Recommended Measures & Estimated Load Reductions

6.1: Agricultural Sustainability

Improving agricultural sustainability will achieve excessive soil loss and sediment reduction goals as well as nutrient loading and loss goals. This measure benefits water quality primarily by keeping soil and fertilizer on the field through reduced erosion and runoff and increased utilization of nutrients by row crops or cover crops.

Objectives in this measure ranked high in surveys of the steering committee and were popular ideas at steering committee meetings because they have the potential to bring long term benefit to the landowner, increasing their likelihood of adoption. The objectives include achieving *Tolerable* soil loss on all fields, increasing the amount of cover crops or other crop rotations that have near year round cover, nutrient management best practices, and installing erosion control structures. Information from the NRCS eFOTG and contacts with NRCS were used extensively in developing the recommendations.

Local farmers and other members of the community working in cooperation with the Big Creek Steering Committee will host field days and public events to increase public awareness and encourage participation. They will either promote the practices or share what didn't work. Other components of the outreach include newsletter articles and other printed materials that are pertinent to local issues and include the yield and costs that were encountered in the demonstration project. A packet of information should also be sent out to landowners in the priority areas including aerial imagery of their farm, locations of critical issues to address, and the cost to address them. One-on-one technical support will also likely be needed to assist landowners trying something for the first time.

6.1.1: Tillage Systems: Achieving Tolerable Soil Loss

Goals Addressed:

- Sediment Loading to Streams and Loss from Fields: Total Suspended Solids target
- Nutrient Loading to Streams and Loss from Fields: Nitrate target

Tolerable soil loss or *T* is a value in tons per acre per year defined by the Natural Resource Conservation Service based mostly on the slope, soil erodibility, and soil depth. It refers to the maximum allowable soil loss that a field can incur without affecting productivity. Achieving *T* on all fields is the most cost effective solution to the sediment loading and soil loss problem because it will actually increase productivity, and in many cases carries no cost to the landowner.

T Values for row crop fields in the Big Creek Watershed range from 2 – 5 tons/acre/year. About 5% of fields have a *T* value of 2 tons/acres/year, less than 1% of fields have a *T* value of 3 tons/acre/year, 20% of fields have a *T* value of 4 tons/acre/year, and 80% of fields have a *T* value of 5 tons/acre/year.

Using a spatial rusle2 model, the number and location of fields in excess of *T* was determined. Overall, 2,739 fields and 50, 619 acres of row crops were found to be losing soil above the tolerable level. By solving for the cover management factor of the RUSLE2 equation based on the landscape of each field, the necessary cover requirement was also determined. This equation is shown below:

C = Soil *T* value / (R X K X LS)

Using the necessary C factor, the fields were grouped into classes based on the management required to achieve the tolerable level of soil loss. The classes are described below:

- Class A – No-Till + Cover Crops, Forage Rotations, Contour Farming, or Minimal Disturbance Planters and Fertilizer Applicators (C < 0.067)

  Class A represents the steepest, most erodible fields with the lowest T values. These fields must be aggressively managed to achieve T. Even with cover crops or contour farming, the use of minimal disturbance planters & fertilizers such as narrow slot planters, drills with single disk openers, high pressure injection coulter fertilizer applicators, or planter mounted fertilizer banding is highly recommended. When diversions are combined with contour farming or a forage crop harvested allowed to continue growing through the winter is included in a rotation, conventional drills and fertilizer applicators will achieve necessary residue levels, saving on the cost of purchasing or leasing new equipment. If no cover crops, forage rotations, or contour farming is used in a corn-soybean rotation, two years of corn should be planted for every year of soybeans for additional residue. A corn-double cropped soybean & winter wheat rotation will meet needed residue levels when no-tilled with minimal disturbance planters and fertilizer applicators.

- Class B –No-till/Strip-Till with Conventional Applicators, High Residue Tillage with Cover Crops, or Crop/Pasture Rotations (0.067 < C < 0.11)

  Class B represents highly erodible fields that are moderately steep or have a very low T value. Tillage on these fields should be kept at a minimum. No-till is preferred, but fall or spring strip-till may be adequate for some rotations and fields. Moderate tillage may be done with “turbo-till” type equipment and other seedbed finisher combination tools, provided cover crops are planted at least after soybeans and minimal disturbance planters and fertilizer applicators are used. Corn-double cropped soybean & wheat rotations can be used to maintain T on these fields with conventional planters and fertilizer knife applicators as long as the only tillage used is a light disking to a depth of 2 inches after corn and before winter wheat. On fields using a continuous corn rotation, strip-till is an effective method to achieve T while conditioning the seedbed and warming the soil where seeds will germinate. High residue cultivators such as rotary hoes can be used to mechanically control weeds with rotations involving cover crops, saving on chemical costs.

- Class C – No-till soybeans, High residue conservation tillage before corn, or winter cover (0.11 < C < 0.16)

  Class C represents fields that may be moderately steep, but have a T value of 4 or 5. Many fields in this class will still benefit greatly from any of the rotations, tools, or methods listed for Class B and Class A, but such practices are not absolutely necessary to continue farming sustainably. The costs of new equipment or additional herbicides may outweigh the soil saving benefits on these more gently sloping fields. Spring disking can be used with cover crops or before corn planting, providing mechanical control of weeds and incorporation of a “green manure” crop to be used as a nitrogen source. However, soybeans should almost always be no-tilled. Combination tools and other “turbo-till” type equipment may be used to prepare the seedbed before corn in corn-double cropped winter wheat & soybean rotations and still achieve a tolerable soil loss. Strip-till methods can be used on these fields even with knife applicators and conventional drills or planters.

- Class D – Conservation Tillage: 20% (soybean) or 30% (corn) residue cover at planting: No-till Corn OR Soybeans, Spring OR Fall Tillage (0.16 < C < 0.22)

  Class D represents fields that can achieve tolerable soil loss with a moderate amount of tillage. These fields may be somewhat steep, but have a high T value. Farmers in these fields must maintain 30% residue cover at planting after corn and 20% residue at planting after soybeans. Despite being some of the more gentle slopes or deeper soils, care must still be taken to maintain these residue levels. Except with some fields using a continuous corn rotation or where winter cover exists, both spring & fall tillage is not recommended with most rotations. Chisels, field cultivators and disks may be used to control weeds and prepare the seedbed on many fields without compromising sustainability, provided tillage does not occur before both corn and soybean plantings.

Locations:

Figure 6.1.1-A: Fields Estimated to be Losing Soil Above T shows the location of the fields that are expected to be losing soil at a rate above the tolerable soil loss for the dominant soil type of each field. Locations were identified using soils data, a digital elevation model, and residue cover estimates from windshield inventories.

Load Reductions & Cost:

Reduction in sediment loading to streams was estimated using a spatially explicit RUSLE2 model described in *Section 3.3.5*. Average values of sediment loading tons/year were determined for each field and the total was determined for each sample point region. A percent contribution was in turn determined for each field by dividing the sediment load from the field by the total sediment load for the sample point region. The *T* value for each field was assumed to be that of the *T* value occupying the majority of the field. The overall load reduction from achieving *T* was calculated as the percent difference between the tolerable soil loss level and the current soil loss level multiplied by the percent contribution of each field. The load reduction for each field achieving *T* was summed to get the total load reduction for each sample point region.

Percent Contribution (%) = Land Unit Load[tons/year] / Region Load [tons/year]

Overall Load Reduction (%) = (Current Load [tons/year] – T value for Field [tons/acre/year] * Field Area [Acres]) * Percent Contribution (%)

Table 6.1.1-A: Reductions with Tolerable Soil Loss Achieved details the progress towards the needed reductions detailed in chapter 5 if all fields achieve *T.* The amount needed and the cost is also provided. By achieving this measure, necessary reduction in soil loss will be met for sample point regions, 4, 8,10, 13a, 15, 16, 17, 20. The cost according to the NRCS eFOTG Indiana Annual Cost Calculator of No-till farming is $20/acre. This may include purchasing, modification, or leasing of new equipment; increased chemical or increased fertilizer costs; or additional management costs.

Other Impacts:

Reducing tillage passes result in savings in fuel costs and labor costs. The savings in fuel costs and labor costs usually meets or exceeds the extra no-till costs described above so that no-till or reducing tillage passes usually carries no overall cost to the farmer or carries an overall benefit.

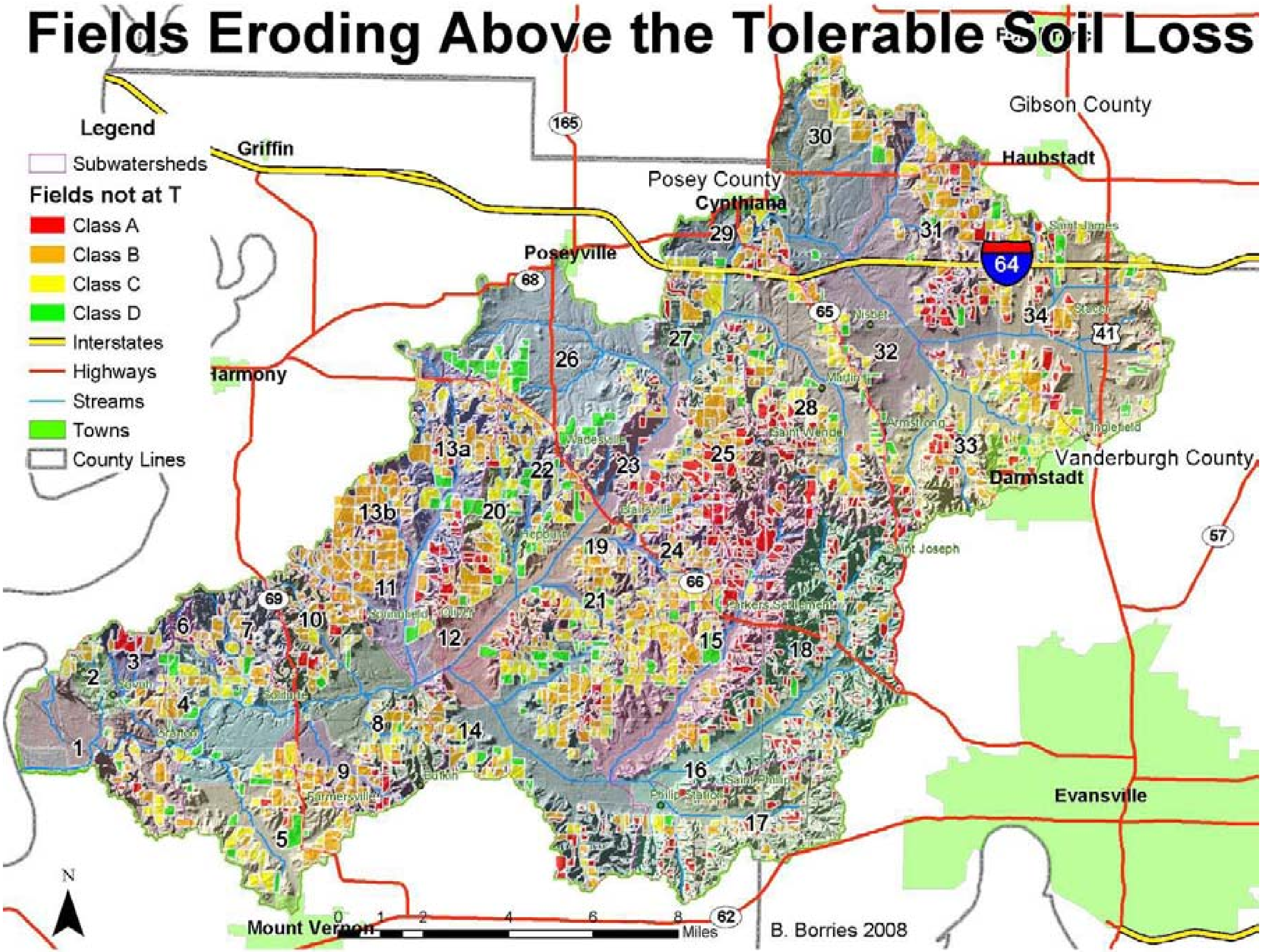


Figure 6.1.1-A: Fields Eroding Above Tolerable Soil Loss

Reductions with Tolerable Soil Loss Achieved

Region/ Sample Point	Needed Sediment Reduction	Total Fields	Total Acres	Total Reduction	Class A Fields	Class A Acres	Class A Reduction	Class B Fields	Class B Acres	Class B Reduction	Class C Fields	Class C Acres	Class C Reduction	Class D Fields	Class D Acres	Class D Reduction
2	**69.80%**	22	211	14.6%	1	3	0.4%	11	131	12.1%	6	58	1.8%	4	19	0.3%
3	**49.20%**	13	450	31.5%	7	267	29.7%	1	55	0.2%	4	88	1.6%	1	40	0.0%
4	**11.4%***	63	1829	13.1%	2	20	0.1%	27	679	8.4%	23	775	4.2%	11	354	0.3%
5	**82.50%**	77	2221	19.6%	8	112	1.5%	34	943	11.5%	23	720	5.6%	12	446	1.0%
7	**60.20%**	59	955	28.3%	17	191	11.2%	26	491	14.1%	15	220	2.7%	1	53	0.4%
8	**25.1%***	94	1633	17.5%	36	436	11.3%	40	797	5.2%	15	313	0.9%	3	87	0.1%
9	**68.50%**	49	1044	24.7%	15	239	6.6%	25	592	15.3%	9	213	2.8%			
10	**19.80%**	38	813	30.0%	11	207	10.9%	23	539	17.2%	2	54	1.7%	2	13	0.1%
11	**62.9%***	77	2245	28.1%	19	399	5.3%	43	1551	21.6%	11	194	1.1%	4	101	0.1%
12	**60.7%***	47	1094	8.9%	17	232	3.9%	15	442	2.8%	10	260	1.6%	5	161	0.5%
131	**29.60%**	116	2632	38.3%	31	551	16.1%	50	1046	16.5%	24	483	4.6%	11	552	1.1%
132	**63.00%**	42	1415	31.1%	5	75	4.0%	30	1219	25.5%	6	112	1.6%	1	10	0.0%
14	**82.1%***	186	3686	31.5%	33	451	6.7%	76	1568	15.9%	50	1106	7.3%	27	561	1.6%
15	**6.80%**	220	4393	48.8%	97	1664	31.1%	48	1058	9.5%	51	1087	7.1%	24	583	1.1%
16	**13.7%***	47	609	25.5%	22	193	16.1%	14	199	4.7%	7	157	4.3%	4	61	0.4%
17	**31.20%**	183	1569	46.9%	106	769	30.7%	48	475	10.9%	22	220	4.4%	7	106	0.9%
18	**56.60%**	308	2754	40.0%	237	1988	33.6%	53	579	5.7%	14	134	0.6%	4	52	0.1%
20	**17.30%**	38	1133	29.4%	5	88	5.4%	8	268	5.9%	15	459	14.0%	10	318	4.1%
21	**87.50%**	94	1834	35.8%	7	75	3.2%	28	568	15.3%	44	956	15.0%	15	235	2.2%
25	**87.50%**	80	1749	46.0%	37	784	28.7%	25	645	14.1%	12	233	2.7%	6	88	0.6%
26	**65.40%**	61	1483	13.3%	7	47	1.1%	17	216	3.5%	22	466	6.0%	15	754	2.7%
28	**60.70%**	231	3631	42.0%	92	1142	25.4%	57	918	10.0%	57	1079	5.4%	25	491	1.3%
30	**50.00%**	41	1068	14.6%	6	79	1.3%	19	516	8.8%	14	379	4.5%	2	94	0.1%
31	**71.2%***	160	3096	32.7%	52	686	13.5%	60	1101	13.0%	34	928	5.4%	14	382	0.8%
33	**73.10%**	193	2954	47.6%	88	1159	27.6%	41	635	9.7%	49	966	9.3%	15	193	1.1%
34	**64.50%**	200	4119	32.2%	75	1343	14.0%	47	954	9.2%	42	1086	7.0%	36	735	2.1%
Total		2739	50619		1033	13200		866	18187		581	12744		259	6489	
Cost – Low:		**$0**			No-Till		**$0**	No-till/Strip Till		**$0**	Residue Management		**$0**	Residue Management		**$0**
Cost – High:		**$1,438,166**			No-till/Strip Till + Contour Farming + Crop Consulting + Cover Crops = $41/acre		**$541,186**	Residue Management + Consulting + Cover Crop = $29/acre		**$527,409**	Residue Management + Consulting + Cover Crop = $29		**$369,572**	Residue Management		**$0**

