Concerns	Supported by Data?	Evidence	Able to Quantify?	Outside Scope?	Group Wants to Focus On?
Decrease in Desirable Fish Species	Yes	There are no fish on the Federal endangered species list within the UMRW, though there are 21 species of fish listed on the Indiana and/or Ohio State Endangered Species list. There are four species of invasive fish that can be found within the four counties of the UMRW.	Yes	No	Yes
Rivers / Streams / Watershed Listed as "impaired" by Regulating State Agency	Yes	Indiana Department of Environmental Management has 35 stream segments listed as impaired in the 2012 Integrated Report and Ohio has eight sub-watershed listed as impaired in the 2012 Integrated Report.	Yes	No	Yes
Barnyard Runoff into Surface Water	Yes	All sub-watersheds that had tributaries to the Maumee River sampled for E.coli exceeded the E.coli standard. While all barnyards located within the UMRW were not examined closely, there were eight locations where barnyard runoff observed during the 2012 windshield survey.	Yes	No	Yes
Livestock Access to Open Water	Yes	All sub-watersheds that had tributaries to the Maumee River sampled for E.coli exceeded the E.coli standard. While all sites with livestock within the UMRW were not observed during the windshield survey of 2012, there were 31 sites where livestock were seen with direct access to open water. Most of the sites were located within the Bottern Ditch sub-watershed where water quality measurements exceeded the target level for nutrients, TSS, T and E.coli.	Yes	No	Yes

Sample Site	Subwatershed
173	West Fork-West Branch
175	Clear Fork-East Branch
172	Nettle Creek-Nettle Creek
133	Bear Creek-Nettle Creek
135	West Fork-West Branch
126	Clear Fork-East Fork
129	Nettle Creek-Nettle Creek
132	Bear Creek-Nettle Creek
131	Bear Creek-Nettle Creek

4.0 Pollution Sources and Loads

4.1 Potential Causes of Water Quality Problems

In this section concerns identified by stakeholders in the watershed and through the watershed inventory will be linked to problems found through the watershed investigation. Additionally, potential causes for the problems identified will be expressed. Finally, potential sources will be identified. Table 4.1 shows the connection between those concerns the stakeholders have chosen to focus efforts on, problems found in the watershed, and the potential causes of those problems. Table 4.2 takes it a step further by identifying potential sources to the problems found in the watershed.

Table 4.1: Concerns, Problems, Potential Causes

Concern(s)	Problem	Potential Cause(s)
- Lack of Water Education/Outreach - Rural legal drains - Combined Sewer Overflows - Failing straight pipe septic systems - Rivers/streams listed as "impaired" by the state regulating office - Structures in the floodplain - Recreation opportunities and safety - Barnyard runoff into surface water - Stormwater control - Livestock access to open water - Unbuffered tile inlets	High levels of E. coli were discovered in areas streams after reviewing historic and current water quality data	- E. coli levels exceed the state standard - Area producers are unaware of the water quality threat of not having adequate manure storage - There is a lack of education and outreach regarding septic management - There has been little effort to address urban issues in the watershed - There is a lack of education and outreach regarding urban stormwater issues - Area producers are unaware of the water quality threat of allowing livestock direct access to open water

Concern(s)	Problem	Potential Cause(s)
- Lack of water education/outreach - Rural legal drains - Combined sewer overflows - Failing or straight pipe septic systems - Rivers/streams listed as impaired by state regulating agency - Barnyard runoff into surface streams - Livestock access to open water - Unbuffered tile inlets - Decrease in desirable fish species - Increase in DRP - Stormwater control - Increasing Hypoxic Zone	Area streams have nutrient levels exceeding the target level set by this project Area streams have nutrient levels exceeding the target level set by this project	- Nitrogen levels exceed the target set by this project - Phosphorus levels exceed the target set by this project - There is a lack of education and outreach regarding septic maintenance - There is a lack of education and outreach regarding water quality issues - There has been little effort to address urban issues in the watershed - Area producers are unaware of the cumulative effects of best management practices
- Failing or straight pipe septic systems - Rivers/streams listed as "Impaired" by the State regulating agency - Structures in the floodplain	Historic design and lack of maintenance of septic systems is an issue in the watershed	- There is a lack of education and outreach regarding septic system maintenance
- Need for wetland protection/restoration - Rivers/streams listed as "impaired" by the State regulating agency - Unbuffered tile inlets - Soil erosion and sedimentation - Barnyard runoff into surface water - Livestock access to open water - Increasing Hypoxic Zone - Stream bank erosion - Fish and Wildlife habitat - Lack of riparian buffers - Increase in DRP - Segmented/lack of forested areas	Best management practices to limit nonpoint source pollution are underutilized in the watershed	- There is a lack of education and outreach regarding the benefits of best management practices - Area producers are unaware of the cumulative effects of best management practices
- Stream bank erosion - Lack of riparian buffers - Rural legal drains - Combined Sewer Overflows		- Turbidity and TSS levels exceed the target set by this project - There has been little effort to

Concern(s)	Problem	Potential Cause(s)
- Need for wetland protection/restoration - Structures in the floodplain - Increase in impervious surfaces - Urban contamination sites - Need for more water quality studies/planning efforts - Fish and wildlife habitat - Soil erosion and sedimentation - Unbuffered tile inlets - Storm water control - Decrease in desirable fish species - Barnyard runoff into surface water - Livestock access to open water	Area streams have turbidity levels that exceed the target set by this project Area streams have turbidity levels that exceed the target set by this project	address urban issues in the watershed - There is a lack of education and outreach regarding stormwater management - Non-functional instream structures that promote streambank erosion and log jams - Area producers are unaware of the cumulative effects of best management practices - There is a lack of education and outreach regarding water quality issues - There is a lack of education and outreach regarding septic maintenance - Area producers are unaware of the water quality threat of allowing livestock direct access to open water - There is a lack of education and outreach regarding the benefits of best management practices
- Stream Bank Erosion - Lack of Riparian Buffers - Rural Legal Drains - Combined Sewer Overflows - Increase in Impervious Surfaces - Urban Contamination Sites - Increase in DRP - Fish and Wildlife Habitat - Soil Erosion and Sedimentation - Unbuffered Tile Inlets - Failing or Straight Pipe Septic Systems - Storm Water Control - Decrease in Desirable Fish Species - Structures in the Floodplain	Sections of the Maumee River and its tributaries are listed as impaired on the OH or IN 303(d) list	- There has been little effort to address urban issues in the watershed - There is a lack of education and outreach regarding the benefits of best management practices - There is a lack of education and outreach regarding septic system maintenance - Area producers are unaware of the cumulative effects of best management practices - Area producers are unaware of the water quality threat of allowing livestock direct

Concern(s)	Problem	Potential Cause(s)
- Rivers/Streams listed as "Impaired" by State Regulating Agency - Urban Contamination Sites - Recreational Opportunities and Safety - Barnyard Runoff into Surface Streams - Livestock Access to Open Water		access to open water - Area producers are unaware of the water quality threat of not having adequate manure storage - Nitrogen, phosphorus, turbidity, TSS, and E. coli levels exceed the targets set by this project
- Stream bank erosion - Lack of riparian buffer - Segmented/Lack of forested areas - Need for wetland protection/restoration	There are ten endangered and/or threatened species on the Federal Endangered Species list	- Nitrogen, phosphorus, and DO (Marsh Ditch only) exceeded the target set by this project, thus lowering the quality of aquatic habitat - Turbidity and TSS exceed the target set by this project - Lack of riparian buffer - Land conversion / segmentation
- Storm water control - Combined Sewer Overflows - Increase in impervious surfaces - Recreational opportunities and safety - Decrease in desirable fish species - Rivers/streams listed as “impaired” by the State regulating agency	CSOs discharge untreated sewage directly into the Maumee River and its tributaries	- There has been little effort to address urban issues in the watershed - There has been little pressure put on administrators of the municipal LTCPs to address stormwater issues - There is a lack of education and outreach regarding stormwater management
- Recreational Opportunities and safety - Lack of water education / outreach - Need for more water quality studies/planning efforts - Decrease in desirable fish species	There are few water related recreational opportunities in the Maumee River Watershed to help shed light on the importance of water quality.	- There has been little advocacy to install more water recreational opportunities within the Upper Maumee Watershed - There are few studies focusing on water related opportunities in the watershed

4.2 Potential Sources Resulting in a Water Quality Problem

Now that stakeholder concerns have been linked to water quality problems and potential causes of those problems, and a thorough watershed inventory has been conducted, sources to the problems can be outlined. Outlining the sources to the problems found in the watershed will help to narrow the land area of where to focus efforts which will have the greatest impact on improving water quality.

Table 4.2: Problems, Causes, and Sources

Problem	Potential Cause(s)	Potential Source(s)
High levels of *E. coli* were discovered in area streams after reviewing historic and current water quality data.	E. coli levels exceed the state standard Areas producers are unaware of the water quality threat of not having adequate manure storage There is a lack of education and outreach regarding septic management There has been little effort to address urban issues in the watershed There is a lack of education and outreach regarding urban stormwater issues Area producers are unaware of the water quality threat of allowing livestock direct access to open water	Fort Wayne has 43 CSOs that discharge to the Maumee River and its tributaries, with 15 of those discharging directly into the UMRW (Bullerman Ditch sub-watershed New Haven has one CSO that discharges to the Maumee River and Hicksville has five CSOs that discharge to a tributary of the Maumee River (Bullerman Ditch and Gordon Creek sub-watersheds) Improperly placed and/or faulty septic systems scattered throughout the project area Livestock with direct access to open water, 31 sites were identified during the windshield survey Bottern Ditch, Black Creek, Marie DeLarme, Gordon Creek, Platter Creek, and Snooks Run sub-watersheds) 13 CFOs (Platter Creek, Zuber Cutoff, Sixmile Creek, Marsh Ditch, and Black Creek sub-watersheds) Barnyard or Pasture runoff problems were identified at 20 locations during the windshield survey (Bottern Ditch, Black Creek, Zuber Cutoff, Platter Creek, Marie DeLarme, North Chaney Ditch, Gordon Creek, Sulphur Creek, Trier Ditch sub-watersheds) Pet waste in urban areas including Fort Wayne, New Haven, Woodburn, Antwerp, Hicksville, Cecil, Sherwood and Defiance According to the Allen County Health Department approximately 9000 septic systems are currently at risk of failing within the County, and a study conducted in Ohio

