prairie Creek and Stump Ditch subwatersheds showed the lowest habitat and biological scores (2-4 index points below the standard). Also, biological measurements showed relatively low-quality communities within the Jenkins Ditch drainage despite offering average to good in-stream habitat. Generally this type of relationship would suggest that a chemical or other environmental stressor (e.g. high bacteria and pathogen loads) is impacting local macroinvertebrates. Some of the highest quality subwatersheds included the Dayton, Mulberry, Kilmore, Spring, and Lauramie Creek drainages. These drainages also rank highly in regards to the percentage of natural land uses within floodplains and riparian areas.

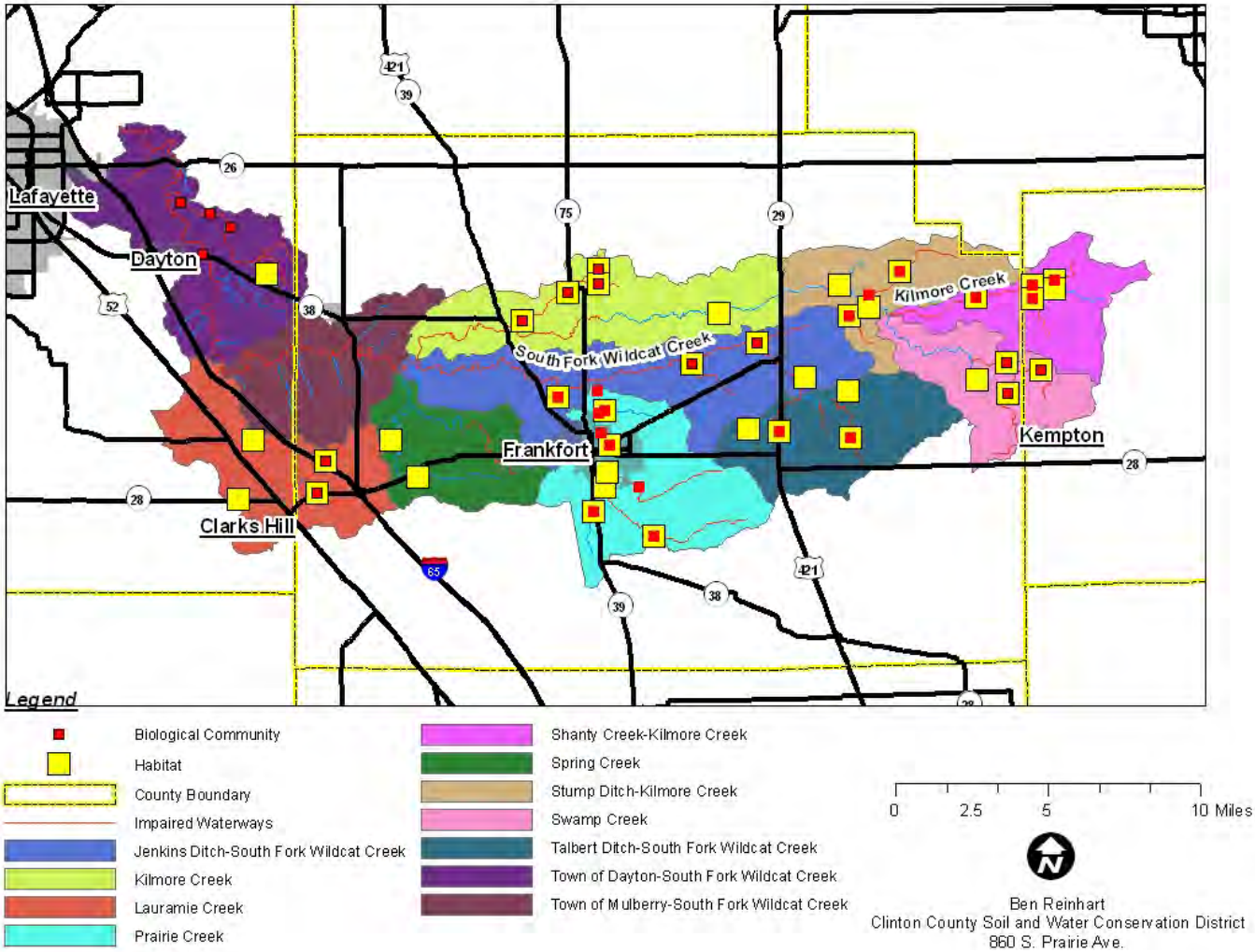

Figure 92. Habitat and Biology Impairments for the South Fork Wildcat Creek Watershed

5.2 ANALYSIS OF STAKEHOLDER CONCERNS

Following the characterization and inventory of the South Fork Wildcat Creek watershed, stakeholder and steering committee concerns were analyzed. As part of this analysis, each concern was evaluated to determine if there was data to support it, if so what evidence is currently available, can the concerned by reasonably quantified, and is the concern within the scope of this project (Table 25). These grading variables helped the steering committee prioritize the wide variety of concerns that were gathered during the initial stages of this watershed planning effort. All but three concerns were accepted by the steering committee during this process. Flooding and drainage issues, in relation to land use change on a watershed-scale, was determined to be a more appropriate issue for local planning professionals. While it was generally agreed upon that certain locales have experienced increased development and growth, it was also determined that these issues are better suited for the established procedures and protocols of the local planning offices. However, the steering committee will look to encourage and support future planning efforts that will help restore the natural functions of local floodplains and riparian areas which will help reduce costly flooding and drainage issues. Other concerns that the steering committee has chosen not to directly focus on are issues related to established regulations and permitting processes. Issues such as municipal stormwater regulations and environmental remediation sites have established guidelines for addressing problems. Here again, the steering committee has instead chosen to play more of a support role by offering help such as general assistance or community outreach to both public and private partners which are already operating under or subject to these set regulations.

Table 25. Analysis of Stakeholder Concerns

Stakeholder Concerns	Supported by Data (Y/N)	Evidence	Quantifiable (Y/N)	Outside WMP Scope (Y/N)	Accepted (Y/N)
Development and land use change has resulted in more frequent flood events and problems with drainage	NO	More detailed data is needed	YES	YES	NO, but will look to support all local planning efforts
Mismanagement of our floodplains and streams (e.g. construction in floodplain, use of natural waterways as drains, channel filling, etc.) has altered the natural hydrology of the watershed resulting in unstable channels and flows as well as reduced flood storage.	YES	Observation and Landowner Accounts	NO	NO	YES

Table 25. Analysis of Stakeholder Concerns (continued)

Stakeholder Concerns	Supported by Data (Y/N)	Evidence	Quantifiable (Y/N)	Outside WMP Scope (Y/N)	Accepted (Y/N)
Developing areas are contributing pathogens and *E. coli* through sewer overflow events and other wastewater discharges.	YES	Watershed Inventories; NPDES Permit Information	YES	YES	NO, but will look to support existing regulations
Livestock and the spreading of their manure increase pathogen and *E. coli* loads in local waters	YES	Observation and Landowner Accounts; Current and Historic Sampling Projects	YES	NO	YES
Lack of septic systems, or maintenance of older systems, increase pathogen and *E. coli* levels especially near local unsewered communities	YES	Observation and Landowner Accounts; Current and Historic Sampling Projects	YES	NO	YES
Urban and industrial areas are contributing various environmental toxins including PCB's	YES	Watershed Inventories; More detailed WQ date is necessary to confirm	YES	YES	NO, but will look to support existing regulations
Current and past landfill sites are introducing sediments and pollutants into local waters	YES	Observation and Landowner Accounts	YES	NO	YES
Stormwater runoff from developed or developing areas contain high levels of water quality pollutants	NO	More detailed WQ data needed within target areas	YES	NO	YES, Committee has assumed this is still a valid concern

Table 25. Analysis of Stakeholder Concerns (continued)

Stakeholder Concerns	Supported by Data (Y/N)	Evidence	Quantifiable (Y/N)	Outside WMP Scope (Y/N)	Accepted (Y/N)
Lawn runoff from high-residential areas contain elevated levels of pesticides and nutrients	NO	More detailed WQ data needed within target areas	YES	NO	YES, Committee has assumed this is still a valid concern
Streambank erosion and slope failures input high levels of sediment directly into local streams	YES	Observation and Landowner Accounts	YES	NO	YES
The lack of conservation tillage practices in the county is contributing to high levels of sediment and nutrients in our waterways	YES	Watershed Inventories	YES	NO	YES
The lack of buffers, filter strips, and grass waterways allow agricultural land to introduce a lot of sediment and nutrients across the watershed	YES	Watershed Inventories	YES	NO	YES
Many people are not aware or know much about the watershed	YES	Social Indicator Survey	YES	NO	YES
There is low public appreciation and support for the watershed as can be seen through illegal dumping activities, passive regulations, and lack of maintained access points or other recreational amenities	YES	Social Indicator Survey	YES	NO	YES
Forested riparian habitat is limited across the watershed impacting local wildlife and water quality	YES	Watershed & Land Use Inventories	YES	NO	YES

5.3 POTENTIAL SOURCES OF WATER QUALITY IMPAIRMENTS

Once the concerns were identified by the steering committee, they were used to identify specific problems that can be seen throughout the watershed. Defined here, a problem is a certain condition in the watershed that occurs due to a particular concern. Also, as you can see in the table below, multiple concerns can all relate to a single specific problem (Table 26). Identified problems were further broken down by the steering committee into potential causes and possible sources of those causes. Both recent and historic water quality data was used by the group to try and provide specific parameters as root causes to problems, where applicable. Then using information from the Watershed Inventory and GIS data, potential sources were characterized for the entire South Fork Wildcat Creek. Many of these sources are also described on a subwatershed level in Chapter 6. Critical and Priority Area Selection.