	Additional Nitrate Reductions from Cover Crop Use in Class A fields																									
Sample Point Region	1	2	3	5	8	9	10	11	12	131	132	14	15	20	21	22	24	25	26	27	28	29	30	31	32	33	34
Needed Nitrate Reductions	18.6%	27.9%	48.6%	52.0%	11.3%	35.6%	20.8%	23.0%	57.7%	59.0%	62.3%	19.1%	2.1%	28.5%	30.7%	27.6%	19.1%	42.7%	47.3%	7.0%	36.9%	11.8%	52.5%	18.3%	3.0%	27.7%	56.6%
Total Nitrate Reduction	0.9%	0.2%	12.3%	1.0%	5.9%	4.7%	6.6%	4.4%	4.6%	6.1%	2.2%	3.1%	13.6%	1.8%	1.9%	1.4%	13.2%	19.7%	0.2%	4.7%	9.2%	2.0%	1.0%	4.4%	7.8%	12.0%	8.5%

Table 6.1.1-A: Reductions with Tolerable Soil Loss Achieved

Nutrient Loading to Streams and Loss from Fields: Nitrate target

Introduction:

Nutrient management planning is applicable to all land where soil amendments are applied. A plan is developed to address the timing, location, methods, and amounts of nutrient applications involving nitrogen, potassium, and phosphorous. After determining a reasonable yield from historical yields and soil productivity, recommendations are made concerning nutrient applications based on all potential sources of nutrients and considering environmentally sensitive areas. By reducing application amounts, or modifying timing, methods, and location based on potential risks, nitrate and orthophosphate loading can be reduced.

The NRCS Offsite Risk Index evaluates the potential for nutrient loading to streams using eight categories: wind erosion, water erosion, surface runoff class, nitrate leach index, subsurface drainage potential, flooding frequency, soil phosphorous level, and distance to waterbody. Wind erosion is not a major concern and little information is available about soil phosphorous so this section will deal mainly with the remaining risk factors. Many measures have already been discussed including: achieving tolerable soil loss, filter strips, cover crops, and measures to control erosion are also important in addressing the risk factors. This section will focus on measures not previously discussed.

- Water Erosion: RKLS

  The water erosion risk factor is based on the R, K, and LS factors. Fields at a high risk due to water erosion generally have a R * K * LS value higher than 37. These are very similar to the fields listed in the achieving tolerable soil loss sections. The goal in areas at risk due to water erosion is to reduce the detachment and transport of sediment, reduce nutrient application when field is not achieving T, and use fertilizer application equipment that preserves residue.

- Surface Runoff Class

  The goal in these areas is to decrease runoff by increasing infiltration and diverting water runoff and reducing slope length. Water diversion and changes in slope length generally requires structures, and measures that increase infiltration through improving soil quality by reducing soil compaction and creating additional soil pore space. Soil compaction may be reduced through avoiding traffic when soil is wet, modifying equipment, and tillage techniques. Incorporation of fertilizer may be beneficial on soils not prone to erosion. Increasing soil organic matter is important in addressing both compaction and pore space. Fertilizer application should be reduced in high runoff areas and especially areas of concentrated flow.

- Nitrate Leaching Index

  The goal in these areas is to tie up nitrogen and reduce leaching. This is accomplished almost solely by agronomic practices. Realistic yield goals should be established and fields should be fertilized accordingly. Legume and other green manure nitrogen credits should be used when determining fertilizer rates. Split applications should be used to apply fertilizer as close to utilization as possible. Pre-side dress nitrate testing should be used to ensure the proper application rate. Changes in crop rotations may also be beneficial to increase utilization of nitrogen and over all application rates should be reduced.

- Subsurface drainage potential

  Subsurface drainage potential is affected by natural soil conditions, the presence of drainage tile, and the presence of surface inlets such as those found in WaSCoBs. The goal in addressing these areas is to decrease loss through the field tile. This may be done through any of the methods listed in the section dealing with nitrate leaching index as well as avoiding or reducing application near tile lines and especially near surface inlets. Areas surrounding surface inlet in WaSCoBs also experience reduced yields and nutrient application should be reduced or eliminated accordingly. The most benefit would be obtained by maintaining permanent cover in a 20 foot buffer around the inlet. Seasonal control of water levels in subsurface tile and constructing wetlands at the outlets are also effective post treatment measures but have less benefit to the farmer.

- Flooding Potential

  Fields at risk for this factor are recommended to consider conversion back to wetlands or natural floodplain. Alternatively, the worst hit areas should consider permanent cover or other practices that control erosion. Otherwise, fertilizer should only be applied during month when flooding is unlikely and should be injected or otherwise incorporated. Surface nutrient applications should not occur.

- Distance to waterbody

  At high risk in this category are fields that are less than 30 feet from a waterbody. Other than diversion and vegetated filter strips, other measures for this risk category include reducing application near the stream, using setbacks, and avoiding surface applications of nutrients.

Locations:

Figure 6.1.2-A: Nutrient Management Planning – Offsite Risk Index shows the location of the fields that are in need of a nutrient management plan to address nutrient risks. This is layered on top of the sample point regions (coded with pastels to distinguish one region from another). Fields are color coded based on the number of risk factors that are present. A gradient of colors details the amount of risk factors present. Green fields have the least risk factors (one factor), red have the most (five factors) and yellow fields represent the median (three factors). Fields with the most risk factors are likely to benefit the most from nutrient management practices, but may also need more measures to obtain the same level of nutrient loading as a similarly sized field with fewer risk factors.

Load Reductions:

When determining load reductions for nutrient best managed practices, it was assumed that every field where practices were applied could reduce nitrate loading by 20%. To estimate the reduction on a field by field basis, each field was assigned a yearly runoff value in volume of runoff per acre using the RUSLE2 program, soils, and cropping data. The event mean concentration was estimated to be 10 mg/L from water monitoring data. The event mean concentration was applied such that a yearly load could be determined from each field by multiplying the runoff volume by the event mean concentration. A total load was determined for each sample point region and the percentage contribution of each field was in turn found by dividing the load of the field by the total load of the sample point region. The percent contribution of each field was multiplied by the 20% estimated reduction to get an estimated reduction for each field that could then be summed to get the total reduction for each sample point region based on the number and location of fields adopting the practice. *Table 6.1.2-A: Nutrient Best Management Practices Load Reductions & Cost.* A cost of $20/acre is assumed based the NRCS eFOTG Indiana Average Annual Cost Calculator.

Annual Nitrate Load [lbs/year] = [Annual Runoff [L/Acre • year-1] * Event Mean Concentration [mg/L] * Land Unit Area [Acres] * Correction Factor [lbs/mg]

Other Impacts:

Nutrient management planning will have mostly positive impacts for all parties depending on the practices recommended by the plan. Some recommendations, for example, in fields that are frequently flooded recommend converting the land back to wetlands. This may have negative economic consequences for farmers especially for those that farm rented land and would not benefit financially from any easement programs that pay the landowner. Most other practices that are part of nutrient management planning will help the farmer make their production more efficient. Nutrient management planning focuses on increasing the utilization of nutrients by plants while reducing losses. Farmers stand to benefit financially in the long term from nutrient management planning. Fertilizer costs for 2009 are estimated at $200/ acre for corn and $100/acre for soybeans. A nutrient management practice that results in a 10% reduction in fertilizer applied to corn or a 20% reduction in fertilizer applied to soybeans will cause the adoption of the practices to carry no costs to the farmer.

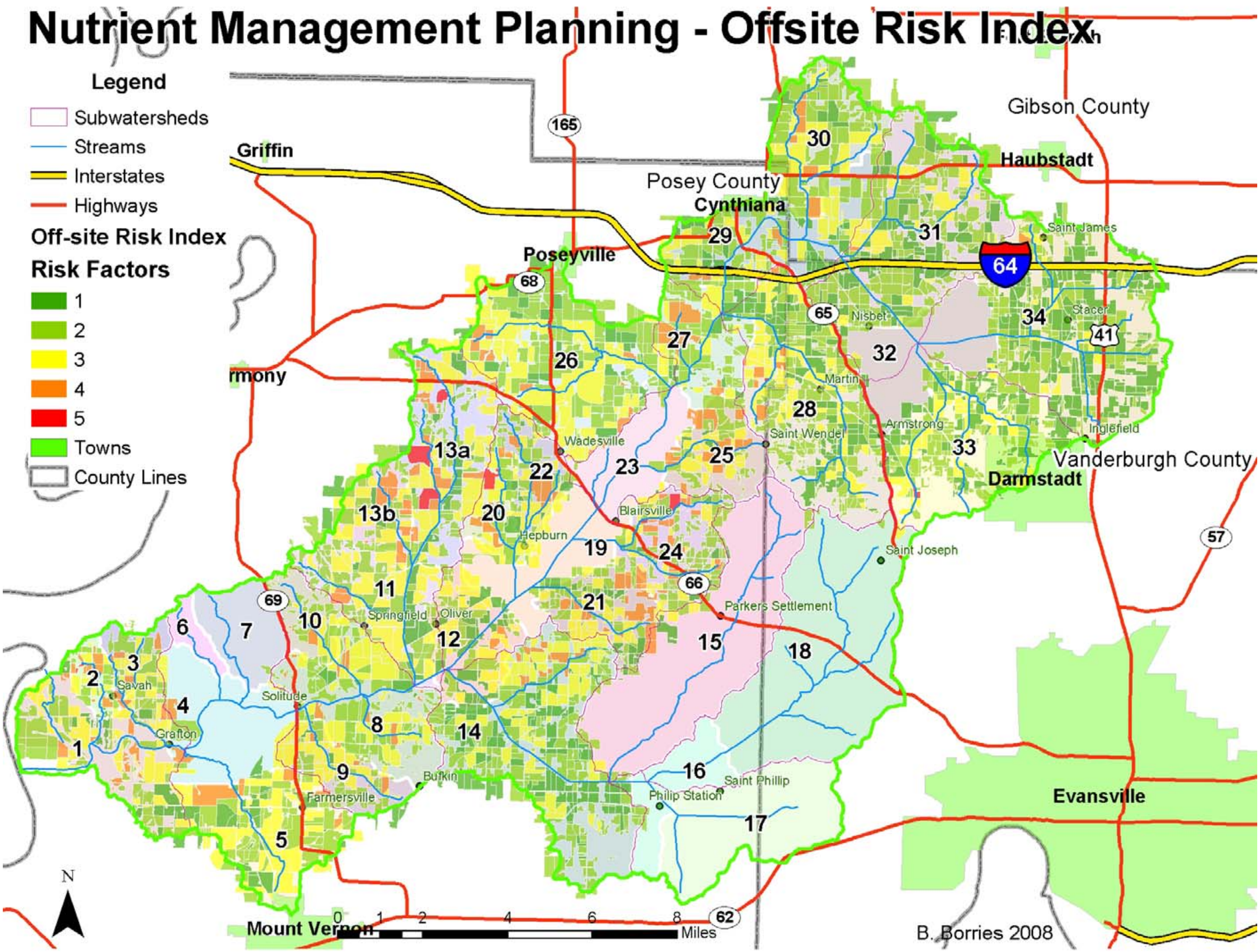


Figure 6.1.2-A: ***Nutrient Management Planning – Offsite Risk Index***

		Offsite Risk Index: Acres of Row Crops with Factors to be Addressed							
Region/ Sample Point	**Needed Nitrate Reduction**	**Distance to Stream**	**Flooding Potential**	**Subsurface drainage potential**	**Nitrate Leaching Index**	**Surface Runoff Class**	**Water Erosion: RKLS**	**Acres of Nutrient Management**	**Nitrate Reduction**
1	**18.60%**	491	1516	2158	3579	1728	1267	2148	10.8%
2	**27.90%**	177	3	617	643	680	217	100	1.8%
3	**48.60%**	227	0	849	975	750	510	162	3.0%
5	**52.00%**	877	0	3779	4781	1271	1917	2637	10.3%
8	**11.30%**	972	0	3319	3119	2002	1572	907	5.4%
9	**35.60%**	530	6	1318	1911	669	1140	315	2.8%
10	**20.80%**	327	0	522	1015	102	865	552	9.2%
11	**23.00%**	804	0	2879	3258	957	2409	823	4.8%
12	**57.70%**	125	0	2415	1808	1219	848	1478	11.1%
131	**59.00%**	974	0	3085	4287	1867	2773	3934	17.0%
132	**62.30%**	475	0	1343	2171	241	1833	820	7.3%
14	**19.10%**	816	15	5053	6203	2104	2829	750	2.7%
20	**28.50%**	654	0	1504	1788	991	719	404	6.4%
21	**30.70%**	495	44	1634	2391	1080	1259	782	6.4%
22	**27.60%**	569	0	1140	1968	471	832	100	6.0%
24	**19.10%**	413	0	1427	2394	1322	2272	810	5.0%
25	**42.70%**	528	51	1192	1316	850	1703	500	5.8%
26	**47.30%**	2024	0	7848	7517	2238	786	6241	16.2%
27	**7.00%**	1146	0	2650	2408	573	1629	175	1.0%
28	**36.90%**	943	458	3548	4338	1734	2956	2094	6.2%
29	**11.80%**	787	178	4347	4515	1535	1402	494	2.0%
30	**52.50%**	1650	35	1607	4145	1834	1062	1820	9.3%
31	**18.30%**	839	412	4120	6099	1384	2726	768	2.0%
33	**27.70%**	1494	449	2381	678	3024	1549	828	3.6%
34	**56.60%**	1342	298	4766	776	3596	1841	2775	6.1%
Total		**23436**	**4260**	**79375**	**87871**	**46091**	**38916**	**31,828**	

Table 6.1.2-A: Nutrient Best Management Practices Load Reductions & Cost

6.1.3: Erosion Control Structures

Sediment Loading to Streams and Loss from Fields: Total Suspended Solids target
Nutrient Loading to Streams and Loss from Fields: Orthophosphate target

Introduction:

Soil loss in areas of concentrated flow can be addressed through structural BMPs including grassed waterways, diversions, pipe drop structures, grade stabilization structures, and water and sediment control basins. This type of erosion is called gully erosion. Classic is where no tillage occurs and ephemeral or annual gully erosion is where it occurs each year but is tilled to create a flattened seedbed. There are 361 fields with classic gully erosion. Sediment loading from gully erosion in the watershed is not nearly as significant as stream bank and sheet & rill erosion, but does account for as much as 9% of sediment loading in a few sub-watersheds and 4% of sediment loading overall. Although only about 4% of sediment loading on average can be controlled in any given area through structural best management practices, controlling these erosive areas may be necessary to allow for other practices such as no-till farming or filter strips and will reduce upland sediment delivery.

