Establishing Benchmarks

3.1: Previous Studies & Monitoring

3.1.1: USGS data 1978-1981

Related Problem Groups	*Concerns Validated?*	*Additional Concerns*
Sediment Loading and Soil Loss	**Yes, Suspended Sediments exceed state threshold**	
Nutrient Loading and Loss	**No, nutrient levels did not exceed standards but are not a good representation since only two samples were tested.**	

Related Problem Groups: **Sediment loading and soil loss, Nutrient Loading and Loss**

The United States Geologic Survey established a testing site on Big Creek in 1978 at the location of its stream flow gauge near Blairsville. Several parameters were tested including temperature, nutrients, specific conductance, dissolved oxygen, pH, heavy metals & other minerals, and suspended sediment. Of the parameters, only suspended sediment and temperature were tested more than twice.

Of the 21 samples tested for suspended sediment, 7 exceeded the threshold for suspended sediment of 30 mg/L cited in many of Indiana's TMDL assessments for the level at which aquatic communities become negatively affected. In addition, 5 other samples were above 70 mg/L and were in danger of exceeding this threshold. Overall, the samples ranged from 8 to 2240 mg/L. Nitrate+nitrite was also tested twice and phosphates and phosphorous were tested once. None of the samples tested for nutrients exceeded the state recommendations for these constituents.

The USGS data, though old, is the only source of suspended solids data and suggests that Big Creek at the Highway 66 bridge still has a high likelihood of exceeding the threshold for suspended solids.

3.1.2: Drinking Water

A small amount of data is available about the groundwater quality of the Big Creek Watershed. Most of the aquifers in the Big Creek Watershed that yield enough water for household purposes are 150-300 feet below the surface in the confined Patoka/Inglefield sandstone bedrock units. A small amount of the watershed overlays a shallower aquifer in the St. Wendel Sandstone unit. Almost all of the watershed has access to significant groundwater resources except for a small portion in Vanderburgh county where the Inglefield unit was pre-historically eroded leaving only the Shelburn formation which normally does not yield enough water for domestic purposes (Cable and Wolf 1977). *Figure 3.1.2-A; Important Freshwater Aquifers & Groundwater Quality Data* shows the location of the important freshwater aquifers as well as a limited amount of groundwater quality data.

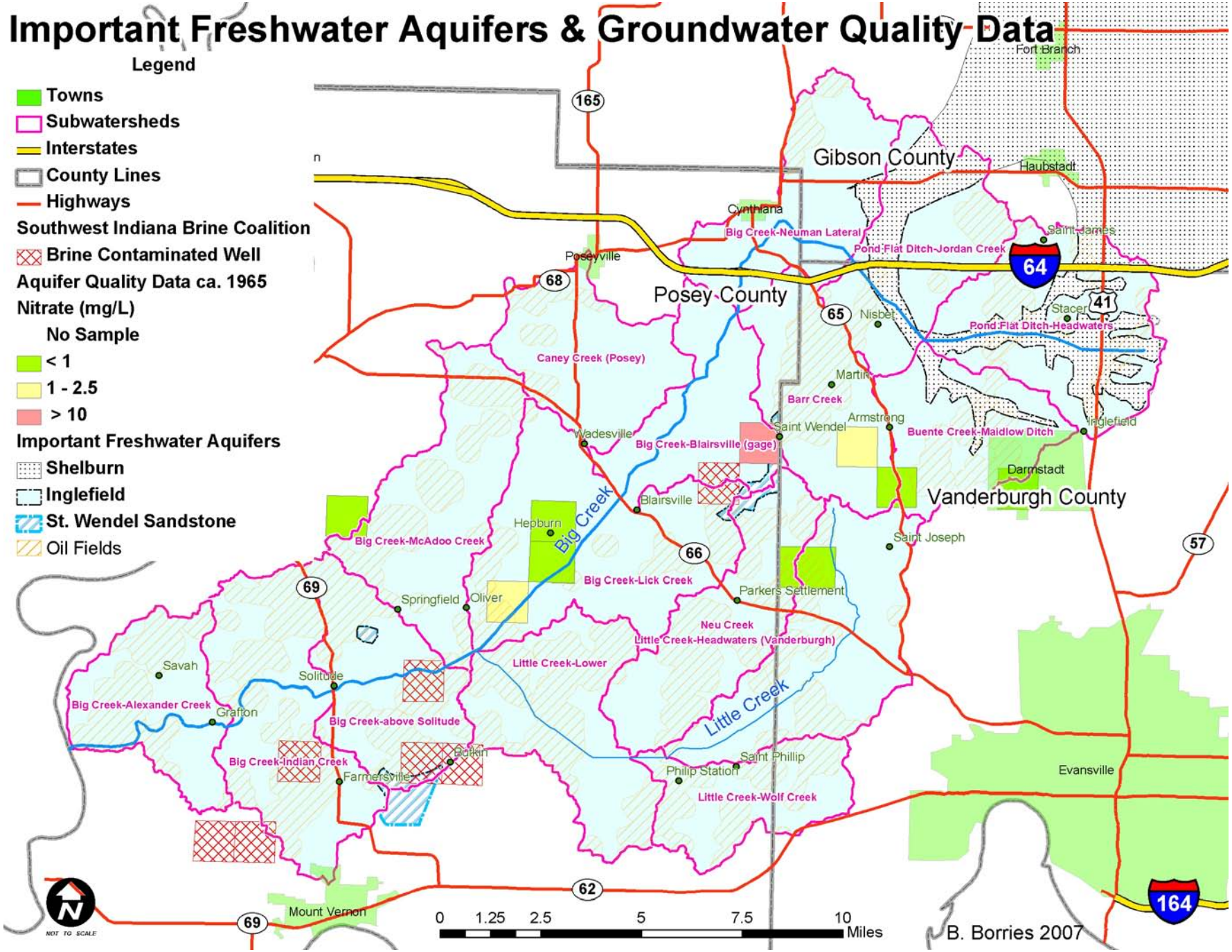


Figure 3.1.2-A: Freshwater Aquifers and Groundwater Quality

In the figure, the areas overlying the important aquifers are shown in solid blue (Patoka/Inglefield Aquifer) and with blue stripes (St. Wendel Sandstone). Groundwater quality data organized by township section is shown as red cross hatched (brine contaminated), or solid green, yellow, and red (low, medium, and high nitrate respectively).

In several areas, brine contaminated wells have been found by the Southwest Indiana Brine Coalition inventory (Hazlewood 2007). Aquifers are sometimes contaminated by brine water when an oil producer is drilling a well using brine water and a connection occurs that allows the brine water to contaminate a freshwater aquifer. For this reason, this map is also overlain by a layer showing the location of oil fields. These are areas where oil production is likely to occur leaving the aquifers in the area susceptible to brine contamination. It is unlikely that brine contaminated aquifers will affect surface water.

Testing for nitrate indicated only one contaminated area near St. Wendel. The cause of the high level is not known, but was thought to be either septic systems or fertilizer. It should be noted that the high nitrate level was found in a location overlying the St. Wendel aquifer which is much more shallow and thus susceptible to contamination from surface sources than the Inglefield aquifer that is present elsewhere (Tulley 1977).

3.1.2: LARE Diagnostic Study of Barr's Creek 1994 & 2004

Related Problem Groups	*Concerns Validated?*	*Additional Concerns*
Sediment Loading and Soil Loss	**Yes, macroinvertebrate population impaired due to insufficient pools**	**Degraded Aquatic Habitat Ineffectiveness of upland BMPs on farthest downstream sample locations**
Channel Quality		

The Barr Creek watershed, a sub-watershed of Big Creek (HUC: 050), was the subject of a Lake and River Enhancement program study involving baseline biological and chemical investigations, implementation of "land treatment" best management practices, and a follow-up study to test the effectiveness of the implementation. The investigations were conducted 10 years apart (1994 and 2004) and included ORP (oxidation/reduction potential), temperature, conductivity, pH, dissolved oxygen, flow, and turbidity, habitat assessment, and macroinvertebrate sampling. A short summary is included here. Full documentation can be obtained through the Indiana Department of Natural Resources (Bright 1994 and V3 Companies 2004). *Figure 3.1.2-A: Location of LARE Diagnostic Study of Barr Creek* shows the location of the area that was studied (in red) and the location of the sample points of the study (as green dots).

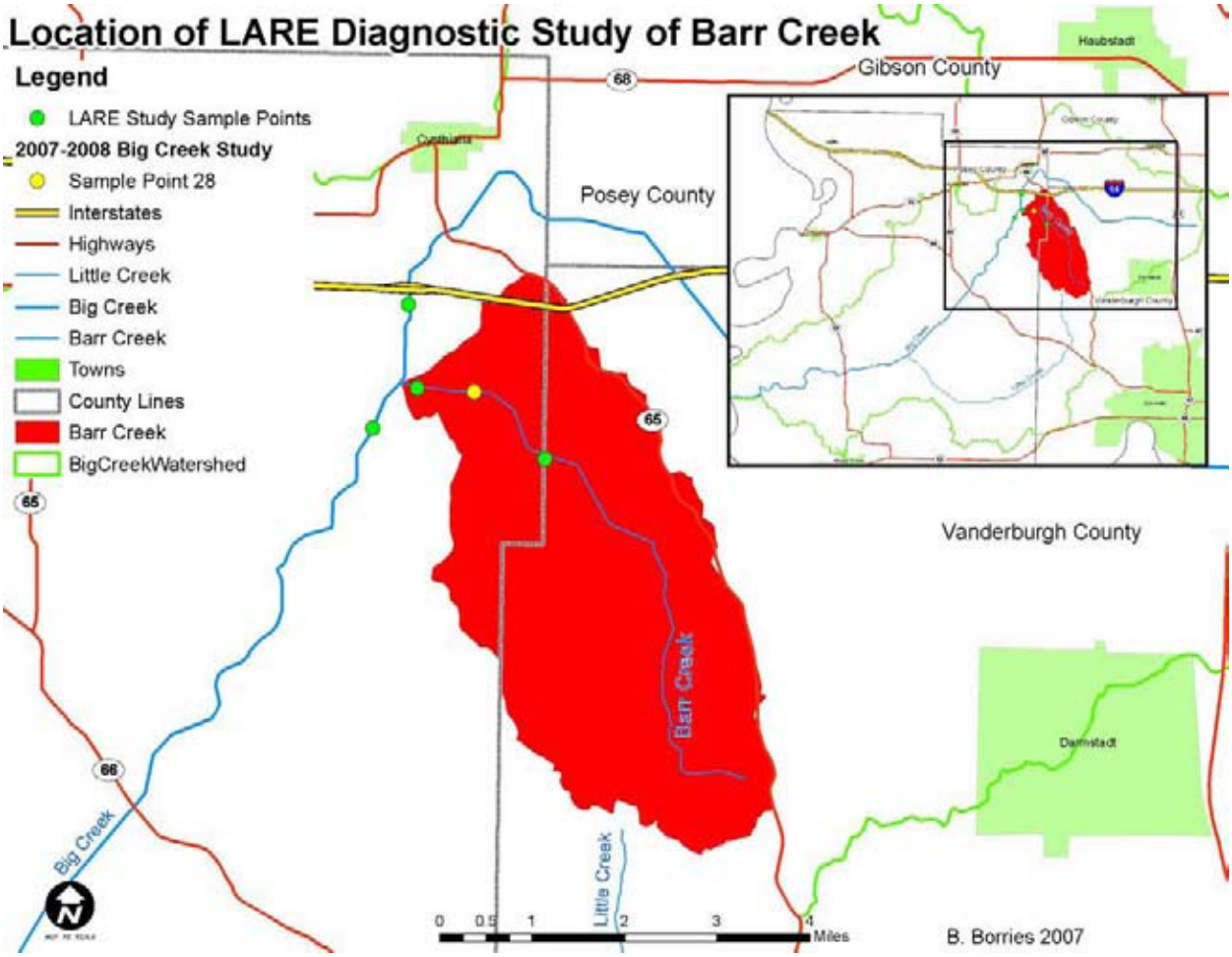


Figure 3.1.2-A: Location of LARE Diagnostic Study of Barr Creek

The report concludes that through the implementation of no-till farming, stormwater runoff diversions, cool-season grass filter strips, pipe structure grade stabilization structures, newly constructed and repaired grass waterways, integrated crop management, pasture and hayland planting, stream bank protections, tree plantings, and waste management systems (all practices were implemented in between the two investigations from 1993 to 1998), there may be an improvement in some attributes investigated. According to an evaluation performed by the investigators, upstream segments noted as having "slight" impairments in the upper reaches in Vanderburgh County during the 1994 study were found to have no impairments during the 2004, but lower reaches in Posey County were not reported as having improved significantly. In addition, an improvement in habitat quality did not seem to occur with the practices that were installed.

The study found that lack of available cover, insufficient pools and riffles, and channel alteration contributed most significantly to poor habitat evaluations. Outcomes of the study are related primarily to the excessive loading and loss problem group establishing that sediment loading and soil loss was a concern due to the predominance of "insufficient pools and riffles" in the habitat assessment, a result of sedimentation. However, since the water quality improvements only appeared in the upper reaches of the study area, it can be concluded that efforts focused only on upland areas may not achieve benefits in the lower reaches and that channel alteration

and a lack of available cover are concerns that need to be addressed to achieve more wholesome water quality improvements.

3.1.3: Work of the Southwest Indiana Brine Coalition from 1997 – 2006

Related Problem Groups	*Concerns Validated?*	*Additional Concerns*
Sediment Loading & Soil Loss	**No, there are few sites exhibiting erosion and the magnitude insignificant compared to other source**	
Education	**Yes, historic brine contamination sites still remain uncorrected. One known groundwater contamination exists. Not enough information exists about other possible groundwater contamination areas**	

The Soutwest Indiana Brine Coalition (SWIBC) is a locally led, grassroots organization working under the umbrella of the Four Rivers RC&D Area Inc. with the purpose to address the damage in Southwest Indiana caused by historic oil production. SWIBC received several grants since their formation that allowed them to inventory the damage, conduct public meetings to inform the public about the magnitude of the damage, and provide technical assistance and money for the landowner to remediate the damage. SWIBC's work spans across 9 counties in SW Indiana and a significant amount of work lies in the Big Creek watershed because of the oil fields and related historic oil production. A final report written for IDEM details the work of the organization from 1997 – 2006 and this work will be summarized here. The full document can be obtained from Four Rivers RC&D Inc. or the IDEM NPS/TMDL Section (Hazlewood 2007).