Table 26. Identification of Potential Sources

Stakeholder Concern	Problem	Potential Causes	Potential Sources
Mismanagement of our floodplains and streams (e.g. construction in floodplain, use of natural waterways as drains, channel filling, etc.) has altered the natural hydrology of the watershed resulting in unstable channels and flows as well as reduced flood storage.	Current management of riparian lands degrade the natural functions and benefits of floodplains	Excessive drainage, loss of natural riparian habitat	• 7.5 % of land within riparian areas and floodplains are developed • 51.5% of land within riparian areas and floodplains are grazed, hayed, or cultivated • Over 200 miles of drain tile and 100 miles of open ditch
Developing areas are contributing pathogens and *E. coli* through Combined Sewer Overflow (CSO) events and other wastewater discharges.	Many surface waters throughout the watershed may be unsafe for recreation or other contact uses	*E. coli* levels exceed accepted target levels	• 40 Active CFO's in the watershed • City of Frankfort CSO • 7 NPDES with ≥1 effluent exceedances • 17 confirmed locations where livestock can freely access waterways • Over 200 miles of drain tile and 100 miles of open ditch • 92% of watershed soils poorly suited for septic systems
Livestock and the spreading of their manure increase pathogen and *E. coli* loads in local waters			
Lack of septic systems, or maintenance of older systems, increase pathogen and *E. coli* levels especially near local unsewered communities			
Urban and industrial areas are contributing various environmental toxins including PCB's			
Current and past landfill sites are introducing sediments and pollutants into local waters			
Stormwater runoff from developed or developing areas contain high levels of water quality pollutants			
Lawn runoff from high-residential areas contain elevated levels of pesticides and nutrients			

Table 26. Identification of Potential Sources (continued)

Stakeholder Concern	Problem	Potential Causes	Potential Sources
Many people are not aware or know much about the watershed	Coordinated efforts for watershed education and outreach have not previously been focused on the watershed	Underutilized partnerships, Lack of Funding, Low exposure to local officials	N/A
There is low public appreciation and support for the watershed as can be seen through illegal dumping activities, passive regulations, and lack of maintained access points or other recreational amenities			
There is low public appreciation and support for the watershed as can be seen through illegal dumping activities, passive regulations, and lack of maintained access points or other recreational amenities	Trash and illegal dumping are apparent in various parts of the watershed	Lack of education & outreach (especially to unique target groups), Lack of affordable disposal outlets	N/A
Current and past landfill sites are introducing sediments and pollutants into local waters			
Streambank erosion and slope failures input high levels of sediment directly into local streams	Surface waters throughout the watershed are often turbid and appear muddy	Total Suspended Sediment (TSS) levels exceed accepted standards	• 7.5 % of land within riparian areas and floodplains are developed • 51.5% of land within riparian areas and floodplains are grazed, hayed, or cultivated • 6% of watershed is HEL, 30% of watershed is PHEL • 17 confirmed locations where livestock can freely access waterways • 8.2% of watershed is impervious surface • 72 locations of active erosion identified through windshield surveys
The lack of conservation tillage practices in the county is contributing to high levels of sediment and nutrients in our waterways			
The lack of buffers, filter strips, and grass waterways allow agricultural land to introduce a lot of sediment and nutrients across the watershed			
Current and past landfill sites are introducing sediments and pollutants into local waters			
Stormwater runoff from developed or developing areas contain high levels of water quality pollutants			

Table 26. Identification of Potential Sources (continued)

Stakeholder Concern	Problem	Potential Causes	Potential Sources
The lack of conservation tillage practices in the county is contributing to high levels of sediment and nutrients in our waterways	High levels of nutrients can be found in surface waters throughout the watershed	Nitrogen and Phosphorus levels exceed accepted target levels	• 40 Active CFO's in the watershed • City of Frankfort CSO • 7 NPDES with ≥1 effluent exceedances • 17 confirmed locations where livestock can freely access waterways • Over 200 miles of drain tile and 100 miles of open ditch • 7.5 % of land within riparian areas and floodplains are developed • 51.5% of land within riparian areas and floodplains are grazed, hayed, or cultivated
The lack of buffers, filter strips, and grass waterways allow agricultural land to introduce a lot of sediment and nutrients across the watershed			
Lawn runoff from high-residential areas contain elevated levels of pesticides and nutrients			
Stormwater runoff from developed or developing areas contain high levels of water quality pollutants			
Forested riparian habitat is limited across the watershed impacting local wildlife and water quality	Many aquatic and terrestrial wildlife are either at risk or occur in much lower numbers	Lack of natural riparian habitat and habitat corridors, Low water quality	• 7.5 % of land within riparian areas and floodplains are developed • 51.5% of land within riparian areas and floodplains are grazed, hayed, or cultivated • 17 confirmed locations where livestock can freely access waterways

6.0 CRITICAL & PRIORITY AREA SELECTION

In order to prioritize future implementation and funding efforts, the steering committee worked to develop Critical Land Areas (CLA) and Priority Protection Areas (PPA). CLA's defined here are areas or specific situations which have a high likelihood of contributing pollutant loads to the watershed. Each water quality parameter has its own set of CLA's. For example, CLA's were developed for Nutrients, TSS, Bacteria & Pathogens, and Environmental Quality. The steering committee also recognized that the South Fork Wildcat Creek watershed has certain land areas where riparian and in-stream habitats exist in a relatively natural condition. These areas have been designated as PPA's and will be prioritized for future protection measures to preserve the existing natural conditions.

CLA's and PPA's were calculated at the subwatershed level using a numeric ranking system that would take into account certain variables related to each water quality parameter (Figure 93). Also, given that modeled load estimates were not calculated for *E.coli*, current load estimates were weighted by a factor of two. All variables used in the selection of CLA's and PPA's are described below.

NUTRIENTS = Modeled Loading + Current Loading + Hydric Soils + Riparian Land Use + Confined Feeding Operations + NPDES Facilities

TOTAL SUSPENDED SOLIDS = Modeled Loading + Current Loading + Erodible Lands + Riparian Land Use + Impervious Surfaces

BACTERIA & PATHOGENS = (Current Loading x 2) + Hydric Soils + Riparian Land Use + Confined Feeding Operations + NPDES Facilities

ENVIRONMENTAL QUALITY = QHEI Score + mIBI Score + Applied Conservation Practices + Riparian Land Use + Impervious Surfaces

Figure 93. Ranking Formulas

6.1 MODELED AND CURRENT POLLUTANT LOAD ESTIMATES

Purdue researchers modeled pollutant yields for nutrients and sediment across the South Fork Wildcat Creek watershed using the Soil & Water Assessment Tool (SWAT). SWAT is a model that was developed by Texas A&M University for the USDA Agricultural Research Service in the early 1990's and has since went through a number of updates and advances. This model incorporates a number of characteristics from the watershed (e.g. weather patterns, soil properties, topography, land use and management, etc.) to estimate pollutant yields across a diverse landscape, continuously over an extended time period. Compared to our calculations of current pollutant loads, which look only at a single point time, the SWAT model allows for a more long-term analysis of pollutant yields. Another important consideration is the SWAT delineates subbasins (i.e. subwatersheds) based on elevation models which may or may not match the Hydrologic Unit Code boundaries of subwatersheds that were used during this watershed planning project. For our comparisons, SWAT subbasins were grouped together to approximate 12-digit Hydrologic Unit Code boundaries, to the closest extent possible.

For the South Fork Wildcat Creek watershed, estimates of annual sediment and nutrient yields were modeled over a period of 15 years starting in 1995. All yields were averaged across the 15-year period for each subwatershed and then divided by the total drainage area. This resulted in average annual yield per acre for nutrients and sediments (Table 27). Each subwatershed was then ranked based on their relative annual yield per acre with a ranking of "1" indicating the highest amount of loading among all drainage areas and "10" indicating the lowest amount of loading (Table 39).

Table 27. SWAT Modeling of Subwatersheds (lbs/ac/year)

Subwatershed	Total Phosphorus	Nitrates	Sediment
Shanty Creek/Swamp Creek	2.7	10.0	2782.7
Stump Ditch-Kilmore Creek	3.5	13.3	4274.6
Kilmore Creek	4.9	22.9	6830.1
Talbert Ditch-South Fork Wildcat Creek	2.9	12.5	3375.2
Prairie Creek	4.7	18.1	5233.0
Jenkins Ditch-South Fork Wildcat Creek	6.3	28.0	8433.4
Spring Creek	2.5	9.2	2203.8
Lauramie Creek	4.0	13.6	4412.9
Town of Mulberry-South Fork Wildcat Creek	3.4	11.3	4706.0
Town of Dayton-South Fork Wildcat Creek	3.0	12.8	3667.9

Estimates of current loading were calculated using water quality data from the South Fork Wildcat Creek Water Quality Assessment which was completed during 2010 and 2011. Most subwatersheds have at least one sampling location located near the outlet of that drainage area. A couple exceptions are the Swamp Creek, Shanty Creek, and Talbert Ditch subwatersheds. In these situations the closest downstream location from the subwatershed outlet was used. Also, in this instance, both the Shanty Creek and Swamp Creek subwatershed will be treated as a single drainage area outletting at Sampling Location #3. The Talbert Ditch subwatershed will be evaluated at Sampling Location #2. The Kilmore Creek subwatershed contains two sampling locations while the Jenkins Ditch subwatershed contains three sampling locations. Water quality data at those locations were averaged to obtain an overall loading for each respective drainage area (Table 28).

Table 28. Sampling Locations Used for Load Estimations

Subwatershed	Sampling Location
Shanty Creek/Swamp Creek	3
Stump Ditch-Kilmore Creek	1
Kilmore Creek	4,5
Talbert Ditch-South Fork Wildcat Creek	2
Prairie Creek	6
Jenkins Ditch-South Fork Wildcat Creek	13,14, 18
Spring Creek	9
Lauramie Creek	10
Town of Mulberry-South Fork Wildcat Creek	15
Town of Dayton-South Fork Wildcat Creek	16

Current loading estimates by subwatershed were calculated by multiplying the average pollutant concentration, an estimate of the volume of streamflow passing through that location at a certain point in time, and a specific conversion factor to transform each concentration measurement into a mass-based or organism-based "load" for that point in time. Our estimates for mass-based pollutants (e.g. nutrients and sediment) are expressed in tons per year (T/Yr). Since *E. coli* does not have a specific mass-based conversion factor, the total number of organisms was calculated to give loads in billions of organisms per year (G-org/Yr). Current loads for each subwatershed and required reductions necessary to meet this project's water quality targets are shown below (Table 29). For the purposes of identifying CLA's and PPA's, current load estimates were divided by the total drainage area to reach a loading per acre estimate. Each subwatershed was then ranked based on their current loading per acre with one being the highest loading per acre. It is important to realize that in some cases prioritized CLA's may not correlate directly with subwatershed estimates for cumulative loads or loading per acre estimates. This can be attributed to a number of reasons. Current loadings are estimated for a single point in time and may not reflect the variation in actual, real world pollutant loading that occurs within each drainage over the course of the seasons. We looked to introduce some of these other variables into our ranking system to account for some of this variability. Another potential reason for this discrepancy is that downstream subwatersheds often "inherit" water quality impairments from more upstream drainages. So, in this case, if you were to focus all of your attention on the drainage area where the loading is documented, you still wouldn't be addressing the true source of the loading which may lie in a completely different watershed. Again, we looked to add in characteristics such as land use and other variables that can help identify these areas.