Problem	Potential Cause(s)	Potential Source(s)
High levels of *E. coli* were discovered in area streams after reviewing historic and current water quality data.		estimates that 25% - 30% of systems within Ohio are currently are failing There are eight waste water treatment plants located in the watershed that discharge to waters of the state
Area streams have nutrient levels that exceed the target level set by this project	- Nitrogen levels exceed the target set by this project - Phosphorus levels exceed the target set by this project - There is a lack of education and outreach regarding septic maintenance - There is a lack of education and outreach regarding water quality issues - There has been little effort to address urban issues in the watershed - Area producers are unaware of the cumulative effects of best management practices	- Lack of proper management measures on agriculture land on PHEL and HEL in the watershed (8.9% and <1%, respectively) - According to the Allen County Health Department approximately 9000 septic systems are currently at risk of failing within the County, and a study conducted in Ohio estimates that 25% - 30% of systems within Ohio are currently are failing - 49 CSOs that discharge to the Maumee River or its tributaries (Bullerman Ditch and Gordon Creek) - 13 CFOs (Platter Creek, Zuber Cutoff, Sixmile Creek, Marsh Ditch, and Black Creek) - Barnyard or Pasture runoff problems were identified at 20 locations during the windshield survey (Bottern Ditch, Black Creek, Zuber Cutoff, Platter Creek, Marie DeLarme, North Chaney Ditch, Gordon Creek, and Sulphur Creek) - 73% of the watershed is in cultivated crops which often are fertilized to promote plant growth. Unsustainable farming techniques increase fertilizer runoff - 14% of the watershed is developed. Over fertilizations of turf grass leads to excess fertilizer runoff

Problem	Potential Cause(s)	Potential Source(s)
Historic design and lack of maintenance of septic systems is an issue in the watershed.	- There is a lack of education and outreach regarding septic system maintenance	- Over 96% of the soil in the watershed is considered "very limited" and 1% of the soil in the watershed is considered "somewhat limited" for the placement septic systems - There is a lack of education and outreach regarding septic system placement and maintenance throughout the watershed - According to the Allen County Health Department approximately 9,000 septic systems are currently at risk of failing within the County, and a study conducted in Ohio estimates that 25% - 30% of systems within Ohio are currently are failing
Best Management Practices to limit nonpoint source pollution are underutilized in the watershed	- There is a lack of education and outreach regarding the benefits of best management practices - Area producers are unaware of the cumulative effects of best management practices	- There is a lack of education and outreach regarding the benefits of agricultural BMPs - Federal and local funding for the implementation of agricultural BMPs and management measures has been cut significantly over the past five years
Area streams have turbidity levels that exceed the target level set by this project	- Turbidity and TSS levels exceed the target set by this project - There has been little effort to address urban issues in the watershed - There is a lack of education and outreach regarding stormwater management - Non-functional instream structures that promote streambank erosion and log jams - Area producers are unaware of the cumulative effects of best management practices - There is a lack of education and outreach regarding water quality issues	- 49 CSOs that discharge to the Maumee River or its tributaries (Bullerman Ditch and Gordon Creek and St. Joseph and St. Marys Watersheds) - Improperly placed and/or faulty septic systems placed throughout the project area (estimates over 9,000 systems) - Livestock with direct access to open water; 31 sites were identified during the windshield survey (Bottern Ditch, Black Creek, Marie DeLarme, Gordon Creek, Platter Creek, and Snooks Run) - Barnyard or Pasture runoff problems were identified at 20 locations during the windshield survey (Bottern Ditch, Black Creek, Zuber Cutoff, Platter Creek, Marie DeLarme, North Chaney Ditch, Gordon Creek, Sulphur Creek, Trier Ditch sub-watersheds)

Problem	Potential Cause(s)	Potential Source(s)
Area streams have turbidity levels that exceed the target level set by this project	- There is a lack of education and outreach regarding septic maintenance - Area producers are unaware of the water quality threat of allowing livestock direct access to open water - There is a lack of education and outreach regarding the benefits of best management practices	- 13 Confined Feeding Operations (Platter Creek, Zuber Cutoff, Sixmile Creek, Marsh Ditch, Black Creek) - Lack of proper management measures on agricultural land on PHEL and HEL in the watershed (8.9% and <1%, respectively) - 40% of corn and 20% of beans are conventionally tilled - The windshield survey revealed 88,436 feet of streambank erosion - The windshield survey revealed over 2,400 feet of gully erosion in agriculture fields - 57% of parcels adjacent to open water have less than a 10 foot buffer and 70% of parcels adjacent to open water have less than a 60 foot buffer - There are eight WWTPs located in the watershed that discharge to waters of the state
Sections of the Maumee River and its tributaries are listed on the IN or OH 303(d) list	- There has been little effort to address urban issues in the watershed - There is a lack of education and outreach regarding the benefits of best management practices - There is a lack of education and outreach regarding septic system maintenance - Area producers are unaware of the cumulative effects of best management practices - Area producers are unaware of the water quality threat of allowing livestock direct access to open water - Area producers are unaware of the water quality threat of not having adequate manure storage - Nitrogen, phosphorus, turbidity, TSS,	- 49 CSOs that discharge to the Maumee River or its tributaries (Bullerman Ditch and Gordon Creek and St. Joseph and St. Marys Watersheds) - Improperly placed and/or faulty septic systems placed throughout the project area (estimates over 9,000 systems) - Livestock with direct access to open water; 31 sites were identified during the windshield survey (Bottern Ditch, Black Creek, Marie DeLarme, Gordon Creek, Platter Creek, and Snooks Run) - Barnyard or Pasture runoff problems were identified at 20 locations during the windshield survey (Bottern Ditch, Black Creek, Zuber Cutoff, Platter Creek, Marie DeLarme, North Chaney Ditch, Gordon Creek, Sulphur Creek, Trier Ditch sub-watersheds) - 13 Confined Feeding Operations (Platter Creek, Zuber Cutoff, Sixmile Creek, Marsh Ditch, Black Creek) - Lack of proper management measures on agricultural

Problem	Potential Cause(s)	Potential Source(s)
Sections of the Maumee River and its tributaries are listed on the IN or OH 303(d) list	and E. coli levels exceed the targets set by this project	land on PHEL and HEL in the watershed (8.9% and <1%, respectively) - 40% of corn and 20% of beans are conventionally tilled - 57% of parcels adjacent to open water have less than a 10 foot buffer and 70% of parcels adjacent to open water have less than a 60 foot buffer - The windshield survey revealed 88,436 feet of streambank erosion - The windshield survey revealed over 2,400 feet of gully erosion in agriculture fields - There are 18 NPDES permitted facilities that discharge into the Maumee River or its tributaries (Trier Ditch – 1, Bullerman Ditch – 2, Bottern Ditch – 2, Marsh Ditch – 2, North Chaney Ditch – 1, Zuber Cutoff – 3, Gordon Creek – 2, Sixmile Cutoff – 3, Platter Creek – 1, Sulphur Creek -1) - There are 148 LUSTs located within the UMRW with 50 of those tanks still actively leaking (Sub-watersheds - Trier Ditch-7, Bullerman Ditch - 31, Sixmile Creek - 1, Bottern Ditch - 3, Black Creek - 3, Marsh Ditch - 1, Gordon Creek - 2, Sixmile Cutoff - 2) - There are eight waste water treatment plants located in the watershed that discharge to waters of the state - (Marsh Ditch, Sixmile Cutoff, Gordon Creek, Bullerman - Ditch, Sulphur Creek, North Chaney Ditch)
There are ten (10) endangered and/or threatened species on the Federal Endangered Species list	- Nitrogen, phosphorus, and DO (Marsh Ditch only) exceeded the target set by this project, thus lowering the quality of aquatic habitat - Turbidity and TSS exceed the target set by this project - Lack of riparian buffer - Land conversion / segmentation	- The UMRW has lost a significant amount of wetlands and currently less than 1.5% of the watershed is considered to be wetland - Same sources as listed above contributing to high turbidity levels in the water which can suffocate aquatic life and smother aquatic habitat - Less than 5% of the watershed is considered to be forested

Problem	Potential Cause(s)	Potential Source(s)
CSO's discharge untreated sewage directly into the Maumee River and its tributaries	- There has been little effort to address urban issues in the watershed - There has been little pressure put on administrators of the municipal LTCPs to address stormwater issues - There is a lack of education and outreach regarding stormwater management	- 49 CSOs that discharge to the Maumee River or its tributaries (Bullerman Ditch and Gordon Creek and St. Joseph and St. Marys Watersheds) - There is a lack of education and outreach regarding stormwater management and impacts o water quality from CSO discharges
There are few water related recreational opportunities in the Maumee River Watershed to help shed light on the importance of water quality	- There has been little advocacy to install more water recreational opportunities within the Upper Maumee Watershed - There are few studies focusing on water related opportunities in the watershed	- There has been little advocacy to install more water recreational opportunities within the Upper Maumee River Watershed - There are few studies focusing on water related recreational opportunities in the watershed

4.3 Pollution Loads and Necessary Load Reductions

Water quality samples were taken from eight sub-watersheds within the project area in 2012 by the Allen County SWCD. However, the SWCD did not have the resources to collect water quality samples from all sub-watersheds. For that reason, this project worked with Purdue University to use their newly calibrated Soil and Water Assessment Tool (SWAT) model to determine current loads for each HUC 12 located within the UMRW. Using the SWAT model for all sub-watersheds will allow the accuracy of the data to be consistent throughout the watershed. Current pollution loads were determined for the fourteen Upper Maumee River sub-watersheds using the SWAT model, and when compared to the water quality targets set by the UMRW steering committee and outlined in Section 3, the model provides detail on how much pollution loads will need to be reduced to meet the targets set by this project.

Current pollution loads and load reductions were analyzed for nitrogen, total phosphorus, and sediment only, as *E.coli* loads cannot be accurately determined, and loads determined for the other parameters measured as part of this project would not be useful to this project. However, it is important to note that *E. coli* is a major concern of the UMRW steering committee and *E.coli* totals will be presented here as well. Table 4.3 is a reminder of the target concentrations for each of the parameters of concern that were set by this project's steering committee. Tables 4.4 through 4.7 show the current and target loads and load reductions needed for nitrogen, total phosphorus, and sediment. As can be seen in the following tables, load reductions were necessary in all sub-watersheds for total phosphorus and sediment and in seven of the sub-watersheds for nitrogen.