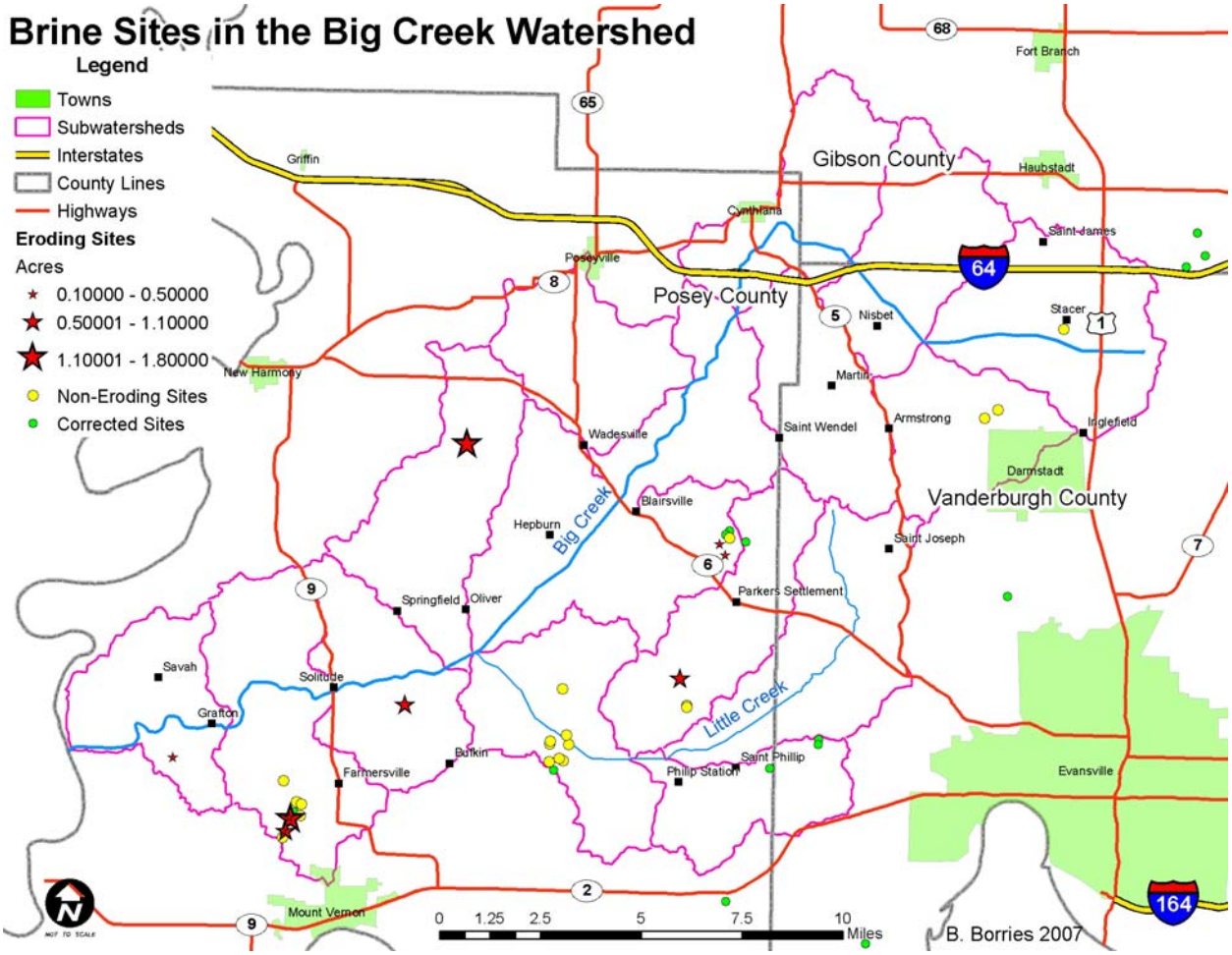


Figure 3.1.3-A: Brine Sites in the Big Creek Watershed

The damage addressed through the coalition includes that from brine in the surface soil, oil sludge in the surface soil, old petroleum wells not capped, and from brine contaminated drinking wells. Damage from historic oil production is most often an eyesore and is confined to what is usually a small area damaged. Brine damaged soils, however, cannot support vegetation and are prone to erosion. The inventory of brine damage to soils (which results in soil erosion and sediment loading to streams) found 184 separate areas totaling 170 acres in the nine county area. Thirty-Seven Sites totaling 39.21 acres were found in the Big Creek watershed. Remediation was attempted on nine of these sites, totaling 16.7 acres leaving about 22.51 of the acres found during the inventory not remediated. Of the sites not remediated, 10 sites totaling 7.61 acres were noted as experiencing erosion which may affect the water quality in Big Creek. One contaminated aquifer was found in the Big Creek watershed north of Mt. Vernon. No attempt was made to remediate the aquifers found in the inventory. Well-capping is regulated by the IDNR Division of Oil and Gas

The main work remaining listed in the document is the plugging of orphan wells, clean up of past oil production areas where there are old oil tanks or pumps, and remediation of oil sludge. The document states that there is a minimum of 400 orphan oil wells in the nine county area that were not plugged. The amount in Big Creek is not known. These wells can still release oil and brine into aquifers and soils. Due to the current price of oil, many of these wells are being

reclaimed and put into production again, which, in most cases, decreases their chances for any further contamination since there is more focus on their maintenance.

3.1.3: IDEM Section 303(d) listing of Big Creek Watershed Waterbodies

Related Problem Groups	*Concerns Validated?*	*Additional Concerns*
Sediment Loading & Soil Loss	**Yes, Impaired Biotic Communities (found in 2 sub-watersheds) is often the result of habitat degradation and low Dissolved Oxygen levels from sediment**	
Pathogens	**No, high levels of pathogen indicators were not reported as a result of 2005 testing**	
Nutrient Loading and Loss	**Yes, one sub-watershed found impaired due to "nutrient criteria"**	

IDEM's Office of Water Quality Assessment Branch conducts routine monitoring of water throughout the state to establish its 303(d) list of impaired water bodies as outlined in the Federal Clean Water Act. Waterbodies that are on this list do not meet water quality standards set by the state of Indiana or the Federal government. During its 2004 and 2006 testing within the Lower Wabash River Watershed, IDEM identified four areas at the 14-digit sub-watershed level within the Big Creek watershed that were impaired. *Figure 3.1.3-A: Impaired Waterbodies Identified by IDEM* shows the location of the areas that contain waterbodies determined to be impaired. The two sub-watersheds impaired based on biotic communities, Big Creek-Alexander Creek and Little Creek-Wolf Creek, are shown in light blue; Little Creek – Headwaters, impaired due to *E. coli* is shown in pink; and the sub-watershed impaired for pH & nutrients, Little Creek-Lower, is shown as orange. Of the 16 sub-watersheds within the Big Creek Watershed, only 6 were assessed by IDEM. This means that four out of six sub-watersheds in Big Creek were found to be impaired before the project started, indicating the possibility of additional impairments within areas that were not tested (IDEM 2006).

The impairments are based on the a water quality assessment methodology established by IDEM's water assessment branch in which the results of the testing are evaluated for compliance with the Indiana Water Quality Standards (327 IAC 2-1-6 and 327 IAC 2-1.5-8). For a site to be listed as impaired based on Impaired Biotic Communities, the Index of Biotic Integrity (IBI) score must be less than 36. For a site to be listed as impaired based on the nutrient criteria, two or more of the following conditions are met: total phosphorous on one or more measurements >0.3 mg/L; nitrogen (measure as NO3+NO2) on one or more measurements > 10 mg/L; dissolved oxygen is below 4 mg/L, consistently 4-5 mg/L, or above 12 mg/L; pH measurement above 9.0 or consistently 8.7-9; and/or algal conditions are described as excessive by a trained observer. For a site to be listed as impaired based on pH, more than 10% of measurements do not fall outside the Indiana standard for pH (>6 or <9). Sites impaired due to *E. coli* exceed 235 colonies/100 mL during "grab samples" or have a geometric mean of greater than125 colonies/100 mL on 5 samples spaced equally throughout a month.

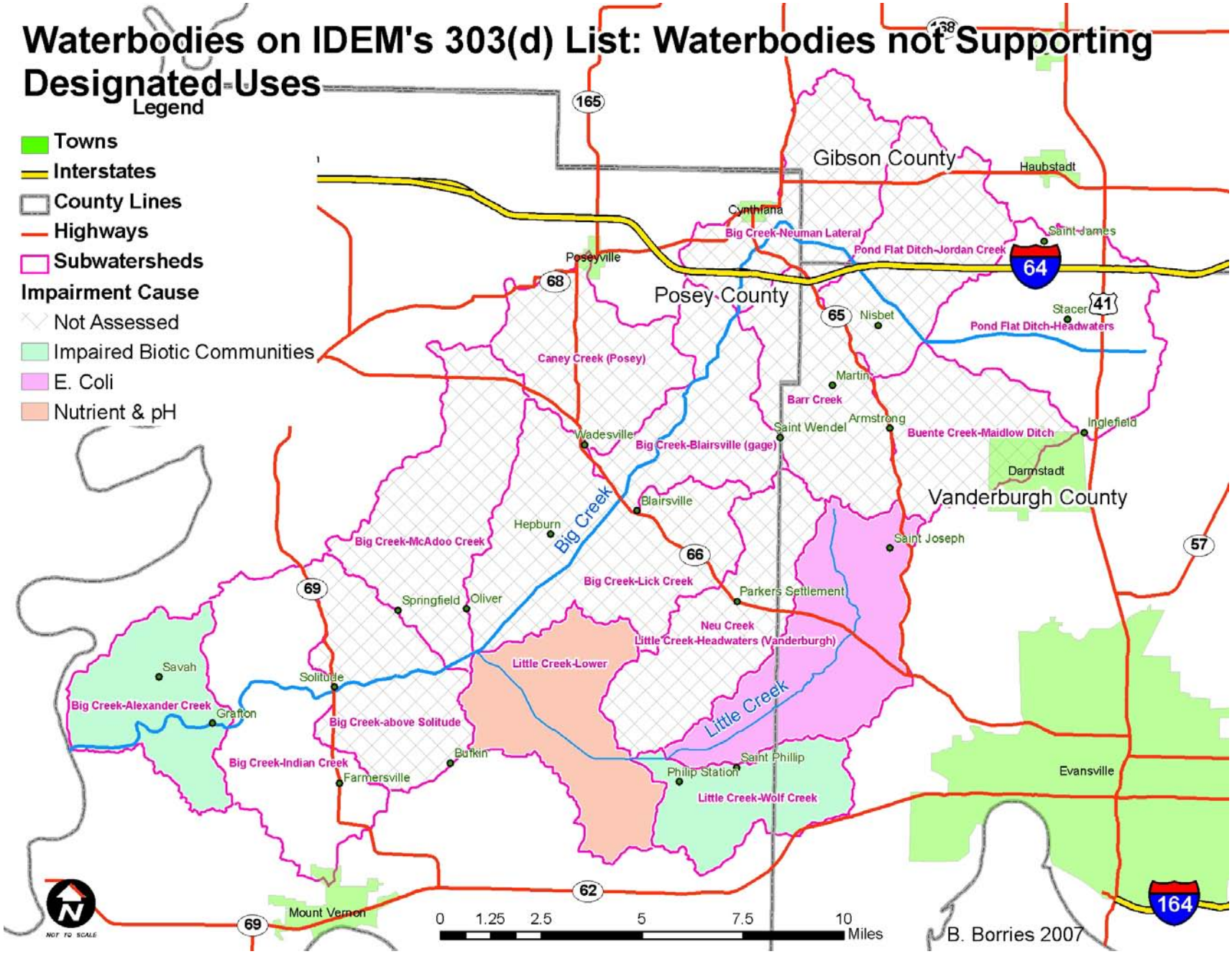


Figure 3.1.3-A: Impaired Waterbodies Identified by IDEM

3.2: Quality Assured Water Monitoring 2007-2008

Related Problem Groups	*Concerns Validated?*	*Additional Concerns*
Sediment Loading & Soil Loss	**Yes, turbidity found to be up to 4 times the state average in Big Creek main channel. Dissolved oxygen was found to be low in several streams.**	
Pathogens	**Yes, *E. coli* impairments found in 12 of 16 sub-watersheds**	
Nutrient Loading and Loss	**Yes, nutrient criteria impairment found in 5 sub-watersheds**	

3.2.1: Testing Methods, Locations, and Parameters

Water quality testing was conducted as part of the project to characterize water quality problems and identify priority areas on a HUC 14 digit level as well as to identify possible sources to direct future land treatment and conservation efforts. Ten water quality parameters (temperature, conductivity, dissolved oxygen concentration, dissolved oxygen saturation, pH, Oxidation-Reduction potential, ammonium, ammonia, nitrate, and turbidity) were tested using a YSI-Sonde 6600 portable unit, orthophosphate was tested using the HACH kit, and *E. coli* was tested using the easy-gel method. A completed description of the methodology can be found in the Quality Assurance Project Plan included as Appendix C. Testing was done with assistance of Joe Craig from Practical Resource Consultants.

Parameters were chosen to give the most complete view of the water quality related to organic pollutants that can be evaluated using mostly field equipment. By looking at parameters in combination with one another and linking data found during inventories, the initial concerns can be evaluated. Turbidity and dissolved oxygen (concentration and saturation) can be used in combination to evaluate the effect of excessive sediment loading and soil loss. *E. coli* is a useful indicator species for the detection of pathogens. Ammonium, ammonia, nitrate, and orthophosphate are all forms of nitrogen and phosphorous based nutrients and can be used to evaluate the effects and locations of excessive nutrient loading and loss. pH and dissolved oxygen can also be used to measure algae blooms a problem related to excessive nutrient loading and loss. Temperature and pH provide conditional information that can have an effect on how the data is interpreted and analyzed. Conductivity and Oxidation Reduction Potential are part of the water quality probe and noted for informational purposes in the appendix. Organic pollutants such as pesticides that may or may not be found were not evaluated as part of this project.

Testing was done at 35* sites around the watershed with at least one site in each of the 16 sub-watersheds. *Figure 3.2.1: 2007-2008 Water Monitoring Sample Points* shows sampling locations. Testing was conducted at each point 8 times a year from March-October.

