4.0 Watershed Inventory – Part II

In order to better understand the water quality concerns in the project area, an inventory and assessment of each subwatershed is necessary. The following sections detail the assessment for each 12-digit HUC subwatershed in the Rock Creek, Griffin Ditch-Wabash River, and Eight Mile Creek watersheds followed by the broader, 10-digit HUC watershed-wide scale summary. Land use, soils characteristics, point and non-point areas of concern, and historical and current water quality sampling information is detailed for each area.

4.1 Subwatersheds of the Rock Creek Watershed

4.1.1 Headwaters-Rock Creek HUC 051201010701

The Headwaters of Rock Creek (HUC: 051201010701) subwatershed contains 16,767 acres, which is 25% of the Rock Creek watershed. There are almost 39 miles of streams in the subwatershed, and an estimated 32 miles of county tile drainage. Six miles of the Rock Creek channel are on the IDEM 303(d) List of Impaired Waters due to *E. coli* and impaired biotic communities. It is estimated that approximately five miles of streams and ditches lack buffers in this subwatershed.

Agriculture is the dominate land use, estimated at 90% of the area. There are approximately 125 acres of wetlands and 575 acres of woodlands scattered throughout the subwatershed. Over 3,969 acres (24%) are considered HEL/PHEL soils. Based on 2013 tillage transect information, an estimated 8,000 acres are conventionally tilled. Cover crops are known to be used in this subwatershed but were not identifiable during the windshield survey. Field observations included: filter strips along most of the steams, fall tillage up to the stream bank on four crop fields; field tile being installed at one location; and a manure transport hose in use at one site. There are three CFOs and approximately 120 hobby farms in the subwatershed that contain an estimated 6,000 animals.

The town of Poneto is located next to the Rock Creek main channel just upstream from the northern subwatershed boundary. The town consists of 77 homes on 68 acres, and is served by Poneto's wetland wastewater treatment facility, (a NPDES facility) which had one observed overflow in 2014 to the Rock Creek. The rural community of Wellsburg is also in this subwatershed. Based on visual estimates there are 262 rural residences with on-site septic systems that may be contributing nutrients and *E.coli* to the streams. An old landfill, referred to as the Poneto Dump is located in the subwatershed, but no information was found for this location.

The IDEM Indiana Water Quality Atlas shows two monitoring sites in this subwatershed that were sampled in 2003. The sampling location on the Rock Creek at CR 900S was sampled for *E. coli* five times over a 30-day period. Those tests resulted in a geometric mean of 997 cfu/100mL, which is well above the *E. coli* target geometric mean of 125 cfu/100mL. The *E. coli* levels also exceeded the state standard on all five samples for the single sample target of 235 cfu/100mL. Concentrations ranged from 325 to 2,419 colonies/100mL. Turbidity also exceeded the Minnesota TMDL criteria for protection of fish and macroinvertebrate health of 25 NTUs on

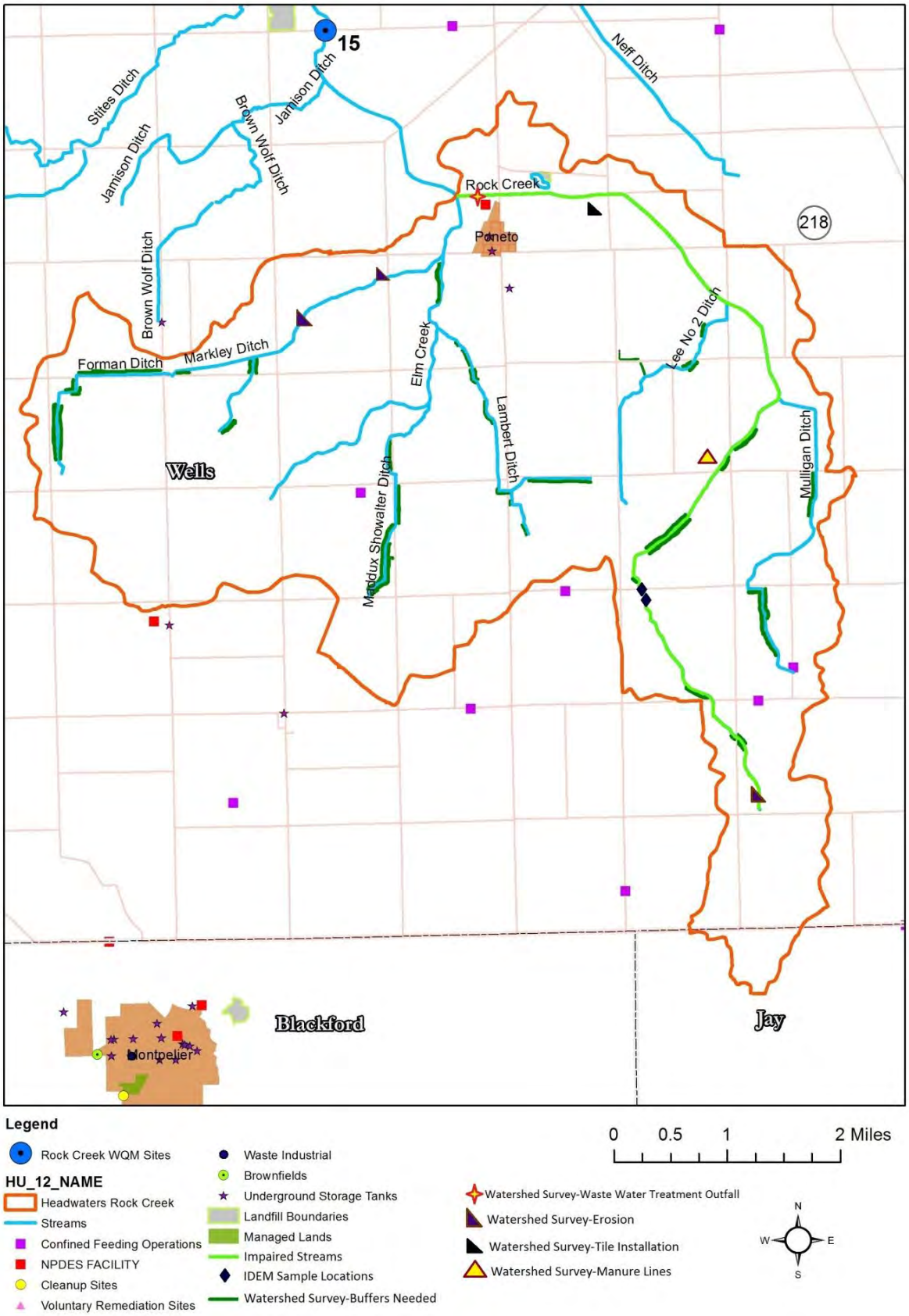
one occasion. The other sampling location, located approximately 800 feet south of the CR 900S, included chemical monitoring and a fish survey. Turbidity levels were exceeded during two testing events, but all of the temperature, dissolved oxygen and pH measurements were within standards or recommendations. The fish survey results included: central stoneroller, bluegill, green sunfish, fathead, blunt nose and black stripe minnows, creek chub, white sucker, red fin shiner and orange throat darter. The majority of these species are adapted for small streams with shallow, slow moving water. Siltation and habitat degradation is their main threat.

The Rock Creek Conservancy District (RCCD) has conducted volunteer habitat and biological sampling at two sites in this subwatershed since 2002. A total of 39 testing events have been recorded through 2010. Macroinvertebrate pollution tolerance index ratings at RCCD site 1, on CR 1000S, have been rated as poor in 36 out of 39 events, with scores of 10 or less on the rating scale, indicating a lack of biological communities. The RCCD site 2, located at CR 700S, was rated poor on 21 events, and received a fair rating on 16 events. This site also achieved a good rating on two events; the first time in 2004 and again in 2009. Habitat evaluations for RCCD site 1 have ranged from a score of 9 to 39, while RCCD site 2 scores range from 21 to 41. The low habitat scores can be attributed to the channelization, shallow depth and low flow in these areas.

Current project monitoring data from Site 15 was used to evaluate the Headwaters subwatershed. Chemistry data was collected twelve times, from September 2013 to November 2014. Dissolved Oxygen levels exceeded the maximum target on three occasions (25% of the samples) and the Dissolved Oxygen Saturation levels were over 100% on those same occasions; which occurred over a range of temperatures, flow conditions and turbidity measurements. Dissolved Oxygen and Saturation levels also dropped below the minimum target on one occasion when *E. coli* test results were well above the *E. coli* target. This was attributed to runoff of animal waste that had been applied to an adjoining field. Turbidity measurements exceeded the target for fish and macroinvertebrate health in four samples (33.3%). *E. coli* exceeded the target in four samples (33.3%), during high flow, moist conditions, mid-range flow, and low flow, indicating both non-point and point sources of pollution. The nitrate target was exceeded in six samples (50%) during high flow, moist conditions, and mid-range flow, and the Total Nitrogen target was exceeded in one sample during high flow, suggesting that nutrients in storm water runoff is the cause. The Nitrite target was not exceeded at any time during the monitoring events.

Habitat evaluations and biological monitoring was conducted once each year, in 2013 and 2014. The stream substrate was silted and smothered, but a variety of stream habitat was present. The riparian area consists of a combination of forested buffer and grass filter strip, with row crops and residential property beyond the riparian area. This site met or exceeded the habitat rating target of good on both occasions. The macroinvertebrate collections also scored excellent and good on the macroinvertebrate pollution tolerance index.

Figure 51: Headwaters – Rock Creek, HUC 051201010701



4.1.2 Mossburg Ditch-Rock Creek HUC 051201010702

The smallest Rock Creek subwatershed is the Mossburg Ditch, which contains 10,839 acres. There are nearly 13 miles of streams and 20 miles of county legal tile. It is estimated that four miles of streams lack 30 foot buffers, and in-stream and gully erosion was observed at six sites.

Approximately 90% of the subwatershed (9,726 acres) is used for cropland and agricultural activities. HEL/PHEL classification applies to 4,506 acres, which is 41.5% of the area. Woodlands total just over 500 acres (4.6% of the area), and there are 115 acres of wetlands. Tillage transect information indicates that the Huntington County portion of this watershed contains more no-till and reduced tillage than the Wells County area. Overall, it is estimated that approximately 4,500 acres are conventionally tilled. A CFO with over 2,000 animals and approximately 50 hobby farms with animals are located in the subwatershed. Observations during the windshield survey included: three areas where buffer/filter strips have been installed and three small pasture areas with horses and cattle. In the western portion of the subwatershed, drainage tile was being installed at two locations, and two ditches had recently had reconstruction activity.

The small community of Buckeye (three residences and a farmer co-op) is within this subwatershed, which consists of 6.8 acres. Based on visual assessments, 125 rural homes (an average of 7 per square mile) have on-site septic systems. This subwatershed also has one (non-leaking) underground storage tank location, and one NPDES clean-up site. No compliance reports were found for those sites.

IDEM sampled in this subwatershed in 1991 and again in 1998. The Mossburg Ditch was monitored at the Huntington/Wells County Line in 1991. No chemical parameters were exceeded, and the macroinvertebrate study found a significant number of organisms that are intolerant to pollution. A second location was monitored in 1998, where the Mossburg Ditch enters Rock Creek near CR 400W. The chemical results showed exceedances of the state standards for nitrogen ammonia and total phosphorus. The macroinvertebrate survey included a mix of both pollution intolerant taxa such as mayflies and caddis flies, as well as pollution tolerant taxa of midges. The IDEM fish sampling resulted in species that are not present in highly polluted or heavily silted areas. Species identified included: stonecat and yellow bullhead catfish, large mouth and rock bass, long ear and green sunfish, darters, minnows and carp.

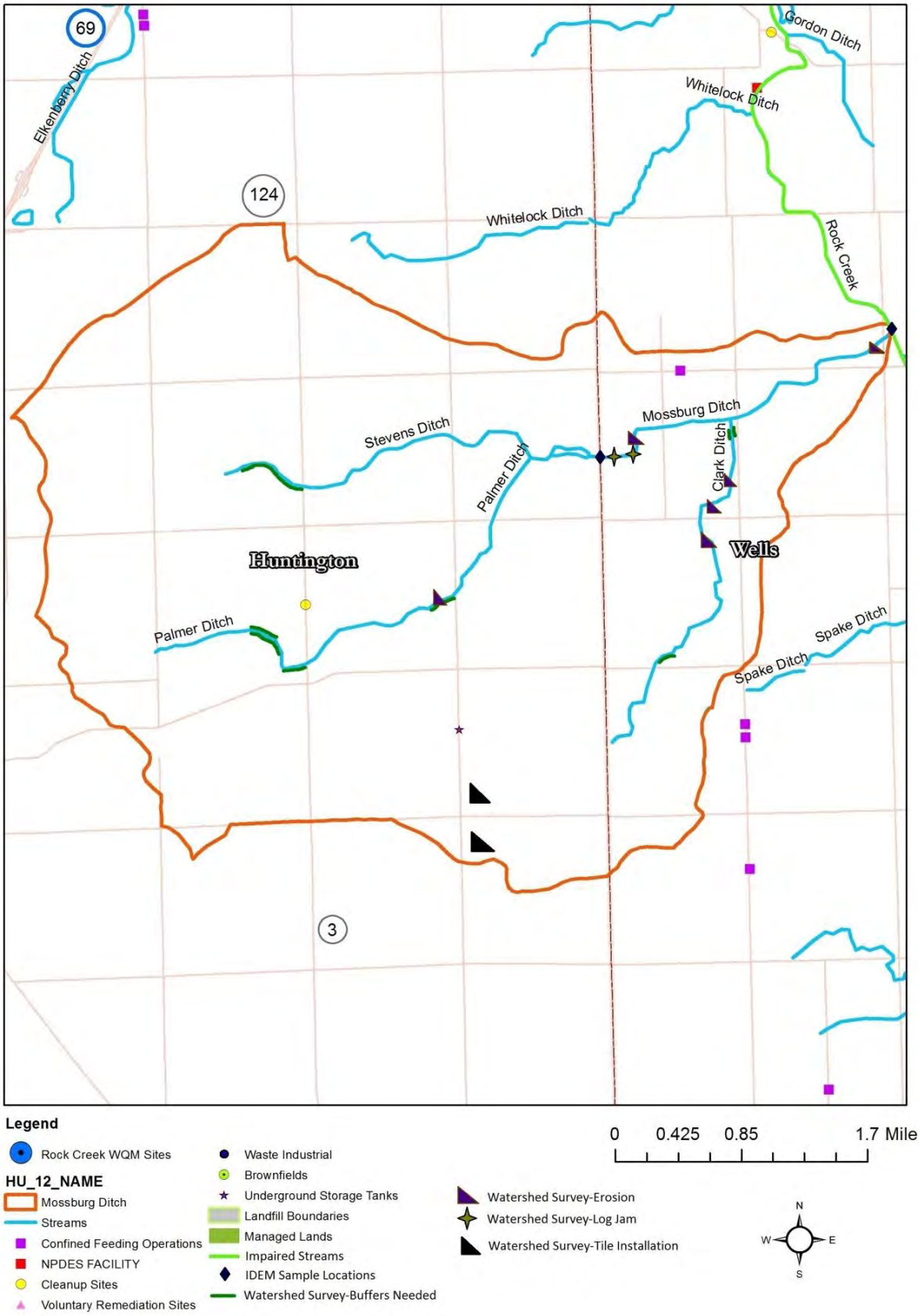
The RCCD volunteer monitoring shows that macroinvertebrate samples at RCCD site 7 on CR 400W at the Mossburg Ditch resulted in 19 poor ratings, 14 fair ratings, and 6 good ratings from 2002-2010. The habitat evaluation scores ranged from 26–54 over this same period. The majority of the time the score was from 35-45 (26 events out of 39), with 18 events having a habitat of score of 40 or greater.

There were no monitoring sites in this subwatershed; therefore, data collected at the downstream water monitoring site 13 was used for evaluating the water quality parameters of the Mossburg Ditch subwatershed. A total of 14 samples were collected from this site during 2013-2014. Dissolved Oxygen exceeded the maximum target on three testing events, and the Dissolved

Oxygen Saturation exceeded 100% on seven sampling events across various flow conditions and temperature fluctuations. Nitrate levels exceeded the target in eight samples. Using the Hoosier Riverwatch field method, the nitrite target was exceeded in one sample; however using approved lab methods the nitrite levels remained within standard recommendations. Total nitrogen and total phosphorus both exceeded the target in one sample; during the high flow spring thaw event.

Habitat evaluations and biological surveys were conducted four times over the collection period. The monitoring site substrate consists of silted large rock. There is a fair amount of in-stream habitat, but undercut banks are present and the site has no shade. The riparian area consists of grass filter strips adjoining row crops. Pools, riffles and runs are present which increases the diversity of the aquatic insects. Native mussels were discovered at this site with one being 3 ½" – 4" in size along with smaller ¾" mussels in clusters. Site 13 scored above the target value indicating good in three out of the four sampling events. The macroinvertebrate collections initially ranked fair, but improved with each sampling event to reach an excellent rating on two occasions.

Figure 52: Mossburg Ditch–Rock Creek, HUC 051201010702



4.1.3 Stites Ditch-Rock Creek HUC 051201010703

The Stites Ditch is 30.6% of the total Rock Creek watershed area and is the largest subwatershed at 20,459 acres. There are over 35 miles of streams and 40 miles of county legal tile. Four miles of the main stem of the Rock Creek channel within this subwatershed are included on the IDEM 303(d) List of Impaired Waters for impaired biotic communities. Based on visual assessments, eight miles of streams lack buffer/filter strip areas.

Cropland is the dominant land use at 91% (18,621 acres), with approximately 4,149 acres classified as HEL/PHEL (20% of cropland acres). Woodlands account for approximately 3.1% of the subwatershed area (640 acres), and wetlands total around 230 acres (0.99% of the subwatershed area). Four pasture/hay areas and one CRP field was observed in the watershed. Several conventionally tilled fields were observed, but over the project period the amount of conventional tillage varies depending on the crop rotation. Areas that were conventionally tilled for corn production, is often then planted by reduced tillage methods for soybeans. Based on the 2013 tillage transect data it is estimated that approximately 10,000 acres is conventional tillage. Grass waterways were observed in the watershed and estimated to total over 11 acres. There are five CFOs within the subwatershed housing approximately 10,700 animals, and hobby farms totaling 131 with an estimated number of 750 additional animals. Manure transport lines were observed at two locations during the windshield survey. In-stream and gully erosion was observed at seven sites, and a total of approximately 160 feet of stream bank erosion was observed at two sites. Tile installation was observed at one location.

The unincorporated town of Liberty Center has over 100 residences, two churches, a convenience store/gas station, post office, fire station and a commercial business that are on individual on-site septic systems on 135 acres. There is a high probability that untreated sewage is reaching the Rock Creek channel less than a mile away through sub-surface tile. The entire Stites Ditch subwatershed contains approximately 380 septic systems, which equates to an average of 9 rural homes per square mile, outside of Liberty Center. There are two underground storage tanks, one leaking and one non-leaking, the closed and monitored Southern Wells Landfill, and an old private landfill. No compliance issues were found for these sites.

IDEM does not have any water quality monitoring stations located in this subwatershed; however the location where the Mossburg Ditch enters the Rock Creek near CR 400 W, discussed in the Mossburg Ditch subwatershed section is just downstream from the Stites Ditch subwatershed boundary. That information was discussed in the Mossburg Ditch subwatershed section.

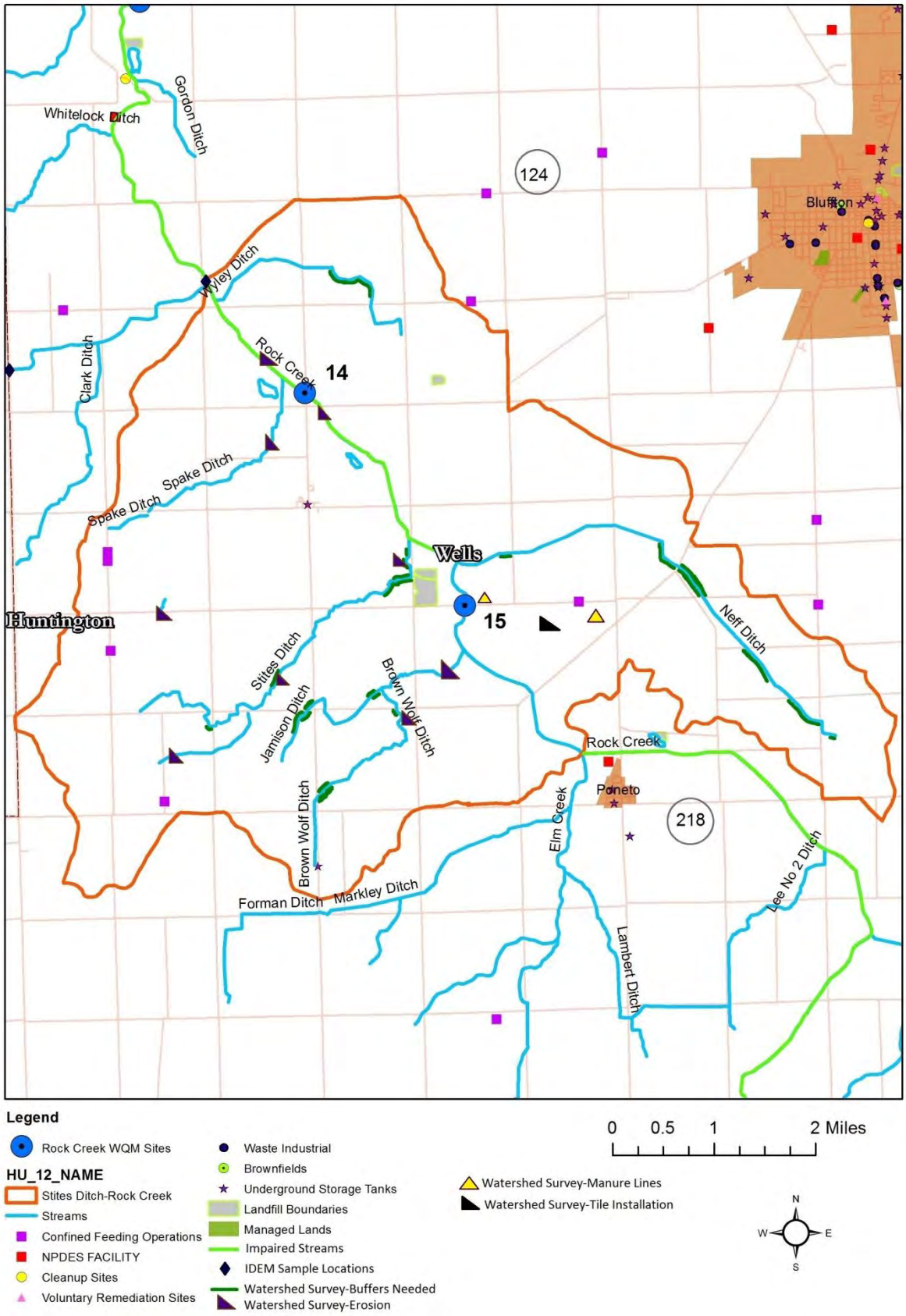
The RCCD biological and habitat evaluations were conducted at four sites within this subwatershed from 2002-2010. RCCD site 3 is located near CR 500S on Hoosier Highway, site 4 is at CR 400S, site 5 is at CR 300S, and site 6 is at CR 200S. Out of the 39 samples, site 3 macroinvertebrate pollution tolerance indexes were 11 poor, 16 fair, 10 good and 2 that achieved excellent. The habitat assessments ranged from 21-57 with almost half of the events with a score of 40 or above. Site 4 macroinvertebrate ratings were 19 poor, 13 fair and 7 good. Habitat assessments for this site ranged from 20-51, with 20 events scoring 40 or more. Site 5 had over half of the ratings, 20 out of 39, in the poor category. The remaining events were rated fair, with

the exception of one event that attained a good rating. Site 5 habitat assessments ranged from 24-54, and had 22 events that scored 40 or above. At site 6, macroinvertebrate ratings on 28 of the events were poor, and the remaining 11 events were fair. Habitat assessments for this location ranged from 26-60, with 20 events that scored 40 or above. The target level of 60 was attained on one occasion, and fell just short of the target on four occasions.

The current project water quality monitoring location site 14 collects the drainage from 68% of the Stites Ditch subwatershed, and was used in the evaluation of water quality issues for the area. Only seven samples were collected from this site during the monitoring program due to sediment in the stream that made it difficult to conduct the monitoring activities. Flow measurements were only successfully collected during three monitoring events, and were estimated for the remaining events. The Dissolved Oxygen level exceeded the target on one occasion, and the Dissolved Oxygen Saturation exceeded the 100% target on two occasions. Turbidity measurements exceeded the target for aquatic health in four samples out of seven. *E. coli* exceeded the target in four samples, under moist and dry conditions indicating the cause is likely animal waste applications and septic system discharges. Nitrate had four exceedances and total nitrogen exceeded the target in two samples, both under moist conditions and mid-range flows. The Total Phosphorus target was only exceeded in one sample under moist conditions during the spring thaw event. Nitrites had no exceedances.

The biological monitoring for macroinvertebrates was not conducted at this site, again due to the unstable substrate and in-stream erosion occurring at or below the water line at the monitoring site. One habitat evaluation was completed in 2014, and the site scored below the target as an indicator of a healthy habitat. This site is heavily silted and smothered with undercut, eroding and collapsing banks at and under the normal flow line. There are no riffles or runs present at this site. The riparian area consists of a narrow row of trees, a filter strip, and row crops.

Figure 53: Stites Ditch–Rock Creek, HUC 051201010703



4.1.4 Elkenberry Ditch-Rock Creek HUC 051201010704 Subwatershed

The Elkenberry Ditch subwatershed contains 18,666 acres, or 28% of the entire Rock Creek watershed. There are over 32 miles of streams and an estimated 35 miles of legal tile in the subwatershed. Over seven miles of the Rock Creek is on the 2012 Indiana 303(d) List of Impaired Waters. Four miles are due to both *E. coli* and impaired biotic communities, and the remainder is due to impaired biotic communities. The majority of the streams have riparian buffers or grass filter strips; therefore, it estimated that only 6.5 miles of buffers are needed in this subwatershed.

Land use in the subwatershed is 86% cropland and pastures/hay (16,081 acres), 9% woodlands (1122 acres) and wetlands (620 acres), and 5% open water and rural residential areas. Agricultural activities include both farming and livestock operations. Soils are classified as HEL/PHEL in 39% of the subwatershed (7,292 acres), with the majority of that being in the western portion. Tillage transect data indicates that there is more no-till and reduced tillage in the Huntington County portion of this subwatershed than in the Wells County area. Based on the 2013 data, conventional tillage was used on approximately 7,000 acres in this subwatershed. Field observations included: conventional tillage at seven locations along stream channels; three dairy operations and two beef cattle operations with animals in large feedlots; a chicken operation located near the Rock Creek; approximately 600 feet of unstable and collapsed stream bank at one location and six additional sites with in-stream and gully erosion; and logging activity at one site on the Rock Creek main channel. There are three CFOs listed for this watershed, however two sites were not constructed. The number of animals in the watershed is estimated at over 32,000 on 89 unregulated farms, and includes chickens, turkey, ducks, horses, sheep, swine, beef and dairy cattle, and buffalo. One farming/dairy operation next to the Rock Creek is certified as organic. At one location, beef cattle are allowed to pasture through a shallow stream that is a tributary to the Rock Creek.

The small communities of Rockford, Plum Tree and Rock Creek Center are located in this subwatershed on approximately 100 acres. Rural residences with on-site septic systems are estimated to be 282. One NPDES site, an active stone quarry is adjacent to the Rock Creek channel. No compliance issues have been reported in the recent past, but the quarry has been stockpiling material in the maintenance easement, floodplain area. An industrial landfill and a clean-up site are located near the Rock Creek and the community of Rockford, but these sites have not been in operation for many years, and no issues were found.

Six sites in this subwatershed have been monitored by IDEM from 1991 – 2008. The station located at CR 200N was monitored for chemistry and macroinvertebrates in 1991. The chemistry samples resulted in no exceedances of the standard targets, and the macroinvertebrate study resulted in a high number of organisms that are intolerant to pollution. A second location, on the Rock Creek in the J.E. Roush Fish and Wildlife area, just downstream from the Elkenberry Ditch tributary was evaluated for chemical and macroinvertebrate health in 1991 and again in 1998. This site had no exceedances of the water quality targets during either event; however based on the number and diversity of taxa, the macroinvertebrate count completed in 1991 had a higher quality biological community than the count completed in 1998.

Two locations were monitored in 2003. The site on the Rock Creek at Huntington CR 500E was monitored for chemical tests and included a fish survey. Dissolved oxygen and turbidity exceeded the water quality target on one occasion. The fish survey revealed 24 different species, ranging from tolerant common carp and white sucker to higher quality fish such as bass and longear sunfish. The other site was on the Rock Creek located at State Road 3 was only monitored for chemistry. At this site, *E. coli* was measured five times over a 30-day period, and resulted in 273 cfu/100mL geometric mean, exceeding the 125 cfu/100mL geometric mean target for *E. coli*. Of those five samples, two exceeded the single sample target. Turbidity results also measured over the 25 NTU target on two occasions.

Monitoring was conducted at two additional sites in 2008. Chemical monitoring was conducted at CR 300N, where *E. coli* was measured five times over a 30-day period, with a geometric mean of 342cfu/100mL, exceeding the geometric mean target. Turbidity results ranged from 14 to 154.1 NTUs and also exceeded the water quality target in six out of eight samples. The other site was located approximately ½ mile north of CR 300N. This site was monitored for chemical tests, macroinvertebrate evaluations and a fish survey. Total Phosphorous measured 0.537 mg/L on one occasion, over the target of 0.3 mg/L; the *E. coli* geometric mean results from the 5 tests over the 30 day period was 380 cfu/100mL; and turbidity results ranged from 14.9 to 573 NTUs, and exceeded the target of 25 NTUs during nine out of ten monitoring events. The macroinvertebrate community was comprised of a mix of organisms, from pollution sensitive taxa to pollution tolerant taxa. Damselfly was the predominant species present, followed by midges and Caddis Fly. The fish survey also included a wide variety of species at the monitoring site, including large and small mouth bass, rock bass, sunfish, logperch, catfish, minnows, suckers and carp.

There are three RCCD monitoring sites in this subwatershed. Site 8 is located on CR 100N, site 9 is on CR 200N; and site 10 is at State Rd. 3 in Huntington County. Sites 8 and 9 in general had higher macroinvertebrate ratings than the other sites in the Rock Creek monitoring program from 2002-2010. At site 8, out of the 39 monitoring events, 10 were rated poor, 16 fair, 11 good, and 2 excellent. At site 9 the ratings were 5 poor, 19 fair, 14 good, and 1 excellent. Site 10 pollution tolerance ratings were 22 poor, 13 fair and 4 good. It is suspected that silting and sediment in the stream at this location may account for the decreased ratings. Habitat evaluations at the sites tend to mirror the macroinvertebrate ratings. Site 8 scored from 29-73, with 27 events scoring a 40 or higher. Out of those, 18 events scored above 50. The target of 60 or more was met on one event, and fell just short of the target on four occasions. Site 9 scored from 31-73 throughout the monitoring period. A total of 26 assessments scored 40 or higher, and the target of 60 or more was met on three monitoring events, and came close on an additional event. Site 10 habitat assessments scored from 30-56, with 21 assessments scoring 40 or higher. The habitat target was not attained at this site during the monitoring period.

Current project monitoring was conducted at two sites in this subwatershed. Site 10, near the mouth of the Rock Creek in the DNR fish and wildlife area, reflects the entire drainage in the Rock Creek watershed. Site 11, also in the DNR fish and wildlife area, is located on the Elkenberry Ditch, just prior to emptying into the Rock Creek, and is representative of the western portion of the Elkenberry Ditch subwatershed area. Samples were collected a total of 12 times at both sites throughout the monitoring period.

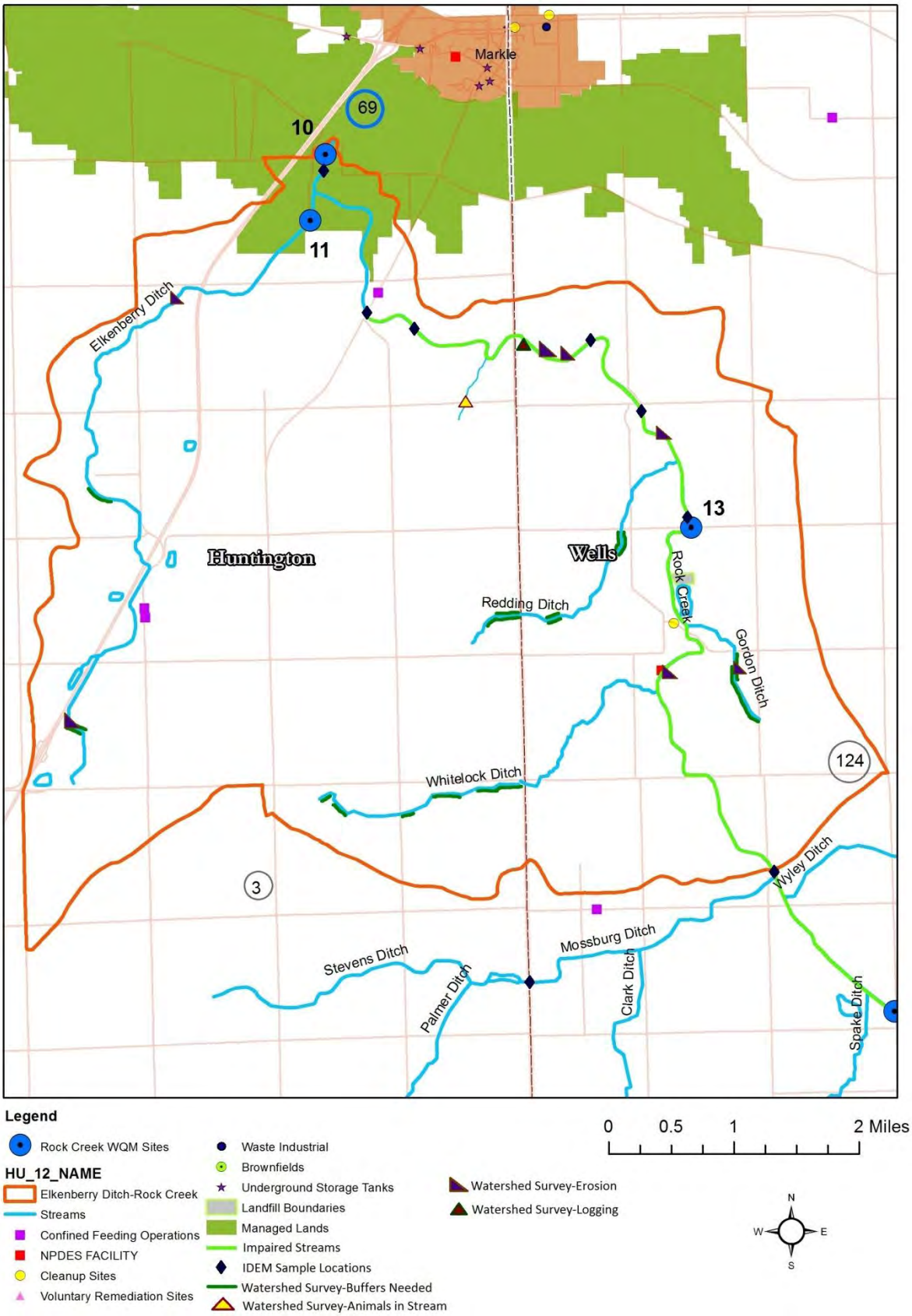
A review of the data collected at Site 10 will be discussed first. Dissolved Oxygen only exceeded the target in one sample. Dissolved Oxygen Saturation exceeded 100% on five occasions during moist and dry conditions with warm temperatures. Turbidity measurements exceeded the target for stream health in six samples (50% of the samples). *E. coli* exceeded the target for full body contact in five samples over all flow conditions, indicating both non-point and point sources. The nitrate target level was exceeded in seven out of 12 samples (58%) during high flow, moist conditions and mid-flow levels. Total nitrogen and total phosphorus both had three exceedances during times of agricultural activity, suggesting surface runoff is carrying the nutrients to the streams. Nitrite did not exceed the target during the monitoring program.

Habitat evaluations and biological monitoring was collected one time each year in 2013 and 2014. Site 10 is mostly natural with a limestone stream bed covered with varying sized rocks. Silting and smothering of the stream bed is a concern, but the aquatic habitat and riffle/run areas provide for diverse communities of aquatic insects. The stream banks are stable and the area is heavily forested. A snail bed is located just downstream from this monitoring location. The habitat evaluations both scored above the target for fish and macroinvertebrate health, with a good rating, and were among the highest scores in the project area. The macroinvertebrate counts resulted in excellent ratings on both occasions and had the highest pollution tolerance index scores of all the sites in the project area.

Site 11 provides insight to the pollutants that are coming into the Rock Creek from the western portion of the Elkenberry Ditch subwatershed. The Dissolved Oxygen levels exceeded the maximum target in four samples. Dissolved Oxygen Saturation exceeded the 100% target in six samples (50% of the time). Turbidity measurements exceeded the target in three samples, all during periods of high flow and moist conditions. Due to the large forest area at this location and upstream of this site, it suggests that organic matter from the forested area observed in the stream in addition to the agricultural activities in the watershed could be contributing to these levels. *E. coli* exceeded the target in six samples (50%) across all flow conditions. This was the only site in the project area where the nitrite level exceeded the target in the laboratory analysis. This occurred in two samples, one in the spring and the other one in the fall; indicating inputs from agricultural activities. Nitrate samples exceeded the target in six samples (50%) across all flow conditions, and total nitrogen exceeded the target in one sample during high flow. Total phosphorus exceeded the target in three samples, during high flow and moist conditions; also indicating agricultural activities as the source of the contaminants.

This site is located on the Elkenberry Ditch just before it enters the Rock Creek. The majority of the time this stream is narrow and shallow over bedrock as it comes through the DNR fish and wildlife area. The habitat evaluation at this site initially scored just under the target for a good rating, but the following year was considerably higher and met the target. In general, the substrate is silted and smothered with a minimum of free rock. Because the area is heavily forested, it is shaded and there is an abundance of organic matter. This site is the location of a crossing for DNR maintenance vehicles, so some bank erosion is occurring from this use. The macroinvertebrate collection changed from poor to good over the monitoring project period. It is suspected that the lack of a diverse aquatic community is due to the fact that the stream is so shallow and slow during most of the year.

Figure 54: Elkenberry Ditch–Rock Creek HUC, 051201010704



4.1.5 Rock Creek 10-digit HUC (HUC: 0512010107) Watershed Summary

The Rock Creek subwatershed has the most rural landscape of the project area. It contains over 131 miles of drainage ditches and streams; and 11.4 miles of the Rock Creek main channel are on the 2012 Indiana 303(d) List of Impaired Waters due to *E. coli* and impaired biotic communities.

Of the project area, this watershed has the highest percentage (89%) and acres (59,877 acres) of agricultural land use. It was noted during the windshield survey that some farm fields had been fall tilled, and drainage tiles were being installed at four locations. Tillage transect data from 2013 indicates that conventional tillage is used on approximately 50% of the cropland, but changes based on cropping rotations. During the desktop survey, it was noted that over 40 grass waterways are located in the watershed, covering approximately 30 acres. There are 10 confined feeding operations (CFOs) within the watershed. Eight are within a half mile of a ditch or stream, and the remaining two are within 1 mile of a ditch or stream. At one location, a shallow stream runs through a pasture, and animals (beef cattle) have direct access to the water. Manure land application from these operations tend to be in close proximity of the animal facility and therefore the nearby streams, as evidenced by the presence of manure transport lines observed during the windshield survey. Some pasture areas were documented, but the acreage was minimal. Also, a number of hobby farms containing horses, beef cattle, hogs and sheep were observed, and based on the desktop survey have been estimated at 392 locations.

When the Rock Creek channel was reconstructed in the late 1960's to early 1970's, the plan included easements on both sides of the channel for grass or natural woody vegetation. Nearly all of this riparian area remains today and is used for maintenance of the channel. It is estimated that only about four miles along the Rock Creek have less than a 30-foot buffer. It was also calculated that 45 miles of buffer strips could be installed on the tributaries that are currently unbuffered. Stream bank erosion totaling over 750 feet was observed at five locations. Overall, this watershed has the most in-steam and gully erosion with twenty-five sites identified during the watershed survey.

The only incorporated community in the Rock Creek watershed is the town of Poneto which consists of 77 homes, and is served by Poneto's wetland wastewater treatment facility (a NPDES facility) which had one observed overflow in 2014 to the Rock Creek. The unincorporated towns and small communities of Liberty Center Wellsburg, Travisville, Rockford, Buckeye, Plum Tree, and Rock Creek Center are also in the watershed and together total approximately 310 acres, but otherwise it remains very rural in population. Based on visual estimates and review of GIS maps, the watershed contains an estimated 1,049 rural residences with on-site septic systems that may be contributing nutrients and pathogens to the local waters. An additional NPDES site is located in the watershed, as well as two remediation clean-up sites. A closed solid waste landfill and an active stone quarry are both adjacent to the main channel. Water quality compliance issues for these sites were not found during the desktop survey; however quarry material has been stockpiled within the Rock Creek floodplain maintenance area.

Based on the water quality monitoring data; nutrients, *E. coli* and turbidity are all issues in this watershed. The predominance of agricultural activities that include tillage and animal manure

land application combined with the number of rural residences with on-site septic systems can be attributed to the high levels of nutrients and *E. coli* in the Rock Creek watershed. Nutrients including Nitrate, Nitrite, Total Nitrogen and Total Phosphorus were monitored during the planning process. Nitrate levels exceeded the target in 52.6% of the samples (30 out of 57). The Nitrite level at the Elkenberry-Rock Creek site 11 measured over the target on two occasions, and was the only site to exceed the target. Total Nitrogen exceeded the target in eight samples out of 55 (14.5%), and Total Phosphorus exceeded the target in 12 samples out of 55 (21.8%).

All of the monitoring data suggests that *E. coli* is a problem across the entire project area. The Rock Creek watershed area exceeded the state standard for full-body recreational contact in 26 of the 58 samples, or 44.8% of the time, across all flow conditions. This indicates that *E. coli* is coming from a combination of sources; from agricultural activities to residential on-site septic systems and waste water treatment facility overflows.

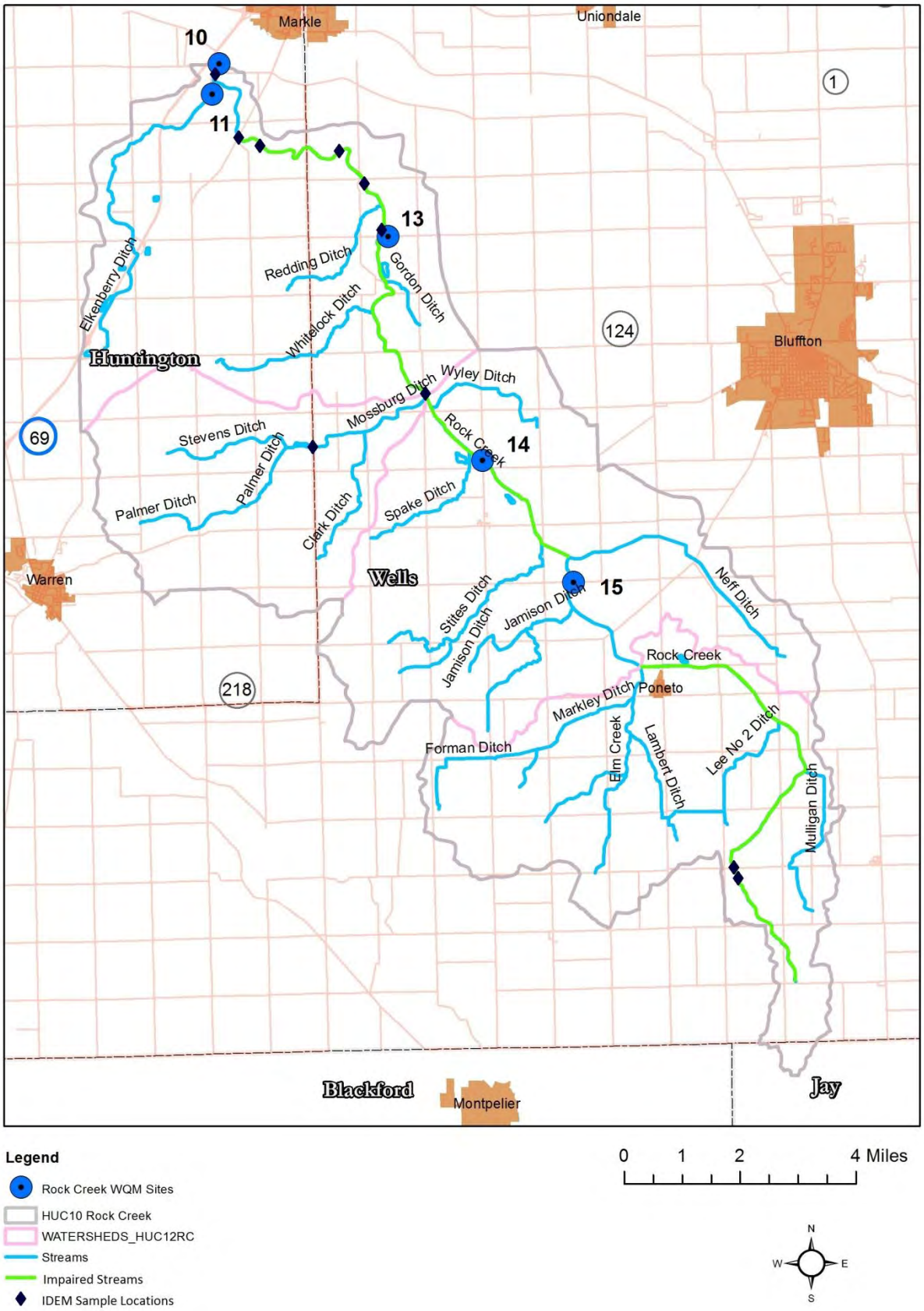
The annual average turbidity measurements for all Rock Creek monitoring sites exceeded both the Indiana average and the water quality target for fish and macroinvertebrate health. However, due to the amount of buffers along the Rock Creek main channel, the levels were lower in the Rock Creek watershed than in the rest of the project area.