Table 29. Load Estimates and Required Load Reductions (T/Yr.; G-Org/Yr.)
Red Text Indicates Values Exceeding Current Water Quality Targets

Subwatershed	Total Phosphorus *Current Load (Target)*		Nitrate-Nitrite *Current Load (Target)*		Total Suspended Solids *Current Load (Target)*		*E. coli** *Current Load (Target)*	
	High Flow	*Low Flow*	*High Flow*	*Low Flow*	*High Flow*	*Low Flow*	*High Flow*	*Low Flow*
Shanty Creek/Swamp Creek	2 (4)	0.1 (0.5)	129 (143)	5 (16)	328 (428)	18 (47)	100,352 (16,182)	809 (1,786)
Stump Ditch-Kilmore Creek	5 (7)	1 (1)	175 (231)	11 (34)	468 (693)	17 (103)	140,392 (26,226)	2,025 (3,906)
Kilmore Creek	23 (32)	1 (4)	887 (1,050)	43 (127)	5,907 (3,150)	63 (382)	441,488 (119,132)	25,419 (14,452)
Talbert Ditch-South Fork Wildcat Creek	7 (14)	0.4 (2)	407 (467)	16 (50)	1,951 (1,402)	20 (151)	398,520 (53,009)	3,274 (5,692)
Prairie Creek	11 (8)	12 (3)	254 (271)	77 (93)	690 (812)	38 (280)	208,579 (30,690)	30,805 (10,602)
Jenkins Ditch-South Fork Wildcat Creek	52 (46)	3 (5)	1,610 (1,538)	78 (180)	8,432 (4,613)	114 (539)	1,065,654 (174,466)	33,347 (20,385)

Table 29. Load Estimates and Required Load Reductions (T/Yr.; G-Org/Yr.) continued

Subwatershed	Total Phosphorus *Current Load (Target)*		Nitrate-Nitrite *Current Load (Target)*		Total Suspended Solids *Current Load (Target)*		*E. coli** *Current Load (Target)*	
	High Flow	*Low Flow*	*High Flow*	*Low Flow*	*High Flow*	*Low Flow*	*High Flow*	*Low Flow*
Spring Creek	3 (5)	1 (3)	91 (152)	16 (89)	381 (457)	28 (266)	79,379 (17,298)	20,142 (10,044)
Lauramie Creek	2 (4)	0.4 (1)	62 (148)	10 (49)	70 (443)	13 (148)	91,350 (16,740)	12,547 (5,580)
Town of Mulberry-South Fork Wildcat Creek	133 (133)	7 (14)	3,940 (4,427)	166 (475)	50,795 (13,280)	196 (1,425)	1,648,504 (502,194)	43,797 (53,902)
Town of Dayton-South Fork Wildcat Creek	249 (162)	5 (18)	4,842 (5,410)	159 (595)	102,794 (16,231)	174 (1,785)	1,578,108 (613,793)	29,431 (67,517)
Subwatershed Totals	486 (415)	30 (51)	12,396 (13,836)	583 (1,709)	171,816 (41,509)	681 (5,126)	5,752,325 (1,569,729)	201,598 (193,866)
LOAD REDUCTIONS								
Shanty Creek/Swamp Creek	-	-	-	-	-	-	84,170 (84%)	-
Stump Ditch-Kilmore Creek	-	-	-	-	-	-	114,166 (81%)	-
Kilmore Creek	-	-	-	-	2,756 (47%)	-	322,356 (73%)	10,967 (43%)
Talbert Ditch-South Fork Wildcat Creek	-	-	-	-	549 (28%)	-	345,511 (87%)	-
Prairie Creek	3 (27%)	9 (75%)	-	-	-	-	177,890 (85%)	20,204 (66%)
Jenkins Ditch-South Fork Wildcat Creek	6 (12%)	-	72 (4%)	-	3,819 (45%)	-	891,188 (84%)	12,961 (39%)
Spring Creek	-	-	-	-	-	-	62, 081 (78%)	10,098 (50%)
Lauramie Creek	-	-	-	-	-	-	74,610 (82%)	6,968 (56%)
Town of Mulberry-South Fork Wildcat Creek	-	-	-	-	37, 515 (74%)	-	1,146,309 (70%)	-
Town of Dayton-South Fork Wildcat Creek	87 (35%)	-	-	-	86,563 (84%)	-	964,315 (61%)	-
Total Reductions	*71 (15%)*	-	-	-	*130,307 (76%)*	-	*4,182,596 (73%)*	*7,732 (4%)*

Note 1. High flow (May-June) and low flow (Sept.-Oct.) averaged estimates from South Fork Wildcat Creek SWAT Model

6.2 LAND USE EVALUATIONS

Various land use metrics were used to evaluate subwatersheds within the South Fork Wildcat Creek watershed for the purpose of determining the need for restoration or protection. First, impervious surfaces were measured throughout each subwatershed. As was discussed in the Land Use

section of this plan, impervious surfaces can make significant impacts towards impacting local waterways. According to the Center for Watershed Protection, impacts on local surface waters begin to show once impervious surfaces exceed 10% of the total watershed land use. Lands with over 10% impervious surfaces were totaled for each subwatershed and divided by the total drainage area for that subwatershed (Table 30). The subwatersheds were then ranked based on the percentage of lands within their boundaries that exceed that 10% impervious surface limit. A ranking of "1" indicates the subwatershed with the greatest amount of impervious surfaces.

Table 30. Evaluation of Impervious Surfaces by Subwatershed

Subwatershed	Impervious Surfaces		
	<10%	*10-25%*	*>25%*
Swamp Creek/Shanty Creek-Kilmore Creek	99%	0.4%	0.5%
Stump Ditch-Kilmore Creek	99%	1%	1%
Kilmore Creek	99%	1%	0.4%
Talbert Ditch-South Fork Wildcat Creek	98%	1%	1%
Prairie Creek	88%	2%	9%
Jenkins Ditch-South Fork Wildcat Creek	95%	1%	4%
Spring Creek	97%	1%	2%
Lauramie Creek	96%	2%	3%
Town of Mulberry-South Fork Wildcat Creek	98%	1%	1%
Town of Dayton-South Fork Wildcat Creek	94%	2%	4%

The second metric used to evaluate land use relates to the type of land cover within the floodplain area of local waterways. For waterways which did not show floodways on the Flood Insurance Rate Maps a floodplain/riparian area of 100' was designated. Land-use/land-cover was divided into two categories, modified or natural. Modified land uses included various degrees of development as well as land used for agricultural purposes such as farming or grazing. Natural land uses including wooded areas, grasslands, and wetlands. Rankings, based on the percentage of modified land within the floodplain/riparian area, for each subwatershed were developed similar to what was described above (Table 31). A subwatershed ranking of "1" indicates the lowest amount of natural land cover within designated floodplain and riparian areas.

Table 31. Floodplain & Riparian Land Use Evaluation by Subwatershed

Subwatershed	Floodplain & Riparian Zone Land Use	
	Modified	*Natural*
Swamp Creek/Shanty Creek-Kilmore Creek	91%	9%
Stump Ditch-Kilmore Creek	83%	17%
Kilmore Creek	49%	51%
Talbert Ditch-South Fork Wildcat Creek	92%	8%
Prairie Creek	82%	18%
Jenkins Ditch-South Fork Wildcat Creek	56%	44%
Spring Creek	74%	26%
Lauramie Creek	60%	40%
Town of Mulberry-South Fork Wildcat Creek	47%	53%
Town of Dayton-South Fork Wildcat Creek	42%	58%

Our third metric addressed the issue of already applied conservation practices within each subwatershed. This measure allows us to see a couple different things. First, it acts as an indicator of interest in participating in government-run conservation programs. Attracting funding and support for implementation programs is not useful or effective if land owners and managers are unwilling to participate in those programs. However, this measure also allows us to identify gaps in applied conservation. These gaps may indicate an unwillingness to participate in government programs. However, these gaps could also indicate areas where outreach efforts have fallen short or where demonstration projects may be targeted. Using NRCS tracking systems the total amount of acres with applied conservation practices were calculated and then divided by the total subwatershed drainage area (Table 32). Subwatersheds were then ranked based on this percentage with "1" indicating the lowest amount of applied conservation acres. It is important to note that certain acres may have multiple practices addressing various resource concerns. In order to avoid inflating estimates for certain subwatersheds and so that all acres would be counted equal, acres with multiple practices were only counted once to get an estimate of unique conservation acres per subwatershed.

Table 32. Subwatershed Evaluation of Applied Conservation

Subwatershed	Total Drainage Area	Applied Conservation	
	Acres	Acres	Percent
Swamp Creek/Shanty Creek-Kilmore Creek	15,110	2,555	16.9%
Stump Ditch-Kilmore Creek	10,594	912	8.6%
Kilmore Creek	17,423	4,509	25.9%
Talbert Ditch-South Fork Wildcat Creek	13,116	4,641	35.4%
Prairie Creek	17,191	1,113	6.5%
Jenkins Ditch-South Fork Wildcat Creek	22,816	4,580	20.1%
Spring Creek	10,218	3,910	38.3%
Lauramie Creek	15,110	2,555	16.9%
Town of Mulberry-South Fork Wildcat Creek	13,335	2,371	17.8%
Town of Dayton-South Fork Wildcat Creek	18,834	1,877	10.0%
South Fork Wildcat Creek Watershed Total	*153,747*	*29,024*	*18.9%*

Last, we looked to quantify and compare the occurrences of two specific land uses, Confined feeding operations (CFO) and NPDES facilities with documented water quality exceedances. CFO's are often targeted due to public perceptions of their operations. However, often times these operations go above and beyond to mitigate their impacts on surrounding lands. Despite this, these operations still represent high threat areas for water quality impacts. These threats not only come from the facility themselves but also from the treatment of animal wastes from that facility. These wastes are often used as fertilizer in farm operations and areas surrounding CFO's can often become saturated with manure-based fertilizers. These fields can contribute high nutrient and bacteria loads not only from surface runoff but also through subsurface tile drainage.

