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Mill Creek-Blue River Watershed Management Plan

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MISSION STATEMENT

"To protect the Mill Creek-Blue River Watershed through education, research and identification of best management practices."

VISION STATEMENT

"A healthy watershed that is sustainable for all Washington County residents."

THANK YOU!

MCBR would not have seen or experienced the many successes in this project if it weren't for the partnerships that were developed by stakeholders, community members and the general public. The partnerships developed throughout the Mill Creek-Blue River Watershed Project helped complete tasks and goals of the project. Each task had numerous supporting agencies, organizations, groups, and individuals who made this project a success. MCBR would like to highlight those organizations and expresses regret if anyone was overlooked.

Indiana Department of Environmental Management – Office of Water Quality
Mill Creek-Blue River Watershed Steering Committee
Washington County Soil & Water Conservation District
White River Resource and Conservation Development
Natural Resource Conservation Service
Indiana State Department of Agriculture
Farm Service Agency
Washington County Purdue Extension
The Nature Conservancy
Salem School Corporation
East Washington School Corporation
West Washington School Corporation
Salem High School Science Department and Club
Landowners along streams and rivers in the Mill Creek-Blue River Watershed
Environmental Laboratories, Inc.
Commonwealth Biomonitoring
City of Salem – Mayor's Office, Fire Department, Parks & Recreations, Streets & Sanitation, Sherriff's Department, Waste Water
Washington County – Commissioners, County Council, Health Department, Planning Commission, Surveyor
Washington County Chamber of Commerce
Purdue University Department of Forestry and Natural Resources
Indiana Department of Fish and Wildlife
Indiana Department of Natural Resources
Washington County Rotary Club
The Salem Leader
Washington County Edition
Zink Signs
Salem True Value
Indiana Conservation Cropping Systems Initiative
US Fish and Wildlife
Indiana Farm Bureau, Inc.
Farbest Farms, Inc.
White River Co-op
Good Earth Master Gardeners
WSLM Radio 97.9FM
Friends of Becks Mill

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ACRONYM LIST

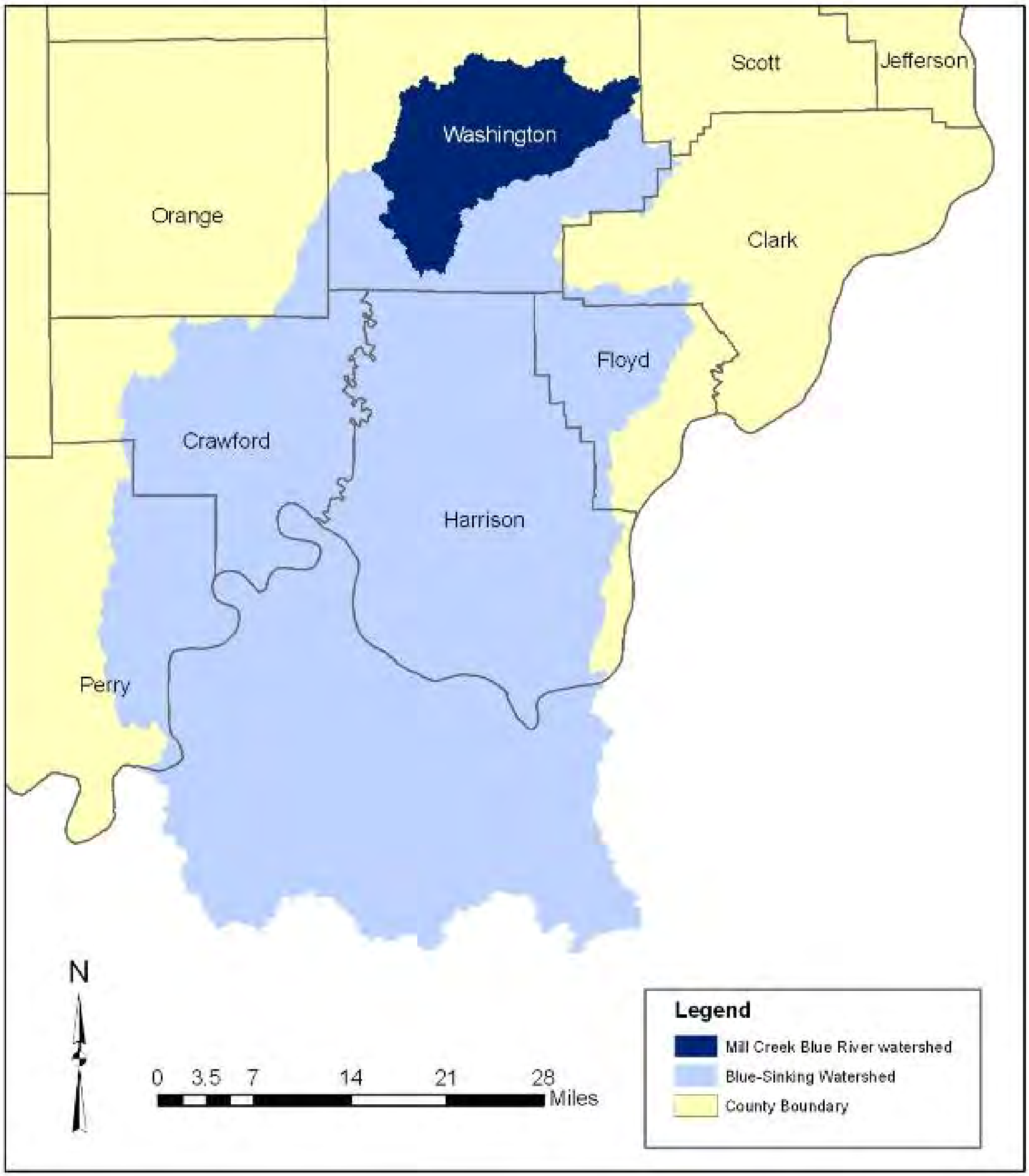
AFO – Animal Feeding Operation
BMP – Best Management Practice
BEHI – Bank Erosion Hazard Index
C – Celsius
CAFO – Concentrated Animal Feeding Operation
CFO – Confined Feeding Operation
CFU – Colony Forming Units
DO – Dissolved Oxygen
E. coli - Escherichia coli
FEMA – Federal Emergency Management Agency
FSA – Farm Service Agency
ft. – Foot/Feet
GIS – Geographic Information System
HBI – Hilsenof Biotic Index
HEL – Highly Erodible Land
HES – Highly Erodible Soil
HUC – Hydrologic Unit Code
IDEM – Indiana Department of Environmental Management
IDNR – Indiana Department of Natural Resources
IGS – Indiana Geological Survey
IKC – Indiana Karst Conservancy
ISDA – Indiana State Department of Agriculture
KICK – Single habitat macroinvertebrate collection method
L – Liter
lb. – Pound/Pounds
LARE – Lake and River Enhancement Program
LUST – Leaking Underground Storage Tank
MCBR – Mill Creek-Blue River Watershed Project
mg. – Milligrams
MHAB – Multi-habitat macroinvertebrate collection method
mIBI – Macroinvertebrate Index of Biotic Integrity
mL – Milliliter
NPDES – National Pollution Discharge Elimination System
NRCS – Natural Resource Conservation Service
NTCHS - National Technical Committee for Hydric Soils
NTU – Nephelometric Turbidity Units
NWI – National Wetlands Inventory
QHEI – Qualitative Habitat Evaluation Index
PHEL – Potentially Highly Erodible Land
PTI – Pollution Tolerance Index
RC&D –Resource Conservation and Development
REHS – Registered Environmental Health Specialist
sec - Second
SICWMA – Southern Indiana Cooperative Weed Management Area

SPEA – School of Public and Environmental Affairs
SWCD – Soil and Water Conservation District
T&E – Threatened and Endangered Species
TKN – Total Kjeldahl Nitrogen
TNC – The Nature Conservancy
USDA – United States Department of Agriculture
USEPA – United States Environmental Protection Agency
USFWS – United States Fish and Wildlife Service
USGS – United States Geological Survey
USTs – Underground Storage Tanks

1.0 Watershed Community Initiative

The state of Indiana is divided up into 39, 8-digit Hydrologic Unit Code watersheds. Each watershed is labeled and identified by a Hydrologic Unit Code (HUC). Within each 8-digit HUC watershed is located 10-digit HUC watersheds. The Mill Creek-Blue River Watershed (MCBR) is a 10-digit HUC watershed (0514010407) and is located in the lower central portion of Washington County, Indiana, in the Blue-Sinking Watershed (05140104). Figure 1 shows the location of MCBR and where it is located in the Blue-Sinking Watershed.