Table 4.3: Target Concentrations for Parameters of Concern

Parameter of Concern	Target Concentration
Nitrate+Nitrite	<1.6 mg/l
Total Phosphorus	<0.08 mg/l
Dissolved Reactive Phosphorus	< 0.05 mg/l
E. coli	<235 CFU/100 ml
Total Dissolved Solids	< 750 mg/l
Total Suspended Solids	< 25 mg/l
Turbidity	< 10 NTU

Table 4.4: Nitrogen Pollution Load Reductions to Meet Target Loads

Sub-watershed			Nitrate+Nitrite N (tons/year)		
Code	Name	Mean Flow (ft^3/sec)	Current	Target	Reduction Needed
41000050101	Trier Ditch	40.44	40.52	63.70	-
41000050102	Bullerman Ditch	51.65	35.21	81.35	-
41000050103	Sixmile Creek	33.91	41.86	53.41	-
41000050104	Black Creek	25.18	29.66	39.65	-
41000050105	Bottern Ditch	48.43	52.68	76.27	-
41000050106	Marsh Ditch	23.65	50.31	37.24	13.06
41000050201	Zuber Cutoff	50.12	124.47	78.93	45.54
41000050202	North Chaney Ditch	22.68	40.10	35.73	4.38
41000050203	Marie DeLarme Creek	69.75	113.67	109.85	3.81
41000050204	Gordon Creek	63.66	90.91	100.27	-
41000050205	Sixmile Cutoff	24.36	46.99	38.36	8.63
41000050206	Platter Creek	31.51	58.50	49.63	8.87
41000050207	Sulphur Creek	26.80	48.66	42.21	6.45
41000050208	Snooks Run	39.73	60.76	62.58	-
		Total	**834.30**	**869.17**	**90.74**

Table 4.5: Total Phosphorus Load Reductions to Meet Target Loads

Sub-watershed			TP (tons/year)		
Code	Name	Mean Flow (ft^3/sec)	Current	Target	Reduction Needed
41000050101	Trier Ditch	40.44	31.89	3.18	28.71
41000050102	Bullerman Ditch	51.65	12.01	4.07	7.94
41000050103	Sixmile Creek	33.91	14.76	2.67	12.09
41000050104	Black Creek	25.18	15.67	1.98	13.68
41000050105	Bottern Ditch	48.43	14.52	3.81	10.71
41000050106	Marsh Ditch	23.65	10.24	1.86	8.37
41000050201	Zuber Cutoff	50.12	32.04	3.95	28.10
41000050202	North Chaney Ditch	22.68	6.44	1.79	4.66
41000050203	Marie DeLarme Creek	69.75	37.21	5.49	31.71
41000050204	Gordon Creek	63.66	44.23	5.01	39.22
41000050205	Sixmile Cutoff	24.36	16.92	1.92	15.00
41000050206	Platter Creek	31.51	25.94	2.48	23.46
41000050207	Sulphur Creek	26.80	29.61	2.11	27.50
41000050208	Snooks Run	39.73	27.54	3.13	24.41
		Total	**319.01**	**43.46**	**275.55**

Table 4.6: Sediment Load Reductions to Meet Target Loads

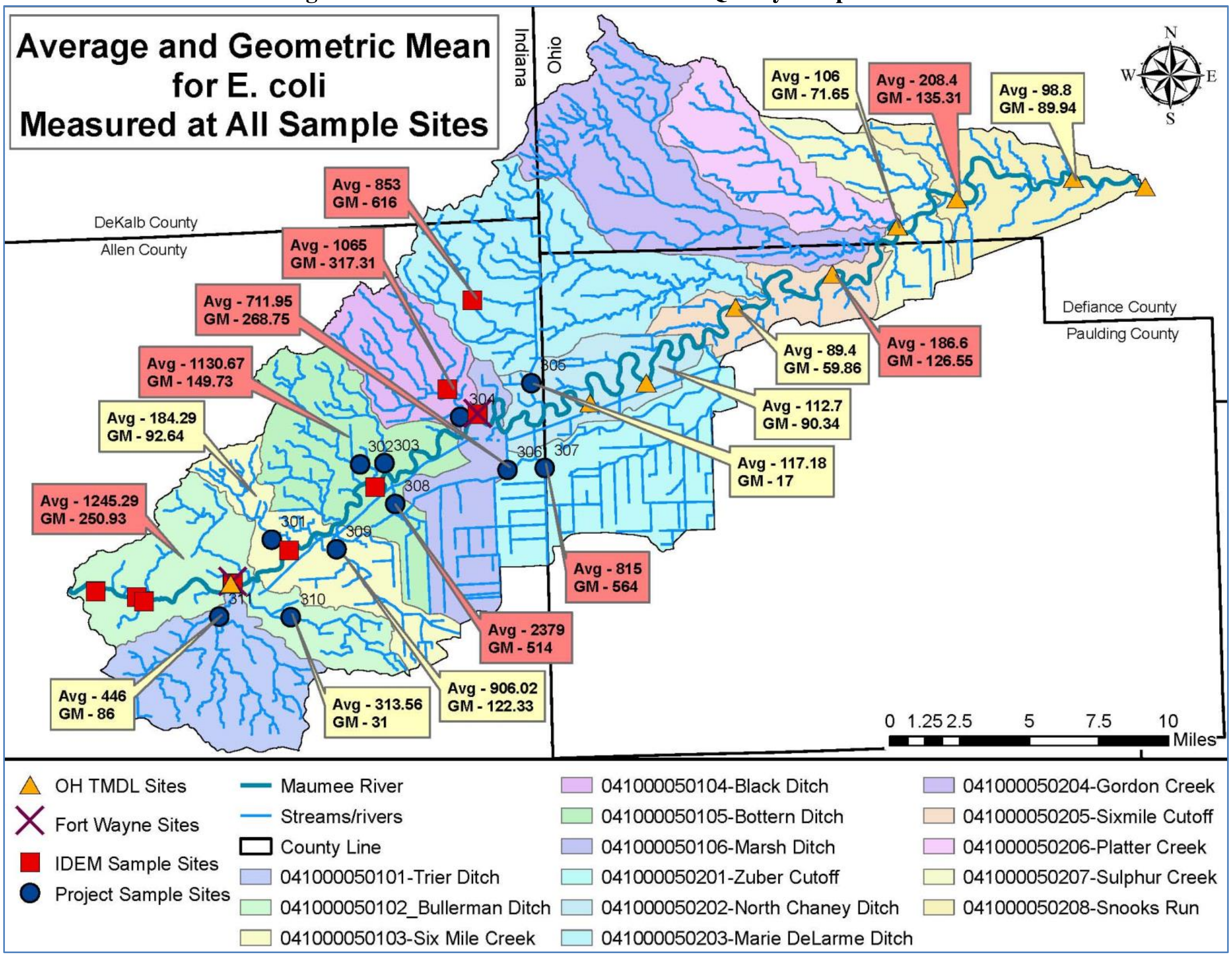
Sub-watershed			Sediment (tons/year)		
Code	Name	Mean Flow (ft^3/sec)	Current	Target	Reduction Needed
41000050101	Trier Ditch	40.44	27358.15	995.26	26362.89
41000050102	Bullerman Ditch	51.65	6905.37	1271.06	5634.31
41000050103	Sixmile Creek	33.91	7332.15	834.50	6497.64
41000050104	Black Creek	25.18	8675.44	619.54	8055.90
41000050105	Bottern Ditch	48.43	6632.02	1191.72	5440.30
41000050106	Marsh Ditch	23.65	4298.34	581.94	3716.40
41000050201	Zuber Cutoff	50.12	12625.18	1233.33	11391.86
41000050202	North Chaney Ditch	22.68	1695.48	558.21	1137.27
41000050203	Marie DeLarme Creek	69.75	21160.31	1716.42	19443.89
41000050204	Gordon Creek	63.66	21469.49	1566.71	19902.77
41000050205	Sixmile Cutoff	24.36	10560.55	599.37	9961.18
41000050206	Platter Creek	31.51	10846.79	775.48	10071.31
41000050207	Sulphur Creek	26.80	33804.57	659.48	33145.09
41000050208	Snooks Run	39.73	19160.92	977.76	18183.16
		Total	**192524.76**	**13580.79**	**178943.97**

Table 4.7: Dissolved Reactive Phosphorus Reductions to Meet Target Loads

HUC12		Mean Flow (ft^3/sec)	Dissolved Reactive Phosphorus (Tons/yr)		
Code	Name		Current Load	Target Load	Reduction Needed
41000050101	Trier Ditch	40.44	11.94	1.99	9.95
41000050102	Bullerman Ditch	51.65	4.07	2.54	1.53
41000050103	Sixmile Creek	33.91	9.45	1.67	7.78
41000050104	Black Creek	25.18	12.19	1.24	10.95
41000050105	Bottern Ditch	48.43	4.18	2.38	1.80
41000050106	Marsh Ditch	23.65	3.24	1.16	2.08
41000050201	Zuber Cutoff	50.12	3.92	2.47	1.46
41000050202	North Chaney Ditch	22.68	3.31	1.12	2.19
41000050203	Marie DeLarme Creek	69.75	5.03	3.43	1.60
41000050204	Gordon Creek	63.66	4.65	3.13	1.52
41000050205	Sixmile Cutoff	24.36	3.83	1.20	2.64
41000050206	Platter Creek	31.51	8.81	1.55	7.26
41000050207	Sulphur Creek	26.80	4.44	1.32	3.12
41000050208	Snooks Run	39.73	5.11	1.96	3.16
		Total	**84.18**	**27.16**	**57.02**

Even though load reductions cannot be determined for *E. coli* it is important to understand the magnitude of the problem it poses to the health of the watershed. Therefore, Figure 4.1 shows the average CFU of *E. coli* at each of the drainage areas associated with a current or historic sample site located within the UMRW. The geometric mean for *E. coli* is also shown for each drainage area as the geometric mean provides a clearer look at the typical condition of the area by taking out the samples of extreme outliers. However, the average *E. coli* CFU provides information as to whether or not *E. coli* can be an issue in the area. Those cells highlighted in pink in Figure 4.1 are those with geometric mean that exceeds the target level set by this project.

Figure 4.1: E. coli Levels of the Drainage Area to Historic and Current Water Quality Sample Sites



5.0 Critical Areas

5.1 Critical Areas to Focus Implementation Efforts

Critical areas are defined by IDEM as areas that have been identified through historical studies, land use information, and water quality data, in the project area as needing implementation efforts to improve current water quality or mitigate the impact of potential sources of NPS to protect water quality. Identifying critical areas and goals to address those critical areas will focus efforts in the watershed on the areas that will have the greatest impact on improving water quality in the UMRW. This Section will identify the critical areas located within the UMRW project area and outline the goals necessary to address those critical areas. Please note that if there are several areas that are considered critical for a particular practice or parameter, a “priority” ranking has been assigned to those areas so that implementation efforts will be focused on the areas that will have the biggest impact on water quality first. Once all possible implementation efforts have been exhausted in Priority Area 1, efforts will be focused on Priority Area 2, and so on.

5.1.1 Stream Buffer Width at Headwater Streams and Bank Erosion Critical Areas

The UMRW Steering Committee expressed concern regarding streambank erosion and the lack of riparian buffers throughout the project area. It should be noted here that the lack of riparian buffer can lead to increased erosion of streambanks.

The windshield and computer based survey of stream buffers revealed that many of the streams in the watershed lack an adequate buffer to filter runoff before it enters the stream or supply suitable habitat for wildlife. Over 71% of the parcels adjacent to open water in the UMRW have a stream buffer of less than 60 feet in width and 57% of parcels adjacent to open water have a stream buffer of less than 10 feet in width.

Stream buffers are important to water quality as vegetated buffers help to slow the velocity of storm flow which allows time for sediment, much of which carries other pollutants attached to the soil particles, to settle out before entering the stream, as well as helps keep soil in place to prevent stream bank erosion. With the majority of streams in the watershed having inadequate buffers, the steering committee has decided to make stream buffer installation a priority of the project.