NPDES facilities are similar in some regards to CFO's. Often times these operations are run within established regulations and impacts on surrounding lands are minimal. However, these facilities can and do have periods where they operate outside of current regulations. During these periods, large amounts of nutrients, sewage, and other pollutants can be discharged directly into local waterways, untreated. For this comparison we only counted NPDES facilities with documented effluent

exceedances and active CFO's (Table 33). Each subwatershed was then ranked based on this total number with a ranking of "1" indicating the highest number of active CFO's/NPDES permits. One note is that previously it was documented that there are currently seven NPDES facilities with documented effluent exceedances while the table below shows a total of eight. This is due to the fact that one NPDES facility discharges in two separate subwatersheds.

Table 33. Comparison of Confined Feeding Operations & NPDES Permits by Subwatershed

Subwatershed	Active Livestock Operations	NPDES Permits (w/exceedances)
Swamp Creek/Shanty Creek-Kilmore Creek	4	0
Stump Ditch-Kilmore Creek	6	0
Kilmore Creek	6	0
Talbert Ditch-South Fork Wildcat Creek	5	0
Prairie Creek	1	1
Jenkins Ditch-South Fork Wildcat Creek	6	2
Spring Creek	1	2
Lauramie Creek	3	2
Town of Mulberry-South Fork Wildcat Creek	7	1
Town of Dayton-South Fork Wildcat Creek	1	0

6.3 CRITICAL SOIL AREAS

Critical soil areas were determined to be those that are highly erodible as well as soils with hydric properties. Highly erodible lands are those land areas which are susceptible to erosion from surface runoff and thus have a high potential of contributing sediment and nutrients to local waterways. These areas were determined by soil type using NRCS Highly Erodible Soils Lists for each county with land area in the South Fork Wildcat Creek watershed. This list classifies each soil type as: 1. Highly Erodible, 2. Potentially Highly Erodible, and 3. Not Highly Erodible. A total Erodibility score was calculated by combining the percentage of total lands within each subwatershed that could be classified as either Highly Erodible or Potentially Highly Erodible (Table 34). Highly erodible lands were weighted by a factor of two, assuming a higher potential for erosion to occur. Each subwatershed was then ranked based on their Erodibility score. A ranking of "1" indicates a greater Erodibility Score

Hydric soils were treated similar to the process described above. A total percentage of land area for each subwatershed was determined based on soil type and NRCS Hydric Soils Lists for each county. Subwatersheds were then ranked based on the percentage of hydric soils within their boundaries. A ranking of "1" indicates the highest occurrence of hydric soils.

Table 34. Evaluation of Hydric & Erodible Soils by Subwatershed

Subwatershed	Hydric Soil	Highly Erodible Soils	Potentially Highly Erodible Soils
		Percent of Total Drainage Area	
Swamp Creek/Shanty Creek-Kilmore Creek	54%	0.4%	24%
Stump Ditch-Kilmore Creek	47%	1%	37%
Talbert Ditch-South Fork Wildcat Creek	52%	0.5%	42%
Prairie Creek	39%	0.3%	40%
Kilmore Creek	22%	6%	56%
Spring Creek	40%	6%	21%
Jenkins Ditch-South Fork Wildcat Creek	26%	6%	44%
Lauramie Creek	36%	13%	4%
Town of Dayton-South Fork Wildcat Creek	16%	19%	2%
Town of Mulberry-South Fork Wildcat Creek	19%	12%	26%

6.4 HABITAT & BIOLOGY

Evaluations of stream habitat and biology were described for each subwatershed using mIBI and QHEI scores collected during the South Fork Wildcat Creek Water Quality Assessment. Subwatersheds which had more than one sampling location within their boundaries took the average score among all sampling sites (Table 35). Each subwatershed was then ranked with a ranking of "1" indicating the lowest scores. Sampling location #3 which was used to evaluate both the Swamp Creek and Shanty Creek subwatershed did not have a mIBI score. Its mIBI ranking was assumed to be "1", based off low QHEI scores, past documented impairments for biological communities, and current 303(d) listings for impaired biotic communities.

Table 35. Evaluation of Habitat & Biological Communities by Subwatershed

Subwatershed	Sampling Locations	Average QHEI	Average mIBI
Town of Dayton-South Fork Wildcat Creek	12,16	73.5	42
Jenkins Ditch-South Fork Wildcat Creek	13,14,17	64.0	39
Kilmore Creek	4,5	67.0	44
Lauramie Creek	10,11	61.5	43
Town of Mulberry-South Fork Wildcat Creek	15	73.0	46
Prairie Creek	6,7,8	52.0	38
Spring Creek	9	68.0	42
Stump Ditch-Kilmore Creek	1	54.0	34
Talbert Ditch-South Fork Wildcat Creek	2	57.0	40
Swamp Creek/Shanty Creek-Kilmore Creek	3	47.0	-

6.5 CRITICAL & PRIORITY LAND AREAS

Final subwatershed rankings are displayed in Table 37. Total scores for Nutrients, TSS, Bacteria & Pathogens, and Environmental Quality were calculated for each drainage area using the ranking formulas mentioned above and then evaluated to determine natural break points. All subwatersheds were grouped as Tier 1, Tier 2, or Tier 3 CLA's based on the above variables and ranking equations (Table

36). Tier 1 subwatersheds represent the highest priority drainage areas and where water quality practices will initially be focused. Tier 2 and 3 subwatersheds are those drainage areas which were determined to be secondary CLA's and will be addressed during the future phases of implementation funding. In regards to the Environmental Quality category, all drainage areas scoring over 30 points were designated as Priority Protection Areas.

Table 36. Critical Land Areas & Priority Protection Areas

Subwatershed	Nutrients	TSS	Bacteria & Pathogens	Environmental Quality
Swamp Creek/Shanty Creek-Kilmore Creek	28	*33*	28	18
Stump Ditch-Kilmore Creek	22	*27*	25	18
Kilmore Creek	28	22	31	38
Talbert Ditch-South Fork Wildcat Creek	23	*26*	21	25
Prairie Creek	24	19	25	10
Jenkins Ditch-South Fork Wildcat Creek	21	16	23	26
Spring Creek	*33*	*28*	24	33
Lauramie Creek	30	23	34	26
Town of Mulberry-South Fork Wildcat Creek	29	22	23	38
Town of Dayton-South Fork Wildcat Creek	*37*	22	33	30

TIER 1, Tier 2, *Tier 3*, **Priority Protection Area**

Table 37. Subwatershed Rankings for Critical Land Area Selections (1=Greater Risk to Water Quality)

Subwatershed	Historic Loading		Current Loading			Average mIBI	Average QHEI
	Nutrients	*Sediment*	*Nutrients*	*TSS*	*E. coli*		
Swamp Creek/Shanty Creek-Kilmore Creek	9	9	9	5	9	1	1
Stump Ditch-Kilmore Creek	5	6	6	4	7	1	3
Kilmore Creek	2	2	5	3	5	7	7
Talbert Ditch-South Fork Wildcat Creek	8	8	6	4	6	4	4
Prairie Creek	3	3	4	4	4	2	2
Jenkins Ditch-South Fork Wildcat Creek	1	1	3	2	3	3	6
Spring Creek	10	10	7	4	4	5	8
Lauramie Creek	4	5	8	5	8	6	5
Town of Mulberry-South Fork Wildcat Creek	7	4	1	1	1	8	9
Town of Dayton-South Fork Wildcat Creek	6	7	2	1	2	5	10

Subwatershed	Hydric Soils	Erodibility	Impervious Surfaces	Riparian Land Use	Applied Conservation	Active Livestock Operations	NPDES Permits (w/exceedances)
Swamp Creek/Shanty Creek-Kilmore Creek	1	7	10	2	4	4	3
Stump Ditch-Kilmore Creek	3	5	9	3	2	2	3
Kilmore Creek	8	1	8	8	8	2	3
Talbert Ditch-South Fork Wildcat Creek	2	6	7	1	9	3	3
Prairie Creek	5	7	1	4	1	6	2
Jenkins Ditch-South Fork Wildcat Creek	7	3	3	7	7	2	1
Spring Creek	4	4	5	5	10	6	1
Lauramie Creek	6	3	4	6	5	5	1
Town of Mulberry-South Fork Wildcat Creek	9	2	6	9	6	1	2
Town of Dayton-South Fork Wildcat Creek	10	2	2	10	3	6	3

NUTRIENTS-Tier 1 CLA's

Tier 1 CLA's for Nutrients included the Stump Ditch-Kilmore Creek, Talbert Ditch-South Fork Wildcat Creek, Prairie Creek and Jenkins Ditch-South Fork Wildcat Creek subwatershed (Figure 94). Both the Jenkins Ditch and Prairie Creek subwatersheds rank in the top four drainage areas for both current and historic modeled nutrient loading. These two drainage areas also rank as the top two subwatersheds for the number of NPDES facilities with documented exceedances. The Stump Ditch and Talbert Ditch subwatersheds contain large occurrences of hydric soils, low percentage of riparian areas with natural land cover, and rank in the top three drainage areas for the occurrence of Confined feeding operations. All of these characteristics present an elevated potential for nutrient loading from surface and subsurface drainage.

TOTAL SUSPENDED SOLIDS-Tier 1 CLA's

Tier 1 CLA's for TSS included both the Prairie Creek and Jenkins Ditch subwatersheds (Figure 95). These two drainage areas ranked in the top three during modeled historic loading for sediment yields and in the top four for current load estimates. Both drainage areas also ranked in the top three for the amount of impervious surfaces present. The Jenkins Ditch subwatershed can be characterized by a more rolling and steep terrain which attributed to it being ranked third in regards to erodible lands. Both subwatersheds ranked in the middle of the pack for the amount of well-buffered floodplains and riparian area with Prairie Creek ranking number four and Jenkins Ditch number seven.