Dissolved oxygen levels exceeded the water quality target of 12 mg/L in 12 samples out of 57 (21%), and saturation levels were over 100% in 23 samples out of 57 (40%). Dissolved oxygen and saturation dipped below the minimum level of 4 mg/L for aquatic organism health on one occasion which had *E. coli* test results that were well above the target. It was noted that the water was tan/black in color on that event, and is being attributed to runoff of animal waste that had been recently applied to an adjoining field.

The habitat evaluations noted bedrock and medium to large rocks on the stream substrate, but all sites were listed as smothered and/or silted. The Rock Creek has grass buffers and wooded riparian areas along almost the entire main channel, with row crops beyond the buffer areas. Site 10 is located in the J.E. Roush Fish and Wildlife area and is the most natural site being monitored in this watershed where the riparian area has been largely undisturbed and consists of forest and wetlands; however turbidity levels in the stream have been over the target in 41% of the monitoring samples. Upstream erosion is believed to be the cause of the elevated turbidity levels, but since undercut banks were noted at all sites during the habitat evaluations, this raises the issue that turbidity may also be from in-stream conditions or eroding stream banks at or under the water line.

The macroinvertebrate studies were averaged for the two testing events, resulting in one fair rating, two good ratings, and one excellent rating. At least two types of native mussels were discovered on the Rock Creek main channel at site 13. One mussel was 3 ½" – 4" in size and others were ¾" and in clusters. A snail bed is located downstream from site 10, and minnows and sunfish were observed during the monitoring events. The Elkenberry Ditch (site 11), a tributary to the Rock Creek, is very narrow and shallow during most of the summer months, often less than a foot in depth at the monitoring site, and heavily shaded with an abundance of organic matter from the forested area which accounts for the low level of macroinvertebrates present at this site.

Figure 55: Rock Creek (HUC: 0512010107) Watershed



4.2 Subwatersheds of the Wabash River-Griffin Ditch Watershed

4.2.1 Johns Creek-Wabash River HUC 051201010801

The Johns Creek subwatershed totals 16,413 acres. There are 32 miles of streams in this subwatershed, with nearly three miles being the scenic Wabash River. Additional drainage is provided by over 24 miles of legal tile. The majority of the streams have riparian buffers or grass filter strips, but it is estimated that 10 miles remain unbuffered. The Wabash River is included on the 2012 IDEM 303(d) list of impaired waters due to *E. coli* and nutrients.

The major land use in the subwatershed is farming and livestock operations. Row crops (12,948 acres) account for 79% of the subwatershed area. Woodlands (725 acres) and wetlands (220 acres) cover 5% of the land area. The remaining land is used for urban and rural residences. Soils classified as HEL/PHEL total 4,466 acres (27%); and the soils throughout the project area are not suited to on-site septic systems. As with other areas in the project, conventional tillage was observed and is estimated to be used on approximately 50% of the crop acres, but tillage operations change based on cropping rotations. There are seven CFOs containing approximately 10,655 animals (swine and dairy), and an estimated 83 unregulated hobby farms with an additional 18,000 animals in the subwatershed. Horses, sheep, and dairy and beef cattle were all observed on pasture or feedlots during the windshield survey.

Almost one-half of the City of Bluffton (1,767 acres), which includes the downtown business area and low density urban residences, is within this subwatershed. The urban area includes over 2,000 residences, schools, parks, a hospital, government buildings, businesses, and industry. Much of the urban land surface is covered by buildings, pavement and compacted landscapes with impaired drainage. This greatly increases the volume and velocity of stormwater runoff to the Wabash River. Common sources of pollutants observed in the urban area includes: sediment from building sites, street construction and utility work; lawn care nutrient and pesticide applications; and grass clippings, leaf and plant debris, oils and other household waste in areas where they can be washed into storm drains. The City of Bluffton municipal waste water treatment facility services this area; however, in the area outside the city limits, there are estimated to be 394 rural on-site septic systems. Five NPDES sites are listed in this watershed; however, three sites have been terminated. There are nine industrial waste sites, one environmental clean-up site, and 17 underground storage tanks (11 leaking, and 6 non-leaking). Field observations noted over two miles of the Wabash River Greenway Trail, 150 acres of native habitat that borders the Wabash River, and two 2-stage ditches installed within a half mile of the Wabash River. One is on the Paxson Ditch and the other on the Johnson Drain.

IDEM has two monitoring sites in this subwatershed. Both are located on the Wabash River near CR 450E and River Road, just east of Bluffton. One station monitored in 1995 and 1997 for chemistry, resulted in exceedances in ammonia nitrogen on both occasions. The other station was monitored in 1993, and had no exceedances of the water quality targets, and the macroinvertebrate sampling completed at this site indicates that a large number of pollution intolerant organisms were present, but the diversity of taxa that was present was very low. The USGS operated a stream gauge station at this location from 2007 to 2015. The station has recently been moved downstream, but past stream flow discharge information is available.

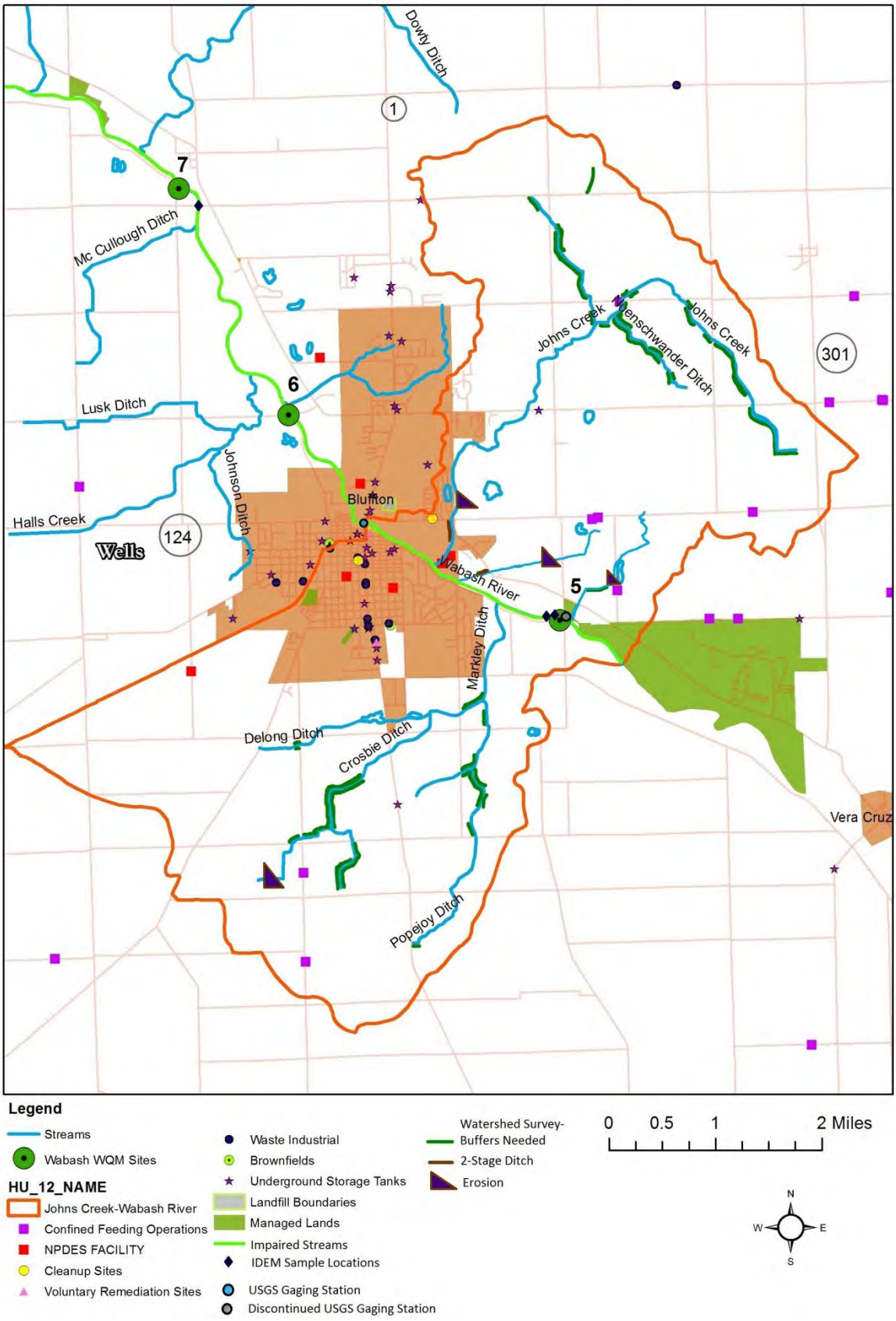
Current monitoring conducted as a part of this project are sites 5 and 6. Site 5 is at the upstream end and site 6 is just downstream of the subwatershed boundary. Dissolved Oxygen levels remained within the target range for aquatic health in all samples at site 5; while site 6 had one exceedance of the 12 mg/L maximum target. Dissolved Oxygen Saturation levels exceeded 100% in five of the 12 samples (41.6%) at both site 5 and 6. The average concentration of turbidity at site 5 was 185.51 NTUs, and site 6 was at 197.55 NTUs. Both sites exceeded the 25 NTU target and the Indiana average of 36 NTU in all samples at both sites across all flow conditions. Sediment, algae and organic matter are all believed to be contributing to the high turbidity measurements.

The Nitrate average concentration at site 5 was 17.25 mg/L and test results ranged from 0.13 mg/L on the 4/25/14-4/26/14 monitoring event to 59.49 mg/L on the 6/13/14-6/15/14 event. Site 6 average concentration was 20.14 mg/L and results ranged from 0.19 mg/L on the 8/4/15-8/5/15 event to 60.47 mg/L on the 6/13/14-6/15/14 event. The number of exceedances of the water quality target for site 5 was five out of 12 samples; and site 6 had seven out of 12 samples that exceeded the Nitrate target of 10 mg/L. Site 5 also had one exceedance of the Nitrite target of 1 mg/L on 11/21/13-11/23/13. Total Nitrogen results exceeded the target in four samples (25%) at site 5, and in two samples at site 6; however, the annual average concentration remained under the target level of 10 mg/L for Total Nitrogen. The Total Phosphorus target was exceeded in seven out of 12 samples (58%) at site 5, and in eight out of 12 samples (66%) at site 6. The annual average concentration was 0.433 mg/L at site 5, and 0.506 mg/L at site 6; both over the 0.3 mg/L target level for Total Phosphorus.

E. coli exceeded the target for full body contact at both sites across all flow conditions indicating both non-point and point sources. Site 5 had exceedances in seven out of 12 samples (58%), and site 6 had exceedances in eight out of 12 samples (66%). Test results at site 5 ranged from 0 to 1,767 cfu/100mL and the annual average concentration was 569 cfu/100mL. Site 6 test results ranged from 67 to 2,200 cfu/100mL, with an annual average concentration of 605 cfu/100mL. It was anticipated that *E. coli* levels would be increased, due to the known input of failing septic systems from the McKinney and Paxson ditches.

Habitat evaluations at site 5 resulted in a good rating. The stream bottom consists of large boulder rock that is silted and smothered, but there is an abundance of in-stream habitat, such as tree roots, shrubs, downed trees, undercut banks, shallow areas, and riffles and runs. The Wabash River Greenway and Bluffton Native Habitat border the river at this site. The biological monitoring also resulted in a good rating with a variety of pollution intolerant macroinvertebrates present in the samples. Site 6 habitat evaluations initially scored under the target for aquatic health, but the following evaluation resulted in a score just over the target to earn a good rating. At the time of the first evaluation, the water level was knee deep, versus the level being chest deep on the second event. This increased the available fish cover that was observed and increased the evaluation score. This site has medium to large rock bottom that is severely silted and smothered. The clay banks are very steep and slippery, and eroded. There is some in-stream habitat, mainly downed trees and overhanging trees and shrubs. The riparian area is rural residential and row crop. The macroinvertebrate sampling at this site resulted in poor and fair ratings, due to the lack of organisms present.

Figure 56: Johns Creek-Wabash River, HUC 051201010801



4.2.2 Dowty Ditch-Wabash River HUC 051201010802

Dowty Ditch is the largest subwatershed in the Wabash River-Griffin Ditch watershed at 17,250 acres. There are nearly 5 miles of the Wabash River, 35 miles of streams and approximately 26 miles of drainage tile in this subwatershed. It is estimated that buffers are needed on 13 miles of the tributary streams. The Wabash River is included on the 2012 IDEM 303(d) list of impaired waters due to *E. coli* and nutrients.

Land use is made up of 12,870 acres of agricultural lands (74.6%), forests 1,327 acres (7.6%), wetlands 202 acres (1.1%), urban area 2,577 acres (14.9%) and less than 2% in other uses. There are 6,384 acres of HEL/PHEL soils (37%) in this subwatershed, and soils are not suited to on-site septic systems. Conventional tillage is estimated to be used on 50% of the cropland acres throughout this watershed. There are three CFOs containing 2,400 swine and 240,000 chickens, and an estimated 104 unregulated farms and hobby farms with over 110,600 animals in the subwatershed.

The urban area includes just over one-half of the City of Bluffton (1,986 acres), adjoining subdivisions outside the city limits (1,062 acres) and the small rural communities of Murray (65 acres) and Kingsland (44 acres). The urban area consists of over 2,500 residences, businesses, and industries. The City of Bluffton, adjoining sub-divisions, and Lancaster Elementary school are serviced by the Bluffton sewer treatment plant, which has had three discharges to the Wabash River. The rural communities of Murray, located next to the Wabash River, and Kingsland, and the remaining rural residences account for the estimated 452 on-site septic systems that are possibly contributing nutrients and *E. coli* to the streams and river. There are two golf courses, a stone quarry, 21 underground storage tanks (12 not leaking, 9 leaking), two industrial waste sites, one Brownfield site, and one NPDES site (Bluffton sewer treatment plant) in the subwatershed. This urban area contributes to increased volume and velocity of stormwater runoff to the Wabash River as well as sediment from individual building sites, street construction and utility work; golf course and lawn care nutrient and pesticide applications; and grass clippings, leaf and plant debris, oils and other household waste in areas where they can be washed into storm drains

Windshield observations noted that a 2-stage ditch is located on the Walter Johnson Drain; conventional tillage was observed at several locations; manure stockpiles were noted at two locations; animals (beef cattle) have direct access to the Lusk Drain; in-stream erosion and gully erosion was observed at five sites; and BMPs were not being maintained at a large commercial construction site allowing sediment to enter the road side ditch.

IDEM monitored two locations in this subwatershed. The IDEM station located southeast of Hale Street in Bluffton, IN was sampled for chemistry and macroinvertebrates in 1991. The chemistry results were all within the recommended water quality targets. The macroinvertebrate assessment showed that the majority of organisms collected were intolerant to pollution, the predominant species were caddis flies and mayflies; however the diversity of taxa of the sample was very low. The second site, located at CR 300N was sampled for chemistry in 1998. *E. coli* results exceeded the single sample target on three occasions out of five in a 30-day period. The geometric mean for the period was 704 cfu/100mL, which also exceeded the target geometric mean of 125 cfu/100mL. Turbidity results from the five sampling events ranged from 62-1000

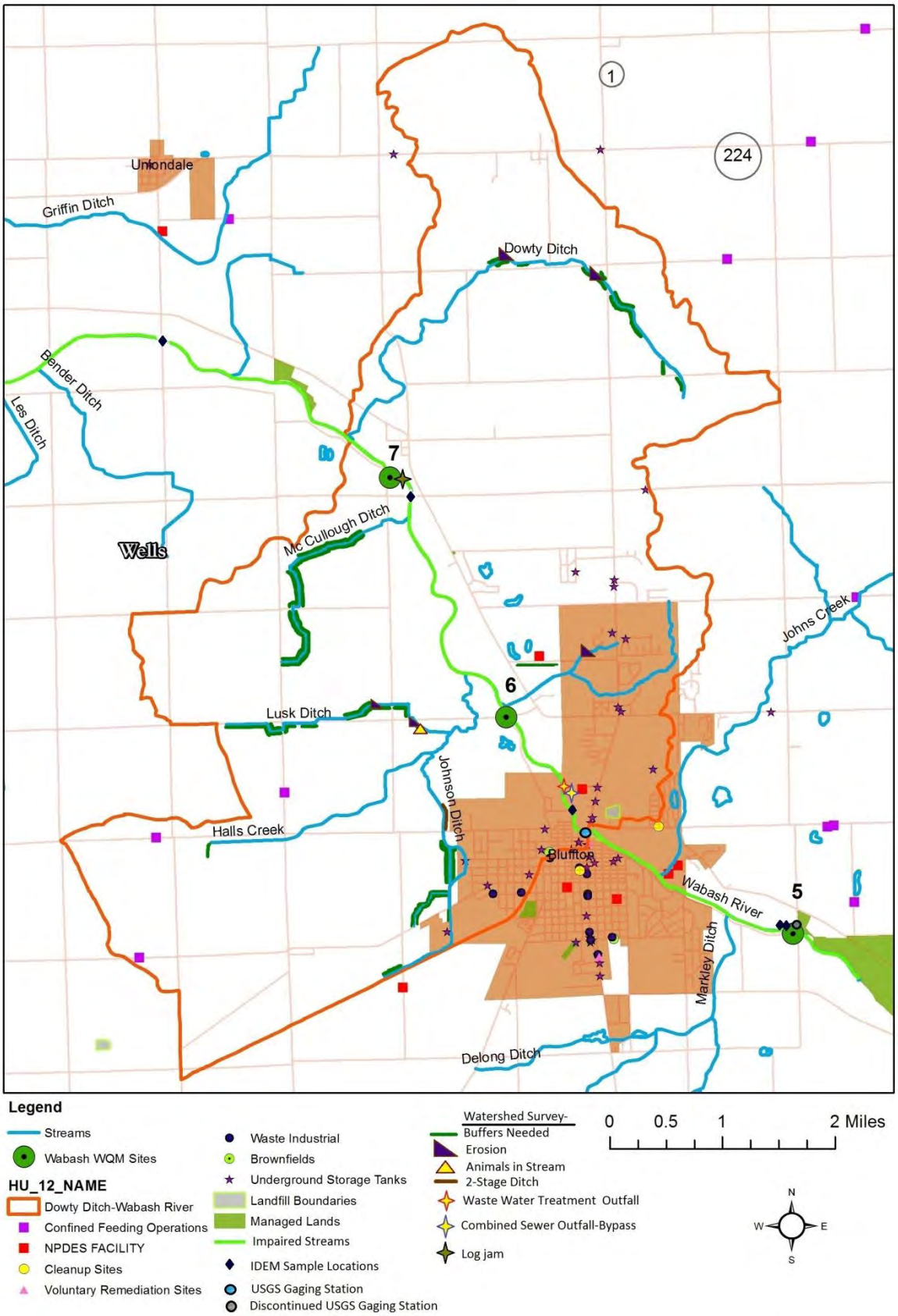
NTU, all exceeding the criteria of 25 NTU for protection of fish and macroinvertebrate health. The USGS stream gauge station located at the SR1 Main Street Bridge was operated from 1930-1971, then discontinued. Water quality data collected at this station from 1968-1971 included temperature, discharge, and suspended sediment. The station was reactivated in early 2015 to measure gage height and precipitation.

Current project monitoring data from site 7 was used as an indicator of water quality for this subwatershed. Monitoring was completed at the site on 14 occasions. Dissolved Oxygen levels exceeded the maximum target in two samples, and Dissolved Oxygen Saturation levels exceeded 100% in five samples. The average concentration of Turbidity was 175.58 NTUs, and the target for aquatic health was exceeded in all samples across all flow conditions.

Nitrate results exceeded the target in nine out of 14 samples (64%) across all flow conditions, and the annual average concentration was 20.34 mg/L, twice the target level. Nitrite was exceeded in one sample, but the average concentration remained well under the target. Total Nitrogen results exceeded the target in three samples during high flow and moist conditions, and had the highest level recorded for all samples that were collected throughout the project. The average concentration of Total Phosphorus was 0.504 mg/L and exceeded the water quality target in nine out of 12 samples (75%) across all flow conditions. This site had the most exceedances of the Total Phosphorus target of all the monitoring sites. *E. coli* exceeded the target for full body contact, with 11 out of 14 samples (78.5%) over the target across all flow conditions, and this site also had the highest number of *E. coli* exceedances of all the monitoring sites.

Habitat evaluations and biological monitoring was completed four times throughout the monitoring period. The site scored above the target for aquatic health receiving a good rating on all monitoring events. This location has a bedrock substrate with large rocks and boulders that is silted and smothered, however the in-stream habitat is diverse and includes roots, shrubs, downed trees, shallow areas, undercut banks, riffles and runs, and several places with aquatic plants throughout the stream section. A wide forested riparian area lines one side of the river. A tree lined buffer separates the river from the county gravel road and row crops on the other side. The macroinvertebrate collections resulted in good and excellent ratings, which were expected due to the abundance and variety of habitat available within this section of the Wabash River.

Figure 57: Dowty Ditch–Wabash River, HUC 051201010802



4.2.3 Bender Ditch-Wabash River HUC 051201010803

The Bender Ditch is the smallest subwatershed in the Wabash River-Griffin Ditch watershed. It contains 10,257 acres, almost four miles of the Wabash River, 12 miles of tributary streams and approximately 15 miles of county tile. Just over five miles of streams are unbuffered, and gully erosion was identified at two sites. The Wabash River is included on the 2012 IDEM 303(d) list of impaired waters due to *E. coli* and nutrients.

Cropland is the dominate land use at 9,008 acres (88%). There are 512 acres of forest (5%) and over 138 acres of wetlands (1%). The remaining area includes the river corridor, and rural homes and farmsteads. Approximately 2,438 acres (23.7%) are classified as HEL/PHEL. Based on the 2013 tillage transect information an estimated 4,500 acres are conventionally tilled, but this amount changes based on crop rotations. The 32-acre "Acres Along the Wabash" nature preserve is located along the Wabash River. An estimated 154 rural homes have on-site septic systems. There are no CFOs in the subwatershed, but 59 unregulated farms and hobby farms contain over 20,000 animals, including beef and dairy cattle, swine, horses, chickens, turkeys and ducks. The Uniondale waste treatment facility outfall is located at the Wabash River in this subwatershed and has one documented release with elevated *E. coli* levels, but also regularly exceeds their permit for phosphorous levels. The only developed area is a part of the Northern Wells High School/Middle School complex, which is served by the Ossian waste water treatment facility.

IDEM collected chemistry data at one site in this subwatershed in June 2003. The site, located at CR 100W, had dissolved oxygen results of 14.2 mg/L and 15.3 mg/L on two out of five monitoring events, exceeding the target concentration of 12 mg/L. *E. coli* also exceeded the water quality target on two occasions with results of 816 cfu/100mL and 46,110 cfu/100mL. The *E. coli* geometric mean of 201 cfu/100mL, calculated from five equally spaced samples over a 30-day period also exceeded the target of 125 cfu/100mL. Turbidity measurements were elevated in four of the five samples, indicating a threat to fish and macroinvertebrate health.

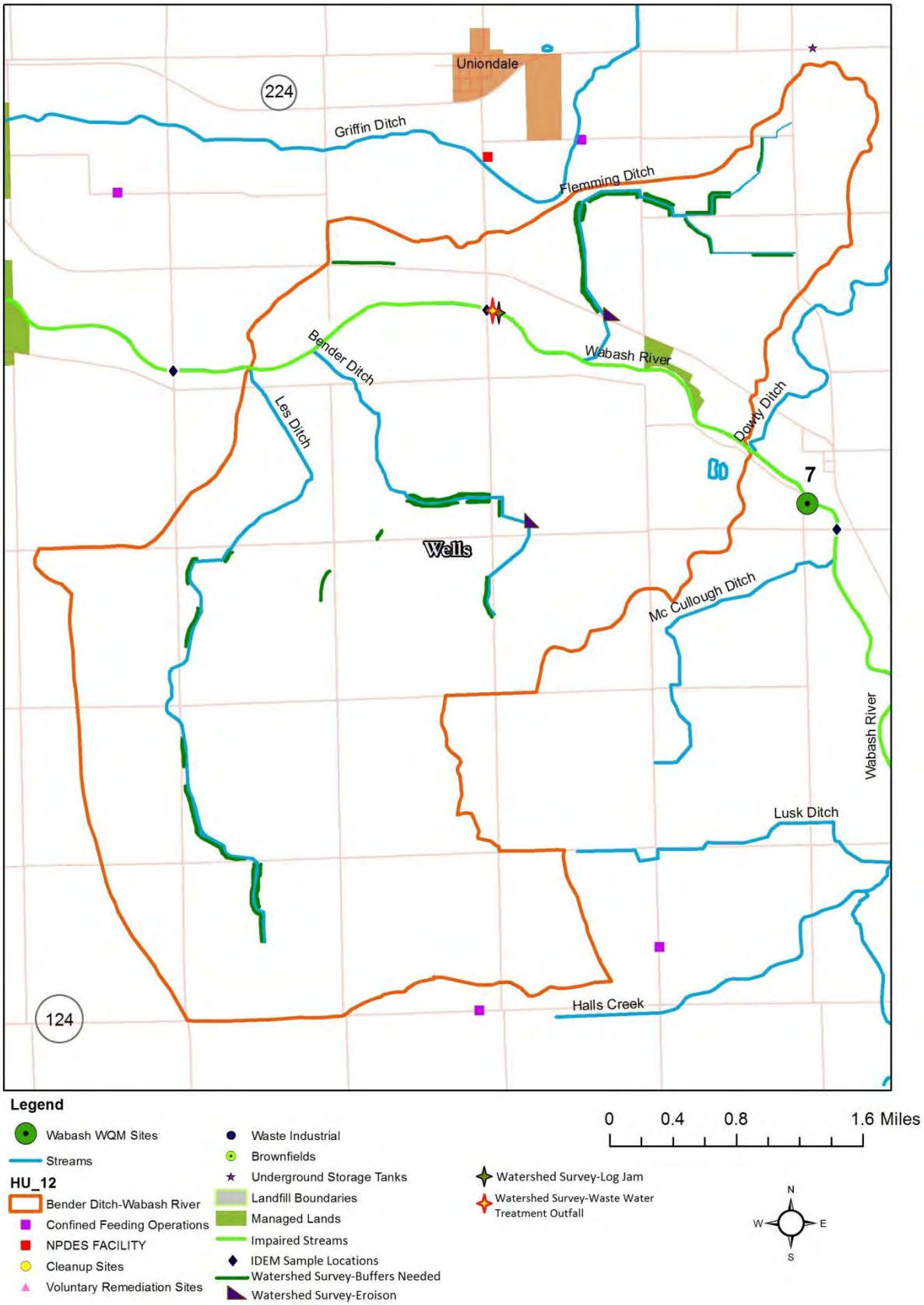
Current monitoring activities were conducted at site 8, which located downstream from the subwatershed boundary; however, the site is a flood reduction impoundment area on the J.E. Roush Fish and Wildlife property. The Wabash River spreads out over several acres and no longer has the same characteristics. The monitoring site is wide and deep, making it beyond the capability of the monitoring equipment to collect flow measurements and unsafe to conduct biological studies. The chemical and habitat evaluations still provide some measure of water quality, but the conclusions are limited by the lack of information. Taking this into consideration, the results from site 8 will be discussed, but Bender Ditch subwatershed will be combined with the Griffin Ditch subwatershed for further evaluation.

Monitoring data was collected on 11 monitoring events. Dissolved oxygen levels exceeded the maximum target in two samples, and dissolved oxygen saturation levels exceeded 100% in four samples. Turbidity measurements exceeded the target for aquatic health in all 11 samples, and the average concentration was 197.04 NTUs, almost eight times the target level. Nitrate results exceeded the target in eight out of the 11 samples (72%), ranging from 0.11 mg/L to 43.47 mg/L, and an average concentration of 18.98 mg/L, nearly double the target level. Total nitrogen

results exceeded the target in two samples, but the average concentration was under the target at 7.95 mg/L. Total phosphorus samples ranged from 0.07 mg/L to 1.16 mg/L, and exceeded the target in seven samples (63%). *E. coli* also exceeded the target for full body contact in seven samples, and ranged from 33 cfu/100mL to 2,333 cfu/100mL. The average concentration for *E. coli* was 506 cfu/100 mL, more than two times the target.

One habitat evaluation was completed at site 8. The substrate was determined to be smaller coarse rock that is smothered and silted. It is a deep area with underwater roots, and downed trees and logs. Shrubs and small trees hang over a combination of stable and eroding steep banks. There are no riffles or runs present at the site. The riparian area is forested wetland bottomlands. The habitat evaluation scored just below the target for aquatic health. Biological monitoring was not conducted.

Figure 58: Bender Ditch–Wabash River, HUC 051201010803



4.2.4 Griffin Ditch-Wabash River HUC 051201010804

The Griffin Ditch subwatershed contains 13,823 acres. A total of six miles of the Wabash River, nearly 12 miles of streams, and an estimated 20 miles of county tile drain the subwatershed. Approximately 5.5 miles of streams are lacking buffer strips, and 100 feet of stream bank erosion was observed on the Wabash River in the J. E. Roush Fish and Wildlife area. In-stream and gully erosion was identified at four additional sites. The Wabash River is included on the 2012 IDEM 303(d) list of impaired waters due to *E. coli* and nutrients.

Agriculture is the primary land use, with cropland and pastures totaling 10,593 acres (76.6%). Forests account for 1,036 acres (7.4%), and wetlands cover only 113.5 acres (0.82%). Urban areas total over 1,600 acres (11.5%), and the remainder of the area includes the river corridor and open space. Approximately 4,964 acres (35%) are classified as HEL/PHEL, and soils are not suited to on-site septic systems. Agricultural operations include both grain farming and livestock operations. Conventional tillage was observed, and is estimated to total 5,000 acres; however, cover crops are known to be used in this area. Two CFOs are listed for this subwatershed; however, one site has been voided leaving one CFO with 1,600 swine. Approximately 73 unregulated animal operations and hobby farms house over 63,700 animals, including beef and dairy cattle, swine, sheep, horses, chickens, turkeys and ducks.

This subwatershed includes the towns of Markle (782 acres) and Uniondale (165 acres), and a portion of the Norwell High School/Middle School complex. The town of Markle operates a traditional waste water treatment plant (NPDES site) with three documented overflows to the Wabash River. The town of Uniondale operates a wetland waste treatment facility (NPDES site) with the emergency overflow to the Griffin Ditch. The Norwell School complex is connected to the Ossian waste water treatment plant. There are 249 rural homes with on-site septic systems that are potentially contributing pollutants to the river and streams. Other sites of concern include ten underground storage tanks (6 leaking), and two industrial clean-up sites.

IDEM has two monitoring stations in this subwatershed on the Wabash River. Chemistry and macroinvertebrate communities were monitored once at Wells County CR 300W in 1991. Dissolved oxygen was lower than the minimum 4.0 mg/L target established for fish and aquatic health; however, the macroinvertebrate survey showed a significant number of pollution intolerant organisms present, such as mayflies, and caddis flies; but the mix of taxa was very low. The second station located at State Road 3 in Huntington Co., just south of Markle, IN, has been monitored regularly from 1991-2013 and over 230 samples have been collected at this site. Dissolved oxygen exceeded the maximum target of 12 mg/L, in 46 samples (20%) with results as high as 15.39 mg/L. Six of the samples dropped under the minimum target of 4 mg/L, with the lowest result being 2.87 mg/L which can result in fish kills and impaired biotic communities.

Nitrate+nitrite exceeded the target of 10 mg/L in approximately 10% of the samples. Concentrations were as much as 2.4 times over the target. Total phosphorus results were over the target of 0.3 mg/L in more than 50% of the samples, with the highest concentration being 1.2 mg/L, or four times the target established in the Wabash River TMDL. Elevated pH levels were recorded in 14 samples, and on one occasion was 9.24. *E. coli* monitoring was completed 75 times from 1991-2003, and 32 samples (43%) exceeded the state standard of 235 cfu/100mL.

Turbidity was collected from 2007-2013, and 82% of the samples were over the target of 25.0 NTUs, which is the criteria used for the protection of fish and macroinvertebrate health.

This projects water quality monitoring data from sites 8 and 9 are used in evaluating the health of the combined drainage area of the Bender Ditch and Griffin Ditch-Wabash River subwatersheds. Site 8 data was discussed in the previous Bender Ditch-Wabash River subwatershed section. At site 9, a total of eleven samples were collected during the monitoring program. Dissolved oxygen levels exceeded the maximum target in one sample following a rain event where fast moving water could have elevated the level. Dissolved oxygen saturation levels exceeded 100% in three samples. The average concentration of turbidity over the monitoring period was 192.04 NTUs, exceeding the target for aquatic health in all samples over high, medium and low flow and moist conditions.

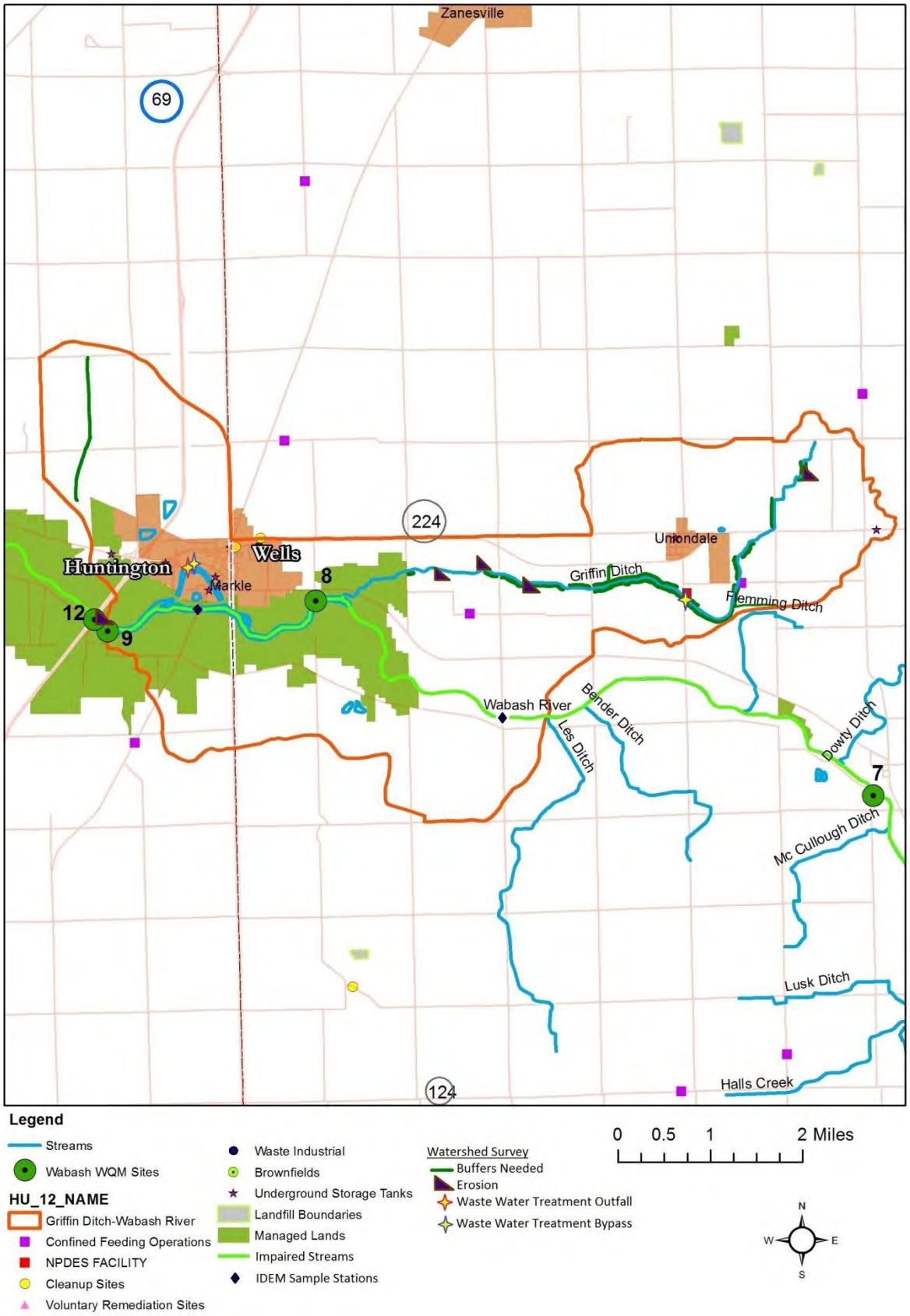
Nitrate samples ranged from 0.11 mg/L to 41.18 mg/L, more than four times the target level, and exceeded the target in nine out of eleven samples (81.8%), and had an average concentration of 18.86 mg/L. Total nitrogen results exceeded the target in three samples, but nitrite results did not exceed the target in any sample. The total phosphorus results exceeded the target in eight out of eleven samples (72%) and had an average concentration of 0.411 mg/L, which is over the target. *E. coli* results only exceeded the target in four samples, but still had an average concentration of 503 cfu/100mL, which is over two times the target for full body contact.

Only one habitat evaluation and biological study was completed at this site. The river has large rocks and boulders on the bottom that is smothered and silted, but a variety of in-stream habitat exists. Underwater tree roots, downed trees and logs, shallow areas, overhanging shrubs and trees, and riffles and runs all contribute to a diverse aquatic community. The banks are stable and the riparian area is forested wetlands. The habitat score was well above the minimum target to be rated as good for aquatic health. The macroinvertebrate collection revealed an abundance and variety of organisms at this site. The majority was pollution intolerant organisms and as such, the site received an excellent rating.

Site 12 on the Wabash River is downstream from the mouth of the Rock Creek, and represents the combined drainage for the Wabash River and Rock Creek watersheds. Data was collected during 11 monitoring events. The dissolved oxygen level exceeded the target on one occasion during a time of increased flow. The dissolved oxygen saturation levels exceeded 100% on four occasions. Turbidity exceeded the target in ten samples over all flow conditions. Nitrate levels exceeded the target in seven samples, ranging from 0.06 mg/L to 44.62 mg/L. Nitrate levels met the target only during low flow. Total nitrogen results exceeded the target of 10 mg/L in only one sample during moist conditions. Total phosphorus levels exceeded the target in three samples, during moist and dry conditions and during low flow. *E. coli* results were exceeded 50% of the time during mid-range flow, dry conditions, and low flow, and had an average concentration of 433 cfu/100mL, above the 235 cfu/100mL target for full body contact.

Habitat evaluations and macroinvertebrate collections were conducted two times at this site. Similar to the conditions at site 9, this site averaged 89.5 on a scale of 100 for habitat, and macroinvertebrates scores ranked good and excellent.

Figure 59: Griffin Ditch–Wabash River, HUC 051201010804



4.2.5 Griffin Ditch-Wabash River 10-digit HUC (HUC: 0512010108) Watershed Summary

Seventeen miles of the scenic Wabash River are included in the Griffin Ditch-Wabash River subwatershed. The watershed contains at total of 117 stream miles. The entire main stem of the Wabash River in the watershed is included on the 2012 IDEM 303(d) list of impaired waters due to *E. coli* and nutrients. This watershed also includes over 2,800 acres of fish and wildlife areas and nature preserves. Approximately 80% of this subwatershed (46,271 acres) is used for agricultural purposes with row crops being the dominate use. Fall tillage operations were observed during the windshield survey and it is estimated that conventional tillage is performed on 50% of the crop acres. This watershed also contained some cover crop fields and several pasture/hay areas. Eleven confined feeding operations (CFOs) are located within the watershed. Ten of these CFO facilities are located less than a half mile from a stream.

The riparian area along the Wabash River tends to be greater than 30 feet in width. It was noted during the windshield survey that there are more forested areas, including fence rows and field borders in this subwatershed, believed to be due to the amount of floodplain present along the river corridor. Many of the streams also have forested riparian areas, but some of them are narrow and not as effective as they could be. In-stream, stream bank and gully erosion was identified at 16 sites in this watershed. Based on the IndianaMap GIS website, it is estimated that an additional 35 miles of buffer or filter strips would benefit the watershed area. The desktop survey also noted 25 grassed waterways within the watershed totaling over 18 acres.

The Wabash River runs through the City of Bluffton, which covers a total area of 8.36 square miles (5,350 acres). The City of Bluffton contains approximately 9,900 people, the largest population center in the project area, with 4,532 housing units, and over 500 businesses, which include various industrial sites. The towns of Markle (population 1,095) and Uniondale (population 310), and unincorporated communities of Murray and Kingsland are also located within the watershed. The developed areas total 6,944 acres which is 12.03% of the watershed. In the rural areas of the watershed, the number of houses average eight per square mile, but the areas adjoining the Bluffton city limits averages 18 homes per square mile, and the western part of the watershed, north of the Wabash River averages 13 homes per square mile. Based on these estimates, there are more than 925 homes in the watershed that have on-site waste water systems that may be contributing nutrients and bacteria to the local streams. The city of Bluffton and town of Markle operate traditional waste water treatment facilities, and the town of Uniondale has a wetland treatment system. Recent NPDES reports show that Bluffton, Markle and Uniondale have all had wastewater discharges to the Wabash River. There are a total of nine NPDES facilities in the watershed; ten industrial waste sites, two Brownfield remediation sites, and four remediation clean-up sites.

Stakeholders identified concerns related to urban development, including residential runoff from chemically treated lawns (fertilizers and pesticides), construction site and road construction erosion causing sedimentation, runoff from asphalt streets and parking lots, lack of green space and dumping and trash in the river and streams. Observations during the windshield survey of the watershed area confirmed these issues as possible contributions of pollutants. Other items noted during the surveys include streams adjacent to or crossing two golf courses, and an active

stone quarry, which presents unique concerns for the watershed. Additionally, there are approximately 353,437 acres in the Upper Wabash River Basin located upstream of this subwatershed that contributes pollutants to the project area.