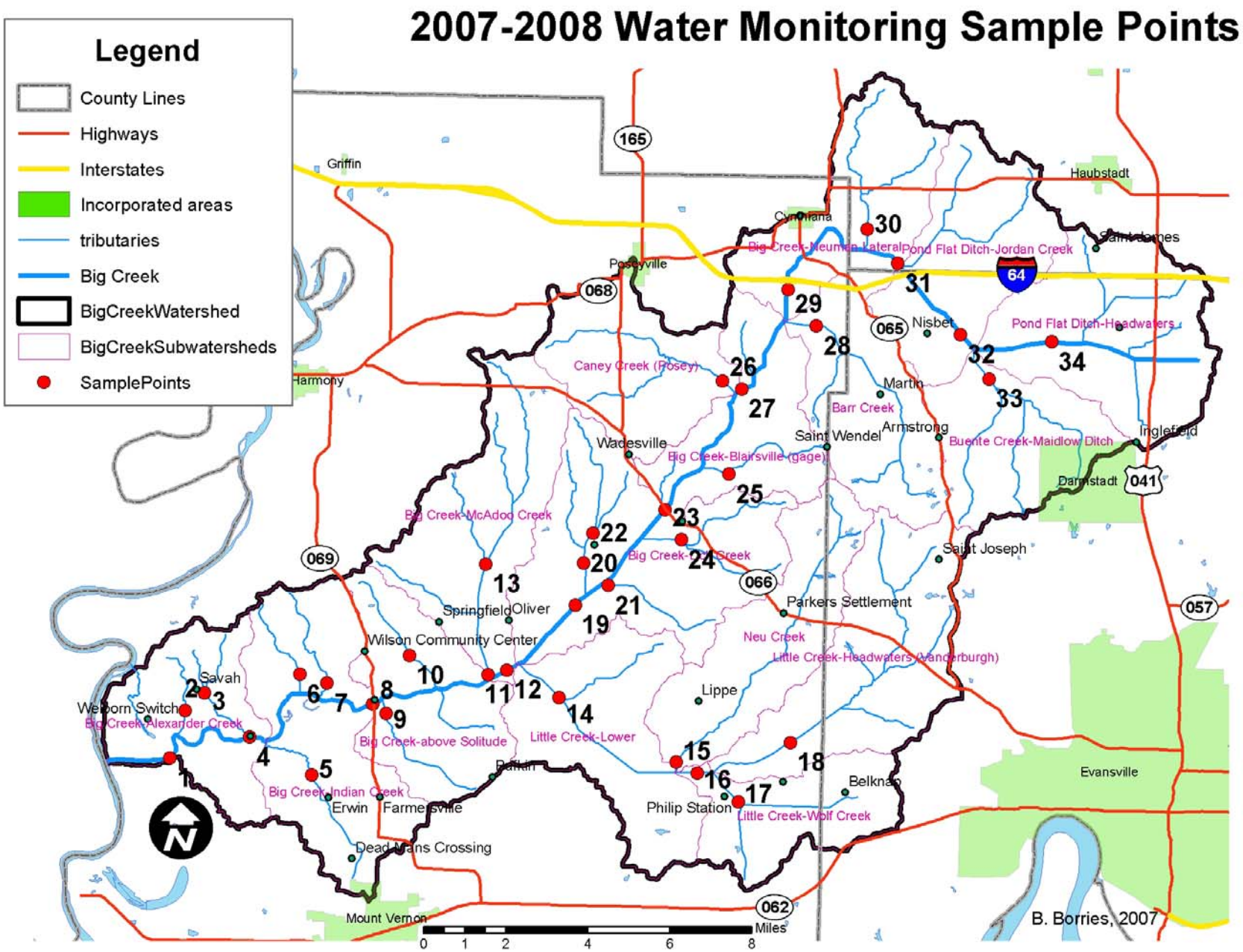


Figure 3.2.1: 2007-2008 Water Monitoring Sample Points

* An additional sampling location was also added at location 13 due to the forking of McAdoo Creek at this point. These sample points are referred to as 13a (east fork) and 13b (west fork) throughout the rest of the plan

3.2.2: Summary of Areas Exceeding State Water Quality Standards

In this section the results of the water monitoring conducted through the project are evaluated against Indiana Water Quality Standards (327 IAC 2-1-6 and 327 IAC 2-1.5-8). Indiana Water Quality Standards are set such that they are equal to or better than the standards set by the federal EPA. In addition, the sampling is evaluated for instances in which the standard for nutrients set forth in the 2005 303(d) listing is exceeded. Similar to the state's 303(d) listing methodology, samples were evaluated at the 14 digit HUC sub-watershed level where a sub-watershed exceeding the standard on more that 10% of the samples collected is said to be not supporting and a sub-watershed exceeding the standard between 1% and 10% of the samples is said to be partially supporting. A sub-watershed that does not exceed the standard at all is said to be fully supporting.

E. coli

Samples taken during 14 rounds of water monitoring in 2007 & 2008 are evaluated using the "grab sample" standard for *E. coli* set at the acceptable level for full-body recreational contact, 235 colonies/100mL. According to this method and based on the 2007 sampling rounds, all of the sub-watersheds are not supporting full body recreational contact (6 of which exceeded the standard on more than 50% of the samples pulled). *Table 3.2.2-A: Full Body Recreational Use Support* indicates the names and HUC addresses of sub-watersheds where *E. coli* levels exceeded the grab sample standard on greater than 10% of samples and sub-watersheds where *E. coli* levels exceeded the grab sample standard on greater than 50% of the samples.

Sub-watersheds Not Supporting (>10% Samples Exceeding)	**Sub-watershed Not Supporting (>50% Samples Exceeding)**
Big Creek – Neuman Lateral (040)	Pond Flat Ditch – Headwaters (010)
Caney Creek (060)	Buente Creek – Maidlow Ditch (020)
Big Creek – Blairsville (070)	Pond Flat – Jordan Creek (030)
Big Creek – Lick Creek (080)	Barr Creek (050)
Little Creek – Headwaters (090)	Little Creek – Lower (120)
Little Creek – Wolf Creek (100)	Big Creek – Above Solitude (140)
Neu Creek (110)	
Big Creek – McAdoo Creek (130)	
Big Creek – Indian Creek (150)	
Big Creek – Alexander Creek (160)	

Table 3.2.2-A: Full Body Recreational Use Support

Nutrients

Although there is no federal standard listed for Nutrients, as section 3.1.3 explains, a methodology has been developed by IDEM's Office of Water Quality Assessment Branch. For the following analysis, sub-watersheds were evaluated on a sample-by-sample basis for 4 of the 5 parameters detailed in section 3.1.3 substituting orthophosphate for total phosphate and nitrate for nitrate+nitrite. Algal growth was not included since a trained observer was not available. Similar to the *E. coli* standard, sites were considered to be partially supporting aquatic life if between 1% and 10% of the samples exceeded the criteria, not supporting if greater than 10% exceeded, and fully supporting if no samples exceeded the criteria. According to this method and based on the 2007 sampling rounds, eight of the sixteen sub-watersheds are not supporting aquatic life based on the nutrient criteria, six sub-watersheds are partially supporting, and 2 sub-watersheds are fully supporting. *Table 3.2.2-B: Aquatic Life Use Support Based on Nutrients* indicates the names and HUC addresses not supporting or partially supporting this use.

Sub-watersheds Partially Supporting (1-10% Exceeding)	**Sub-watersheds Not Supporting (>10% Exceeding)**
Pond Flat Ditch – Headwaters (010)	Pond Flat – Jordan Creek (030)
Big Creek – Neuman Lateral (040)	Barr Creek (050)
Big Creek – Blairsville (070)	Caney Creek (060)
Little Creek – Wolf Creek (100)	Big Creek – Lick Creek (080)
Big Creek – Above Solitude (140)	Neu Creek (110)
Big Creek – Indian Creek (150)	Little Creek – Lower (120)
	Big Creek – McAdoo Creek (130)
	Big Creek – Alexander Creek (160)

Table 3.2.2-B: Aquatic Life Use Support Based on Nutrients

Dissolved Oxygen

The state standards specify that waters should not have a daily average of less than 5 mg/L and should never be below 4 mg/L. For this evaluation, the standard of 5 mg/L is used since samples were always taken during the day when dissolved oxygen levels are expected to be higher.
Similar to the *E. coli* standard, sites were considered to be partially supporting aquatic life if between 1% and 10% of the samples exceeded the criteria, not supporting if greater than 10% exceeded, and fully supporting if no samples exceeded the criteria. According to this method and based on the 2007 sampling rounds, 7 of the 16 sub watersheds are not supporting aquatic life based on the dissolved oxygen criteria, 3 sub-watersheds are partially supporting, and 6 sub-watersheds are fully supporting. *Table 3.2.2-C: Aquatic Life Use Support Based on Dissolved Oxygen* indicates the names and HUC addresses not supporting or partially supporting this use.

Sub-watersheds Partially Supporting (1-10% Exceeding)	Sub-watersheds Not Supporting (>10% Exceeding)
Big Creek – Blairsville (070)	Pond Flat Ditch – Headwaters (010)
Big Creek – McAdoo Creek (130)	Buente Creek – Maidlow Ditch (020)
Big Creek – Indian Creek (150)	Pond Flat – Jordan Creek (030)
	Caney Creek (060)
	Little Creek – Lower (120)
	Big Creek – Above Solitude (140)
	Big Creek – Alexander Creek (160)

Table 3.2.2-C: Aquatic Life Use Support Based on Dissolved Oxygen

Nitrate

The state standards specify that for drinking water and aquatic life use, waters should not exceed 10 mg/L. Similar to the *E. coli* standard, sites were considered to be partially supporting aquatic life if between 1% and 10% of the samples exceeded the criteria, not supporting if greater than 10% exceeded, and fully supporting if no samples exceeded the criteria. According to this method and based on the 2007-2008 sampling rounds, 6 of the 16 sub watersheds are not supporting aquatic life and drinking water use based on the nitrate criteria, 3 sub-watersheds are partially supporting, and 7 sub-watersheds are fully supporting. *Table 3.2.2-D: Aquatic Life & Drinking Water Use Support Based on Nitrate* indicates the names and HUC addresses not supporting or partially supporting this use. *Figure 3.2.2-D: Drinking Water & Aquatic Life Use Support Based on Nitrate* shows the location of the impaired areas in the Big Creek Watershed.

Sub-watersheds Partially Supporting (1-10% Exceeding)	Sub-watersheds Not Supporting (>10% Exceeding)
Big Creek – Blairsville (070)	Big Creek – Neuman Lateral (040)
Big Creek – Above Solitude (140)	Barr Creek (050)
Big Creek – Alexander Creek (160)	Caney Creek (060)
	Big Creek – Lick Creek (080)
	Neu Creek (110)
	Big Creek – McAdoo Creek (130)
	Big Creek – Indian Creek (150)

Table 3.2.2-D: Aquatic Life & Drinking Water Use Support Based on Nitrate

3.2.3: Turbidity

No state standard exists for turbidity or for the similar measurement of total suspended solids. However, included in the law regarding state standards, the following statement exists:

(1) All surface waters at all times and at all places, including waters within the mixing zone, shall meet the minimum conditions of being free from substances, materials, floating debris, oil, or scum attributable to municipal, industrial, agricultural, and other land use practices, or other discharges that do any of the following:
(A) Will settle to form putrescent or otherwise objectionable deposits.
(B) Are in amounts sufficient to be unsightly or deleterious.
(C) Produce color, visible oil sheen, odor, or other conditions in such degree as to create a nuisance.
(D) Are in concentrations or combinations that will cause or contribute to the growth of aquatic plants or algae to such degree as to create a nuisance, be unsightly, or otherwise impair the designated uses

Turbidity is a measure of the clarity of water and may affect any of the above statements. Interesting patterns emerged from turbidity. *Table 3.2.3-A: Turbidity* shows the results of the monitoring. The turbidity (y-axis) in NTUs is graphed against the sample point where it was measured (x-axis). Samples taken from Big Creek are shown as black diamonds, Little Creek is shown as purple squares, and the remaining tributaries are shown as green triangles.

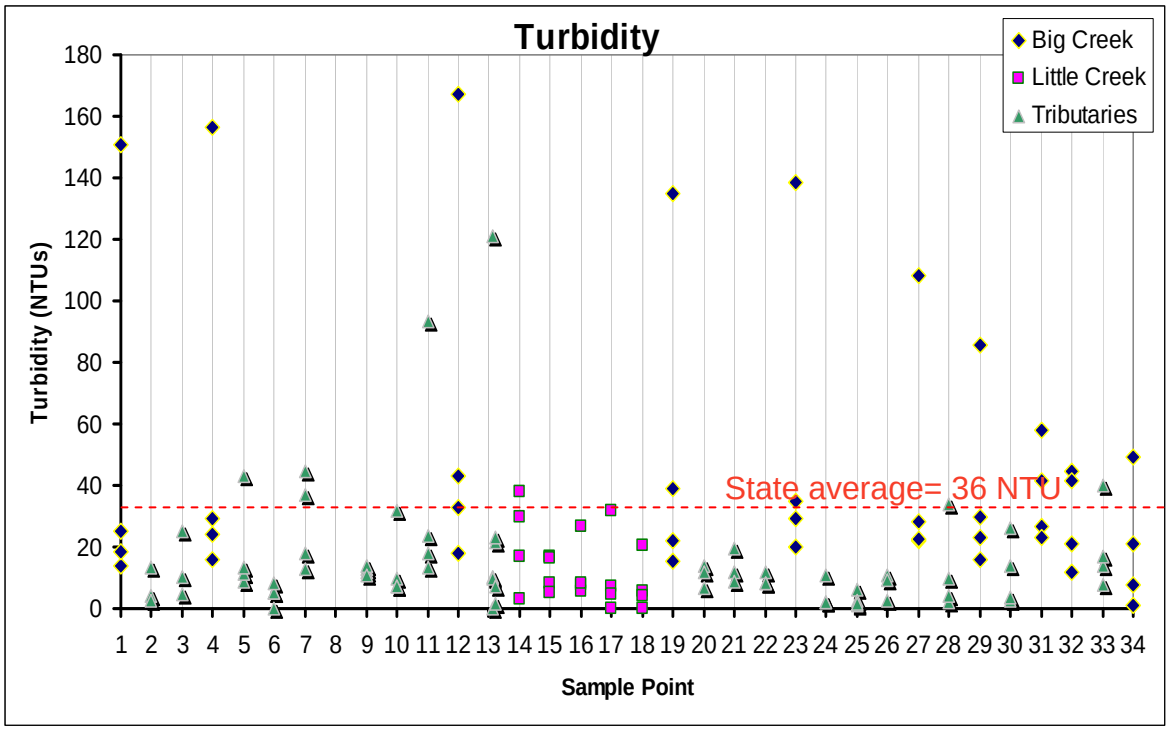


Table 3.2.3-A: Turbidity

In general, the turbidity in the waters of the Big Creek watershed is above average for the state (State Average = 36 NTU from Hoosier Riverwatch training manual). During at least one monitoring round for each site, the level of turbidity was anywhere from just above the average (i.e. 38 NTU on site 23) to over 4 times the state average (170 NTU on site 12). The highest turbidity measurements occur immediately after a storm and go down the longer it has been since a rain depending on the intensity of the storm. The highest turbidity levels occurred on Big Creek. The levels on Little Creek and other tributaries are much lower with the exception of samples on McAdoo Creek which also had very high scores. From this information, it seems

that a considerable amount of sediment is originating from bank scour and overland flow immediately adjacent to Big Creek, compared to overland flow entering the tributaries.