Locations:

Figure 6.1.3-A: Fields with Gully Erosion shows the location of the fields that are in need of a structural BMP to control gully erosion. The figure also shows the needed reductions in total suspended solids for each area. These locations were identified through windshield and GIS inventories and the statewide tillage transect.

Load Reductions:

Sediment loads associated with gully erosion features were determined with the Region V Load Reduction Model. Their numbers were combined with the sediment loads from sheet, rill, and stream bank erosion to get the total load for each sample point region. An example taken from the spreadsheet model is shown in *Table 6.1.3-A: Structural BMP Example* using the field identified as having an amount near the average soil loss from ephemeral gullies of the fields identified. About 322 feet of gully erosion was identified during the inventory on the example field. The average depth of the gullies was about 1 foot with a top width of 3 feet and a bottom width of 1 foot. Determining the actual structures installed, and what sizes and specs they must meet would require a field scale investigation, but the BMPs would most likely include a combination of water and sediment control basins, grassed waterways, and grade stabilization structures. An underground outlet and pipe would be necessary for conveyance of runoff collected at any of the structures. The example results in an overall load reduction of 19.2 tons/year if the erosion is controlled. The maximum amount of gully erosion in any one field is about 6500 feet long and controlling the soil loss would result in a sediment load reduction of about 110.5 tons/year and a phosphorous load reduction of 19.2 lbs/year. The nitrogen load reduction in the chart is not expected to translate exactly into nitrate load since the formula used in the model estimates nitrogen transported attached to soil. *Table 6.1.3-B: Structural BMP Load Reduction & Cost Estimate* shows the expected reduction and cost estimates for addressing gully erosion in each of the Region/Sample Point areas. Reductions shown in red are those critical to achieving sediment load reduction goals, however, landowners may find it necessary or desirable to address gully erosion in other areas in order to accomplish recommended no-till or filter strip/stream bank stabilization measures in other areas where the reduction in gully erosion is not, by itself, critical to achieve sediment reduction goals.

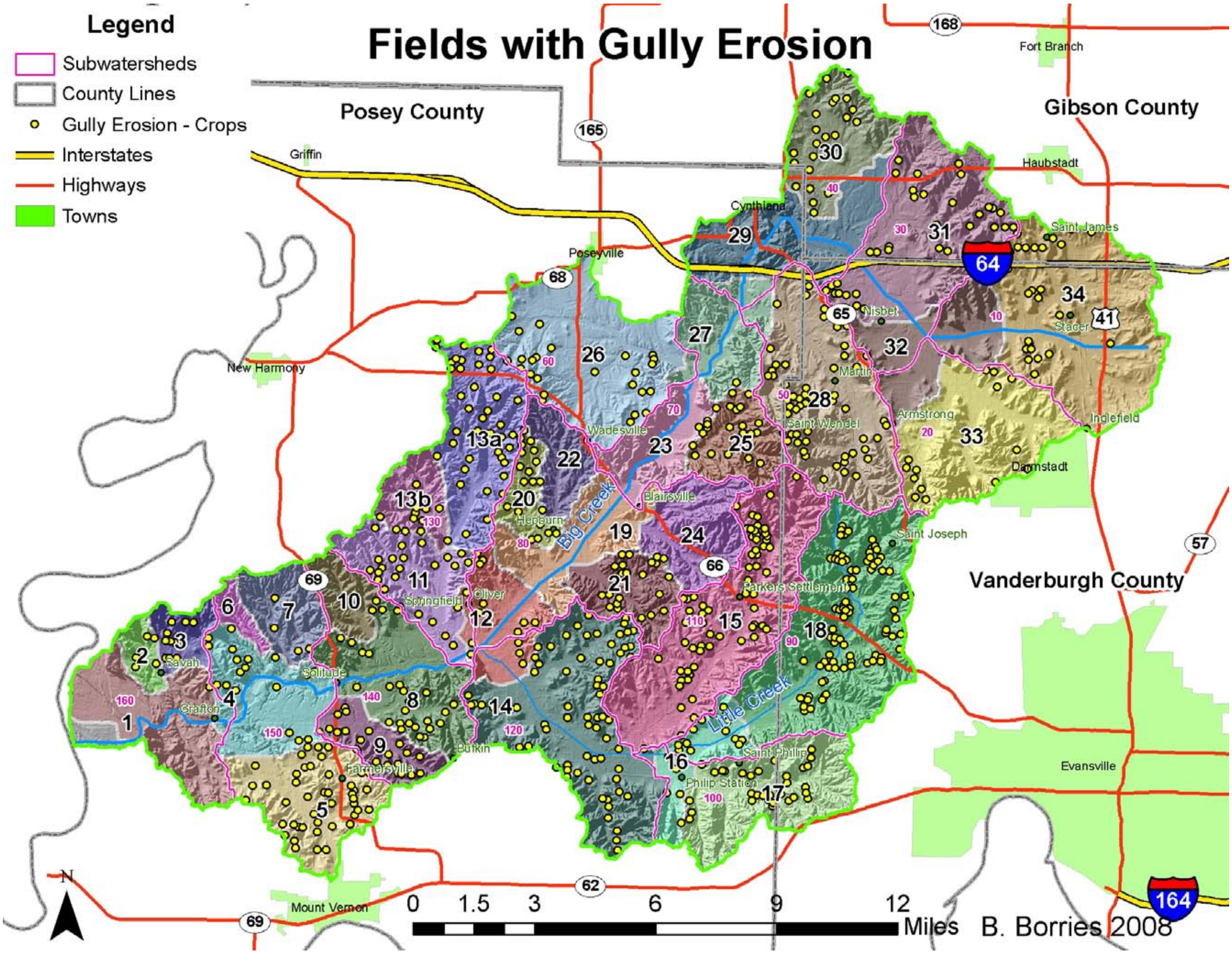


Figure 6.1.2-A: Fields with Gully Erosion

Other Impacts:

Structural BMPs have mostly positive impacts, though they are costly. All except grassed waterways tend to increase the amount of tillable space in a field by breaking up long flow paths. Grassed waterways require that a wide strip of a normally cropped field be converted to permanent turf grasses. Water & Sediment Control Basins can actually increase the amount of farmable area by controlling erosive areas that normally experience reduced or absent yields. In addition, any gullies that are controlled are flattened, reducing the depth of flow in the former gully area. Deeper flows carry more sediment and are less affected by surface roughness and vegetated buffer strips. The costs are the biggest drawback. It may cost as much as $40,000 for a system Water and Sediment Control Basins because of the earth work and underground tile. There is also a chance that trees and other wildlife habitat near streams will be affected in the process of running tile line that carries water to a natural stream from above ground inlets. Modification of habitat should be avoided as it may negate the benefits of the project. Because of the compaction from heavy equipment and disturbance of the soil structure, many fields experience a yield loss where the dirt work was done after a structural BMP is installed. *Table 6.1.3-B: Structural BMP Load Reduction& Cost Estimate* shows the expected load reduction and cost for the recommended structural BMPs. Red percentages and cost figures show the percent reduction and cost that is absolutely necessary, or has the highest priority, to achieve sediment reduction targets. In the sample point regions where other measures that achieve more reduction at a lower cost (such as filter strips and achieving *T*) can meet targets the percentage and cost is shown in black. The total reduction and cost for controlling all of the gully erosion regardless of priority is shown can be determined by combining red and black numbers. This is shown because even though, controlling gully erosion may not be necessary to achieve reduction targets, it may be necessary or helpful for farmers switching working towards achieving *T* or establishing filter strips.

Structural BMP Example

Parameter	**Gully**
Top Width (ft)	3
Bottom Width (ft)	1
Depth (ft)	1
Length (ft)	6500
Number of Years	5
Soil Weight (tons/ft3)	0.0425
	0.0005
	0.001

Estimated Load Reductions

	BMP Efficiency*	**Gully**
Sediment Load Reduction (ton/year)	1.0	19.2
Phosphorus Load Reduction (lb/year)		19.2
Nitrogen Load Reduction (lb/yr)		38.8

Table 6.1.3-A: Structural BMP example

Region/ Sample Point	Needed Sediment Reduction	Fields	Reduction
2	**69.80%**	5	**4%**
3	**49.20%**	10	**6%**
4	**11.4%***	19	*1%*
5	**82.50%**	44	**7%**
7	**60.20%**	4	**2%**
8	**25.1%***	26	*1%*
9	**68.50%**	22	**4%**
10	**19.80%**	0	*0%*
11	**62.9%***	26	**4%**
12	**60.7%***	15	**1%**
131	**29.60%**	40	*6%*
132	**63.00%**	10	**3%**
14	**82.1%***	70	**8%**
15	**6.80%**	64	*6%*
16	**13.7%***	18	*6%*
17	**31.20%**	32	*5%*
18	**56.60%**	84	**3%**
20	**17.30%**	21	*11%*
21	**87.50%**	22	**4%**
25	**87.50%**	25	**6%**
26	**65.40%**	26	**5%**
28	**60.70%**	55	**4%**
30	**50.00%**	26	**6%**
31	**71.2%***	42	**5%**
33	**73.10%**	15	**2%**
34	**64.50%**	33	**3%**
Total		754	
	Cost – Low:	$2,000/field	**$1,068,000** *($440,000)*
	Cost – High:	$6,800/field	**$3,631,200** *($1,496,000)*

Table 6.1.3-B: Structural BMP Load Reduction & Cost Estimate

Goals Addressed:

Sediment Loading to Streams and Loss from Fields: Total Suspended Solids target
Nutrient Loading to Streams and Loss from Fields: Nitrate target

Introduction:

The most significant progress towards achieving the goal for sediment loading and soil loss, the number one goal of the project, will be achieved through changes in residue management and use of winter cover crops on row crop fields. In addition, cover crops reduce nitrate by reducing runoff, immobilizing nutrients, and providing a nitrogen source that can be used to replace commercial fertilizer.

Locations:

Figure 6.1.4-A: Additional Cover Crop Locations shows the location of fields where cover crops are recommended to achieve additional nitrate and sediment load reductions. Fields that still need additional nitrate and sediment load reductions to achieve goals after the implementation of measures in *Sections 6.1.1, 6.1.2*, and *6.1.3* are shown as orange, yellow or green. Fields grouped into “Class B” or “Class C” according to the classifications described in *Section 6.1.1* are shown as orange and yellow respectively. Other locations are shown as green.

Load Reductions & Cost:

Load reduction will vary greatly depending on the initial rotation and tillage system, the topography of the field, and the rotation and tillage system chosen.

Table 6.1.4-C: Additional Cover Crop Load Reductions & Cost Estimates shows the overall reduction for the recommended amount of additional cover crops. Reductions in sediment loading were determined using the spatial RUSLE2 & sediment delivery model based on cover factors determined with the USDA RUSLE2 program. Nitrate reductions were estimated similar to the method described for nutrient best management practices. It was assumed that the cover crops reduced runoff by as much as 1/3 and that soil nitrate susceptible to wash-off by rain was reduced by as much as half (through reduced application for corn and increased uptake by cover crops). This results is an overall reduction of about 60% for each field. This was applied to the percent contribution of each field to get the reduction that is summed to get the overall reduction for each sample point region.

The cost for cover crops estimated in the eFOTG Indiana Annual Average Cost Calculator is $45/acre for each year planted. For the cost estimates, it’s assumed that the cover crops are planted every other so the cost per acre was assumed to be about $23/acre because RUSLE2 modeling showed less impact when planting every than every other year. This is due to the increased cover provided by corn compared to soybeans, the increased nitrogen need of corn compared to soybeans, and the wide use of winter wheat as a cash crop which as a side effect reduces runoff and erosion.

Other Impacts:

Cover crops have been shown to both repress weeds without the use of herbicide and reduce the dependence on commercial fertilizer. Cover crops and residue management also improve soil tilth, soil biology, and reduce compaction. The negative impact is the increased amount of time required for management. This includes planting of the cover crop and controlling its growth before the planting of the primary crop in spring. Cover crops can reduce the cost of planting by reducing the need for fertilizer or chemicals to control weeds and disease. The cost of planting corn is estimated at $512/acre. If cover crops reduces this overall cost by 9% there will be no cost to the farmer. If farmers reduce fertilizer inputs by 33%, then there will be a savings of 13%.