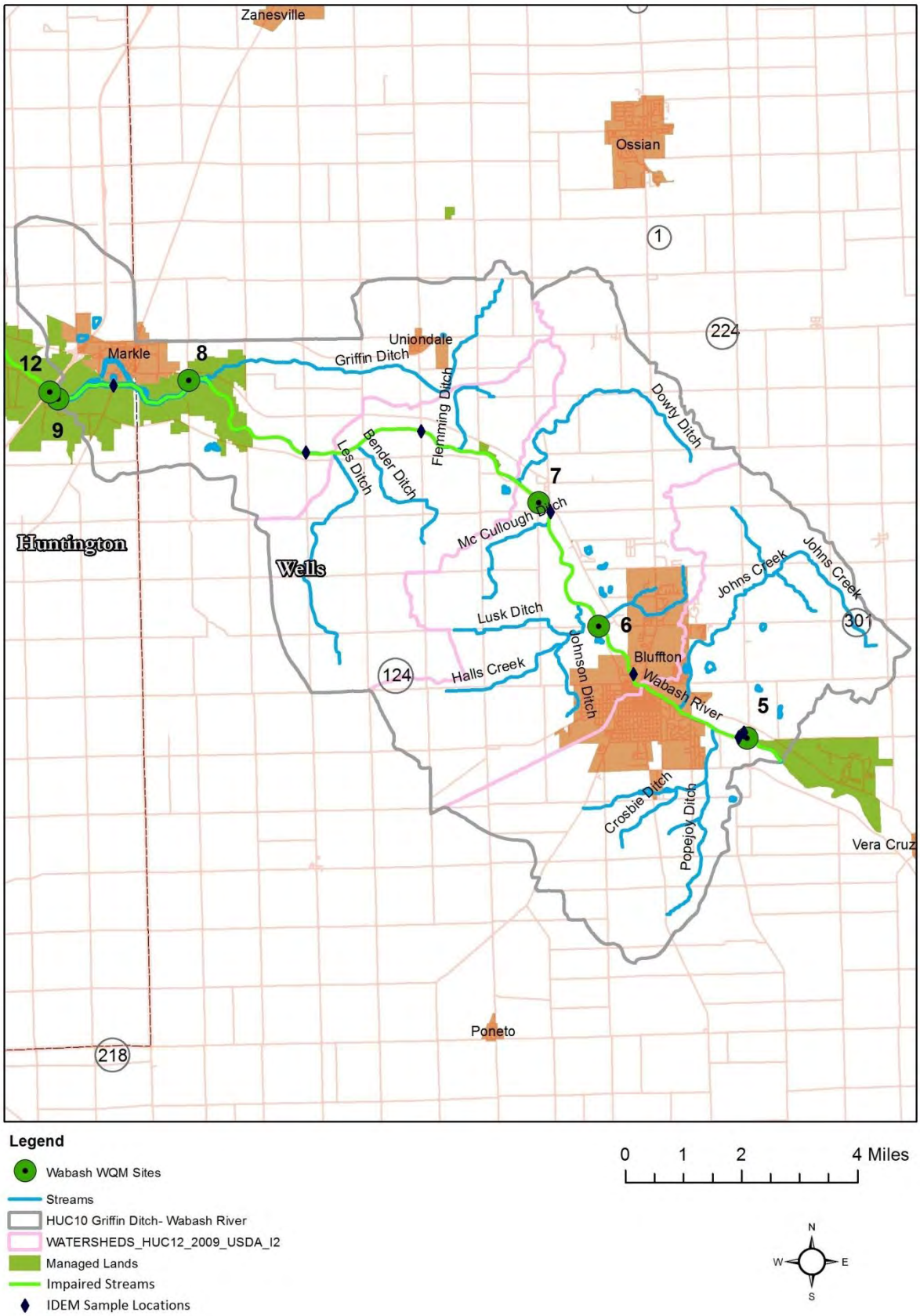
The water quality monitoring data indicate that *E. coli*, nutrients and turbidity are the main concerns in this subwatershed. Due to the size of the river, you would expect that the volume of water would dilute contaminants; but that does not appear to generally be the case. The *E. coli* average concentrations ranged from 433 cfu/100 mL to 605 cfu/100 mL. These levels were above the state water quality standard for full body contact 71% of the time, suggesting that there are continuous inputs of *E.coli* along the entire length of the Wabash River in the project area. The majority of occurrences were at a time of normal to low flow during late fall and again during the summer months. The high flow event on 3/15/14 yielded no test results over the target on the Wabash River; suggesting *E. coli* levels were diluted and resulted in all sites meeting the water quality standard on this date.

Total nitrogen and nitrates, as well as total phosphorus levels have been over the water quality targets throughout the monitoring period. Total nitrogen samples had exceedances 21% of the time, while the nitrate target was exceeded in 63.3% of the samples. The nitrate average concentrations ranged from 15.37 mg/L to 20.34 mg/L, which is 1.5 – 2 times the target level. Total phosphorus exceeded the target concentration in 59.4% of the samples. It is believed that some of these nutrients are coming from human activities in the populated areas along the river, such as lawn care and urban runoff, but seasonal occurrences also point to agricultural activities and septic discharges.

Turbidity measurements were over the target level for fish and macroinvertebrate health 96% of the time throughout the monitoring period. The average concentrations ranged from 175.58 – 197 NTUs for the sites in the rural landscape. The one exception was site 12 in the DNR fish and wildlife area where the turbidity average concentration was 71.22 NTUs, which is still nearly three times higher than the target level. This is due to a combination of sediment, organic matter and algae present in the river. This is further supported by the dissolved oxygen saturation levels. They tend to be lower during the winter-spring season staying within the state standard; then rising to levels of super saturation during the summer-fall cycle. This suggests that those levels are affected by seasonal occurrences of plant and algae growth which is fueled by excessive nutrients.

The habitat evaluations on the Wabash River list the substrate as being large size rock and boulders with some bedrock locations, but all sites were rated as silted and smothered with undercut banks. The riparian areas varied from medium to wide with a combination of forests, grasses, row crops, and urban areas. Site 6, downstream from the City of Bluffton, scored the lowest on the evaluation due to siltation and erosion, narrow riparian areas, and man-made alterations at the site. The macroinvertebrate pollution tolerance index ranked the Wabash River sites ranging from good to excellent, except for site 6 which received scores of poor and fair, and seems to be impacted the most by urban influences mentioned above.

Figure 60: Wabash River-Griffin Ditch (HUC: 0512010108) Watershed



4.3 Subwatersheds of the Eight Mile Creek Watershed

4.3.1 Maple Creek-Eight Mile Creek HUC 051201010901

Maple Creek subwatershed is the most rural in the Eight Mile Creek Watershed. It contains 12,420 acres, over 19 miles of streams, and approximately 32 miles of county tile. It is estimated that 13 miles of streams lack buffer areas, and gully erosion was identified at two locations.

The dominate land use is agricultural farming and livestock operations. Cropland and pastures total over 11,103 acres, or 89% of the area. Forests and wetlands make up almost 5% of the subwatershed (589 acres), and the rest is rural homes, farmsteads and rural communities. The landscape is relatively flat in this subwatershed, with approximately 2,240 acres (18%) that are classified as HEL/PHEL, and soils that are not suited to on-site septic systems. An estimated 5,400 acres were planted by conventional tillage and one manure stockpile was observed during the windshield survey. Cover crops are known to be used by farmers in this area. There are five CFOs listed for this subwatershed, however one site has been voided. The remaining four CFOs house over 13,260 animals. Approximately 66 unregulated animal operations and hobby farms have beef and dairy cattle, swine, horses, chicken, turkeys and ducks totaling approximately 33,880 additional animals.

This subwatershed includes the small unsewered communities of Craigville (65 acres) and Tocsin (90 acres). There are estimated to be 293 rural residences with on-site septic systems in this subwatershed that are potentially contributing pollutants to the streams. Only one NPDES clean-up site is within the subwatershed boundaries, and no compliance issues were found for this site.

Historical water monitoring data was not found for this subwatershed, therefore the review of this project water quality monitoring data at sites 3 and 4 is the only available date used to evaluate the contributions from this area. Site 4 is near the middle of the subwatershed and site 3 is less than a mile downstream from the subwatershed boundary.

A total of 12 samples were collected at both sites during the monitoring program. Dissolved oxygen levels exceeded the maximum target in two samples at site 4 and one sample at site 3, during dry low flow periods in both hot and cold weather conditions. Dissolved oxygen saturation levels exceeded 100% in three samples at site 4 and four samples at site 3 in June, July, August and September during dry low flow and moist periods when the weather was hot. Turbidity exceeded the target for aquatic health in seven of the 12 samples at both site 3 and 4 throughout the monitoring period. Turbidity at both sites is over three times the target level, which can also contribute to the exceedances of the dissolved oxygen and dissolved oxygen saturation tests.

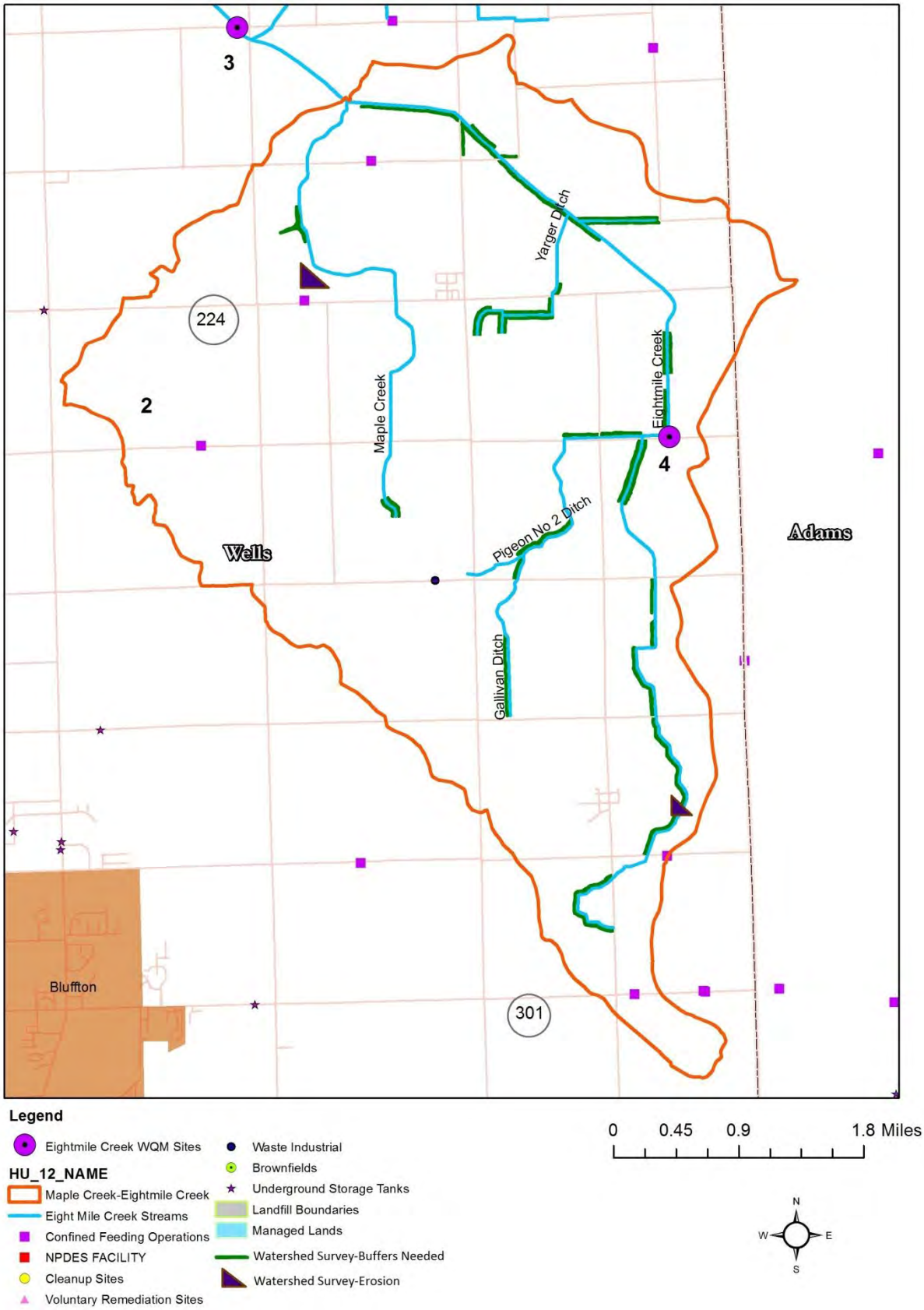
Nitrate results at site 4 ranged from 0.04 mg/L to 46.9 mg/L; and results at site 3 ranged from 0 mg/L to 35.46 mg/L. Both sites exceeded the water quality target in seven out of 12 samples (58%). The total nitrogen target was exceeded in two samples at site 4, one during moist conditions following a wet weather event and the other at low flow following spring planting. Site 3 had one exceedance of the total nitrogen target following a wet weather event. Total

nitrogen average concentration at site 4 was 18.7 mg/L, and at site 3 was 16.8 mg/L; both one and a half times the target for water quality. Both sites also exceeded the total phosphorus target in four samples throughout the monitoring project. Results ranged from 0.06 mg/L to 1.32 mg/L at site 4, and from 0.05 mg/L to 0.71 mg/L at site 3. The exceedances occurred during high flow events and in fall to early winter periods, suggesting phosphorus in surface runoff as the cause for the exceedances.

E. coli is also a concern for this subwatershed. *E. coli* exceeded the target for full body contact in seven of the 12 samples (58%) at site 4, with the highest recorded result of all the monitoring sites (3,800 cfu/100mL) occurring on the 11/1/13-11/3/13 monitoring date following a rain event. The *E. coli* target was exceeded across all flow conditions. Site 4 also had the highest average concentration of *E. coli* at 766 cfu/100ml, indicating that surface and tile drainage are contributing to the pollutant load. Site 3 had similar *E. coli* test results, but on a smaller scale. The target was exceeded in eight out of 12 samples (66%) and exceedances were across all flow conditions; however the range of results were lower in comparison, from 0 cfu/100mL to 1,800 cfu/100mL, and the average concentration was 441 cfu/100mL.

Habitat evaluation and biological studies were completed once each year at both sites. The substrate is considered small and fine rock that is silted and smothered. The monitoring sites are shallow and there is very little in-stream habitat, only some occasional larger rock and undercut banks. The banks are stable to eroding, steep and grassed, but void of trees or shrubs for shading. Riffles and runs are non-existent or of minimal size and effect. The riparian area consists of narrow filter strips with row crops beyond. The stream is designed as a drainage ditch and maintained for that purpose. The habitat score for both sites were below the target that would be considered conducive to warm water fauna. As with some of the other monitoring sites, initially the sites rated poor to fair on the macroinvertebrate collection index. However, by the second assessment, both sites improved in both number and variety of specimens collected and received a good rating.

Figure 61: Maple Creek-Eight Mile Creek, HUC 051201010901



4.3.2 Moser Lake-Eight Mile Creek HUC 051201010902

The Moser Lake subwatershed of the Eight Mile Creek encompasses 12,421 acres; nearly the same amount as the Maple Creek subwatershed. There are almost 18 miles of streams in the subwatershed, and over 20 miles of county drainage tile. Buffers are lacking on approximately 12 miles of streams. Five 2-stage ditches are in this subwatershed on the Eight Mile Creek. The entire 6.5 miles of the Eight Mile Creek in this subwatershed is on the 2012 Indiana 303(d) List of Impaired Waters due to *E. coli* and impaired biotic communities.

Cropland and pasture/hay land is the primary land use on over 10,314 acres (83%). Over 4,284 acres (34%) are classified as HEL/PHEL. Forests (557 acres) and wetlands (125 acres) account for just over 5% of the area. Conventional tillage is estimated on 49% of the crop land (5,000 acres). There are five grassed waterways in this subwatershed totaling over 8 acres of conservation cover. Three CFOs are listed for this subwatershed, but one permit has been voided. The remaining two CFO sites house approximately 2,000 swine, and 680 veal cattle. There are approximately 58 unregulated livestock operations and hobby farms located in the subwatershed with an estimated 12,400 additional animals, including: beef and dairy cattle, swine, horses, chicken and ducks. Field observations noted conventional tillage, a manure stockpile and cover crops in the subwatershed area. The Wells Co. Surveyor has installed 2-stage ditches in this subwatershed. Four are located within the Town of Ossian on the Eight Mile Creek, two east of State Road 1 and two west of State Road 1; and the fifth 2-stage ditch site is on the Eight Mile Creek east of CR 1000N.

The urban area includes the town of Ossian, part of the rural community of Kingsland and rural homes on 1,304 acres, or almost 11% of the subwatershed. The town of Ossian operates a waste water treatment plant (NPDES facility) that serves the 1,385 homes, and 110 businesses and manufacturing facilities; however, a number of reported sewage treatment overflows impact the water quality in the Eight Mile Creek. Two additional NPDES facilities are listed as being in the subwatershed, but records indicate that they have both been terminated. The Ossian town dump is noted to be along the Eight Mile Creek, but it has not been open for a number of years, and no information was found for the site. Visual counts estimate 369 rural residences with on-site septic systems, but the soils are defined as being unsuitable for these systems. Three industrial waste clean-up sites are also within the town of Ossian. No compliance issues were found for these sites.

A total of ten locations in the Moser Lake subwatershed have been sampled by IDEM. Four sites are located on the Eight Mile Ditch east of State Road 1 next to the Brook Ridge Estates subdivision and five sites are within the Town of Ossian on the west site of State Road 1. The only site outside of Ossian to be sampled was Moser Lake located near CR 100E and CR1000N.

Moser Lake was monitored for chemistry in 1991, 1996, and 1999. Dissolved oxygen saturation levels ranged from 5.5 % – 47.3%, all considered low for fish and aquatic health. Dissolved oxygen fell to 0.5 mg/L on one event, well below the 4.0 mg/L minimum target, and exceeded the maximum target of 12 mg/L during another event. Total phosphorus had one exceedance of the suggested target.

The 1998 monitoring results at the site between Lafever and Mill Streets show that water quality targets were exceeded for nitrogen ammonia, total phosphorus, and turbidity. The macroinvertebrate community was mostly comprised of midges and worms that are fairly tolerant to pollution; and the diversity of taxa in the sample was low. The fish survey also included a majority of pollution tolerant species including: carp, creek chub, green sunfish, yellow bullhead catfish, minnows and shiners.

During 2003, one site on the Eight Mile Creek east of State Road 1 was monitored for chemistry, macroinvertebrate communities and a fish survey. Four turbidity measurements ranged from 34.6 – 110 NTUs, and exceeded the recommended target of 25 NTUs for the protection of macroinvertebrate and fish health. The macroinvertebrate collection identified a higher abundance of sediment tolerant organisms present, compared to the number of pollution intolerant mayflies, and caddis flies. Overall, the diversity of the community was very low. The fish survey also resulted in a number of pollution tolerant species, including: orange spotted sunfish, green sunfish, yellow bullhead catfish, creek chubs, and minnows and shiners. A second site on the Wm. Smith drain, a tributary to the Eight Mile Creek near Wood Creek Drive, was sampled for chemistry. At this site, *E. coli* exceeded the target in three single samples; however the geometric mean of the five samples collected over the 30-day period met the geometric mean target. Turbidity exceeded the water quality target in all samples.

In 2005, chemistry samples were collected at three stations on the Eight Mile Creek east of State Road 1, and at the State Road 1 Bridge, the Wm. Smith drain near Eight Mile Creek, and east of Lynn Drive near the Ossian waste water treatment plant. The monitoring on Eight Mile east of State Road 1 resulted in: four exceedances of the *E. coli* target, ranging from 240 cfu/100ml to 87,000 cfu/100mL; nitrogen ammonia exceeding the target of 0.21 mg/L with a result of 10.2 mg/L; and total phosphorus measuring 1.77 mg/L, exceeding the target of 0.3 mg/L. The State Road 1 Bridge site had an exceedance of the dissolved oxygen saturation level, but all other tests were within the recommended standard. The Wm. Smith drain recorded a dissolved oxygen result of 17.77 mg/L, in exceedances of the 12 mg/L target; dissolved oxygen saturation at 197.4%; and turbidity result of 99 NTUs, above the target for aquatic health. The site east of Lynn Drive recorded exceedances of the water quality target for *E. coli* at 980 cfu/100mL (four times the target level); nitrogen ammonia at 3.8 mg/L (18 times the target), and total phosphorus at 4.23 mg/L (14 times the target).

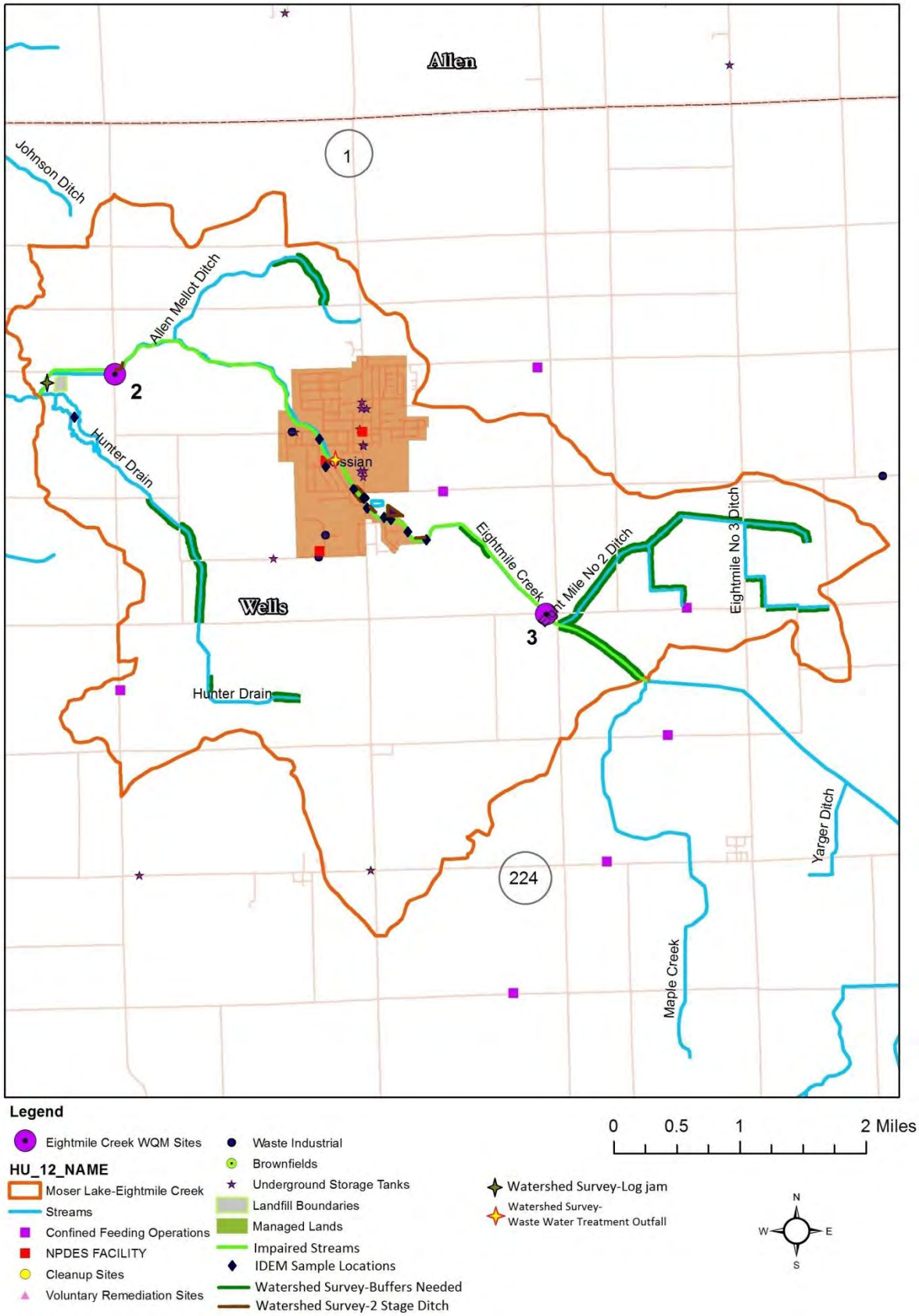
Current water quality monitoring used to evaluate this subwatershed was conducted at site 2 at CR 1000N at a 2-stage ditch location. Monitoring samples were collected a total of 14 times throughout the monitoring project. Dissolved oxygen levels exceeded the maximum target in five samples under moist, dry and low flow conditions, in both extremely warm and cold weather. Dissolved oxygen saturation levels exceeded 100% in eight samples out of 14 (57%) during both warm and cold weather and across the various flow conditions except during high flows. Turbidity exceeded the target for aquatic health in only four of the 14 samples during mid, moist and high flow conditions.

Based on the monitoring data, nutrients and *E. coli* have proven to be concerns at this site. Nitrate results exceeded the water quality target in all samples. The average concentration was the highest in the entire project area at 34.48 mg/L, more than three times the water quality target

level. The nitrite target was also exceeded in one sample, which was the only site in this subwatershed to exceed the target for Nitrite. This site also had the most exceedances of total nitrogen in the project, with five samples out of 12 (41%) exceeding the target. Total phosphorus results exceeded the water quality target in seven samples out of 12 (58%), and the average concentration was 1.09 mg/L, which is also three times the target level. *E. coli* exceeded the target for full body contact in eight out of 14 samples (57%), with an average concentration of 552 cfu/100mL. The exceedances occurred across all flow conditions. The samples with the three highest results occurred in November of each year under moist, mid-range flow and dry conditions. It is believed that overflows from the Ossian waste water treatment facility are having a dramatic impact on the test results at this site.

Habitat evaluations and biological studies were completed twice each year. This location is a site of a 2-stage ditch. The stream substrate is small to medium rock that is silted and smothered. In-stream habitat consists of aquatic plants and undercut banks with riffles and runs. The banks are generally stable with minimal erosion, and small trees and shrubs overhang the stream. The riparian area on one side of the stream is wide and constructed as a 2-stage ditch with established grass and residential property and cropland in the upland area. The other side is a steep bank with a narrow tree line that separates the stream from adjoining residential property. Just downstream, concrete construction debris has been placed on the bank, possibly in an attempt to stop erosion. Large trees have become unstable and fallen into the creek. The macroinvertebrate collections have received index ratings of good and excellent due to the variety and abundance of organisms present at the site.

Figure 62: Moser Lake-Eight Mile Creek, HUC 051201010902



4.3.3 Big Creek-Eight Mile Creek HUC 051201010903

Big Creek subwatershed contains 11,414 acres and is the most rural in the Eight Mile Creek watershed. A total of almost 24 miles of streams and 14 miles of county tile drain the subwatershed area. Most of the streams have adequate buffer strips and riparian area, however it is estimated that just over 9 miles are unbuffered. Severe bank erosion observed at two locations in this subwatershed is estimated to total 500 feet. Gully erosion was also observed at one site.

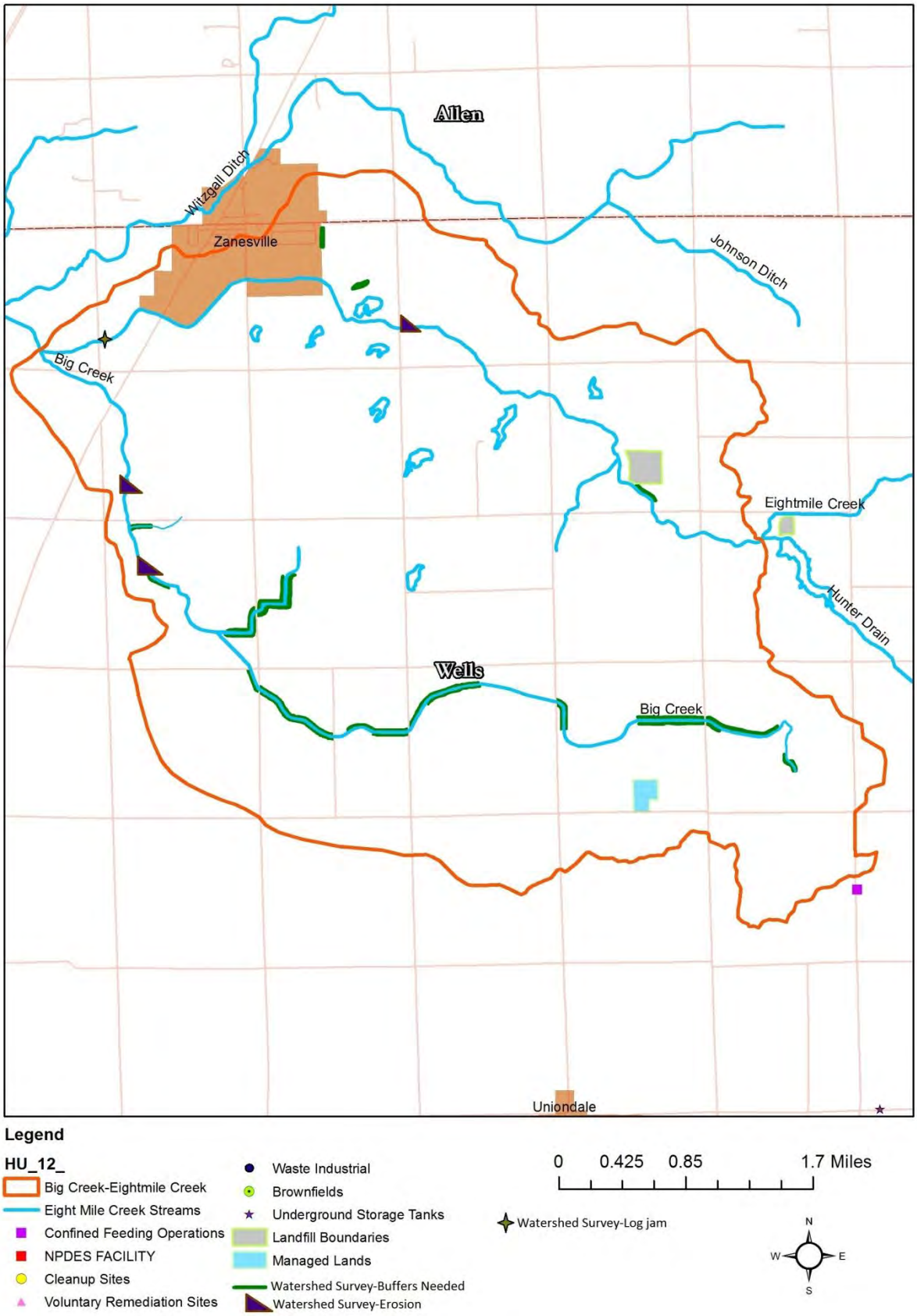
Agriculture is the dominate land use with cropland (9,065 acres) and pasture/hay lands (317 acres) accounting for 82.1% of the area. Forests cover over 988 acres (8.6%) and wetlands total 262 acres (2.2%). The largest percentage of HEL/PHEL soils in the Eight Mile Creek watershed are contained this subwatershed, at 5,908 acres (52%). Based on the 2013 tillage transect, it is estimated that 4,000 acres are conventionally tilled, but varies from year to year based on crop rotations due to landowners using reduced tillage or no-till on soybeans, but conventional tillage on corn. Approximately 650 acres of Conservation Reserve Program grass plantings were noted during the windshield survey. The desktop survey noted eleven conservation grass waterways in this subwatershed totaling over 15 acres. There are 97 unregulated livestock operations or hobby farms containing over 138,000 animals, including beef and dairy cattle, swine, horses, chickens turkeys and ducks. There are no CFOs in this subwatershed.

This subwatershed contains over one-half of the town of Zanesville (345 acres) which is serviced by a waste water treatment facility outside the project area. However, other common urban pollution sources, such as erosion from increased quantity and velocity of stormwater runoff, fertilizer use on lawns and parks, and contaminants from oils, road salts, etc. are still concerns in this subwatershed. The Northern Wells Landfill is located next to the Eight Mile Creek. It is a closed facility that continues to be monitored and inspected on a routine basis and no current compliance issues were noted. There are no NPDES sites in the subwatershed. Approximately 380 rural homes and farmsteads have on-site septic systems that are potentially contributing nutrients and pathogens to the streams.

IDEM does not have any monitoring locations in this subwatershed; however, a site is located approximately one-half mile downstream in the Pleasant Run Ditch-Eight Mile Creek subwatershed that is discussed in the next section.

Due to the locations of this projects water quality monitoring test sites, data is not available that is specific to this subwatershed; therefore the Big Creek subwatershed was combined with the Pleasant Run Ditch subwatershed for the purpose of evaluating and discussing the monitoring data. Data collected at site 1 is used as the indicator of the accumulated drainage area from the Big Creek and Pleasant Run Ditch-Eight Mile Creek subwatersheds. A review of the data results for this combined area is included in the Pleasant Run Ditch-Eight Mile Creek subwatershed section (Section 4.3.4 on page 139).

Figure 63: Big Creek-Eight Mile Creek, HUC 051201010903



4.3.4 Pleasant Run Ditch-Eight Mile Creek HUC 051201010904

Pleasant Run Ditch subwatershed encompasses 15,437 acres and is the largest subwatershed in the Eight Mile Creek watershed. There are approximately 29 miles of streams and 14 miles of county drainage tile. Buffers and riparian area is prevalent throughout the area, but eight miles of unbuffered streams would benefit from filter strips. In-stream and gully erosion was noted at three locations. The 5.6 miles of the Eight Mile Creek that runs through this subwatershed is on the 2012 Indiana 303(d) List of Impaired Waters due to impaired biotic communities.

Land use includes 11,623 acres of cropland (75%), 648 acres of pasture and grass plantings (4.2%), 1,151 acres of forest (7.4%), 310 acres of wetlands (2%), and 1,465 acres of urban area. Soils classified as HEL/PHEL cover 4,617 acres (29.9%). Farm operators use more reduced tillage and no-till in this subwatershed compared to the rest of the Eight Mile Creek watershed. Based on 2013 transect tillage reports, an estimated 4,200 acres (36%) are conventionally tilled. Nine conservation grass waterways totaling approximately seven acres are located in this subwatershed. There are no CFO facilities, but 133 livestock operations and hobby farms house over 43,000 animals; including beef and dairy cattle, swine, sheep, horses, chickens, turkey and ducks. Three locations of dairy cattle in feed lots and pastures in upland areas to nearby streams were observed during the windshield survey.

This subwatershed contains the remaining portion of the town of Zanesville (218 acres), and the large industrial area that includes the General Motors facility at the I-69/I-469 interchange on an estimated 678 acres. The same urban pollution concerns apply to this subwatershed as were detailed in the Big Creek section (4.3.3) above. There are seven underground storage tank sites (4 not leaking, 3 leaking), and three industrial waste sites in the area. Rural residences are more concentrated in this subwatershed due to the proximity to employment and amenities offered by nearby Fort Wayne, IN. On-site septic systems in this subwatershed service approximately 594 rural homes and farmsteads.

IDEM has two monitoring stations in this subwatershed. One station is located on the Witzgall Ditch between Indianapolis and Feighner Roads in Allen County, IN. This site was sampled in 1998. The chemistry resulted in exceedances of the water quality targets for nitrogen ammonia (14 mg/L), and nitrogen, nitrate+nitrite (13 mg/L). The macroinvertebrate collection lists the predominant organisms as the fairly tolerant midges and pollution tolerant aquatic worms; however the overall sample contained a large variety of different taxa that are intolerant to pollution. The fish survey also shows a variety of species, from the pollution tolerant creek chub and green sunfish to the fairly intolerant Johnny darter and sand shiner. The second location monitored in this subwatershed is on the Eight Mile Creek at CR 500W in Wells County. Chemistry and macroinvertebrate assessments were conducted in 1991, and again in 2004. All chemistry results met the recommended target. In 1991, the macroinvertebrate community was dominated by midges, which are fairly tolerant to pollution; however mayflies, caddis flies, and riffle beetles that are intolerant to pollution were also present in the sample. The 2004 sample was dominated by caddis flies and mayflies, and included midges, and black flies.

The current the water monitoring results from location site 1 for this project are used to evaluate both the Pleasant Run Ditch and Big Creek-Eight Mile Creek subwatersheds. Samples were

collected on 12 events throughout the monitoring project. Dissolved oxygen levels exceeded the maximum water quality target in only one sample that occurred on 4/25/14-4/26/14 following a wet weather event. Dissolved oxygen saturation levels exceeded 100% in four samples out of 12 during both warm and cold weather and across various flow conditions. Turbidity exceeded the target for aquatic health in five samples out of 12. The exceedances occurred under high flow, moist and dry conditions. The average concentration for Turbidity was 84.49 NTUs, which is over three times the target level.

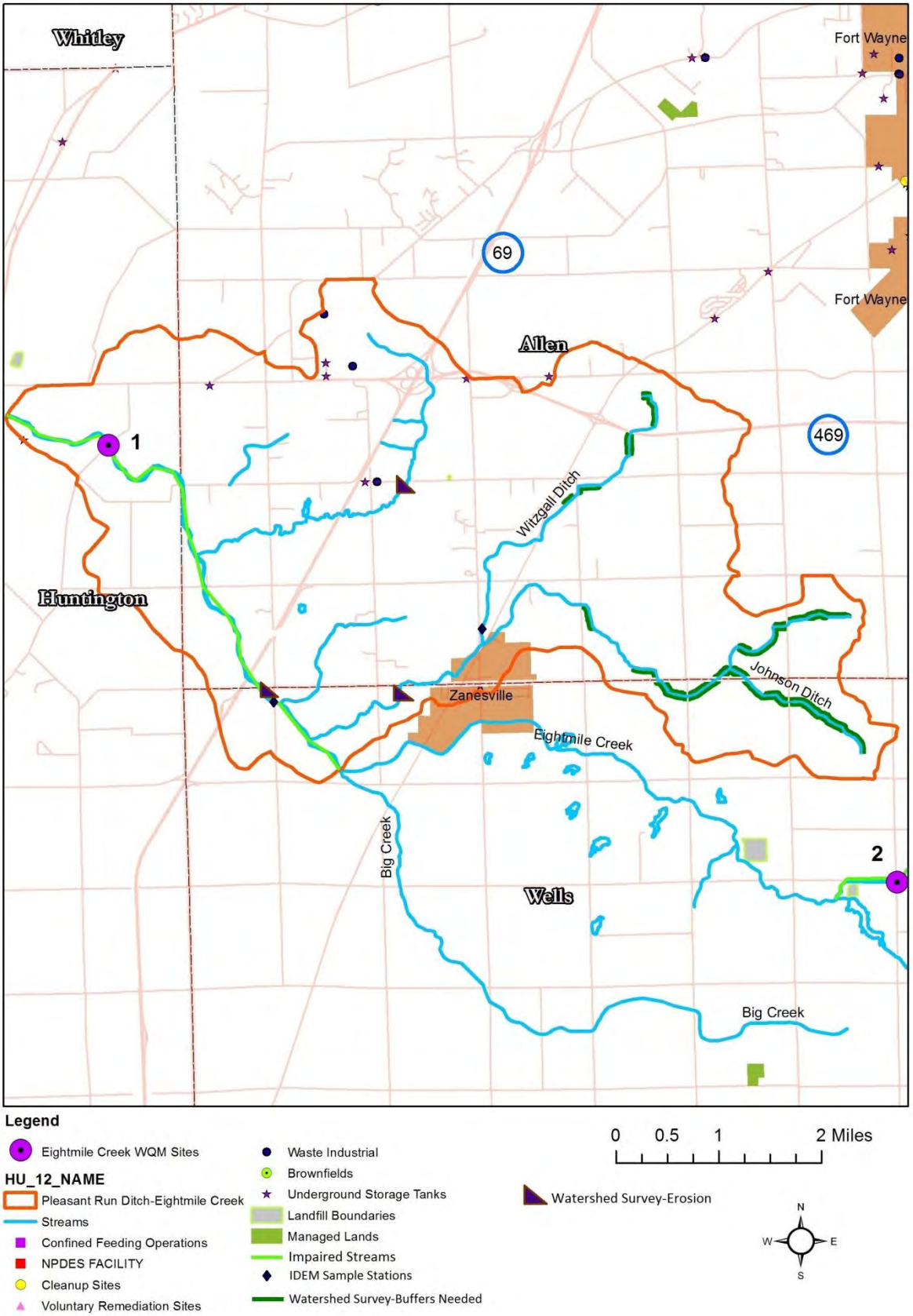
Site 1 exceeded the nitrate target in five samples out of 12 (41%), which was the lowest number of exceedances when compared to the other Eight Mile Creek sites. The nitrate average concentration was 9.34 mg/L, meeting the water quality target as well as being the lowest concentration of all the monitoring sites in the project area. The total nitrogen results exceeded the target on one occasion, on 4/5/14 which was due to spring melt. The total phosphorus tests exceeded the target level in four samples out of 12 (33%). The exceedances coincide with fall agricultural activities, and spring runoff during wet weather events. In general, when comparing the Eight Mile Creek monitoring results for these nutrients, this site has less exceedances and lower concentrations than the other sites. This may be due to the increased amount of buffers, forest, wetlands and conservation areas; or may be due to dilution of the pollutants by the time they reach this site.

E. coli exceeded the target for full body contact in seven out of 14 samples (50%), with an average concentration of 497 cfu/100mL. The exceedances occurred across all flow conditions. The samples with the three highest results occurred in August and November under dry and moist conditions, indicating both inputs from surface and sub-surface sources.

Habitat evaluations and biological studies were completed two times during the monitoring program (9/12/13 and 9/6/14). In the initial assessment, the stream substrate had both small and large rock that was silted, and the in-stream habitat consisted of roots, aquatic plants and undercut banks with riffles and runs. The banks were a combination of stable and eroding, with trees over hanging and shading the stream. The riparian area was a forested buffer with grass filter strip adjoining row crops and residential property. The ranking for the site resulted in a good rating meaning that it was conducive for warm water fauna. When the second evaluation was completed, the site had dramatically changed. Ditch maintenance had been completed on approximately three miles of the stream. All trees on the banks and in the buffer area had been cut and cleared. The stream bottom was now very sandy, and most of the in-stream habitat was removed. The riparian area was now void of grass and trees, just bare soil. It was not apparent if seeding had yet occurred. This time the site received a rating below the water quality target.

During the first macroinvertebrate collection, only a few organisms were found which resulted in a rating of fair. On the second event, a variety of organisms from the various groups were collected, resulting in an improved score and a rating of excellent. It was expected that the results would have been much less due to the recent habitat alterations, but that did not seem to be the case. It was suggested that maybe the removal of sediment during the ditch maintenance actually improved the conditions for the macroinvertebrates. This site will continue to be monitored to further evaluate the changes in the habitat and biotic communities.

Figure 64: Pleasant Run Ditch-Eight Mile Creek, HUC 051201010904



4.3.5 Eight Mile Creek 10-digit HUC (HUC: 0512010109) Watershed Summary

The Eight Mile Creek watershed contains over 112 miles of streams and ditches, and approximately 6.5 miles of the Eight Mile Creek are listed on the 2012 Indiana 303(d) List of Impaired Waters due to *E. coli* and impaired biotic communities, and another 5.6 miles is listed due to impaired biotic communities.

Agriculture is the primary land use on approximately 85% of the land area (43,956 acres). This watershed contains the largest amount of grasslands (909 acres) and pasture/hay land (1,071 acres) in the Upper Wabash River Phase 2 project area. There are six CFOs in the watershed, all in the eastern, more rural part of the watershed, and all are located within a half mile of a stream. As with the rest of the project area, fall tillage was observed during the windshield survey and conventional tillage is estimated on 18,600 acres (42%), however more cover crops fields were established in this subwatershed.

The western portion of this subwatershed is more rolling and has more slope than the rest of the nearly flat project area. The windshield survey revealed that a larger portion of the grasslands, pastures/hay land and woodlands are located in this area. The desktop survey showed 31 grassed waterway have been installed on approximately 33 acres to reduce the erosion from farm fields entering the streams; however, over 1300 feet of stream bank erosion and was observed in the Big Creek subwatershed. The majority of the streams have filter strips, but based on the windshield and desktop surveys, it is estimated that the installation of approximately 52 miles of additional buffer areas would be a benefit to the watershed. A 2-stage ditch (1,750 feet) was installed in 2012 on the Eight Mile Creek by the Wells County Surveyor's office and this location is a water quality monitoring site. It will be assessed for the possible benefits to water quality, and as an option to reduce flooding. It was discovered that four additional 2-stage ditch areas are located on the Eight Mile Creek in the Town of Ossian.

The urban areas in this subwatershed are the towns of Ossian (population 3,289) and Zanesville (population 600), and smaller communities of Tocsin and Craigville. The town of Ossian operates a municipal waste water facility to service the 1,385 homes, and 110 businesses and manufacturing facilities. There are three NPDES permitted facilities and seven industrial waste sites within the watershed. NPDES reports show that the town of Ossian waste water treatment plant has had overflow discharges to the Eight Mile Creek three times in the last year due to storm events or equipment issues. The North Wells landfill also borders the Eight Mile Creek. The landfill was capped in 1995, but continues to be inspected. Past landfill inspection reports have listed sparse vegetation and leachate as compliance issues that require monitoring and corrective action. Discharges from this site would be a water quality issue.

Most of the development in the watershed is considered low intensity (1,022 acres), but there are also medium intensity (262 acres) and high intensity (678 acres) areas. In the eastern portion of the watershed, and more rural areas south and west of Ossian, the average number of homes equal 14 per square mile. The number of homes per square mile increases to 31 in the north-western portion of the watershed due to the proximity to jobs, shopping, and other amenities that are offered in Allen County and Fort Wayne, IN. Based on these averages and estimating the square mile areas using the IndianaMap GIS site over 1,600 homes in the watershed have septic

systems. As discussed previously, limited suitability of soils and lack of maintenance contributes nutrients and bacteria to local streams.