3.2.4: Biological Monitoring – Qualitative Habitat Assessment

Biological monitoring was included in the watershed assessment as a response to the 303(d) listing o f two sub-watersheds on the basis of impaired biological communities. Habitat assessments provide a way to analyze the non-chemical stressors that lead to poor aquatic communities. The Ohio Qualitative Habitat Evaluation Index (QHEI) was used to evaluate habitat at each of the sample points where chemical monitoring occurred (assessments at sites 4, 11, 13b, and 33 were not completed due to a lack of resources). The Ohio QHEI assigns a numeric score to a stream reach based on 7 metrics: substrate, in-stream cover, channel morphology, riparian zone, pool quality, riffle quality, and map gradient (Ohio EPA 2006). Sites may receive a maximum score of 100. IDEM's Office of Water Quality Assessment Branch has set a standard for a site to be impaired due to habitat. IDEM has determined that a score of less than 51 indicates poor habitat. However, a site will not be listed on the 303(d) if it is only impaired based on habitat; rather the QHEI criteria allows for the determination of the stressor as a non-chemical habitat related stressor instead of a chemical one.

Figure 3.2.4: Qualitative Habitat Evaluation Index Results in the Big Creek Watershed shows the results of the Ohio QHEI. Overall, most sites exhibited poor quality according to IDEM's criteria. Sites exhibiting poor habitat include sites 1, 5, 7, 8, 9 10, 12, 13, 15, 16, 18, 20, 21, 22, 23, 26, 28, 29, 30, 31, 32, 34. The most common metrics resulting in low scores were those related to morphology and the riparian zone. This agrees with other assessments including the inventory of riparian vegetation in *Section 3.3.1* and the morphology and stability assessment in *Section 3.3.6.* While some management measures may improve the condition of the riparian area and floodplain, morphology is mostly affected by historic channelization which may have occurred at the site or upstream (as a result of increased stream power) or downstream (as a result of headward erosion leading to morphological degradation) of the site. Sedimentation of pool and riffle habitat is also prevalent as well as sparse and monotypic in-stream cover as a result of woody debris removal and riparian vegetation controls. The sites with the best habitat scores generally had more stable substrate types such as cobble, bedrock, and larger gravels as well as steeper slopes.

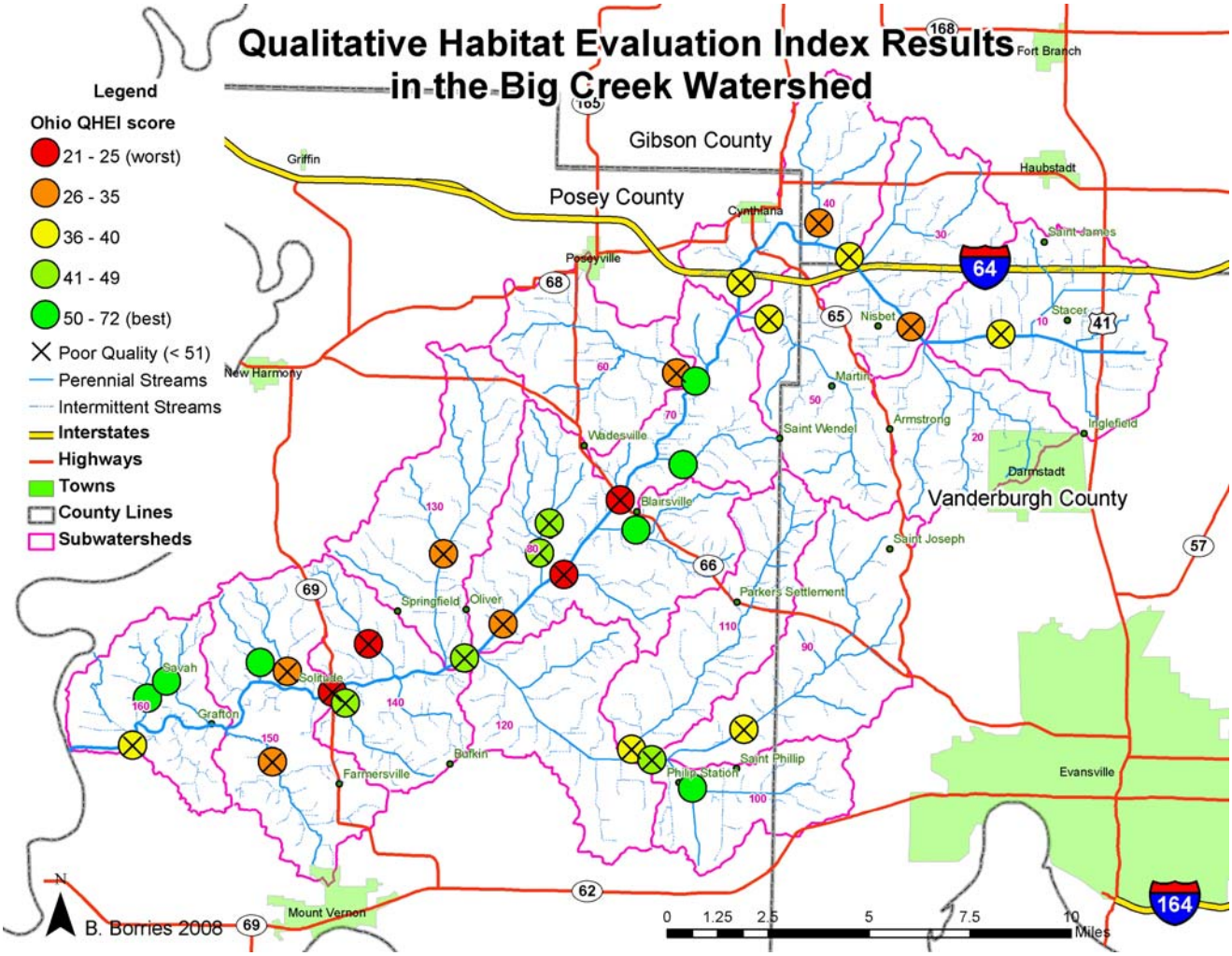


Figure 3.2.4: Qualitative Habitat Evaluation Index Results in the Big Creek Watershed

Sampling for benthic macro-invertebrates was also completed at each sample point to complement the chemical monitoring (sites 4, 11, 13b, and 33 were not completed due to a lack of resources). The EPA Rapid Bio-Assessment Protocol (RBP) multi-habitat approach was used in collecting the organisms. This consists of 20 "jabs" with a dip net to collect organisms from all habitat types present at the reach, including riffles, undercut banks, rootwads and rootmats, overhanging vegetation and aquatic vegetation. Organisms were identified down to the family level out of practicality. Because no multi-habitat macro-invertebrate Index of Biotic Integrity (mIBI) has yet been developed for this state or region, three indices will serve as the main analysis method for the benthic macro-invertebrates section of the biological monitoring: a Hilsenhoff Family Biotic Index (FBI), Percent of sample composed of Ephemeroptera (mayfly), Tricoptera (caddisfly), or Plecoptera (stonefly) species (%EPT), and the number of families in the sample reach. A higher quality site will have a lower FBI score, a higher % EPT score, and a higher number of families. The FBI is a measure of the tolerance of organisms to organic pollution. A higher score indicates more tolerance to pollution which generally coincides with lower quality water.

Table 3.2.5-A: Benthic Macro-invertebrate Metric Scores shows the results of the analysis of the macro-invertebrate sampling. Six sites are distinct in having an EPT % higher than zero and an FBI score less than eight. These sites can be considered to have a higher quality macro-invertebrate community than the rest. These sites include: 16, 24, 25, 27, 29, and 30. Common attributes of these sites include more stable substrate such as larger gravel and cobble and less sedimentation. Overall, samples collected did not indicate high quality communities which is in agreements with the other analyses of in-stream habitat and biological communities. A lack of well developed riffle and

Site	# Families	Family Biotic Index	% EPT
1	5.00	8.467797	0.00
2	5.00	6.666667	0.00
3	5.00	6.6	0.00
5	5.00	8.111111	0.00
6	5.00	5.446429	0.00
7	5.00	5.083333	0.00
8	7.00	8.443038	0.03
9	5.00	7.924242	0.00
10	5.00	6.141414	0.00
12	4.00	8.107143	0.04
13	4.00	6.916667	0.00
15	7.00	7.275862	0.00
16	7.00	6.916667	0.31
17	11.00	5.479452	0.15
18	10.00	8.46281	0.02
19	4.00	8.772093	0.00
23	4.00	8.681818	0.00
24	6.00	7.969697	0.09
25	4.00	6.658537	0.04
26	4.00	8.128205	0.04
27	9.00	7.792793	0.03
28	7.00	6.259259	0.00
29	11.00	7.621622	0.11
30	4.00	6.75	0.25
31	5.00	8.672131	0.03
32	7.00	8.147059	0.03
34	9	8.597015	0.00

Table 3.2.5-A: Benthic Macro-invertebrate Metric Scores

pool habitat and woody debris limited the types of habitat available in all the streams leading to the poor quality communities.

3.2.6: Biological Monitoring – Fish

Thanks to efforts of University of Southern Indiana professor Dr. Jim Bandoli and his students, data was made available on the fish communities at each sample point (sites 1 and 4 were not completed because they were thought to more accurately represent fish communities of the Wabash River and not Big Creek). During the summer of 2008, Dr. Bandoli and his students collected fish using a multi-habitat approach. Block nets were utilized to collect organisms after they were ushered out of refuge by student assistants. Organisms were identified to the species level in the field and in a laboratory by Dr. Bandoli. Dr. Bandoli provided the data to the watershed coordinator and it was analyzed using Indiana's Index of Biotic Integrity (Simon and Dufour 1998).

The results of the analysis are shown in *Figure 3.26-A: Fish Index of Biotic Integrity in the Big Creek Watershed.* Sites are color-coded based on their IBI score. Blue sites have the highest (best quality) score followed by green, yellow, orange, and red. Sites that are at or below the standard for the IBI are considered to have Impaired Biotic Communities (IBC). Sites 2, 3, 8, 14, 15, 22, 24, 26, 27, 28, 29, and 32 were found to be not supporting aquatic life due to IBC. There is no single thing that seems to be common among these sites; however, they all either have low QHEI scores or were found to exceed the criteria for nutrients and sediment. All sites found to be not supporting due to IBC were found to have a high (a score of 4 out of 5) risk rating under the Watershed Assessment of River Stability and Sediment Supply (WARSSS) except for site 24 which was found to have a low risk rating (2 out of 5). WARSSS is a method of assessing channel stability and morphology adopted by the federal EPA. More information can be found in *section 3.3.6: Watershed Assessment of River Stability and Sediment Supply*.

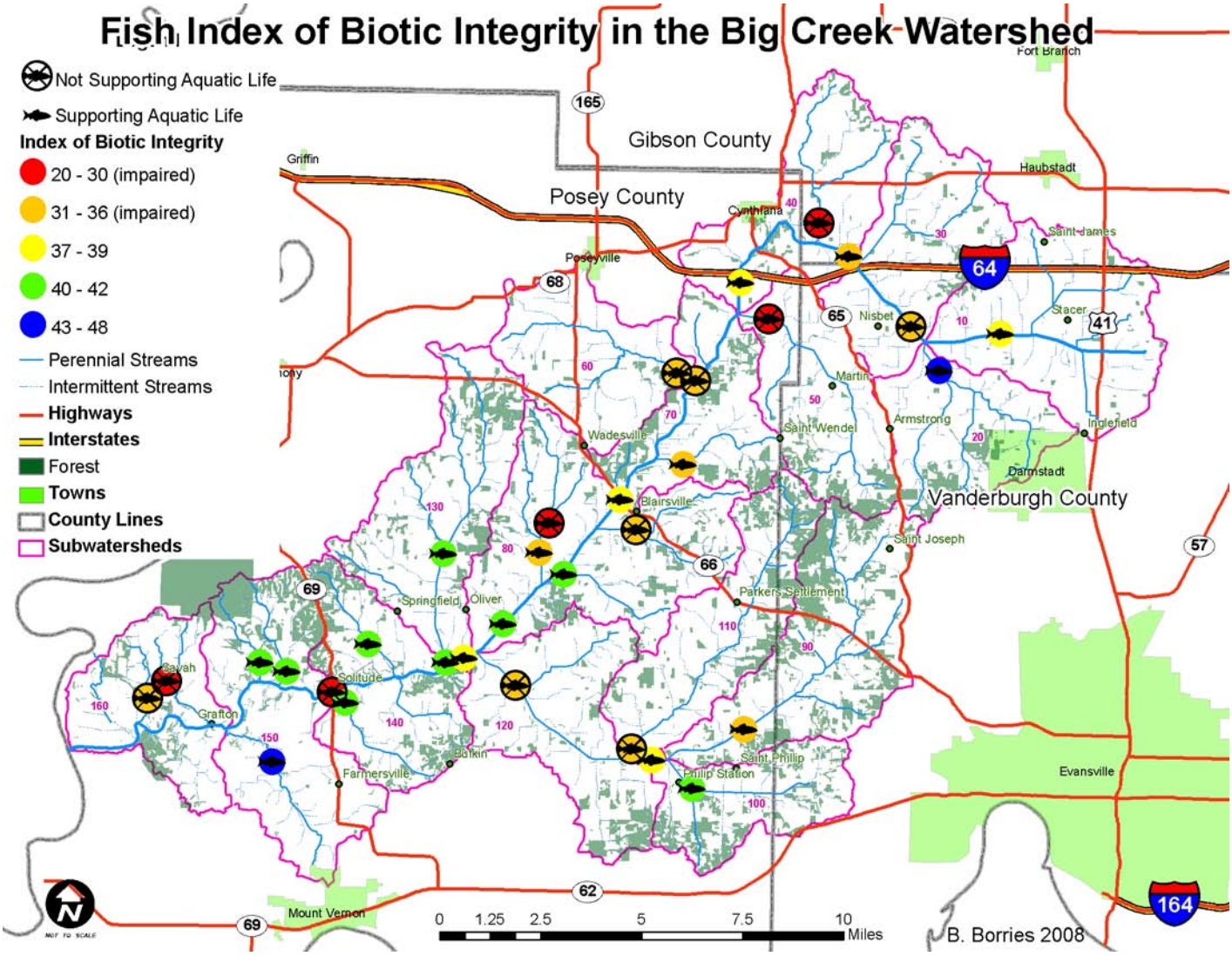


Figure 3.2.6-A: Fish Index of Biotic Integrity in the Big Creek Watershed

Related Problem Groups	*Concerns Validated?*	*Additional Concerns*
Sediment Loading & Soil Loss	**Yes, lack of buffers/filter strips found in several areas, especially along the Big Creek main channel**	
Pathogens		
Channel Quality		
Nutrient Loading and Loss		
Education		

Stream-side vegetation can filter pollutants before they enter a stream, stabilize stream banks, reduce algal growth, slow storm event flow, and improve habitat. The watershed was inventoried for vegetation along the perennial streams. Each stream length was categorized based on the width of permanent vegetation between the stream and the adjacent non-forest land use. Each length was grouped as less than 30 feet, 30-50 feet of grass, greater than 50 feet of grass, 30-50 feet of trees, or greater than 50 feet of trees. The results are shown in *Figure 3.3.1-A: Riparian Vegetation in the Big Creek Watershed*.