BACTERIA & PATHOGENS-Tier 1 CLA's

Virtually the entire South Fork Wildcat Creek watershed experiences exceedances for *E. coli*. Tier 1 CLA's for Bacteria & Pathogens including Stump Ditch-Kilmore Creek, Talbert Ditch-South Fork Wildcat Creek, Jenkins Ditch-South Fork Wildcat Creek, Prairie Creek, Spring Creek, and the Town of Mulberry-South Fork Wildcat Creek (Figure 96). The Town of Mulberry drainage area ranked as the number one subwatershed for *E. coli* loads per acre. This drainage area also is ranked highest for the occurrence of Confined feeding operations and contains NPDES facilities with documented exceedances. The Jenkins Ditch, Prairie Creek, and Spring Creek subwatersheds all rank in the top four drainages areas for *E. coli* loading per acre. Jenkins Ditch and Spring Creek also rank the highest for having multiple NPDES facilities with documented exceedances. Jenkins Ditch also ranks number two for the amount of Confined feeding operations present. The Stump Ditch and Talbert Ditch subwatersheds contain large occurrences of hydric soils, low percentage of riparian areas with natural land cover, and rank in the top three drainage areas for the occurrence of Confined feeding operations. These characteristics can all lead to increased bacteria and pathogen loading through failing septic systems, runoff from livestock areas, and agricultural tile drainage.

ENVIRONMENTAL QUALITY-Tier 1 CLA's

Tier 1 CLA's for Environmental Quality include the Stump Ditch-Kilmore Creek, Shanty Creek-Kilmore Creek, Swamp Creek, and Prairie Creek subwatersheds (Figure 97). These drainage areas rank as the lowest scoring subwatersheds for both indices of biological communities as well as aquatic habitat evaluations. All of these subwatersheds also rank in the top four for lowest percentage of natural land

cover within floodplains and riparian areas and low participation in government-funded conservation programs. Prairie Creek also ranks as number one for the concentration of impervious surfaces within its boundaries.

Subwatersheds designated as PPA's included the Kilmore Creek, Spring Creek, and Town of Mulberry-South Fork Wildcat Creek drainage areas. All three of these subwatersheds rank highly in terms of well protected floodplains and riparian areas, participation in conservation programs, relatively low amounts of development and impervious surfaces. All three of these characteristics help to understand why some of the highest quality habitats and biological communities are found within these areas.