The Eight Mile Creek water quality monitoring data indicates that turbidity, nutrients and *E. coli* are concerns in this subwatershed. Turbidity measurements were above the target level 53% of the time throughout the monitoring period. Turbidity levels were elevated across all flow conditions during the monitoring period. This would indicate that organic matter, as well as sediment in the stream is contributing to the stream degradation.

Nitrates regularly exceeded the target levels. Of the 48 samples collected during the monitoring program, 33 samples (68.75%) exceeded the nitrate water quality target. Most of the exceedances occurred during high flow, moist conditions and mid-range flows indicating nutrients were being carried into the streams during wet weather events. Due to the topography of this watershed, and the primary land use being agriculture, storm water runoff and erosion from agricultural activities are believed to be a major contributor of these nutrients. All four Eight Mile Creek sites exceeded the total nitrogen target on the 4/25/14-4/26/14 monitoring event, which indicates runoff from a recent weather event was the probable cause. Overall, the total nitrogen samples only had nine exceedances out of the 48 samples (18.75%). Three of the sites remained within the water quality target the majority of the time. The exception is site 2 in the Moser Lake subwatershed. It is located downstream from the town of Ossian and exceeded the nitrate target in all samples across all flow conditions, and had an annual average concentration of 34.48 mg/L throughout the monitoring period, over three times the water quality target. It was also the only Eight Mile Creek site to exceed the nitrite target in one sample, and had five of the nine exceedances of the total nitrogen target.

Total phosphorus monitoring results exceeded the target in 19 of the 48 samples (39.5%), with three sites each having four exceedances, and site 2 with seven out of 12 samples over the water quality target. Most of the target exceedances occurred during high flow and moist conditions. Again, the exception to the monitoring results is site 2. That site exceeded the total phosphorus target in seven samples across all flow conditions, had the highest result of total phosphorus at 2.39 mg/L out of all 15 monitoring sites in the project area, and had an annual average concentration of 1.099 mg/L, three times the water quality target.

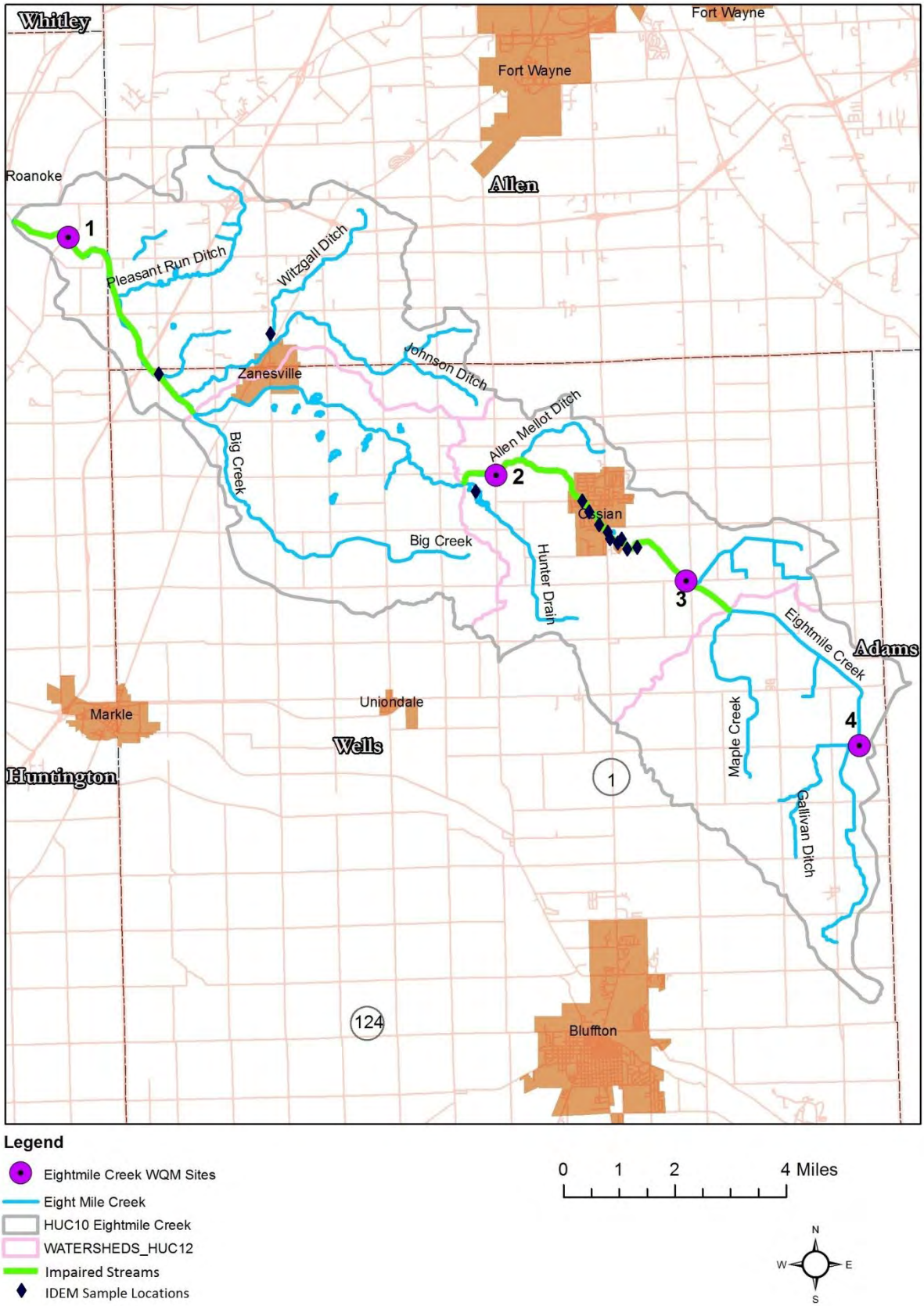
E. coli exceeded the state standard for full body contact in 30 out of 50 samples (60% of the time). All four monitoring sites had the highest exceedances on 11/1/13-11/3/13 between 400 cfu/100mL and 3800 cfu/100mL and on 11/21/13-11/23/13 between 267 cfu/100mL and 1833 cfu/100mL. These events occurred at periods of normal flow. Due to the timing of these events, animal manure land applications and on-site septic systems are believed to be the cause. Site 4 had the highest sample result of all 15 monitoring sites in the project area, as well as the highest annual average concentration of 766 cfu/100mL, over three times the water quality target for full body contact.

In general, site 1 monitoring results tend to be lower than the other monitoring sites in the Eight Mile Creek watershed and may be due to having a larger percentage of woodlands, grass lands, hay lands and conservation waterways than the remainder of the watershed area, or the concentrations of nutrients are diluted by this point.

Habitat evaluations and macroinvertebrate sampling on the Eight Mile Creek ranged lower overall from the other watersheds in the Phase 2 project area. The substrate of the stream ranged from small fine material at site 4 to a combination of small material and larger rocks downstream at site 1. Silting of the substrate was noted along with undercut banks and shallow areas of cover. Many man-made changes have occurred to the entire length of the Eight Mile Creek and the riparian area ranges from narrow to medium width with adjacent cropland. Initially sites 1 and 2 met the standard to be considered conducive to warm water fauna, but later evaluations indicated changes to the habitat that lowered the scores and resulted in all sites failing to reach the target for good aquatic health. Three miles of riparian buffer was cleared at site 1 near the end of the monitoring period, leaving no buffers and exposed soil at the monitoring site. This location will continue to be monitored to determine the effects of the ditch maintenance at this site.

Biological monitoring was conducted at three of the sites once each year, and twice each year at site 2. On the first monitoring event, the macroinvertebrate ratings ranged from poor to fair with the exception of site 2, which was rated as good. The following monitoring event resulted in an increase of organisms present at the sites and the ratings improved to good and excellent. Site 2 rated better overall than the other sites in this watershed, which may be due to the benefits of the 2-stage ditch at the monitoring location.

Figure 65: Eight Mile Creek (HUC: 0512010109) Watershed



5.0 Review of Watershed Problems and Causes

5.1 Summary of Watershed Inventory

The goal of the watershed inventory is to identify activities that might be contributing to nonpoint source pollution. These were discussed in detail in the individual subwatershed sections; therefore, this is an overall summary of the land use information and water quality impairments.

Land Use

The Headwaters-Rock Creek subwatershed has the greatest number of total stream miles (39 miles) in the project area; with the Dowty Ditch-Wabash River and Stites Ditch-Rock Creek with the next greatest number at 35 miles each. The Griffin Ditch-Wabash River only has 12 miles of streams, but drains the largest number of acres per stream miles (1,151 acres). Bender Ditch-Wabash River also has 12 miles of streams and drains an estimated 854 acres per stream mile; followed by Mossburg Ditch-Rock Creek, which has 13 miles of streams and drains approximately 833 acres per stream mile.

The Griffin Ditch-Wabash River only has 12 miles of streams in the subwatershed, and 6 miles (50%) are on the IDEM 303(d) list. The same applies to the Moser Lake-Eight Mile Creek with 6.5 miles of impaired streams out of a total 18 stream miles (36.1%) and Bender Ditch-Wabash River subwatersheds with 4 miles of impaired streams out of a total 12 stream miles (33%). The Elkenberry Ditch-Rock Creek subwatershed has the largest number of stream miles (7 miles) on the IDEM 303(d) list of impaired waters, however based on the total number of stream miles in the subwatershed; this only equals 21.9%. The Stites Ditch-Rock Creek contains the greatest amount of drainage tile (40 miles), followed by Elkenberry Ditch-Rock Creek (35 miles), Maple Creek-Eight Mile Creek (32 miles) and Headwaters-Rock Creek (32 miles) subwatersheds.

The Stites Ditch-Rock Creek is the largest subwatershed in the project area, and has the highest percentage of agricultural land use (91%). It is followed by the Headwaters-Rock Creek (90%), Mossburg Ditch-Rock Creek (90%), Maple Creek-Eight Mile Creek (89%), Bender Ditch-Wabash River (88%), and Elkenberry Ditch-Rock Creek (86%) subwatersheds. In comparison to the total subwatershed acres, the Stites Ditch-Rock Creek, Headwaters-Rock Creek and Maple Creek-Eight Mile Creek subwatersheds also contain the least percentage of woodlands and wetlands, 4.2%, 4.1%, and 4.7% respectively. The Big Creek-Eight Mile Creek subwatershed has the highest percentage of HEL/PHEL soils at 52%, followed by Mossburg Ditch-Rock Creek with 41.5%, Elkenberry Ditch-Rock Creek with 39% and Dowty Ditch-Wabash River with 37%.

Nearly 100 miles of streams were identified in the project area as lacking buffer areas that would adequately provide filtering of sediment and nutrients along the stream reaches. The Maple Creek- Eight Mile subwatershed is in need of 13 miles of stream buffers on its 32 miles of streams (68.4%). The Dowty Ditch-Wabash River subwatershed, on the other hand, was also estimated to require 13 miles of stream buffers on its 26 miles of streams or only 37.1% of the stream miles in that subwatershed. The Moser Lake-Eight Mile Creek subwatershed is estimated to have 12 miles of streams lacking buffers on its 18 miles of streams (66.6%), followed by 10 miles of stream buffers out of 32 miles of streams (31.2%) in the Johns Creek-Wabash River subwatershed. In-stream, stream bank and gully erosion was identified in all subwatersheds.

The Stites Ditch-Rock Creek subwatershed had the highest number with 9 sites; followed by Elkenberry Ditch-Rock Creek with 7 sites and Mossburg Ditch-Rock Creek with 6 sites.

Based on tillage transect information the subwatersheds that have the highest percentage of conventional tillage in the project area are Stites Ditch-Rock Creek (53.7%), Headwaters-Rock Creek (53%), Johns Creek-Wabash River (50%), Bender Ditch-Wabash River (49.9%), and Dowty Ditch-Wabash River (49.7%). The largest number of CFO's is located in the Johns Creek-Wabash River subwatershed, followed by the Stites Ditch-Rock Creek and Maple Creek-Eight Mile Creek subwatersheds. The Pleasant Run Ditch- Eight Mile Creek subwatershed has the highest number of hobby farms (133), and based on the acreage in the subwatershed, it would be the most concentrated in the project area. The Big Creek-Eight Mile Creek subwatershed with 97 hobby farms would be the fifth highest in the number of hobby farms, but would rate as the second most concentrated subwatershed for hobby farms.

The Pleasant Run Ditch-Eight Mile Creek has the greatest number of on-site septic systems (594), and greatest concentration of systems based on the total subwatershed acres. Dowty Ditch-Wabash River subwatershed has the next greatest number of septic systems (452), but is rated as fourth in concentration compared to the total acres. The Big Creek-Eight Mile Creek subwatershed with 380 septic systems is ranked as fifth by number of systems, but would be the second highest in concentration of systems when compared to the total acreage in the subwatershed. The same applies to the Moser Lake-Eight Mile Creek rated sixth by number of systems (369), but rated third by concentration.

The Dowty Ditch-Wabash River subwatershed contains the largest amount of development in the project area (3,159 acres), which includes part of the City of Bluffton, surrounding subdivisions, and smaller rural communities. The Johns Creek-Wabash River subwatershed contains approximately 1,767 acres of developed area; followed by the Moser Lake-Eight Mile Creek subwatershed (1,024 acres) and Griffin Ditch-Wabash River subwatersheds (947 acres). Waste water treatment facilities for the urban areas are located in the Headwaters-Rock Creek subwatershed, Dowty Ditch-Wabash River subwatershed, Griffin Ditch-Wabash River subwatershed, and Moser Lake-Eight Mile Creek subwatershed. Overflows to the streams and river have occurred at all waste treatment locations.

The Johns Creek-Wabash River subwatershed contains the greatest number of NPDES sites (5), leaking underground storage tanks (11), industrial waste sites (10), and environmental clean-up sites (2). Moser Lake-Eight Mile Creek has three NPDES sites, five leaking underground storage tanks, and three industrial waste sites; followed by Dowty Ditch-Wabash River with two NPDES sites, ten leaking underground storage tanks, and two industrial waste sites.

Water Quality Information

Based on historic water quality data and the current water quality assessment, water quality impairments were identified during the watershed inventory process. These include elevated nutrients (nitrate, nitrite, total nitrogen, and total phosphorus), *E. coli*, and turbidity, as well as poor macroinvertebrate communities and low-scoring habitat evaluations. Figures 66–68 highlight locations where the water monitoring data results failed to meet the selected target.

Nutrients

Nutrients have long been identified as a pollutant concern in the Upper Wabash River – Phase 2 project watersheds. Current sampling efforts show the nitrate levels exceeded the target of 10 mg/L, a State of Indiana standard for waters designated as a drinking water source, at all 15 monitoring sites in all subwatersheds. Out of the 178 nitrate samples collected, 109 samples (61%) exceeded the target. The majority of exceedances occurred from mid-range flow to high flow conditions; however, exceedances in dry and low flow conditions occurred in the Moser Lake-Eight Mile Creek, all four Wabash River subwatersheds, and Elkenberry Ditch-Rock Creek subwatershed. Average nitrate concentrations ranged from 9.34 mg/L to 34.48 mg/L. The Pleasant Run/Big Creek-Eight Mile Creek subwatershed average was the only one that met the target. The Moser Lake-Eight Mile Creek subwatershed had the highest average.

The nitrite level of 1mg/L was exceeded two times in the Elkenberry Ditch-Rock Creek subwatershed during dry and moist conditions. It was also exceeded once each in the Johns Creek-Wabash River subwatershed during low flow and Maple Creek-Eight Mile Creek subwatershed during high flow. The Elkenberry Ditch-Rock Creek was the only subwatershed to have an average concentration of 1.508 mg/L that exceeded the target level.

Total nitrogen levels exceeded the target of 10 mg/L in at least one sample at all monitoring locations in all subwatersheds during moist conditions or high flow events. Additional exceedances of the total nitrate target included: Moser Lake-Eight Mile Creek subwatershed exceeded the target during twice during low flow, and once each during dry conditions and mid-range flows. The Maple Creek-Eight Mile Creek subwatershed had an additional exceedance during mid-range flow. The Johns Creek-Wabash River subwatershed also had one exceedance each during low flow and dry conditions. The Stites Ditch-Rock Creek subwatershed had an additional exceedance under mid-range flow conditions.

The total phosphorus target of 0.3 mg/L is the Wabash River TMDL target selected by IDEM. This target was exceeded in 78 of the 178 samples (44%) that were collected during the monitoring period. All sites exceeded the target on at least one occasion. Several monitoring sites exceeded the target in multiple samples over all flow conditions. The Dowty Ditch-Wabash River subwatershed had the most exceedances (11 out of 14), followed by Johns Creek-Wabash River subwatershed (9 out of 11), Griffin Ditch/Bender Ditch-Wabash River subwatershed (8 out of 11), Moser Lake-Eight Mile Creek subwatershed. All of the Rock Creek subwatershed sites only exceeded the target during moist conditions or high flow. Average concentrations for total phosphorus ranged from 0.17 mg/L in the Elkenberry Ditch-Rock Creek subwatershed to 1.099 mg/L in the Moser Lake-Eight Mile Creek subwatershed.

E. coli

E. coli has historically been a concern for water quality in the project area. Current sampling shows that all subwatersheds in the project area exceeded the *E. coli* target of 235 cfu/100mL for full body contact. All monitoring sites had at least three events that exceeded the target, and the average concentrations ranged from 295 cfu/100mL to 766 cfu/100mL. The Dowty Ditch-Wabash River had the most exceedances in 11 out of 14 samples (79%). The Moser Lake-Eight Mile Creek, Maple Creek-Eight Mile Creek, Johns Creek-Wabash River, and Dowty Ditch-Wabash River subwatersheds had exceedances across all flow conditions. The Pleasant Run/Big

Creek-Eight Mile Creek and Stites Ditch-Rock Creek subwatersheds had exceedances across the various flow conditions except during high flow. In the Rock Creek watershed, the Headwaters-Rock Creek subwatershed was the only one to have an exceedance during low flow. The Maple Creek-Eight Mile Creek subwatershed had the highest single result of 3,800 cfu/100mL.

Turbidity

The water quality target for turbidity of 25 NTUs is based on the Minnesota TMDL criteria for the protection of fish and macroinvertebrate health. A total of 175 turbidity samples were completed throughout the monitoring project, 114 samples (65%) exceeded the target. During two spring sampling events, following snow and ice melt and early wet weather events, all 15 monitoring sites exceeded the target during both events. The turbidity average concentration ranged from 44.64 NTUs in the Stites Ditch/Mossburg Ditch-Rock Creek subwatershed to 197.55 NTUs in the Johns Creek-Wabash River subwatershed. All of the Wabash River subwatersheds had the highest number of exceedances across all flow conditions. The Griffin Ditch/Bender Ditch-Wabash River subwatershed exceeded the target in 100% of the (11) samples, followed by the Johns Creek-Wabash River subwatershed with 95% (23 out of 24 samples), and the Dowty Ditch-Wabash River with 11 out of 13 samples (85%). Turbidity levels also exceeded the target during low flow in the Maple Creek-Eight Mile Creek subwatershed, and Stites Ditch-Rock Creek subwatershed.

Macroinvertebrate Communities

The Hoosier Riverwatch Pollution Tolerance Index (PTI) was used to evaluate the macroinvertebrate communities. The index score of 0-10 is considered poor, 11-16 is rated as fair, 17-22 is good, and 23 or more is considered excellent. The water quality target that was selected for this parameter was >10. The macroinvertebrate communities were sampled a minimum of two times during the project, and the index scores were averaged to obtain an overall rating. One location within the Dowty Ditch-Wabash River subwatershed failed to meet the target with a rating of 7.5. Locations that met the target but rated as fair include Maple Creek-Eight Mile Creek, Moser Lake-Eight Mile Creek, and Elkenberry Ditch-Rock Creek subwatersheds. The remaining subwatersheds scored a good rating or higher.

Habitat

The Hoosier Riverwatch Citizen's Qualitative Habitat Evaluation Index (CQHEI) was used for the habitat evaluations. The CQHEI score of >60 is considered to be conducive to support aquatic life, and was selected for the target. The habitat evaluations were completed a minimum of two times during the monitoring project. The index scores were then averaged to obtain an overall rating. The average scores ranged from a low of 30 at a location in the Maple Creek-Eight Mile subwatershed, to 89.5 at a site in the Griffin Ditch-Wabash River subwatershed. Locations not meeting the target included sites in the Stites Ditch-Rock Creek, Griffin Ditch-Wabash River, Dowty Ditch-Wabash River, and all of the four Eight Mile Creek subwatersheds.

Figure 66: Water Quality Monitoring Exceedances – Rock Creek, HUC 0512010107

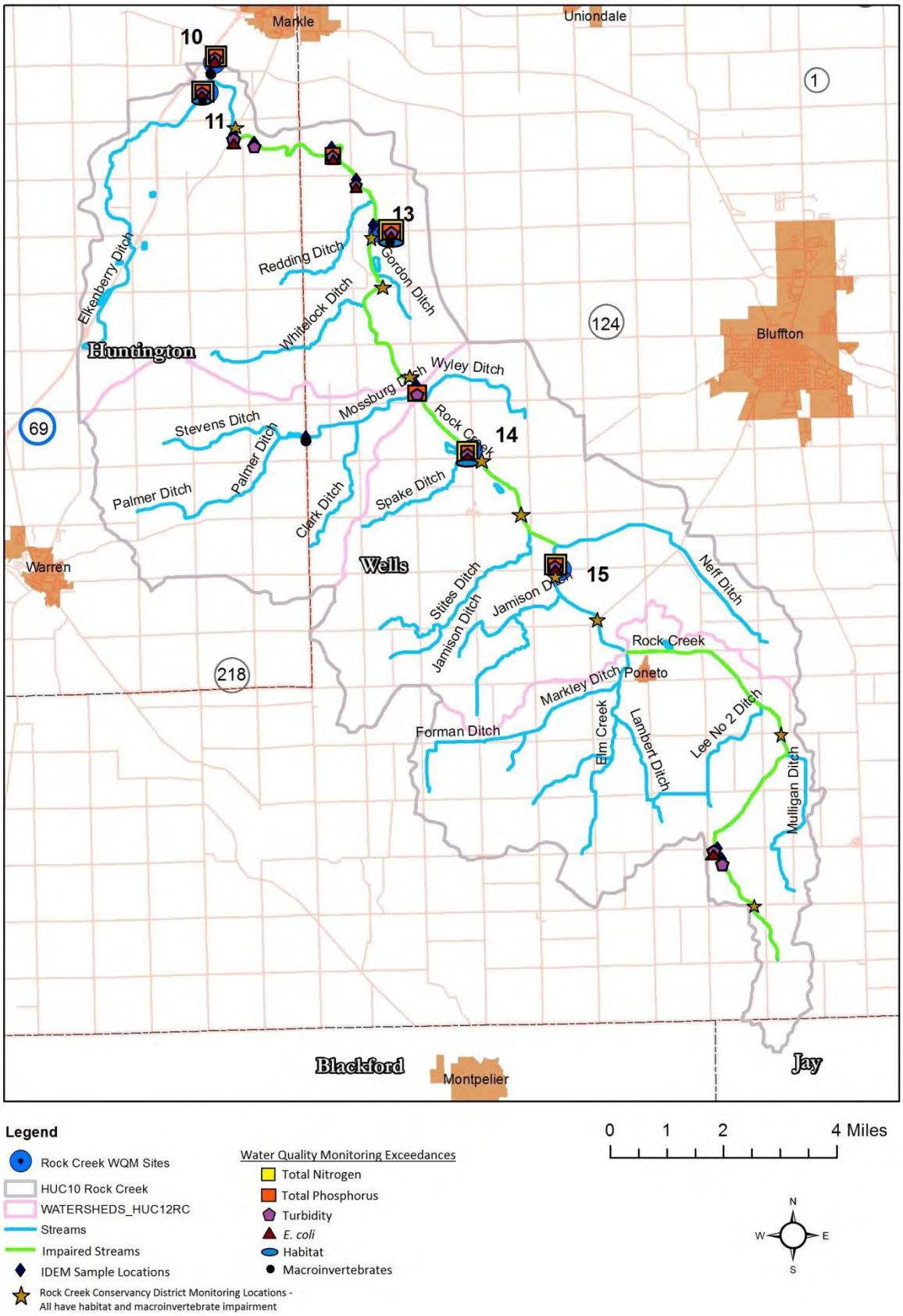


**Figure 67: Water Quality Monitoring Exceedances–
Griffin Ditch-Wabash River, HUC 0512010108**

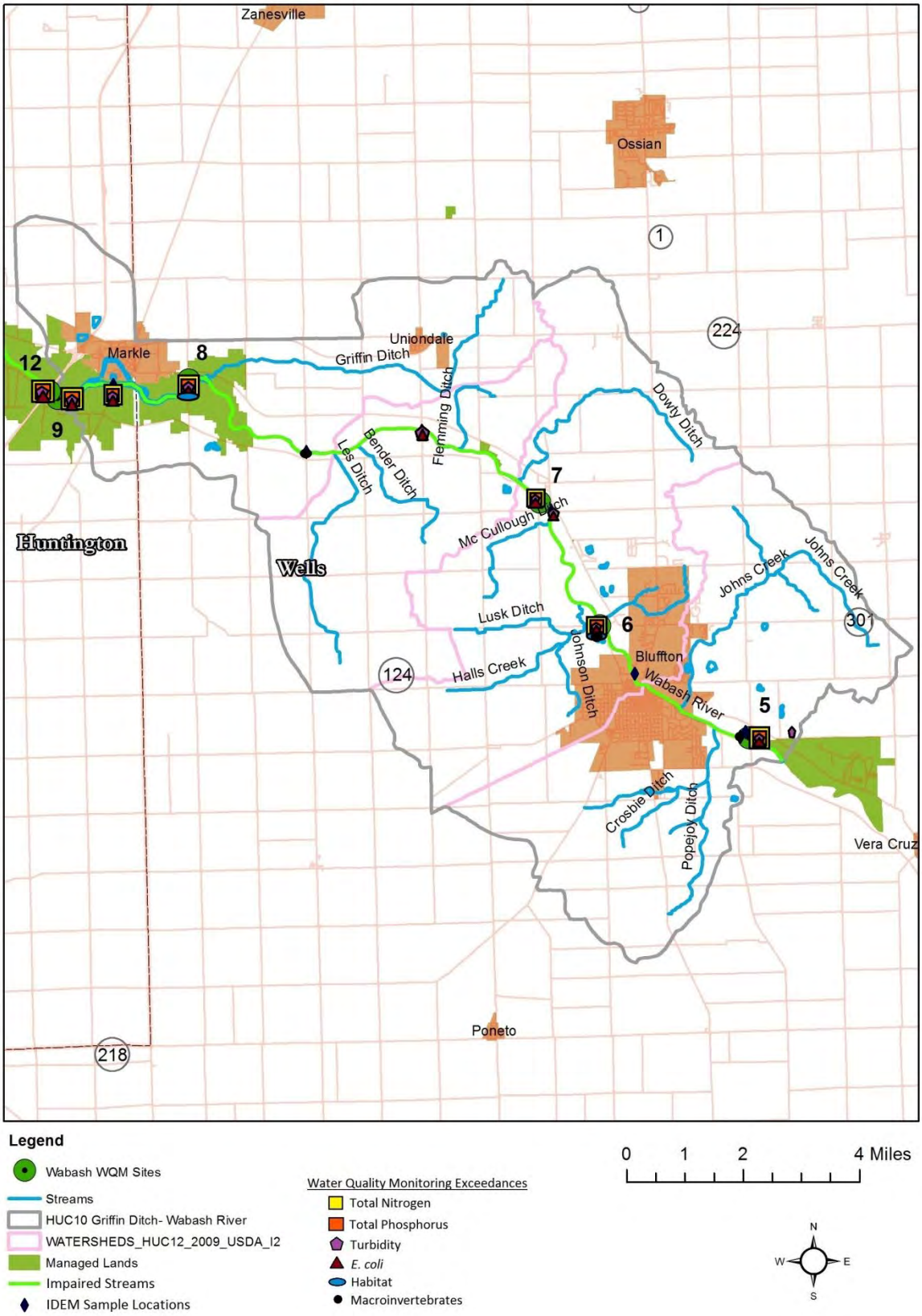
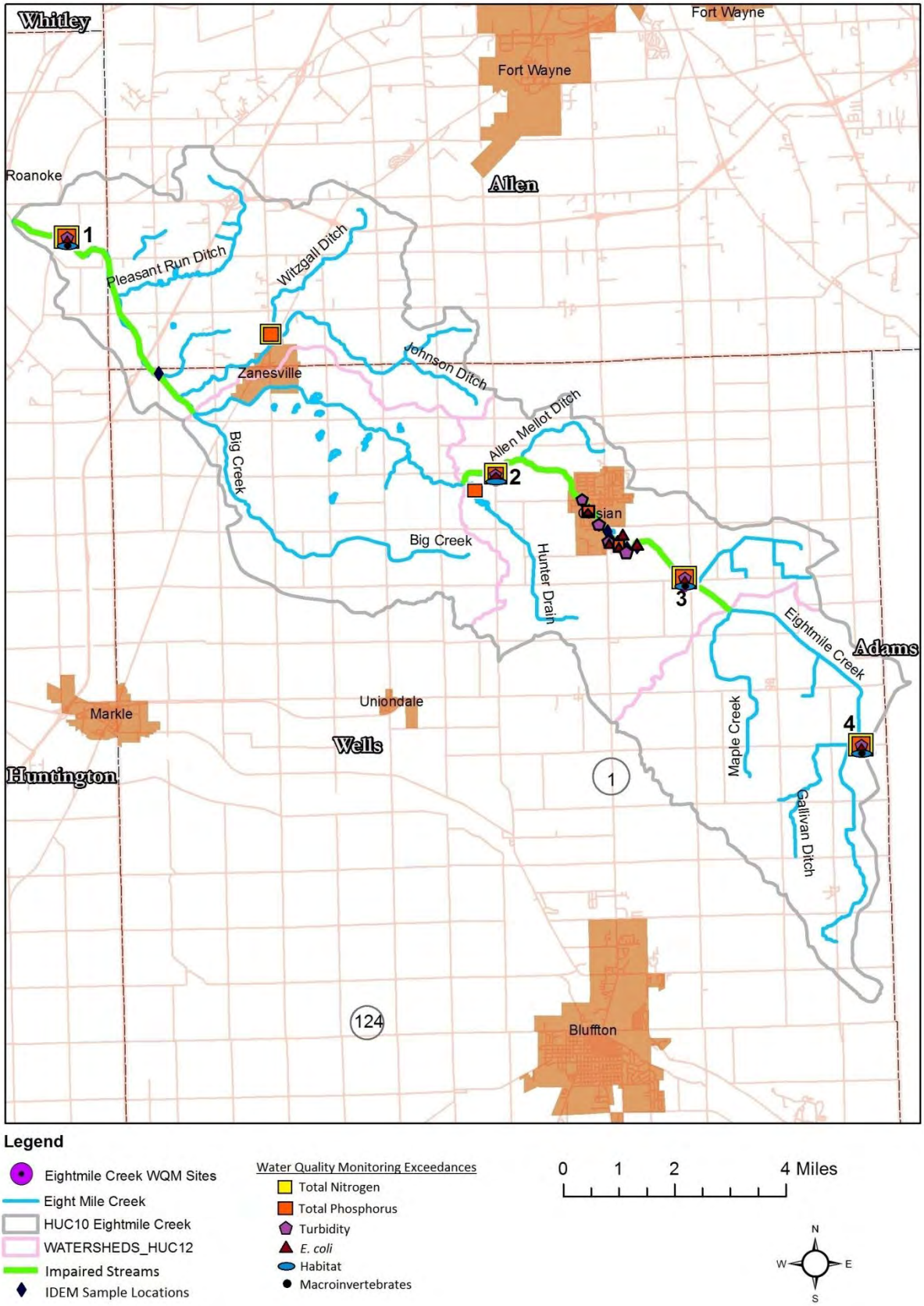


Figure 68: Water Quality Monitoring Exceedances – Eight Mile, HUC 0512010109



5.2 Analysis of Stakeholder Concerns

A list of initial watershed concerns was generated by stakeholders, UWRBC members and steering committee members at public meetings early in the planning process. The list was reviewed several times by the UWRBC members and steering committee members and then compared to the watershed inventory information to see what evidence supported or did not support the concern. The list of concerns was further evaluated to determine whether the concern was quantifiable, whether it is within the scope of the watershed management plan, and if it is something that the group wants to focus on. The following tables represent a work in progress and additional concerns, problems, causes and sources may be added upon additional analysis of monitoring data or as additional watershed information comes to light.

Table 5-1: Stakeholder Concerns

Stakeholder Concerns	Supported by Data?	Evidence	Able to Quantify?	Outside of Scope?	Group wants to focus on?
Log jams and debris in the river and streams.	Yes	Observed during watershed inventory: Rock Creek–2, Wabash River–1, Eight Mile-2.	Yes	No	Yes
Encourage 2-stage ditches.	Yes	Two possible sites for a 2-stage ditch on Eight Mile Creek.	Yes	No	Yes
Flooding along the river and streams.	Yes	Observed in all watersheds during spring snow/ice melt.	Yes	No	Yes
In-stream and stream bank erosion causing sedimentation.	Yes	Sediment and undercut banks noted at all sites on CQHEI; turbidity exceeded target levels in 60% of the samples; windshield survey noted erosion in all watersheds.	Yes	No	Yes
Agriculture fertilizer (nitrogen and phosphorus) runoff into streams.	Yes	61% of nitrate and 57% of total phosphorus results exceeded target levels	Yes	No	Yes
Manure management; stockpiling and application practices.	Yes	3 manure stockpiles present in watersheds (1 in each); 56% of *E. coli,* 61% nitrate and 57% total phosphorus results exceeded target levels	Yes	No	Yes
Tillage to the edge of stream banks; no filter strips or riparian area.	Yes	Observed during watershed inventory – (buffers needed - Rock Creek 48 mi., Wabash River-Griffin 35 mi., Eight Mile 38 mi.)	Yes	No	Yes
Conservation tillage has low adoption rates.	Yes	Tillage Transect: 87% corn production, 22% bean production using conventional tillage = 66,405 acres	Yes	No	Yes

Stakeholder Concerns	Supported by Data?	Evidence	Able to Quantify?	Outside of Scope?	Group wants to focus on?
Lack of buffers and filter strips on streams.	Yes	Observed during watershed inventory – needed on Rock Creek 48 mi., Wabash River-Griffin 35 mi., Eight Mile38 mi.	Yes	No	Yes
Residential runoff from chemically treated lawns (fertilizers and pesticides).	No	More detailed data is needed within targeted urban/residential areas. The stakeholders would like to address this issue if future evidence is found.	No	No	Yes
Construction Site (and road construction) erosion causing sedimentation.	No	More detailed data is needed. The stakeholders would like to address this issue if future evidence is found.	No	No	Yes
High *E. coli* levels.	Yes	*E. coli* exceeded target levels in 56% of samples	Yes	No	Yes
Failing septic systems, severely limiting soils, lack of maintenance.	Yes	4,000 rural on-site septic systems are estimated to be in the project area on severely limiting soils. It is very likely that some are failing; *E. coli* target level exceeded in 56% of samples; nitrate target exceeded in 61% of samples; total phosphorus exceeded target in 57% of samples	Yes	No	Yes
Wastewater treatment in unincorporated communities.	Yes	There are 9 rural unincorporated communities in project area with on-site septic systems.	Yes	No	Yes
Runoff from asphalt streets and parking lots.	No	Impervious area 3% of the project area. More detailed data is needed within targeted urban areas	No	No	Yes
Wetlands drained and forests cleared.	Yes	USDA verification, Observed during watershed inventory	Yes	No	Yes
Lack of green space and trails.	Yes	Observed during watershed inventory	Yes	No	Yes
Dumping, trash in river and streams.	Yes	Observed during water testing and watershed inventory – River clean ups have removed 4 truckloads of debris	Yes	No	Yes

It should be noted that flooding concerns are listed as being outside the scope of the watershed management plan and will only be addressed in relation to the effect it has on the water quality within the watersheds or for BMPs that are intended to improve water quality but also reduce flooding impacts as a secondary benefit.

5.3 Identified Problems

After several reviews and evaluations of the stakeholder concerns and watershed inventory information, the UWRBC members and steering committee identified problems associated with each concern. As the UWRBC steering committee continued their review of the concerns, they realized that some of the concerns were actually problems or causes of pollution in the watershed. The problems were identified, and the concerns related to those problems were grouped together. Table 5-2 reflects the group of concerns that represent the problem or the condition that exists in the watershed.

Table 5-2: Problems identified for the Wabash River Watershed – Phase 2 project area based on stakeholder and inventory concerns.

Stakeholder Concerns:	Problems:
• Log jams and debris in the river and streams. • In-stream and stream bank erosion causing sedimentation. • Dumping, trash in river and streams.	Restricted/redirected flow within the stream or river.
• Flooding along the river and streams. • In-stream and stream bank erosion causing sedimentation. • Tillage to the edge of stream banks; no filter strips or riparian area. • Conservation tillage has low adoption rates. • Lack of buffers and filter strips on streams. • Construction site (and road construction) erosion causing sedimentation. • Wetlands drained and forests cleared. • Lack of green space and trails.	Sediment and increased levels of turbidity threatens the water quality health of the streams and river in the watershed.
• Encourage 2-stage ditches. • Tillage to the edge of stream banks; no filter strips or riparian area. • Conservation tillage has low adoption rates. • Lack of buffers and filter strips on streams. • Runoff from asphalt streets and parking lots. • Wetlands drained and forests cleared. • Lack of green space, native habitat and trails.	Increased surface drainage and tile drainage throughout the watersheds threatens water quality.
• Flooding along the river and streams. • Agriculture fertilizer (nitrogen and phosphorus) runoff into streams. • Manure management; stockpiling and application practices. • Conservation tillage has low adoption rates. • Lack of buffers and filter strips on streams. • Residential runoff from chemically treated lawns (fertilizers and pesticides). • Failing septic systems, severely limiting soils, lack of maintenance. • Wastewater treatment in unincorporated communities. • Wetlands drained and forests cleared. • Lack of green space and trails.	Excess nutrients increase aquatic plants and algae. Algae blooms in the river and streams threaten aquatic communities and may pose a human health risk.

Stakeholder Concerns:	Problems:
• Flooding along the river and streams. • Manure management; stockpiling and application practices. • Lack of buffers and filter strips on streams. • High *E. coli* levels. • Failing septic systems, severely limiting soils, lack of maintenance. • Wastewater treatment in unincorporated communities. • Runoff from asphalt streets and parking lots. • Wetlands drained and forests cleared. • Lack of green space and trails.	E. coli and other pathogens pose a health risk for recreational activities throughout the watersheds.
• Log jams and debris in the river and streams. • Encourage 2-stage ditches. • Agriculture fertilizer (nitrogen and phosphorus) runoff into streams. • Manure management; stockpiling and application practices. • Tillage to the edge of stream banks; no filter strips or riparian area. • Conservation tillage has low adoption rates. • Lack of buffers and filter strips on streams. • Residential runoff from chemically treated lawns (fertilizers and pesticides). • Construction site (and road construction) erosion causing sedimentation. • Failing septic systems, severely limiting soils, lack of maintenance. • Wastewater treatment in unincorporated communities. • Wetlands drained and forests cleared. • Lack of buffers and filter strips on streams. • Lack of green space, native habitat and trails. • Dumping, trash in river and streams.	Lack of education on the economic benefit of BMPs. Competing land uses limit BMP implementation that would/could improve water quality. Individuals lack knowledge of BMPs, where they could/should be implemented, and how to fund practices. General public's lack of understanding or sense of responsibility for how and why their actions impact water quality.

5.4 Potential Causes for Water Quality Impairments

The UWRBC members and steering committee evaluated the list of problems that had been identified and developed a list of the potential causes of impairment that keep the streams and river in the project area from meeting their designated uses (e.g. aquatic life use, recreational use, and fishable uses).

Table 5-3: Problems and potential causes of water quality impairments in the Upper Wabash River Phase 2 project area.

Problems:	Potential Causes:
Restricted/redirected flow within the stream or river.	• Log jams and debris in the river and streams. • In-stream sand and silt bars. • Lack of floodplain management.
Sediment and increased levels of turbidity threatens the water quality health of the streams and river in the watershed.	• Turbidity levels exceed the target established for fish and macroinvertebrate health. • Sediment, organic matter and algae in the streams and river.
Increased surface and subsurface flow throughout the watersheds threatens water quality.	• Wetlands drained and forests cleared. • Loss of ponding areas in the watershed and floodplain storage. • Lack of floodplain management causing flooding along the river and streams. • Increase of tile installation. • Traditional ditch maintenance. • Lack of green space, native habitat and trails.
Excess nutrients increase aquatic plants and algae, and algal blooms threaten aquatic communities and can pose a human health risk.	• Excess nutrients – nitrogen and phosphorus in the water. • Nitrate and total nitrogen levels exceed state targets. • Total phosphorus levels exceed state targets.
E. coli and other pathogens pose a health risk for recreational activities throughout the watersheds.	• E. coli levels exceed state standard.
Lack of education on the economic benefit of BMPs. Competing land uses limit BMP implementation that would/could improve water quality. Individuals lack knowledge of BMPs, where they could/should be implemented and how to fund practices. General public's lack of understanding or sense of responsibility for how and why their actions impact water quality.	• Lack of education to land users on the economic benefit of BMPs. • Lack of appreciation for and understanding of environmental benefits versus financial benefits. • Lack of education to land users, funders, and the general public on the use of BMPs. • Lack of education to the public about their contribution to the health of the streams and river.

6.0 Identifying Sources of Pollution

6.1 Problems, Potential Causes, and Potential Sources

From the list of problems and potential causes, the UWRBC members and steering committee developed a list of potential sources; or in other words, the location or activity that the pollutant(s) come from, lack of awareness, or loss of a particular land use.

Table 6-1: Problems, potential causes, and potential sources of water quality impairments in the Upper Wabash River Phase 2 project area.

Problem:	**Restricted/redirected flow within the stream or river.**
Potential Causes:	• Log jams and debris in the river and streams. • In-stream sand and silt bars. • Lack of floodplain management.
Potential Sources:	• 7 locations where the trees are falling into the streams and river due to unstable banks or diseased and dying trees: Mossburg Ditch-Rock Creek; Johns Creek, Dowty Ditch, and Griffin Ditch-Wabash River, and Moser Lake, Big Creek and Pleasant Run Ditch-Eight Mile Creek subwatersheds. • Unanchored cut trees and cut fire wood observed in the Johns Creek-Wabash River and Elkenberry Ditch-Rock Creek subwatersheds during the windshield survey.
Problem:	**Sediment and increased levels of turbidity threatens the water quality health of the streams and river in the watershed.**
Potential Causes:	• Turbidity levels exceed the target established for fish and macroinvertebrate health. • Sediment, organic matter and algae in the streams and river.
Potential Sources:	• 50 locations of in-stream, stream bank and gully erosion were observed in all subwatersheds. The most sites are located in the Stites Ditch-Rock Creek, Mossburg Ditch-Rock Creek, and Elkenberry Ditch-Rock Creek subwatersheds; followed by the Griffin Ditch-Wabash River, Dowty Ditch-Wabash River, and Johns Creek-Wabash River subwatersheds. • 100 miles of streams and river lack forested buffers and grass filter strips. All subwatersheds lack buffers. The Maple Creek, and Moser Lake-Eight Mile Creek subwatersheds and Bender Ditch and Griffin Ditch -Wabash River subwatersheds need buffers on more than 40% of their stream miles. • Low adoption rates of conservation tillage. Conventional tillage is used on 56% of the agricultural acres in all subwatersheds. The Stites Ditch and Headwaters-Rock Creek, and Johns Creek and Bender Ditch-Wabash River subwatersheds are estimated to have conventional tillage on 50% or more of the cropland acres. • Lack of buffer areas at tile inlets. 296 miles of county tile plus private tile are in the project area. Tile inlet buffers are needed in all subwatersheds. The Stites Ditch, Elkenberry Ditch and Headwaters-Rock Creek, and Maple Creek-Eight Mile Creek subwatershed contain the most miles of drainage tile. • 32% of watershed is HEL/PHEL soils. The subwatersheds with the highest percentage of HEL/PHEL soils are: Big Creek-Eight Mile Creek; Mossburg Ditch and Elkenberry Ditch-Rock Creek; and Dowty Ditch-Wabash River subwatersheds. • Observed that cropland buffer areas (fence rows and fence borders) were lacking in all watersheds. • USDA verification of removal and lack of wetlands and riparian areas throughout all watersheds. The subwatersheds with the less than 5% wetlands and woodlands are: Headwaters, and Stites Ditch-Rock Creek; and Maple Creek-Eight Mile Creek.