Figure 1. – Blue-Sinking and Mill Creek-Blue River Watershed Locations



The Mill Creek-Blue River (MCBR) watershed covers 99,854 acres and includes six 12-digit sub-watersheds (Figure 2, Table 1). Detailed information about each subwatershed is discussed in 4.0 Watershed Inventory II-B: Subwatershed Discussions.

Figure 2. - 12-digit Subwatersheds of Mill Creek-Blue River Watershed

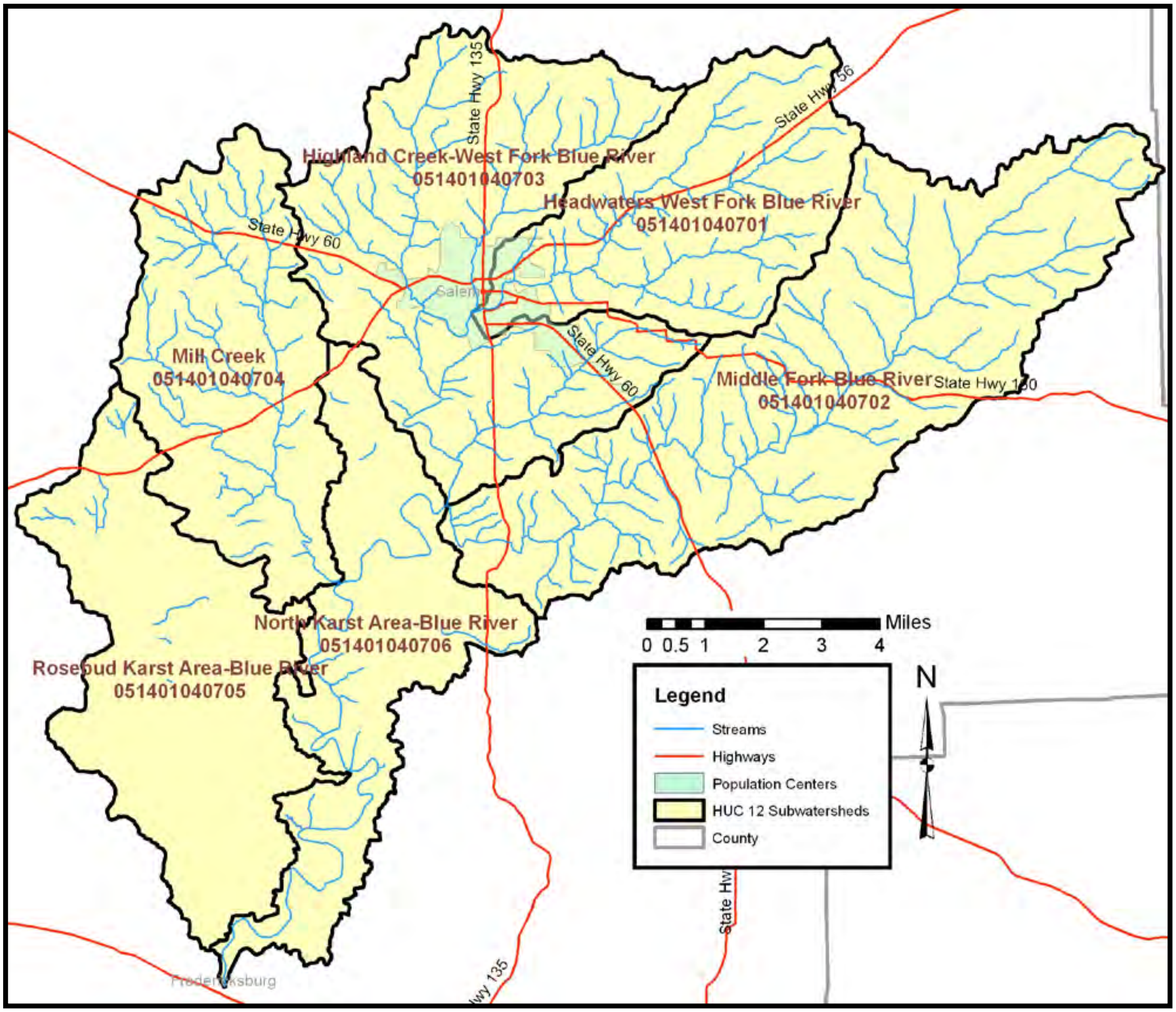


Table 1. - 12-digit Subwatersheds in MCBR Watershed

Name	HUC	Area (Acres)
Headwaters West Fork Blue River	051501040701	12,516.07
Middle Fork Blue River	051401040702	25,733.08
Highland Creek-West Fork Blue River	051401040703	19,884.64
Mill Creek	051401040704	13,413.48
Rosebud Karst Area-Blue River	051401040705	15,813.45
North Karst Area-Blue River	051401040706	12,493.05

There is approximately 117 miles of streams in the watershed including 19.3 miles of Blue River, 17.5 miles of Blue River Middle Fork, 13.9 miles of West Fork Blue River, 7.2 miles of Mill Creek, 4.7 miles Highland Creek, 4.6 miles of Brock Creek, 3 miles of Lockwood Branch, 1.96 miles of Goose Creek, 1.02 miles of Hoggatt Branch, and 43 miles of unnamed streams.

Approximately 36% of the watershed is used for pasture and hay land, 29% is forestland, 26% is cultivated cropland, 6% is open space, 1% is urban and the remaining 2% is open water and wetlands as identified by United States Geological Survey (USGS) land use land cover data layer.

The most populated portion of the watershed, the City of Salem, is located in the middle of the watershed. Salem has a population of 6,463 residents. The City of Salem, Indiana and many residents within the Mill Creek-Blue River Watershed have an interest and passion for good water quality. There are many water features, whether historic or needed for everyday use, that affect the individuals in this area.

In the watershed, many individuals expressed concerns, including ones pertaining to water quality, through local events, publications and public meetings. Through these events and publications, some concerns came to the attention of local conservation organizations. Areas of water with possible *E.coli* contamination, sedimentation and excess nutrients led stakeholders of the watershed to see the need to develop a plan of action.

In August of 2008, seeing the need to address these concerns and provide education to prevent future water quality problems, the White River Resource Conservation and Development (RC&D) took action. The need for awareness of water quality concerns led to the Mill Creek-Blue River Project (MCBR). This project was designed to develop a watershed management plan, complete water quality testing, and promote water quality education in the watershed. The grant was awarded to the White River RC&D in November 2010 from the Indiana Department of Environmental Management (IDEM).

Local community members were encouraged to attend the kick-off stakeholder meeting through press releases in Salem's *The Leader* and Salem's *The Salem Democrat.* Flyers were distributed among the community and placed on display boards and bulletins to announce the first meeting. Also, introductions to the watershed project were announced at various town and local organizational meetings. Additionally, a database of key stakeholders located in the watershed was developed and each recipient was sent a formal invitation to attend the February meeting.

In February 2011, two stakeholder meetings, scheduled on the same day at different times, were held to highlight and share ongoing concerns of the community (Table 2). The goals of the first meetings were to establish a steering committee of local stakeholders to develop a Watershed Management Plan for Mill Creek-Blue River Watershed. As a result of the stakeholder meeting, a list of goals was set to precede hands-on involvement of a steering committee.

The goals of the Steering Committee are to:

1. Develop watershed management plan by:
    a. Develop mission statement and vision statement;
    b. Define pollutant sources and causes, area of protection and problem statements;
    c. Set goals and develop solutions based on measurable indicators from water testing results of watershed streams;
    d. Create an action plan to set priorities, timeframes, and task assignments;
    e. Evaluate the plan by interests generated through the watershed group and data obtained though monitoring.
2. Attend scheduled MCBR Steering Committee meetings;
3. Attend and support watershed project activities;
4. Promote and share watershed plan information with the community.

1.1 Project Initiative

After the kick off meeting, individuals were informed of the various tasks to be implemented to complete the watershed management plan. Stakeholder involvement is key to developing a watershed management plan. Stakeholder involvement and interest were stressed in areas of the watershed management plan, education in the classroom, public workshops and field days, stream bank clean-up events, storm drain marking events and water testing and monitoring.

Support will be given by the stakeholders to help in the development of the watershed management plan through support, assistance, and/or representation on the watershed steering committee.

1.2 Mill Creek-Blue River Steering Committee and Stakeholders Concerns

Stakeholders who showed interest in becoming a part of the Mill Creek-Blue River Watershed Project (Table 3) set up their first meeting. The first steering committee meeting was held on March 8, 2011, 5:00PM in the Washington County USDA Service Center Conference Room.