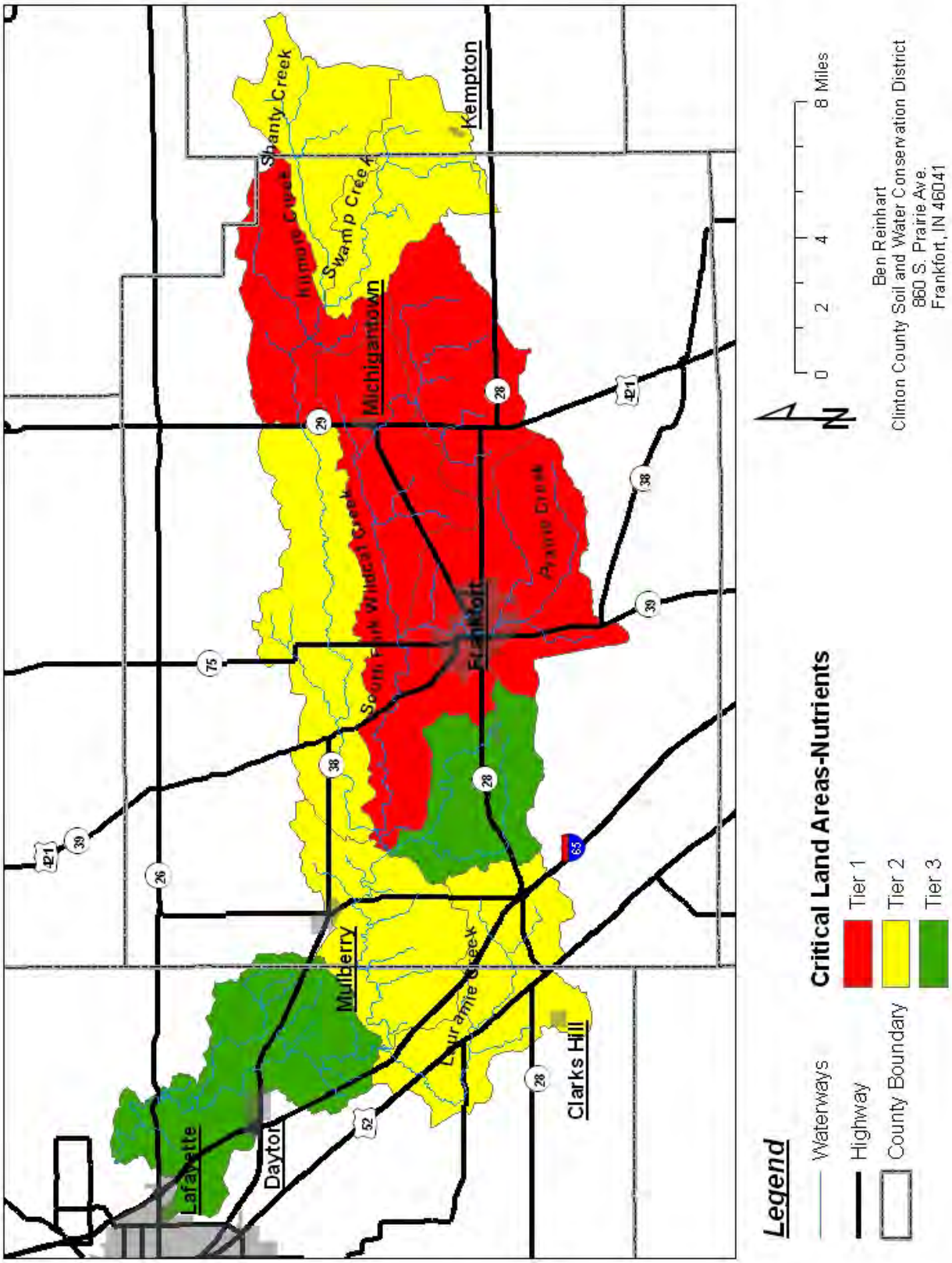

Figure 94. Tier 1 Critical Land Areas - Nutrients

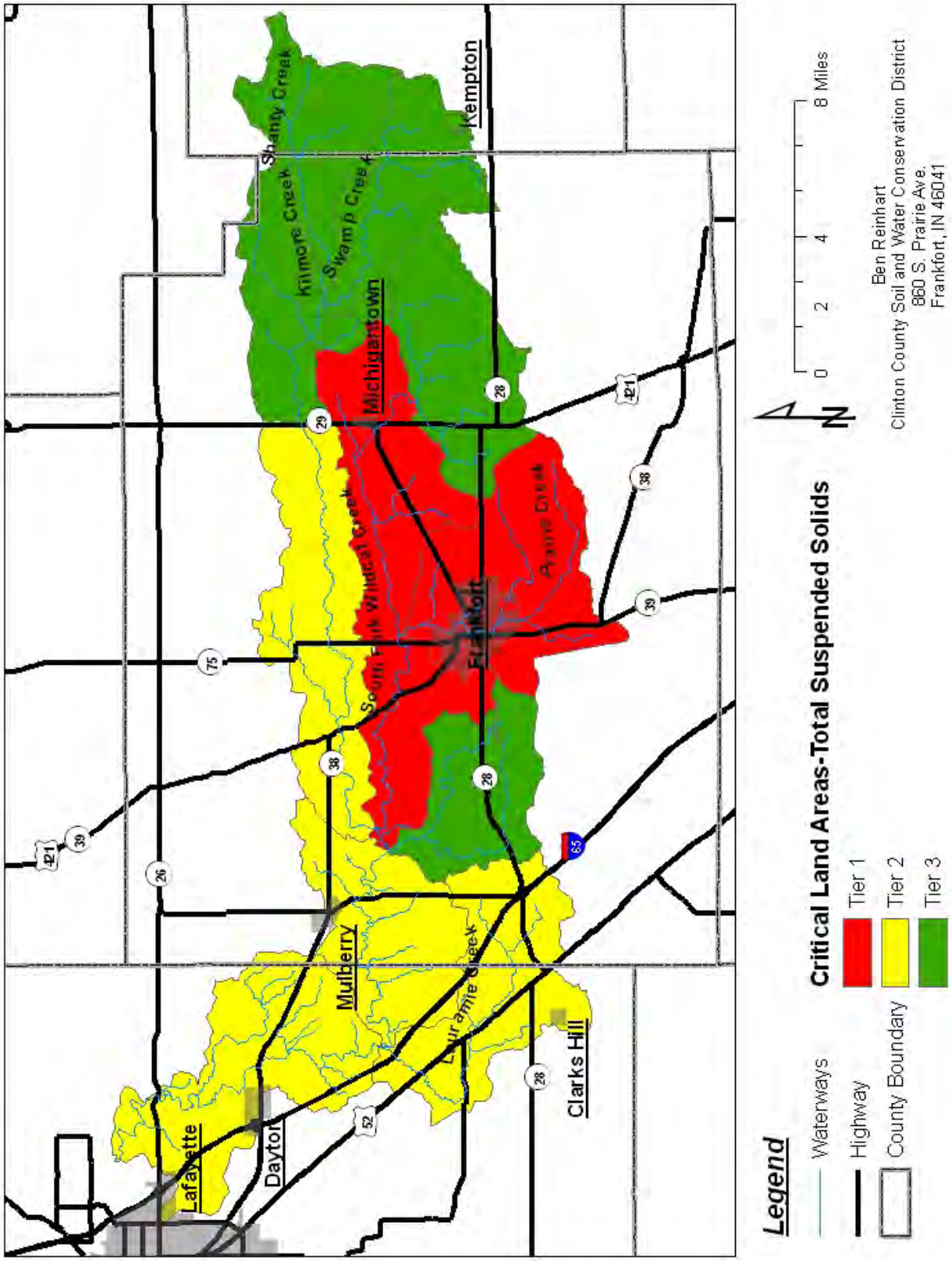

Figure 95. Tier 1 Critical Land Areas-Total Suspended Solids

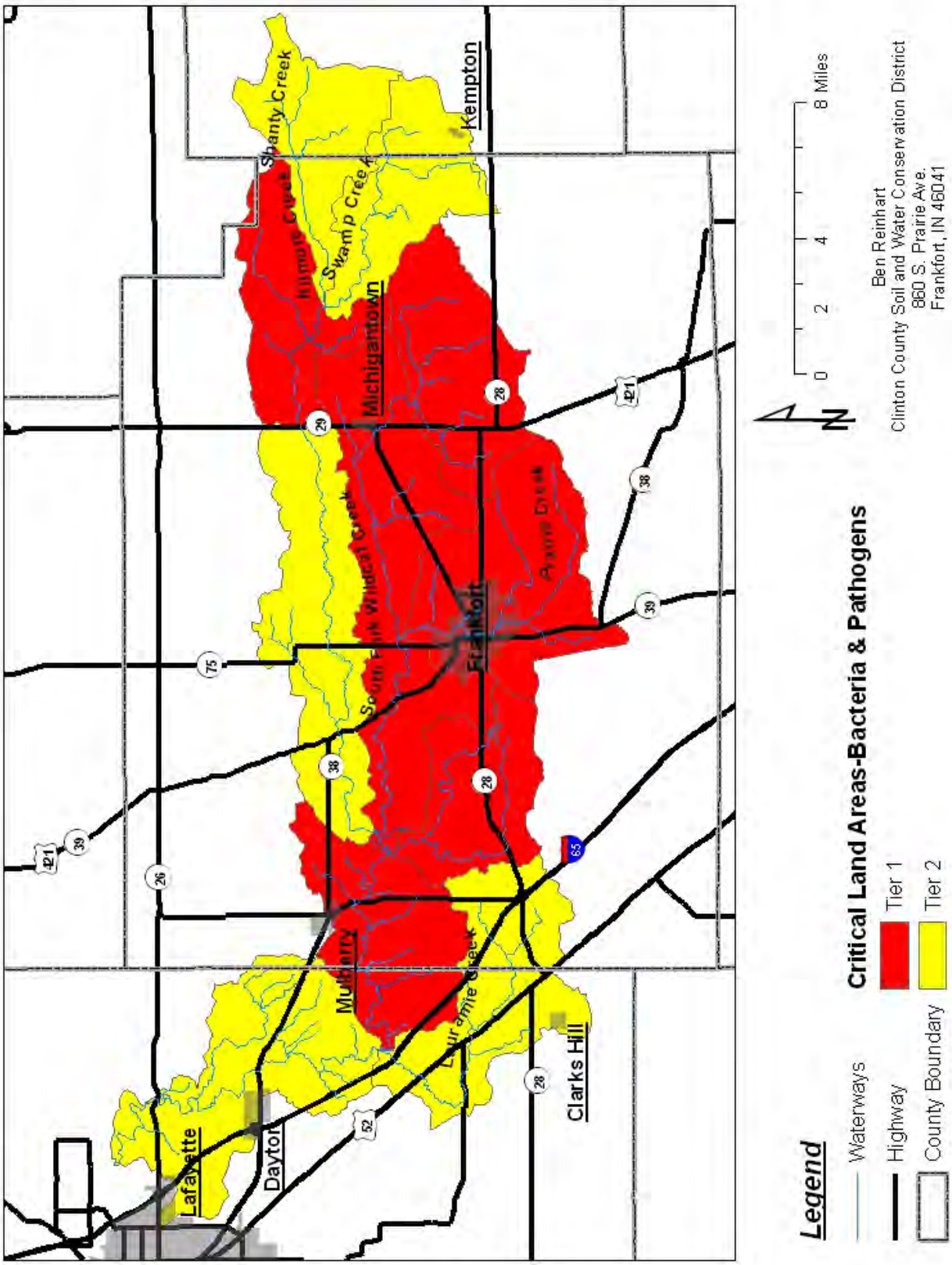

Figure 96. Tier 1 Critical Land Areas – Bacteria & Pathogens

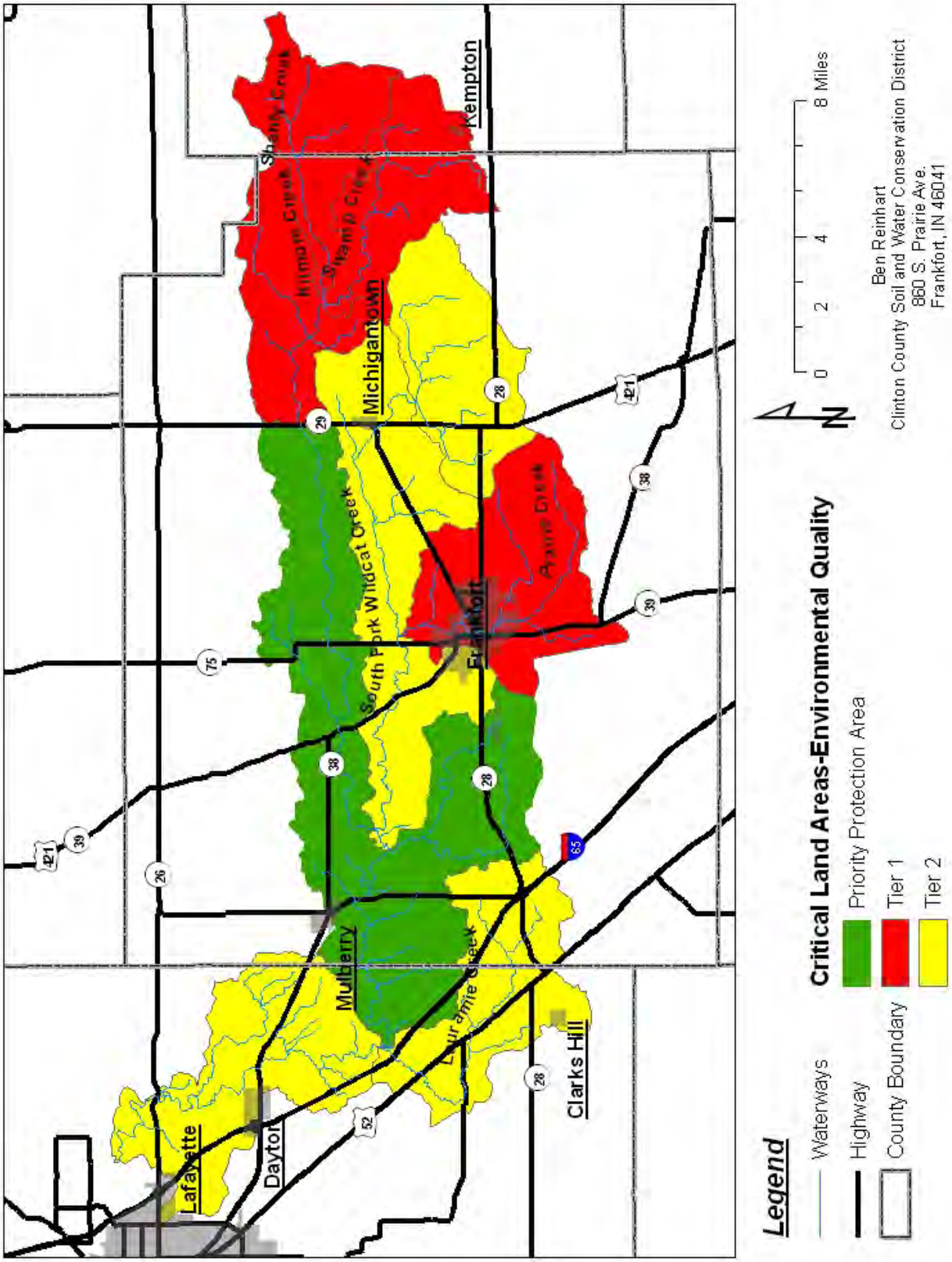

Figure 97. Tier 1 Critical Land Areas & Priority Protection Areas – Environmental Quality

7.0 WATER QUALITY GOALS AND INDICATORS

Water quality impairments were shown for nutrients, total suspended solids, and *E.coli*. To address these impairments the Steering Committee developed various goals, including indicators, used to measure progress towards each goal. Pollutant concentrations measured during our water quality assessment were averaged for both high and low flow periods of the year to obtain an overall annual average concentration for the South Fork Wildcat Creek Watershed. Goals for both nutrients (i.e. nitrogen and phosphorus) and Total Suspended Solids were established by comparing averaged annual concentrations for the watershed to median concentration values collected from IDEM fixed stations within the Eastern Corn Belt Plains ecoregion spanning from 1990-2010. These targets, if achieved, will meet the reductions called for in the South Fork Wildcat Creek TMDL. Goals for bacteria and pathogens were established by comparing average annual *E.coli* concentrations against the State of Indiana's recreational standard for surface waters of 125 CFU/100 mL.

The Spreadsheet Tool for the Estimation of Pollutant Loads (STEPL) was used to model load reductions and develop scaled goals. Model input data was downloaded for each subwatershed from the STEPL Model Input Data Server which includes data on land use, climate and runoff information, soil, livestock operations, and septic systems. Urban land use values were manually input based on the 2006 National Land Cover Dataset. This input data provided modeled pollutant loads from each respective subwatershed and land use. Load reduction efficiencies for individual Best Management Practices (BMP) were collected through a review of research literature and entered into STEPL. The Steering Committee has agreed that the most effective approach to reduce pollutant loadings result from a suite of BMP's acting together rather than any single implemented BMP. This is commonly referred to as a Resource Management System (RMS). In order to incorporate this philosophy into the STEPL model for the South Fork Wildcat Creek Watershed, related BMP's were grouped into RMS packages. Using the BMP Calculator through STEPL, these combinations of practices were modeled to calculate load reduction efficiencies for the entire applied RMS package. These RMS packages were assigned to each respective subwatershed based on land use type and management, topography, and general soil properties. For example, subwatersheds which contained a higher concentration of livestock operations were assigned an RMS package that included livestock waste management, as one may assume manure would more commonly be handled and used as a farming input in these areas. Based on the STEPL model, to achieve our overall goal statements listed below, RMS packages would need to be implemented on approximately 90% of the cropland within each subwatershed as well as the implementation of urban conservation practices within the Prairie Creek and Jenkins Ditch subwatersheds. These overall modeling results were then scaled down to reflect the amount of expected conservation practices to be implemented within a five year period (~20% of land within Tier 1 CLA's). All model input data, BMP load reduction efficiencies, and RMS prescriptions by subwatershed can be found in Appendix H.

It is important to note that certain pieces of these RMS packages are already implemented on certain land parcels throughout each subwatershed. For example, based on survey data collected during this planning effort, over 60% of agricultural producers are already implementing some form of variable rate fertilizer management and/or conservation tillage. The role of future implementation efforts should be

focused on adding to these already applied practices in order to complete a holistic RMS system on these land areas.

STEPL modeling did not cover goal statements related to bacteria and pathogens or overall environmental quality. Progress towards these goal statements will be undoubtedly linked with implemented conservation practices for nutrients and total suspended solids but lacking supporting modeling data will assume an overall target achievement date of 30 years.