Table 6-1: Problems, potential causes, and potential sources of water quality impairments in the Upper Wabash River Phase 2 project area.

Problem:	**Increased surface and subsurface flow throughout the watersheds threatens water quality.**
Potential Causes:	• Wetlands drained and forests cleared. • Loss of ponding areas in the watershed and floodplain storage. • Lack of floodplain management causing flooding along the river and streams. • Increase of tile installation. • Traditional ditch maintenance. • Lack of green space, native habitat and trails.
Potential Sources:	• USDA verification of removal and lack of wetlands and riparian areas throughout all watersheds. The subwatersheds with the less than 5% wetlands and woodlands are: Headwaters, and Stites Ditch-Rock Creek; and Maple Creek-Eight Mile Creek. • 100 miles of streams and river lack forested buffers and grass filter strips. All subwatersheds lack buffers. The Maple Creek, and Moser Lake-Eight Mile Creek subwatersheds and Bender Ditch and Griffin Ditch -Wabash River subwatersheds need buffers on more than 40% of their stream miles. • Low adoption rates of conservation tillage that could reduce run-off. Conventional tillage is used on 56% of the agricultural acres in all subwatersheds. The Stites Ditch and Headwaters-Rock Creek, and Johns Creek and Bender Ditch-Wabash River subwatersheds are estimated to have conventional tillage on 50% or more of the cropland acres. • Increase of tile installation in the watersheds; 4 new installation sites observed in the Headwaters, Stites Ditch, Mossburg Ditch and Elkenberry Ditch-Rock Creek subwatersheds. • Lack of buffer areas at tile inlets. 296 miles of county tile plus private tile are in the project area. Tile inlet buffers are needed in all subwatersheds. The Stites Ditch, Elkenberry Ditch and Headwaters-Rock Creek, and Maple Creek-Eight Mile Creek subwatershed contain the most miles of drainage tile. • Ditch maintenance is preformed on nearly all streams, and was observed in the Headwaters-Rock Creek and Pleasant Run Ditch-Eight Mile Creek subwatersheds. • Lack of green space and native habitat in urban areas observed in urban landscapes.

Table 6-1: Problems, potential causes, and potential sources of water quality impairments in the Upper Wabash River Phase 2 project area.

Problem:	**Excess nutrients increase aquatic plants and algae, and algal blooms in the river and streams threaten aquatic communities and can pose a human health risk.**
Potential Causes:	• Excess nutrients – nitrogen and phosphorus in the water. • Nitrate and total nitrogen levels exceed state targets. • Total phosphorus levels exceed state targets.
Potential Sources:	• Unknown amount of over application of fertilizer on cropland and residential areas, and limited use of soil testing and variable rate fertilizer applications based on responses to social surveys. • Lack of buffer areas at tile inlets. 296 miles of county tile plus private tile are in the project area. Only a few buffer areas were observed, and tile inlet buffers are needed in all subwatersheds. The Stites Ditch, Elkenberry Ditch and Headwaters subwatersheds of the Rock Creek, and Maple Creek-Eight Mile Creek subwatershed contain the most miles of drainage tile. • Increase of tile installation in watersheds; 4 new installation sites observed in the four Rock Creek subwatersheds: Headwaters, Stites Ditch, Mossburg Ditch and Elkenberry Ditch. • Observed that cropland buffer areas (fence rows and fence borders) were lacking in all watersheds. • 27 CFOs in the project area; 24 located within a ½ mile of the streams and river, and 3 located within 1 mile of the streams and river. The highest number of CFOs is in the Johns Creek-Wabash River, Stites Ditch-Rock Creek, and Maple Creek-Eight Mile Creek subwatersheds. • Animal waste runoff from land applications, manure stock piles, and 1,050 hobby farms. Two manure distribution lines were observed in the Stites Ditch-Rock Creek subwatershed, three manure stockpiles were observed in the Stites Ditch-Rock Creek, Dowty Ditch-Wabash River, and Moser Lake-Eight Mile Creek subwatersheds. An estimated 1,050 hobby farms are located throughout all subwatersheds, with the heaviest concentrations located in the Pleasant Run Ditch, and Big Creek subwatersheds of the Eight Mile Creek, Dowty Ditch-Wabash River subwatershed, and Headwaters-Rock Creek subwatershed. • 100 miles of streams and river lack forested buffers and grass filter strips. Tillage goes to the edge of banks. All subwatersheds lack buffers. The Maple Creek, and Moser Lake-Eight Mile Creek subwatersheds and Bender Ditch and Griffin Ditch - Wabash River subwatersheds need buffers on more than 40% of their stream miles. • 12 documented municipal wastewater treatment plant sanitary sewer overflows to the Headwaters-Rock Creek, Dowty Ditch and Griffin Ditch-Wabash River subwatersheds, and Moser Lake-Eight Mile Creek subwatershed. • Over 3,900 on-site septic systems on severely limited soils throughout all watersheds. It is likely that failing and/or lack of maintenance, and outdated direct connect on-site septic systems are present in all watersheds. The subwatersheds with the heaviest concentration of septic systems based on subwatershed area are: Pleasant Run Ditch, Big Creek and Moser Lake-Eight Mile Creek, and Dowty Ditch-Wabash River. • USDA verification of removal and lack of wetlands and riparian areas throughout all watersheds. The subwatersheds with the less than 5% wetlands and woodlands are: Headwaters, and Stites Ditch-Rock Creek; and Maple Creek-Eight Mile Creek.

Table 6-1: Problems, potential causes, and potential sources of water quality impairments in the Upper Wabash River Phase 2 project area.

Problem:	**E. coli and other pathogens pose a health risk for recreational activities throughout the watersheds.**
Potential Causes:	E. coli levels exceed state standard.
Potential Sources:	• Lack of wastewater treatment in 10 unincorporated communities in all of the Rock Creek subwatersheds, Johns Ditch and Dowty Ditch-Wabash River, and Maple Creek-Eight Mile Creek subwatersheds. • Over 3,900 on-site septic systems on severely limited soils throughout all watersheds. It is likely that failing and/or lack of maintenance, and outdated direct connect on-site septic systems are present in all watersheds. The subwatersheds with the heaviest concentration of septic systems based on subwatershed area are: Pleasant Run Ditch, Big Creek and Moser Lake-Eight Mile Creek, and Dowty Ditch-Wabash River. • Animal waste runoff from land applications and 1,050 hobby farms. Two manure distribution lines were observed in the Stites Ditch-Rock Creek subwatershed. An estimated 1,050 hobby farms are located throughout all subwatersheds, with the heaviest concentrations located in the Pleasant Run Ditch, and Big Creek subwatersheds of the Eight Mile Creek, Dowty Ditch-Wabash River subwatershed, and Headwaters-Rock Creek subwatershed. • Abundance of animal waste generated and brought into the watershed. Three manure stockpiles were observed in the Stites Ditch-Rock Creek, Dowty Ditch-Wabash River, and Moser Lake-Eight Mile Creek subwatersheds. • 12 documented municipal wastewater treatment plant sanitary sewer overflows to the Headwaters-Rock Creek, Dowty Ditch and Griffin Ditch-Wabash River subwatersheds, and Moser Lake-Eight Mile Creek subwatershed.
Problems:	**1) Lack of education on the economic benefit of BMPs.** **2) Competing land uses limit BMP implementation that would/could improve water quality.** **3) Individuals lack knowledge of BMPs, where they could/should be implemented and how to fund practices.** 4) **General public's lack of understanding or sense of responsibility for how and why their actions impact water quality.**
Potential Causes:	• Lack of appreciation for and understanding of environmental benefits versus financial benefits. • Lack of education to land users, funders and the general public on the use of BMPs. • Lack of education to the public about their contribution to the health of the streams and river. • Lack of understanding and appreciation for natural areas.
Potential Sources:	• Lack of education to land users on the economic and environmental value of BMPs evidenced by project social surveys. • Lack of avenues to get the public to participate in educational activities. • Limited community involvement in environmental activities as evidenced by lack of participation in river clean-up and monitoring events. • Competition from other causes. • Lack of stewardship for Mother Nature.

6.2 Pollutant Load Estimates

Nonpoint source pollution comes from many sources found throughout the watershed on public and private lands. As rainfall and snowmelt runoff moves over and through the ground it picks up and carries away natural and human-made pollutants depositing them into streams, lakes, rivers, wetlands and ground waters.

The water quality targets listed in Table 3-4 (page 85) represent the quantitative value used to measure whether or not the applicable water quality standard is attained for each pollutant of concern. Those numeric water quality targets are then translated into the loading capacity of a stream or river. EPA defines loading capacity as "the greatest amount of loading that a water can receive without violating water quality standards". The loading capacity provides a reference, which helps guide pollutant reduction efforts needed to bring a stream or river into compliance with water quality standards. Two methods have been used to understand the loading of nutrients and pathogens in the water bodies in the project area; measured results from the water quality monitoring events and hydrologic simulation models.

Measured Results from Water Quality Monitoring

The water quality monitoring data collected throughout the project shows the actual levels of contaminants in the streams and river at a specific time. The parameter test results are often related to stream flow rates. For instance, sediment and turbidity concentrations typically increase with rising flows as a result of factors such as channel scour from higher velocities. Other parameters, such as nitrogen or *E. coli*, may be more concentrated at low flows and more diluted by increased water volumes at higher flows.

The monitoring data results for nutrients and *E. coli* can be combined with the flow data to estimate the current loads and target loads in the water bodies. Current loading estimates for each monitoring site is calculated by multiplying the average pollutant concentration, the stream flow measurement, and a conversion factor to transform each concentration measurement into "load" for that point in time. The estimated target loads are calculated by multiplying the stream flow by the water quality target (Table 3-4, page 85) for the individual parameter, and the conversion factor.

Most of the 12-digit HUC subwatersheds have a water monitoring site located near the outlet of that drainage area; therefore, the water monitoring locations were assigned to each subwatershed based on their location (Table 6-2). The exceptions are the Mossburg Ditch-Rock Creek, Bender Ditch-Wabash River, and Big Creek-Eight Mile Creek subwatersheds. Monitoring site 13 has been assigned to the Mossburg Ditch-Rock Creek subwatershed. The Bender Ditch and Griffin Ditch-Wabash River subwatersheds will be treated as a single drainage area at monitoring site 9, and the Big Creek and Pleasant Run Ditch-Eight Mile Creek subwatersheds will be treated as a single drainage area at monitoring site 1.

It is important to note that the UWRBC Phase 2 project area receives pollutant loading from the upstream Upper Wabash River Basin watershed containing approximately 353,437 acres. The accumulated pollutant loading from the upstream area is illustrated by the current load and target load at Site 5 on the Wabash River at the most upstream point on the Wabash River in this project area. Site 11 on the Elkenberry Ditch, a tributary to the Rock Creek channel only takes

into consideration the drainage from the western portion of the subwatershed. Site 12 is the total of the entire Wabash River as well as the entire Rock Creek watershed to that monitoring point. These sites are shown for comparison purposes and to provide for further evaluation across the project area.

Table 6-2: Monitoring Sites Used for Load Estimates

Monitoring Sites	Subwatershed Name	12-digit HUC
1	Pleasant Run/Big Creek-Eight Mile Creek	051201010904 & 051201010903
2	Moser Lake-Eight Mile Creek	051201010902
3	Maple Creek-Eight Mile Creek	051201010901
6	Johns Creek-Wabash River	051201010801
7	Dowty Ditch-Wabash River	051201010802
9	Bender Ditch/Griffin Ditch-Wabash River	051201010803 & 051201010804
10	Elkenberry Ditch-Rock Creek	051201010704
13	Mossburg Ditch-Rock Creek	051201010702
14	Stites Ditch-Rock Creek	051201010703
15	Headwaters-Rock Creek	051201010701
5	Upstream Wabash River watershed that is not in the project area.	
11	Western portion of Elkenberry Ditch subwatershed	
12	Total of all of the Wabash River and Rock Creek subwatersheds	

There are some limitations in using the measured data to estimate loads and load reductions. The sampling methods did not allow for continuous flow measurements at each site, and the only USGS gage in the project area is located on the Wabash River at the most upstream point. Due to its location, it does not allow for accurate estimations of continuous flow for the downstream subwatersheds, or take into consideration the impoundment area in the J.E. Roush Fish and Wildlife area (site 8) on the Wabash River; which is too deep and wide to conduct flow measurements.

The measured data from each monitoring location may be somewhat skewed due to the accumulation and/or assimilation of the nutrients and *E. coli* as it moves through the individual watersheds. Additionally, the UWRBC used turbidity as a measurement of the cloudiness of the water versus monitoring for total suspended solids; therefore, we were not able to estimate sediment loads in the project area which would have been useful in determining the effects of gully, stream bank and in-stream erosion in the project area.

The measured current load estimates and target loads in the following table are expressed in pounds per year (lbs/yr) for nutrients, and billions of organisms per year (G-org/yr) for *E.coli*.

Table 6-3: Measured Current Load and Target Load Estimates by Subwatershed. (Pounds Per Year or Billions of Organisms Per Year)

Red text indicates values exceed current water quality targets.

Subwatershed		Site	Nitrate *Current Load* *Target Load* *(lbs/yr)*	Nitrite *Current Load* *Target Load* *(lbs/yr)*	Total Nitrogen *Current Load* *Target Load* *(lbs/yr)*	Total Phosphorus *Current Load* *Target Load* *(lbs/yr)*	*E. coli* *Current Load* *Target Load* *(G-org/yr)*
Eight Mile Creek	Pleasant Run/ Big Creek	1	1,408,827 1,508,843	7,227 150,891	765,770 1,508,837	41,245 45,260	340,419 160,909
	Moser Lake	2	1,792,150 519,833	4,380 51,976	500,342 519,833	57,086 15,622	130,288 55,438
	Maple Creek	3	551,369 328,135	2,920 32,850	200,458 328,135	8,176 9,855	65,759 34,996
Wabash River–Griffin Ditch	Johns Creek	6	28,161,648 13,984,683	160,527 1,398,461	12,749,377 13,984,683	707,370 419,531	3,842,681 1,491,379
	Dowty Ditch	7	24,760,359 12,173,699	121,107 1,217,367	10,398,368 12,173,699	613,054 365,219	3,222,333 1,298,246
	Bender Ditch/ Griffin Ditch	9	34,009,768 18,031,876	230,826 1,803,173	13,950,227 18,031,876	740,950 540,930	4,116,015 1,922,989
Rock Creek	Elkenberry Ditch	10	3,313,470 2,056,337	17,958 205,641	1,376,050 2,056,337	46,793 61,685	479,503 219,299
	Mossburg Ditch	13	1,617,753 1,434,888	7,373 143,518	667,220 1,434,888	25,623 43,070	317,811 153,022
	Stites Ditch	14	1,358,603 864,247	14,308 86,432	551,880 864,247	15,695 25,915	115,866 92,166
	Headwaters	15	599,038 478,296	2,044 47,815	230,388 478,296	9,198 14,381	69,950 51,011
Upstream Wabash River watershed not in project area		5	22,677,231 13,146,205	259,004 1,314,657	10,878,533 13,146,205	586,263 394,419	3,397,047 1,401,963
Western portion of Elkenberry Ditch subwatershed		11	211,043 159,359	24,017 15,914	77,526 159,359	2,701 4,745	36,156 16,996
Total Wabash River & Rock Creek subwatersheds		12	29,758,158 19,356,680	173,813 1,935,668	11,402,819 19,356,680	526,111 580,715	3,805,921 2,064,269

Based on the annual measured current loads, the largest contributors of nitrate, nitrite, total nitrogen, total phosphorus and *E. coli* in the project area are the Wabash River subwatersheds; Johns Creek, Dowty Ditch and Bender Ditch/Griffin Ditch. The Elkenberry Ditch-Rock Creek subwatershed also ranked high as a contributor of nitrate, nitrite, total nitrogen and *E. coli,* while the Moser Lake-Eight Mile Creek subwatershed is a major contributor of nitrate and total phosphorus.

To calculate the total current and target loads for the UWRBC Phase 2 project area, the downstream monitoring locations in each subwatershed are used because they include the accumulation and/or assimilation of the pollutant loads throughout each subwatershed. Site 1 represents the entire Eight Mile Creek subwatershed, Site 9 represents the entire Wabash River subwatershed, and Site 10 represents the entire Rock Creek subwatershed. The total current and target loads for Sites 1, 9, and 10 are added together. The total current and target loads for Site 5 (upstream Wabash River watershed area) are subtracted from the totals to reflect the actual loading within the project area.

Table 6-4: Measured Current Load and Target Load Estimates for UWRBC Phase 2 Project Area. (Pounds Per Year or Billions of Organisms Per Year)

Red text indicates values exceed current water quality targets.

Subwatershed		Site	Nitrate *Current Load* *Target Load* *(lbs/yr)*	Nitrite *Current Load* *Target Load* *(lbs/yr)*	Total Nitrogen *Current Load* *Target Load* *(lbs/yr)*	Total Phosphorus *Current Load* *Target Load* *(lbs/yr)*	*E. coli* *Current Load* *Target Load* *(G-org/yr)*
Eight Mile Creek	Pleasant Run/ Big Creek	1	1,408,827 1,508,843	7,227 150,891	765,770 1,508,837	41,245 45,260	340,419 160,909
Wabash River–Griffin Ditch	Bender Ditch/ Griffin Ditch	9	34,009,768 18,031,876	230,826 1,803,173	13,950,227 18,031,876	740,950 540,930	4,116,015 1,922,989
Rock Creek	Elkenberry Ditch	10	3,313,470 2,056,337	17,958 205,641	1,376,050 2,056,337	46,793 61,685	479,503 219,299
TOTALS			38,732,065 21,597,056	256,011 2,159,705	16,092,047 21,597,050	828,988 647,875	4,935,937 2,303,197
Upstream Wabash River watershed not in project area		5	22,677,231 13,146,205	259,004 1,314,657	10,878,533 13,146,205	586,263 394,419	3,397,047 1,401,963
Phase 2 Project Area Loading			16,054,834 8,450,851	-2,993 845,048	5,213,514 8,450,845	242,725 253,456	1,538,890 901,234

In total, the annual measured current load in the Phase 2 project area is 38,732,065 pounds of nitrate, 256,011 pounds of nitrite, 16,092,047 pounds of total nitrogen, 828,988 pounds of total phosphorus, and 4,935,937 billions of organisms of *E. coli* in the project area.

The annual measured loading estimates were then normalized by the total area draining to the sample location. The total drainage area for each sample location was derived from the L-THIA watershed delineator tool developed by Purdue University, Agricultural and Biological Engineering department with support from USEPA, USDA, US Army CERL, and the Corps of Engineers.

Table 6-5: Measured Current Load and Target Load Estimates by Subwatershed. (Pounds Per Acre Per Year or Billions of Organisms Per Acre Per Year)

Red text indicates values exceed current water quality targets.

Subwatershed (Acres*) *Based on Purdue University L-THIA watershed delineator.		**Site**	**Nitrate** *Current Load Target Load (lbs/ac/yr)*	**Nitrite** *Current Load Target Load (lbs/ac/yr)*	**Total Nitrogen** *Current Load Target Load (lbs/ac/yr)*	**Total Phosphorus** *Current Load Target Load (lbs/ac/yr)*	***E. coli*** *Current Load Target Load (G-org/ac/yr)*
Eight Mile Creek	Pleasant Run/ Big Creek (50,338 acres)	1	27.99 29.97	0.14 3.00	15.21 29.97	0.82 0.90	6.76 3.20
	Moser Lake (21,530 acres)	2	83.24 24.14	0.20 2.41	23.24 24.14	2.65 0.73	6.05 2.57
	Maple Creek (15,108 acres)	3	36.50 21.72	0.19 2.17	13.27 21.72	0.54 0.65	4.35 2.32
Wabash River–Griffin Ditch	Johns Creek (370,754 acres)	6	75.96 37.72	0.43 3.77	34.39 37.72	1.91 1.13	10.36 4.02
	Dowty Ditch (381,733 acres)	7	64.86 31.89	0.32 3.19	27.24 31.89	1.61 0.96	8.44 3.40
	Bender Ditch/ Griffin Ditch (410,719 acres)	9	82.81 43.90	0.56 4.39	33.97 43.90	1.80 1.32	10.02 4.68
Rock Creek	Elkenberry Ditch (66,637 acres)	10	49.72 30.86	0.27 3.09	20.65 30.86	0.70 0.93	7.20 3.29
	Mossburg Ditch (53,208 acres)	13	30.40 26.97	0.14 2.70	12.54 26.97	0.48 0.81	5.97 2.88
	Stites Ditch (29,944 acres)	14	45.37 28.86	0.48 2.89	18.43 28.86	0.52 0.87	3.87 3.08
	Headwaters (20,089 acres)	15	29.82 23.81	0.10 2.38	11.47 23.81	0.46 0.72	3.48 2.54
Upstream Wabash River watershed not in project area (353,437 acres)		5	64.16 37.20	0.73 3.72	30.78 37.20	1.66 1.12	9.61 3.97
Western portion of Elkenberry Ditch subwatershed (6,136 acres)		11	34.39 25.97	3.91 2.59	12.63 25.97	0.44 0.77	5.89 2.77
Total Wabash River & Rock Creek subwatersheds (477,393 acres)		12	62.33 40.55	0.36 4.05	23.89 40.55	1.10 1.22	7.97 4.32

When the loading is based on the per acre rate, the greatest contributor of nitrate and total phosphorus is the Moser Lake-Eight Mile Creek subwatershed. The Wabash River subwatersheds; Johns Creek, Dowty Ditch, and Bender Ditch/Griffin Ditch are significant contributors of all nutrients and *E. coli.* The Stites Ditch-Rock Creek is a major contributor of nitrite, and the Elkenberry Ditch-Rock Creek is a major contributor of *E. coli*.

Table 6-6: Measured Current Load and Target Load Estimates for UWRBC Phase 2 Project Area. (Pounds Per Acre Per Year or Billions of Organisms Per Acre Per Year)

Red text indicates values exceed current water quality targets.

Subwatershed	Site	Nitrate	Nitrite	Total Nitrogen	Total Phosphorus	*E. coli*
		Current Load Target Load (lbs/ac/yr)	*Current Load Target Load (lbs/ac/yr)*	*Current Load Target Load (lbs/ac/yr)*	*Current Load Target Load (lbs/ac/yr)*	*Current Load Target Load (G-org/ac/yr)*
Eight Mile Creek 50,338 acres	1	27.99 29.97	0.14 3.00	15.21 29.97	0.82 0.90	6.76 3.20
Wabash River–Griffin Ditch 410,719 acres	9	82.81 43.90	0.56 4.39	33.97 43.90	1.80 1.32	10.02 4.68
Rock Creek 66,637 acres	10	49.72 30.86	0.27 3.09	20.65 30.86	0.70 0.93	7.20 3.29
Total Per Acre Per Year 527,694 acres		73.40 40.93	0.49 4.09	30.50 40.93	1.57 1.23	9.35 4.36

Hydrologic Simulation Model Results

Various hydrologic simulation models were compared and evaluated for use in determining estimates of the pollutant loads in the water bodies. The load duration curve (LDC) approach was selected because it uses the project monitoring sites which allows for comparison between the measured load and modeled load for each subwatershed. It also provides a way to characterize the water quality concentrations at the full range of flow conditions. With this model the frequency and magnitude of water quality standard exceedances, allowable loadings, and the size of load reductions are more easily understood. The pattern of impairment can be examined to see if it occurs across all flow conditions, corresponds strictly to high flow events, or conversely, only to low flows.

The LDC presents the flow conditions plotted as a percent of time that a given flow occurs within the stream (curve). The flow ranges fall into five flow zones; high flow (0-10), moist conditions (10-40), mid-range flow (40-60), dry conditions (60-90), and low flow (90-100). Each parameter sample result (point) is plotted against the "percent of time" for the day of sampling; and a pattern develops which describes the characteristics of the water quality impairment. The points (sample results) that plot above the curve indicate an exceedance of the water quality target, while those below the curve show compliance. Exceedances observed in the high (0-10) and moist range (10-40) generally reflect potential nonpoint source contributions associated with surface runoff or storm water loads, while exceedances in the low flow zone (90-100) indicates the influence of point sources.

When using the LDC method, EPA recommends that the 90th percentile of the measured load be used as a "margin of safety" to account for the uncertainty associated with water quality that varies across different flow conditions. For example, the loading capacity as calculated at the mid-point of each of the five flow zones and the loading capacity calculated at the minimum flow in each zone can vary greatly. In some cases, an overall load reduction value results in no reduction needed, but with further review of the waste load allocation over time, loads above the target during a specific flow condition are often offset by loads significantly under the target during the other flow conditions resulting in a no net load reduction. When this is the case, it is necessary to look at the load allocations under the various flow conditions to identify a link

between the source of the pollutant and delivery mechanism to determine under what conditions reductions may be needed.

The modeled target load, observed load, required reduction for each flow regime, and overall required reduction are displayed in the load reduction reports. *E. coli* load reduction reports only provide the target load, observed loads and required reduction information by flow regime, and do not give the overall loads and required reduction.

For the subwatersheds with more than one monitoring location, the downstream location is used to indicate the load for the entire or combined subwatersheds. Again, site 5 is the accumulated pollutant loading from the upstream Wabash River area; site 11 on the Elkenberry Ditch, a tributary to the Rock Creek channel only takes into consideration the drainage from the western portion of the subwatershed; and site 12 is a total of all of the Wabash River and Rock Creek subwatersheds.

Table 6-7: LDC Modeled Load and Target Load Estimates by Subwatershed. (Pounds Per Year)

Red text indicates values exceed modeled water quality targets.

Subwatershed		Site	Nitrate *Modeled Load* *Target Load* *(lbs/yr)*	Nitrite *Modeled Load* *Target Load* *(lbs/yr)*	Total Nitrogen *Modeled Load* *Target Load* *(lbs/yr)*	Total Phosphorus *Modeled Load* *Target Load* *(lbs/yr)*
Eight Mile Creek	Pleasant Run/ Big Creek	1	1,487,908 1,509,877	7,201 150,990	179,675 1,509,877	16,918 45,297
	Moser Lake	2	1,594,802 520,202	4,745 52,020	276,090 520,202	74,325 15,607
	Maple Creek	3	678,400 328,380	4,008 32,839	128,987 328,380	7,147 9,851
Wabash River – Griffin Ditch	Johns Creek	6	27,559,471 13,994,279	192,319 1,399,428	7,519,949 13,994,279	195,312 419,827
	Dowty Ditch	7	28,978,795 12,182,025	222,541 1,218,202	8,513,552 12,182,025	315,572 365,460
	Bender Ditch/ Griffin Ditch	9	28,415,443 18,044,268	231,844 1,804,425	11,509,972 18,044,268	433,043 541,328
Rock Creek	Elkenberry Ditch	10	7,354,746 2,057,782	22,156 205,780	1,797,362 2,057,782	27,120 61,732
	Mossburg Ditch	13	3,440,337 1,435,874	12,370 143,587	548,226 1,435,874	112,938 43,077
	Stites Ditch	14	1,218,490 1,119,010	21,889 111,902	399,084 1,119,010	6,388 33,569
	Headwaters	15	922,293 478,657	2,154 47,866	215,124 478,657	6,183 14,359
Upstream Wabash River watershed not in project area		5	27,206,516 13,155,414	268,020 1,315,540	6,585,549 13,155,414	160,418 394,664
Western portion of Elkenberry Ditch subwatershed		11	283,777 159,498	50,538 15,951	79,789 159,498	9,231 4,785
Total Wabash River & Rock Creek subwatersheds		12	27,108,477 19,369,962	304,994 1,936,997	6,196,934 19,369,962	116,253 581,098

Based on the annual modeled load estimates, the Johns Creek, Dowty Ditch, and Bender Ditch/Griffin Ditch subwatersheds are the largest contributors of all nutrients. The Elkenberry Ditch-Rock Creek subwatershed is a major contributor of nitrate, nitrite and total nitrogen; and the Mossburg Ditch-Rock Creek subwatershed is a major contributor of total phosphorus.

To calculate the total modeled load and modeled target load for the UWRBC Phase 2 project area, the downstream monitoring locations in each subwatershed are used. Site 1 represents the entire Eight Mile Creek subwatershed, Site 9 represents the entire Wabash River subwatershed, and Site 10 represents the entire Rock Creek subwatershed. The total modeled load and target load for Sites 1, 9, and 10 are added together. The modeled load and target load for Site 5 (upstream Wabash River watershed area) are subtracted from the totals to reflect the actual modeled loading within the project area.

Table 6-8: LDC Modeled Load and Target Load Estimates for the UWRBC Phase 2 Project Area. (Pounds Per Year)

Red text indicates values exceed current water quality targets.

Subwatershed		Site	Nitrate	Nitrite	Total Nitrogen	Total Phosphorus
			Modeled Load *Target Load* *(lbs/yr)*	*Modeled Load* *Target Load* *(lbs/yr)*	*Modeled Load* *Target Load* *(lbs/yr)*	*Modeled Load* *Target Load* *(lbs/yr)*
Eight Mile Creek	Pleasant Run/ Big Creek	1	1,487,908 1,509,877	7,201 150,990	179,675 1,509,877	16,918 45,297
Wabash River – Griffin Ditch	Bender Ditch/ Griffin Ditch	9	28,415,443 18,044,268	231,844 1,804,425	11,509,972 18,044,268	433,043 541,328
Rock Creek	Elkenberry Ditch	10	7,354,746 2,057,782	22,156 205,780	1,797,362 2,057,782	27,120 61,732
TOTALS			37,258,097 21,611,927	261,201 2,161,195	13,487,009 21,611,927	477,081 648,356
Upstream Wabash River watershed not in project area		5	27,206,516 13,155,414	268,020 1,315,540	6,585,549 13,155,414	160,418 394,664
Phase 2 Project Area Loading			10,051,581 8,456,513	-26,759 845,655	6,901,460 8,456,513	316,663 253,692

The load duration curve estimates the modeled loads in the UWRBC Phase 2 project area to be 37,258,097 pounds of nitrate, 241,261 pounds of nitrite, 13,487,009 pounds of total nitrogen, and 477,081 pounds of total phosphorus.

The annual modeled loading estimates were also normalized by the total area draining to the sample location and represented in pounds per acre per year. The total drainage area for each sample location was derived from the L-THIA watershed delineator tool developed by Purdue University, Agricultural and Biological Engineering department with support from USEPA, USDA, US Army CERL, and the Corps of Engineers.

Table 6-9: LDC Modeled Load and Target Load Estimates by Subwatershed. (Pounds Per Acre Per Year)

Red text indicates values exceed current water quality targets.

Subwatershed (Acres*) *Based on Purdue University L-THIA watershed delineator.		Site	**Nitrate**	**Nitrite**	**Total Nitrogen**	**Total Phosphorus**
			Modeled Load Target Load (lbs/ac/yr)	*Modeled Load Target Load (lbs/ac/yr)*	*Modeled Load Target Load (lbs/ac/yr)*	*Modeled Load Target Load (lbs/ac/yr)*
Eight Mile Creek	Pleasant Run/ Big Creek (50,338 acres)	1	29.56 29.99	0.14 3.00	3.57 29.99	0.34 0.90
	Moser Lake (21,530 acres)	2	74.07 24.16	0.22 2.42	12.82 24.16	3.45 0.73
	Maple Creek (15,108 acres)	3	44.90 21.74	0.27 2.17	8.54 21.74	0.47 0.65
Wabash River – Griffin Ditch	Johns Creek (370,754 acres)	6	74.33 37.75	0.52 3.77	20.28 37.75	0.53 1.13
	Dowty Ditch (381,733 acres)	7	75.91 31.91	0.58 3.19	22.30 31.91	0.83 0.96
	Bender Ditch/ Griffin Ditch (410,719 acres)	9	69.18 43.93	0.56 4.39	28.02 43.93	1.05 1.32
Rock Creek	Elkenberry Ditch (66,637 acres)	10	110.37 30.88	0.33 3.09	26.97 30.88	0.41 0.93
	Mossburg Ditch (53,208 acres)	13	64.66 26.99	0.23 2.69	10.30 26.99	2.12 0.81
	Stites Ditch (29,944 acres)	14	40.69 37.37	0.73 3.74	13.33 37.37	0.21 1.12
	Headwaters (20,089 acres)	15	45.91 23.83	0.11 2.38	10.71 23.83	0.31 0.72
Upstream Wabash River watershed not in project area (353,437 acres)		5	76.98 37.22	0.76 3.72	18.63 37.22	0.45 1.12
Western portion of Elkenberry Ditch subwatershed (6,136 acres)		11	46.25 25.99	8.24 2.60	13.00 25.99	1.50 0.78
Total Wabash River & Rock Creek subwatersheds (477,393 acres)		12	56.78 40.57	0.64 4.06	12.98 40.57	0.24 1.22

Based on the annual modeled load estimates per acre, the Elkenberry Ditch-Rock Creek subwatershed is the largest contributor of nitrate; followed by the Dowty Ditch-Wabash River, Johns Creek-Wabash River, and Moser Lake-Eight Mile Creek subwatersheds. The western portion of the Elkenberry Ditch-Rock Creek is the leading contributor of nitrite. The Bender Ditch-Wabash River subwatershed is the highest contributor for total nitrogen; followed by the Elkenberry Ditch-Rock Creek subwatershed and Dowty Ditch and Johns Creek subwatersheds of the Wabash River. The Moser Ditch-Eight Mile Creek is the largest contributor of total phosphorus. Additional major contributors include the Mossburg Ditch-Rock Creek, Bender Ditch/Griffin Ditch and Dowty Ditch-Wabash River subwatersheds.

Table 6-10: LDC Modeled Load and Target Load Estimates for the UWRBC Phase 2 Project Area. (Pounds Per Acre Per Year)

Red text indicates values exceed current water quality targets.

Subwatershed	Site	Nitrate	Nitrite	Total Nitrogen	Total Phosphorus
		Current Load *Target Load* *(lbs/ac/yr)*	*Current Load* *Target Load* *(lbs/ac/yr)*	*Current Load* *Target Load* *(lbs/ac/yr)*	*Current Load* *Target Load* *(lbs/ac/yr)*
Eight Mile Creek 50,338 acres	1	29.56 29.99	0.14 3.00	3.57 29.99	0.34 0.90
Wabash River–Griffin Ditch 410,719 acres	9	69.18 43.93	0.56 4.39	28.02 43.93	1.05 1.32
Rock Creek 66,637 acres	10	110.37 30.88	0.33 3.09	26.97 30.88	0.41 0.93
Total Per Acre Per Year **527,694 acres**		70.61 40.96	0.49 4.09	25.56 40.96	0.90 1.23

Measured vs. Modeled Loads

Tables 6-11 through 6-20 compare the loads derived from the measured data and the modeled data. Nitrate, nitrite, total nitrogen and total phosphorus estimates are based on pounds per year and pounds per acre per year. Because the LDC model does not estimate an overall load or target load for E. coli, our measured estimates are the only source to estimate *E. coli* concentrations in the project area. The *E. coli* annual and per acre estimates are based on billions of organisms per year and billions of organisms per acre per year.

Table 6-11: Measured Loads vs. Modeled Loads - Nitrate.

Subwatershed		Site	Nitrate				
			Measured Load ***(lbs/yr)***	*Modeled Load* ***(lbs/yr)***	*Comparison: Measured/ Modeled*	*Measured Load* ***(lbs/ac/yr)***	*Modeled Load* ***(lbs/ac/yr)***
Eight Mile Creek	Pleasant Run/ Big Creek	1	1,408,827	1,487,908	95%	27.99	29.56
	Moser Lake	2	1,792,150	1,594,802	112%	83.24	74.07
	Maple Creek	3	551,369	678,400	81%	36.50	44.90
Wabash River – Griffin Ditch	Johns Creek	6	28,161,648	27,559,471	102%	75.96	74.33
	Dowty Ditch	7	24,760,359	28,978,795	85%	64.86	75.91
	Bender Ditch/ Griffin Ditch	9	34,009,768	28,415,443	120%	82.81	69.18
Rock Creek	Elkenberry Ditch	10	3,313,470	7,354,746	45%	49.72	110.37
	Mossburg Ditch	13	1,617,753	3,440,337	47%	30.40	64.66
	Stites Ditch	14	1,358,603	1,218,490	111%	45.37	40.69
	Headwaters	15	599,038	922,293	65%	29.82	45.91
Upstream Wabash River watershed not in project area		5	22,677,231	27,206,516	83%	64.16	76.98
Western portion of Elkenberry Ditch subwatershed		11	211,043	283,777	74%	34.39	46.25
Total Wabash River & Rock Creek subwatersheds		12	29,758,158	27,108,477	110%	62.33	56.78

Table 6-12: Measured Loads vs. Modeled Loads for Nitrate for the UWRBC Phase 2 Project Area.

Subwatershed		Site	Nitrate				
			Measured Load ***(lbs/yr)***	*Modeled Load* ***(lbs/yr)***	*Comparison: Measured/ Modeled*	*Measured Load* ***(lbs/ac/yr)***	*Modeled Load* ***(lbs/ac/yr)***
Eight Mile Creek	Pleasant Run/ Big Creek	1	1,408,827	1,487,908	95%	27.99	29.56
Wabash River – Griffin Ditch	Bender Ditch/ Griffin Ditch	9	34,009,768	28,415,443	120%	82.81	69.18
Rock Creek	Elkenberry Ditch	10	3,313,470	7,354,746	45%	49.72	110.37
TOTALS			**38,732,065**	**37,258,097**	**104%**	**73.40**	**70.61**
Upstream Wabash River watershed not in project area		5	22,677,231	27,206,516	83%	64.16	76.98
Phase 2 Project Area Loading			16,054,834	10,051,581	160%	30.42	19.05

Table 6-13: Measured Loads vs. Modeled Loads - Nitrite.

Subwatershed		Site	Nitrite				
			Measured Load ***(lbs/yr)***	*Modeled Load* ***(lbs/yr)***	*Comparison: Measured/ Modeled*	*Measured Load* ***(lbs/ac/yr)***	*Modeled Load* ***(lbs/ac/yr)***
Eight Mile Creek	Pleasant Run/ Big Creek	1	7,227	7,201	100.3%	0.14	0.14
	Moser Lake	2	4,380	4,745	92%	0.20	0.22
	Maple Creek	3	2,920	4,008	73%	0.19	0.27
Wabash River – Griffin Ditch	Johns Creek	6	160,527	192,319	83%	0.43	0.52
	Dowty Ditch	7	121,107	222,541	54%	0.32	0.58
	Bender Ditch/ Griffin Ditch	9	230,826	231,844	99.5%	0.56	0.56
Rock Creek	Elkenberry Ditch	10	17,958	22,156	81%	0.27	0.33
	Mossburg Ditch	13	7,373	12,370	60%	0.14	0.23
	Stites Ditch	14	14,308	21,889	65%	0.48	0.73
	Headwaters	15	2,044	2,154	95%	0.10	0.11
Upstream Wabash River watershed not in project area		5	259,004	268,020	97%	0.73	0.76
Western portion of Elkenberry Ditch subwatershed		11	24,017	50,538	48%	3.91	8.24
Total Wabash River & Rock Creek subwatersheds		12	173,813	304,994	57%	0.36	0.64

Table 6-14: Measured Loads vs. Modeled Loads for Nitrite for the UWRBC Phase 2 Project Area.

Subwatershed		Site	Nitrite				
			Measured Load ***(lbs/yr)***	*Modeled Load* ***(lbs/yr)***	*Comparison: Measured/ Modeled*	*Measured Load* ***(lbs/ac/yr)***	*Modeled Load* ***(lbs/ac/yr)***
Eight Mile Creek	Pleasant Run/ Big Creek	1	7,227	7,201	100.3%	0.14	0.14
Wabash River – Griffin Ditch	Bender Ditch/ Griffin Ditch	9	230,826	231,844	99.5%	0.56	0.56
Rock Creek	Elkenberry Ditch	10	17,958	22,156	81%	0.27	0.33
TOTALS			**256,011**	**261,201**	**98%**	**0.49**	**0.49**
Upstream Wabash River watershed not in project area		5	259,004	268,020	97%	0.73	0.76
Phase 2 Project Area Loading			-2,993	-6,819	44%	-0.57	-1.29

Table 6-15: Measured Loads vs. Modeled Loads – Total Nitrogen.

Subwatershed		Site	Total Nitrogen				
			Measured Load ***(lbs/yr)***	*Modeled Load* ***(lbs/yr)***	*Comparison: Measured/ Modeled*	*Measured Load* ***(lbs/ac/yr)***	*Modeled Load* ***(lbs/ac/yr)***
Eight Mile Creek	Pleasant Run/ Big Creek	1	765,770	179,675	426%	15.21	3.57
	Moser Lake	2	500,342	276,090	181%	23.24	12.82
	Maple Creek	3	200,458	128,987	155%	13.27	8.54
Wabash River – Griffin Ditch	Johns Creek	6	12,749,377	7,519,949	170%	34.39	20.28
	Dowty Ditch	7	10,398,368	8,513,552	122%	27.24	22.30
	Bender Ditch/ Griffin Ditch	9	13,950,227	11,509,972	121%	33.97	28.02
Rock Creek	Elkenberry Ditch	10	1,376,050	1,797,362	77%	20.65	26.97
	Mossburg Ditch	13	667,220	548,226	122%	12.54	10.30
	Stites Ditch	14	551,880	399,084	138%	18.43	13.33
	Headwaters	15	230,388	215,124	107%	11.47	10.71
Upstream Wabash River watershed not in project area		5	10,878,533	6,585,549	165%	30.78	18.63
Western portion of Elkenberry Ditch subwatershed		11	77,526	79,789	97%	12.63	13.00
Total Wabash River & Rock Creek subwatersheds		12	11,402,819	6,196,934	184%	23.89	12.98

Table 6-16: Measured Loads vs. Modeled Loads for Total Nitrogen for the UWRBC Phase 2 Project Area.

Subwatershed		Site	Total Nitrogen				
			Measured Load ***(lbs/yr)***	*Modeled Load* ***(lbs/yr)***	*Comparison: Measured/ Modeled*	*Measured Load* ***(lbs/ac/yr)***	*Modeled Load* ***(lbs/ac/yr)***
Eight Mile Creek	Pleasant Run/ Big Creek	1	765,770	179,675	426%	15.21	3.57
Wabash River – Griffin Ditch	Bender Ditch/ Griffin Ditch	9	13,950,227	11,509,972	121%	33.97	28.02
Rock Creek	Elkenberry Ditch	10	1,376,050	1,797,362	77%	20.65	26.97
TOTALS			**16,092,047**	**13,487,009**	**119%**	**30.50**	**25.56**
Upstream Wabash River watershed not in project area		5	10,878,533	6,585,549	165%	30.78	18.63
Phase 2 Project Area Loading			5,213,514	6,901,460	76%	9.88	13.08

Table 6-17: Measured Loads vs. Modeled Loads – Total Phosphorus.

Subwatershed		Site	Total Phosphorus				
			Measured Load ***(lbs/yr)***	*Modeled Load* ***(lbs/yr)***	*Comparison: Measured/ Modeled*	*Measured Load* ***(lbs/ac/yr)***	*Modeled Load* ***(lbs/ac/yr)***
Eight Mile Creek	Pleasant Run/ Big Creek	1	41,245	16,918	244%	0.82	0.34
	Moser Lake	2	57,086	74,325	77%	2.65	3.45
	Maple Creek	3	8,176	7,147	114%	0.54	0.47
Wabash River – Griffin Ditch	Johns Creek	6	707,370	195,312	362%	1.91	0.53
	Dowty Ditch	7	613,054	315,572	194%	1.61	0.83
	Bender Ditch/ Griffin Ditch	9	740,950	433,043	171%	1.80	1.05
Rock Creek	Elkenberry Ditch	10	46,793	27,120	173%	0.70	0.41
	Mossburg Ditch	13	25,623	112,938	23%	0.48	2.12
	Stites Ditch	14	15,695	6,388	246%	0.52	0.21
	Headwaters	15	9,198	6,183	149%	0.46	0.31
Upstream Wabash River watershed not in project area		5	586,263	160,418	365%	1.66	0.45
Western portion of Elkenberry Ditch subwatershed		11	2,701	9,231	29%	0.44	1.50
Total Wabash River & Rock Creek subwatersheds		12	526,111	116,253	453%	1.10	0.24

Table 6-18: Measured Loads vs. Modeled Loads for Total Phosphorus for the UWRBC Phase 2 Project Area.