Previous studies indicate that the majority of the pollution found in water comes from headwater streams. For that reason, the steering committee has decided to make all stream buffers less than 60 feet in width at headwater streams critical for the installation of riparian buffer strips. The steering committee has also decided to follow the NRCS recommended widths for an adequate riparian buffer. The NRCS recommends that land with a slope of 0 – 2% have a minimum of a 20 foot buffer, land with a slope of 2 – 4% have a minimum of a 40 foot buffer, and land with a slope greater than 4% have a minimum buffer of 60 feet. Slope in relation to stream buffers has not been inventoried at this time and will be assessed on a case by case basis at the time of implementation, at which time priority will be given to those areas where the most significant runoff and erosion potential exists.

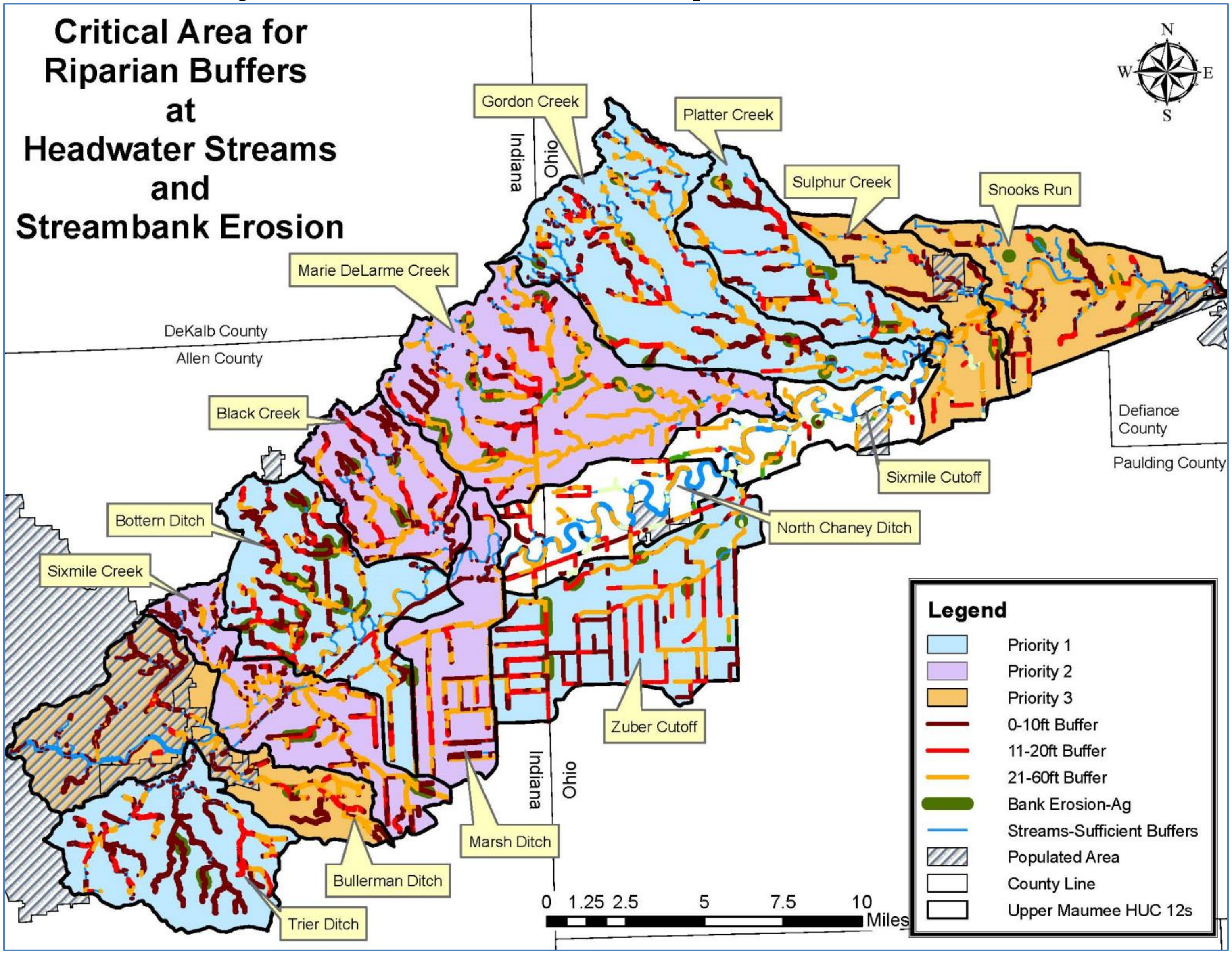
The windshield survey conducted in 2012 in the UMRW revealed more than 72,846 linear feet of stream bank erosion along streams within the agricultural landscape in the UMRW. This streambank erosion may be due to a lack of adequate riparian buffer to slow the velocity and erosive power of stormwater, producers farming up to the streambank, the lack of adoption of conservation tillage practices, or other conventional farming techniques. Management measures will need to be taken to address the areas identified during the windshield survey, and any future bank erosion sites to prevent further erosion and sedimentation of the stream.

Figure 5.1 is a map showing the location of the land parcels with a riparian buffer of less than 60 feet, as well as the location of streambank erosion that was observed during the windshield survey. As can be seen in the map, streambank erosion was observed at, or directly downstream of where the riparian buffer is less than 60 feet, and more often found at or downstream of a buffer of less than 20 feet. Based on the information depicted in the map, and necessary load reductions in the HUC 12s, the installation of riparian buffers at headwater streams and streambank erosion remediation will be prioritized per sub-watershed, as outlined in Table 5.1. It should be noted that based on how the buffer inventory was conducted, by an outside source, there is no way to determine the actual stream miles that need a riparian buffer at this time. However, the map below provides a picture of where to start the implementation process in regards to riparian buffers.

Table 5.1: Critical Area for Stream Buffer at Headwaters and Streambank Erosion

Priority	Sub-watershed
Priority 1	Trier Ditch, Zuber Cutoff, Gordon Creek, Platter Creek, Bottern Ditch
Priority 2	Black Creek, Sixmile Creek, Marie DeLarme Creek, Marsh Ditch
Priority 3	Bullerman Dtich, Sulphur Creek, Snooks Run

Figure 5.1: Critical Areas for Agriculture Based Streambank Erosion and Riparian Buffer Width



5.1.2 Urban Pollutant Sources Based Critical Areas

The UMRW Steering Committee voiced several concerns regarding urban land use issues that affect water quality, and urban pollutants including, combined sewer overflows, an increase in imperviousness, urban contamination sites such as industries and commercial areas, structures located within the flood plain and general stormwater management.

Urban pollutants can be much different than those found throughout the agricultural community. For example, fertilizer from urban lawns, golf courses, parks and cemeteries often contains nutrients that are in excess of what the grass typically requires and are more likely to runoff during wet weather events than fertilizers used in agriculture. It is also common to have runoff of heavy metals, oil, gas and other substances from automobiles, and sediment and salts from road de-icing operations. Pet waste left on lawns can make its way into the sewer system or open water and increase *E. coli* and nutrient levels. Wildlife and bird waste, is often a problem in urban retention ponds. Finally, excess stormwater, due to the increase in imperviousness within urban areas, can become a pollutant itself by causing surface and stream bank erosion.

A significant issue in the UMRW is the presence of 21 CSOs located within the watershed, as well as an additional 28 CSOs located upstream of the Maumee River in the St. Joseph and St. Marys Rivers. The increase in impervious surfaces in urban areas, specifically within Fort Wayne, has increased the number of CSO events each year. Fort Wayne's Long Term Control Plan includes plans to construct an underground storage tunnel to convey combined sewers to the waste water treatment plant prior to being discharged back into the river, thus limiting the number of CSO events to four annually (construction to begin in 2017). While this is a significant decrease in the amount of untreated combined sewage entering the river, raw sewage and other urban pollutants will still be discharged directly into the river and effect water quality, aquatic life, and recreational opportunities in the rivers. The cities of New Haven and Hicksville also have an approved LTCP, though they lack the funding and resources of the larger city of Fort Wayne and are not able to control the excess stormwater issue to the same degree. Therefore, additional stormwater management measures will need to be implemented at the individual homeowner level, as well as at commercial sites and new developments that go above and beyond any state mandated stormwater management measures. Fort Wayne's LTCP also includes plans to separate some of the combined sewers so that raw sewage from those areas will never enter the river. However, that also means that stormwater still will not be treated prior to being discharged into the river which indicates an increase in urban polluted runoff entering open water.

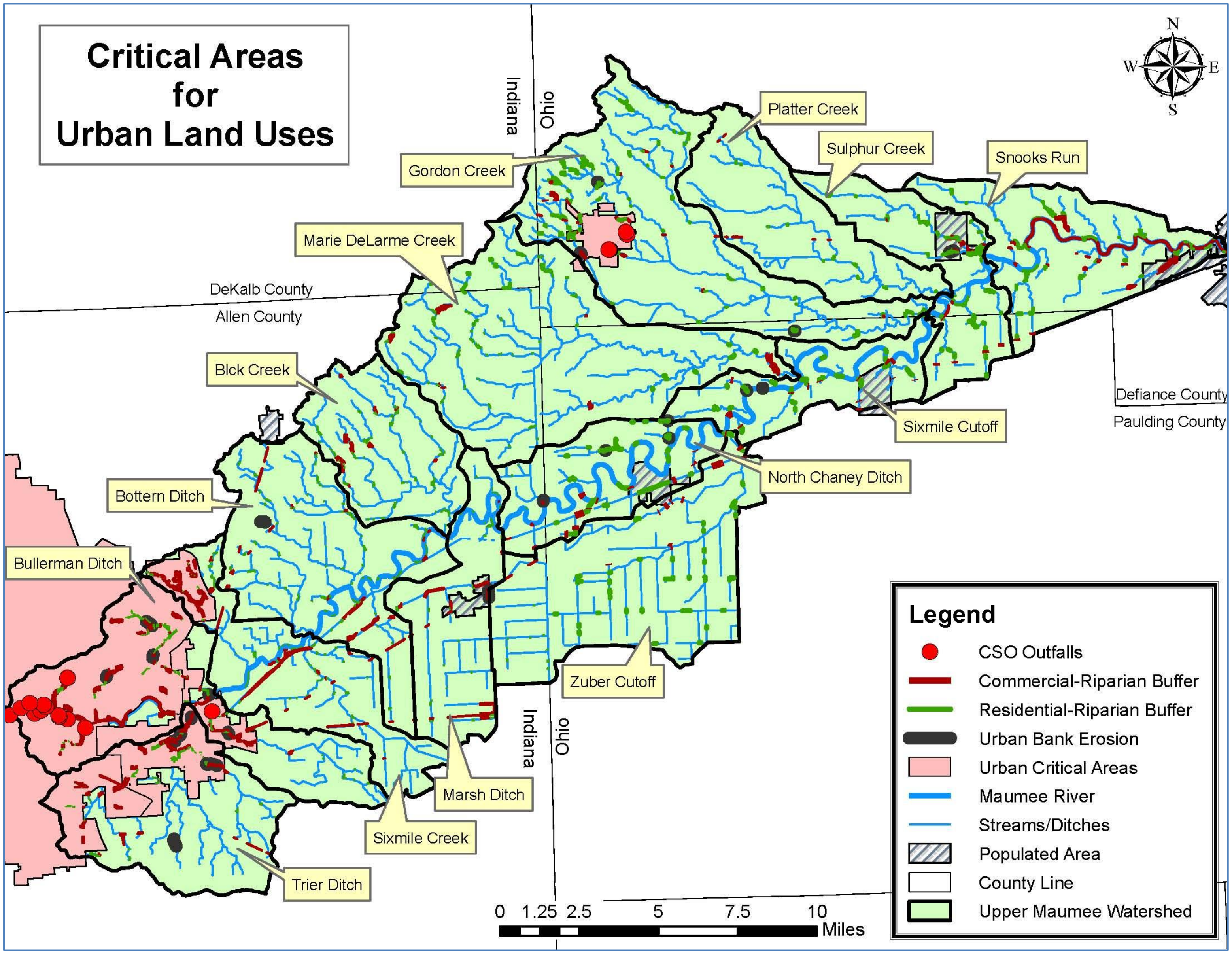
The windshield survey conducted in 2012 in the UMRW revealed more than 14,860 linear feet of stream bank erosion along streams within the urban landscape in the UMRW. This streambank erosion may be due to a lack of adequate riparian buffer to slow the velocity and erosive power of stormwater exacerbated by the increase in imperviousness. Management measures will need to be taken to address areas identified during the windshield survey, and