At each of the February stakeholder meetings, a number of concerns were communicated and written down on a poster pad for everyone to see and review. These points were revisited again for individuals who did not attend the stakeholder meeting. The review of these concerns led to discussion of goals and outcomes the steering committee would like to further pursue in the next two years.

Steering Committee Members discussed and reviewed the stakeholder concerns and ideas of interest to focus on as the project began, including aquatic habitat and environment, water runoff from agriculture, urban/residential and industrial, lack of knowledge to care for and maintain wetland property, karst areas and septic systems, and educating the public, both young and old, of water quality in our watershed.

At the conclusion of the first meeting, members developed a vision and mission statement. The Steering Committee's vision is to "Have a healthy watershed that is sustainable for Washington County residents." Through this vision, their main mission with this project is, "To protect the

Mill Creek-Blue River Watershed through education, research and identification of best management practices."

Table 2. - Stakeholder Concerns in Mill Creek-Blue River Watershed

Make sure to focus on "all" aspects of land use – urban, suburban, agriculture, forests
Seeing stability in biological data
Hellbender Salamander – decreasing and at critical level, reproduction level is low
Seeing improvements after introduction of new waste water treatment plant
Population data for small and large mouth bass through state (1998-every two years), strictly sport fish, and data for Lake Salinda
Maintaining septic systems – help Karsts Purdue study – 1/3 are failing
People dumping into sinkholes
Development and lack of land owner maintenance near or in the floodplain areas.
Lake Salinda – water quality issues
Concerns about bypass construction and how that will affect water quality
Stream bank erosion
Log jams in Blue River
Invasive species, both plant and animals
Trash in the river and on the streets
Increase of water speed due to impervious surfaces in Salem
Livestock with access to streams and creeks
Overuse of fertilizers
No filter strips along rivers and creeks

Other comments and information that have been presented during these meetings were recorded too. These were used to further education of the steering committee and in the development of the watershed management plan. These included:

- Purdue research from graduate student and teachers – 7 testing sites completed once per week for nine months (tested for general and pesticides 20-30), manuscript available after publication;
- 2007-09 grant received for Eastern Hellbender salamander (Purdue University) – assess population, health utilization of habitat, population density down in Indiana, health remains good, few reproductive species, dissolved oxygen was good, eutrophication low, 3 pesticides came back in readable amounts April-June;
- Develop Eastern Hellbender traveling exhibit;
- Partner with Purdue University to educate on Eastern Hellbender;
- Work with Purdue University to identify water testing sites.

Table 3. Mill Creek-Blue River Steering Committee Members

	Steering Committee Member	Organization Represented
1	Tom Godfrey	Washington County SWCD
2	Michael Ponsford	Washington County SWCD
3	Jim Brown	Washington County SWCD
4	Larry Lehman	Salem, Indiana Resident
5	John Calhoun	Salem High School
6	Greg McCurdy	Salem High School
7	Jim Day	Salem, Indiana Landowner
8	Jack Mahuron	Salem, Indiana Resident
9	Cassie Hauswald	The Nature Conservancy
10	Ruth Hackman	Natural Resource Conservation Service
11	Seth Harden	Natural Resource Conservation Service
12	David Hoar	White River Resource Conservation and Development
13	Brad Shelton	Washington County Purdue Extension
14	Danielle Walker	Washington County Purdue Extension
15	Kevin Baird	Indiana State Department of Agriculture

2.0 WATERSHED INVENTORY I – Geology/Topography, Hydrology, Soils, Land Use, and Planning Efforts

Washington County, Indiana, is known for its unique, diverse lay of the land. Residents and visitors are attracted to many natural sites including Historic Becks Mill, Delaney Park and Jackson-Washington State Forest.

2.1 Geology/Topography

"During the War of 1812, caves with large bat populations were sources of saltpeter – potassium nitrate – the major ingredient of black powder. Early settler used flowing springs and waterfalls at cave entrances to turn waterwheels that drove sawmills and gristmills. Some caves became fruit cellars and other became commercial tourist attractions" (Camp, Mark J. and Graham T. Richardson, pg. 80).

Collectively, the watershed has a very diverse lay of the land due to the steep hills, karst areas, sinkholes and various flat areas. The steep hills increase the velocity of water traveling or exiting across forest or cropland. The sinkholes can hold water or be instantly formed, consuming available water. Sinkholes vary from year to year. These characteristics can be found miles or even feet apart from each other.

In the southern portion of MCBR, karst is a distinctive type of landscape or topography (Figure A). Karst landscapes usually occur where carbonate rocks (limestone and dolostone) underlie the surface. Freely circulating slightly acidic rainwater and the water in the soil slowly dissolve the fractures in the limestone and create sinkholes, caves, and other features that characterize karst landscapes. The drainage alternates because of the sinkholes. These features are sensitive to contamination because most of the surface water flows directly into them and, therefore, are not filtered by soil and bedrock (Mark A. Buehler, Hasenmueller, Powell, and Sowder, 2002).

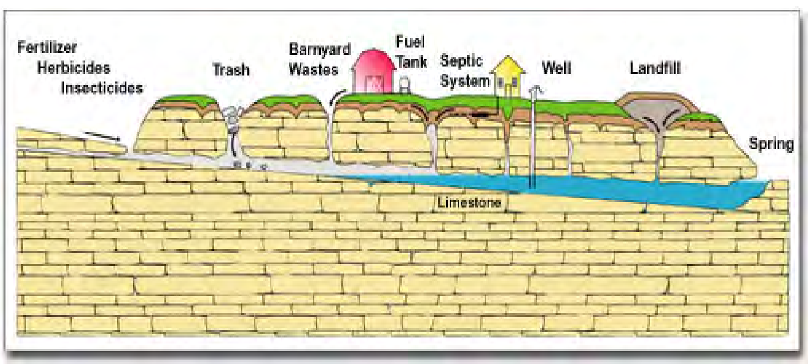


Figure A. Underground Karst Diagram
Diagram concept by R.L. Powell; drafted by R.S. Taylor

The Nature Conservancy (TNC) states the karst area of Indiana as a wondrous but delicate underground ecosystem. "Caves provide essential habitat for unique plants and animals, some of which spend their entire lives in complete darkness - many of them that would not be able to survive otherwise. With our biodiversity at risk, it is important to be careful above and below our karst regions. With some of the species at risk of extinction, it is important to take care when caving as not to disturb what is down below."

Another important reason to be concerned about karst and caves is the systems carry water from the surface to the underground aquifers where most of our drinking water originates. In fact, almost 25% of the groundwater is located in caves and karst regions. The protection and management of these vital water resources are critical to public health and to sustainable economic development. Once a cave is damaged, its formations and the creatures that live within it cannot be recovered.