Subwatershed		Site	Total Phosphorus				
			Measured Load ***(lbs/yr)***	*Modeled Load* ***(lbs/yr)***	*Comparison: Measured/ Modeled*	*Measured Load* ***(lbs/ac/yr)***	*Modeled Load* ***(lbs/ac/yr)***
Eight Mile Creek	Pleasant Run/ Big Creek	1	41,245	16,918	244%	0.82	0.34
Wabash River – Griffin Ditch	Bender Ditch/ Griffin Ditch	9	740,950	433,043	171%	1.80	1.05
Rock Creek	Elkenberry Ditch	10	46,793	27,120	173%	0.70	0.41
	TOTALS		**828,988**	**477,081**	**174%**	**1.57**	**0.90**
Upstream Wabash River watershed not in project area		5	586,263	160,418	365%	1.66	0.45
Phase 2 Project Area Loading			242,725	316,663	77%	0.46	0.60

Table 6-19: Measured Loads – *E. coli*.

Subwatershed		Site	*E. coli*	
			Measured Load (G-org/yr)	*Measured Load (G-org/ac/yr)*
Eight Mile Creek	Pleasant Run/Big Creek	1	340,419	6.76
	Moser Lake	2	130,288	6.05
	Maple Creek	3	65,759	4.35
Wabash River – Griffin Ditch	Johns Creek	6	3,842,681	10.36
	Dowty Ditch	7	3,222,333	8.44
	Bender Ditch/Griffin Ditch	9	4,116,015	10.02
Rock Creek	Elkenberry Ditch	10	479,503	7.20
	Mossburg Ditch	13	317,811	5.97
	Stites Ditch	14	115,866	3.87
	Headwaters	15	69,950	3.48
Upstream Wabash River watershed not in project area		5	3,397,047	9.61
Western portion of Elkenberry Ditch subwatershed		11	36,156	5.89
Total Wabash River & Rock Creek subwatersheds		12	3,805,921	7.97

Table 6-20: Measured Loads for *E. coli* for the UWRBC Phase 2 Project Area.

Subwatershed		Site	*E. coli*	
			Measured Load (G-org/yr)	*Measured Load (G-org/ac/yr)*
Eight Mile Creek	Pleasant Run/Big Creek	1	340,419	6.76
Wabash River – Griffin Ditch	Bender Ditch/Griffin Ditch	9	4,116,015	10.02
Rock Creek	Elkenberry Ditch	10	479,503	7.20
	TOTALS		**4,935,937**	**9.35**
Upstream Wabash River watershed not in project area		5	3,397,047	9.61
Phase 2 Project Area Loading			1,538,890	2.92

6.3 Target Load Reductions Needed

Based on a review of the measured versus modeled loads, the measured load data was used to rank the subwatersheds by the current loading per acre for nitrate, total phosphorus and *E. coli*. The measured load data shows that nitrate will need to be reduced by 44% to reach the target load; however nitrite and total nitrogen do not require any reductions. The phosphorus reduction of 22% will exceed the Wabash River TMDL of a 4% reduction for phosphorus; however, the reduction of 53% indicated by the measured load data for *E. coli* will meet the target load for the project area, but is below the TMDL recommended reduction of 87%. These individual subwatershed load reductions shown in the following charts are used in addition to other characteristics in the subwatersheds to identify critical areas in the project area and also used in determining long-term goals.

Table 6-21: Measured vs. Modeled Load Reduction Estimates – Nitrate.

Subwatershed		**Site**	**Nitrate**					
			Measured Reduction (lbs/yr)	*Measured Reduction (lbs/ac/yr)*	*%*	*Modeled Reduction (lbs/yr)*	*Modeled Reduction (lbs/ac/yr)*	*%*
Eight Mile Creek	Pleasant Run/Big Creek	1	-	-	-	-	-	-
	Moser Lake	2	1,272,317	59.10	71%	1,074,600	49.91	67%
	Maple Creek	3	223,234	14.78	40%	350,020	23.16	52%
Wabash River – Griffin Ditch	Johns Creek	6	14,176,965	38.24	50%	13,565,192	36.58	49%
	Dowty Ditch	7	12,586,660	32.97	51%	16,796,770	44.00	58%
	Bender Ditch/ Griffin Ditch	9	15,977,892	38.91	47%	10,371,175	25.25	36%
Rock Creek	Elkenberry Ditch	10	1,257,133	18.86	38%	5,296,964	79.49	72%
	Mossburg Ditch	13	182,865	3.43	11%	2,004,463	37.67	58%
	Stites Ditch	14	494,356	16.51	36%	99,480	3.32	8%
	Headwaters	15	120,742	6.01	20%	443,636	22.08	48%
Upstream Wabash River watershed not in project area		5	9,531,026	26.97	42%	14,051,102	39.75	52%
Western portion of Elkenberry Ditch subwatershed		11	51,684	8.42	24%	124,279	20.26	44%
Total Wabash River & Rock Creek subwatersheds		12	10,401,478	21.78	35%	7,738,515	16.21	29%

>50 lbs/ac/yr | 30-50 lbs/ac/yr | 10-30 lbs/ac/yr | 0-10 lbs/ac/yr | No reduction required

THE MEASURED NITRITE AND TOTAL NITROGEN RESULTS REQUIRE NO REDUCTIONS.

Table 6-22: Measured vs. Modeled Load Reduction Estimates – Total Phosphorus.

Subwatershed		Site	Total Phosphorus					
			Measured Reduction (lbs/yr)	*Measured Reduction (lbs/ac/yr)*	*%*	*Modeled Reduction (lbs/yr)*	*Modeled Reduction (lbs/ac/yr)*	*%*
Eight Mile Creek	Pleasant Run/Big Creek	1	-	-	-	-	-	-
	Moser Lake	2	41,464	1.92	73%	58,718	2.72	79%
	Maple Creek	3	-	-	-	-	-	-
Wabash River – Griffin Ditch	Johns Creek	6	287,839	0.78	41%	-	-	-
	Dowty Ditch	7	247,835	0.65	40%	-	-	-
	Bender Ditch/ Griffin Ditch	9	200,020	0.48	27%	-	-	-
Rock Creek	Elkenberry Ditch	10	-	-	-	-	-	-
	Mossburg Ditch	13	-	-	-	69,861	1.31	62%
	Stites Ditch	14	-	-	-	-	-	-
	Headwaters	15	-	-	-	-	-	-
Upstream Wabash River watershed not in project area		5	191,844	0.54	33%	-	-	-
Western portion of Elkenberry Ditch subwatershed		11	-	-	-	4,446	0.72	48%
Total Wabash River & Rock Creek subwatersheds		12	-	-	-	-	-	-

>1.0 lbs/ac/yr | 0.5-1.0 lbs/ac/yr | 0-0.5 lbs/ac/yr | No reduction required

Table 6-23: Measured Load Reduction Estimates for *E. coli*.

Subwatershed		Site	*E. coli*		
			Measured Reduction G-org/yr	*Measured Reduction G-org/ac/ yr*	*%*
Eight Mile Creek	Pleasant Run/Big Creek	1	179,510	3.56	53%
	Moser Lake	2	74,850	3.48	57%
	Maple Creek	3	30,763	2.03	47%
Wabash River – Griffin Ditch	Johns Creek	6	2,351,302	6.34	61%
	Dowty Ditch	7	1,924,087	5.04	60%
	Bender Ditch/Griffin Ditch	9	2,193,026	5.34	53%
Rock Creek	Elkenberry Ditch	10	260,204	3.91	54%
	Mossburg Ditch	13	164,789	3.09	52%
	Stites Ditch	14	23,700	0.79	20%
	Headwaters	15	18,939	0.94	27%
Upstream Wabash River watershed not in project area		5	1,995,084	5.64	59%
Western portion of Elkenberry Ditch subwatershed		11	19,160	3.12	53%
Total Wabash River & Rock Creek subwatersheds		12	1,741,652	3.65	46%

>5 G-org/ac/yr | 3-5 G-org/ac/yr | 2-3 G-org/ac/yr | 0-2 G-org/ac/yr

Target Reductions Based on Flow Events

Another advantage of the load duration curve framework is the ability to provide meaningful connections between the load allocations and implementation efforts that will most effectively address water quality concerns. In general, waste load allocations from waste water treatment plants can play a significant role in nutrient and *E. coli* levels during low flow conditions. Actions to address this might involve review of facility permits and compliance. Under high flow conditions, stream bank erosion and channel processes may account for higher loading of total sediment. Implementation efforts might include bank stabilization practices. Water quality concerns during mid-range flows and moist conditions may be the result of runoff from impervious surfaces in urban areas; while in agricultural watersheds the saturated soils and the larger drainage area are potentially contributing pollutants in runoff. Low impact development techniques might be used in urban areas and conservation practices such as cover crops would be appropriate in agricultural areas. Tables 6-24 through 6-28 display the subwatersheds with exceedances during the various flow zones.

Table 6-24: Nitrate LDC Flow Zones - Modeled Loads Exceed Target Loads and Required Reductions.

NITRATE – LDC FLOW ZONE LOADS, TARGET LOADS AND REQUIRED REDUCTION							
Subwatershed		**Site**	***Flow Zone***	***90th Percentile Load (lbs/y)***	***Target Load (lbs/y)***	***Required Reduction (lbs/y)***	***%***
Eight Mile Creek	Pleasant Run/ Big Creek	1	Moist	5,278,236	483,315	4,794,921	91%
			Mid-range	810,559	372,282	438,277	54%
	Moser Lake	2	Moist	2,351,600	344,918	2,006,682	85%
			Mid-range	1,594,802	215,178	1,379,624	86%
			Dry	229,643	34,255	195,388	85%
			Low Flow	80,961	20,670	60,291	74%
	Maple Creek	3	Moist	1,673,164	161,629	1,511,535	90%
			Mid-range	411,808	92,137	319,671	78%
Wabash River – Griffin Ditch	Johns Creek	6	Moist	94,899,234	4,557,543	90,341,691	95%
			Mid-range	5,753,364	2,441,189	3,312,175	58%
			Dry	7,094,410	2,080,916	5,013,494	71%
	Dowty Ditch	7	Moist	85,478,109	5,388,334	80,089,775	94%
			Mid-range	6,032,348	2,830,597	3,201,751	53%
			Dry	8,041,687	2,423,469	5,618,218	70%
			Low Flow	498,451	417,757	80,694	16%
	Bender Ditch/ Griffin Ditch	9	Moist	84,484,470	4,955,218	79,529,252	94%
			Mid-range	12,974,940	3,894,090	9,080850	70%
			Dry	5,610,181	2,720,742	2,889,439	52%
Rock Creek	Elkenberry Ditch	10	Moist	10,695,026	1,311,941	9,383,085	88%
			Mid-range	1,443,487	550,646	892,841	62%
	Mossburg Ditch	13	Moist	7,774,507	1,720,055	6,064,452	78%
			Mid-range	746,921	414,607	332,314	44%
	Stites Ditch	14	Mid-range	1,389,672	374,052	1,015,620	73%
	Headwaters	15	Moist	2,562,362	247,269	2,315,093	90%
			Mid-range	228,892	138,992	89,900	39%

Table 6-24: Nitrate LDC Flow Zones - Modeled Loads Exceed Target Loads and Required Reductions (continued).

Subwatershed	Site	*Flow Zone*	*90th Percentile Load (lbs/y)*	*Target Load (lbs/y)*	*Required Reduction (lbs/y)*	*%*
Upstream Wabash River watershed not in project area	5	Moist	97,871,283	4,573,293	93,297,990	95%
		Mid-range	5,822,823	2,724,681	3,098,142	53%
		Dry	7,800,021	1,779,313	6,020,708	77%
Western portion of Elkenberry Ditch subwatershed	11	Moist	591,789	188,406	403,383	68%
		Mid-range	238,060	49,020	189,040	79%
		Dry	91,947	9,647	82,300	90%
Total Wabash River & Rock Creek subwatersheds	12	Moist	99,640,766	6,075,410	93,565,356	94%
		Mid-range	13,371,322	4,260,269	9,111,053	68%
		Dry	3,177,380	1,560,196	1,617,184	51%

Modeled nitrate loads exceeded the target load in all subwatersheds during mid-range flow conditions; and twelve out of the thirteen subwatersheds exceeded the target load during moist conditions. This suggests that nitrates are readily available in all watersheds from sources such as fertilizer and animal or human waste; and is washed into the streams and river by surface runoff and through subsurface tile drainage.

The Moser Lake-Eight Mile Creek; Johns Creek, Dowty Ditch and Bender Ditch-Wabash River subwatersheds; and western portion of the Elkenberry Ditch-Rock Creek, upstream Wabash River watershed, and the combined watersheds of the Wabash River and Rock Creek exceeded the target load during dry periods. The Moser Lake-Eight Mile Creek and Dowty Ditch-Wabash River subwatersheds also exceeded the target load during low flow, suggesting that there is a continuous source of nitrates available in those subwatersheds which could be from waste treatment facilities or on-site septic systems.

Table 6-25: Nitrite LDC Flow Zones - Modeled Loads Exceed Target Loads and Required Reductions.

NITRITE – LDC FLOW ZONE LOADS, TARGET LOADS AND REQUIRED REDUCTION								
Subwatershed		**Site**	*Flow Zone*	*90th Percentile Load (lbs/y)*	*Target Load (lbs/y)*	*Required Reduction (lbs/y)*	*%*
Eight Mile Creek	Pleasant Run/Big Creek	1	Moist	51,783	48,333	3,450	7%
Wabash River – Griffin Ditch	Dowty Ditch	7	Moist	600,768	538,835	61,933	10%
Upstream Wabash River watershed not in project area		5	Moist	610,390	457,330	153,060	25%
			Dry	215,591	177,930	37,661	17%
Western portion of Elkenberry Ditch subwatershed		11	Moist	40,771	18,841	21,930	54%
			Dry	40,796	964	39,832	98%

Nitrite modeled loads exceeded the target load during moist conditions in the Pleasant Run Ditch-Eight Mile Creek and Dowty Ditch-Wabash River subwatersheds. The upstream Wabash River watershed and western portion of the Elkenberry Ditch-Rock Creek subwatershed exceeded the target load during both moist and dry conditions. Potential sources may be storm water runoff from agricultural activities during moist conditions and point sources such as septic system inputs during dry conditions.

Table 6-26: Total Nitrogen LDC Flow Zones - Modeled Loads Exceed Target Loads and Required Reductions.

TOTAL NITROGEN – LDC FLOW ZONE LOADS, TARGET LOADS AND REQUIRED REDUCTION							
Subwatershed		**Site**	***Flow Zone***	***90th Percentile Load (lbs/y)***	***Target Load (lbs/y)***	***Required Reduction (lbs/y)***	***%***
Eight Mile Creek	Pleasant Run/Big Creek	1	Moist	2,162,833	483,315	1,679,518	78%
			Dry	77,271	66,740	10,531	14%
	Moser Lake	2	Moist	1,469,640	344,918	1,124,722	77%
			Mid-range	256,591	215,178	41,413	16%
			Dry	57,312	34,255	23,057	40%
			Low Flow	20,871	20,670	201	1%
	Maple Creek	3	Moist	819,702	161,629	658,073	80%
Wabash River – Griffin Ditch	Johns Creek	6	Moist	38,947,727	4,557,543	34,390,184	88%
	Dowty Ditch	7	Moist	47,343,201	5,388,334	41,954,867	89%
	Bender Ditch/Griffin Ditch	9	Moist	53,588,730	955,218	48,622,512	91%
Rock Creek	Elkenberry Ditch	10	Moist	5,466,058	1,311,941	4,154,117	76%
	Mossburg Ditch	13	Moist	3,148,023	1,720,055	1,427,968	45%
	Headwaters	15	Moist	1,213,961	247,269	966,692	80%
Upstream Wabash River watershed not in project area		5	Moist	46,278,971	4,573,293	41,705,678	90%
			Low Flow	410,764	375,629	35,135	9%
Western portion of Elkenberry Ditch subwatershed		11	Moist	341,030	188,406	152,624	45%
			Dry	15,213	9,647	5,566	37%
Total Wabash River & Rock Creek subwatersheds		12	Moist	50,655,138	6,075,410	44,579,728	88%
			Dry	1,799,618	1,560,196	239,422	13%

All of the subwatersheds in the project except for the Stites Ditch-Rock Creek subwatershed exceeded the modeled target load for total nitrogen during moist conditions. The Pleasant Run Ditch-Eight Mile Creek, western portion of the Elkenberry Ditch-Rock Creek, and the combined Wabash River and Rock Creek subwatersheds also exceeded the target load during dry conditions.

The Moser Lake-Eight Mile Creek requires load reductions across the various flow conditions suggesting sources such as fertilizer and animal waste in surface runoff and tile drainage, as well as discharges from waste water treatment facilities or rural septic systems that contribute to the cause of those levels. Based on the modeled load duration curves the Stites Ditch-Rock Creek subwatershed requires no load reductions for total nitrogen.

Table 6-27: Total Phosphorus LDC Flow Zones - Modeled Loads Exceed Target Loads and Required Reduction.

TOTAL PHOSPHORUS – LDC FLOW ZONE LOADS, TARGET LOADS AND REQUIRED REDUCTION							
Subwatershed		**Site**	***Flow Zone***	***90th Percentile Load (lbs/y)***	***Target Load (lbs/y)***	***Required Reduction (lbs/y)***	***%***
Eight Mile Creek	Pleasant Run/Big Creek	1	Moist	207,404	14,498	192,906	93%
			Low Flow	1,975	887	1,088	55%
	Moser Lake	2	Moist	128,896	10,348	118,548	92%
			Mid-range	7,326	6,457	869	12%
			Dry	5,125	1,029	4,096	80%
			Low Flow	2,336	621	1,715	73%
	Maple Creek	3	Moist	41,752	4,847	36,905	88%
			Mid-range	5,811	2,763	3,048	52%
Wabash River – Griffin Ditch	Johns Creek	6	Moist	2,295,200	136,725	2,158,475	94%
			Mid-range	183,179	73,237	109,942	60%
			Dry	96,207	62,426	33,781	35%
			Low Flow	14,293	11,362	2,931	21%
	Dowty Ditch	7	Moist	1,781,346	161,651	1,619,695	91%
			Mid-range	183,997	84,917	99,080	54%
			Dry	117,559	72,704	44,855	38%
			Low Flow	13,556	12,534	1,022	8%
	Bender Ditch/Griffin Ditch	9	Moist	2,364,521	148,657	2,215,864	94%
			Mid-range	148,175	116,822	31,353	21%
			Dry	115,442	81,621	33,821	29%
			Low Flow	53,885	36,902	16,983	32%
Rock Creek	Elkenberry Ditch	10	Moist	215,051	39,358	175,693	82%
			Mid-range	17,786	16,520	1,266	7%
			Dry	11,957	7,245	4,712	39%
	Mossburg Ditch	13	Moist	159,834	51,600	108,234	68%
	Headwaters	15	Moist	47,560	7,417	40,143	84%
Upstream Wabash River watershed not in project area		5	Moist	2,421,176	137,200	2,283,976	94%
			Mid-range	151,767	81,742	70,025	46%
			Dry	67,244	53,378	13,866	21%
Western portion of Elkenberry Ditch subwatershed		11	Moist	15,078	5,654	9,424	63%
Total Wabash River & Rock Creek subwatersheds		12	Moist	2,545,240	182,263	2,362,977	93%
			Dry	71,029	46,808	24,221	34%
			Low Flow	38,730	29,996	35,734	23%

Total phosphorus target loads were exceeded during moist conditions in twelve out of the thirteen subwatersheds. The Maple Creek and Moser Lake subwatersheds in Eight Mile Creek, all of the Wabash River – Griffin Ditch subwatersheds, Elkenberry Ditch-Rock Creek subwatershed and the upstream Wabash River watershed also exceeded the target load during mid-range flows.

Moser Lake-Eight Mile Creek and Johns Creek, Dowty Ditch, and Bender Ditch-Wabash River subwatersheds exceeded the target load across the various flow conditions. The Elkenberry Ditch-Rock Creek subwatershed and upstream Wabash River watershed requires load reductions under dry conditions; and the Pleasant Run Ditch-Eight Mile Creek requires reductions during low flow. The western portion of the Elkenberry Ditch-Rock Creek and the combined drainage of the Wabash River and Rock Creek subwatersheds also require load reductions during dry conditions and low flow. This could be due to surface runoff from urban areas as well as agricultural activities, tile drainage, on-site septic system failure, and waste water treatment facility discharges. The Stites Ditch-Rock Creek subwatershed does not require any reductions in total phosphorus loads.

Table 6-28: *E. coli* LDC Flow Zones - Modeled Loads Exceed Target Loads and Required Reductions.

***E. coli* – LDC FLOW ZONE LOADS, TARGET LOADS AND REQUIRED REDUCTION**							
Subwatershed		**Site**	***Flow Zone***	***90th Percentile Load (lbs/y)***	***Target Load (lbs/y)***	***Required Reduction (lbs/y)***	***%***
Eight Mile Creek	Pleasant Run/ Big Creek	1	Moist	299,702	51,502	248,200	83%
			Mid-range	186,296	39,676	146,620	79%
			Dry	22,338	7,118	15,220	68%
			Low Flow	4,672	3,139	1,533	33%
	Moser Lake	2	Moist	331,128	36,756	294,372	89%
			Mid-range	153,081	22,922	130,159	85%
			Dry	77,672	3,650	74,022	95%
			Low Flow	5,110	2,190	2,920	57%
	Maple Creek	3	Moist	189,399	17,228	172,171	91%
			Mid-range	21,353	9,819	11,534	54%
			Dry	3,176	1,424	1,752	55%
Wabash River – Griffin Ditch	Johns Creek	6	Moist	1,348,274	485,815	862,459	64%
			Mid-range	2,037,576	260,209	1,777,367	87%
			Dry	1,221,582	221,811	999,771	82%
			Low Flow	141,146	40,369	100,777	71%
	Dowty Ditch	7	Moist	3,842,392	574,364	3,268,028	85%
			Mid-range	2,237,706	301,746	1,935,960	87%
			Dry	737,921	258,347	479,574	65%
			Low Flow	67,890	44,530	23,360	34%
	Bender Ditch/ Griffin Ditch	9	Moist	2,871,674	528,192	2,343,482	82%
			Mid-range	1,609,395	415,078	1,194,317	74%
			Low Flow	371,899	131,108	240,791	65%
Rock Creek	Elkenberry Ditch	10	Moist	623,347	139,832	483,515	78%
			Mid-range	366,752	58,692	308,060	84%
			Dry	205,313	25,733	179,580	87%
	Mossburg Ditch	13	Moist	796,941	183,340	613,601	77%
			Mid-range	302,074	44,205	257,869	85%

Table 6-28: *E. coli* LDC Flow Zone - Modeled Loads Exceed Target Loads And Required Reductions (continued)

Subwatershed		Site	*Flow Zone*	*90th Percentile Load (lbs/y)*	*Target Load (lbs/y)*	*Required Reduction (lbs/y)*	*%*
Rock Creek	Stites Ditch	14	Dry	77,380	25,368	52,012	67%
	Headwaters	15	Moist	65,080	26,353	38,727	60%
			Mid-range	63,620	14,819	48,801	76%
			Dry	3,833	2,884	949	24%
			Low Flow	6,351	1,862	4,489	71%
Upstream Wabash River watershed not in project area		5	Moist	628,275	487,494	140,781	22%
			Mid-range	651,817	290,431	361,386	55%
			Dry	1,417,113	189,654	1,227,459	87%
			Low Flow	63,510	40,041	23,469	37%
Western portion of Elkenberry Ditch subwatershed		11	Moist	223,380	20,075	203,305	91%
			Mid-range	7,665	5,220	2,445	32%
			Dry	2,081	1,022	1,059	51%
Total Wabash River & Rock Creek subwatersheds		12	Moist	2,838,496	647,620	2,190,876	77%
			Mid-range	1,479,272	454,133	1,025,139	69%
			Dry	369,818	166,294	203,524	55%
			Low Flow	763,726	106,580	657,146	86%

All subwatersheds in the project area exceeded the target load during at least one flow regime, requiring reductions to the *E. coli* loads in all subwatersheds. The most exceedances occurred during moist conditions and mid-range flow. The Pleasant Run Ditch-Eight Mile Creek, Moser Lake-Eight Mile Creek, Johns Creek-Wabash River, Dowty Ditch-Wabash River, Headwaters-Rock Creek, upstream Wabash River watershed, and the combined drainage of the Wabash River and Rock Creek subwatersheds all exceeded the target load across the various flow conditions. This indicates continuous sources of *E. coli* within the river and streams coming from a combination of waste water treatment plants, failing or illicit on-site septic systems, and animal waste handling and application.

The Maple Creek-Eight Mile Creek, Elkenberry Ditch-Rock Creek, and Stites Ditch-Rock Creek exceeded the target load during dry conditions, and the Bender Ditch-Wabash River exceeded the target load during low flow. Because those are more rural subwatersheds in the project area it is suspected that failing septic systems may be the cause of the inputs.

7.0 Water Quality Improvement Goals

7.1 Water Quality Goals and Indicators

The steering committee reviewed the stakeholder concerns, monitoring data, and potential causes and sources of pollution and developed a list of broad concerns for project goals. Specific concerns were grouped together and outlined below:

Broad Concerns for Project Goals

1. Nutrients and *E. coli* Goals = Water Quality Concerns
    - Over application of fertilizers and animal waste, and limited use of variable rate technology.
    - Lack of cropland and tile inlet buffer areas, wetlands and riparian areas.
    - Discharges from on-site septic systems and municipal waste water treatment facilities.
2. Sediment Goals = Erosion Concerns
    - Channelization, in-stream and stream bank erosion.
    - Lack of riparian areas, buffers and filter strips.
    - Low adoption of conservation tillage and tillage to edge of stream banks.
    - Construction site erosion.
3. Habitat and Recreation Goals = Habitat Protection and Restoration Concerns
    - Loss of riparian area habitat and natural ecosystems resulting in impaired biotic communities.
    - Lack of green space and connecting trails for recreation.
4. Flooding/Floodplain Goals = Flow Concerns
    - Log jams and in-stream obstructions due to unstable banks and downed trees.
    - Lack of upland areas for water storage.
    - Floodplain restoration needed to provide natural flood control benefits.
5. Education/Outreach Goals = Lack of Knowledge Concerns
    - Competing land uses limit BMP implementation that could improve water quality.
    - Limited community involvement in environmental activities to benefit the health of the watershed.
    - Lack of appreciation for and understanding of environmental benefits versus financial benefits.

The broad concerns were then refined into specific goal statements to address the water quality problems along with goal indicators to measure progress towards each goal. Long-term, short-term and scaled goals of five, ten and twenty years were developed based on the measured results for load reductions and average target concentrations of the pollutants.

As stated previously, the UWRBC Phase 2 project area receives pollutant loading from the upstream Wabash River watershed containing approximately 350,394 acres that is outside of this project area. The accumulated pollutant loading from the upstream area adds to the current loads within the project area, and it is expected that the goals will only be achieved if BMPs are implemented in the upstream Wabash River watershed.

Education and outreach also plays a critical role in changing attitudes and behavior of the stakeholders. Social indicator surveys conducted throughout the planning process were also used to evaluate the awareness, and acceptance to practice adoption to meet the project goals.

Nutrients and *E. coli* Goal Statement

Excess nutrients and *E. coli* impact our stream and river environments by causing increased plant and algal growth. When these plants die and decompose, it depletes the dissolved oxygen in the water resulting in a decrease in aquatic and biotic communities. Exceedances of the nitrate, phosphorus and *E. coli* allowable loads and target concentrations support the stakeholder concerns of excess nutrients and *E.coli* in the streams and river.

Nitrate Long-term Goal: Reduce nitrate loading by 44.24% from 38,732,065 lbs/yr to 21,597,056 lbs/yr; a reduction of 17,135,009 lbs/yr; and reduce average annual concentrations from 17.56 mg/L to 10 mg/L (43.05%) in the Upper Wabash River Phase 2 project area by the year 2035 to meet water quality targets.

Nitrate Scaled Goals: Reduce nitrate loading by 11.06% (4,283,766 lbs/yr); and reduce the average annual concentrations by 10.76% or 1.89 mg/L (from 17.27 mg/L to 15.67 mg/L) by 2020. Reduce nitrate loading an additional 11.06% (4,283,766 lbs/yr); and reduce average annual concentrations from 15.67 mg/L to 13.78 mg/L (1.89 mg/L, 11.06%) by 2025. Reduce nitrate loading by an additional 22.12% (8,567,505 lbs/yr) for a total of reduction of 17,135,037 lbs/yr or 44.24%; and reduce average annual concentrations from 13.78 mg/L to 10 mg/L (3.78 mg/L, 21.53%) by 2035.

Phosphorus Long-term Goal: Reduce phosphorus loading by 21.85% from 828,988 lbs/yr to 647,875 lbs/yr; a reduction of 181,114 lbs/yr; and reduce the phosphorus average annual concentration by 0.0821 mg/L (21.49% reduction) from 0.3821 mg/L to 0.3 mg/L in the Upper Wabash River Phase 2 project area by the year 2035 to meet water quality targets.

Phosphorus Scaled Goals: Reduce phosphorus loading by 5.46% (45,262 lbs/yr) and reduce the average annual concentration by 0.0205 mg/L (5.37% reduction) by 2020. Reduce phosphorus loading an additional 5.46% (45,262 lbs/yr) and reduce the average annual concentration by an additional 5.46% (0.0205 mg/L). Reduce phosphorus loading by an additional 10.93% (90,608 lbs/yr) for a total reduction of 21.85%; and reduce the average annual concentration by an additional 0.0411 mg/L (10.74%) by 2035 for a total reduction of 21.49 % or 0.0821 mg/L.

***E. coli* Long-term Goal:** Reduce *E. coli* loading by 53.34% from 4,935,937 G-org/yr to 2,303,197 G-org/yr and reduce the average annual concentration in the Upper Wabash River Phase 2 project area by 51.07% from 480.24 cfu/100mL to 235 cfu/100mL by the year 2035.

***E. coli* Scaled Goals:** Reduce *E. coli* loading by 13% (641,672 G-org/yr) from 4,935,937 G-org/yr to 4,294,265 G-org/yr and reduce the average annual concentration by 12.76% (61.28 cfu/100 ml) from 480.24 cfu/100 ml to 418.96 cfu/100 ml by 2020. Reduce *E. coli* loading by an additional 13.34% (658,454 G-org/yr) and reduce the average annual concentration by an additional 12.76% (61.28 cfu/100 ml) by 2025. Reduce *E. coli* loading by an additional 27%

(1,332,703 G-org/yr) for a total of 53.34% (total of 2,632,829 G-org/yr) and reduce the average annual concentration by an additional 25.55% (122.70 cfu/100 ml) for a total reduction of 51.07% (245.24 cfu/100 ml) by year 2035 to reach the state standard of 235 cfu/100 ml for full-body contact for *E. coli*.

Goal Indicators:
Water quality monitoring data will be used as the primary indicator to show progress towards attaining these goals. The monitoring data will be used to model load duration curves and target concentrations across flow conditions to document changes in the nutrient and *E. coli* levels over time. Other indicators include tracking best management practices implemented in the project area, and using models to estimate load reductions.

Sediment Goal Statement
Turbid water is caused by suspended matter including clay, silt, and organic and inorganic matter; and can be the result of soil erosion, urban runoff, algal blooms, and bottom sediment disturbances. Because turbidity was measured during the planning process versus measuring total suspended sediments, load models were not available. However, turbidity concentrations and habitat assessments collected throughout the planning process confirm sediment is a problem in the project area.

Sediment Long-term Goal: Reduce erosion and sediment in the project area streams and river by reducing the average concentration of turbidity measurements from 106.96 NTUs to the Indiana average of 36 NTUs (66.34 % reduction) by year 2035.

Sediment Scaled Goal: Reduce erosion and sediment by reducing the average concentration of turbidity measurements by 16.58% (from 106.96 NTUs to 89.22 NTUs) by 2020. Reduce erosion and sediment by reducing the average concentration of turbidity measurements by an additional 16.58% (to 71.48 NTUs) by 2025. Reduce erosion and sediment by reducing the average concentration of turbidity measurements by an additional 33.18% (to 35.99 NTUs) by 2035.

Goal Indicators:
Turbidity measurements will be used as the primary indicator to show progress towards attaining this goal. To better define the amount of sediment reduction needed, total suspended solids (TSS) monitoring will be considered for inclusion in monitoring programs. If TSS monitoring data is available, it will be used to model load duration curves and target concentrations across flow conditions to document changes in the sediment loading. Other indicators include tracking best management practices implemented in the project area, and using models to estimate load reductions.

Habitat and Recreation Goal Statement
Stream side vegetation (riparian areas) and wetlands are important components to a stream ecosystem. They provide bank support and stabilization, erosion and flood control, water quality protection, fish and wildlife habitat, migration corridors, a buffer from development, and scenic beauty. Green space and trails also provide a number of these benefits to nature and the public by connecting natural areas, cultural and historic sites and communities. Biological monitoring

and habitat evaluations confirm that the project area has impaired biological communities and altered habitats. These goals address stakeholders concerns about habitat degradation and corridor protection, as well as the lack of green spaces and trails for recreational purposes.

Habitat Long-term Goal: Restore natural habitat and protect natural land uses within the stream and river corridors in the project area to meet or exceed the CQHEI target of 60 at all project monitoring sites (an increase from 53%) by 2035. When combined with other goals to reduce sediment and nutrient loadings, this should improve the Pollution Tolerance Index (PTI) rating at all sites to meet the fair to excellent ratings (a score of 11 or better) by the year 2035.

Recreation Long-term Goal: Develop partnerships with local government agencies, parks departments, and trails groups to plan and install 5 miles of connecting trails and green space along the river corridor for recreational purposes by 2035.

Goal Indicators:
Biological monitoring and habitat assessments will be used to document changes in the environmental conditions to determine improvement in habitat quality and diversity of biological communities. Social indicators may also be used to assess changes in awareness, attitudes and behavior related to habitat quality. The UWRBC will form a trails sub-committee to work on the planning and installation of connecting trails within the project area. Recreation goals will be evaluated based on the success of the partnerships with other groups, and the amount of trails planned and installed in the project area, as well as trails that connect the project area to adjoining communities.

Flooding/Floodplain Management Goal Statement
Log jams, downed trees and in-stream obstructions due to unstable stream banks contribute to flooding along the river and streams. Floodplain land uses for agriculture and urban activities without buffer areas can compromise habitat and water quality. Additionally, the lack of upland water storage areas in the watersheds and predominance of subsurface tile contribute to increased river and stream water levels and flow velocities during storm events. The steering committee noted the importance of restoring the floodplain to natural land uses (wooded areas, grasslands, and wetlands) for the purposes of flood control. Because this goal would require stakeholder attitude changes, it is expected that this will be an education and outreach effort that will take place over an extended period of time.

Flooding/Floodplain Management Long-term Goals: Increase the amount of riparian areas on local streams and rivers by 5% by 2035.

Flooding/Floodplain Management Short-term Goal: Increase stakeholder awareness of the benefits of upland storm water storage areas and floodplain management practices; such as riparian forest buffers, riparian herbaceous cover, bottomland timber establishment, 2-stage ditches, and wetland creation, enhancement and restoration by 2020.

Goal Indicators:
Social indicator data will be used as the primary indicator to assess changes in awareness, attitudes and behavior, as well as tracking participation in educational outreach activities. The

implementation of best management practices, such as grass plantings or riparian buffers; and windshield surveys and habitat evaluations will be used to measure physical changes to floodplain areas.

Education/Outreach Goal Statement

The steering committee identified a number of education and outreach objectives. Most notably was the issue of competing land uses that limit the use of best management practices that could improve water quality but due to financial considerations are often not implemented; and a general lack of appreciation for and understanding of the environmental benefits versus the financial benefits. Also of concern was the lack of community involvement in environmental activities that benefit the health of the watershed. Awareness and education is needed regarding conservation tillage, fertilizer use, animal waste storage and application, managing drainage water, septic systems, and storm water runoff, as well as the variety of best management practices available to landowners.

Education/Outreach Long-term Goal: Promote the streams and river in the project area to educate landowners and land users about best management practices and provide information on what individuals and communities can do to improve the water quality in the streams and river so that they meet their designated use for aquatic habitat by the year 2035.

Education/Outreach Short-term Goals: Increase individual and community participation in community events such as water monitoring, river clean-up events, and other public outreach activities related to water quality and habitat improvement by 200 people by 2020. Increase community awareness of water quality issues specifically related to nutrient, sediment and bacterial loading and the effects on aquatic habitats. Increase stakeholder participation in conservation programs that put best management practices on the ground.

Goal Indicators

Track participation in water quality program activities, river and stream clean-ups, workshops and field days. Track participation in conservation cost-share programs. Collect social indicator data from stakeholder surveys to document changes in awareness, attitudes and behavior related to water quality improvements. Water monitoring data and habitat assessments will also be conducted and evaluated to document physical changes in habitat or biological quality.

7.2 Critical Land Areas

Critical land areas (CLA) can be described as those areas where there is a need for best management practices to address nonpoint sources of pollution, or areas in need of protection to prevent degradation of the natural resource. Identifying and prioritizing critical areas for improvement enables stakeholders to focus their efforts to those areas in the watershed that will result in the greatest benefit.

A number of factors were considered in determining critical land areas and priority rankings. The watershed inventory, GIS mapping, water quality monitoring data, and load calculations were evaluated against the list of potential sources for each parameter for each subwatershed in the project area. Pollutant sources that were identified as important were: land use, highly erodible soil, number of small unregulated farms and confined feeding operations, number of animals in the subwatershed; waste water treatment facility discharges and the estimated number of on-site septic systems. Critical areas were also based on the water quality data, and the exceedances of the water quality targets. It was noted that flow conditions played a large role on the water quality data exceedances; therefore, exceedances under the various conditions were also evaluated. Based on the percent of the factors that are met, the subwatersheds are categorized as high, medium, low or no priority for further critical land area refinement.

Critical Land Areas for Nutrients

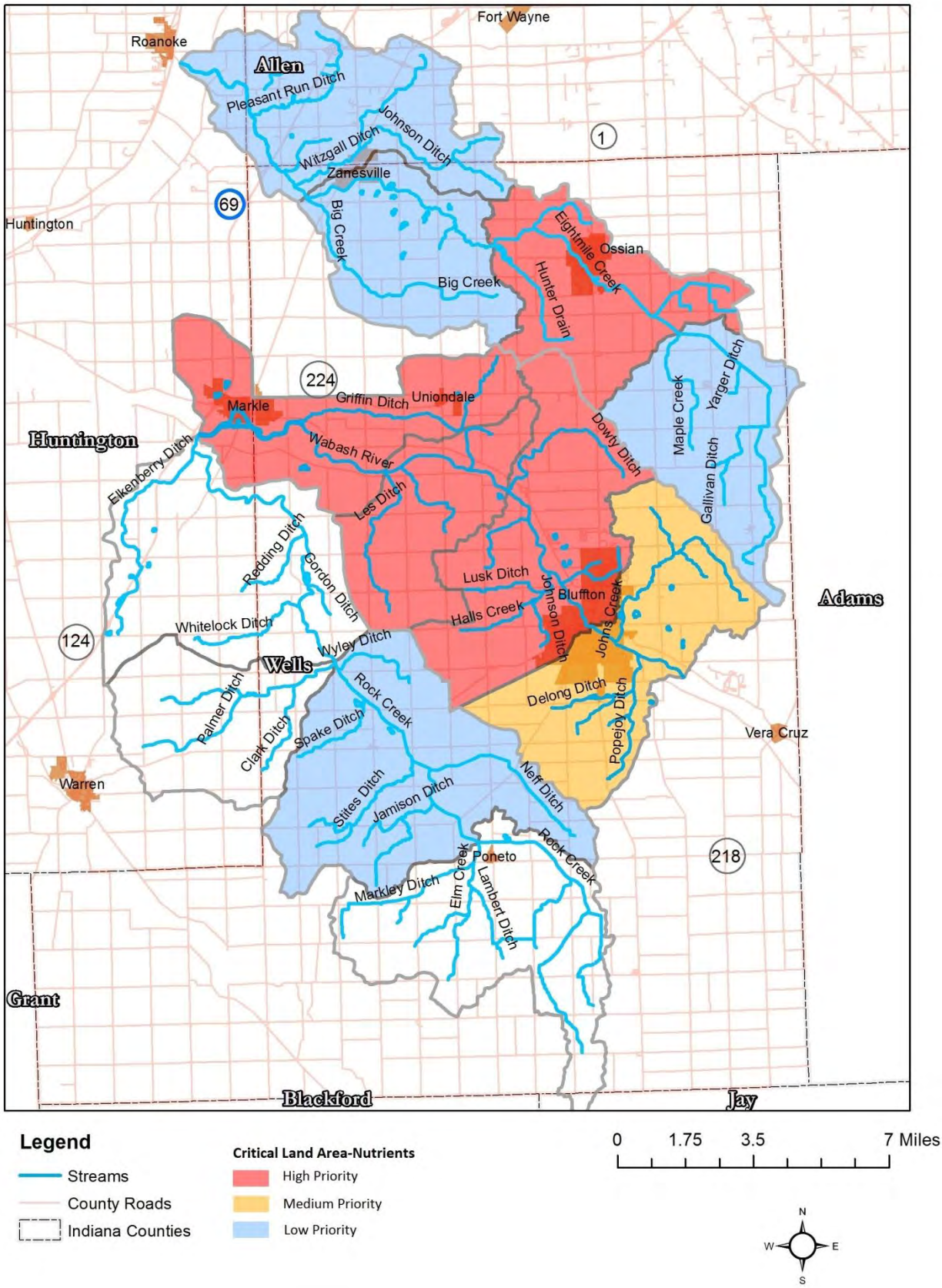
Nutrients are readily available in the Upper Wabash River – Phase 2 project watersheds from sources such as human and animal waste, urban and agricultural fertilizer use, rural septic systems and waste water treatment facilities. A variety of potential sources of pollution were used to evaluate the subwatersheds for the critical land areas for nutrients. These included: land use, tillage operations, HEL/PHEL soils, streams that are lacking buffers, CFOs, hobby farms, animals in the subwatersheds, septic systems, and NPDES sites. Measured load reductions and exceedances of water quality targets were also used in determining critical land areas.

Table 7-1: Critical Land Area for Nutrients

	Pleasant Run / Big Creek (Eight Mile Creek)	Moser Lake (Eight Mile Creek)	Maple Creek (Eight Mile Creek)	Johns Creek (Wabash River)	Dowty Ditch (Wabash River)	Bender Ditch / Griffin Ditch (Wabash River)	Elkenberry Ditch (Rock Creek)	Mossburg Ditch (Rock Creek)	Stites Ditch (Rock Creek)	Headwaters Rock Creek
Potential Sources of Nutrients										
% agricultural land use	79	83	89	79	75	82	86	90	91	90
% conventional tillage	40	48	49	50	50	49	44	46	54	53
% of HEL/PHEL soils	39	34	18	27	37	31	39	41.5	20	24
% of streams lacking buffers	33	67	68	31	37	44	20	31	23	13
# of CFOs	0	2	4	7	3	1	1	1	5	3
# of CFO animals	0	2,680	13,260	10,655	242,400	1,600	30,100	2,077	10,720	5,538
# of hobby farms	230	58	66	83	104	132	89	50	131	122
# of unregulated farm animals (STEPL input data)	181,543	12,427	33,886	17,945	110,609	83,996	3,001	300 (est.)	750 (est.)	492
# of septic systems per acre	974 1:28 ac	369 1:34 ac	293 1:42 ac	394 1:42 ac	452 1:38 ac	503 1:48 ac	282 1:66 ac	125 1:87 ac	380 1:62 ac	262 1:64 ac
# of WWTP Overflows	0	3	0	0	3	4	0	0	0	1
# of NPDES sites	0	3	0	15	12	2	1	0	0	1
Measured Load Reduction Required (lbs/ac/yr)										
Nitrate	0	59.10	14.77	38.25	32.97	38.90	18.85	3.42	16.51	6.00
Nitrite	0	0	0	0	0	0	0	0	0	0
Total Nitrogen	0	0	0	0	0	0	0	0	0	0
Phosphorus	0	1.93	0	0.78	0.65	0.48	0	0	0	0
Number of Flow Conditions that have Load Reduction Requirements										
Nitrate	2	4	2	3	4	3	2	2	1	2
Nitrite	1	0	0	0	1	0	0	0	0	0
Total Nitrogen	2	4	1	1	1	1	1	1	0	1
Phosphorus	2	4	2	4	4	4	3	1	0	1
% of Exceedances of Target Concentration										
Nitrate	45	100	64	58	64	82	58	50	57	50
Nitrite	0	0	8	0	0	0	0	0	0	0
Total Nitrogen	8	42	8	25	25	27	25	8	29	8
Phosphorus	33	64	33	75	79	73	25	21	14	17
SCORE	**6**	**13**	**6**	**11**	**15**	**12**	**5**	**2**	**7**	**5**
	26%	**56%**	**26%**	**48%**	**65%**	**52%**	**22%**	**8%**	**30%**	**22%**
High priority: over 50%; Medium priority: 35-49%; Low priority: 25-35%; Not priority: <25%.										