any future bank erosion sites identified in the urban community to prevent further erosion and sedimentation of the stream.
It was common to see residential properties and industrial sites with little to no riparian buffer throughout the urban areas within the UMRW during the windshield survey conducted in 2012. It was observed that most homeowners mow their lawns directly up to the streambank to maximize their lawn space, and many commercial and industrial facilities did not have a stream buffer as the land is used for parking, or another aspect of the business. The desktop riparian buffer inventory identified residential and commercial property that is located directly adjacent to open water to help focus implementation efforts.

Based on the windshield survey, riparian buffer inventory, and CSO events, the UMRW steering committee has decided to make all CSO communities critical for education and outreach, as well as implementation of stormwater management measures to decrease urban pollutants

While all of Fort Wayne is not located within the UMRW, the Steering Committee believes that implementation efforts should extend beyond the UMRW in Fort Wayne to include the entire Western Lake Erie Basin watershed since Fort Wayne is located at the headwaters of the Maumee River and contributes significantly to the impairment of water quality in the Maumee River through surface flow of storm water carrying pollutants and CSO discharges. Figure 5.2 is a map showing the location of all CSOs within the UMRW and all critical urban areas to focus implementation efforts. (Refer to figure 2.19 on page 59 to see all of Fort Wayne's CSOs).

Figure 5.2: Critical Areas for Urban Land Uses and Combined Sewer Overflows



5.1.3 Livestock / Manure Runoff Based Critical Areas

The UMRW steering committee voiced concern regarding runoff from all animal feeding operations. The concern can be validated by the thirty (30) locations that were observed during the windshield survey where livestock had direct access to open water which poses a direct threat to water quality from soil erosion, and the direct deposit of nutrients and pathogens via animal waste. While only 30 locations were observed during the windshield survey, there could be more areas where livestock are posing a threat to water quality by having direct access to open water that may be identified in the future since only observations made from the road were possible during the windshield survey. There were also 21 sites where manure was noted to have the potential to runoff a livestock operation either from the barnyard or pasture field during the 2012 windshield survey. Without proper manure management at livestock operations, surface and ground water has the potential to become contaminated with excess nutrients and bacteria.

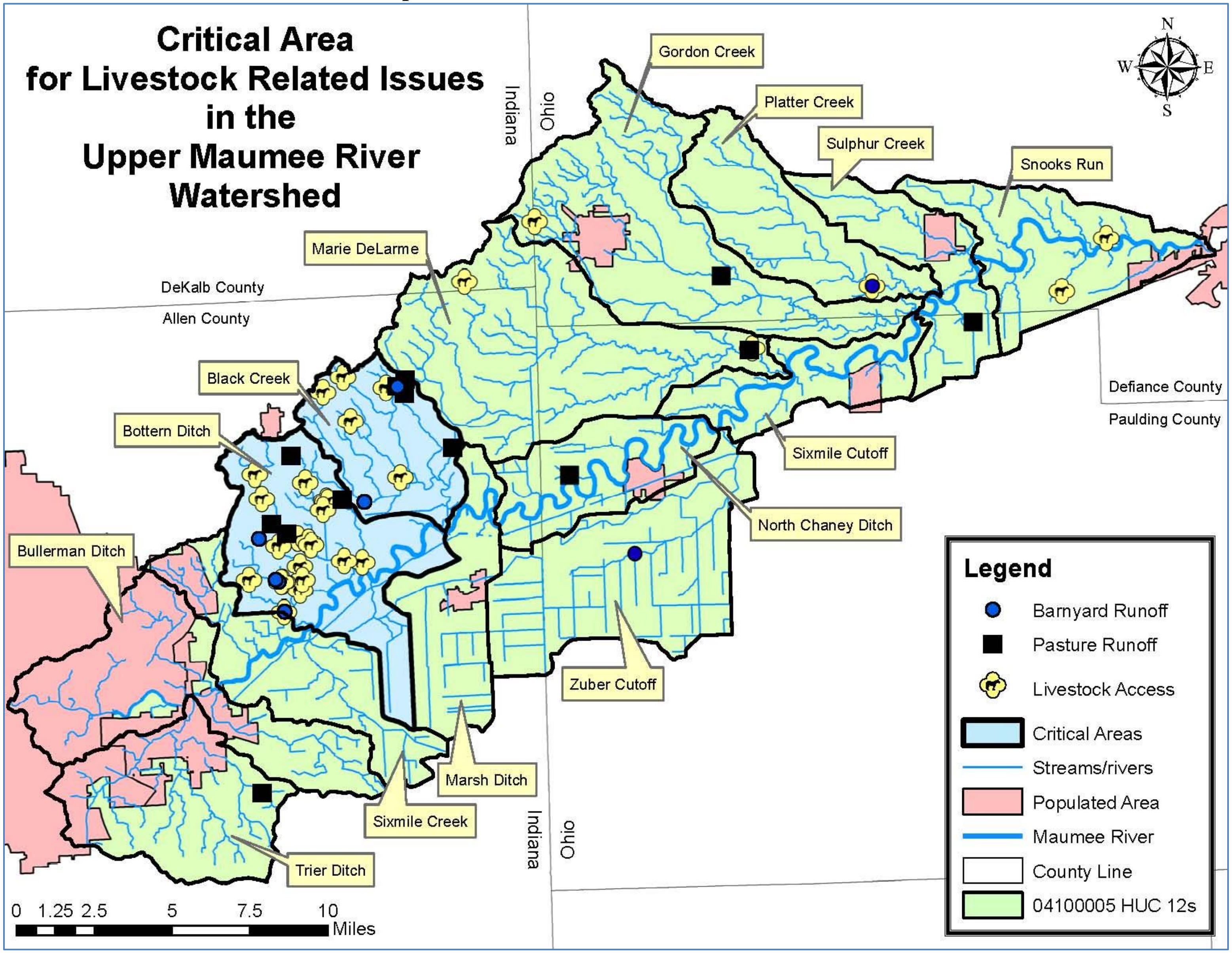
Due to the overwhelming evidence supporting the concern, the UMRW steering committee has made all current and future locations in the project area where livestock have direct access to open water, and all current and future livestock operations that exhibit the potential for manure runoff a priority. Based on water quality data, the SWAT model load reductions, and the number of livestock access and manure runoff potential from identified barnyards and pastures identified during the windshield survey per sub-watershed, Bottern Ditch and Black Creek sub-watersheds are critical for livestock related issues. Table 5.2 lists the number of livestock issues observed during the 2012 windshield survey in Bottern Ditch and Black Creek and Figure 5.3 is a map showing the locations where livestock were seen in, or where livestock access to the water was verified, as well as, all 21 sites where the potential for manure runoff to occur was observed. However, it is important to note that any future locations identified where livestock have direct access to surface water, or manure runoff is a possibility, will also be critical for the implementation of best management practices to permanently remove the potential for manure contamination from livestock within Bottern Ditch and Black Creek.

Table 5.2: Livestock Based Critical Area

Critical Source	Critical Area	Number in CAs
Current and Future Pasture and Barnyard Runoff	Bottern Ditch and Black Creek	14 Sites (2012)[1]
Current and Future Livestock with Direct Access to Open Water	Bottern Ditch and Black Creek	25 Sites (2012)[1]

[1] Total number was derived from the 2012 windshield survey.