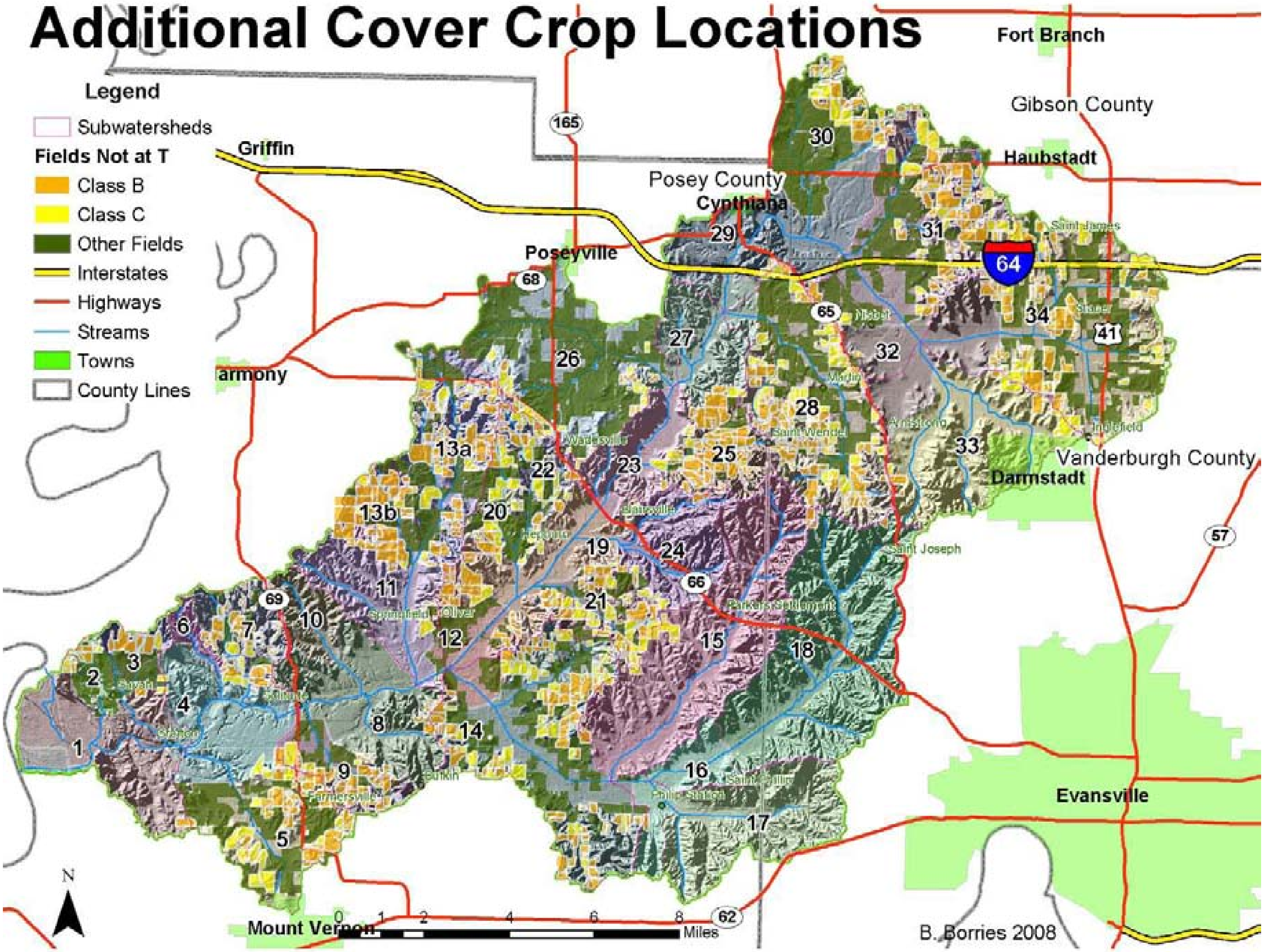


Figure 6.1.4-A: Additional Cover Crop Locations

			Total			**Class B & C *from T***			**Other**		
Region/ Sample Point	**Needed Sediment Reduction**	**Needed Nitrate Reduction**	**Acres**	**Total Sediment Reduction**	**Total Nitrate Reduction**	**Acres**	**Sediment Reduction**	**Nitrate Reduction**	**Acres**	**Sediment Reduction**	**Nitrate Reduction**
1	**NONE**	**18.6%**	616		9.1%				616		9.1%
2	**69.80%**	**27.90%**	664	28.6%	22.9%	190	8.6%	12.4%	474	20.0%	10.5%
3	**49.20%**	**48.60%**	143		28.8%	143		9.0%			19.8%
5	**82.50%**	**52.00%**	3860	19.3%	33.4%	1663	10.4%	20.2%	2197	8.9%	13.2%
7	**60.20%**	**NONE**	711	1.5%	0.0%	711	1.5%				
9	**68.50%**	**35.6%**	805	11.2%	21.5%	805	11.2%	21.5%			
11	**62.9%**	**23.0%**	442		7.6%				442	7.6%	
12	**60.7%***	**57.7%**	1272	2.7%	29.1%	702	2.7%	8.6%	570	20.5%	
131	**29.60%**	**59.0%**	1529		20.5%	1529		20.5%			
132	**63.00%**	**62.3%**	1331	16.9%	32.2%	1331	16.9%	32.2%			
14	**82.1%***	**19.1%**	5223	14.1%	10.0%	2674	14.1%	10%	2549	10.7%	
20	**17.30%**	**28.5%**	299		14%				299	14%	
21	**87.50%**	**30.7%**	2093	25.4%	30.8%	1524	18.1%	30.8%	569	7.3%	
22	**NONE**	**27.6%**	515		15.0%	515		15%			
25	**87.50%**	**42.7%**	1146	15.5%	32.1%	877	10.4%	32.1%	269	5.1%	
26	**65.40%**	**47.3%**	5796	19.4%	22.8%	682	5.6%	4.4%	5114	13.8%	18.4%
28	**60.70%**	**36.9%**	1997	17.6%		1997	17.6%				
29	**NONE**	**11.8%**	275		4.1%				275		4.1%
30	**50.00%**	**52.5%**	3313	8.1%	36.9%	895	8.1%	13.5%	2418		23.4%
31	**71.2%***	**18.3%**	2029	11.3%	5.0%	2029	11.3%	5%			
33	**73.10%**	**27.7%**	1601	11.3%	5.0%	1601	11.3%	5%			
34	**64.50%**	**56.6%**	5888	9.7%	35.5%	2040	9.7%	10.6%	3848	2.2%	24.9%
Total			40,932			21,908			19,024		
Cost – Low:			**$941,436**			Cover Crop = $23/acre		**$503,884**	Cover Crop = $23/acre		**$401,074**
Cost – High:			**$1,187,028**			Consulting + Cover Crop = $29/acre		**$635,332**	Consulting + Cover Crop = $29/acre		**$505,702**

Table 6.1.4-C: Additional Cover Crop Load Reductions & Cost Estimate

6.1.5: Standards and Specifications

Standards and specs for all the practices described in these measures can be found in the NRCS eFOTG. The USDA-NRCS offers standards and specs for the Diversion (Code 362), Grade Stabilization Structure (Code 410), Grassed Water way (Code 412), Pipe Drop Structure (Underground Outlet – Code 620), and Water and Sediment Control Basin (Code 638). Also, Cover Crops (code 329), Residue Management: No-till/strip-till/ridge-till (code 340), Conservation Tillage (code), Terrace (code 600), and contour farming (code 330) are found in the eFOTG. The USDA-NRCS offers standards and specs for Nutrient Management Planning (Code 590). The USDA-NRCS Offsite Risk Index (ORI) and Indiana Nutrient and Sediment Loss Risk Assessment tool provide details on recommended measures associated with nutrient management planning based on field scale factors (NRCS USDA 2008).

Erosion Control Structures should be designed to control as to close to 100% of the soil loss as possible. Standards & specifications for cropping and tillage systems can also be found within the USDA's RUSLE2 documentation and modeling outputs.

6.1.6: Action Register

<table>
<tr><th>Measure</th><th>Action Items</th><th>Milestones</th><th>Timeline</th><th>Responsible parties</th></tr>
<tr><td rowspan="8">Agricultural Sustainability

Goals Addressed:

1. Sediment Loading and Soil Loss

4. Nutrient Loading and Loss</td><td rowspan="5">Demonstration Project: Agronomic Practices (may also include ag structures)

Cost: ~$60,000K</td><td>1. Identify Landowners/Farmer Promoters</td><td>2009</td><td>Coordinator, Steering Committee</td></tr>
<tr><td>2. Begin no-till, cover crops, and nutrient management BMPs at locations not found before</td><td>2010</td><td>Farmer Promoters, Coordinator</td></tr>
<tr><td>3. Track costs & yields to share in further outreach</td><td>2010+</td><td>Farmer Promoters, Coordinator</td></tr>
<tr><td>4. Host field day</td><td>2010+ (yearly)</td><td>Coordinator, SWCDs</td></tr>
<tr><td>5. Field day attendees install or adopt practices</td><td>2010+ (yearly)</td><td>Coordinator</td></tr>
<tr><td rowspan="3">One-on-one Farm Management Assistance

Cost: $5K-$10K/year</td><td>1. Create packet for each farm in critical areas including aerial imagery, areas for BMP implementation, cost, and possible savings</td><td>2010+</td><td>Coordinator, NRCS, Purdue Extension Service, ISDA, SWCD, FSA</td></tr>
<tr><td>2. Deliver to landowner and/or operator</td><td>2010+</td><td>Coordinator</td></tr>
<tr><td>3. Follow-up with landowners adopting or installing practices</td><td>2010+</td><td>Coordinator</td></tr>
</table>

Agricultural Sustainability Goals Addressed: *1. Sediment Loading and Soil Loss* *4. Nutrient Loading and Loss*	Technical Assistance & Education (general) Cost: $5K-$10K/year	1. Identify most pertinent issues for adopting measures	2009	Coordinator, Steering Committee, NRCS, Purdue Extension Service, ISDA, SWCD, FSA
		2. Develop targeted informational/technical materials	2010+	Coordinator
		3. Distribute materials at events or by request	2010+	Coordinator, SWCD, Purdue Extension
		4. Provide one-on-one assistance as needed to landowners adopting or installing practices	2010+	Coordinator, NRCS, Purdue Extension Service, ISDA, SWCD, FSA
	Administer additional cost-share or incentive opportunities, track changes Administrative Cost: $5K-$10K/year Cost-Share target: 75%	1. Research and Identify potential opportunities, apply for grants where needed	2009	Coordinator, Steering Committee SWCD, NRCS, ISDA, IDNR
		2. Create materials or other means to outline cost-share opportunities for recommended measures	2010+	Coordinator
		3. Contact individuals or distribute materials	2010+	Coordinator
		4. Assist with necessary paperwork for landowners installing or adopting practices	2010+	Coordinator, SWCD, NRCS, ISDA, IDNR
		5.Follow-up	2011+	Coordinator

Table 6.1.6-A: Agricultural Sustainability Action Register

6.2: Riparian Area Re-Vegetation and Channel Stabilization

Riparian area re-vegetation and channel stabilization efforts have the potential to benefit water quality, aquatic habitat, and drainage. Countless meetings identified vegetated filter strips and stream restoration as desirable due not only to water quality benefits, but also the access that they provided for regulated drains. Their use is strongly encouraged by all three Posey, Vanderburgh, and Gibson County Surveyors. NRCS eFOTG and staff were consulted regularly for input on this measure.

6.2.1: Establishment of Permanent Riparian Vegetation

Sediment Loading to Streams and Loss from Fields: Total Suspended Solids target
Pathogens: *E. coli* Target
Nutrient Loading to Streams and Loss from Fields: Nitrate target

Introduction:

Establishing permanent riparian vegetation may form a filter capable of reducing runoff and sediment, stop an eroding bank, and create aquatic habitat. Vegetated filter strips are strips of permanent vegetation adjacent to a stream between the waterway and a crop field or other land use that generates contaminated runoff. Vegetated filter strips have the most effect on sheet flow. In many fields, the area that drains to the filter strip generates concentrated flow that is not affected by the filter strip. Vegetated filter strips provide the most water quality benefits through reducing runoff and sediment loading from the fields, preventing erosion, and creating aquatic habitat. Berms which are common next to crop fields in flat areas may prevent overland flow from occurring across the riparian area. Instead, water is conveyed to the ditch through surface inlets or un-vegetated channels and gullies. Riparian vegetation does not form a filter strip along these fields unless reshaping occurs, but is still important in these locations for preventing erosion, creating aquatic habitat, and eliminating soil disturbance and chemical application immediately adjacent to water bodies. For the greatest impact, the riparian area should be reshaped before re-vegetation so that it can filter the greatest amount of runoff from a field.

Locations:

Figure 6.2-A: Vegetated Filter Strip and Stream Bank Stabilization Locations shows the critical areas for stream bank stabilization and vegetated filters. These areas are mostly row crops fields next to stream segments without riparian vegetation. The locations are focused on those sample point regions that need reductions in either sediment loading or nitrate loading. A special focus has been placed on row crop fields adjacent to regulated drains. Many stream segments in the regulated drain system need regular maintenance, and filter strips in these areas provide year round access as well as reduce the amount of sediment that reaches the drains and must later be removed using tax dollars. In the figure, fields where a vegetated filter strip is recommended that are along regulated drains are shown in orange. Fields where a vegetated filter strip is recommended that are along other streams and ditches are shown in green. The most fields where vegetated filter strips are recommended are in the flatter, heavily agricultural areas of the Pond Flat – Headwaters (010), Buente Creek – Maidlow Ditch (020), Pond Flat – Jordan Creek (030), and Caney Creek (060) sub-watersheds.

Other Impacts:

Vegetated filter strips, in addition to reducing sediment and nutrient loads, also benefits wildlife habitat and aesthetics and when the filter strip is grass, provides additional drainage and access during wet periods. The access benefits both farm operations and the maintenance of legal drains. Areas immediately adjacent to streams also often have poor yields due to wetness, erosion, or weed competition. Using set aside programs such as the USDA Conservation Reserve Program allows producers to maintain profits on these areas while redirecting the management time and costs to the rest of the field. On the other hand, filter strips require that land that may be currently in production with yield comparable to the rest of the field be set aside and placed in permanent perennial cover. There is also some slight cost in establishing the filter strip which may vary depending on the amount of erosion and runoff currently occurring at the site. A USDA study of the socio-economic implications of the CRP program in rural communities found that even areas where a very high amount of land was placed into a easement, including entire farms, initially experienced job loss, but that after a few years the loss subsided due to increased growth in the recreation sector and increased jobs in adjacent areas with low CRP enrollment. The amount of land recommended to be set-aside through filter strips is likely small enough to have little or no impact on the local economy.

6.2.2: Stream Bank Stabilization

Sediment Loading to Streams and Loss from Fields: Total Suspended Solids target

Introduction:

Stream bank stabilization is the means by which an eroding stream bank is re-vegetated, stabilized or reshaped to eliminate sediment delivery to waterways and prevent scouring and eventual loss of adjacent lands. Stabilization methods should address the root cause of the instability using an analysis method such as WARSSS. In many ways other recommended measures address the watershed sources of channel instability through preventing erosion and reducing runoff. Yet, there are sources of instability that are not caused by the overland flow. Direct channel impacts, channelization, and invasive annual weeds are at the root of many eroding stream banks. Economic and effective techniques exist, especially for smaller streams and channels that can stabilize a channel while improving aquatic habitat. These involve a combination of management measures, channel protection, reshaping of the channel cross-section, and establishment of appropriate vegetation.

Locations:

Figure 6.2-A: Vegetated Filter Strip and Stream Bank Stabilization Locations shows the critical areas for stream bank stabilization and vegetated filters. These are stream segments without vegetated filter strips and the adjacent eroding stream banks that are experiencing “moderate” to “severe” erosion. Fields and stream segments have been categorized based on whether or not they are along legal drains. Eroding stream segments are shown in yellow for moderate and red for severe. Those that are along legal drains also have a grew outline. Locations are widespread with the majority of eroding stream segments being along Big Creek and McAdoo Creek, while

Other Impacts:

Stream bank stabilization has the potential to not only benefit water quality, but also to help protect land adjacent to eroding streams from eroding into the water way or floodway. It is also a safety measure where there is public access, since it stabilizes a brittle, usually steep bank. The only drawback may occur as a result of damages to land or habitat during construction since heavy equipment is often used or if alteration must be made to the slope of the bank to achieve stability. Modifying the slope of the bank may cause a landowner to lose some of his land or cause hydrologic changes to downstream neighbors. Stream bank stabilization may also be cost prohibitive because of the high cost of labor and materials.

Regulatory Permits:
The excerpt below is from the Indiana Drainage Handbook (Burke and Beik 1996). It details the permits and procedures required for activities associated with stream bank stabilization. At least early coordination is required for all stream bank stabilization activities that occur in a floodway or affect a drainage classified as water of the state. A regional permit may be issued for projects causing fill to be placed in less that 300 linear feet of stream or affecting less than one tenth of an acre. Other projects may require an individual 401 (issued by IDEM) or 404 (issued by Army Corps of Engineers) permit.