Based on these criteria, Moser Lake-Eight Mile Creek, Dowty Ditch and Bender Ditch/Griffin Ditch-Wabash River are the high priority critical land areas for nutrients. Johns Creek-Wabash River, Pleasant Run/Big Creek-Eight Mile Ditch, Maple Creek-Eight Mile Ditch and Stites Ditch-Rock Creek would also be considered critical land areas for nutrients.

Figure 69: Critical Land Areas for Nutrients



Critical Land Areas for *E. coli*

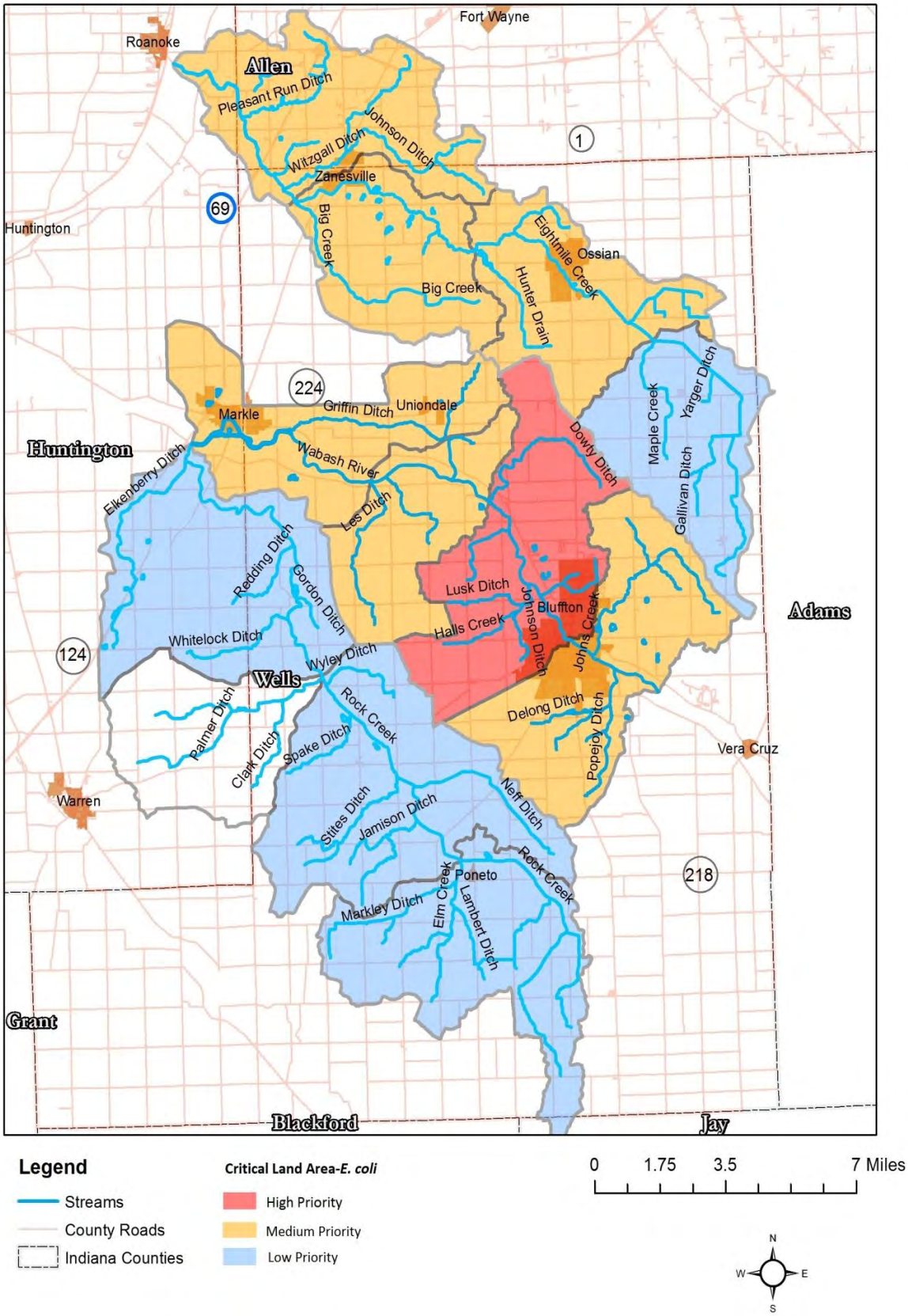
Critical land areas for *E. coli* were based on the potential sources of *E.coli* which included: tile drainage, confined feeding operations, hobby farms, on-site residential septic systems and waste water treatment facilities. The water quality monitoring data measured load reductions, average annual concentration, exceedances of the water quality targets, and number of flow zones that require load reductions were also used in determining the critical areas for *E. coli*.

Table 7-2: Critical Land Area for *E. coli*

	Pleasant Run / Big Creek (Eight Mile Creek)	Moser Lake (Eight Mile Creek)	Maple Creek (Eight Mile Creek)	Johns Creek (Wabash River)	Dowty Ditch (Wabash River)	Bender Ditch / Griffin Ditch (Wabash River)	Elkenberry Ditch (Rock Creek)	Mossburg Ditch (Rock Creek)	Stites Ditch (Rock Creek)	Headwaters Rock Creek
Potential Sources of *E. coli*										
# of acres per mile of tile in watershed	959	621	388	684	663	688	533	542	511	524
# of CFOs	0	2	4	7	3	1	1	1	5	3
# of CFO animals	0	2,680	13,260	10,655	242,400	1,600	30,100	2,077	10,720	5,538
# of hobby farms	230	58	66	83	104	132	89	50	131	122
# of unregulated farm animals (STEPL input data)	181,543	12,427	33,886	17,945	110,609	83,996	3,001	300 (est.)	750 (est.)	492
# of septic systems per acre	974 1:28 ac	369 1:34 ac	293 1:42 ac	394 1:42 ac	452 1:38 ac	503 1:48 ac	282 1:66 ac	125 1:87 ac	380 1:62 ac	262 1:64 ac
# of WWTP Overflows	0	3	0	0	3	4	0	0	0	1
***E. coli* Water Quality Monitoring Data**										
measured load reduction (G-org/ac/yr)	6.76	6.05	4.35	10.36	8.44	10.02	7.20	5.97	3.87	3.48
measured average concentration (cfu/100mL)	497.17	552.29	441.58	605.50	583.28	503.00	513.83	488.07	295.42	322.25
% of exceedances of target (235 cfu/100mL)	70	62	73	67	79	36	50	42	50	33
# of flow conditions with load reductions	4	4	3	4	4	3	3	2	1	4
SCORE	**7**	**7**	**3**	**7**	**10**	**7**	**4**	**0**	**3**	**3**
	64%	**64%**	**27%**	**64%**	**91%**	**64%**	**36%**	**0%**	**27%**	**27%**
High priority: >75%; Medium priority: 50-74%; Low priority: 25-50%; Not priority: <25%.										

Based on these criteria, Dowty Ditch-Wabash River would be considered the highest priority subwatershed for *E. coli*. Pleasant Run/Big Creek-Eight Mile Creek, Moser Lake-Eight Mile Creek, Johns Creek-Wabash River, and Bender Ditch/Griffin Ditch-Wabash River are also considered critical land areas for *E. coli*.

Figure 70: Critical Land Areas for *E. coli*



Critical Land Areas for Sediment

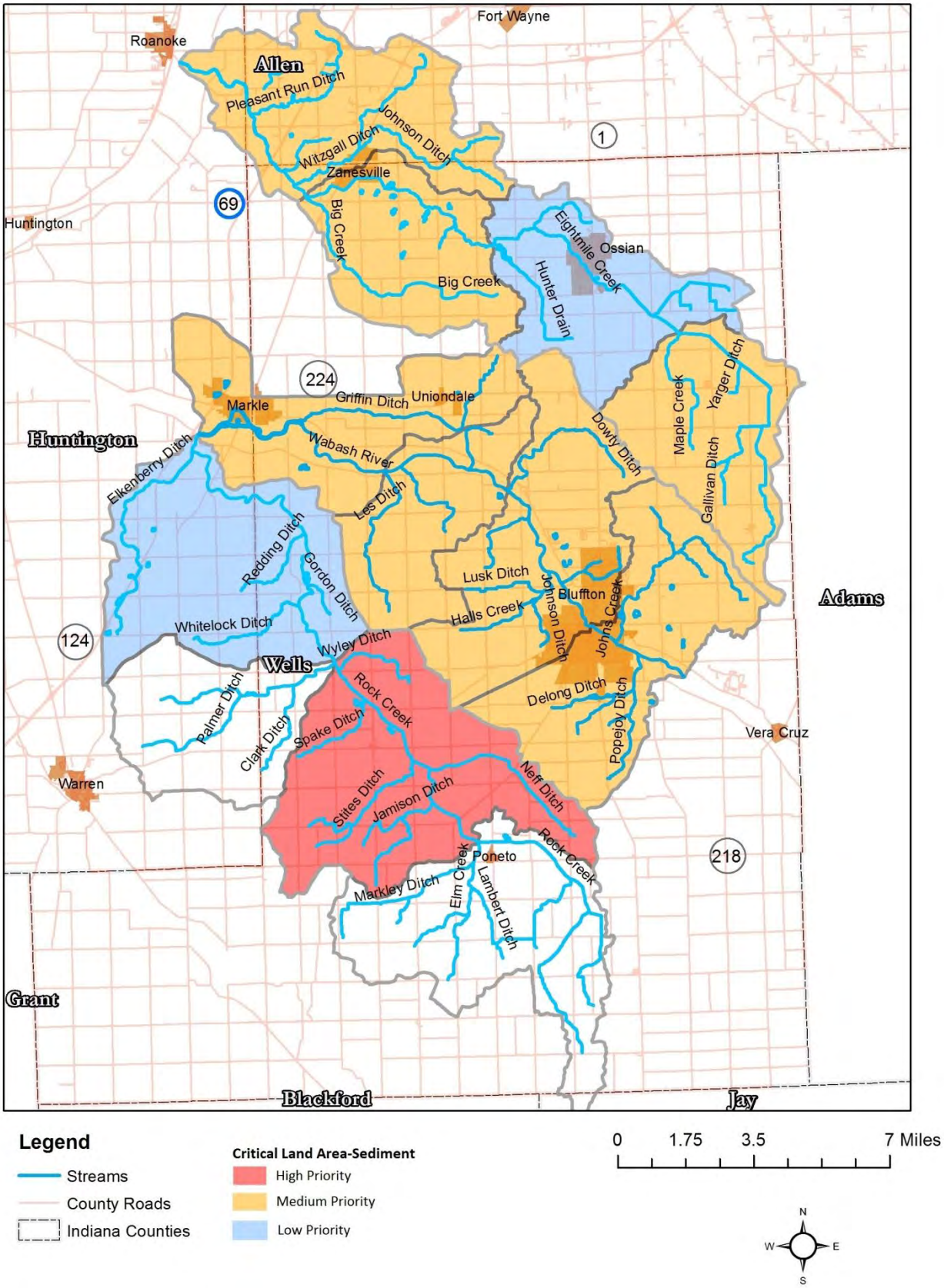
Highly erodible and potentially highly erodible soils, land use, conventional tillage, and streams lacking buffers were used along with turbidity measurements and habitat assessments to determine the sediment based critical areas.

Table 7-3: Critical Land Area for Sediment

	Pleasant Run / Big Creek (Eight Mile Creek)	Moser Lake (Eight Mile Creek)	Maple Creek (Eight Mile Creek)	Johns Creek (Wabash River)	Dowty Ditch (Wabash River)	Bender Ditch / Griffin Ditch (Wabash River)	Elkenberry Ditch (Rock Creek)	Mossburg Ditch (Rock Creek)	Stites Ditch / (Rock Creek)	Headwaters Rock Creek
Potential Sources of Sediment										
% of agricultural land use	79	83	89	79	75	82	86	90	91	90
% of HEL/PHEL soils	41	34	18	27	37	29	39	42	20	24
% conventional tillage	42	48	49	50	50	49	44	46	54	53
% streams lacking buffers	33	67	68	31	37	44	20	31	23	13
feet of streambank erosion	500	0	0	0	0	100	600	0	160	0
Measured Water Quality Data										
turbidity average concentration (NTUs)	84.49	63.95	89.68	197.55	175.58	192.04	58.40	44.64	60.23	51.14
habitat average score less than CQHEI target of 60	59.00	50.88	41.50	54.50	78.88	87.00	82.00	60.88	47.00	65.50
% turbidity exceedances of target = 25 NTUs	41.67	38.46	50.00	100.00	84.62	100.00	50.00	23.08	28.57	33.33
SCORE	**4**	**3**	**4**	**4**	**4**	**4**	**3**	**2**	**5**	**2**
	50%	**38%**	**50%**	**50%**	**50%**	**50%**	**38%**	**25%**	**63%**	**25%**
High priority: >50%; Medium priority: 40-50%; Low priority: 30-39%; Not a priority: <30%.										

The Stites Ditch-Rock Creek is the most critical land area for sediment, followed by Pleasant Run/Big Creek-Eight Mile Creek, Maple Creek-Eight Mile Creek, and the Wabash River subwatersheds of Johns Creek, Dowty Ditch, and Bender Ditch/Griffin Ditch.

Figure 71: Critical Land Areas for Sediment



Critical Land Areas for Habitat and Biology

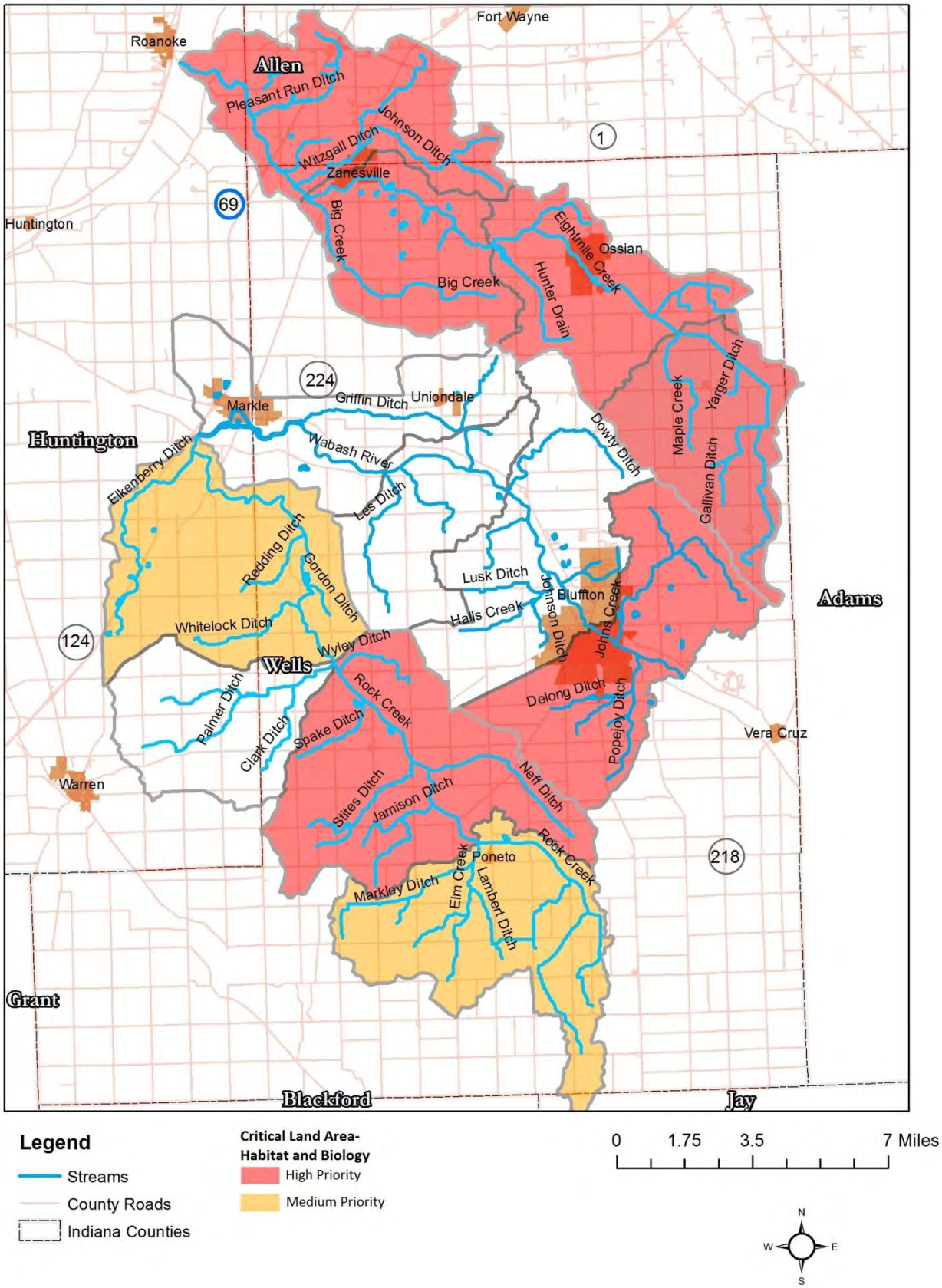
The IDEM 303(d) listing of impaired waters and the evaluations of the stream habitat and biology assessments collected during the monitoring activities were used to determine critical areas for habitat and biological communities.

Table 7-4: Critical Land Area for Habitat and Biology

	Pleasant Run / Big Creek (Eight Mile Creek)	Moser Lake (Eight Mile Creek)	Maple Creek (Eight Mile Creek)	Johns Creek (Wabash River)	Dowty Ditch (Wabash River)	Bender Ditch / Griffin Ditch (Wabash River)	Elkenberry Ditch (Rock Creek)	Mossburg Ditch (Rock Creek)	Stites Ditch / (Rock Creek)	Headwaters Rock Creek
Measured Water Quality Data										
habitat average score less than CQHEI target of 60	59.00	50.88	41.50	54.50	78.88	87.00	82.00	60.88	47.00	65.50
macroinvertebrate PTI average: less than 17 (good) rating	17.50	21.75	15.00	7.50	25.00	26.00	31.50	25.00	22.50	20.50
IDEM 303(d) Listing for Impaired Biotic Communities										
IDEM 303(d) list of impaired biotic communities	1	1	0	0	0	0	1	0	1	1
SCORE	**2**	**2**	**2**	**2**	**0**	**0**	**1**	**0**	**2**	**1**
	67%	**67%**	**67%**	**67%**	**0%**	**0%**	**33%**	**0%**	**67%**	**33%**
High priority: =67%; Medium priority: =33%; Not a priority = 0%.										

Based on these criteria, the Eight Mile subwatersheds, Pleasant Run/Big Creek, Moser Lake, and Maple Creek, as well as Johns Creek-Wabash River and Stites Ditch-Rock Creek are the critical land areas for habitat and biology.

Figure 72: Critical Land Areas for Habitat and Biology



Critical Land Areas for Flooding/Floodplain Management

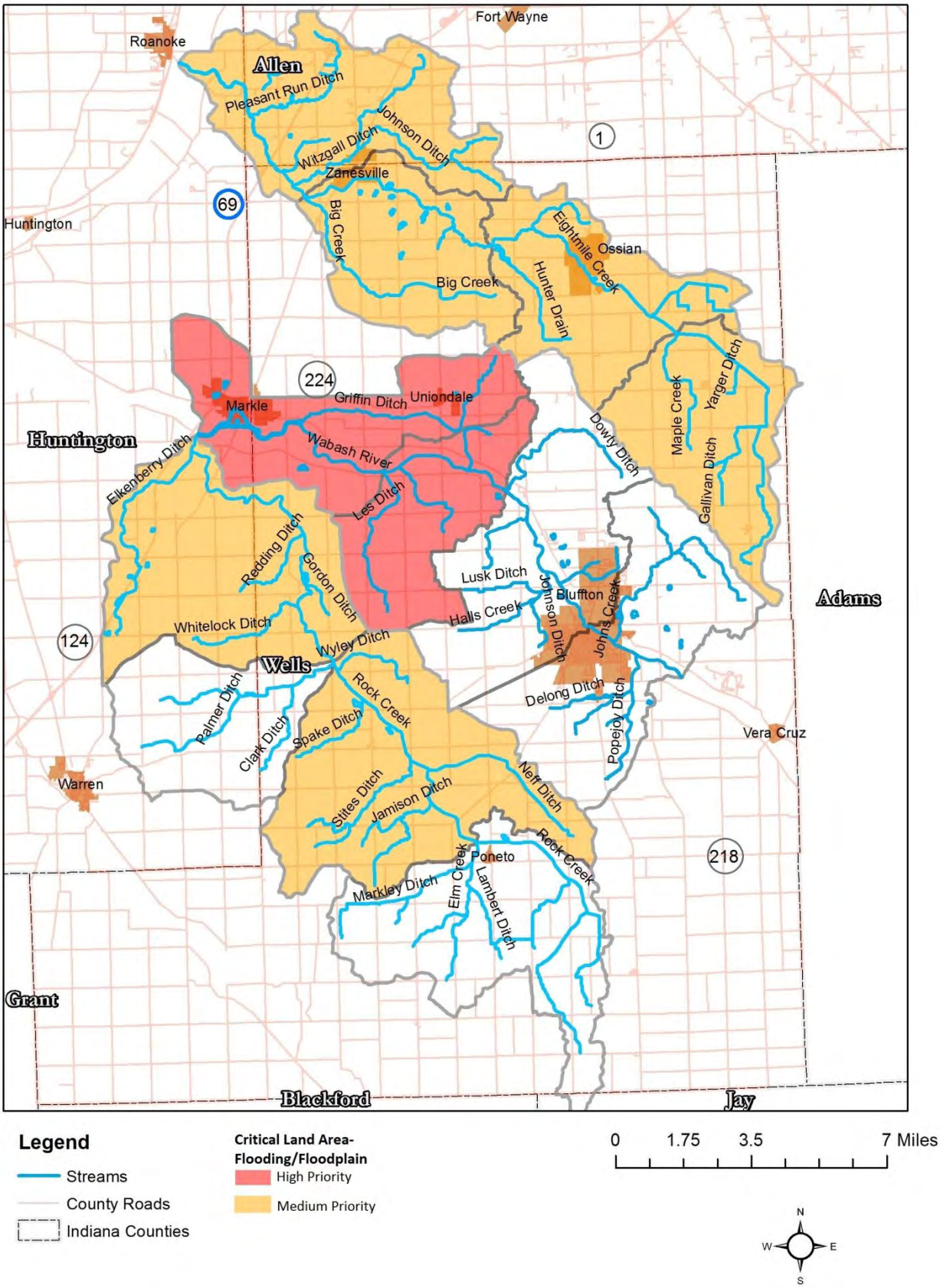
Critical land area for flooding and flood plain management were evaluated by using the percent of streams that are lacking buffer areas and the streambank erosion observed in the project area.

Table 7-5: Critical Land Area for Flooding/Floodplain Management

	Pleasant Run / Big Creek (Eight Mile Creek)	Moser Lake (Eight Mile Creek)	Maple Creek (Eight Mile Creek)	Johns Creek (Wabash River)	Dowty Ditch (Wabash River)	Bender Ditch / Griffin Ditch (Wabash River)	Elkenberry Ditch (Rock Creek)	Mossburg Ditch (Rock Creek)	Stites Ditch / (Rock Creek)	Headwaters Rock Creek
Measured Water Quality Data										
% streams lacking buffers	33	67	68	31	37	44	20	31	23	13
feet of streambank erosion	500	0	0	0	0	100	600	0	160	0
SCORE	**1**	**1**	**1**	**0**	**0**	**2**	**1**	**0**	**1**	**0**
	50%	**50%**	**50%**	**0%**	**0%**	**100%**	**50%**	**0%**	**50%**	**0%**
High priority: =100%; Medium priority: =50%; Not a priority = 0%.										

The Bender Ditch/Griffin Ditch-Wabash River subwatershed is rated as the highest priority critical land area for flooding and floodplain management. The Eight Mile Creek subwatersheds; Pleasant Run/Big Creek, Moser Lake, and Maple Creek; as well as the Elkenberry Ditch and Stites Ditch in the Rock Creek watershed are also critical land areas for flooding and floodplain management.

Figure 73: Critical Land Areas for Flooding/Floodplain Management



7.3 Summary of Critical Land Areas

The individual critical land areas for nutrients, E. coli, sediment, and habitat and biology were then combined to determine the overall ranking for prioritizing watershed activities that will address the most critical areas first. The subwatersheds were grouped as High Priority, Medium Priority, Low Priority and Not a Priority based on the overall ranking results. High Priority CLA subwatersheds represent the drainage areas where water quality practices will initially be focused, followed by the Medium Priority and Low Priority subwatersheds. Subwatersheds with no critical parameters are not a priority for present water quality implementation practices.

Table 7-6: Priority Critical Land Areas

	Pleasant Run / Big Creek (Eight Mile Creek)	Moser Lake (Eight Mile Creek)	Maple Creek (Eight Mile Creek)	Johns Creek (Wabash River)	Dowty Ditch (Wabash River)	Bender Ditch / Griffin Ditch (Wabash River)	Elkenberry Ditch (Rock Creek)	Mossburg Ditch (Rock Creek)	Stites Ditch / (Rock Creek)	Headwaters Rock Creek
CLA–Nutrients SCORE	**6**	**13**	**6**	**11**	**15**	**12**	**5**	**2**	**7**	**5**
%	**26%**	**56%**	**26%**	**48%**	**65%**	**52%**	**22%**	**8%**	**30%**	**22%**
High priority: over 50%; Medium priority: 35-49%; Low priority: 25-35%; Not priority: <25%.										
CLA–*E. coli* SCORE	**7**	**7**	**3**	**7**	**10**	**7**	**3**	**0**	**3**	**3**
%	**64%**	**64%**	**27%**	**64%**	**91%**	**64%**	**27%**	**0%**	**27%**	**27%**
High priority: >75%; Medium priority: 50-74%; Low priority: 25-50%; Not priority: <25%.										
CLA–Sediment SCORE	**4**	**3**	**4**	**4**	**4**	**4**	**3**	**2**	**5**	**2**
%	**50%**	**38%**	**50%**	**50%**	**50%**	**50%**	**38%**	**25%**	**63%**	**25%**
High priority: >50%; Medium priority: 40-50%; Low priority: 30-39%; Not a priority: <30%.										
CLA–Habitat & Biology SCORE	**2**	**2**	**2**	**2**	**0**	**0**	**1**	**0**	**2**	**1**
%	**67%**	**67%**	**67%**	**67%**	**0%**	**0%**	**33%**	**0%**	**67%**	**33%**
High priority: =67%; Medium priority: =33%; Not a priority = 0%.										
CLA–Flooding/ Floodplain Mgmt. SCORE	**1**	**1**	**1**	**0**	**0**	**2**	**1**	**0**	**1**	**0**
	50%	**50%**	**50%**	**0%**	**0%**	**100%**	**50%**	**0%**	**50%**	**0%**
High priority: =100%; Medium priority: =50%; Not a priority = 0%.										
# of CRITICAL LAND AREAS	**5**	**5**	**5**	**4**	**3**	**4**	**4**	**0**	**5**	**2**
High Priority: 5; Medium Priority: 3-4; Low Priority: 1-2; Not a priority: 0										

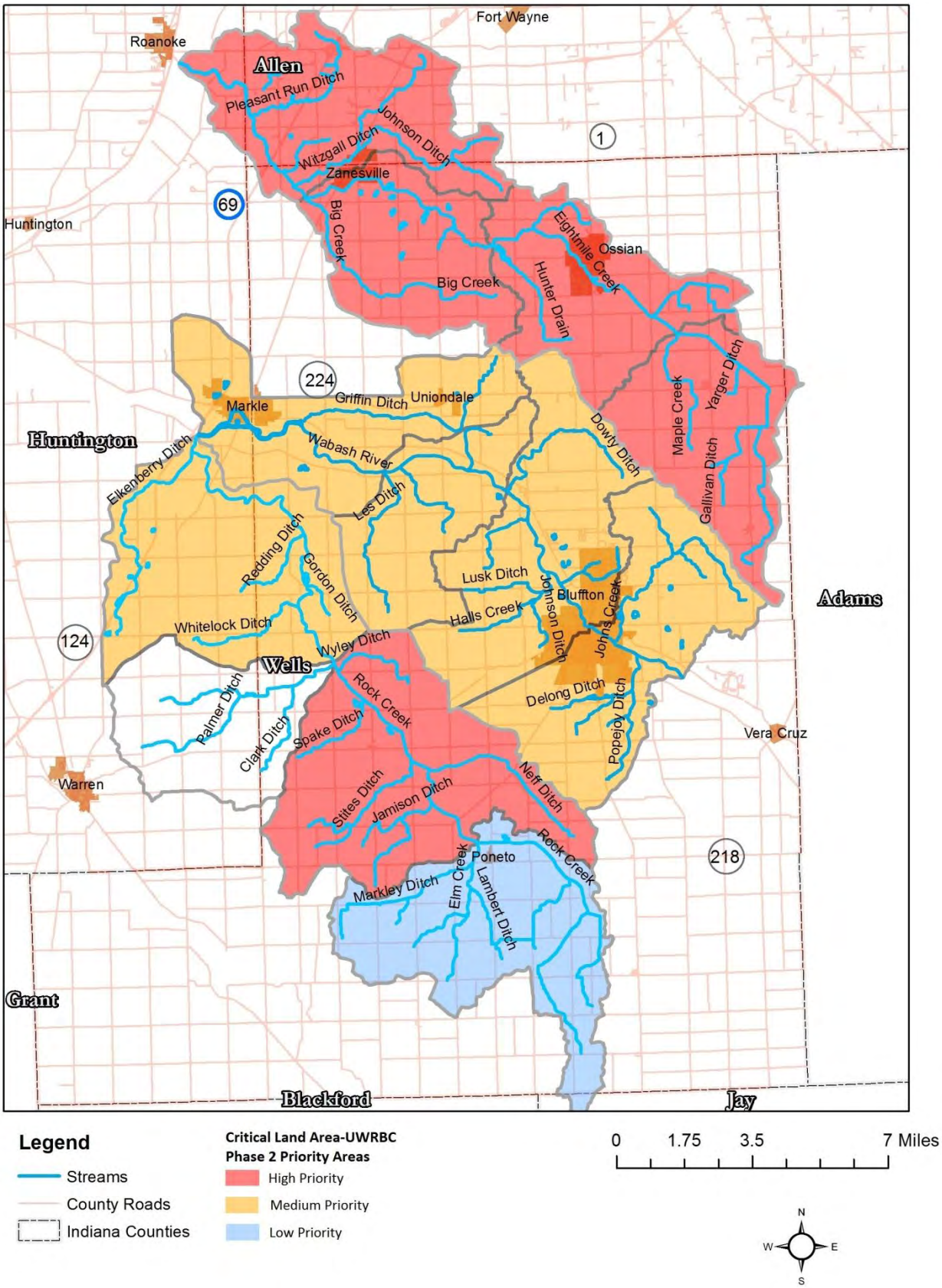
<u>High Priority Critical Land Areas:</u> Pleasant Run/Big Creek-Eight Mile Creek, Moser Lake-Eight Mile Creek, Maple Creek-Eight Mile Creek, and Stites Ditch-Rock Creek.

<u>Medium Priority Critical Land Areas:</u> Johns Creek-Wabash River, Dowty Ditch-Wabash River, Bender Ditch/Griffin Ditch-Wabash River, and Elkenberry Ditch-Rock Creek.

<u>Low Priority Critical Land Area:</u> Headwaters Rock Creek

<u>Not a Priority Critical Land Area:</u> Mossburg Ditch-Rock Creek

Figure 74: Priority Critical Land Areas



8.0 Implementation Strategies

Developing and implementing programs and practices in the Upper Wabash River – Phase 2 project area is the primary objective to achieve the plan's goals; however resources, manpower, and equipment are all limiting factors. In order for the watershed management plan to be successful, costs associated with meeting the objectives must be considered. Additionally, project partners will prove to be valuable during implementation efforts through leveraging of funds and technical support. Measurements of success are also necessary, as they provide a way to evaluate progress towards each goal. These items have been incorporated into the action register (Pages 209-220) that provides the details of the tasks that need to be accomplished to meet the objectives and goals.

8.1 Objectives to Reach Goals

The UWRBC Steering Committee and stakeholders have identified the following objectives:

- Develop and promote a cost-share program for implementing BMPs.
- Work with landowners to install best management practices using the cost-share program.
- Develop and conduct a water quality monitoring program and public monitoring events.
- Develop and provide educational opportunities for stakeholder participation; including workshops and field days on water quality issues, BMPs, septic systems, etc.; hold events for stakeholder participation, such as river clean-ups, river floats or other activities.
- Promote current USDA Farm Bill, ISDA or other conservation programs.
- Work with partners, other groups and agencies to promote and install best management practices.

Indicators for water quality improvement such as water monitoring data, habitat and biological assessments, and pollutant load modeling will be used to evaluate progress and aid in the review of the effectiveness of the selected objectives. Social data will also be used to help track progress towards the goals and objectives.

8.2 Best Management Practices and Estimated Load Reductions

A variety of best management practices (BMPs) are available for on-the-ground implementation. Many of these practices result in the reduction of nutrients, *E. coli*, and sediment, as well as improve habitat and riparian corridors, and reduce flooding concerns. A list of BMPs developed by the Steering Committee was reviewed and the practices were evaluated for their effectiveness in reducing nutrients, *E. coli* and sediment.

The Steering Committee members, with technical assistance from NRCS and ISDA staff, identified a list of best management practices which could be used to achieve the water quality goals described in this plan (pages 184-187). Consideration was given to practices that are easily adopted or expanded. This list does not include all practices that could be beneficial, but is a starting point for developing future implementation programs. This list is primarily focused on practices for agricultural lands, which is the predominant land use in the Upper Wabash River – Phase 2 project area. Some practices can also be applied or adapted to urban areas. Additional practices or alternative technologies may be both possible and necessary to reach the water quality goals. Descriptions of the practices are included in Appendix I.

List of Best Management Practices

- Agronomy Consultations by a Certified Crop Advisor
- Amending Soil Properties with Gypsum Products
- Bottomland Timber Establishment
- Clearing and Snagging
- Conservation Cover
- Conservation Tillage-Residue and Tillage Management, Mulch Till and No Till/Strip Till
- Cover Crops
- Critical Area Planting
- Diversion
- Drainage Water Management
- Field Borders & Filter Strips
- Grassed Waterway & Grade Stabilization Structures
- Greenways and Trails
- Heavy Use Area Protection
- Livestock Exclusion (access control, fence, pipeline, watering facility, etc.)
- Low Impact Development Workshops
- Nutrient Management & Pest Management
- Open Channel – Two Stage Ditch
- Precision/Variable Rate Technology – Equipment Modifications
- Prescribed Grazing (fence, pipeline, watering facility, etc.)
- Rain Gardens & Rain Barrels
- Riparian Forest Buffer & Herbaceous Cover
- Roof Runoff Structure
- Septic System Care and Maintenance Workshops
- Stormwater Runoff Control
- Soil Sampling
- Stream Crossing (access road, fence)
- Tree and Shrub Establishment
- Underground Outlet (Blind inlet)
- Waste Utilization
- Water and Sediment Control Basin
- Wetland Creation, Enhancement and Restoration

The list of BMPs was compared and assigned to the critical land use areas for each pollutant of concern based on the benefit provided by the practice. Education and outreach programs are considered a suggested BMP for all critical areas. Region 5 Model load reduction estimates were calculated for nitrogen, phosphorus, and sediment based on the implementation of a single BMP. In some instances data is not available to estimate load reductions for the BMP or management measure. It is very important to understand that these are only estimates for BMP effectiveness and that results will vary by field within the subwatersheds in the project area.

The UWRBC Phase 2 project area receives pollutant loading from the upstream Wabash River watershed containing approximately 353,437 acres that is outside of this project area. The

accumulated pollutant loading from the upstream area adds to the loading from within the project area, and it is expected that the goals will only be achieved if these same BMPs are implemented in the upstream Wabash River watershed.

Table 8-1: Best Management Practices or Measures for Critical Areas with Expected Load Reductions

Critical Land Area	Reason for being Critical	Suggested BMP or Measure	Estimated Load Reduction for a single BMP*		
			Nitrogen lbs/yr	Phosphorus lbs/yr	Sediment tons/yr
Critical Area for Nutrients (nitrogen and phosphorus) High Priority Moser Lake, Dowty Ditch, Bender Ditch/ Griffin Ditch Medium Priority Johns Creek Low Priority Pleasant Run Ditch/Big Creek, Maple Creek, Stites Ditch	Fertilizer Application	Agronomy Consultations	N/A	N/A	N/A
		Amending Soil Properties with Gypsum Products	ND	ND	ND
		Nutrient Management (& Pest Management when required for practice implementation)	ND	ND	ND
		Precision/Variable Rate Technology	ND	ND	ND
		Soil Sampling	N/A	N/A	N/A
		Underground Outlet (Blind Inlet)	ND	ND	ND
		Drainage Water Management	ND	ND	ND
	Tillage Practices	Conservation Cover (20 ac.)	83	42	29
		Conservation Tillage - Mulch Till and No Till/StripTill (100 ac.)	304–333	152 –166	115 –124
		Cover Crops (100 ac.)	291	146	103
		Field Borders & Filter Strips (40 ac. benefitted)	152	77	51
		Grassed Waterway & Grade Stabilization Structures	171	85.5	85.5
		Riparian Forest Buffer & Riparian Herbaceous Cover (20 ac. benefitted)	48 – 83	24 – 42	19 – 29
	Livestock & Manure Application	Diversion (modeled as Gully Stabilization)	86.4	43.2	43.2
		Livestock Exclusion (modeled as Fence - 500 ft.)	76.5	38.3	38.3
		Prescribed Grazing (20 ac.)	68	34	25
		Stream Crossing	10.7	5.8	5.8
		Waste Utilization (management system - 50 dairy cattle on feedlot)	1803	195	N/A
	Urban	Low Impact Development Workshops	N/A	N/A	N/A
		Rain Gardens and Rain Barrels	N/A	N/A	N/A
		Septic System Care and Maintenance Workshop	N/A	N/A	N/A

Critical Land Area	Reason for being Critical	Suggested BMP or Measure	Estimated Load Reduction for a single BMP*		
			Nitrogen lbs/yr	Phosphorus lbs/yr	Sediment tons/yr
Critical Area for *E. coli* High Priority Dowty Ditch Medium Priority Pleasant Run Ditch/Big Creek, Moser Lake, Johns Creek, Bender Ditch/ Griffin Ditch, Low Priority Maple Creek, Elkenberry Ditch, Stites Ditch, Headwaters Rock Creek	Fertilizer Application	Drainage Water Management	ND	ND	ND
		Precision/Variable Rate Technology	ND	ND	ND
		Underground Outlet (Blind Inlet)	ND	ND	ND
	Livestock & Manure Application	Diversion (modeled as Gully Stabilization)	86.4	43.2	43.2
		Livestock Exclusion (modeled as Fence - 500 ft.)	76.5	38.3	38.3
		Prescribed Grazing (20 ac.)	68	34	25
		Stream Crossing	10.7	5.8	5.8
		Waste Utilization (management system - 50 dairy cattle on feedlot)	1803	195	N/A
	Tillage Practices	Field Borders & Filter Strips (40 ac. benefitted)	152	77	51
		Riparian Forest Buffer & Riparian Herbaceous Cover (20 ac. benefitted)	48 – 83	24 – 42	19 – 29
	Residential	Septic System Care and Maintenance Workshop	N/A	N/A	N/A
Critical Area for Sediment High Priority Stites Ditch Medium Priority Pleasant Run Ditch/Big Creek, Maple Creek, Johns Creek, Dowty Ditch Bender Ditch/ Griffin Ditch, Low Priority Moser Lake, Elkenberry Ditch	Tillage Practices	Amending Soil Properties with Gypsum Products	ND	ND	ND
		Bottomland Timber Establishment/ Tree and Shrub Establishment (20 ac. treated)	48	24	19
		Conservation Tillage - Residue & Tillage Management, Mulch Till and No Till/Strip Till (100 ac.)	304 –333	152 –166	115 –124
		Cover Crops (100 ac.)	291	146	103
		Field Borders & Filter Strips (40 ac. benefitted)	152	77	51
		Grassed Waterway & Grade Stabilization Structures	171	85.5	85.5
		Riparian Forest Buffer & Riparian Herbaceous Cover (20 ac. benefitted)	48 – 83	24 – 42	19 – 29
		Underground Outlet (Blind Inlet)	ND	ND	ND
		Water and Sediment Control Basin	SS	SS	SS
	In-stream Erosion	Clearing and Snagging	ND	ND	ND
		Open Channel – Two Stage Ditch	67.2	33.6	33.6
	HEL/PHEL	Conservation Cover (40 ac.)	155	78	53
	Livestock	Critical Area Planting (2 ac.)	10	5	4
		Diversion (modeled as Gully Stabilization)	86.4	43.2	43.2
		Heavy Use Area Protection (1 ac.)	12	6	6
		Prescribed Grazing (20 ac.)	68	34	25
		Stream Crossing	10.7	5.8	5.8
	Urban	Low Impact Development Workshops	N/A	N/A	N/A
		Stormwater Runoff Control	ND	ND	ND

Critical Land Area	Reason for being Critical	Suggested BMP or Measure	Estimated Load Reduction for a single BMP*		
			Nitrogen lbs/yr	Phosphorus lbs/yr	Sediment tons/yr
Critical Area for Habitat & Biology High Priority Pleasant Run Ditch/Big Creek, Moser Lake, Maple Creek, Johns Creek, Stites Ditch Medium Priority Elkenberry Ditch, Headwaters Rock Creek	Low habitat evaluation scores and biotic assessment	Bottomland Timber Establishment/ Tree and Shrub Establishment (20 ac. treated)	48	24	19
		Critical Area Planting (2 ac.)	10	5	4
		Field Borders & Filter Strips (40 ac. benefitted)	152	77	51
		Greenways and Trails (1 ac.)	11	5	6
		Riparian Forest Buffer & Riparian Herbaceous Cover (20 ac. benefitted)	48 – 83	24 – 42	19 – 29
		Wetland Creation, Enhancement and Restoration (20 ac. Benefitted)	68	34	25
**All load reductions are Region 5 Model calculation examples.* *ND = No data to perform calculations; N/A = Not applicable for Region 5 Model; SS = site specific.*					

Based on the estimated load reductions and the percentages of land use available for BMP implementation, the practices that would make the most impact in reducing nutrients and sediment are conservation tillage, cover crops, filter strips and field borders, conservation cover, grassed waterways, and waste management practices. The actual number and types of BMPs implemented and the associated load reductions will depend upon several factors including site specific conditions, willing landowners and available resources.

The following tables show the load reduction goals and the number of acres of individual BMPs (conservation tillage, cover crops, filter strips and field borders, conservation cover, grassed waterways, and waste management practices) that would be needed to meet the 5-year, 10-year and 20-year load reduction goals for nitrate and total phosphorus. The sediment goal is based on the average concentration of turbidity measurements; therefore current load reduction estimates are not available.

Table 8-2: Load Reductions Necessary to Meet Goals.

	Nitrate (lbs/year)	Phosphorus (lbs/year)
Measured Load	38,732,065	828,988
2035 Target Load	21,597,056	647,875
Load Reduction Needed	**17,135,009**	**181,113**
Load Reduction to meet 2020 Goal	4,283,766	45,262
Additional Load Reduction to meet 2025 Goal	4,283,766	45,262
Additional Load Reduction to meet 2035 Goal	8,567,505	90,608
Total Reduction	**17,135,037**	**181,132**

Table 8-3: Estimated Acres needed to meet Nitrate Load Reduction Goals.