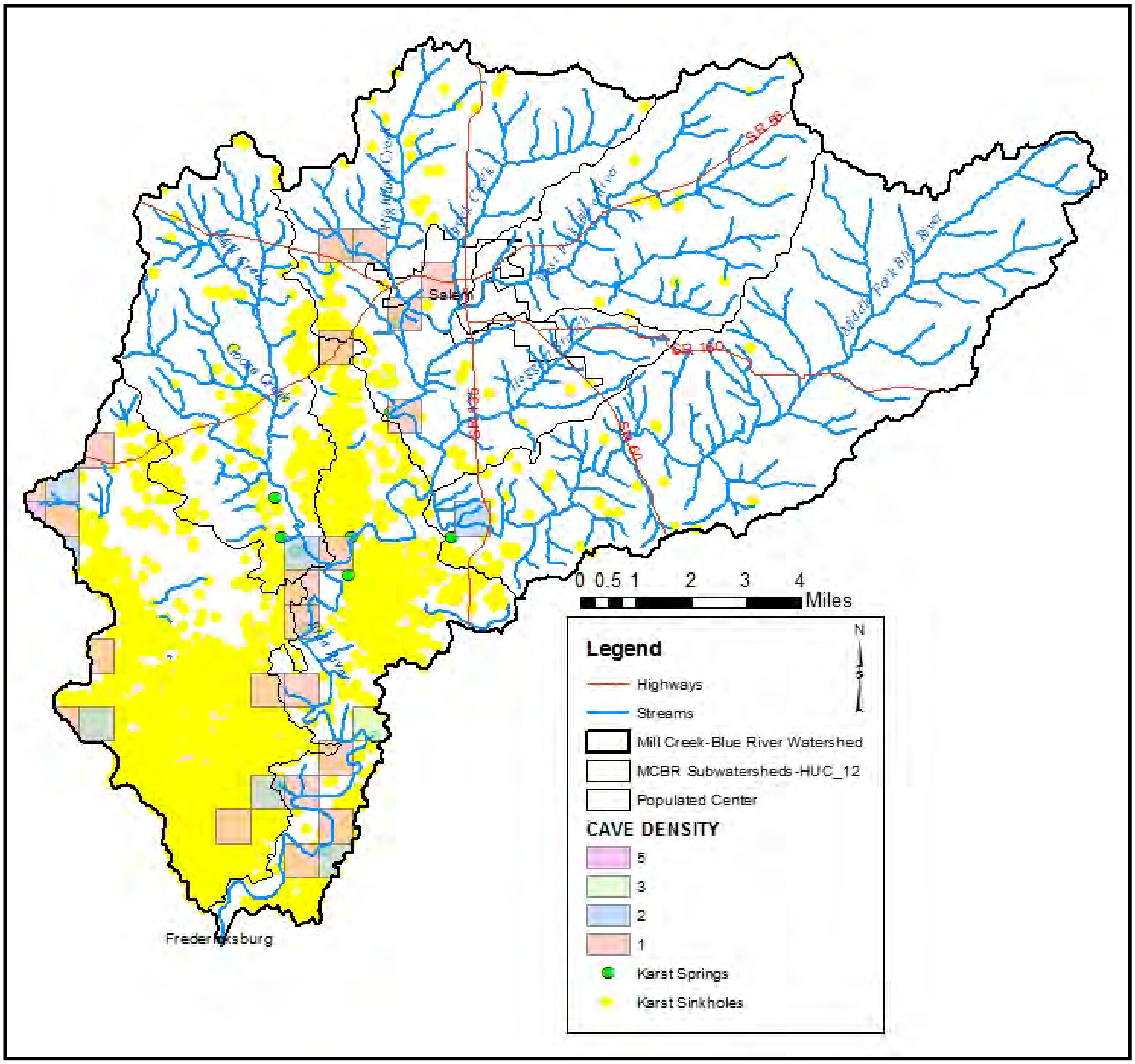
Karst systems are critical environmental resources. In fact, 40% of our drinking water passes through cave and karst systems. According the USGS's Ground Water Resources Program, "the importance of ground-water in complex geologic environments can no longer be overlooked" (The Natural Heritage of Indiana, 2011).

Bill Schulze, Indiana Karst Conservancy (IKC), shared his knowledge and interpretation of the karst and cave features in the MCBR Watershed. "Approximately 95 square miles of karst and sinking stream areas are found in the Blue-Sinking watershed. Karst spring density appears to occur predominately within three miles of Blue River. Topographically, limestone is a primary formation of the Blue River group in the cave features" (W. Schulze, 2011).

Stated in the NRCS watershed assessment document, (2006) "The Blue-Sinking watershed is located in extreme southern part of Indiana. The watershed encompasses approximately 1,242 square miles in eight different counties. It is subdivided into 68 sub basins represented on the map by 12 digit HUCs. The Crawford Upland region is typical of karst (limestone) topography with its many sink holes and caves formed as water dissolved the rock. The limestone walls along the Blue River are usually shrouded in a heavy cover of trees and shrubs." (Natural Resource Conservation Service, page 3). This plateau developed on Mississippian limestones and extends from the eastern part of Owen County southward to the Ohio River in Harrison County. The second karst area is located in southeastern Indiana and is known as the Muscatatuck Plateau. This plateau developed on limestones of Silurian and Devonian age." The IGS karst landscape is identified in Figure 3.

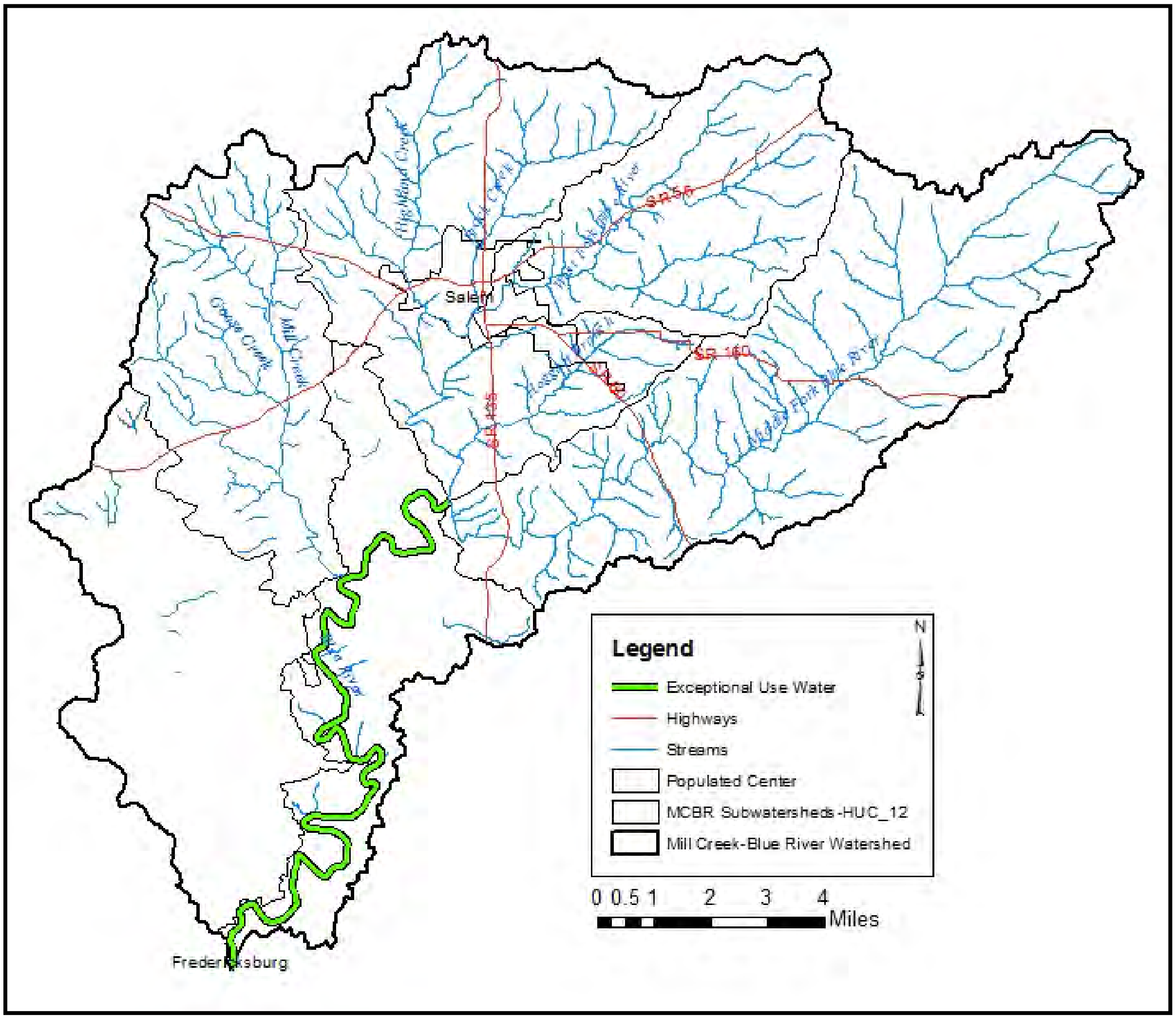
Furthermore, MCBR is located at the north of the Blue-Sinking Watershed and contains 16,982 acres of karst features. This area is identified in Figure 3. Due to the vulnerability of karst areas, it is important to educate and communicate with the community of these sensitive areas. This land is used for beneficial resources including drinking water, ecosystems of wildlife, and septic systems – to name a few (Protecting Natural Resources, 2011).

Figure 3. – Karst and Sinkhole Areas in the Mill Creek-Blue River Watershed



2.2 Hydrology
Watershed Streams
As mentioned in the introduction, there are approximately 117 miles of streams in the watershed including 19.3 miles of Blue River, 17.5 miles of Blue River Middle Fork, 13.9 miles of West Fork Blue River, 7.2 miles of Mill Creek, 4.7 miles of Highland Creek, 4.6 miles of Brock Creek, 3 miles of Lockwood Branch, 1.96 miles of Goose Creek, 1.02 miles of Haggott Branch, and 43 miles of unnamed streams (Figure 4.). An approximately 18 mile segment of the Blue River within the watershed is classified as exceptional use water in the Indiana Water Quality Standards (IAC 2-1-11(b)). Exceptional use waters are those that provide unusual aquatic habitat, are an integral feature of an area of exceptional natural beauty or character; or support unique assemblages of aquatic organisms.

Figure 4 . – Streams of Mill Creek-Blue River Watershed



Lakes and Wetlands
As defined by EPA, “Wetlands are areas where water covers the soil, or is present either at or near the surface of the soil all year or for varying periods of time during the year, including during the growing season.”