ACTIVITY	KEY PRACTICES	REQUIRED AUTHORIZATIONS AND PROCESSING METHODS[1]							GENERAL NOTES
		LOCAL	IDNR		IDEM		COE		
			AUTH.	PROC.	AUTH.	PROC.	AUTH.	PROC.	
Eroded Streambank Repair	Vegetative Stabilization Methods (P501, P502, P503, P504, P505)	YES[3]	YES[5]	EC	YES	SA	YES	GP	b
	Combined Structural and Vegetative Methods (P506, P507, P508, P509, and other combined practices)	YES[4]	YES[5]	IP	YES	SA	YES	GP	
	Structural Stabilization Methods (P510, P511, P512, P513, P514, P515)	YES[3]	YES[5]	IP	YES	SA	YES	GP	
Channel Excavation /Dredging	Bottom Dipping (P601)	YES[3]	YES[5]	IP	YES	NSA	YES	IP	c
	Bank Excavation (P602)	YES[3]	YES[5]	IP	YES	NSA	YES	IP	c
	Overbank Excavation (P603)	YES[3]	YES[5]	IP	NO	N/A	NO[8]	N/A	
Restoration of Channel to As-built Conditions	All potential practices utilized to maintain/restore a man made ditch or a previously modified reach of a natural stream to as-built dimensions/shape using the originally permitted material.	YES[3]	YES[5]	EC	YES[7]	NSA	YES[10]	EC	d

ABBREVIATIONS/ACRONYMS:

IDNR Indiana Department of Natural Resources

IDEM Indiana Department of Environmental Management

COE U.S. Army Corps of Engineers

AUTH. Authorization

PROC. Processing Method

N/A Not Applicable

EC Early Coordination/Notification Process (COE and IDNR have allowed this process so that the applicant may obtain a "prior finding", request confirmation that an individual permit would not be required if certain practice(s) is performed in a manner described in this handbook, or to pre-determine the permit conditions if a permit is determined to be required.)

IP Individual Permit

GP General Permit (either Nationwide or Regional)

NSA No Separate Authorization (Separate application or authorization from IDEM is not required for this activity. The application for IDEM Section 401 Water Quality Certification is made through the COE permit process)

SA Separate Authorization (Although some projects in the noted category are covered by a COE Nationwide Permit, blanket IDEM Water Quality Certification has been denied for this particular Nationwide Permit. Therefore, these projects would still need an individual IDEM Water Quality Certification.)

NOTES (superscript numbers):

3 Authorization is required according to most local ordinances. However, note that local Drainage Boards, County Surveyors, and municipalities are normally exempt from their own local stormwater ordinances and codes (except for floodplain zoning ordinances).

5 Authorization required only if the Indiana Department of Natural Resources (IDNR) has jurisdiction. IDNR has no jurisdiction if (a) the activity is occurring entirely outside the Floodway (if determined), or (b) the drainage area is less than one square mile (640 acres) or (c) the activity is occurring under county's direction and is on a stream or an open drain that is less than 10 miles long, and (d) where the work is not within one half (½) mile of a public freshwater lake.

GENERAL NOTES:

a Anyone applying herbicides for debrushing or to kill stumps must comply with pesticide label use and rate directions. Applications may be done only by or under the direct supervision of a certified applicator, certified by the office of the Indiana Chemist at Purdue University.

b The noted practice(s), when appropriate and if done properly, is considered by most agencies to be preferable over other alternatives.

c Because of potential adverse environmental impacts associated with the noted practice(s), most agencies exercise a high degree of oversight on the activity and frequently require various mitigation measures, as appropriate.

d For the purpose of this Handbook, this activity is defined as all potential maintenance/channel reconstruction practices utilized to restore channel cross sections to their as-built or permitted conditions, both in terms of dimensions and material. The evidence for the as-built conditions such as court records, permits, as-built construction plans, etc. would most likely be requested by regulatory agencies.

6.2.3: Standards and Specifications

The USDA-NRCS offers standards and specs for stream channel stabilization (Code 584) and Streambank and Shoreline Stabilization (580). Additional details may also be found in the practices Riparian Herbaceous Cover (390), Riparian Forest Buffer (391), Stream Habitat Improvement and Management (395), and Filter Strip (393). In all stream bank and filter strips activities, vegetative methods are preferred to bank armoring with rip rap or other hard materials and a natural outlet is preferred to a controlled pipe outlet.

6.2.4: Load Reductions

The Region V Pollutant Load Estimation Spreadsheet Tool was used to estimate the potential reduction by stabilizing the stream bank as estimated by a visual inventory. The reduction in sediment in sheet flow runoff was determined using a variation of the Spreadsheet tool. The reductions for fields less than 20 acres were estimated by assuming a 65% reduction in the sediment load that was determined using the RUSLE2 and sediment delivery model described in section 3.3.5. This estimate assumed that all runoff from fields under 20 acres after the filter strip was installed would be in the form of sheet flow. Vegetated filter strips are fairly ineffective at filtering concentrated flow and thus to account for the increased runoff contribution of concentrated flow in larger fields, the reduction in sediment load from fields larger than 20 acres was calculated as 33% of the load calculated with the sediment delivery model. The nitrate reduction was calculated as 20% of the nitrate load from each field. The nitrate load was calculated by estimating the runoff based on land use and soil type using the USDA RUSLE2 computer program and multiplying the runoff by the mean event concentration for nitrate (about 10 mg/L for row crops). This nitrate reduction estimate assumed that storm event flow runoff would be predominantly in the form of overland flow and not through tile drains. It was also assumed, when calculating the load reduction that measures recommended to be applied in other sections had been applied before the filter strip, such that the sediment and nitrate load to be reduced reflects the load after other recommended measures were applied. The results of the load reduction estimates area shown in *Table 6.2-A: Vegetated Filter Strip and Stream Bank Stabilization Load Reduction and Cost Estimate.*

Measure	Action Items	Milestone	Timeline	Responsible parties
Stream bank Stabilization & Vegetated Filter Strips Goals Addressed *1. Sediment Loading and Soil Loss* *2. Pathogens* *3. Channel Quality* *4. Nutrient Loading & Loss.*	Demonstration Project: Stream bank Stabilization, Vegetated Filter Strips (may also include ag structures) Cost: $80K	1. Identify Landowners/Farmer Promoters	2009	Coordinator, Steering Committee
		2. Stabilize stream bank and establish vegetated filter strip at locations not found before	2010	Farmer Promoters, Coordinator
		3. Track costs & yields to share in further outreach	2010+	Farmer Promoters, Coordinator
		4. Host field day	2010+ (yearly)	Coordinator, SWCDs
		5. Field day attendees adopt or install practices	2010+ (yearly)	Coordinator
	Technical Assistance & Education (general) Cost: $5k-$10K/year	1. Identify most pertinent issues for adopting measures	2009	Coordinator, Steering Committee
		2. Develop targeted informational/technical materials	2010+	Coordinator
		3. Distribute materials at events or by request	2010+	Coordinator, SWCD, Purdue Extension
		4. One on one assistance provided to landowners installing or adopting practices	2010+	Coordinator, NRCS, Purdue Extension Service, ISDA, SWCD, FSA
	Administer additional cost-share or incentive opportunities Cost: $5K-$10K/year Cost-share target: 75%	1. Research and Identify potential opportunities, apply for grants where needed	2009	Coordinator, Steering Committee SWCD, NRCS, ISDA, IDNR
		2. Create materials or other means to outline cost-share opportunities for recommended measures	2010+	Coordinator
		3. Contact individuals or distribute materials	2010+	Coordinator
		4. Assist with necessary paperwork for landowners installing or adopting practices	2010+	Coordinator, SWCD, NRCS, ISDA, IDNR
	Develop ordinance, or Long term plan for crop fields along regulated drains Administrative: $5K Establish Filter Strips: >$30K Bank erosion: $1.5M-$9M	1. Send letter to all landowners about ordinance or plan	2010	Coordinator, Drainage Boards, SWCDs
		2. Host meeting for public comment	2010	Coordinator, Drainage Boards, SWCDs
		3. Implement program	2011+	Coordinator, Drainage Boards, SWCDs, NRCS
		4. Landowners adopt practice	2011+	Coordinator

Table 6.2.4-A: Vegetated Filter Strip and Channel Stabilization Action Register

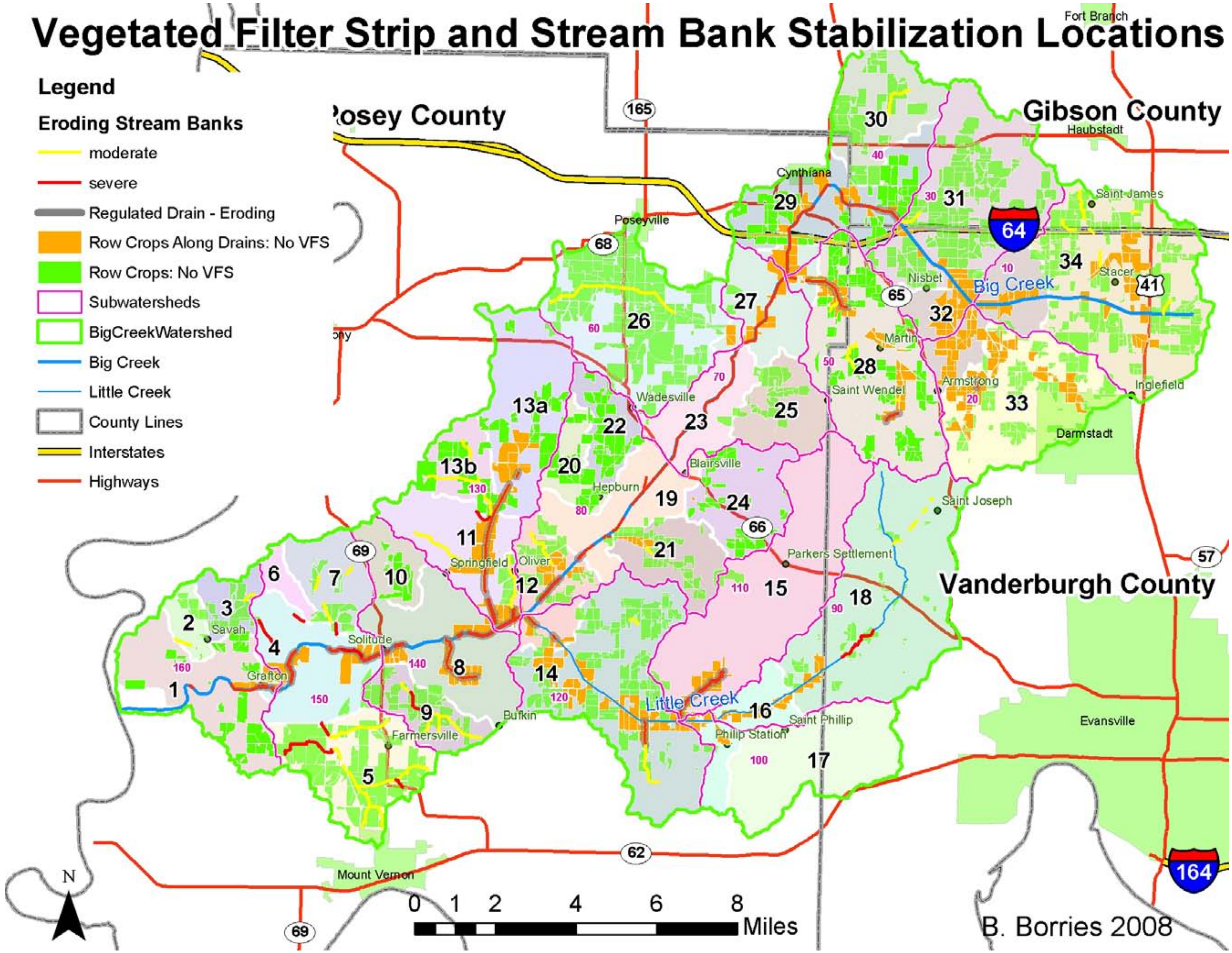


Figure 6.2-A: Vegetated Filter Strip and Stream Bank Stabilization Locations

			Total			Vegetated Filter Strips: Regulated Drains					Vegetated Filter Strips: Other				
Region/ Sample Point	Needed Sediment Reduction	Needed Nitrate Reduction	Total Fields	Total Sediment Reduction	Total Nitrate Reduction	Fields	Sediment Reduction	Nitrate Reduction	Linear Feet	Stream bank Stabilization Reduction	Fields	Sediment Reduction	Nitrate Reduction	Feet	Stream bank Stabilization Reduction
1	NONE	18.60%	4		3.2%	4		0.3%			33		2.9%		
2	69.80%	27.90%	10	16.7%	2.9%	0					10	5.2%	2.9%	2,155	11.5%
3	49.20%	48.60%	15	17.6%	5.1%	0					15	5.5%	5.1%	1,516	12.1%
4	11.40%	NONE	9	44.8%		9	0.6%		22,251	44.2%					
5	82.50%	52.00%	72	35.4%	7.3%	0					72	9.1%	7.3%	45,442	26.3%
7	60.20%	NONE	16	28.1%		0					16	4.9%		6,778	23.2%
8	25.10%	11.30%	21	27.2%		21	0.8%	2.9%	24,962	26.4%					
9	68.50%	35.60%	40	34.2%	7.1%	0					40	6.8%	7.1%	18,459	27.4%
10	19.80%	20.80%	14	7.5%	5.0%	0					14	7.5%	5.0%		
11	62.905	23.00%	20	31.1%	6.2%	16	1.9%	4.0%	23,923	28.7%	4	0.5%	1.2%		
12	60.7%*	57.70%	55	47.6%	5.9%	23	1.2%	3.8%	21,744	39.1%	22	2.7%	2.1%	12,035	4.6%
131	29.60%	59.00%	49	10.3%	6.5%	12	1.9%	2.4%	15,993	8.4%	37		4.1%		
132	63.00%	62.30%	21	24.0%	4.7%	1	0.1%	0.2%			20	7.7%	4.5%	14,678	16.2%
14	82.1%*	19.10%	189	15.9%	9.3%	39	1.4%	3.2%	12,658	1.5%	150	9.2%	6.1%	13,027	3.3%
15	6.80%	2.10%	12		0.9%	12	0.4%	0.9%							
16	13.70%	NONE	22	4.4%		22	4.4%			0.0%					
18	56.60%	NONE	13	17.5%		8	0.4%			0.1%	26	2.4%		9,457	14.7%
20	17.30%	28.50%	26	10.1%	6.3%	0					26	10.1%	6.3%		
21	87.50%	30.70%	62	7.2%	3.7%	13	1.1%	1.6%			49	6.0%	2.1%	926	0.1%
22	NONE	27.60%	37		6.7%	0					37		6.7%		
24	NONE	19.10%	33		1.9%	1		0.0%			33		1.9%		
25	87.50%	42.70%	23	9.8%	4.6%	1	0.0%	0.0%		0.0%	22	5.9%	4.6%	0	3.9%
26	65.40%	47.30%	140	26.4%	8.1%	2	0.4%	0.1%		0.0%	138	15.0%	8.0%	20,659	11.0%
27	NONE	7.00%	26		5.2%	26		5.2%							
28	60.70%	36.90%	149	9.2%	3.6%	37	1.5%	1.9%	8,825	5.5%	112	7.7%	1.7%		
29	NONE	11.80%	41		3.7%	18		2.2%			23		1.5%		
30	50.00%	52.50%	41	23.0%	4.6%	0					41	8.8%	4.6%	4,856	14.2%
31	71.2%*	18.30%	175	19.8%	6.5%	16	0.5%	0.7%	3,353	5.3%	159	8.5%	5.8%	3,072	6.5%
32	NONE	3.00%	50		7.2%	50		7.2%							
33	73.10%	27.70%	212	14%	6.4%	57	3.4%	4.3%	1,858	1.2%	155	9.4%	2.1%	0	
34	64.50%	56.60%	232	12.8%	6.4%	35	1.6%	1.9%		1.5%	197	9.7%	4.5%	13,207	4.4%
Total			1,964			423			Lf: 202,214; 294 Ac.		1,451			166,267 ft.; 44 ac.	
		Cost – Low:	$2,047,844			20 ft access strip		$29,701	$1.10 sq yd	$1,564,399	$150/field		$217,650	$1.10 sq yd	$236,094
		Cost – High:	$11,243,161			$300/field		$126,900	$1.10 sq yd + $5.50 cu. Ft	$9,264,399	$300/field		$435,300	$1.10 sq yd. + $5.50 cu ft	$1,416,562

Table 6.2-A: Vegetated Filter Strip & Stream Bank Stabilization Load Reduction & Cost Estimate

6.3: Pasture Improvements

Pasture improvements were selected by the steering committee after information was presented regarding their impact on *E. coli* and sediment loading. NRCS eFOTG and staff were consulted for input on the measure.