UWRBC Phase 2 Project Area Ag Land Use: 150,104 acres Upstream Wabash River Watershed Ag Land Use: 286,409 acres			Estimated Acres to meet 2020 Nitrate Load Reduction Goal of 4,283,766 lbs/yr.		Additional Estimated Acres to meet 2025 Nitrate Load Reduction Goal of 4,283,766 lbs/yr.		Additional Estimated Acres to meet 2035 Nitrate Load Reduction Goal of 8,567,505 lbs/yr.	
Suggested BMP **(acres used to calculate load reduction)**	**Load Reduction Per Acre (lbs/yr)**							
	Project Area	**Upstream Watershed**	**Project Area (acres)**	**Upstream Watershed (acres)**	**Project Area (acres)**	**Upstream Watershed (acres)**	**Project Area (acres)**	**Upstream Watershed (acres)**
Conservation Cover (50ac.)	3.8	3.14 - 5.18	500,264	568,736	500,264	568,736	1,000,524	1,137,466
Conservation Tillage-Mulch Till (50ac.)	3.26	2.8 - 5.08	583,129	604,445	583,129	604,445	1,166,255	1,208,884
Conservation Tillage-No Till/ StripTill (50ac.)	3.56	3.08 – 5.56	533,989	551,614	533,989	551,614	1,067,956	1,103,223
Cover Crops (50ac.)	3.12	2.56 - 4.14	609,296	706,403	609,296	706,403	1,218,587	1,412,800
Field Borders & Filter Strips (2 ac./50 ac. benefitted)	98	81.5–134.5	19,398	21,103	19,398	21,103	38,796	42,204
Grassed Waterway (1 ac. /1000 ft.)	459	459	4,142	5,193	4,142	5,193	8,283	10,383
Waste Utilization (mgmt. system– 1 ac. feedlot, 50 dairy cattle)	1803	1803 – 1816	1,054	1,319	1,054	1,319	2,109	2,638

In order to meet the nitrate load reduction goals, multiple BMPs will need to be implemented on the same parcel or tract of land. It is also apparent that practices will need to be implemented in the upstream watershed area. Based on the load reduction per acre amounts, it is unrealistic to expect that the practices implemented on agricultural acres will be sufficient to meet the load reduction goals; therefore other pollution reduction efforts, such as low impact development practices in urban areas and septic system maintenance throughout the project area, is likely to have an important effect on water quality by reducing both nutrients and *E. coli*.

Table 8-4: Estimated Acres to meet Phosphorus Load Reduction Goals.

UWRBC Phase 2 Project Area Ag Land Use: 150,104 acres Upstream Wabash River Watershed Ag Land Use: 286,409 acres			Estimated Acres to meet 2020 Phosphorus Load Reduction Goal of 45,262 lbs/yr.		Additional Estimated Acres to meet 2025 Phosphorus Load Reduction Goal of 45,262 lbs/yr.		Additional Estimated Acres to meet 2035 Phosphorus Load Reduction Goal of 90,608 lbs/yr.	
Suggested BMP (acres used to calculate load reduction)	**Load Reduction Per Acre (lbs/yr)**		**Project Area (acres)**	**Upstream Watershed (acres)**	**Project Area (acres)**	**Upstream Watershed (acres)**	**Project Area (acres)**	**Upstream Watershed (acres)**
	Project Area	**Upstream Watershed**						
Conservation Cover (50ac.)	1.9	1.58 – 2.6	10,572	11,981	10,572	11,981	21,163	23,987
Conservation Tillage-Mulch Till (50ac.)	1.64	1.4 – 2.54	12,248	17,631	12,248	17,631	24,518	25,620
Conservation Tillage-No Till/ StripTill (50ac.)	1.78	1.54 – 2.78	11,284	11,656	11,284	11,656	22,589	23,335
Cover Crops (50ac.)	1.56	1.28 – 2.06	12,876	14,904	12,876	14,904	25,775	29,835
Field Borders & Filter Strips (2 ac./50 ac. benefitted)	49	41 – 68	410	443	410	443	821	887
Grassed Waterway (1 ac. /1000 ft.)	229	229	88	110	88	110	176	220
Waste Utilization (mgmt. system– 1 ac. feedlot, 50 dairy cattle)	195	195 -197	103	129	103	129	206	258

As stated previously, the UWRBC Phase 2 project area receives pollutant loading from the upstream Upper Wabash River Basin watershed that contains approximately 353,437 acres. The accumulated pollutant loading from the upstream area adds to the current loads within the project area. The loading from the upstream area represents 56% of the nitrate load reduction that is needed to meet the target load; 106% of the phosphorus load reduction that is needed to meet the target load; and 76% of the *E. coli* load reduction that is needed to meet the target load as outlined in the goals identified in this plan. The load reduction goals will only be achieved if a variety of BMPs are also implemented in the upstream Upper Wabash River Basin watershed using NRCS, ISDA, and local SWCD conservation cost-share and promotional programs.

8.3 Action Register and Schedule

The Action Register will help guide the implementation of both on-the-ground land use management practices and education and outreach activities of the UWRBC. It identifies the scheduled objectives, milestones, estimated costs, and potential project partners for each of the goals in this watershed management plan.

The action register covers a 5-year timeline to meet the initial goals outlined in this plan. Included in the action register is the development and promotion of a cost-share program, an education and outreach (E&O) program, and water quality monitoring. The costs are based on the salary for the watershed coordinator and water quality consultants to conduct a three-year cost-share/implementation project, education and outreach activities and water quality monitoring program.

It is anticipated that the three-year cost-share/implementation project conducted by the UWRBC will generate significant interest in the best management practices (BMPs) and future BMP projects will be funded through the Farm Service Agency (FSA), Natural Resource Conservation Service (NRCS), Indiana State Department of Agriculture (ISDA), Soil and Water Conservation District (SWCD) programs or other federal, state or local agencies. The UWRBC will support partner agencies with education and outreach and volunteer monitoring as available. Practice implementation costs are based on NRCS Conservation Activity Plan and Technical Service Provider payment rates.

The action register was based on the funding that would realistically be available within the project area and the volume of practices that could reasonably be installed within a five-year time period.

Table 8-5: Action Register and Schedule of UWRBC Activities

Action Register and Schedule					
5-year Nutrient Goals: Reduce nitrate loading by 11.06% (4,283,766 lbs/yr) and reduce the annual average concentration of nitrate by 10.76% (1.89 mg/L) by 2020. **Reduce phosphorus loading by 5.46% (45,262 lbs/yr) and reduce the annual average concentration by 5.37% (0.0205 mg/L) by 2020.**					
Objectives	**Target Audience**	**Milestones**	**Estimated Costs**	**Potential Partners/ Technical Assistance**	**Potential Funding Sources**
Develop Nutrient and Pest Management plans and implement on 2,500 acres of cropland.	Agricultural Landowners & Operators	Develop and promote cost-share program beginning in 2015.	$15,000/yr*	Technical Service Providers, NRCS, ISDA, SWCDs, Purdue Extension, Ag Vendors	IDEM 319 Grants, NRCS Farm Bill Programs and initiatives, ISDA Clean Water Indiana Grants
		Personal visits with landowners.	$10,000/yr*		
		Conduct E&O program featuring BMPs beginning in 2015.	E&O program		
		Provide cost-share for agronomy consultations and development of nutrient and pest management plans on 500 acres annually. ($15.50/ac)	$38,750		
		Provide cost-share for small farm producers to conduct soil sampling on 500 acres annually. ($1/ac)	$2,500		
		Identify alternate funding sources to increase participation.	E&O program		
		Conduct water quality monitoring to measure possible reductions.	13,000/yr*		
Amend Soil Properties with Gypsum Products on 1,000 acres of cropland.	Agricultural Landowners & Operators	Develop and promote cost-share program beginning in 2015.	$15,000/yr*	NRCS, ISDA, SWCDs, Purdue Extension, Ag Vendors	IDEM 319 Grants, NRCS Farm Bill Programs and initiatives, ISDA Clean Water Indiana Grants
		Personal visits with landowners.	$10,000/yr *		
		Conduct E&O program featuring BMPs beginning in 2015.	E&O program		
		Using all funding sources, annually implement 200 acres of gypsum applications. ($35/ac)	$35,000		
		Conduct water quality monitoring to measure possible reductions.	13,000/yr*		
Increase Conservation Tillage - residue and tillage management, mulch till and no till/strip till by 5,000 acres.	Agricultural Landowners & Operators	Develop and promote cost-share program beginning in 2015.	$15,000/yr*	NRCS, ISDA, SWCDs, CTIC, CCSI, Purdue Extension	IDEM 319 Grants, NRCS Farm Bill Programs and initiatives, ISDA Clean Water Indiana Grants
		Personal visits with landowners.	$10,000/yr *		
		Conduct E&O program featuring BMPs beginning in 2015.	E&O program		
		Using all funding sources, annually implement 1,000 acres of conservation tillage. (avg. $20/ac)	$100,000		
		Provide cost-share for equipment modifications. (avg. $4,000 each)	$20,000		
		Identify alternative funding sources to increase participation.	E&O program		
		Conduct water quality monitoring to measure possible reductions.	13,000/yr*		

Table 8-5: Action Register and Schedule of UWRBC Activities

Objectives	Target Audience	Milestones	Estimated Costs	Potential Partners/ Technical Assistance	Potential Funding Sources
Implement Precision/ Variable Rate Technology for fertilizer and manure application on 1,000 acres.	Agricultural Landowners & Operators	Develop and promote cost-share program beginning in 2015.	$15,000/yr*	NRCS, ISDA, SWCDs, Purdue Extension, Ag Vendors	IDEM 319 Grants, NRCS Farm Bill Programs and initiatives, ISDA Clean Water Indiana Grants
		Personal visits with landowners.	$10,000/yr *		
		Conduct 1 public meeting program featuring BMPs beginning in 2015.	$10,000/yr*		
		Provide cost-share for equipment modifications. (avg. $7,500 each)	$37,500		
		Identify alternative funding sources to increase participation.	E&O program		
		Conduct water quality monitoring to measure possible reductions.	13,000/yr*		
Implement cover crops on 2,500 acres.	Agricultural Landowners & Operators	Develop and promote cost-share program beginning in 2015.	$15,000/yr*	NRCS, ISDA, SWCDs, CCSI, Purdue Extension, Ag Vendors	IDEM 319 Grants, NRCS Farm Bill Programs and initiatives, ISDA Clean Water Indiana Grants
		Personal visits with landowners.	$10,000/yr *		
		Conduct 1 field day featuring BMPs beginning in 2015.	E&O program		
		Promote Soil Health with partners.	E&O program		
		Using all funding sources, implement cover crops on 500 acres annually. (avg. $40/ac)	$100,000		
		Identify alternative funding sources to increase participation.	E&O program		
		Conduct water quality monitoring to measure possible reductions.	13,000/yr*		
Increase landowner awareness of Drainage Water Management practices (Underground Outlet-blind inlet, Saturated Buffers, etc.).	Agricultural Landowners & Operators; County Surveyors; Tile Installers; Contractors	Develop and promote cost-share program beginning in 2015.	$15,000/yr*	NRCS, ISDA, SWCDs, Purdue Extension, Purdue Extension WQ Program, TNC, LICA	IDEM 319 Grants, NRCS Farm Bill Programs and initiatives, ISDA Clean Water Indiana Grants
		Personal visits with landowners.	$10,000/yr *		
		Conduct E&O program featuring BMPs beginning in 2015.	E&O program		
		Develop survey to evaluate barriers to using practices.	E&O program		
		Using all funding sources, install one drainage water mgmt. practice.	$3,000		
		Conduct water quality monitoring to measure possible reductions.	13,000/yr*		
Increase the use of Field Borders, Filter Strips, Conservation Cover, Riparian Forest Buffers and Riparian Herbaceous Cover on 100 acres.	Agricultural Landowners & Operators	Develop and promote cost-share program beginning in 2015.	$15,000/yr*	NRCS, ISDA, SWCDs, Purdue Extension, DNR	IDEM 319 Grants, NRCS Farm Bill Programs and initiatives, ISDA CREP and Clean Water Indiana Grants, LARE Grants,
		Personal visits with landowners.	$10,000/yr *		
		Conduct E&O program featuring BMPs beginning in 2015.	E&O program		
		Using all funding sources, implement buffer practices on 20 acres annually. ($9/ac to $825/ac.)	$10,000		
		Identify alternative funding sources to increase participation.	E&O program		
		Conduct water quality monitoring to measure possible reductions.	13,000/yr*		

Table 8-5: Action Register and Schedule of UWRBC Activities

Objectives	Target Audience	Milestones	Estimated Costs	Potential Partners/ Technical Assistance	Potential Funding Sources
Restrict livestock access from 1,000 feet of watershed streams and increase Prescribed Grazing and Waste Utilization on 500 acres.	Landowners with livestock; livestock access to watershed streams	Develop and promote cost-share program beginning in 2015.	$15,000/yr*	NRCS, ISDA, SWCDs, Purdue Extension	IDEM 319 Grants, NRCS Farm Bill Programs and initiatives, ISDA Clean Water Indiana Grants, LARE Grants
		Personal visits with landowners.	$10,000/yr *		
		Conduct E& O program featuring BMPs beginning in 2015.	E&O program		
		Using all funding sources, implement livestock exclusion practices (fence, stream crossings, etc.) on 1,000 feet of streams, and prescribed grazing and waste utilization on 500 ac. over 5 years.	Exclusion: $10,000 Grazing: $14,000 Waste Utilization: $23,500		
		Identify alternative funding sources to increase participation.	E&O program		
		Conduct water quality monitoring to measure possible reductions.	13,000/yr*		
Develop a Low Impact Development educational program.	Urban residents; Contractors; Developers	Conduct 1 public meeting featuring BMPs beginning in 2015.	E& O program	SWCDs, Purdue Extension, Area Plan Commission	IDEM 319 Grants, ISDA Clean Water Indiana Grants, Private Grants
		Survey local contractors on use of low impact development measures	E&O program		
Promote Rain Gardens and Rain Barrels.	Urban and rural residential landowners	Develop and promote cost-share program beginning in 2015.	$15,000/yr*	SWCDs, Purdue Extension	IDEM 319 Grants, , ISDA Clean Water Indiana Grants, Private Grants
		Conduct E&O program featuring BMPs beginning in 2015.	E&O program		
Increase awareness of septic system problems and maintenance.	Rural residential landowners	Develop and promote cost-share program beginning in 2015.	$15,000/yr*	SWCDs, Purdue Extension, IOWPA, Health Departments	IDEM 319 Grants, Private Grants
		Conduct 1 workshop program featuring BMPs beginning in 2015.	E&O program		

* One cost-share program, one education and outreach (E&O) program, and one water quality monitoring (WQM) program will be developed covering all strategies. Development and promotion of the cost-share program is 37.5% of the Watershed Coordinator (WC) salary. The personal landowner visits are 25% of the WC salary. Education and outreach costs are 25% of the WC salary, as well as costs to conduct meetings, field days, workshops or other events. The water quality monitoring program costs include 12.5% salary for the WC and costs for consulting services for monitoring and laboratory services.

Table 8-5: Action Register and Schedule of UWRBC Activities

Action Register and Schedule					
5-year *E. coli* Goal: Reduce *E. coli* loading by 13% (641,672 G-org/yr) and reduce the average annual concentration by 12.76% (61.28 cfu/100mL) by 2020.					
Objectives	**Target Audience**	**Milestones**	**Estimated Costs**	**Potential Partners/ Technical Assistance**	**Potential Funding Sources**
Increase landowner awareness of Drainage Water Management practices (Underground Outlet-blind inlet, Saturated Buffers, etc.).	Agricultural Landowners & Operators; County Surveyors; Tile Installers; Contractors	Develop and promote cost-share program beginning in 2015.	$15,000/yr*	NRCS, ISDA, SWCDs, Purdue Extension, Purdue Extension WQ Program, TNC, LICA	IDEM 319 Grants, NRCS Farm Bill Programs and initiatives, ISDA Clean Water Indiana Grants
		Personal visits with landowners.	$10,000/yr *		
		Conduct E&O program featuring BMPs beginning in 2015.	E&O program		
		Develop survey to evaluate barriers to using practices.	E&O program		
		Using all funding sources, install one drainage water mgmt. practice.	$3,000		
		Conduct water quality monitoring to measure possible reductions.	13,000/yr*		
Implement Precision/ Variable Rate Technology for fertilizer and manure application on 1,000 acres.	Agricultural Landowners & Operators	Develop and promote cost-share program beginning in 2015.	$15,000/yr*	NRCS, ISDA, SWCDs, Purdue Extension, Ag Vendors	IDEM 319 Grants, NRCS Farm Bill Programs and initiatives, ISDA Clean Water Indiana Grants
		Personal visits with landowners.	$10,000/yr *		
		Conduct E&O program featuring BMPs beginning in 2015.	E&O program		
		Provide cost-share for equipment modifications. ($7,500 each)	$37,500		
		Identify alternative funding sources to increase participation.	E&O program		
		Conduct water quality monitoring to measure possible reductions.	13,000/yr*		
Implement livestock practices (fencing, diversion, waste utilization, etc.) at 5 "hobby farm" locations.	Livestock "hobby farms"	Develop and promote cost-share program beginning in 2015.	$15,000/yr*	NRCS, ISDA, SWCDs, Purdue Extension	IDEM 319 Grants, NRCS Farm Bill Programs and initiatives, ISDA Clean Water Indiana Grants
		Personal visits with landowners.	$10,000/yr *		
		Conduct E&O program featuring BMPs beginning in 2015.	$10,000/yr*		
		Using all funding sources, annually implement livestock practices on 1 hobby farm. ($5,000 to $6,000 ea)	$20,000 - $30,000		
		Conduct water quality monitoring to measure possible reductions.	13,000/yr*		
Increase the use of Field Borders, Filter Strips, Conservation Cover, Riparian Forest Buffers and Riparian Herbaceous Cover on 100 acres.	Agricultural Landowners & Operators	Develop and promote cost-share program beginning in 2015.	$15,000/yr*	NRCS, ISDA, SWCDs, Purdue Extension, DNR	IDEM 319 Grants, NRCS Farm Bill Programs and initiatives, ISDA CREP and Clean Water Indiana Grants, LARE Grants
		Personal visits with landowners.	$10,000/yr *		
		Conduct E&O program featuring BMPs beginning in 2015.	E&O program		
		Using all funding sources, implement buffer practices on 20 acres annually. ($9/ac to $825/ac.)	$10,000		
		Conduct water quality monitoring to measure possible reductions.	13,000/yr*		

Table 8-5: Action Register and Schedule of UWRBC Activities

Objectives	Target Audience	Milestones	Estimated Costs	Potential Partners/ Technical Assistance	Potential Funding Sources
Increase awareness of septic system problems and maintenance	Rural residential landowners	Develop and promote cost-share program beginning in 2015.	$15,000/yr*	SWCDs, Purdue Extension, IOWPA, Health Departments	IDEM 319 Grants, Private Grants
		Conduct 1 workshop program featuring BMPs beginning in 2015.	E&O program		
		Conduct water quality monitoring to measure possible reductions.	13,000/yr*		

* One cost-share program, one education and outreach (E&O) program, and one water quality monitoring (WQM) program will be developed covering all strategies. Development and promotion of the cost-share program is 37.5% of the Watershed Coordinator (WC) salary. The personal landowner visits are 25% of the WC salary. Education and outreach costs are 25% of the WC salary, as well as costs to conduct meetings, field days, workshops or other events. The water quality monitoring program costs include 12.5% salary for the WC and costs for consulting services for monitoring and laboratory services.

Action Register and Schedule

5-year Sediment Goal: Reduce average concentrations of turbidity measurements from 106.96 NTUs to 89.22 NTUs (16.58%) by 2020.

Objectives	Target Audience	Milestones	Estimated Costs	Potential Partners/ Technical Assistance	Potential Funding Sources
Amend Soil Properties with Gypsum Products on 1,000 acres of cropland.	Agricultural Landowners & Operators	Develop and promote cost-share program beginning in 2015.	$15,000/yr*	NRCS, ISDA, SWCDs, Purdue Extension, Ag Vendors	IDEM 319 Grants, NRCS Farm Bill Programs and initiatives, ISDA Clean Water Indiana Grants
		Personal visits with landowners.	$10,000/yr *		
		Conduct E&O program featuring BMPs beginning in 2015.	E&O program		
		Using all funding sources, annually implement 200 acres of gypsum applications. ($35/ac)	$35,000		
		Conduct water quality monitoring to measure possible reductions.	13,000/yr*		
Implement Bottomland Timber Establishment/ Tree and Shrub Establishment on 50 acres of floodplain areas.	Agricultural Landowners & Operators; Landowners of floodplain areas.	Develop and promote cost-share program beginning in 2015.	$15,000/yr*	NRCS, ISDA, SWCDs, Purdue Extension, DNR	IDEM 319 Grants, NRCS Farm Bill Programs and initiatives, ISDA CREP and Clean Water Indiana Grants, LARE Grants,
		Personal visits with landowners.	$10,000/yr *		
		Conduct E&O program featuring BMPs beginning in 2015.	E&O program		
		Using all funding sources, annually implement bottomland timber and tree and shrub establishment practices on 10 acres. ($825/ac)	$41,250		
		Identify alternative funding sources to increase participation.	E&O program		
		Conduct water quality monitoring to measure possible reductions.	13,000/yr*		

Table 8-5: Action Register and Schedule of UWRBC Activities

Objectives	Target Audience	Milestones	Estimated Costs	Potential Partners/ Technical Assistance	Potential Funding Sources
Increase Conservation Tillage - residue and tillage management, mulch till and no till/strip till by 5,000 acres.	Agricultural Landowners & Operators	Develop and promote cost-share program beginning in 2015.	$15,000/yr*	NRCS, ISDA, SWCDs, CTIC, CCSI, Purdue Extension, Ag Vendors	IDEM 319 Grants, NRCS Farm Bill Programs and initiatives, ISDA Clean Water Indiana Grants
		Personal visits with landowners.	$10,000/yr *		
		Conduct E&O program featuring BMPs beginning in 2015.	$10,000/yr*		
		Using all funding sources, annually implement 1,000 acres of conservation tillage. (avg. $20/ac)	$100,000		
		Provide cost-share for equipment modifications. (avg. $4,000 each)	$20,000		
		Identify alternative funding sources to increase participation.	E&O program		
		Conduct water quality monitoring to measure possible reductions.	13,000/yr*		
Implement cover crops on 2,500 acres.	Agricultural Landowners & Operators	Develop and promote cost-share program beginning in 2015.	$15,000/yr*	NRCS, ISDA, SWCDs, CCSI, Purdue Extension, Ag Vendors	IDEM 319 Grants, NRCS Farm Bill Programs and initiatives, ISDA Clean Water Indiana Grants
		Personal visits with landowners.	$10,000/yr *		
		Conduct E&O program featuring BMPs beginning in 2015.	E&O program		
		Promote Soil Health with partners.	E&O program		
		Using all funding sources, annually implement cover crops on 500 acres. (avg. $40/ac)	$100,000		
		Identify alternative funding sources to increase participation.	E&O program		
		Conduct water quality monitoring to measure possible reductions.	13,000/yr*		
Increase the use of Field Borders, Filter Strips, Conservation Cover, Riparian Forest Buffers and Riparian Herbaceous Cover on 100 acres.	Agricultural Landowners & Operators	Develop and promote cost-share program beginning in 2015.	$15,000/yr*	NRCS, ISDA, SWCDs, Purdue Extension, DNR	IDEM 319 Grants, NRCS Farm Bill Programs and initiatives, ISDA CREP and Clean Water Indiana Grants, LARE Grants
		Personal visits with landowners.	$10,000/yr *		
		Conduct E&O program featuring BMPs beginning in 2015.	E&O program		
		Using all funding sources, annually implement buffer practices on 20 acres. ($9/ac to $825/ac.)	$10,000		
		Conduct water quality monitoring to measure possible reductions.	13,000/yr*		

Table 8-5: Action Register and Schedule of UWRBC Activities

Objectives	Target Audience	Milestones	Estimated Costs	Potential Partners/ Technical Assistance	Potential Funding Sources
Increase Grassed Waterway & Grade Stabilization Structures on 20 acres.	Agricultural Landowners & Operators	Develop and promote cost-share program beginning in 2015.	$15,000/yr*	NRCS, ISDA, SWCDs, Purdue Extension,	IDEM 319 Grants, NRCS Farm Bill Programs and initiatives, ISDA Clean Water Indiana Grants, LARE Grants
		Personal visits with landowners.	$10,000/yr *		
		Conduct E&O program featuring BMPs beginning in 2015.	E&O program		
		Using all funding sources, implement grass waterway and grade stabilization structures on 4 acres annually. (WW-$4,200/ac)	WW: $84,000; Structure $5,000 ea		
		Conduct water quality monitoring to measure possible reductions.	13,000/yr*		
Increase landowner awareness of Drainage Water Management practices (Underground Outlet-blind inlet, Saturated Buffers, etc.).	Agricultural Landowners & Operators; County Surveyors; Tile Installers; Contractors	Develop and promote cost-share program beginning in 2015.	$15,000/yr*	NRCS, ISDA, SWCDs, Purdue Extension, Purdue Extension WQ Program, TNC, LICA	IDEM 319 Grants, NRCS Farm Bill Programs and initiatives, ISDA Clean Water Indiana Grants
		Personal visits with landowners.	$10,000/yr *		
		Conduct E&O program featuring BMPs beginning in 2015.	E&O program		
		Develop survey to evaluate barriers to using practices.	E&O program		
		Using all funding sources, install one drainage water mgmt. practice.	$3,000		
		Conduct water quality monitoring to measure possible reductions.	13,000/yr*		
Promote Water and Sediment Control Basins and install practice if possible	Agricultural Landowners & Operators	Develop and promote cost-share program beginning in 2015.	$15,000/yr*	NRCS, ISDA, SWCDs, Purdue Extension	IDEM 319 Grants, NRCS Farm Bill Programs and initiatives, ISDA Clean Water Indiana Grants
		Personal visits with landowners.	$10,000/yr *		
		Conduct E&O program featuring BMPs beginning in 2015.	E&O program		
		Using all funding sources, install one WASCOB practice.	$3,000		
		Conduct water quality monitoring to measure possible reductions.	13,000/yr*		
Promote and complete Clearing and Snagging practice in 5 locations to reduce in-stream sedimentation.	Landowners along streams and river; County Surveyors	Develop and promote cost-share program beginning in 2015.	$15,000/yr*	NRCS, ISDA, SWCDs, Purdue Extension, County Surveyors	IDEM 319 Grants, NRCS Farm Bill Programs and initiatives, ISDA Clean Water Indiana Grants, Ditch Maintenance Funds
		Personal visits with landowners.	$10,000/yr *		
		Conduct E&O program featuring BMPs beginning in 2015.	E&O program		
		Using all funding sources, complete clearing and snagging at 5 locations. ($8,000/500 ft.)	$40,000		
		Conduct water quality monitoring to measure possible reductions.	13,000/yr*		

Table 8-5: Action Register and Schedule of UWRBC Activities

Objectives	Target Audience	Milestones	Estimated Costs	Potential Partners/ Technical Assistance	Potential Funding Sources
Increase awareness on the use of 2-stage ditches, and implement a 2- stage ditch as possible.	Landowners along streams and river; County Surveyors	Develop and promote cost-share program beginning in 2015.	$15,000/yr*	NRCS, ISDA, SWCDs, TNC, Purdue Extension, County Surveyors	IDEM 319 Grants, NRCS Farm Bill Programs and initiatives, ISDA Clean Water Indiana Grants, Ditch Maintenance Funds
		Personal visits with landowners.	$10,000/yr *		
		Conduct 1 field day program featuring BMPs beginning in 2015.	E&O program		
		Using all funding sources, implement two-stage ditches	Unable to determine		
		Conduct water quality monitoring to measure possible reductions.	13,000/yr*		
Implement livestock practices – stream crossing, prescribed grazing, waste utilization, diversion, critical area plantings, and/or heavy use area protection - at 5 locations.	Landowners with livestock	Develop and promote cost-share program beginning in 2015.	$15,000/yr*	NRCS, ISDA, SWCDs, Purdue Extension	IDEM 319 Grants, NRCS Farm Bill Programs and initiatives, ISDA Clean Water Indiana Grants
		Personal visits with landowners.	$10,000/yr *		
		Conduct E&O program featuring BMPs beginning in 2015.	E&O program		
		Using all funding sources, implement 500 acres/or 5 locations of prescribed grazing, waste utilization, diversions, etc. (Grazing $28/ac, diversion $6/ft, heavy use $1.50/ft2, waste utilization $47/ac)	Depending on practice installed		
		Conduct water quality monitoring to measure possible reductions.	13,000/yr*		
Investigate Low Impact Development programs.	Urban residents; Contractors; Developers	Survey local contractors on use of low impact development measures	E&O program	SWCDs, Purdue Extension, Area Plan Commission	IDEM 319 Grants, ISDA Clean Water Indiana Grants, Private Grants
Develop educational program and implement Stormwater Runoff Control practices as possible.	Urban, rural development sites; Contractors; Developers; City and Town Officials	Conduct E&O program featuring BMPs beginning in 2015.	E&O program	SWCDs, IDEM Rule 5 staff, Purdue Extension, Area Plan Commission	IDEM 319 Grants, ISDA Clean Water Indiana Grants, Private Grants
		Survey local contractors and developers on use of stormwater runoff control practices.	E&O program		

* One cost-share program, one education and outreach (E&O) program, and one water quality monitoring (WQM) program will be developed covering all strategies. Development and promotion of the cost-share program is 37.5% of the Watershed Coordinator (WC) salary. The personal landowner visits are 25% of the WC salary. Education and outreach costs are 25% of the WC salary, as well as costs to conduct meetings, field days, workshops or other events. The water quality monitoring program costs include 12.5% salary for the WC and costs for consulting services for monitoring and laboratory services.

Table 8-5: Action Register and Schedule of UWRBC Activities

Action Register and Schedule

20-year Habitat and Recreation Goals: Restore natural habitat and protect natural land uses within stream and river corridors to meet their aquatic life use to meet or exceed the CQHEI target of 60 at all project monitoring sites by 2035.

Develop partnerships with local government agencies, parks departments and trail groups to plan and install 5 miles of connecting trails and green space along the river corridor for recreational purposes by 2035.

Objectives	Target Audience	Milestones	Estimated Costs	Potential Partners/ Technical Assistance	Potential Funding Sources
Increase the use of Field Borders, Filter Strips, Conservation Cover, Riparian Forest Buffers and Riparian Herbaceous Cover on 100 acres.	Agricultural Landowners & Operators	Develop and promote cost-share program beginning in 2015.	$15,000/yr*	NRCS, ISDA, SWCDs, Purdue Extension, DNR	IDEM 319 Grants, NRCS Farm Bill Programs and initiatives, ISDA CREP and Clean Water Indiana Grants, LARE Grants
		Personal visits with landowners.	$10,000/yr *		
		Conduct E&O program featuring BMPs beginning in 2015.	E&O program		
		Using all funding sources, implement buffer practices on 20 acres annually. ($9/ac to $825/ac.)	$10,000		
		Identify alternative funding sources to increase participation.	E&O program		
		Conduct water quality monitoring to measure possible reductions.	13,000/yr*		
Implement Bottomland Timber Establishment/ Tree and Shrub Establishment on 50 acres of floodplain areas.	Agricultural Landowners & Operators; Landowners of floodplain areas	Develop and promote cost-share program beginning in 2015.	$15,000/yr*	NRCS, ISDA, SWCDs, Purdue Extension, DNR	IDEM 319 Grants, NRCS Farm Bill Programs and initiatives, ISDA CREP and Clean Water Indiana Grants, LARE Grants
		Personal visits with landowners.	$10,000/yr *		
		Conduct E&O program featuring BMPs beginning in 2015.	E&O program		
		Using all funding sources, implement buffer practices on 20 acres annually. ($9/ac to $825/ac.)	$10,000		
		Identify alternative funding sources to increase participation.	E&O program		
		Conduct water quality monitoring to measure possible reductions.	13,000/yr*		
Implement Critical Area Plantings on 3,000 feet of streambanks, or 4 acres of other areas needing stabilization to reduce erosion.	Agricultural Landowners & Operators; Landowners of floodplain areas; County Surveyors	Develop and promote cost-share program beginning in 2015.	$15,000/yr*	NRCS, ISDA, SWCDs, Purdue Extension, DNR, County Surveyors	IDEM 319 Grants, NRCS Farm Bill Programs and initiatives, ISDA CREP and Clean Water Indiana Grants, LARE Grants
		Personal visits with landowners.	$10,000/yr *		
		Conduct E&O program featuring BMPs beginning in 2015.	E&O program		
		Using all funding sources, implement critical area plantings on 3,000 feet of streambanks, or 4 acres of other areas needing stabilization. ($325/ac)	$1,500		
		Identify alternative funding sources to increase participation.	E&O program		
		Conduct water quality monitoring to measure possible reductions.	13,000/yr*		

Table 8-5: Action Register and Schedule of UWRBC Activities

Objectives	Target Audience	Milestones	Estimated Costs	Potential Partners/ Technical Assistance	Potential Funding Sources
Promote Greenways and Trails for outdoor recreation opportunities	Landowners, County Residents, Local Government	Conduct E&O program featuring BMPs beginning in 2015.	E&O program	IDNR, Local Government, Acres, Inc., local trail groups	IDNR Outdoor Recreation Grants, Private Grants
		Identify alternative funding sources for trail development	E&O program		
Increase Wetland Creation, Enhancement and Restoration on 20 acres for water storage and water quality improvement.	Agricultural Landowners & Operators; Suburban and rural landowners	Develop and promote cost-share program beginning in 2015.	$15,000/yr*	NRCS, ISDA, SWCDs, DNR, USF&W, TNC, Acres Inc.	IDEM 319 Grants, NRCS Farm Bill Programs and initiatives, ISDA CREP and Clean Water Indiana Grants, LARE Grants, Private Grants
		Personal visits with landowners.	$10,000/yr *		
		Conduct E&O program featuring BMPs beginning in 2015.	E&O program		
		Using all funding sources, implement wetland creation, enhancement and restoration on 20 acres. ($500 - $4,500/ac)	$10,000 - $90,000		
		Identify alternative funding sources to increase participation.	E&O program		
		Conduct water quality monitoring to measure possible reductions.	13,000/yr*		

* One cost-share program, one education and outreach (E&O) program, and one water quality monitoring (WQM) program will be developed covering all strategies. Development and promotion of the cost-share program is 37.5% of the Watershed Coordinator (WC) salary. The personal landowner visits are 25% of the WC salary. Education and outreach costs are 25% of the WC salary, as well as costs to conduct meetings, field days, workshops or other events. The water quality monitoring program costs include 12.5% salary for the WC and costs for consulting services for monitoring and laboratory services.

Action Register and Schedule

Flooding/Floodplain Management Goal: Increase stakeholder awareness of the benefits of upland storm water storage areas and floodplain management practices by 2020; and increase the amount of riparian areas on streams and the Wabash River by 5% by 2035.

Objectives	**Target Audience**	**Milestones**	**Estimated Costs**	**Potential Partners/ Technical Assistance**	**Potential Funding Sources**
Increase the use of Field Borders, Filter Strips, Conservation Cover, Riparian Forest Buffers and Riparian Herbaceous Cover on 100 acres.	Agricultural Landowners & Operators	Develop and promote cost-share program beginning in 2015.	$15,000/yr*	NRCS, ISDA, SWCDs, Purdue Extension, DNR	IDEM 319 Grants, NRCS Farm Bill Programs and initiatives, ISDA CREP and Clean Water Indiana Grants, LARE Grants
		Personal visits with landowners.	$10,000/yr *		
		Conduct E&O program featuring BMPs beginning in 2015.	E&O program		
		Using all funding sources, implement buffer practices on 20 acres annually. ($9/ac to $825/ac.)	$10,000		
		Identify alternative funding sources to increase participation.	E&O program		
		Conduct water quality monitoring to measure possible reductions.	13,000/yr*		

Table 8-5: Action Register and Schedule of UWRBC Activities

Objectives	Target Audience	Milestones	Estimated Costs	Potential Partners/ Technical Assistance	Potential Funding Sources
Implement Bottomland Timber Establishment/ Tree and Shrub Establishment on 50 acres of floodplain areas.	Agricultural Landowners & Operators; Landowners of floodplain areas	Develop and promote cost-share program beginning in 2015.	$15,000/yr*	NRCS, ISDA, SWCDs, Purdue Extension, DNR	IDEM 319 Grants, NRCS Farm Bill Programs and initiatives, ISDA CREP and Clean Water Indiana Grants, LARE Grants
		Personal visits with landowners.	$10,000/yr *		
		Conduct E&O program featuring BMPs beginning in 2015.	E&O program		
		Using all funding sources, implement buffer practices on 20 acres annually. ($9/ac to $825/ac.)	$10,000		
		Identify alternative funding sources to increase participation.	E&O program		
		Conduct water quality monitoring to measure possible reductions.	13,000/yr*		
Promote Greenways and Trails for outdoor recreation opportunities	Landowners, County Residents, Local Government	Conduct E&O program featuring BMPs beginning in 2015.	E&O program	IDNR, Local Government, Acres, Inc., local trail groups	IDNR Outdoor Recreation Grants, Private Grants
		Identify alternative funding sources for trail development	E&O program		
Increase Wetland Creation, Enhancement and Restoration on 20 acres for water storage and water quality improvement.	Agricultural Landowners & Operators; Suburban and rural landowners	Develop and promote cost-share program beginning in 2015.	$15,000/yr*	NRCS, ISDA, SWCDs, DNR, USF&W, TNC, Acres Inc.	IDEM 319 Grants, NRCS Farm Bill Programs and initiatives, ISDA CREP and Clean Water Indiana Grants, LARE Grants, Private Grants
		Personal visits with landowners.	$10,000/yr *		
		Conduct E&O program featuring BMPs beginning in 2015.	E&O program		
		Using all funding sources, implement wetland creation, enhancement and restoration on 20 acres. ($500 - $4,500/ac)	$10,000 - $90,000		
		Identify alternative funding sources to increase participation.	E&O program		
		Conduct water quality monitoring to measure possible reductions.	13,000/yr*		

* One cost-share program, one education and outreach (E&O) program, and one water quality monitoring (WQM) program will be developed covering all strategies. Development and promotion of the cost-share program is 37.5% of the Watershed Coordinator (WC) salary. The personal landowner visits are 25% of the WC salary. Education and outreach costs are 25% of the WC salary, as well as costs to conduct meetings, field days, workshops or other events. The water quality monitoring program costs include 12.5% salary for the WC and costs for consulting services for monitoring and laboratory services.

Table 8-5: Action Register and Schedule of UWRBC Activities

Action Register and Schedule					
Education and Outreach Programs and Activities					
Objectives	**Target Audience**	**Milestones**	**Estimated Costs**	**Potential Partners/ Technical Assistance**	**Potential Funding Sources**
Host BMP field days, and workshops annually.	Community Residents, Landowners, Agricultural Producers	Conduct E&O program featuring BMPs beginning in 2015.	$6,000/yr*	NRCS, CTIC ISDA, CCSI, SWCDs, Purdue Extension, DNR, Ag Vendors, others	IDEM 319 Grants, Water Indiana Grants, Ag Vendors, Private Grants
		Identify additional partners for E&O programs.	E&O program		
		Identify alternative funding sources to increase BMP installation.	E&O program		
Continue water quality monitoring and Hoosier Riverwatch volunteer monitoring activities	Community Volunteers, Schools, FFA and other Youth Groups	Conduct E&O program featuring monitoring activities.	$2,000/yr*	ISDA, SWCDs, Hoosier Riverwatch	IDEM 319 Grants, SWCDs, Private Grants
		Identify funding sources to continue monitoring programs.	E&O program		
Develop strategies to reduce CSO impacts to waterways.	Waste treatment facilities, City and Town Officials	Conduct E&O program featuring BMPs beginning in 2015.	E&O program	SWCDs, Purdue Extension, Health Departments	City / Town Funding, User Fees
Provide opportunities for stakeholder involvement in environmental activities.	Community Volunteers, Businesses, Schools, FFA and other Youth Groups	Conduct E&O program featuring river clean-ups, water quality monitoring, canoe floats, and other events.	$1,000/yr*	ISDA, SWCDs, Hoosier Riverwatch, IDNR, Parks Department	SWCDs, Businesses, Private Grants
		Identify funding sources to continue programs.	E&O program		
Share and communicate activities on a regular basis.	Community members; Community groups; Local Government Officials	Conduct E&O program with updates to website, social media, newsletters, public meetings, media releases, fairs, river events, etc.	$500/yr*	NRCS, ISDA, SWCDs, IDNR, Parks Departments, and others	UWRBC Funding, Private Grants
Develop partner list and track stakeholder participation.	Community members	Conduct E&O program that will include developing partner list and track stakeholder participation.	$500/yr*	NRCS, ISDA, SWCDs	UWRBC Funding, SWCDs

* One cost-share program, one education and outreach (E&O) program, and one water quality monitoring (WQM) program will be developed covering all strategies. Development and promotion of the cost-share program is 37.5% of the Watershed Coordinator (WC) salary. The personal landowner visits are 25% of the WC salary. Education and outreach costs are 25% of the WC salary, as well as costs to conduct meetings, field days, workshops or other events. The water quality monitoring program costs include 12.5% salary for the WC and costs for consulting services for monitoring and laboratory services.

9.0 Project Tracking and Future Activities

9.1 Evaluating Effectiveness of Project

Indicators for measuring progress have been identified for each goal established by the Steering Committee and stakeholders. Water quality monitoring data, habitat, and biological surveys will continue to be collected throughout practice implementation and will be compared to the baseline data contained in this plan. Meadow-Wood Environmental Laboratory will serve as the Water Quality Coordinator and perform laboratory testing at a cost of approximately $39,000 over the three-year implementation period. Following implementation, on-going volunteer water quality monitoring will be conducted using the UWRBC monitoring equipment and Hoosier Riverwatch methods. Load reduction estimates based on actual monitoring data will be used for comparison to the baseline modeling to show improvements in water quality.

Best management practices installed throughout the implementation program will be mapped and modeled for their respective load reductions. This information will be reviewed by the Steering Committee and partners to determine the success or failures of installed practices and used for evaluating the watershed management plan action items or when considering revisions and refinement to the implementation strategies.

Social data will be used to track stakeholder attitudes, awareness, behaviors and participation in conservation programs and the implementation of best management practices that directly affect water quality improvement and protection. Surveys and questionnaires will be used to gather the social data, and personal interviews will be completed with landowners interested in applying for financial assistance programs. The social data will be evaluated by the Steering Committee and partners to determine the effectiveness of our education and outreach efforts, as well as identify improvements for future implementation programs.

The overall project progress will be tracked using the action register (Appendix J) as a guide for the schedule of activities to be completed throughout the implementation project. A tracking database will be developed by the UWRBC to include measureable items such as workshops held, BMPs installed, meetings held, stakeholder and volunteer participation, etc.; and will be updated quarterly with completed items. Individual landowner contacts and information will also be tracked for installed and future projects.

Information about the watershed management plan, implementation project, water quality monitoring and educational and outreach events will be posted to the Upper Wabash River Basin Commission website (http://uwrbc.org) and other social media as wells as in news releases provided to media outlets advertising project events.

9.2 Future Watershed Activities

The Upper Wabash River Basin Commission has been awarded an IDEM 319 grant to implement best management practices in the project area over a three-year period based on the approval of this plan. The implementation project includes developing and promoting a BMP cost-share program, BMP implementation, water quality monitoring, and education and outreach activities. The critical areas, BMPs, goals and objectives outlined in this watershed management

plan will be the basis for the implementation grant project.

Support from the Upper Wabash River Basin Commission members, steering committee, partners and stakeholders is necessary for the success of future programs and for achieving the goals and objectives outlined in this plan. The UWRBC members and steering committee will continue to meet bi-monthly to provide guidance and review findings and progress of the project activities.

This watershed management plan will be reviewed and updated as goals, objectives and strategies are met; and as proven technologies and additional management measures are approved. At a minimum, it is expected that the plan will be reevaluated annually within the three-year implementation period and on a five-year basis thereafter. Revisions to the plan can be completed at any time due to changes in water quality, land use, regulations, attitudes and behavior or for other reasons that are deemed appropriate.

The Upper Wabash River Basin Commission continues to conduct water monitoring activities and partners with the NRCS, ISDA and SWCDs in the Phase 1 project area; and is committed to future planning and implementation projects in the proposed Phase 3 project area. The UWRBC will work to integrate this watershed management plan and the plan that was developed for the Phase 1 project area into a regional effort for the entire area under the jurisdiction of the UWRBC to capitalize on the potential shared resources.

This watershed management plan will be available to the public through the UWRBC, local libraries, County Surveyor offices and Soil and Water Conservation Districts in Adams, Jay, Wells and Huntington Counties.

For additional information on this watershed management plan or future activities, contact the Upper Wabash River Basin Commission, 117 W. Harvest Road, Bluffton, IN 46714. Phone 260/824-0624 ext. 3.