Figure 5.3: Critical for Small Scale Livestock Operations



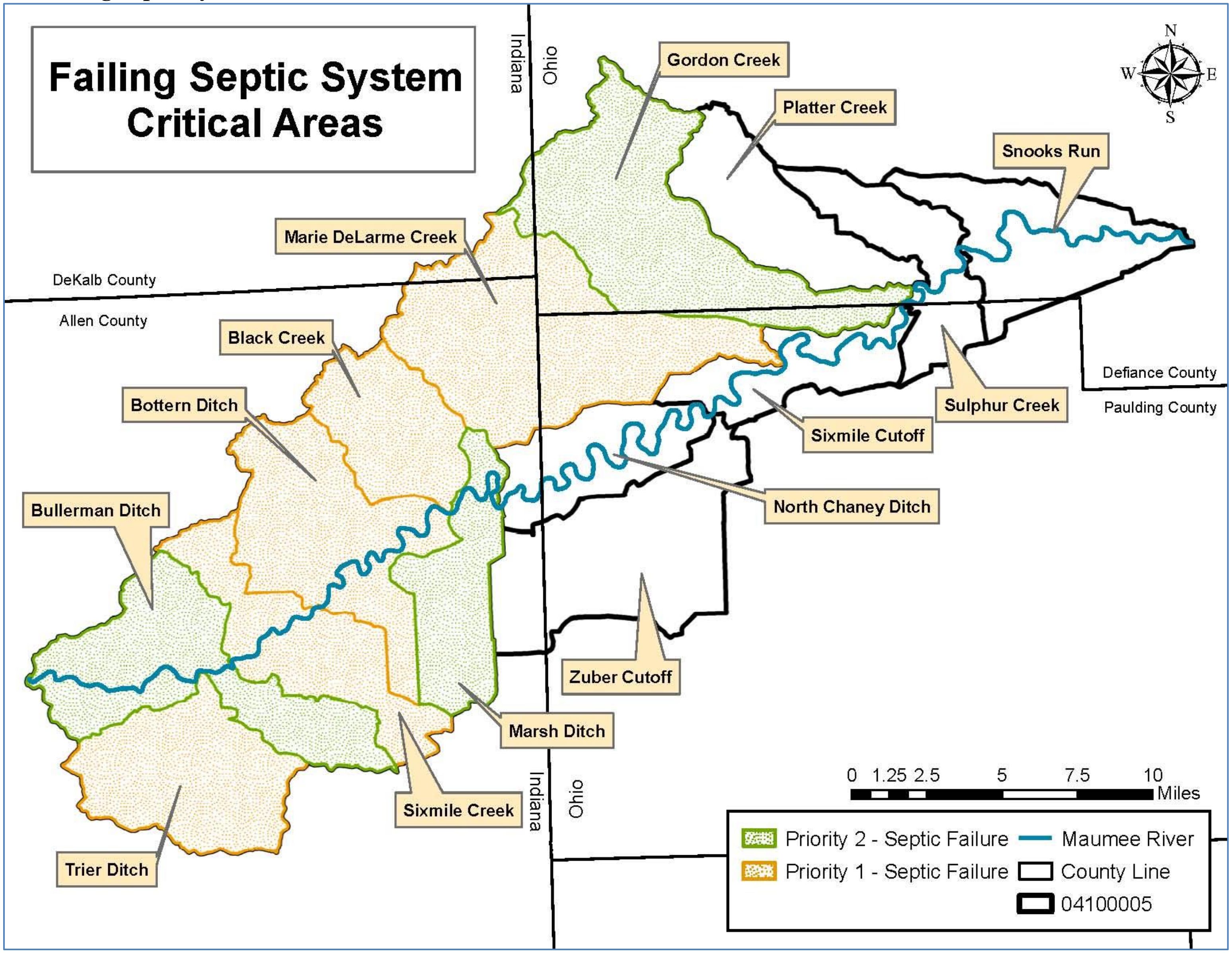
5.1.5 Septic System Critical Areas

Nearly every sub-watershed had sample sites that exceeded the state standard for *E. coli*. Much of the *E. coli* contamination will be addressed in other critical areas including remediating livestock operations that are not utilizing proper manure management practices, and reducing the number of CSO events in urban areas. Another major source of *E. coli* contamination that can be controlled is septic tank leachate, which is also a contributor to DRP and nitrogen. Based on results of the septic tank failure analysis, every sub-watershed is experiencing failures anywhere from 56 households in Sixmile Cutoff to 784 households in Bottern Ditch. Due to the water quality issues that can arise in ground and surface water from septic tanks that are failing, or straight piped to an open ditch it was determined that septic tank education and outreach, and septic tank maintenance, repair and elimination cost assistance will be available in the critical areas outlined in Table 5.3 for septic system failures. *E. coli* was only sampled in the main stem of the Maumee River in sub-watersheds located in Ohio, and due to dilution of those samples, assumptions cannot be made as to whether one sub-watershed has a greater water quality problem from *E. coli* than another. Therefore, prioritization was given based on the estimated number of failing septic systems per sub-watershed. Priority was first given to those sub-watersheds with greater than 300 households estimated to be failing, and second priority was given to those sub-watersheds with between 199 and 300 households estimated to be failing. Figure

Table 5.3: Septic Tank Based Critical Areas

Critical Sub-watershed for E. coli/Septic Systems	Priority
Trier Ditch	1
Sixmile Creek	1
Bottern Ditch	1
Black Creek	1
Marie DeLarme Creek	1
Bullerman Ditch	2
Marsh Ditch	2
Gordon Creek	2

Figure 5.4: Failing Septic System Critical Areas



5.1.6 Pollutant Based Critical Areas

The UMRW Steering Committee expressed concern regarding several problems, land uses and practices that can be observed throughout the watershed that may be contributing to the high nutrient, bacteria, and sediment levels demonstrated by water quality data and the SWAT model. These problems include streambank erosion, lack of riparian buffer, rural legal drains, CSOs, wetland protection and restoration, increase in impervious surfaces, increasing hypoxic zone, soil erosion and sedimentation, unbuffered tile inlets, failing or straight pipe septic systems, barnyard runoff, and livestock with access to open water. Also, the SWAT model indicates nutrient and/or sediment load reductions are necessary to meet target loads in all the sub-watersheds located in the UMRW and the water quality data collected by this project and the OH EPA show exceedances in every sub-watershed for one or more of the following parameters; E. coli, nitrogen, phosphorus, turbidity, or TSS.

The windshield survey conducted as part of this project revealed several areas of concern to help validate stakeholder concerns and are listed in the above critical areas. It was also noted during the survey that many streams and ditches have been straightened and have lost their natural shelf and flood plain and much of the woody riparian area has been cleared. This practice does a great job to quickly move water away from farm fields; however it also increases stream flow causing bank erosion, increases water temperatures, and decreases aquatic and riparian habitat. In addition to those areas, 37% of fields in corn and 16% of fields in beans are conventionally tilled, which allows for surface flow of sediment and fertilizers to discharge into open water and many field tiles were noted as discharging during a drought season. This may indicate that the water table is very high and with heavy precipitation, these field tiles could discharge at a greater rate, exacerbating existing bank erosion surrounding the tile outlets as well as carry excess nutrients to open water more easily. Furrows are another common means of transporting excess water from farm fields within the watershed. The furrows also transport sediment and other pollutants to open water as well as can cause severe bank erosion.

For the reasons listed above, the UMRW Steering Committee has decided to make certain sub-watersheds critical based on actual water quality data and the results of the SWAT model.
In light of the excessive plant growth issues occurring each year in the Western Lake Erie Basin at the mouth of the Maumee River and several hundreds of yards out to open water, it was decided that focus should be placed on controlling the phosphorus (total and dissolved reactive) runoff prior to addressing nitrogen. However, it should be noted that many practices that will be implemented to address P, will also address N runoff.

DRP and total phosphorus often originate from different sources. While TP finds its way to open water through septic system leachate, over application of lawn fertilizers, and WWTP effluent, the main mechanism for TP to reach open water is from sediment runoff. TP attaches to soil particles and as the soil moves over land or through field tiles, the TP moves with it. Therefore, sediment issues will need to be addressed to make a significant impact on TP.

DRP, on the other hand, does not attach to soil particles and is free flowing, and readily available for plant uptake within the water column. DRP is typically transported to open water through field tiles within the agricultural community, manure runoff, and septic system leachate. Therefore, those sources of DRP will need to be addressed to meet water quality targets for DRP.

Sediment Based Critical Area

Based on available water quality data collected in the watershed, the SWAT model, and landuse data collected through windshield and desktop surveys the sub-watersheds listed in Table 5.4 are considered to be critical for addressing sediment.

For those sub-watersheds where actual water quality data was collected for an extended period of time, and from more than just the main stem of the Maumee, the actual water quality data percent exceedance was weighted higher than the SWAT load reduction results. All sub-watersheds located in Ohio that were only sampled six times in the main stem of the Maumee River were ranked based on the SWAT load reduction model. However, those sub-watersheds in Ohio where a TSS or turbidity exceedance was found are weighted as more critical since typically the main stem will have fewer samples that exceed target levels due to dilution. So, if an exceedance was found in the mainstem, it can be assumed that TSS loading is very high.

Finally, the land use inventory was reviewed to help determine the most critical areas for sediment. Bullerman Ditch, Black Creek and Bottern Ditch all had many exceedances for TSS, turbidity, and TP. However, the problems attributing to those exceedances will likely be addressed through the critical areas for urban land uses, and livestock, therefore they were not considered critical based solely on available water quality data and SWAT load reductions.

Priority was assigned to each of the critical sub-watersheds for sediment based on the estimated load reductions from the SWAT model, and whether or not there were water quality exceedances recorded in that sub-watershed from the water quality data that was collected.

Table 5.4: Sediment Based Critical Areas

Critical Sub-watershed for Sediment	TSS/Turbidity % Exceedance	Total P % Exceedance	SWAT Load Reduction Needed (T/yr)	Priority
Trier Ditch	0/75	46	26,362.89	1
Zuber Cutoff	NA/100	43	11,391.86	1
Sixmile Creek	100/73	57	6,497.64	1
Gordon Creek	17/NA	0	19,902.77	1
Sulphur Creek	90/NA	0	33,145.09	1
Snooks Run	50/0	0	18,183.16	1
Marsh Ditch	62/91	22	3,716.4	1
Marie DeLarme Ditch	0/NA	0	19,443.89	2
Platter Creek	17/0	0	10,071.31	2

*NA means that that parameter was not sampled

Dissolved Reactive Phosphorus Based Critical Area

There is not any historic or current water quality data pertaining to DRP within the UMRW. However the SWAT model estimates that a load reduction for DRP is needed in every sub-watershed located within the UMRW. As stated above, DRP often comes from more specific sources than other pollutants such as septic leachate, field tiles, and manure runoff. Based on the SWAT model and windshield and desktop surveys, the sub-watersheds outlined in Table 5.5 are considered to be critical. Those sub-watersheds with an estimated load reduction needed of greater than 2 tons/year are considered to be critical for DRP. Of those sub-watersheds, first priority was assigned to those sub-watersheds with a necessary load reduction of greater than 5 tons/year, then whether or not there are known septic system failures of greater than 199 households within that sub-watershed and/or livestock or manure runoff issues, another major contributor to DRP.

Table 5.5: Dissolved Reactive Phosphorus Based Critical Areas

Critical Sub-watershed for DRP	SWAT Load Reduction Needed (T/yr)	Septic System Failure Estimated at >199 Households	Livestock and/or Manure Runoff Issues	Priority
Trier Ditch	9.95	X		1
Sixmile Creek	7.78			1
Black Creek	10.95	X	X	1
Platter Creek	7.26		X	1
Marsh Ditch	2.08			2
North Chaney Ditch	2.19			2
Sixmile Cutoff	2.64			2
Sulphur Creek	3.12			2
Snooks Run	3.16			2

Figure 5.5 is map of the UMRW with the sub-watersheds that are critical for sediment and DRP. However, to further prioritize the implementation of management measures to address the major pollution issues found within the UMRW, emphasis will be put on addressing DRP first. Therefore, critical sub-watersheds that are ranked as a priority 1 for DRP, or those ranked as a priority 1 or 2 and also a priority 1 for sediment will be addressed before the other critical areas. The sub-watersheds that are considered to be critical for only one parameter, or assigned a priority 2 for both DRP and sediment will be addressed after all implementation efforts have been exhausted in the sub-watersheds that are prioritized as a 1 for implementation. Table 5.6 lists the implementation prioritization for those sub-watersheds deemed critical for sediment and DRP and Figure 5.6 is a map depicting the prioritization.