To determine a "score" for each stream segment, each category of vegetation was given a number. A section with less than 30 feet of vegetation = 1, 30-50 feet of grass = 2, greater than 50 of grass= 3, 30-50 feet of trees = 4, and >50 feet of trees = 5. The score for each side of each segment was added to get the score that is depicted on the map with red stream segments having the least vegetation (score=2), green having the most vegetation (score=10) and yellow having a mid-range score (score=6). An additional analysis was done to determine the percent of streams having little to no riparian vegetation, herbaceous (grasses) vegetation of 30 ft or more, and forested riparian areas. A bar graph is shown to the right of the map. Red indicates the proportion of stream segments with no vegetation, yellow indicates herbaceous vegetation, and green represents stream segments with forested riparian areas.

Riparian vegetation varies among the sub-watersheds with as much as 90% of stream segments in the Caney Creek sub-watershed (060) having little to no vegetation to about 35% of stream segments in the Little Creek – Headwaters. Forested riparian areas account for up to 65% of the stream segments in the Big Creek – Alexander Creek sub-watershed (160) to as little as 5% in the Pond Flat – Headwaters sub-watershed (010). Herbaceous riparian areas make up the least amount of stream segments, from about 15% in Pond Flat – Headwaters sub-watershed (010) to almost none in the Big Creek – Alexander Creek sub-watershed (160)

Riparian Vegetation in the Big Creek Watershed

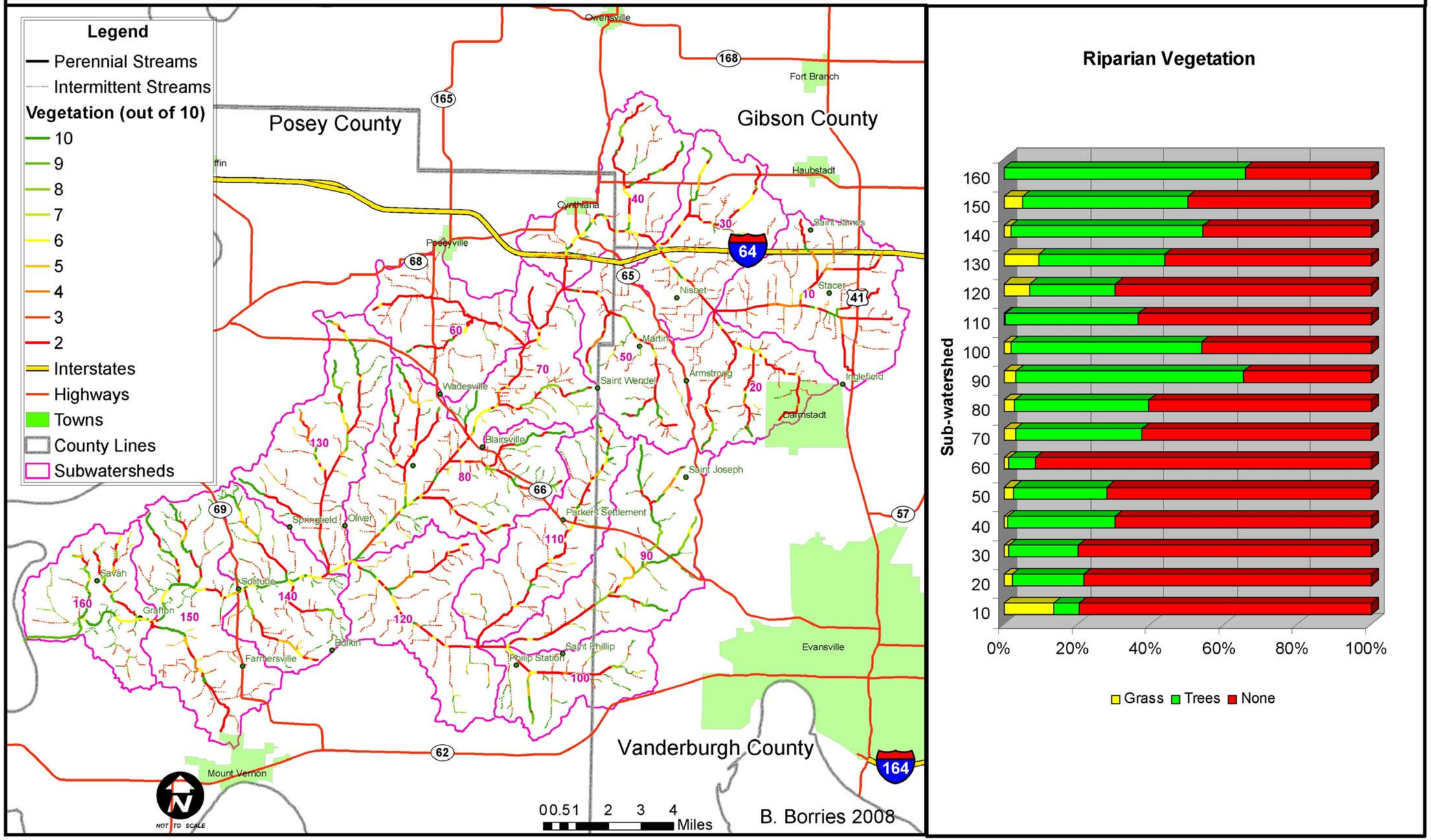


Figure 3.3.1-A: Riparian Vegetation in the Big Creek Watershed

The results of the inventory indicate a great need for riparian vegetation in the Big Creek Watershed. At least 30 feet of a vegetated filter strip is recommended for both pastures and cropland. Riparian vegetation effectively filters sheet flow from pasture and cropland, removing up to 65% of sediment and nutrients. In addition, the areas next to streams have the greatest opportunity for delivery of sediment and nutrients because of their proximity to the stream and taking these areas out of productions keeps them from being sources of direct runoff to the stream.

It is not necessarily true that the sub-watersheds with the most riparian vegetation have the least water quality problems. Steeper, more erodible areas tend to have more riparian vegetation because the land is more difficult to farm. These steeper more erodible areas have more potential for contributing higher pollutant loads and this greater potential may exceed the filtering capacity of the vegetated riparian areas. In addition, larger fields dominate the Big Creek Watershed, creating concentrated flow that moves through vegetated areas without any reduction in pollutants or slowing of runoff. Riparian vegetation works through creating increased infiltration of runoff and is only effective on sheet flows. Concentrated flows must be dispersed in order for the vegetation to slow runoff and filter pollutants. Many fields also have tile drainage and surface inlets that bypass the riparian area all together. Fields with tile drainage and surface inlets such as those used in Water and Sediment Control Basins and pipe drop structures are not as likely to benefit from riparian vegetation. Riparian vegetation also helps slow runoff and intercepts other pollutants such as *E. coli* from residential, commercial, and industrial areas.

3.3.2: Tillage Inventories

Related Problem Groups	*Concerns Validated?*	*Additional Concerns*
Sediment Loading & Soil Loss	**Yes, too much tillage found across the watershed**	
Nutrient Loading and Loss	**Yes, too much tillage found across the watershed**	

The amount of tillage or passes made with disks, field cultivators, and other farm equipment has been shown to affect the amount of sheet and rill erosion that occurs and thus the amount of sediment that enters a stream. To measure this variable, the amount of residue (pieces of corn stalks, soybean pieces, weeds, etc.) or cover remaining after crops are planted in the spring is often used. The most exact way to achieve this mean is to use a string with marks made at regular percentages and count how many of these marks rest on a piece of crop residue, thereby creating an estimated percentage of the field covered by residue. A number of estimating techniques exist to translate this into an estimated soil loss useful in evaluating the field's impact on water quality.

Statewide Tillage Transect

Under the direction of NRCS District Conservationists in each county, a statewide transect is conducted each spring. The numbers are collected and used in a modeling program that estimates the amount of soil loss. These numbers can then be broken down into counties and even 11-digit watersheds such as Big Creek.

Figure 3.3.2-A: Big Creek Watershed Average Tillage Use (1996-2004) shows the average percent of fields using no-till (>90% residue cover), mulch till (50-80% residue cover), reduced till (30-50% residue cover), and conventional tillage (<30% residue cover) based on the 1996-2004 data for corn (lavender bar) and soybean (purple bar). The state average for no-till is shown as a green bar to compare and is 61% for soybeans and 19% for corn. In general, no-till use is lower in the Big Creek Watershed than the rest of the state. Especially notable is the very high amount of conventional tillage exhibited, being the majority for corn and making up almost a third of soybean fields.

Figure 3.3.2-B: Corn Tillage Trends and *Figure 3.3.2-C: Soybean Tillage Trends* shows the changes in the tillage use over these 8 years. In contrast to the rest of the state which saw a 11% increase in no-till on corn fields from 1990 to 2004 and a 52% increase in no-till use for soybeans, no-till use for corn and soybeans is decreasing while conventional tillage use is increasing in the Big Creek watershed.

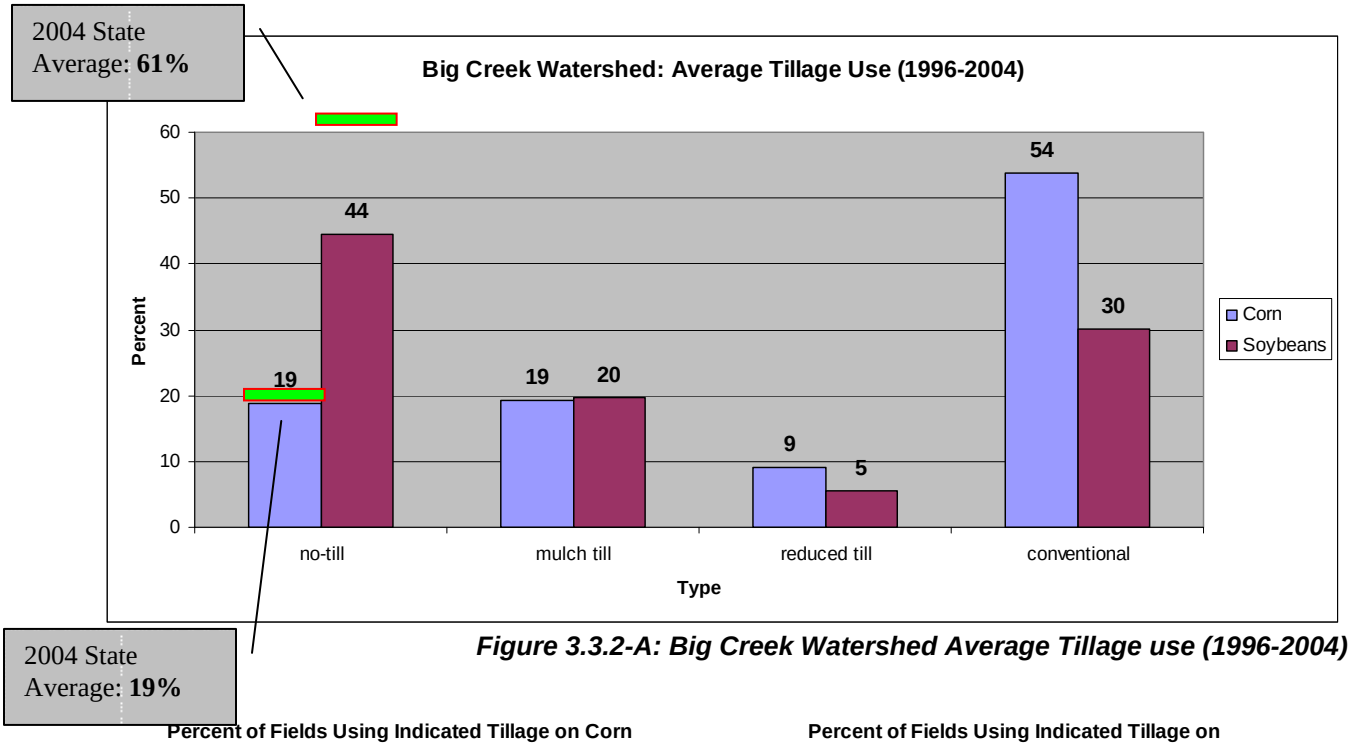


Figure 3.3.2-A: Big Creek Watershed Average Tillage use (1996-2004)

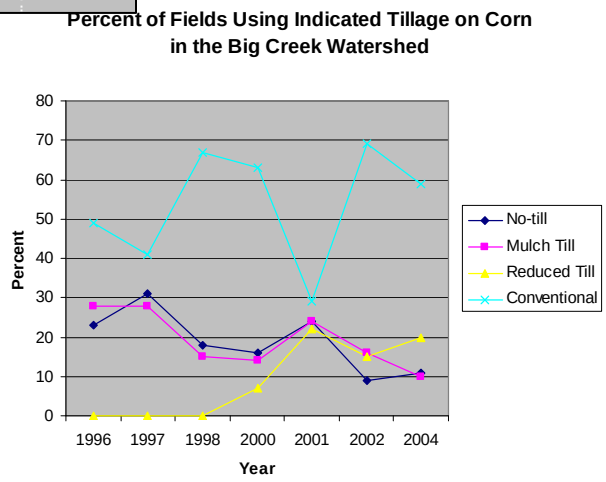


Figure 3.3.2-B: Corn Tillage Trends

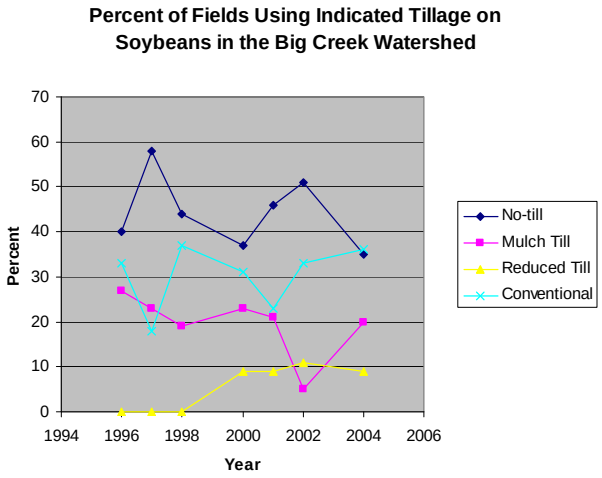


Figure 3.3.2-C: Soybean Tillage Trends

2007 Big Creek Watershed Transect

In an attempt to identify any spatial trends among the 14-digit sub-watersheds in Big Creek, a separate, more comprehensive tillage transect was completed in 2007 in only the Big Creek watershed following the protocols outlined for the statewide transect. The amount of residue for each field was averaged for each sub-watershed. To maintain quality in the data, only sub-watersheds where 10% of the crop acres were sampled are described. The Barr Creek sub-watershed was not inventoried sufficiently to provide quality data and is not included.