6.3.1: Riparian Grazing

Sediment Loading to Streams and Loss from Fields: Total Suspended Solids target
Nutrient Loading to Streams and Loss from Fields: Nitrate target
Pathogens: *E. coli* Target

Introduction:

Access control is an effective method to reduce sediment, nutrient, and *E. coli* loads associated with livestock. The control is usually accomplished with fencing and may also include a stream crossing. This measure is also best combined with other pasture BMPs, especially alternative water systems which provide livestock an alternative to the stream for water after they have been excluded from the area. When livestock have access to sensitive riparian areas, gully and stream bank erosion is more likely to occur and nutrients and *E. coli* have a direct route to water ways since any riparian filter will have been bypassed once the animal enters the stream. In addition, the trampling of the riparian area reduces its positive water quality effects. Disturbance of the stream bottom by the animals also disturbs stream sediments releasing *E. coli* and suspended solids into the water column. This is especially a problem during low flow periods.

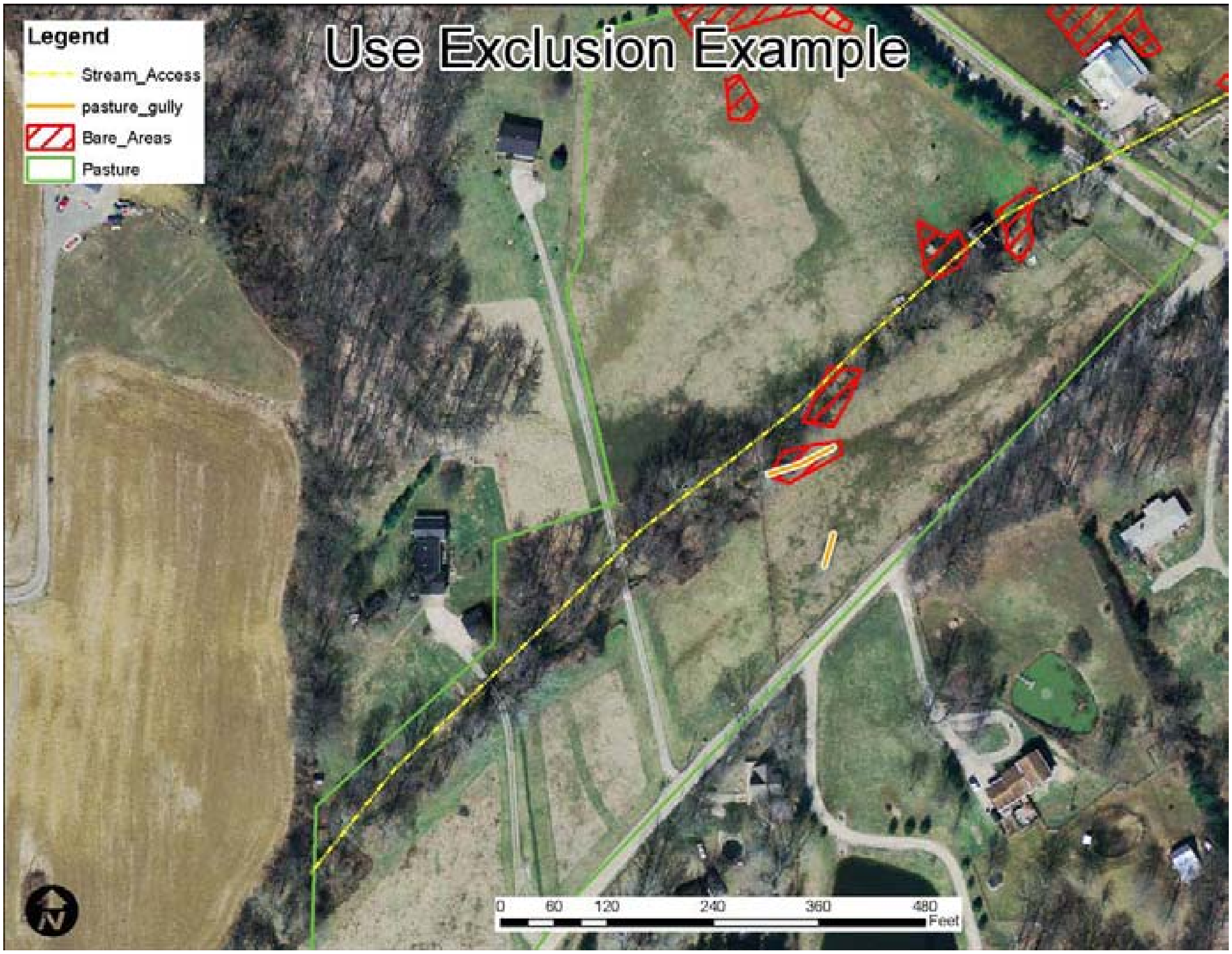
Locations:

There are 16 stream segments with livestock access, among 13 pastures. Pastures do not make up much of the watershed and so access areas, likewise, are uncommon. They are found in 9 of the 16 sub-watersheds. The location of these areas is shown in *Figure 6.3-A: Locations of Pasture Improvements*

Load Reductions:

Load reduction from use exclusion of streams may come from the stabilization of stream banks, critical area plantings on bare areas and gully erosion. This will result in a reduction of sediment and nutrient loading. The increased buffering capacity of the riparian area and the reduction in stream bottom disturbance will cause a reduction in *E. coli* loading. An example field is shown in *Figure 6.3.1-A: Use Exclusion Example.* In the field, there is a quarter of a mile of the stream that is accessible by livestock in the pasture. There is one gully and 1/5 of an acre of bare areas associated with the stream access in need of critical area plantings or grade stabilization structures. The load reductions associated with fixing these erosion areas and excluding the livestock is shown below in *Table 6.3.1: Use Exclusion Example Load Reductions.* The reduction in sediment loading from bank stabilization is about 30 tons/year. Additional load reductions also are shown for phosphorous and nitrogen. Overall, in pastures near streams without use exclusion there are 10 gullied pasture areas, 13.6 acres of bare areas, and about 2 miles of access areas with some stream bank erosion. Addressing these areas could reduce the sediment loading by a total of about 730 tons/year. Overall load reductions and cost estimates for this and other pasture measures are shown in *Figure 6.3: Pasture Improvement Load Reductions & Cost Estimates.*

Figure 6.3.1-A: Use Exclusion Example



Reduction from Stream Bank Stabilization

Parameter	Bank #1	Bank #2
Length (ft)	1200	1200
Height (ft)	3	3
Lateral Recession Rate (ft/yr)*	0.2	0.2
Soil Weight (tons/ft3)	0.0425	0.0425
Soil P Conc (lb/lb soil)**	0.0005	0.0005
Soil N Conc (lb/lb soil)**	0.001	0.001
	Bank #1	**Bank #2**
Sediment Load Reduction (ton/year)	30.6	30.6
Phosphorus Load Reduction (lb/year)	30.6	30.6
Nitrogen Load Reduction (lb/yr)	61.2	61.2

Reduction from Gully Stabilization

Parameter	**Gully**
Top Width (ft)	10
Bottom Width (ft)	5
Depth (ft)	3
Length (ft)	60
Number of Years	5
Soil Weight (tons/ft3)	0.0425
Soil P Concentration (lbs/lb soil)	0.0005
Soil N Concentration lbs/lb soil	0.001
Sediment Load Reduction (ton/year)	11.5
Phosphorus Load Reduction (lb/year)	11.5
Nitrogen Load Reduction (lb/yr)	23.0

Load Reduction from Critical Area Planting

USLE or RUSLE	Before Treatment	After Treatment
Rainfall-Runoff Erosivity Factor (R)	220.00	220.00
Soil Erodibility Factor (K)	0.37	0.37
Length-Slope Factor (LS)	0.60	0.60
Cover Management Factor (C<=1.0)*	0.40	0.03
Support Practice Factor (P<=1.0)*	1.00	1.00
Predicted Avg Annual Soil Loss (ton/acre/year)	19.25	1.44
Enter contributing area (acres)	0.2	
	Sediment Load Reduction (ton/year)	4
	Phosphorus Load Reduction (lb/year)	3
	Nitrogen Load Reduction (lb/yr)	7

Table 6.3.1-A: Use Exclusion Example Load Reduction

Other Impacts:

As part of comprehensive management, use exclusion from streams can do more than just control pollutant loading. It also improves the health of livestock. Streams as water sources may carry microorganisms and other pollutants that are harmful to livestock health when ingested. An alternative watering source fed by a well or an upland pond provides clean drinking water to the livestock. Limited stream side "flash" grazing may even still be appropriate after the erosion is controlled. The limited amount of access control recommended will have a negligible effect on the amount of available grazing lands and thus a negligible socio-economic effect outside of the cost of installation.

6.3.2: Critical Area plantings, Gully Stabilizations, & Pasture Renovations

Sediment Loading to Streams and Loss from Fields: Total Suspended Solids target
Nutrient Loading to Streams and Loss from Fields: Nitrate target
Pathogens: *E. coli* Target

Introduction:

While overall, pastures generally experience much less erosion and cause less sediment load to waterways, isolated bare areas and gully erosion can contribute significantly to the soil loss and sediment loading problem. In addition, sediment and runoff leaving these sites carry much more nutrients and pathogens than crop fields or residential areas. Bare areas in need of critical area plantings, or heavy use protection usually occur near watering areas, feeding area, shaded areas where animals like to lounge, and sensitive areas with steep slopes or high soil moisture. Gully erosion similarly forms in these areas, and unlike gully erosion in crop fields, is not controlled each year with tillage passes. Instead these gullies require a combination of structural and non-structural management practices to eliminate the gully erosion. Erosion controlled on these sites reduces the sediment load and allows vegetation to be reestablished to filter pollutants such as *E. coli* and nutrients associated with livestock waste.

Locations:

Figure 6.3-A: Locations of Bare Areas and Gullies in Pastures shows the locations of the areas that need critical area plantings, gully stabilizations, pasture renovations, or other measures to control erosion and reestablish vegetation. There are 73.3 acres of bare pasture areas and 271 locations of pasture gully erosion not associated with stream access.

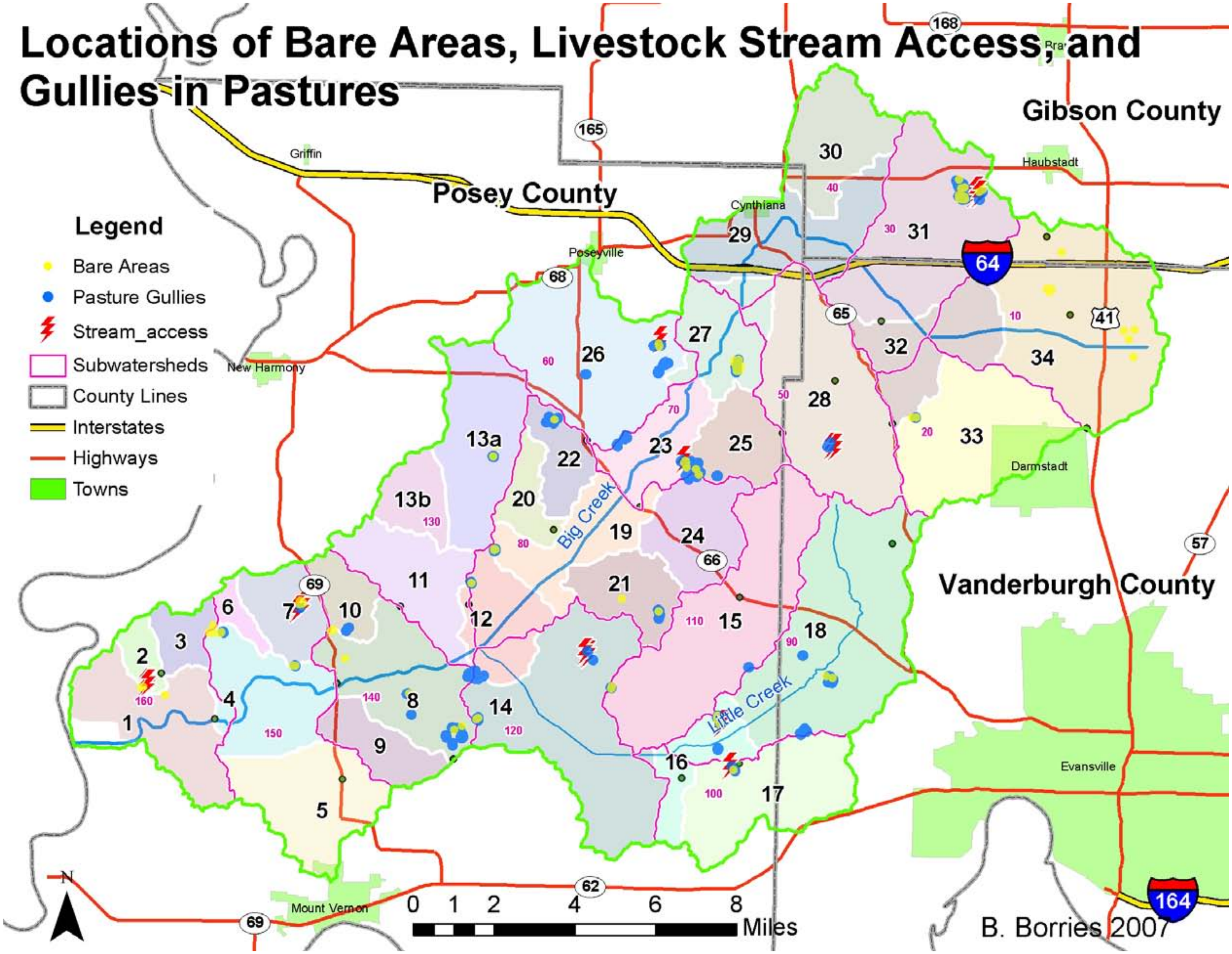


Figure 6.3-A: Locations of Pasture Improvements

Load Reduction:

			Bare Areas		Gullies		Livestock Access	
Region/ Sample Point	**Needed Sediment Reduction**	**Total Sediment Reduction**	**Acres**	**Sediment Reduction**	**Gullies**	**Sediment Reduction**	**Stream Access Points**	**Sediment Reduction**
2	**69.8%**	**6.0%**	1				3	6.0%
3	**49.2%**	**0.1%**	1	0.1%				
4	**11.4%***	**0.0%**	3	0.0%	2	0.0%		
7	**60.2%**	**2.1%**	3	0.3%	4	0.2%	2	1.6%
8	**25.1%***	**0.5%**	3	0.0%	31	0.5%		
10	**19.8%**	**3.0%**	1	0.0%	3	3.0%		
12	**60.7%***	**1.0%**	4	0.2%	13	0.8%		
131	**29.6%**	**0.1%**	2	0.0%	3	0.1%		
14	**82.1%***	**1.2%**	7	0.1%	10	0.3%	2	0.8%
15	**6.8%**	**0.1%**	1	0.0%	3	0.1%		
16	**13.7%***	**3.4%**	4	0.4%	10	3.0%		
17	**31.2%**	**2.3%**	1	0.1%	6	1.1%	1	1.1%
18	**56.6%**	**1.7%**	1	0.0%	19	1.0%	1	0.7%
21	**87.5%**	**1.5%**	5	0.0%	9	1.5%		
25	**87.5%**	**3.8%**	7	0.2%	15	3.4%	1	0.2%
26	**65.4%**	**2.2%**	3	0.0%	21	1.4%	1	0.8%
28	**60.7%**	**0.6%**	5	0.0%	6	0.2%	2	0.4%
31	**71.2%***	**2.7%**	5	0.2%	33	2.0%	3	0.5%
33	**73.1%**	**0.2%**	3	0.0%	2	0.2%		
34	**64.5%**	**0.2%**	13	0.2%	0	0.0%		
Total			74		190		16	
Cost – Low:		**$175,900**	$950/ acre	$70,073	$475/ Gully	$89,300	Fence: $1.29/ft	$16,527
Cost – High:		$178,940		$70,073	$2000/ Gully	$37,600	Fence + Critical Area Planting	$19,567

Table 6.3-A: Pasture Improvements Load Reduction & Cost Estimate

Other Impacts:

Improvements to pastures can mean more productivity from pastures as well. No permanent total is recommended for these practices so there will be a negligible socio-economic effect except for the initial cost of construction.

6.3.3: Pond & Lagoon Renovations

Sediment Loading to Streams and Loss from Fields: Total Suspended Solids target
Nutrient Loading to Streams and Loss from Fields: Nitrate target
Pathogens: *E. coli* Target

Introduction:

A small number of ponds and wastewater treatment lagoons are in need of renovation to address runoff issues. Lagoons and ponds were identified that are within the 100 year floodplain of waterways or have evidence of regularly exceeding the volume of the basin during rainfall events resulting in erosion of the spillway and other downstream areas. While only two were identified, the concentration of pollutants in the basin and later in runoff is enough to cause water quality issues downstream.

Locations:

The Ponds and Lagoons in need of renovation are located in the Big Creek – Blairsville and Buente Creek – Maidlow Ditch Sub-watersheds.

Load Reductions:

Load reductions will be based on the amount of runoff that is kept in the basin after renovation or will be based on the filtering and infiltration effects of a renovated spillway.

6.3.4: Standards and Specifications

The USDA-NRCS offers standards and specs for Use Exclusion (Code 472). Other practices that may be used with the Use Exclusion include Fence (code 382), Stream Crossing (code 578), and Filter Strip (code 393). Where significant erosion has occurred, practices to control the erosion may apply including Stream bank and shoreline stabilization (code 580), Critical Area Plantings (code 342), Diversion (code 362), Heavy Use Area Protection (561), or Grade Stabilization Structure (code 410). An alternative watering source can be provided with a pond (code 378) and a Watering Facility (code 614).

The standards and specs for this practice are similar to those for use exclusion with stream access. Controlling erosion and runoff at these areas may involve many practices including Fence (code 382), Critical Area Plantings (code 342), Diversion (code 362), Heavy Use Area Protection (561), or Grade Stabilization Structure (code 410). Some locations may need the addition of a Waste Treatment Lagoon (code 359) or Wastewater Treatment Strip (code 635) if sufficient vegetation cannot be established.
The USDA-NRCS maintains standards and specifications for Ponds (code 378) and Waste Treatment Lagoons (code 359).

Measure	Action Items	Milestones	Timeline	Responsible parties
Pasture & Livestock Improvements Goals Addressed: *1. Sediment Loading & Soil Loss* *2. Pathogens* *3. Channel Quality* *4. Nutrient Loading & Loss*	Demonstration Project: Pasture & Livestock Improvements Cost: $25K	1.Identify Landowners/Farmer Promoters	2009	Coordinator, Steering Committee
		2. Establish riparian fencing, critical area planting, and/or manure management BMPs at locations in need of practices	2010	Farmer Promoters, Coordinator
		3. Track costs & yields to share in further outreach	2010+	Farmer Promoters, Coordinator
		4. Host field day	2010+ (every other year)	Coordinator, Soil & Water Conservation Districts
		5. Field day attendees and others adopt or install practices	2010+ (every other year)	Coordinator
	Technical Assistance & Education (general) Cost: $1k-$5K/year	1. Identify most pertinant issues for adopting measures	2009	Coordinator, Steering Committee
		2. Develop targeted informational/technical materials	2010+	Coordinator
		3. Distribute materials at events or by request	2010+	Coordinator, SWCD, Purdue Extension
		4. Provide one-on-one assistance to landowners installing or adopting practices	2010+	Coordinator, NRCS, Purdue Extension Service, ISDA, SWCD, FSA
	Administer additional cost-share or incentive opportunities Cost: $1K-$5K/year Cost-share target: 75%	1. Research and Identify potential opportunities, apply for grants where needed	2009	Coordinator, Steering Committee SWCD, NRCS, ISDA, IDNR
		2. Create materials or other means to outline cost-share opportunities for recommended measures	2010+	Coordinator
		3. Contact individuals or distribute materials	2010+	Coordinator
		4. Assist with necessary paperwork for landowners to receive funding for adopting or installing practices	2010+	Coordinator, SWCD, NRCS, ISDA, IDNR

6.4: Wastewater Measures

Wastewater issues were not among major concerns except around the Wadesville and Blairsville area at the beginning of the project, but their importance was recognized as water quality and inventory data was presented. The Wadesville-Blairsville Regional Sewer District has been in existence for several years with the purpose of developing centralized wastewater option for the areas surrounding Wadesville and Blairsville. The measures related to the WBRSD are direct reflections of their previous and current efforts. Alternatives to traditional sewers are also explored that are more affordable to residents.

6.4.1: Wadesville-Blairsville Regional Sewer District: Extension of Sewer Lines from Poseyville

Nutrient Loading to Streams and Loss from Fields: Nitrate target
Nutrient Loading to Streams and Loss from Fields: Ammonia nitrogen target
Pathogens: *E. coli* Target

Summary:

Water quality monitoring indicated a likelihood of septic systems failing or not fully treating wastewater from homes. Some straight pipes may also exist in which wastewater is discharged directly to waterways or to a field tile. Residents of Wadesville and Blairsville report seeing surfacing septic effluent including one area near a school and other areas where stagnant surface waters smell like effluent. The Wadesville-Blairsville Regional Sewer District was created through a previous 205(j) grant and the board of directors has been working for a number of years to obtain funding to bring sewers to the Wadesville-Blairsville area. The current plan is to send the wastewater to Poseyville for treatment creating a sewer line along State Roads 165 and 66. Extension of this sewer line supports the pathogen and nutrient goals by eliminating confirmed discharges from on-site wastewater systems.

Locations:

Figure 6.4-A: Locations of Recommended Measures for Wastewater Treatment shows the locations of important features of the Wadesville-Blairsville Sewer District (WBRSD).

Load Reductions:

Currently the WBRSD is expected to impact 400 homes or about 1000 people. The extension of conventional sewers to this area will result in a 100% treatment of pollutant loads associated with septic systems in this area. The actual load reduction will be dependent upon the number of homes that currently have failing or malfunctioning septic systems.

Other Impacts:

Conventional sewer systems are expensive but also bring extra value to the home. The connection to the sewers becomes an asset to the homeowner and its value gets transferred when the home is sold. On the other hand, monthly sewer rates for the project are estimated to be above $80/month which may cause economic hardship for lower income residents. Each property owner will also have to finance the connection to the sewer and the decommissioning of the existing septic system.

6.4.2: Decentralized Septic Tank Effluent Pump/SepticTank Effluent Gravity-based Wastewater Treatment

Nutrient Loading to Streams and Loss from Fields: Nitrate target
Nutrient Loading to Streams and Loss from Fields: Ammonia nitrogen target
Pathogens: *E. coli* Target

Summary:

A link between higher densities of homes on septic systems and impairments based on ammonia nitrogen was found during water monitoring. Septic tank effluent pump and septic tank effluent gravity systems offer a compromise between septic systems and conventional sewers. Property owners keep their septic tank, but the effluent flows to a central treatment facility where it is treated. This eliminates both the discharge of ammonia nitrogen and nitrates to ground and surface waters and the risk of contamination from *E. coli.* Both systems use a system of small diameter plastic pipes laid just below the frost line for collection. Where sufficient slope is present, gravity systems carry the effluent without the use pumps, and STEP systems add a pump to the septic tank to force the effluent uphill or across very flat areas. Secondary treatment occurs after collections and can be accomplished with facilities such as sequencing batch reactors or pumped to existing wastewater treatment facilities.

Locations:

Figure 6.4-A: Locations of Recommended Measures for Wastewater Treatment shows the location and number of homes with septic systems that would be affected by creating a STEP/STEG wastewater treatment system.

Load Reductions:

According to census data, the proposed locations of STEP/STEG would eliminate *E. coli,* nitrate, and ammonia nitrogen loads from over 3000 septic systems. The population in these areas totals over 9500. The actual numeric load reduction is dependent upon the number of these homes that have septic systems that are failing or incompletely treating the pollutants.

Other Impacts:

A preliminary cost estimate was made using the Water And Wastewater Treatment Technologies Appropriate for Reuse program developed by Humboldt State University (Finney and Gearheart 2004). The program allows for the estimation of capital and maintenance costs of a number of treatment and collection systems. Costs can be annualized and spread across the number to be served by the system creating an estimated monthly rate. A cost estimate was done assuming that most houses would not require a pump to force effluent to the nearest treatment locations and that a sequencing batch reactor would be created to treat each neighborhood with a common catchment. Estimates ranged from a total $30-$40/month rate once capital costs were annualized and maintenance costs were included. This rate is slightly higher than annualized cost of a convention septic tank and absorption field bed, but is less than a septic tank and sand mound or absorption trench. Much of the area recommended for a STEP/STEG is located on soils with a shallow clay layer that would require an absorption trench system for proper treatment.

Nutrient Loading to Streams and Loss from Fields: Nitrate target
Nutrient Loading to Streams and Loss from Fields: Ammonia nitrogen target
Pathogens: *E. coli* Target

Summary:

Additional septic system education or services should be developed to encourage better care and maintenance of septic systems. Some areas have such a low density of homes that wastewater collection would be cost prohibitive. Proper maintenance of septic systems in these areas can allow for homes in these areas to have little effect on the aquatic environment. About 6700 people and 2400 homes would still remain on septic systems.

Locations:

Figure 6.4-A: Locations of Recommended Measures for Wastewater Treatment shows the locations of the other wastewater collections systems. Remaining areas where wastewater treatment has not been recommended is where septic system education will be needed.

Load Reductions:

According to 2000 census data, the remaining areas without wastewater collection affect 6700 people and about 2400 houses. A maximum 65% treatment efficiency for ammonia nitrogen and nitrate and near 100% treatment efficiency for pathogens can be achieved with septic systems that are properly functioning. The actual load reduction will be dependent upon how many septic systems are currently malfunctioning and how effective an outreach or information program are.

Other Impacts:

The impacts of this recommendation are small. The education may be accomplished using existing resources or by expanding the resources currently available. The result of the education effort should be behavior changes and only a few whole system overhauls so the economic impact should be small. On the other hand, measures to improve the performance of septic systems also tend to reduce water use and improve the aesthetics of the land.