NUTRIENTS – GOAL STATEMENT

Nutrients such as phosphorus and nitrogen impact our local environments and wildlife. The steering committee would like to reduce average annual total phosphorus (TP) concentrations from 0.23 mg/L to 0.12 mg/L (a 48% reduction) and average annual nitrate-nitrite concentrations from 6.11 mg/L to 2.9 mg/L (a 53% reductions).

Scaled Goal (5 Years)

Reduce average annual Total Phosphorus and Nitrate-Nitrite concentrations by 13%

Indicators

Water quality data will be used as the primary indicator to show progress towards attaining this goal. Field-collected data on orthophosphates (a subcomponent of Total Phosphorus) and nitrate-nitrite will be paired with modeling data to document changes in dissolved nutrient levels over time.

TOTAL SUSPENDED SOLIDS – GOAL STATEMENT

Total suspended solids (TSS) such as sediment, floatable debris, and organic matter has been identified as a problem throughout the South Fork Wildcat Creek Watershed. The Steering Committee would like to reduce average annual TSS concentrations from 30.3 mg/L to 19 mg/L (a 37% reduction).

Scaled Goal (5 Years)

Reduce average annual TSS concentrations by 13%

Indicators

Water quality data will be used as the primary indicator to show progress towards attaining this goal. Field-collected data on Total Suspended Solids and turbidity will be paired with modeling data to document changes in suspended solids over time.

BACTERIA & PATHOGENS – GOAL STATEMENT

Bacteria and harmful pathogens have been identified as one of the greatest water quality concerns within the South Fork Wildcat Creek Watershed. The Steering Committee would like to reduce current average annual E. coli concentrations from 407 CFU/100 mL to 125 CFU/100 mL (a 69% reduction) by 2042.

Indicators

Water quality data will be used as the primary indicator to show progress towards attaining this goal. Field-collected data on bacteria and pathogens will be paired with modeling data to document changes in pathogen levels over time.

ENVIRONMENTAL QUALITY – GOAL STATEMENT

Many locations across the South Fork Wildcat Creek Watershed have impaired biological communities and habitats. The Steering Committee would like to increase stakeholder awareness regarding the importance of restoring and protecting natural land uses within floodplain and riparian areas. All waterways which are currently listed on the 303(d) Impaired Waters List will be restored to their aquatic life use designation by 2042.

Indicators

Water quality data will be paired with social indicator data to document changes in environmental condition and overall awareness. Social indicator data will be collected during and after implementation phases to assess changes in awareness, attitudes, and behavior related to the quality of the South Fork Wildcat Creek Watershed. Analysis of social indicator data will follow the Social Indicator Planning and Evaluation System (SIPES) for Nonpoint Source Management Manual and the online Social Indicators Data Management and Analysis (SIDMA) Tool. Field-collected data using methods comparable to the ones used during this study will be evaluated to document changes in habitat or biological quality.

8.0 IMPLEMENTATION STRATEGIES

8.1 Best Management Practices for Watershed Protection and Restoration

Steering Committee members identified a generalized list of Best Management Practices which could be used within the South Fork Wildcat Creek Watershed to achieve the water quality goals described above (Table 38-41). Please note that this list is not all-inclusive and other practices may come into play in future implementation programs as there are improvements in technology and land management strategies. This list is heavily focused on practices for agricultural-based rural land which is by far the most common land use within the watershed. Some of these practices (e.g. conservation cover and buffers, conservation planning, critical area planting, streambank stabilization) can also be applied or adapted to more urban areas. However, as we move into an implementation phase it is expected that the Steering Committee will work to broaden the list of Best Management Practices to more adequately address urban and residential areas. Complete reviews of each of these identified Best Management Practices are provided in the Appendix I.

Table 38. BMP's for Nitrogen and Phosphorus Load Reductions

Tier 1 Critical Areas	Water Quality Impairment	Implementation Strategy	Estimated Cost	Practice Examples and Description (Load Reduction Efficiency, %)
Stump Ditch-Kilmore Creek	Nitrogen and/or Phosphorus	Conservation Tillage	$11-$52/ac.	No-till, Strip Till, Mulch Till (Nitrogen – 15%, Phosphorus – 30%, Sediment – 70%)
		Agricultural Waste Management	$46.50/ac. For waste application $0.31/yd^3 for waste closure $9,519/Comprehensive Nutrient Management Plan $53/ft^3 for waste transfer	Waste Utilization, Waste Transfer, Waste Closure (Nitrogen – 75%, Phosphorus – 75%)
Talbert Ditch-South Fork Wildcat Creek		Conservation Cover & Buffers	$452/ac. For seedings and plantings $4,345/ac. For installed waterways and swales	Filter Strip, Riparian Plantings, Grassed Waterways, Bioswales (Nitrogen – 54%, Phosphorus – 58%, Sediment – 58%)
		Cover Crops	$56/ac.	Planting of non-income crop for improved soil health and erosion control (Nitrogen – 43%, Phosphorus – 32%, Sediment – 15%)
Prairie Creek		Streambank Stabilization	$11.50/foot of 2-stage ditch $1.50/foot of fencing	Channel Reconstruction (2-stage ditch), Exclusion Fencing, Bank Stabilization (Nitrogen – 65%, Phosphorus – 78%, Sediment – 76%)
Jenkins Ditch-South Fork Wildcat Creek		Nutrient Management	$13.25/ac. For adaptive nutrient management $2,128/Nutrient Management Plan	Development of Nutrient Management Plan, Upgrades to precision application equipment, Applied On-Farm Research (Nitrogen – 7%, Phosphorus – 5%)
		Drainage Water Management	$24/ac. annual labor costs $1,456.75/control structure	Managing groundwater levels and tile flow on drained cropland (Nitrogen – 33%, Phosphorus – 30%)
		Denitrifying Bioreactors	$7,829/structure	Denitrifying Bioreactor (Nitrogen – 50%, Phosphorus – 80%)
		Septic System Upgrades	Highly Variable Based on System	Upgrade of septic system (Nitrogen – 50%)
		Stormwater Infiltration	$3,790/structure	Bioretention basins, rain gardens (Nitrogen – 85%, Phosphorus – 85%, Sediment – 90%)

Table 39. BMP's for TSS Load Reductions

Tier 1 Critical Area	Water Quality Impairment	Implementation Strategy	Estimated Cost	Practice Examples and Description (Load Reduction Efficiency, %)
Prairie Creek	Total Suspended Sediments	Conservation Tillage	$11-$52/ac.	No-till, Strip Till, Mulch Till (Nitrogen – 15%, Phosphorus – 30%, Sediment – 70%)
		Conservation Cover & Buffers	$452/ac. For seedings and plantings $4,345/ac. For installed waterways and swales	Filter Strip, Riparian Plantings, Grassed Waterways, Bioswales (Nitrogen – 54%, Phosphorus – 58%, Sediment – 58%)
		Cover Crops	$56/ac.	Planting of non-income crop for improved soil health and erosion control (Nitrogen – 43%, Phosphorus – 32%, Sediment – 15%)
Jenkins Ditch-South Fork Wildcat Creek		Streambank Stabilization	$11.50/foot of 2-stage ditch $1.50/foot of fencing	Channel Reconstruction (2-stage ditch), Exclusion Fencing, Bank Stabilization (Nitrogen – 65%, Phosphorus – 78%, Sediment – 76%)
		Critical Area Stabilization	$1.50/ft^2	Heavy Use Area Protection (Nitrogen – 20%, Phosphorus – 20%, Sediment – 40%)
		Pasture Management	$28/ac.	Rotational Grazing (Nitrogen – 9%, Phosphorus – 24%, Sediment – 30%)
		Conservation Planning	- (Provided as Public Service)	Development of Conservation Plan for land use management (Nitrogen – 5%, Phosphorus – 1%, Sediment – 14%)
		Water and Sediment Control Basins	$2,884/structure	WASCOBs (Nitrogen – 20%, Phosphorus – 20%, Sediment – 60%)
		Stormwater Infiltration	$3,790/structure	Bioretention basins, rain gardens (Nitrogen – 85%, Phosphorus – 85%, Sediment – 90%)

Table 40. BMP's for Bacteria Load Reductions

Tier 1 Critical Area	Water Quality Impairment	Implementation Strategy	Estimated Cost	Practice Examples and Description (Load Reduction Efficiency, %)
Stump Ditch-Kilmore Creek	Bacteria & Pathogens	Conservation Cover & Buffers	$452/ac. For seedings and plantings $4,345/ac. For installed waterways and swales	Filter Strip, Riparian Plantings, Grassed Waterways, Bioswales (Nitrogen – 54%, Phosphorus – 58%, Sediment – 58%)
		Pasture Management	$28/ac.	Rotational Grazing (Nitrogen – 9%, Phosphorus – 24%, Sediment – 30%)
Talbert Ditch-South Fork Wildcat Creek		Conservation Planning	- (Provided as Public Service)	Development of Conservation Plan for land use management (Nitrogen – 5%, Phosphorus – 1%, Sediment – 14%)
Prairie Creek		Agricultural Waste Management	$46.50/ac. For waste application $0.31/yd^3 for waste closure $9,519/Comprehensive Nutrient Management Plan $53/ft^3 for waste transfer	Waste Utilization, Waste Transfer, Waste Closure (Nitrogen – 75%, Phosphorus – 75%)
Jenkins Ditch-South Fork Wildcat Creek		Denitrifying Bioreactors	$7,829/structure	Denitrifying Bioreactor (Nitrogen – 50%, Phosphorus – 80%)
Spring Creek		Septic System Upgrades	Highly Variable Based on System	Upgrade of septic system (Nitrogen – 50%)
Town of Mulberry-South Fork Wildcat Creek				