A range of 30% was found in the distribution of average residue cover amounts among the sub-watersheds. The lowest amount of cover was found in the Caney Creek (060) sub-watershed and the highest amount was found in the Little Creek-Headwaters (090) sub-watershed.

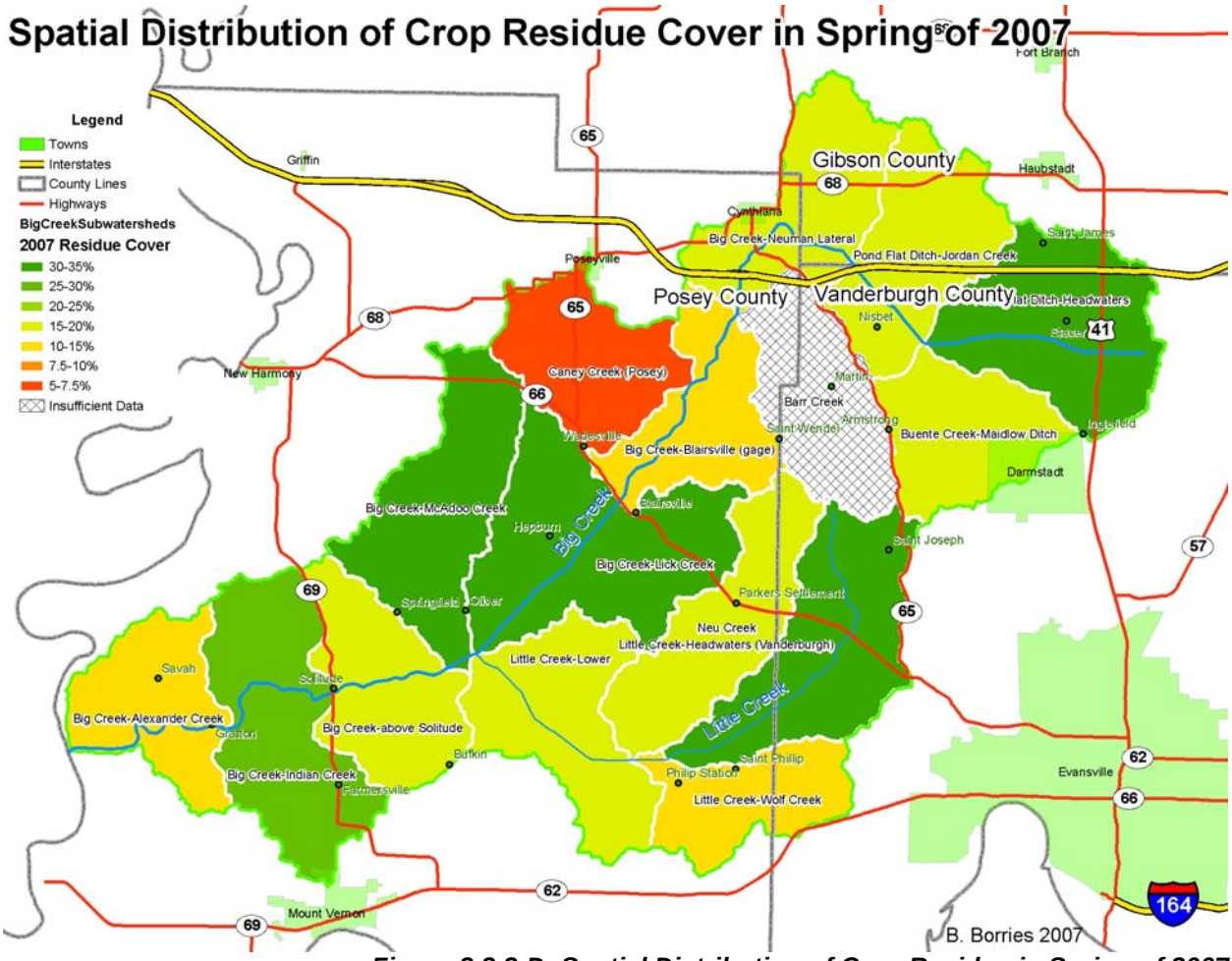


Figure 3.3.2-D: Spatial Distribution of Crop Residue in Spring of 2007

3.3.3: Stream bank Erosion Inventory

During the spring of 2008 an inventory of the integrity and erosion of streams and ditches in the Big Creek Watershed was conducted. Methods described in the Region V Load Reduction Spreadsheet tool were used to estimate a lateral reduction rate. Observation were made from

public road bridges and culverts where possible and from aerial photos in accessible areas. The results of the inventory are shown in *Figure 3.3.3-A: Stream Bank Erosion Inventory.*

Streams were given a relative erosion level of low, low-medium, medium, medium-severe, and severe based on the Lateral Recession Rate. Stream banks with med to severe erosion are considered in need of restoration. Low and low-medium are expected to contribute a much less significant sediment load through the erosion. Streams located in Vanderburgh County have much less erosion than those in Gibson in Posey, especially Posey. This is due partly to the majority of the headwater stream being located in Vanderburgh. This means that less volumes of water are flowing through Vanderburgh County streams and thus much less shear stress is exerted against the bank. Maintenance along Vanderburgh County legal drains is also much more regular and the ditch banks are much more likely to be at an appropriate slope than in Posey and Gibson Counties because of the increased maintenance that has been done over the years. Erosion generally increases downstream on the Big Creek main channel with severe erosion occurring especially after the confluence of Big Creek and Little Creek. Many other factors cause stream banks to become more or less stable on a reach by reach basis including vegetation, peak discharge of the area draining to the reach, stream bank slopes, recent excavation activities, and the apparent down-cutting of the Big Creek main channel.

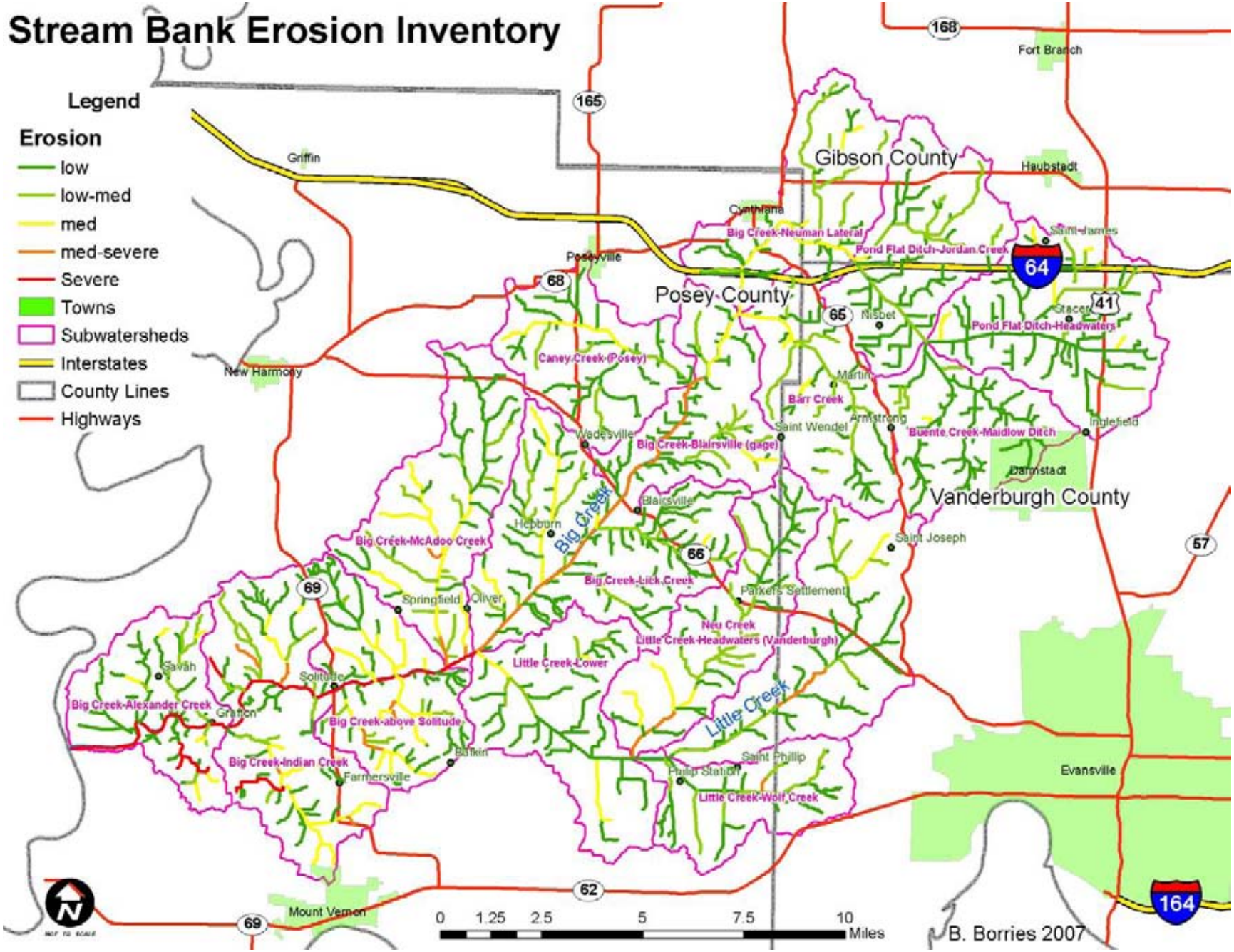


Figure 3.3.3-A: Stream Bank Erosion Inventory

3.3.4: Pastures

After being identified through windshield inventories, aerial photos, and other GIS layers, pastures were further evaluated based on the amount of areas with less than 50% estimated vegetation cover and the length of waterways without exclusion fencing (stream access). The results area shown in *Table 3.3.4: Pastures*

Acres of Pasture	**Acres of Pasture with Bare soil**	**Feet of Cattle Access**
1124	*85*	*12814*

Table 3.3.4: Pastures

3.3.5: Inventory of Erosion and Sediment Delivery

An inventory of erosion and sediment delivery was created using data from the stream bank inventory, an inventory of classic and ephemeral gully sources, and a GIS model, SEDMOD (Spatially Explicit Delivery MODel), that utilizes the RUSLE2 formula (Fraser 1999). The inventory exists as a geodatabase easily summarized at a variety of geographic scales and summarized here by sub-watershed in *Figure 3.3.5-A: Inventory of Erosion and Sediment Delivery.* By comparing sources and water monitoring data with the inventory, measures can be prioritized based on the types of erosion they address, critical land uses and geographic areas can be identified, and a relative scale can be developed for comparing expected reductions from one field to the next.

The stream bank erosion estimate was accomplished using a visual estimation method as detailed in the Region V pollutant load reduction model. Estimated sizes of ephemeral or annual gully and classic gully erosion locations were also put into the Region V pollutant load reduction model to estimate the yearly load. The SEDMOD model uses GIS data including soils data, land use data, and a 10 meter digital elevation model. The LS factor in the RUSLE2 equation comes from the topography. The K factor is part of the soils data and the land use data provides the C factor. The model also estimates sediment delivery as a percent using 6 factors calculated along a flow path to the nearest stream including hillslope curvature, slope, TOPMODEL based wetness, percent clay makeup of soil, proximity to a stream, and Mannings roughness factor. The sediment delivery percent was applied to the sheet and rill estimate and the estimate of ephemeral gullies located outside the riparian areas (Van Remortel, et al 2004).

Figure 3.3.5-A shows a breakdown of the types and amounts of erosion among each sub-watershed. A table is provided to show the numbers that were estimated. A bar graph relates the erosion among sub-watersheds. A pie chart shows contribution of each type of sub-watershed.

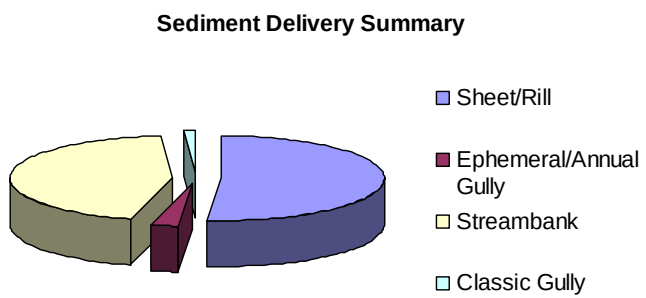
The data as displayed in the figure shows a consistently high sediment load among all sub-watersheds which is agreeable with the water monitoring data that indicates all sub-watersheds exceeding desired levels for turbidity on 10% or more of samples. The sub-watersheds showing the highest sediment load in the inventory are also among those indicated as severely impaired or exceeding desired levels for turbidity on greater than 50% of samples collected.

Among the types of erosion, stream bank and sheet/rill erosion are among the most significant overall, and sheet and rill erosion is consistently high among all the sub-watersheds. This

explains how even though structural best management practices are common among row crop fields, all sub-watersheds are still consistently above the desired level for turbidity. Structural best management practices typically only address class and ephemeral gully erosion, which was found to be a much less significant aspect of sediment loading. On the other hand, the most important management practice in addressing sheet and rill erosion is residue management and as the tillage inventories suggest, residue levels in the watershed are very low.