Measure	Action Items	Milestones	Timeline	Responsible parties
Wastewater Measures Goals Addressed: *2. Pathogens* *4. Nutrient Loading & Loss*	Field Day/Bus Tours Cost: $5K-$10K	Take bus tours of facilities in Darmstadt where STEP system exists, including interviews with town leaders, wastewater technicians, and residents	2010	SWCD, Community Groups, Local Leadership, Coordinator
		Take bus tours of community where STEG system exists, including interviews with town leaders, wastewater technicians, and residents	2011	SWCD, Community Groups, Local Leadership, Coordinator
		Follow-up with attendees	2012	Coordinator
	Create Design & Detailed Cost Estimate for decentralized wastewater options Cost: $50k-$100K	Identify other communities or areas just outside Big Creek where wastewater is already planned or needed to identify additional partners	2012	Coordinator, Community Groups, Local Leadership, Health Department
		Establish regional wastewater treatment area(s)	2012	Coordinator, Community Groups, Local Leadership, Health Department
		Secure funding for design work	2012	Coordinator, SWCD, Local Leadership, Health Department, Community Groups
		Host public meeting with results of design	2013	Coordinator, SWCD, Local Leadership, Health Department, Community Groups
	Construct Decentralized Wastewater Collection System Cost: Varies	Secure funding	2013	Coordinator, Community Groups, Local Leadership, Health Department
		complete construction	2014	Local Leadership, Health Department, Contractors
	Implement WBRSD as designed Cost:~ $10 million	Secure funding	2010	WBRSD, Local Leadership, Health Department
		Complete construction	2011+	WBRSD, Local Leadership, Health Department
	Septic System Education Cost: $15K	Link Health department septic system information with soils data and/or data about septic system by address or zipcode	2010	Coordinator, Health Department, Purdue Extension, SWCD
		Distribute materials with care and maintenance recommendations that are specific to the location and season they are mailed	2011	Coordinator, Health Department, Purdue Extension, SWCD

Table 6.4.4: Wastewater Measures Action Register

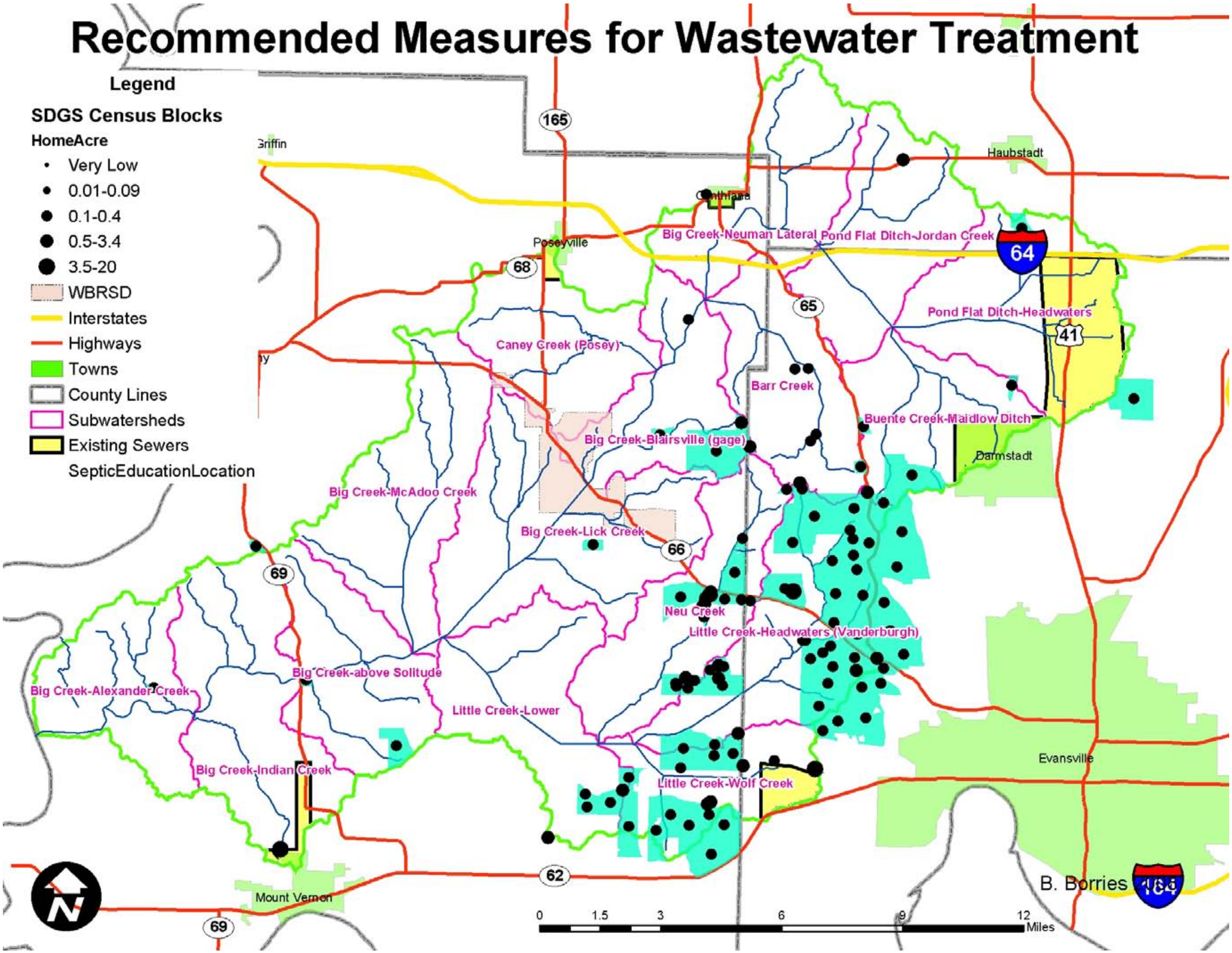


Figure 6.4-A: Locations of Recommended Measures for Wastewater Treatment

6.5: Storm water Treatment & Management

The steering committee and the public expressed numerous concerns over the treatment and management of storm water. Posey County does not have a drainage ordinance and Vanderburgh and Gibson Counties' ordinance only affect 10-year storm event discharges. None of the counties have specific regulations for protecting water quality beyond what is required by state or federal standards. Vanderburgh County is a Municipal Separate Storm Sewer System (MS4) community. This means that the community operates a rain water conveyance system serving over 10,000 people in an urban area. Input from public meetings identified the use of wetlands and drainage as concerns. Some concerns were specifically related to the management of storm water runoff from residential areas where pavement increases the peak discharge. Committee members also identified the need for measures that address contaminated runoff from cropland with internal drainage and tile drains where filter strips would be ineffective.

6.5.1: Wetland Enhancement

Summary:

Degradation of existing wetlands has occurred because of silt loads, historic channelization, and historic draining. As a result, many existing wetlands do not hold water for as long or have lost most of their hydrologic connection to the rest of the stream systems. Wetland enhancement can increase the treatment, ecologic, and hydrologic functions of wetlands by restoring them to their original condition or otherwise improving them.

Locations:

Figure 6.5-A: Locations of Recommended Areas for Storm Water Treatment and Management shows the locations of existing wetlands and lakes. Many wetlands, especially along Big Creek where channelization occurred nearly a hundred years ago, have lost some of the hydrologic connection to the surrounding area through berms between the surrounding land uses and the wetland or historic drainage ditches that have lowered the pool elevation.

Load and Cost Estimates:

Load reductions cannot be predicted without individual assessments of the wetland and their drainages, but a newly constructed wetland is expected to treat as much as 71% of suspended sediment, 55% of nitrate, 41% of phosphorous, and 26% of ammonia nitrogen. NRCS cost estimate data price wetland enhancement at $2000/acre.

Other Impacts:

Introducing contaminated flow to a wetland or changing its hydrologic regime for flood control or treatment purposes may cause negative effects to the flora and fauna of the wetland even if other functions are improved. On the other hand, a wetland enhancement where present ecology is considered may improve the diversity and other measures of the quality of the flora and fauna assemblage.

6.5.2: Constructed Wetlands

Summary:

Where pollutant loads are so high that acceptable best management practices will likely not achieve water quality standards and desired levels due to land use intensity and landscape features, constructed wetlands are an effective way to treat the contaminated storm water runoff.

Locations:

Figure 6.5-A: Locations of Locations of Recommended Areas for Storm Water Treatment and Management shows the locations of sample point regions where needed pollutant reductions were so high that it is unlikely water quality goals can be achieved with any combinations of the other recommended measures. These areas are good candidates for achieving water quality targets with constructed wetlands.

Load Reductions and Cost Estimates:

Load reductions will vary depending on the design of the wetland, but when properly constructed, wetlands may treat as much as 71% of suspended sediment, 55% of nitrate, 41% of phosphorous, and 26% of ammonia nitrogen. According to NRCS cost estimate data, constructed wetlands cost $2000/acre to establish. If land must be purchased, this amount may be increased by $2000 - $10000/acre depending on the cost of the land.

Other Impacts:

Constructed wetlands, in addition to reducing pollutant loads, also reduce the length and intensity of flooding by retaining water in storage areas. On the other hand, wetlands are costly to install and normally require that productive lands be set aside as a permanent wetland.

6.5.3: Urban & Sub-urban Measures

Summary:

A number of best management practices are recommended for controlling urban and sub-urban stormwater and runoff including constructed wetland, retention basins, and permeable concrete. Only general recommendations, cost estimates, and load estimates will be made here due to the limited impact of urban and sub-urban areas in the watershed.

Locations:

Figure 6.5-A: Locations of Recommended Areas for Storm Water Treatment and Management shows the locations of incorporated areas, low and high density residential/commercial/industrial areas, and sub-divisions. Recommendations apply to all residential/commercial/industrial areas.

Load Reductions & Cost Estimate:

Load reductions may vary, but the table shown below indicates average reduction with different BMPs. The Indiana Advisory Committee on Intergovernmental Regulations Financial Needs for Wastewater and Water Infrastructure was used to obtain cost estimates for storm water treatment & management for urban & sub-urban areas. The document provides a generalized cost per acre per year depending on whether incidental, minimum, moderate, advanced, or exceptional management is needed. For the estimate it was assumed that Posey County was currently using incidental management. This is defined as reactive incidental maintenance and regulation as part of other programs. It is recommended that Posey County shift to moderate management defined as additional maintenance programs, better regulation and inspection, some planning, minor capital programs, and general upgrade of capabilities (Lindsey et. al 2003). According to the study, this shift will cost $45-$60/acre (of developed land) per year. It was assumed that Vanderburgh County is already at the moderate level and due to the increasing population should shift to the advanced level. This includes added maintenance, master planning, regional treatment, some water quality data collection, multi-objective planning, strong control of development and other programs, and utility funding. This shift will cost $30-$60/acre per year.

Other Impacts:

Establishing more comprehensive storm water controls may have dramatic impacts on county government who would have to endure much of the cost. The only staff Posey County maintains for urban and sub-urban storm water issues is one part time employee for reviewing storm water pollution prevention plans. A drainage board oversees mostly agricultural ditches and a planning and zoning commission has other regulatory authority but none specific to water quality. Vanderburgh County has more regulations, staff, and organizational structure, but is still deficient in areas of their MS4 requirements. Vanderburgh County does not currently have a program to assess post-construction BMPs after the construction has ended and does not have a plan or measure for conserving natural areas.

6.5.4: Standards and Specifications

The NRCS eFOTG offers standards and specifications for constructed wetlands, and wetland enhancement. IDEM issues guidelines for all MS4 communities to follow.

6.5.5: Action Register

Measure	Action Items	Milestones	Timeline	Responsible parties
Storm water Treatment and Management Goals Addressed: *1. Sediment Loading & Soil Loss* *2. Pathogens* *3. Channel Quality*	Demonstration Project: Constructed Wetland or Wetland Enhancement Cost: $25K	1.Identify Landowners/Farmer Promoters	2009	Coordinator, Steering Committee
		2. Establish constructed wetland or enhance existing wetland	2010	Farmer Promoters, Coordinator
		3. Track costs & benefits to share in further outreach	2010+	Farmer Promoters, Coordinator
		4. Host field day	2010+ (every other year)	Coordinator, Soil & Water Conservation Districts
		5. Field day attendees and others adopt or install practices	2010+ (every other year)	Coordinator

4. Nutrient Loading & Loss *5. Education*	Technical Assistance & Education (general) Cost: $1k-$5K/year	1. Identify most pertinant issues for adopting measures	2009	Coordinator, Steering Committee
		2. Develop targeted informational/technical materials	2010+	Coordinator
		3. Distribute materials at events or by request	2010+	Coordinator, SWCD, Purdue Extension
		4. Provide one-on-one assistance to landowners installing or adopting practices	2010+	Coordinator, NRCS, Purdue Extension Service, ISDA, SWCD, FSA
	Administer additional cost-share or incentive opportunities Cost: $1K-$5K/year Cost-share target: 75%	1. Research and Identify potential opportunities, apply for grants where needed	2009	Coordinator, Steering Committee SWCD, NRCS, ISDA, IDNR
		2. Create materials or other means to outline cost-share opportunities for recommended measures	2010+	Coordinator
		3. Contact individuals or distribute materials	2010+	Coordinator
		4. Assist with necessary paperwork for landowners to receive funding for adopting or installing practices	2010+	Coordinator, SWCD, NRCS, ISDA, IDNR

Table 6.5.5-A: Storm water Treatment and Management

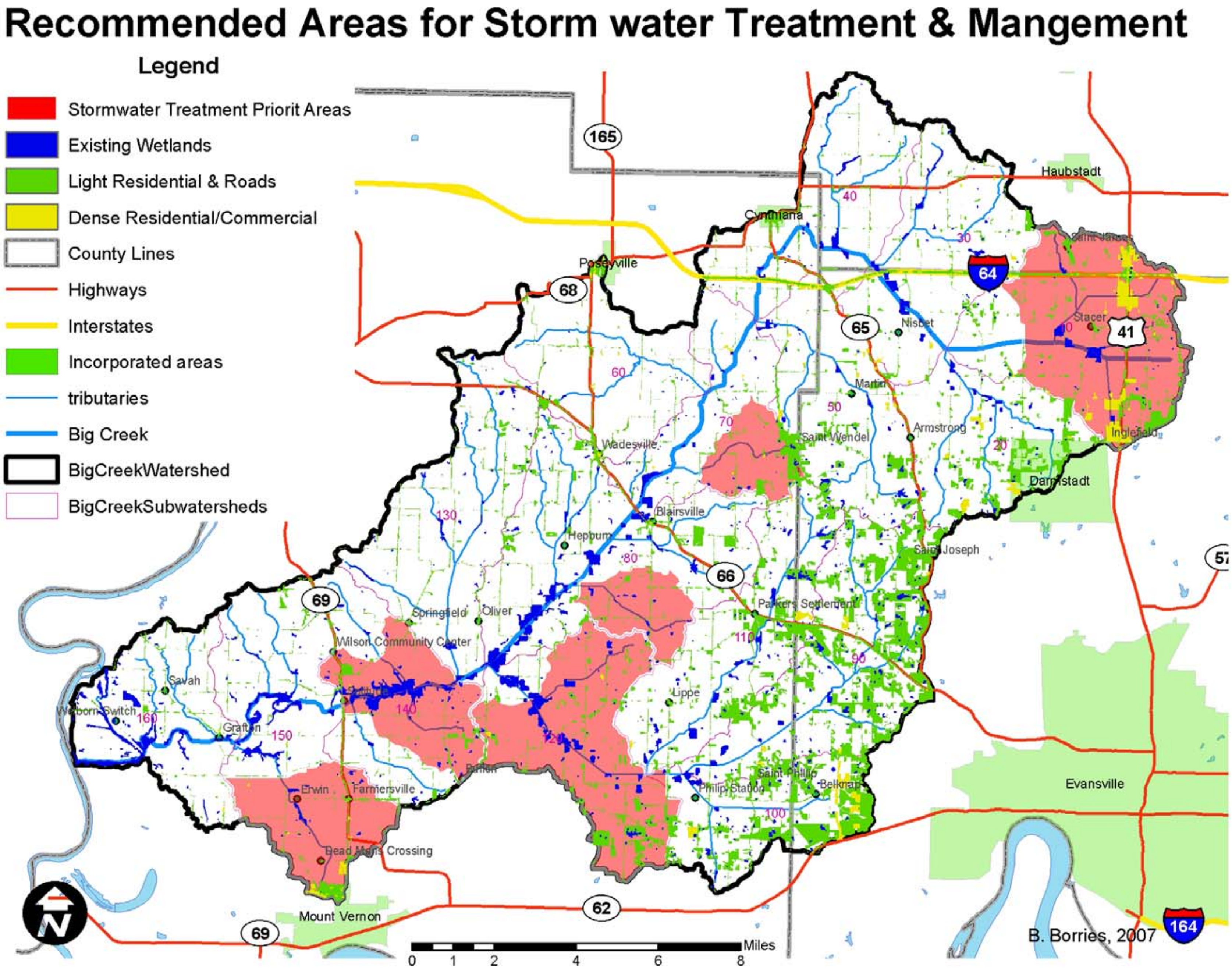


Figure 6.5-A: Recommended Areas for Storm Water Treatment and Management