Table 41. BMP's for Biological and Habitat Impairments

Tier 1 Critical Area	Water Quality Impairment	Implementation Strategy	Estimated Cost	Practice Examples and Description (Load Reduction Efficiency, %)
Swamp Creek	Degraded Habitat and/or Biological Community	Conservation Cover & Buffers	$452/ac. For seedings and plantings $4,345/ac. For installed waterways and swales	Filter Strip, Riparian Plantings, Grassed Waterways, Bioswales (Nitrogen – 54%, Phosphorus – 58%, Sediment – 58%)
		Conservation Planning	- (Provided as Public Service)	Development of Conservation Plan for land use management (Nitrogen – 5%, Phosphorus – 1%, Sediment – 14%)
Shanty Creek-Kilmore Creek		Streambank Stabilization	$11.50/foot of 2-stage ditch $1.50/foot of fencing	Channel Reconstruction (2-stage ditch), Exclusion Fencing, Bank Stabilization (Nitrogen – 65%, Phosphorus – 78%, Sediment – 76%)
		Conservation Tillage	$11-$52/ac.	No-till, Strip Till, Mulch Till (Nitrogen – 15%, Phosphorus – 30%, Sediment – 70%)
Stump Ditch-Kilmore Creek		Cover Crops	$56/ac.	Planting of non-income crop for improved soil health and erosion control (Nitrogen – 43%, Phosphorus – 32%, Sediment – 15%)
		Stormwater Infiltration	$3,790/structure	Bioretention basins, rain gardens (Nitrogen – 85%, Phosphorus – 85%, Sediment – 90%)
Prairie Creek		Drainage Water Management	$24/ac. annual labor costs $1,456.75/control structure	Managing groundwater levels and tile flow on drained cropland (Nitrogen – 33%, Phosphorus – 30%)
		Denitrifying Bioreactors	$7,829/structure	Denitrifying Bioreactor (Nitrogen – 50%, Phosphorus – 80%)

8.2 Outreach and Education for Watershed Protection and Restoration

As part of any implementation phase for watershed restoration education and outreach plays a critical role in initiating changes in attitudes and behavior. Steering Committee members reviewed various outreach strategies and education topics to focus on within designated critical areas. Social data which was collected through the Social Indicator Survey was used to identify current barriers to practice adoption, evaluate attitudes and values, and take into consideration current awareness. Table 42 lists the desired social outcomes, and recommended strategies to achieve those outcomes, for the South Fork Wildcat Creek Watershed Management Plan.

Table 42. Desired Social Outcomes for the South Fork Wildcat Creek Watershed Management Plan

Ag Social Outcomes	Strategies	Non-Ag Social Outcomes	Strategies
Increase knowledge of practices such as cover cropping and drainage water management	Workshop, Field Days, Community Events	**Increase knowledge of recommended water quality practices for residential and commercial land used**	Workshop, Field Days, Community Events
Increase adoption of water quality practices within critical areas	Cost-Share, Technical Assistance Programs, Workshops, Field Days	**Increase awareness and appreciation of watershed efforts**	Media outreach (Website, Social Media, Newspaper), Signage, Newsletter, Community Events
Increase capacity to fund and manage water quality practices within critical areas	Cost-Share, Technical Assistance	**Change attitudes to highlight the recreational qualities and opportunities of the South Fork Wildcat Creek**	Recreational Field Days, Media, Community Events
Change attitudes to highlight the recreational qualities and opportunities of the South Fork Wildcat Creek	Recreational Field Days, Media, Newsletter, Community Events	**Reduce financial and technical assistance constraints on landowners to implement water quality practices**	Cost-Share, Technical Assistance Programs, Workshops, Field Days
Increase awareness of consequences of poor water quality on local communities	Media Outreach (Website, Social Media, Newspaper), Newsletter, Community Events	**Increase capacity to fund and manage water quality practices within residential and commercial land uses**	Cost-Share, Technical Assistance
		Increase adoption of water quality practices within residential and commercial land uses	Cost-Share, Technical Assistance Programs, Workshops, Field Days, Community Events

8.3 Action Register and Schedule

In an effort to bring together identified strategies for both on-the-ground land use management practices as well as education and outreach priorities, the Steering Committee compiled an Action Register to help guide future efforts. This Action Register identifies strategies, estimated costs, milestones, and potential project partners for each goal of the South Fork Wildcat Creek Watershed Management Plan. Project partners will be extremely valuable during implementation efforts through leveraging of funds and technical support. The complete Action Register can be found in Appendix J.

9.0 FUTURE ACTIVITIES & PROJECT TRACKING

9.1 Tracking Effectiveness

Indicators have been identified for each goal outlined above. Water quality data will be collected using both field-collected data as well as modeling results. Temperature, dissolved oxygen, pH, conductivity, orthophosphates, nitrate-nitrite, turbidity, total suspended solids, and *E.coli* will be sampled weekly, or as funding permits, at select sampling locations (Figure 98). Orthophosphates will be sampled either using a portable colorimeter or Hoosier Riverwatch methods. Turbidity will be measured using Hoosier Riverwatch methods. Total suspended solids and *E. coli* will be analyzed at the Frankfort Wastewater Treatment Plant. Remaining parameters will be measure with a YSI handheld multiparameter meter. Streamflow data will be collected during each sampling visit using a velocity meter and channel dimensions. Habitat and biological communities will be evaluated annually at each of the sites samples during this study. All water quality data will be maintained in a database by the Clinton County SWCD. The total estimated costs for sample collection, equipment maintenance, and database management is $12,558.97.

Any implemented Best Management Practices will be mapped and modeled for their respective load reductions. We will also evaluate the potential for developing an online mapping application where community members can place a “push pin” where Best Management Practices have been completed. These “push pins” would then be field verified by the Clinton County SWCD or qualified volunteers on a quarterly basis.

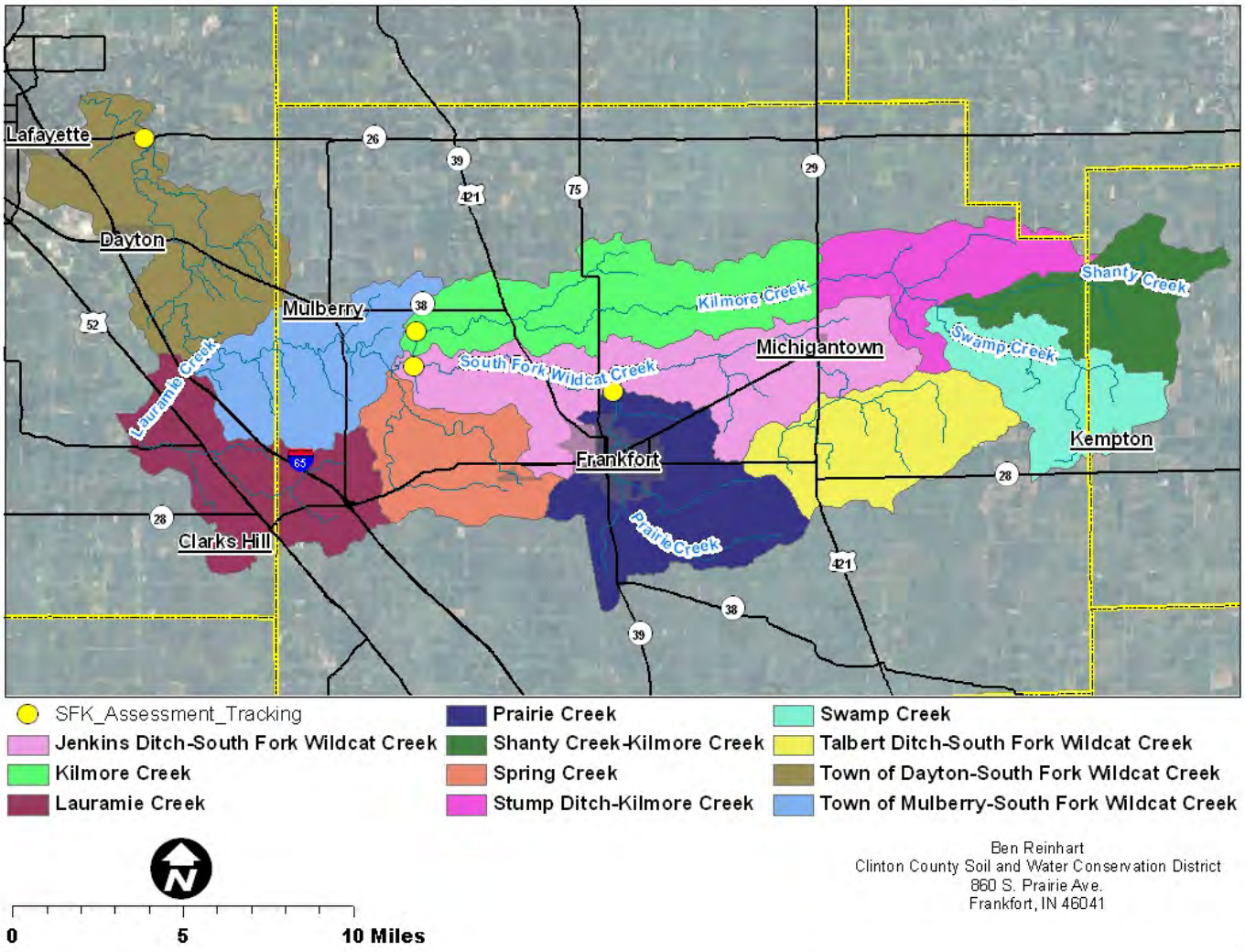

Figure 98. Locations for Long Term Tracking of Water Quality

Social data will also be used to help track progress towards our goals and objectives. All attendees of field days, workshops, or informational meetings will be given an end-of-session questionnaire to evaluate any immediate changes in knowledge and awareness. Annual follow-up questionnaires will also be distributed to get a more accurate estimate of how/if individuals apply information that they received at our events. Personal interviews will be completed with any landowners taking advantage of financial assistance programs to evaluate usefulness and effectiveness as well as to identify improvements for future programs. Website statistics (e.g. Google Analytics) will be used to collect data on our online presence such as visits to specific pages and document downloads. Annual cost estimates for social indicator tracking and evaluation, including both materials and staff time for data analysis, is $2,762.80.

9.2 Future Plans

It is anticipated that the Clinton County SWCD will remain the project leader for watershed projects which relate to the South Fork Wildcat Creek Watershed. However, strong support from groups such as the Wildcat Creek Foundation, Wildcat Guardians, USDA Natural Resources Conservation Service, and local governmental agencies will be necessary for achieving project goals and objectives.

It is expected to reevaluate, and revise if necessary, the South Fork wildcat Creek Watershed Management Plan on a five year basis. This will primarily be meant to take into consideration changes in local land use, regulations, and to document associated changes in water quality. Changes in attitudes, awareness, and behavior will also be evaluated at this time through the delivery of a social indicator survey. Addendums to address extraordinary issues may be completed outside of the five year interval if deemed appropriate by local community leaders. This plan may also be revised to allow better integration into regional planning efforts which may occur in future years.