Wetlands have many beneficial characteristics to help sustain wildlife, also. “Inland wetlands are most common on floodplains along rivers and streams (riparian wetlands), in isolated depressions surrounded by dry land (for example, playas, basins, and "potholes"), along the margins of lakes and ponds, and in other low-lying areas where the groundwater intercepts the soil surface or where precipitation sufficiently saturates the soil (vernal pools and bogs).”

MCBR houses 1,162 acres of wetlands (Figure 5). Stakeholders are concerned with the lack of knowledge to care for and maintain wetland property.

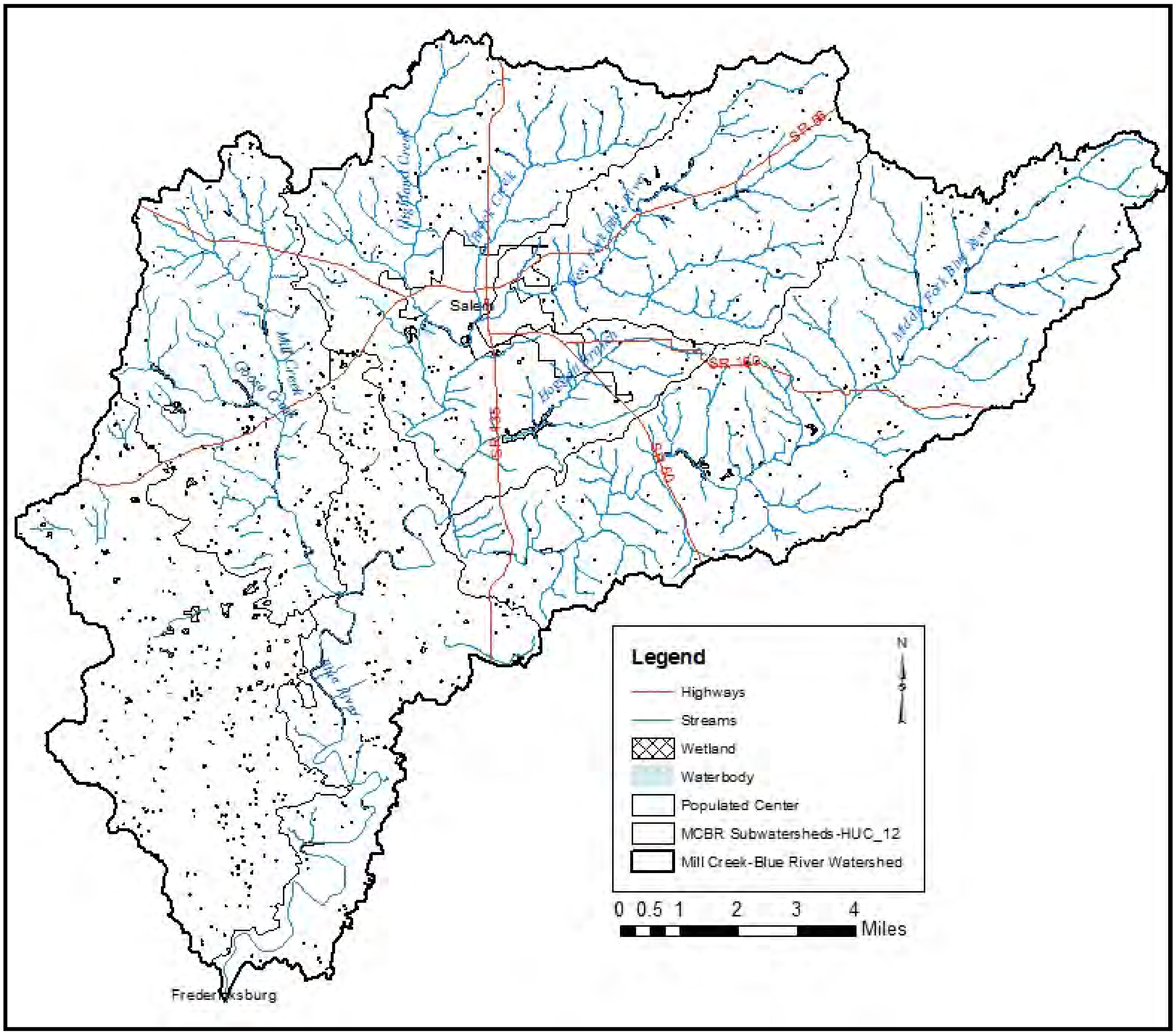
The waters in MCBR watershed are used for various purposes. Approximately 1,056 lakes and ponds cover 375 acres in the watershed, both private and public, it is important to share the importance of water quality to land and home owners (Figure 5).

Water in the watershed includes rivers, creeks, streams, ponds, and lakes. MCBR contains one major lake, Lake Salinda. This is a back-up drinking reservoir for the City of Salem. The lake is located about one half-miles south of Salem. Lake Salinda is estimated to be about 88 acres and mainly used for public recreation and viewing. Lake Salinda was included on IDEM's 2008 303(d) list of impaired waters for algae and taste and odor.

Hydrologic modifications have been developed in the watershed mainly for water use in the City of Salem. Lake Salinda was built in 1947 for the purpose of holding the city's drinking water. A spillway was built by the Army Corps of Engineers to help sustain the water level and reduce sedimentation by widening the spillway from 75 feet to 150 feet. It was developed in 1979. This water is a reserve for the City of Salem if Lake John Hay cannot be used. Lake Salinda was once the primary drinking water source for Salem residents and is now the back-up source. Lake Salinda offers tournament fishing and serves as a popular fishing spot for area anglers. Lake access includes one boat ramp." (City of Salem, 2011).

In MCBR, streams, lakes, and rivers are predominately used by the public. This includes, but is not limited to, viewing pleasure, recreation for swimming, fishing, and floating, volunteer water testing, research of aquatic habitat, back-up water resource for the City of Salem (specifically Lake Salinda) and water access for agriculture livestock.