Table 5.6: Critical Area Prioritization

Critical Sub-watershed for DRP and/or Sediment	Implementation Prioritization
Trier Ditch	1
Sixmile Creek	1
Black Creek	1
Platter Creek	1
Sulphur Creek	1
Snooks Run	1
Marsh Ditch	1
Zuber Cutoff	2
North Chaney Ditch	2
Marie DeLarme Creek	2
Gordon Creek	2
Sixmile Cutoff	2

Figure 5.5: Critical Areas for Sediment and Dissolved Reactive Phosphorus

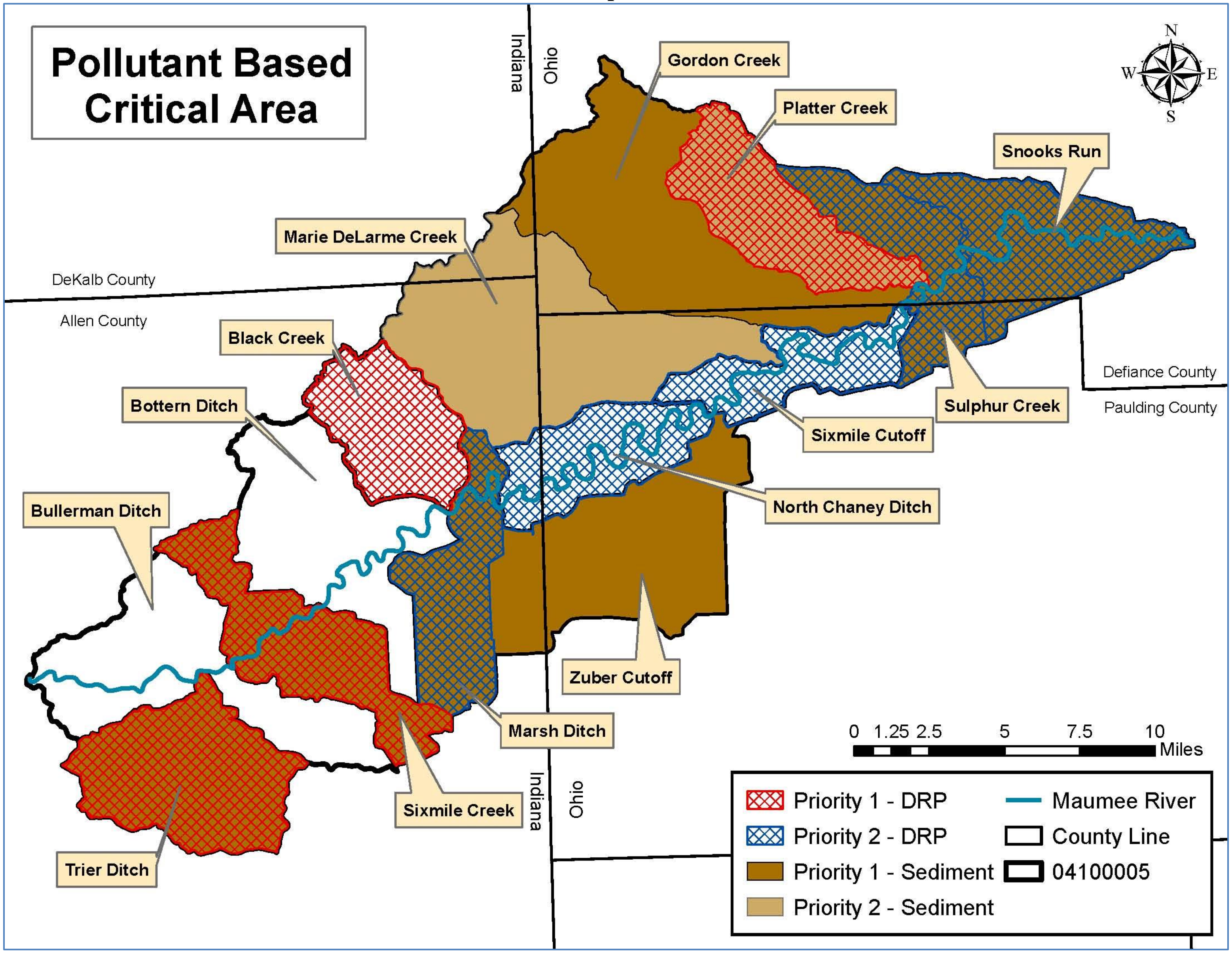
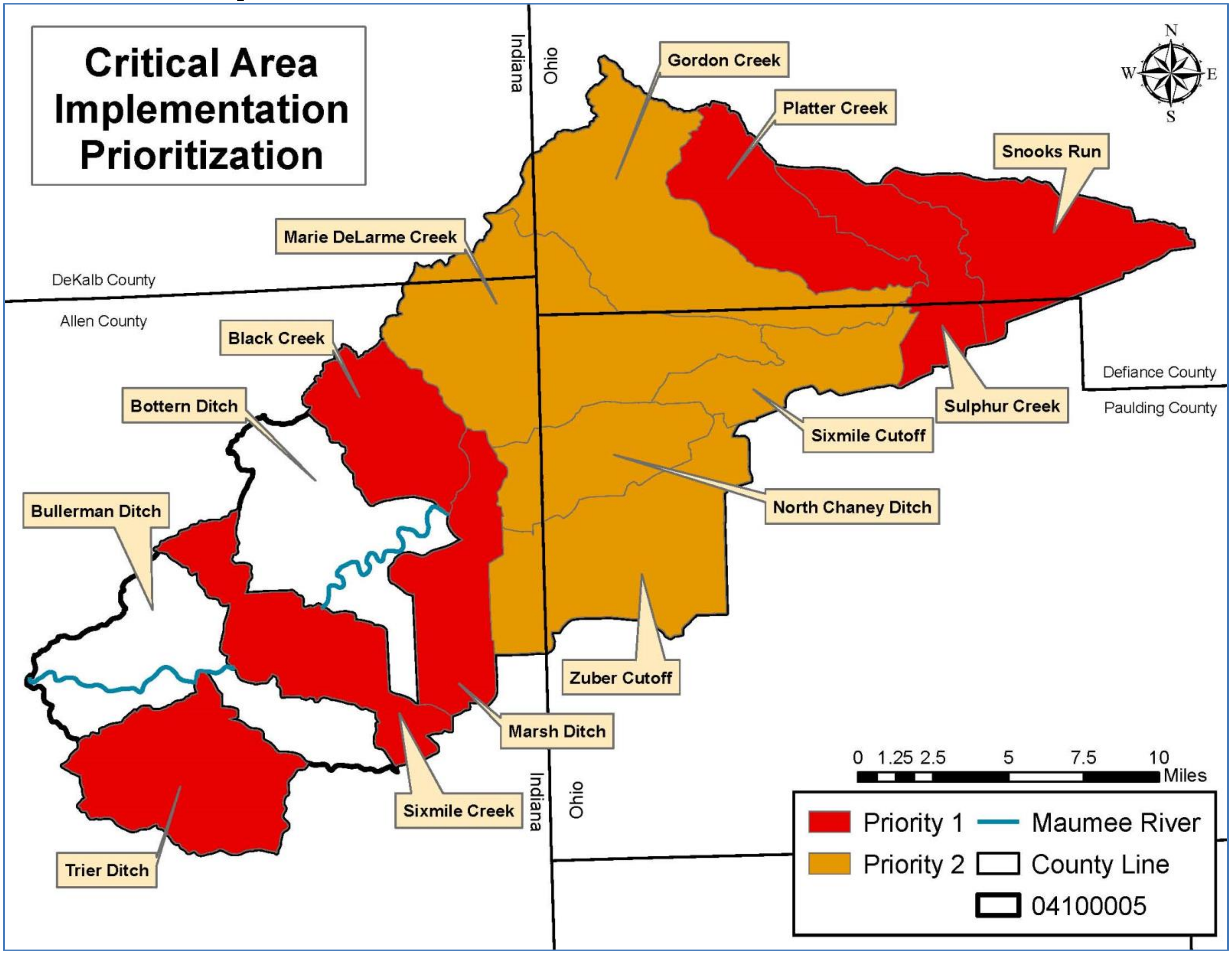


Figure 5.6: Prioritization of Implementation Efforts in Pollutant Based Critical Areas



5.2 Critical Area Summary

The UMRW steering committee looked closely at all available data that has been gathered throughout this watershed investigation and determined that several areas in particular are contributing to NPS and the degradation of water quality within the UMRW. Existing water quality data and the SWAT load reduction model indicates that every sub-watershed within the UMRW is a significant contributor to water quality issues within the Maumee River. However, different sources of pollution are present in each of the sub-watersheds, and therefore, particular sources will be addressed within the critical areas listed below.

- Riparian Buffers at headwater streams and streambank erosion:
    - Priority 1 – Trier Ditch, Zuber Cutoff, Gordon Creek, Platter Creek, Bottern Ditch
    - Priority 2 – Black Creek, Sixmile Creek, Marie DeLarme Creek, Marsh Ditch
    - Priority 3 – Bullerman Ditch, Sulphur Creek, Snooks Run

- Urban Landuses and Combined Sewer Overflows:
    - Surface Flow and volume of Polluted Stormwater, riparian buffers in residential and commercial areas in Fort Wayne, New Haven and Hicksville
    - CSO Discharges in Fort Wayne, New Haven, and Hicksville

- Livestock Operations with Direct Access to Open Water and Potential Manure Runoff
    - Bottern Ditch and Black Creek

- Septic Tank Failures
    - Priority 1 – Trier Ditch, Sixmile Creek, Bottern Ditch, Black Creek, Marie DeLarme Creek
    - Priority 2 - Bullerman Ditch, Marsh Ditch, and Gordon Creek

- Dissolved Reactive Phosphorus and Sediment
    - Priority 1 – Trier Ditch, Sixmile Creek, Black Creek, Marsh Ditch, Platter Creek, Sulphur Creek, Snooks Run
    - Priority 2 – Zuber Cutoff, North Chaney Ditch, Marie DeLarme Creek, Gordon Creek, Sixmile Cutoff

6.0 Goals, Management Measures, and Objectives

6.1 Goal Statements and Progress Indicators

The UMRW steering committee used historic studies, land use, and water quality data, as well as current data, stakeholder input, problems found during the project investigation, and identified critical areas to determine overall goals for the watershed. The overarching goal of the project is to reduce pollutant loads and mitigate pollution sources so that water quality measurements will meet the project's target levels and/or state or federal water quality standards. However, to reach that principle goal of improving the quality of water in the UMRW smaller, more attainable, goals were written. Each of the goal statements in the following Section is written to take small steps toward meeting the main goal of this project. It is also important to be able to measure the progress being made toward meeting each of the goals. Therefore, indicators were determined that will be used as a measurement tool and are listed in the following section as well.

6.1.1 Reduce Nitrogen Loading

The average historic nitrate+nitrite levels measured in the UMRW exceeded the target level in all but four sub-watersheds and TKN, while not measured in every sub-watershed, exceeded target levels in eleven of the fifteen sub-watershed sampled. The SWAT model indicates a load reduction of 10.9% of the current nitrogen loading in the UMRW is needed to meet target levels. The SWAT model results indicate a nitrogen load reduction is needed in Marsh Ditch, Zuber Cutoff, North Chaney Ditch, Marie DeLarme Creek, Sixmile Cutoff, Platter Creek and Snooks Run to meet the overall 10.9% reduction in the watershed. While critical areas were not identified using nitrogen as a factor, as the major concern in the UMRW is phosphorus, many management measures that will be implemented to address phosphorus will also minimize nitrogen loading.

<u>Goal Statement - Nitrogen</u>

The goal of this project is for nitrate+nitrite levels in sampled water to meet the target level of 1.6 mg/L set by this project in 35% of the samples by 2020, 60% of the samples by 2030 and in all samples by year 2044. According to the SWAT model it would require a 10.9% reduction in nitrogen loading.