Estimated Sediment Delivered to Waterways by Sub-watershed

Sub-watershed	Sheet/Rill Delivery in Tons (percent of total)		Annual Gully Delivery in Tons (percent of total)		Streambank Erosion in Tons (percent of total)		Classic Gully Erosion in Tons (percent of total)		Total Delivery
PFD-Headwaters (010)	10720	(87.5%)	342	(2.8%)	1186	(9.7%)	0	(0.0%)	12248
Buene Cr.- Maidlow D (020)	8024	(94.1%)	142	(1.7%)	330	(3.9%)	33	(0.4%)	8529
PFD-Jordan Creek (030)	10381	(74.0%)	681	(4.9%)	2435	(17.4%)	525	(3.7%)	14022
Big Creek-Neuman Lat (040)	9041	(50.3%)	594	(3.3%)	8326	(46.3%)	12	(0.1%)	17973
Barr Creek (050)	11095	(65.9%)	584	(3.5%)	5067	(30.1%)	82	(0.5%)	16827
Caney Creek (060)	6043	(81.8%)	345	(4.7%)	808	(10.9%)	189	(2.6%)	7385
Big Creek-Blairsville (070)	11768	(43.0%)	491	(1.8%)	14301	(52.3%)	806	(2.9%)	27366
Big Creek-Lick Creek (080)	19331	(52.5%)	1277	(3.5%)	15676	(42.6%)	536	(1.5%)	36820
Little Creek-Headwater (090)	10086	(71.9%)	468	(3.3%)	3031	(21.6%)	445	(3.2%)	14030
Little Creek-Wolf Creek (010)	6433	(82.5%)	382	(4.9%)	811	(10.4%)	171	(2.2%)	7797
Neu Creek (110)	10919	(81.6%)	802	(6.0%)	1566	(11.7%)	100	(0.7%)	13387
Little Creek-Lower (120)	10582	(73.0%)	959	(6.6%)	2657	(18.3%)	303	(2.1%)	14501
Big Creek-McAdoo Cr (130)	16135	(57.0%)	1047	(3.7%)	10978	(38.8%)	134	(0.5%)	28294
Big Creek-Solitude (140)	10264	(35.3%)	487	(1.7%)	17968	(61.7%)	390	(1.3%)	29109
Big Creek-Indian Creek (150)	13154	(29.6%)	985	(2.2%)	30210	(67.9%)	157	(0.4%)	44507
Big Creek-Alex Creek (160)	7253	(17.7%)	462	(1.1%)	33237	(81.0%)	89	(0.2%)	41041
	171228	(51.3%)	10049	(3.0%)	148586	(44.5%)	3971	(1.2%)	333835



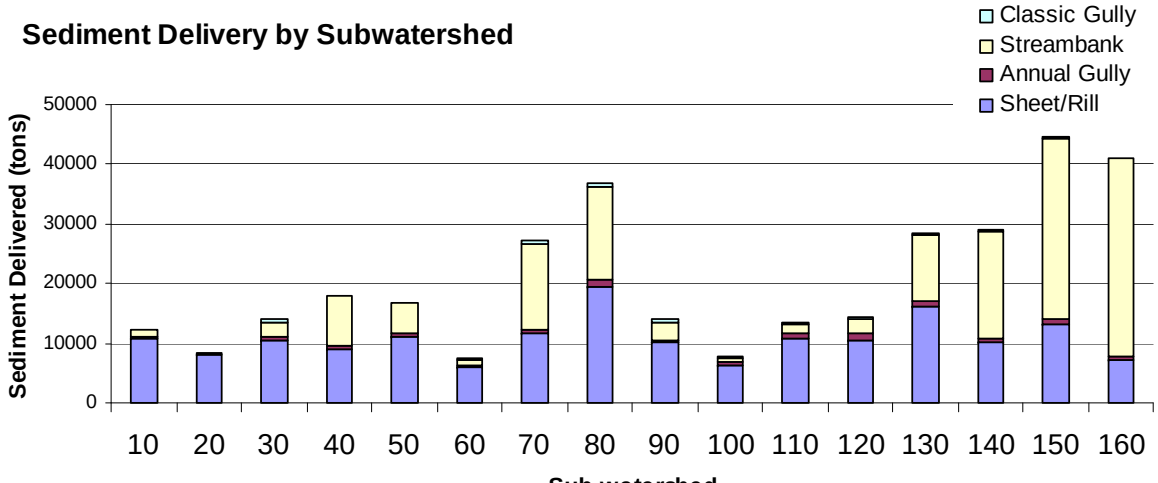


Figure 3.3.5-A: Inventory of Erosion & Sediment Delivery

3.3.6: Watershed Assessment of River Stability and Sediment Supply

To determine the impact of stream morphology and stability on water quality concerns, the Watershed Assessment of River Stability and Sediment Supply (WARSSS) was used following EPA guidance. The WARSSS protocol involves three phases: Reconnaissance Level Assessment (RLA), Rapid Resource Inventory for Sediment and Stability Consequence (RRISSC), and Prediction Level Assessment (PLA). For the purposes of the project it was only practical to work through the second phase. This phase guides the user to the most critical locations so that the Prediction Level Assessment can be focused on the worst sites. The RRISSC provides a risk rating for each site. The RRISSC was conducted for each of the sample points utilizing cross-section data, information about the watershed, and pictures of the site taken throughout the year. The WARSSS process suggests that the PLA be conducted on all sites with a "high" or "very high" risk rating followed by the appropriate remediation actions (USEPA 2008).

Figure 3.3.6-A: Watershed Assessment of River Stability and Sediment Supply in the Big Creek Watershed shows the results of the WARSSS. Sites with a high risk rating are shown in red followed by sites with a moderate risk rating in yellow and low risk rating in green. Most sites had a risk rating of "High" associated with a score of four out of five. Nine sites received a risk rating of moderate or 3 out of 5. Only one site received a low risk rating. All sites on Big Creek main channel received a "high" risk rating. Tributaries of Big Creek entering Big Creek near the lower end of the main channel tended to the highest risk ratings of the tributaries. The most common causes of the high risk rating involved increased runoff and evapo-transpiration due to clearing of natural vegetation without use of appropriate BMPs (i.e. no-till farming), low width/depth ratios, dominance of stream bank vegetation by annual forbs, direct channel disturbances such as building or berms with spoil piles, and general surface erosion. Risk was compounded on many sites by an "unstable" channel shape according to the Rosgen stream classification. Cross-sections at many sites revealed a "G" shaped channel or an "F" shaped channel, shapes commonly associated with channelized stream systems. G and F shaped channels are typically narrow with steep side and are thus prone to bank erosion and down-cutting. Other sites that were not in a G or an F shape, were experiencing erosion patterns that suggested they were evolving to that shape.

Channel instability has other consequences than just stream bank erosion and associated sediment loading. Unstable channels tend to experience unexpected changes in the duration and occurrence of both flooding and saturation, drying out areas that used to be wet and saturating areas that used to be dry. Several wetlands near the unstable channels have been reported drier than in this past. This is most likely a consequence of less flooding into the historic floodplain. In channels experiencing down-cutting, the channel will progress through several stages with an end result of the old floodplain being relocated entirely within the now enlarged historic channel. This causes problems, not only for the stream itself but for the larger river or stream into which feeds. The containment of the historic floodplain within the historic channel results in increased peak flows and serious flooding problems for larger main channels such as Big Creek. Headward erosion is also likely to occur into fields and other upland areas that drain to unstable channels. This causes increased gully erosions, converts sheet flow to concentrated flow, and once again increases the peak flow coming off upland sites.

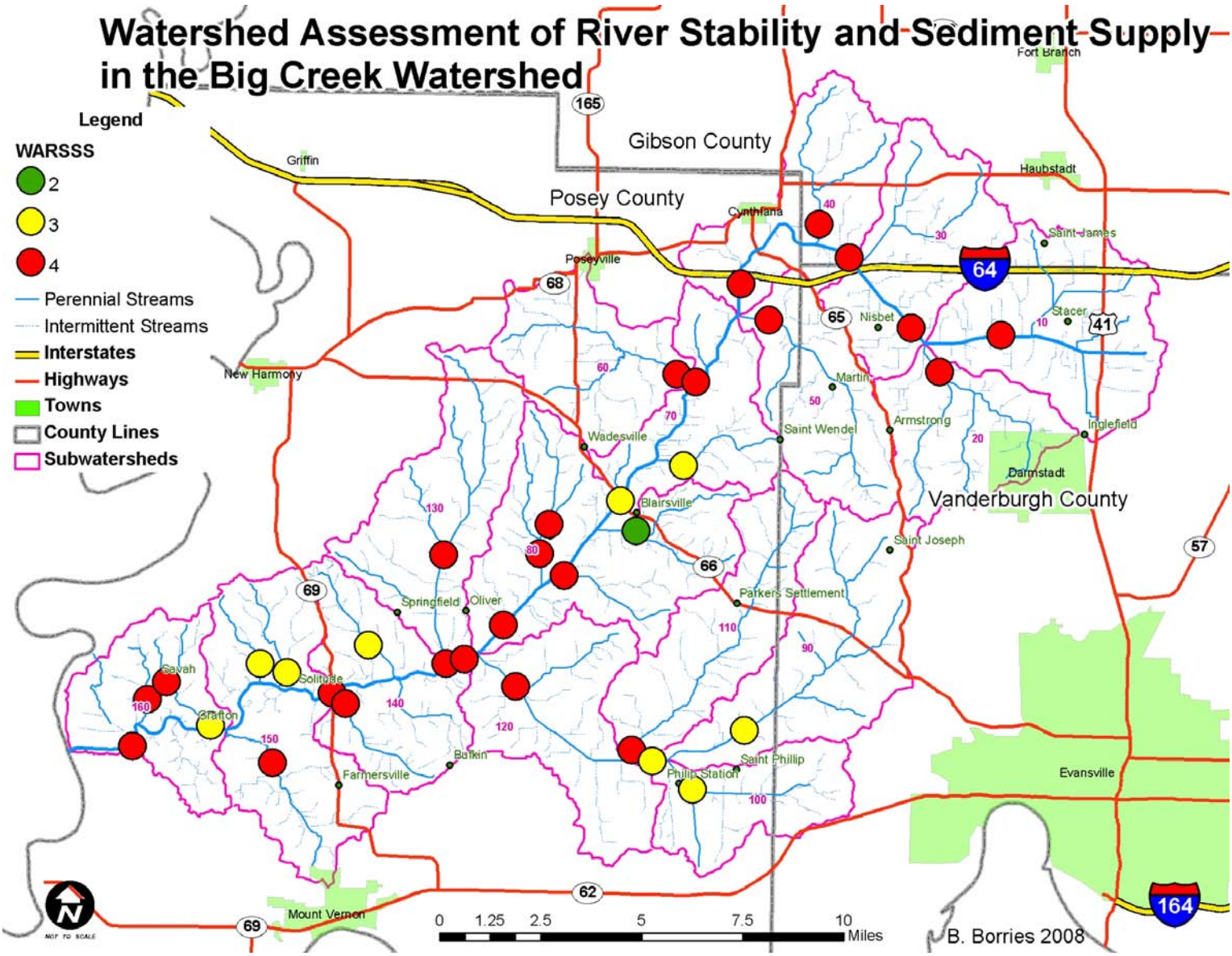


Figure 3.3.6-A: Watershed Assessment of River Stability and Sediment Supply

Related Problem Groups	*Concerns Validated?*	*Additional Concerns*
Sediment Loading & Soil Loss	**Yes, more structures needed at waterway openings and where farms wash into creeks to control near bank gully erosion**	**WaSCoBs may be increasing amount of nitrate loading** **Condition of existing structures** **Need for BMPs focused on filtering of water soluble contaminants**
Nutrient Loading and Loss	**Yes, most BMPs are not focused on reducing loading of water soluble nitrate**	

Using aerial photos, field inspections, and the United States Department of Agriculture database of Conservation Reserve Program and Environmental Quality Incentive Program participants, a database of the existing agricultural best management practices was compiled. A map has been created showing the location of the practices within the watershed. *Figure 3.4-A: Agricultural Best Management Practices* shows the location of these practices which include terrace (including parallel tile outlet systems) shown as red circles with a black center, Dry dams (alternately called water and sediment control basins or WaSCoBs) illustrated as hatched areas for the entire fields that contain a system of risers and tile, grassed waterways shown as dark blue outlined fields, and filter strips shown as green lines outlined in black.

Structural BMPs including filter strips, grassed waterways, and WaSCOBs are common throughout the watershed anywhere row crops exist. Some terraces can be found, mostly in the Pond Flat – Headwaters Sub-watershed. Overall, there are 57 fields with grassed waterways, 112 filter strips, 371 fields with WaSCoBs, and 29 terrace systems. Despite the number of row crop fields with BMPs, water quality impairments related to agricultural runoff still prevail. In section 3.3.5, a sediment inventory details the types of erosion and their estimated relative contribution to the total sediment load. The most significant types of erosion include sheet/rill erosion and stream bank erosion. While all the BMPs indirectly affect stream bank and sheet/rill erosion, none, except for terraces address either directly. Sheet/rill erosion is best addressed through agronomic practices such as residue management, contour tillage, and cover crops. The most common BMP, WaSCoBs, are mostly designed to control ephemeral and classic gully erosion. Filter strips help stabilize stream banks and filter some runoff, but are only effective at filtering sheet flow and most fields are so large that concentrated flow is common across filter strips. Grassed waterways also provide some filtering, but are mostly designed to control ephemeral and classic gully erosion.

The most common BMPs are also not effective at controlling dissolved pollutants such as nitrate. Filter strips designed for controlling erosion should be at least 50 feet in width and are only effective at filtering runoff as sheet flow. Filter strips of this width are very uncommon in the watershed. Grassed waterways and WaSCoBs can actually increase nitrates in runoff and terraces don't affect nitrate loading either way.