Figure 5. – Hydrology of the Mill Creek-Blue River Watershed

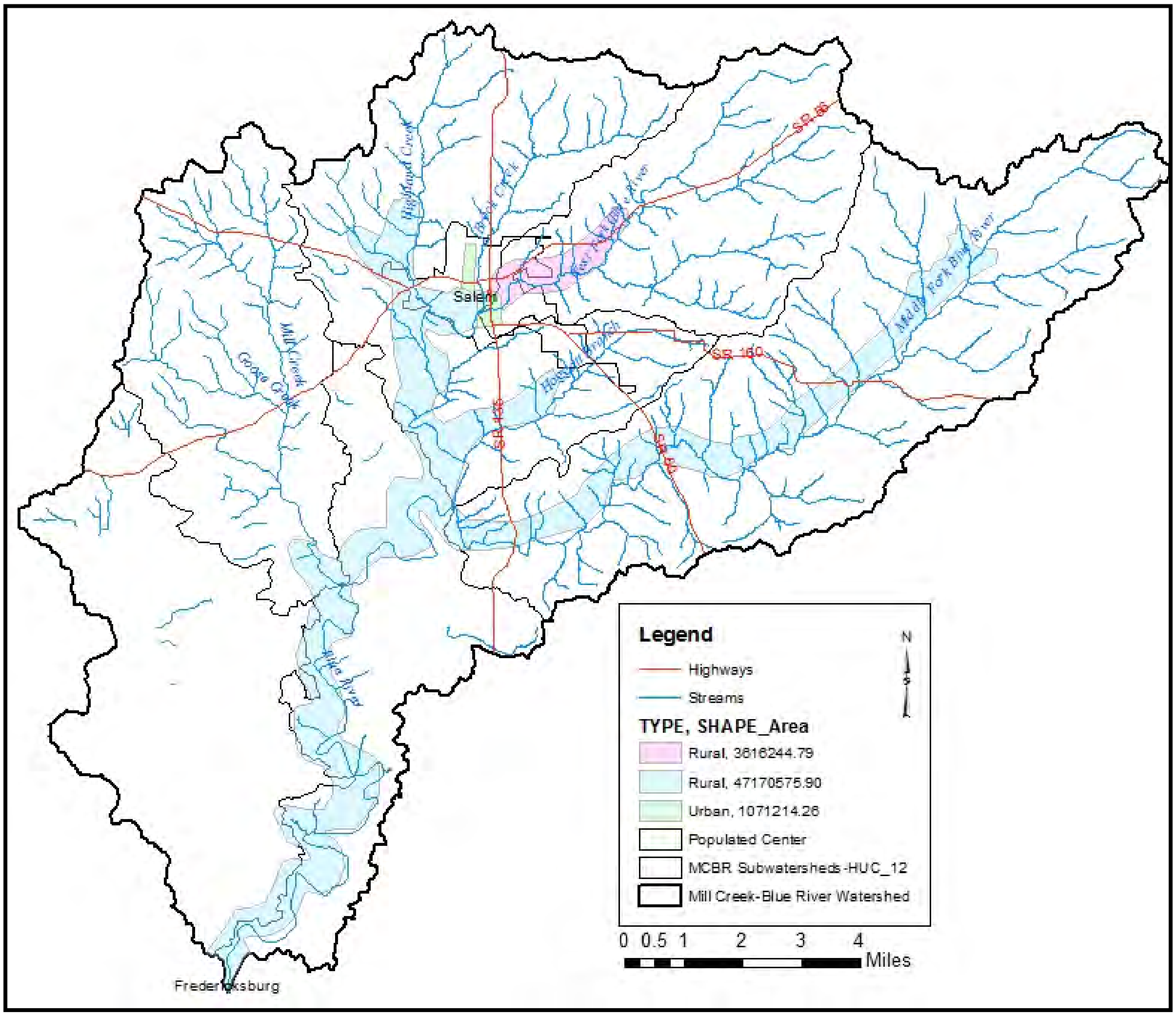


Floodplains

"Floodplains are, in general, those lands most subject to recurring floods, situated adjacent to rivers and streams. Floodplains are therefore "flood-prone" and are hazardous to development activities if the vulnerability of those activities exceeds an acceptable level" (Strahler, A.N. and Strahler. A.H., 1973).

Identified by the Indiana Department of Natural Resources (IDNR), MCBR contains about 2% of floodplain covering 2,324 acres, including rural and urban areas (Figure 6). Local stakeholders are concerned with the development and lack of land owner maintenance near or in the floodplain areas. Floodplains in MCBR are located next to agriculture land, residential development and within the city limits of Salem.

Figure 6. – Floodplain location in the Mill Creek-Blue River Watershed



Stormwater and Storm Drains, Ditches, Legal Drains
Storm drains are located in various locations throughout the watershed, but mainly in the City of Salem. All storm drains lead directly to Brock Creek. This untreated water could relate to the stakeholders concern of sustainable biological habitat in the watershed. Problems could arise if water is moved to drains containing sediment, waste, chemicals, dead animal and plant waste, and other sources of dumping. As confirmed by Jeffrey Souder, Washington County Surveyor, there are no ditches or legal drains in MCBR at this time (J. Souder, personal communication, 25 May 2011).

2.3 Soil Characteristics

There are many soil types found in MCBR. Soil characteristics influence relief, soil type and drainage patterns. The soil types are grouped into soil associations, which are identified at a larger scale. However, soil associations are not used on a field level to make management decisions. Specific soil types are used to make decisions regarding highly erodible soil, hydric soil and septic system suitability for the watershed and are detailed below.

Soil Associations

The watershed is covered by 26 soil associations, covering 92% or 99,392.8 acres of the watershed (Table 4, Figure 7). The other small percentage of the watershed is covered by pits (quarries), 175.9 acres, and water, 216.1 acres. Soil in MCBR can be summarized as susceptible to water erosion from steep hills and predominately high leaching because of the karst topography. The water quickly infiltrates into the soil, taking the nutrients found in the soil with it, and drains into the groundwater. This also can lead to eutrophication downstream. Eutrophication is the process by which a body of water becomes enriched in dissolved nutrients that stimulate the growth of aquatic plant life usually resulting in the depletion of dissolved oxygen.

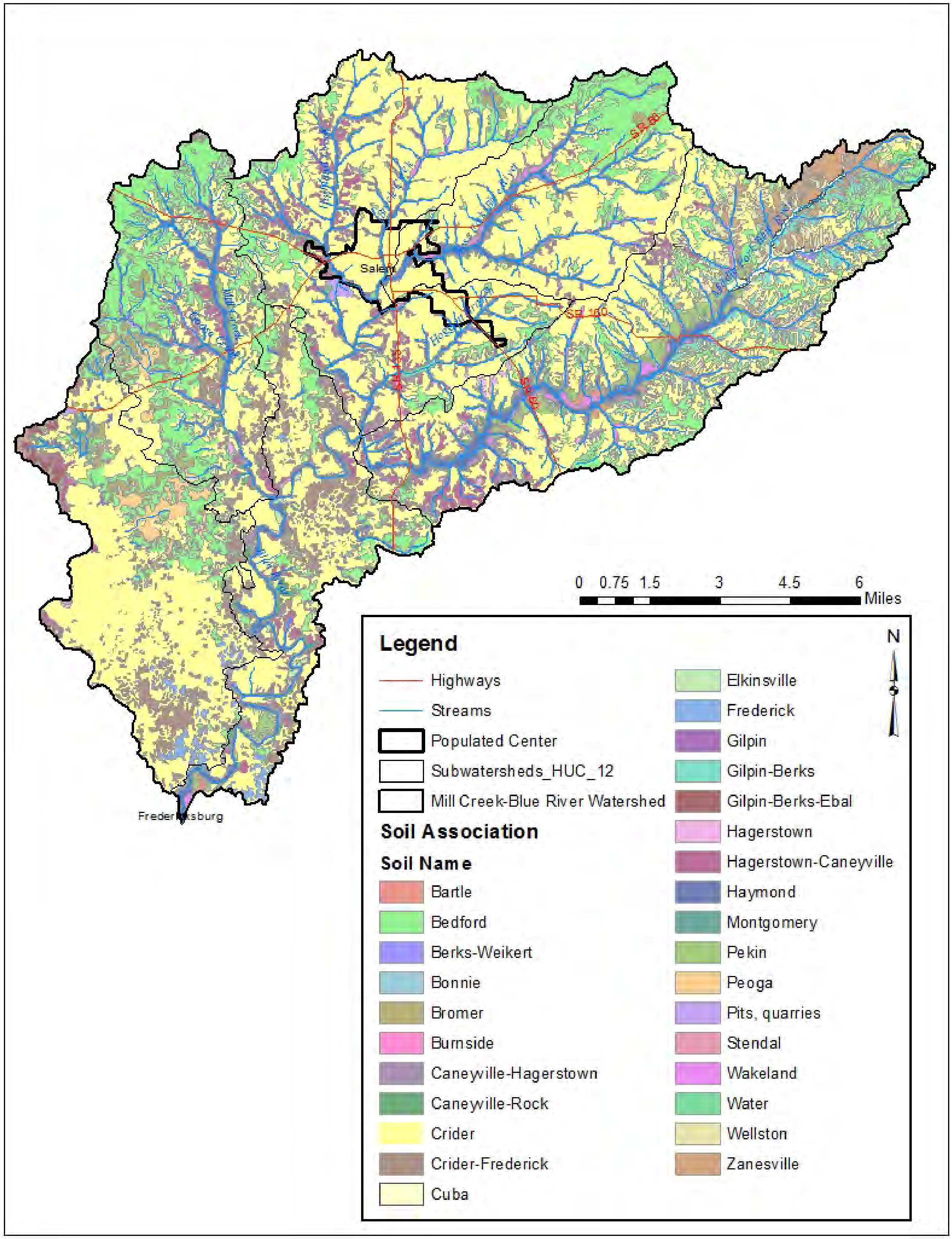
The Crider soil association predominates covering over 48% of the watershed (Table 4, Figure 7). The Crider association is a sloping, deep, well drained soil in the uplands. The soil is moderately permeable and has a high water capacity. Most areas of this soil are used for cultivated crops. Other uses include hay and pasture and specialty cops. Erosion is a hazard, especially near the production of cultivated crops. This soil is well suited for grasses and legumes, trees, dwellings and septic tanks. These recommendations may be limited due to slope steepness.

The Bedford soil association roughly covers 19% of MCBR. Bedford soil is nearly level, deep, moderately well drained and is found on soil uplands. It is moderately permeable above the fragipan and very slowly permeable in the fragipan. The available water capacity is moderate with slow runoff. This soil type is well suited for grasses and some legumes, but is poorly suited to deep-rooted legumes. Also, this soil is well suited for trees. Due to the wetness and very slow permeability, this soil is classified as a severely limited site for septic system use (Robards, 1988).