<u>Indicator</u>

Water quality and social indicators will be used to show the progress toward meeting the goal for nitrogen levels in the UMRW. An administrative goal will also be used to measure the progress toward meeting the goal for nitrogen levels in the UMRW.

<u>Water Quality Indicator</u>

Nitrate+Nitrite will be measured at a minimum monthly throughout the year at the eleven historic sample sites in Indiana and the eight proposed sample sites in Ohio, ideally samples will be measured weekly during the recreational season. Sampling efforts will begin after three to five years of implementation. To determine if the milestones set for the nitrogen goal are being met, it would be expected to see that more water quality samples are meeting the target level for nitrate+nitrite of 1.6 mg/L each year of sampling after three to five years of implementation.

Social Indicator
A post implementation social indicator survey will be conducted to compare to the Ohio State University study *Farmers, Phosphorus, and Water Quality* to learn the degree to which social changes occurred in the UMRW after implementation of the UMRW WMP. It is expected that at least 50% of the survey respondents will have a better understanding of the water quality issues and land use impacts on water quality in the UMRW than did during the first round of returned surveys. The social indicator study will be disseminated after five years of implementation.

Administrative Indicator
The load reductions as a result of best management practices that are installed in the watershed, as determined by the load reduction models, will be monitored to determine if the BMPs that are being installed are working adequately to reduce overall loadings of nitrogen to reach the 10.9% reduction needed to meet the target load.

Administrative Indicator
The number of best management practices that can reduce nitrogen levels that are installed in the watershed will be monitored. Annual goals for each of the various BMPs that can reduce nitrogen levels are described in the Action register in Section 6.3.

6.1.2 Reduce Total Phosphorus Loading

The average historic total phosphorus levels measured in the UMRW exceeded the target level in all sub-watersheds. The SWAT model also indicated that total phosphorus exceeded the target level in all sub-watersheds and subsequent load reductions would be necessary to meet target loads for the watershed. According to the SWAT model a reduction of 86.4% in phosphorus loading will be necessary to meet target phosphorus loads in the UMRW.

Goal Statement – Total Phosphorus
The goal of this project is for total phosphorus levels in sampled water to meet the target level of 0.08 mg/L in all tributaries and 0.3 mg/L in the main channel of the Maumee River set by this project in 16% of the samples by year 2020, 50% of samples by 2030, and in all samples by year 2044. According to the SWAT load reduction model it would require an 86.4% reduction in phosphorus loading.

Indicator
Water quality and social indicators will be used to show the progress toward meeting the goal for total phosphorus levels in the UMRW. An administrative goal will also be used to measure the progress toward meeting the goal for total phosphorus levels in the UMRW.

Water Quality Indicator
Total phosphorus will be measured at a minimum monthly throughout the year at the eleven historic sample sites in Indiana and the eight proposed sample sites in Ohio, ideally samples will be measured weekly during the recreational season. Sampling efforts will begin after three to five years of implementation. To determine if the milestones set for the phosphorus goal are being met, it would be expected to see that water quality samples are showing a decreasing trend in phosphorus loading with more samples meeting the target level for total phosphorus of 0.08 mg/L in tributaries and 0.30 mg/L in the mainstem of the Maumee River each year of sampling after three to five years of implementation.

Social Indicator
A post implementation social indicator survey will be conducted to compare to the Ohio State University study *Farmers, Phosphorus, and Water Quality* to learn the degree to which social changes occurred in the UMRW after implementation of the UMRW WMP. It is expected that at least 50% of the survey respondents will have a better understanding of the water quality issues and land use impacts on water quality in the UMRW than did during the first round of returned surveys. The social indicator study will be disseminated after five years of implementation.

Administrative Indicator
The load reductions as a result of best management practices that are installed in the watershed, as determined by the load reduction models, will be monitored to determine if the BMPs that are being installed are working adequately to reduce overall loading of total phosphorus to reach the 86.4% reduction needed to meet the target load.

Administrative Indicator
The number of best management practices that can reduce total phosphorus levels (as described in Section 6.2) that are installed in the watershed will be monitored. Annual milestones for each of the various BMPs that can reduce phosphorus levels are described in the Action register in Section 6.3.

6.1.3 Reduce Dissolved Reactive Phosphorus
DRP has not historically and is not currently being monitored within the UMRW, however there are plans to begin monitoring this parameter as it is considered the limiting factor to the increased hypoxic zone in the WLEB. For these reasons, Purdue University simulated current DRP loading in the UMRW using their recalibrated SWAT model. According to the SWAT model, DRP exceeds target levels in all sub-watersheds in the UMRW and a 32% decrease in DRP is needed in the watershed to meet target levels. Significant DRP sources in the UMRW include

fertilizer and manure surface and tile runoff from agriculture fields, as well as failed, leaking, or straight pipe septic systems.

Goal Statement – Dissolved Reactive Phosphorus

The goal of this project is to have all sampled water within the UMRW meet the target water quality level for DRP of < 0.05 mg/L in 20% of the samples by 2020, 50% of the samples by 2035, and 100% of the samples by 2044. According to the SWAT load reduction model it would require a 32.3% watershed-wide reduction in DRP loading to meet the target load.

Indicator

Water quality and social indicators will be used to show the progress toward meeting the goal for DRP levels in the UMRW. An administrative indicator will also be used to measure the progress toward meeting the goal for sediment levels in the UMRW.

Water Quality Indicator

DRP will be measured at a minimum monthly throughout the year at the eleven historic sample sites in Indiana and the eight proposed sample sites in Ohio, ideally samples will be measured weekly during the recreational season. DRP sampling will begin immediately after funding is acquired, and will continue for a minimum of two years, to help form a baseline loading in the UMRW. Sampling efforts will resume after three to five years of implementation. To determine if the milestones set for the DRP goal are being met, it would be expected to see that water quality samples are showing a decreasing trend in DRP loading with more samples meeting the target level for DRP of 0.05 mg/L each year of sampling after three to five years of implementation.

Social Indicator

A post implementation social indicator survey will be conducted to compare to the Ohio State University study *Farmers, Phosphorus, and Water Quality* to learn the degree to which social changes occurred in the UMRW after implementation of the UMRW WMP. It is expected that at least 50% of the survey respondents will have a better understanding of the water quality issues and land use impacts on water quality in the UMRW than did during the first round of returned surveys. The social indicator study will be disseminated after five years of implementation.

Administrative Indicator

The load reductions as a result of best management practices that are installed in the watershed, as determined by the load reduction models, will be monitored to determine if the BMPs that are being installed are working adequately to reduce overall loading of DRP to reach the 32.3% reduction needed to meet the target load.

Administrative Indicator

The number of best management practices that can reduce DRP levels (as described in Section 6.2) that are installed in the watershed will be monitored. Annual milestones for each of the various BMPs that may reduce DRP levels are described in the Action register in Section 6.3.

6.1.4 Reduce Sediment Loading

The average historic turbidity levels measured in the UMRW exceeded the target level in all sub-watersheds where turbidity samples were taken and TSS levels exceeded the target level in six of the thirteen sub-watersheds that were sampled for TSS. The SWAT model indicated that sediment exceeded the target level in all sub-watersheds and subsequent load reductions would be necessary to meet target loads for the watershed. According to the SWAT model a reduction of 92.9% in sediment loading will be necessary to meet target sediment loads in the UMRW.

Goal Statement – Sediment

The goal of this project is to have all sampled water within the UMRW meet the target water quality level for TSS of 25mg/L in 20% of the samples by 2020, 50% of the samples by 2035, and in all of the samples by 2044. According to the SWAT load reduction model it would require a 92.9% reduction in TSS loading to meet the target load.

Indicator

Water quality and social indicators will be used to show the progress toward meeting the goal for sediment levels in the UMRW. An administrative indicator will also be used to measure the progress toward meeting the goal for sediment levels in the UMRW.

Water Quality Indicator

Turbidity and TDS will be measured at a minimum monthly throughout the year at the eleven historic sample sites in Indiana and the eight proposed sample sites in Ohio, ideally samples will be measured weekly during the recreational season. TSS sampling will begin immediately after funding is acquired, and will continue for a minimum of two years, to help form a baseline loading in the UMRW. Sampling efforts will resume after three to five years of implementation. To determine if the milestones set for the sediment goal are being met, it would be expected to see that water quality samples are showing a decreasing trend in sediment loading with more samples meeting the target level for turbidity of 10.4 NTU and TSS of 25 mg/L each year of sampling after three to five years of implementation.

Social Indicator

A post implementation social indicator survey will be conducted to compare to the Ohio State University study *Farmers, Phosphorus, and Water Quality* to learn the degree to which social changes occurred in the UMRW after implementation of the UMRW WMP. It is expected that at least 50% of the survey respondents will have a better understanding of the water quality issues and land use impacts on water quality in the UMRW than did during the first round of returned surveys. The social indicator study will be disseminated after five years of implementation.

Administrative Indicator

The load reductions as a result of best management practices that are installed in the watershed, as determined by the load reduction models, will be monitored to determine if the BMPs that are being installed are working adequately to reduce overall loading of sediment to reach the 92.9% reduction needed to meet the target load.

Administrative Indicator

The number of best management practices that can reduce sediment levels (as described in Section 6.2) that are installed in the watershed will be monitored. Annual milestones for each of the various BMPs that can reduce sediment levels are described in the Action register in Section 6.3.

6.1.5 Reduce *E. coli* Loading

After analyzing both water quality data collected by this project in 2012 and all historical water quality data, average *E. coli* levels exceeded the state standard of 235 CFU/100ml in all sub-watersheds located within the Indiana portion of the watershed where the majority of samples were taken from tributaries to the Maumee River. It is assumed that E.coli analysis performed by the OEPA as part of their TMDL development did not exceed target levels because samples were taken from the main stem of the river where pollutants can become diluted due to the volume of water. Excessive *E. coli* could be from wildlife, leaking failed or straight pipe on-site waste management, CSO events, WWTPs, or animal operations located within the UMRW.

Goal Statement – *E. coli*

The goal of this project is to have 35% of water quality samples meet the state standard of 235 CFU/100ml for *E. coli* by 2020, 50% meet water quality standards by 2035, and all water quality samples meet the state standard for *E. coli* by 2044.

Indicator

Water quality and social indicators will be used to show the progress toward meeting the goal for *E. coli* levels in the UMRW. An administrative goal will also be used to measure the progress toward meeting the goal for *E. coli* levels in the UMRW.

Water Quality Indicator

E. coli will be measured at a minimum monthly throughout the year at the eleven historic sample sites in Indiana and the eight proposed sample sites in Ohio, ideally samples will be measured weekly during the recreational season. Sampling efforts will begin after three to five years of implementation. To determine if the milestones set for the *E. coli* goal are being met, it would be expected to see that water quality samples are showing a decreasing trend in *E. coli* with more samples meeting the target level for *E. coli* of 235 CFU/100ml for a single sample each year of sampling after three to five years of implementation.