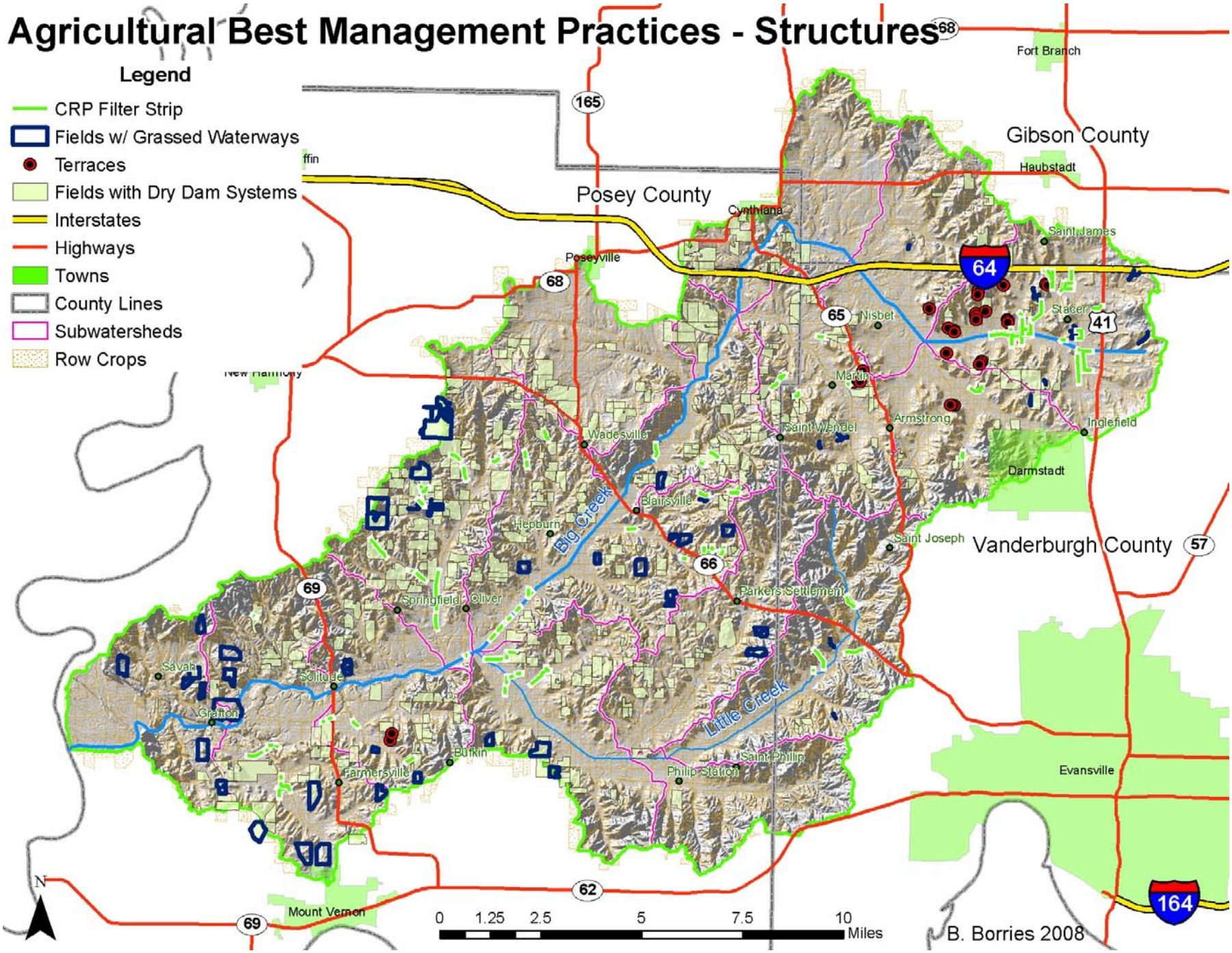


Figure 3.4-A: Agricultural Best Management Practices

3.5: NPDES and IDEM Land Application Permit Information

Related Problem Groups	*Concerns Validated?*	*Additional Concerns*
Pathogens	**No, permit operators do not report *E. coli* levels**	**No *E. coli* levels are reported by the operators**
Excessive Nutrient Loading and Loss	**Yes, two operators reported violation in the concentration of ammonia nitrogen in the effluent**	

As shown in *Figure 2.4.5-A: National Pollution Discharge Elimination System Permit Locations,* there are 6 NPDES permitted pipe discharges within the Big Creek Watershed. These are considered "point sources" of pollution. Operators of these permitted facilities must monitor and submit information about the discharges that come from these pipes and adhere to minimum or maximum levels of pollutants and other parameters in the water that is discharged from the locations. Information about these levels and any recorded violations can be accessed via the Environmental Protection Agencies website. Three of the six NPDES permit operators reported violations since obtaining permits. AC Ranch Mobile Home Park located in the Neu Creek sub-watershed reported 2 violations in 2005 for exceeding the maximum concentration for ammonia. Wells Town & Country Estates located in the Little Creek – Headwaters Sub-watershed reported 7 violations for dissolved oxygen concentration during 2003 & 2004. It also reported 8 violations for ammonia from 2003-2005. Ameriqual, located in the Pond Flat Ditch – Headwaters reported 2 violations for temperature both in 2006. Past violations cannot be linked to any current water monitoring data as the pipes with nutrient violations do not drain to sample points where concentrations were significantly higher than other sites, but violations in dissolved oxygen and ammonia concentrations have the potential to create water quality problems downstream related to excessive nutrient loading and loss. Testing for *E. coli,* an indicator for pathogen related concerns, is not required by any of the permit holders. It may be a contaminant of concern since *E. coli* is commonly associated with wastewater facilities.

3.6: Indiana State Department of Health: Unsewered Communities Report

Related Problem Groups	*Concerns Validated?*	*Additional Concerns*
Pathogens	**Yes, local health departments report problems surrounding areas without centralized wastewater treatment and monitoring events showed *E. coli* "hotspots" near the towns**	
Excessive Nutrient Loading and Loss		

The Unsewered Communities Report is the result of a survey of local health departments conducted by the Indiana State Department of Health and the Rural Community Assistance program. Its purpose is to identify communities for assistance with outstanding sewage disposal problems. The local health departments were asked to list the top ten communities with sewage problems that don't have a collection system and a centralized wastewater plant. The results are shown in *Figure 3.6-A: Unsewered Communities.* In the figure, green bars indicated the number of homes with wastewater issues and the blue bar indicates the number of businesses with wastewater issues. Saint Joseph was the only community listed in Vanderburgh County within the watershed and is said to have 35 homes and 3 businesses. In

Posey County, Wadesville is listed as having 75-100 homes, Blairsville is listed as having 40 homes, and Parkers Settlement is listed as having 25 homes. No communities listed in Gibson County were within the boundaries of the Big Creek Watershed (ISDH and RCAP 2007).

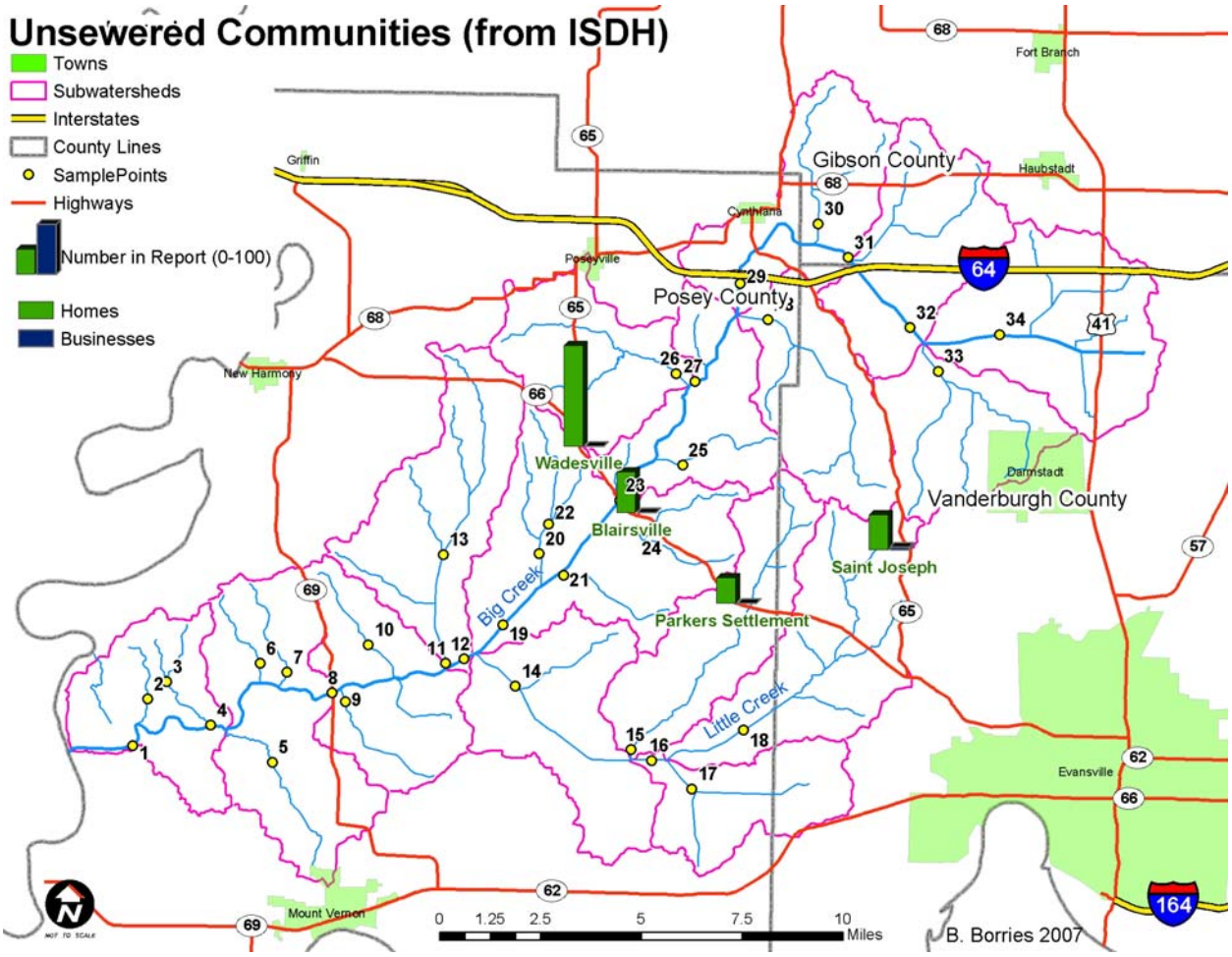
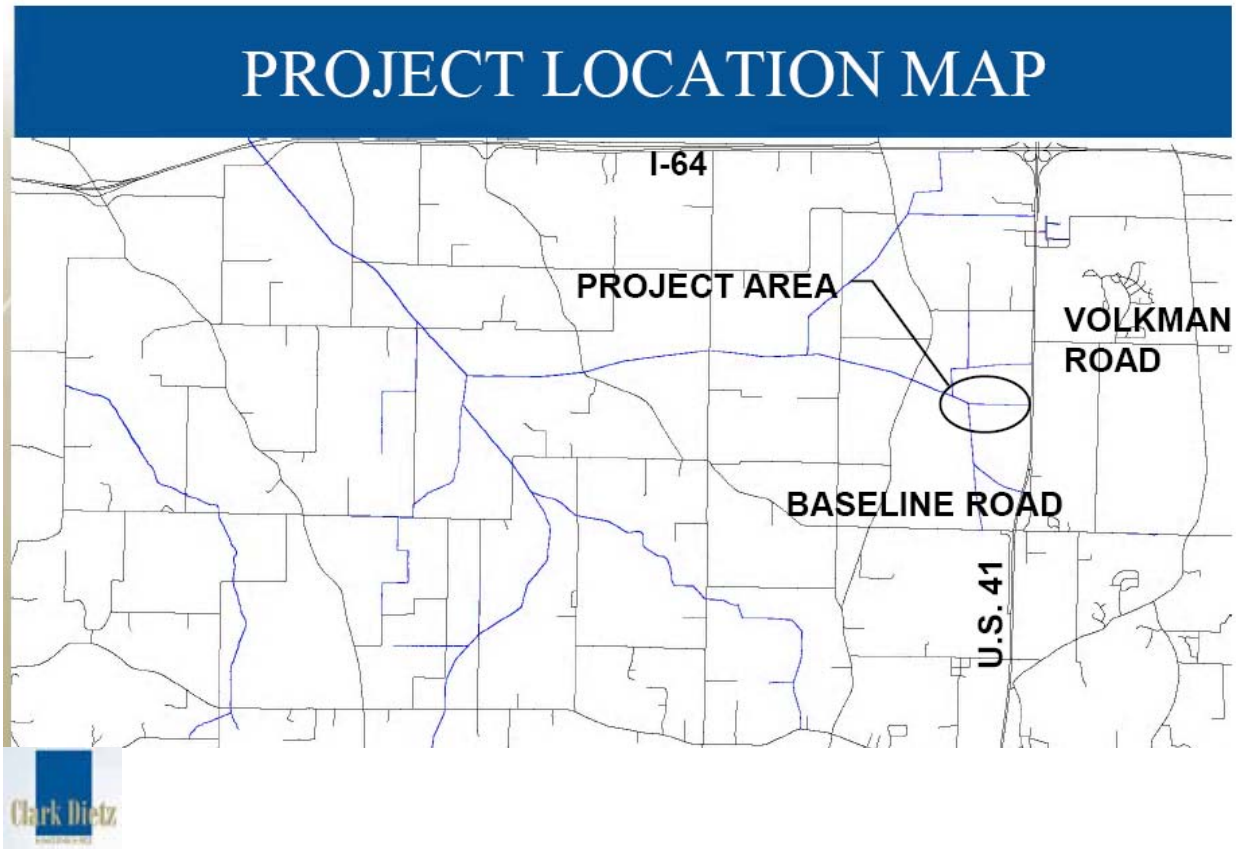


Figure 3.6-A: Unsewered Communties

Homes within the communities listed in the report are likely to have inadequate septic systems that may fail causing loading of pathogens and nutrients to waterways, showing up in the water quality data as high *E. coli,* nitrate, orthophosphate, ammonia or ammonium. Contaminants originating from these sources are likely to be encountered in higher concentrations after a gentle rain or during dry seasons rather than storm events since the contaminants would most likely travel through pipes or subsurface flows independent of overland runoff. This type of event did yield high levels of *E. coli* during one sampling round on sample point 15 downstream of Parkers Settlement (500 colonies/100 mL on 4/19/07), and on sample point 23 near Wadesville and Blairsville during 3 rounds (495 colonies/100 mL on 7/31/07, 429 colonies/100 mL on 9/11/07, and 650 colonies/100 mL on 10/9/07). It should be noted however, that pastures, an additional source of pathogens, exist upstream of both sample points and could contribute part or all of the pathogens detected. Their magnitude and location are discussed later.

3.7: Report on Pond Flat Main Ditch: May 5, 2007

Related Problem Groups	*Concerns Validated?*	*Additional Concerns*
Channel Quality	**Yes, model in report shows railroad bridge in floodway of Pond Flat Main Ditch with or with out increase in ditch size**	



The Vanderburgh County Surveyor's office commissioned a study to determine the cause of the flooding and alternatives in response to complaints about the Pond Flat Main Ditch breaching its banks during storm events more frequently than a 10-year design storm. The study evaluated mainly the one obstruction caused by a railroad bridge 1 mile west of Highway 41 North. The study evaluated only options that would increase the channel depth and width including a "two-stage" ditch design. None of the options created enough flow area to keep floodwaters from breaching the ditch's banks except when the railroad bridge was removed.

3.8: Interviews

3.8.1: Interview with Septic System Repair & Maintenance Contractors

Related Problem Groups	*Concerns Validated?*	*Additional Concerns*

Pathogens	**Yes, local contractors report 300 repairs a year, but claims residents only repair after a neighbor notices and threatens action**	
Excessive Nutrient Loading and Loss		

Interviews with local excavators and health department staff provided important information about septic system maintenance. During an interview with one excavator, concerns about septic systems were confirmed. The excavator, who works primarily in the Big Creek Watershed reported that many septic systems that are serviced are only serviced after complaints by neighbors. On the other hand, operators of another company that performs pump-outs reports pumping out over a hundred septic systems a year, which is a significant number but indicates that some are not pumping septic systems as regularly as is normally recommended.