Table 4. – Soil Associations in the Mill Creek-Blue River Watershed

Soil Name	Area (acres)	Percent of Watershed
Bartle	162.6	0.16%
Bedford	19,044.2	19.16%
Berks-Weikert	111.8	0.11%
Bonnie	3.7	0.004%
Bromer	1,450.5	1.45%
Burnside	1,019.4	1.02%
Caneyville-Hagerstown	1,224.5	1.23%
Crider-Frederick	4,220.6	4.24%
Crider	47,865.5	48.15%
Cuba	337.2	0.33%
Elkinsville	381.7	0.38%
Frederick	756.8	0.76%
Gilpin-Berks-Ebal	286.8	0.28%
Gilpin-Berks	1,964.9	1.97%
Gilpin	12.3	0.01%
Hagerstown-Caneyville	5,546.2	5.58%
Hagerstown	418.8	0.42%
Montgomery	176.4	0.17%
Pekin	1,312.1	1.32%
Peoga	1,070.8	1.07%
Stendal	35.2	0.03%
Wakeland	1,136.4	1.14%
Wellston	1,723.1	1.73%
Zanesville	1,532.8	1.54%
Total	**99,392.8**	**92.25%**

Figure 7. Soil Associations in the Mill Creek-Blue River Watershed



Highly Erodible Soil (HES)
In the NRCS field office tech guide of 1992, Section II-iii-A-(5), describes highly erodible soils as follows. “The Food Security Act of 1985 required that soil survey map units be separated into three categories on the basis of potential erodibility due to wind erosion and sheet and rill erosion. A Highly Erodible Soil Map Unit list designates the category assigned to each map unit. It has been determined that no map units are highly erodible because of only wind erosion in Indiana. The equation for determining potential erodibility from sheet and rill erosion is

$$A=\frac{RK(LS)}{T}$$

(A) is the amount of soil loss in tons per acres, R is the rainfall factor, K is the soil erodibility factor, and L and S are the slope length and steepness factors, respectively, that T is the tolerable soil loss in tons per acre.”

“A map unit is designated highly erodible (class 1) if the value (A) obtained from the $\frac{RK(LS)}{T}$ equation is equal to or greater than 8 when the minimum slope length and minimum slope percent are used.”

“A map unit is designated potentially highly erodible (class 2) if the values obtained from the $\frac{RK(LS)}{T}$ equation is less than 8 when the minimum slope length and minimum slope percent are used.

A map unit is designated not highly erodible (class 3) if the values obtained from the $\frac{RK(LS)}{T}$ equation is less than 8 when the maximum slope length and maximum slope percent are used.”

“The minimum and maximum slope percent are obtained from the map unit name, i.e. Miami silt loam, 2 to 6 percent slopes. Two is the minimum value and 6 is the maximum value. The minimum and maximum slope lengths were determined by district conservationists, soil scientists and other local people.”

Moreover, highly erodible land is identified by two factors according to NRCS; slope and feet. The distance measured to determine the slope also is used to define the steepness of the soil type. The soil type is marked with a map symbol to describe the steepness. For example, Bedford silt loam, 2% to 6% slope is abbreviated BdB. Bd represents the soil type, Bedford, and the last letter, B, defines the percent slope. This soil type is not considered a highly erodible land unless the steepness to measured slope is 150 feet. This defines this soil as potentially highly erodible (PHEL). Over 85% of the soils in the MCBR watershed are considered HEL or PHEL (Table 5, Table 6, Figure 8).

This scientific data is used by NRCS for application purposes. Visit NRCS online or contact your local NRCS Field Office District Conservationist for more information.

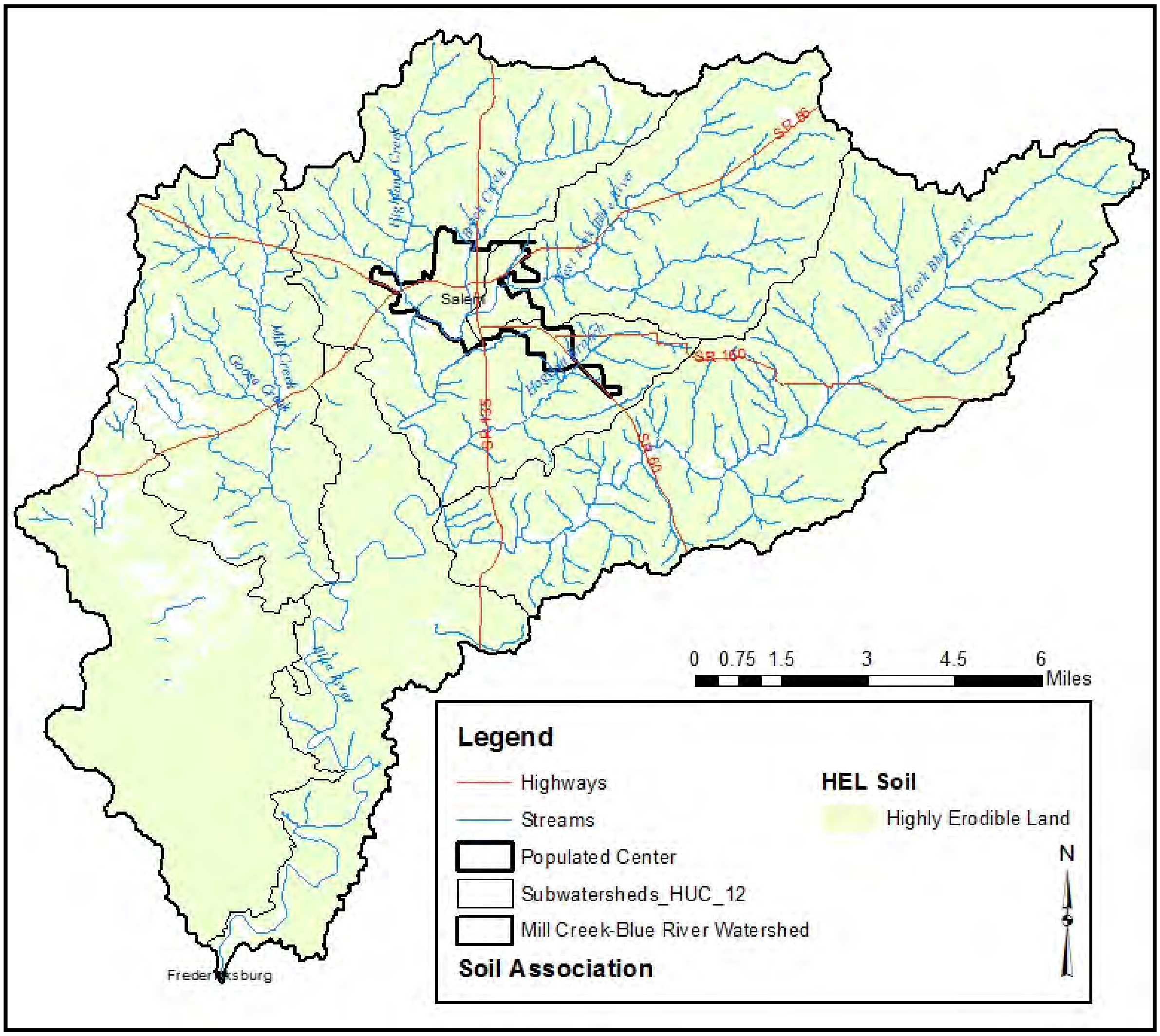
Table 5. – Highly Erodible Land in the Mill Creek-Blue River Watershed

Map Unit Name and Percent Slope	Map Symbol	Acres in MCBR	Percent of MCBR
Bedford silt loam, 2-6 percent slope	BdB	16,489	16.51
Bedford silt loam, 6-12 percent slope	BdC2	1,188	1.19
Berks-Weikert complex, 25-75 percent slope	BhF	110	0.11
Caneyville-Hagerstown silt loams, 18-25 percent slope	CaE2	1,227	1.23
Caneyville-Rock outcrop complex, 25-50 percent slope	CdF	1,186	1.88
Crider silt loam, 2-6 percent slope	CoB	9,465	9.48
Crider silt loam, 6-12 percent slope	CoC2	27,275	27.31
Crider silt loam, 12-18 percent slope	CoD2	1,865	1.87
Crider silty clay loam, 6-12 percent slope	CrC3	190	0.19
Crider silty clay loam, 12-18 percent slope	CrD3	150	0.19
Crider silt loam, karst, 4-12 percent slope	CsC2	8,935	8.95
Crider-Frederick silt loams, karst, 12-22 percent slope	CtD2	4,227	4.23
Elkinsville silt loam, 2-6 percent slope	ElB	239	0.24
Elkinsville silt loam, 6-12 percent slope	ElC2	139	0.14
Frederick silt loam, karst, 12-22 percent slope	FwD2	757	0.76
Gilpin silt loam, 12-18 percent slope	GlD2	12	0.01
Gilpin-Berks loams, 18-50 percent slope	GnF	1,962	1.94
Gilpin-Berks-Ebal complex, 18-50 percent slope	GpF	287	0.29
Hagerstown silt loam, 6-12 percent slope	HaC2	333	0.33
Hagerstown silty clay loam, 6-12 percent slope	HcC3	87	0.09
Hagerstown-Caneyville silt loams, 12-18 percent slope	HeD2	5,554	5.56
Pekin silt loam, 2-6 percent slope	PeB	1,164	1.17
Pekin silt loam, 6-12 percent slope	PeC2	128	0.13
Wellston silt loam, 6-12 percent slope	WeC2	1,146	1.15
Wellston silt loam, 12-18 percent slope	WeD	345	0.35
Zanesville silt loam, 6-12 percent slope	ZaC2	1,188	1.19
TOTAL	---	85,648	86.49

Table 6. - Potentially Highly Erodible Land in Mill Creek-Blue River Watershed

Map Unit Name	Map Symbol	Percent Slope (HEL if > 150 ft)	Acres in MCBR	Percent of MCBR
Bedford silt loam	BdB	4	16,489	16.51
Crider silt loam	CoB	4	9,465	9.48
Elkinsville silt loam	ElB	5	239	.24
Pekin silt loam	PeB	4	1,164	1.17
Zanesville silt loam	ZaB	4	1,189	1.19
TOTAL	---	---	**28,546**	**28.59**

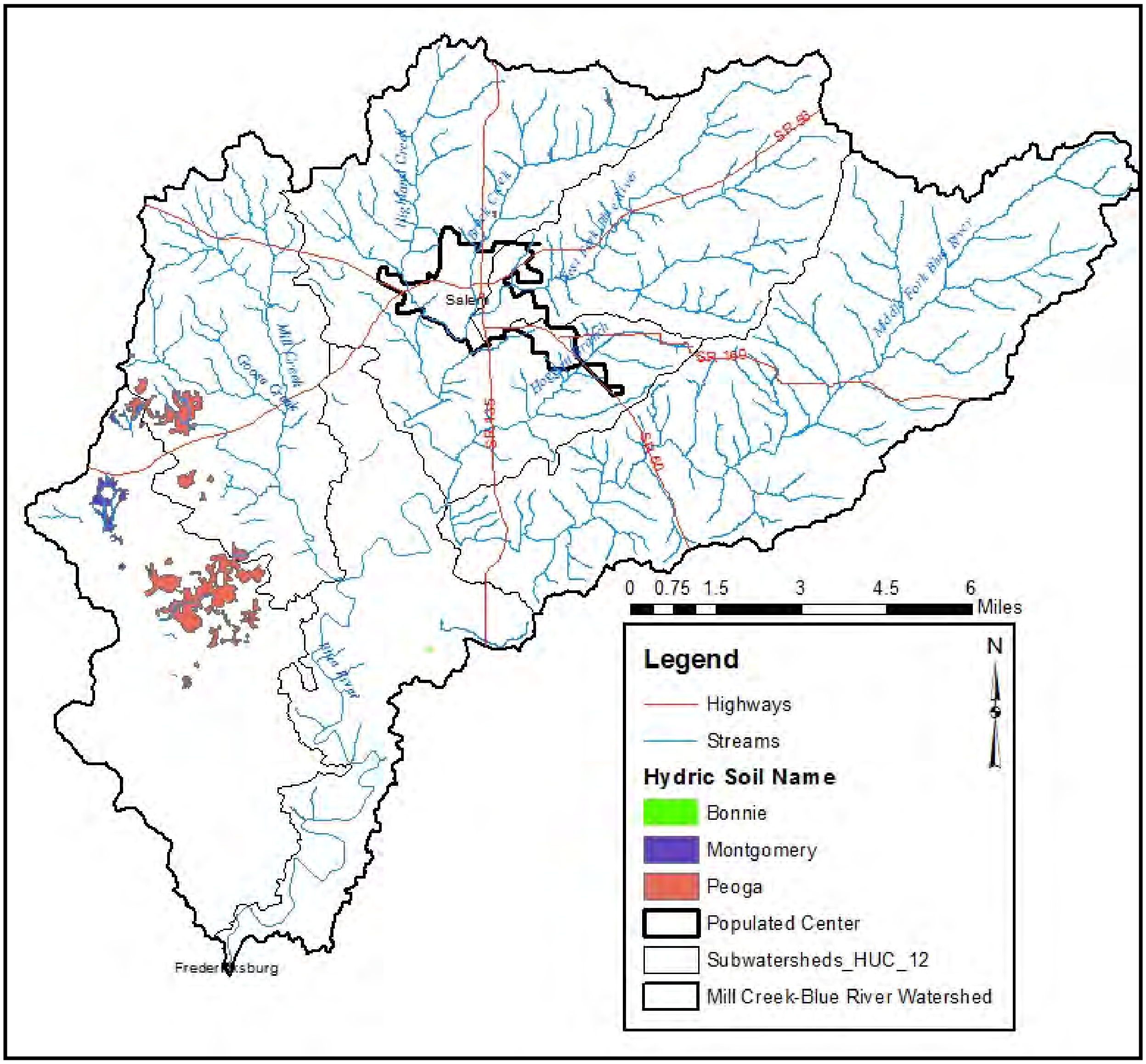
Figure 8. – Highly Erodible Land in the Mill Creek-Blue River Watershed



Hydric Soil
NRCS Hydric Soils Technical Notes online state, "Hydric soils are defined by the National Technical Committee for Hydric Soils (NTCHS) as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register, 1994). These soils, under natural conditions, are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytic vegetation."

There are three soil types in MCBR that are identified as hydric soils by NRCS. These soil types include Bonnie, Montgomery, and Peoga, and covers 1,251 acres or 1.25% of MCBR (Figure 9). Each soil type is identified as poorly drained and has either a water table at a depth of 1.0 foot or less.

Figure 9. - Hydric Soil Classification in the Mill Creek-Blue River Watershed



Septic Systems in the Blue River Watershed
The level of suburban growth in the Blue River watershed presents a potential threat to water quality as additional septic systems come on line in the upper Blue River watershed surrounding the city of Salem. Stakeholders in the watershed are concerned about the lack of maintenance on septic systems.

Any person who lives outside of the Salem city-limits relies upon a septic system to treat the wastewater in their home (Figure 10). Washington County's health department issues permits for proper septic system installation. Septic permits do not have a mechanism for ensuring proper treatment beyond installation. The burden of maintenance is assumed by the homeowner. Septic system maintenance involves routine pumping based upon a formula that accounts for number of bedrooms and size of septic tank with a general rule-of-thumb that a family of four has their tank pumped every 3 to 5 years. Pumping of solids from the septic system along with other easy solutions will keep the septic system functioning properly for many years; including:

1. Perform regular maintenance on the septic system
2. Divert rain water from the septic tank drain field
3. Don’t overload the septic tank and drain field with leaky fixtures
4. Keep tree roots away from the septic system
5. Use garbage disposal sparingly, compost your kitchen scraps when possible
6. Don’t pour grease down the drain
7. Avoid hazardous chemicals and heavy duty cleaners
8. Don’t drive on the septic tank or drain field

The Environmental Protection Agency (EPA) estimates that 10-20% of all septic systems in the United States malfunction each year. Many septic systems in the Blue River watershed are old and/or unmaintained due in large part to the homeowner’s lack of knowledge on basic septic system function and maintenance requirements. Some citizens are unaware where their septic system even is, let alone how much it will cost to fix and maintain it. Most homeowners in the Blue River watershed do not get their drinking water from on-site wells so there is not an obvious connection between a functioning septic system and water contamination.

Many residents moving into the Blue River watershed are re-locating from an urban, sewered setting to a rural, unsewered area and do not know they have a septic system or how to maintain it. A previous survey conducted in Floyd and Harrison County revealed that apprehension exists among residents about septic system maintenance and responsibility (Septic Management District Consumer Survey, 2000).

One recommendation for improvements to septic systems in the Blue River watershed is a webpage dedicated to septic system basics that can be linked to the Mill Creek-Blue River watershed group, NRCS, the Washington County Health Department and The Nature Conservancy along with other stakeholders. The webpage could list maintenance tips, a list of septic haulers serving the watershed and a contact person within the county for concerns related to function and impacts.

Septic System Soil Suitability

The Natural Resources Conservation Service (NRCS) ranks each soil type for the use of septic tank absorption field. Each soil type is ranked as severely limited, moderately limited or slightly limited. Fifty-two percent of the soils in the MCBR watershed are considered very limited and 47% are considered somewhat limited (Table 7, Figure 11). Seven soil characteristics, including position in the landscape, soil texture, slope, soil structure, soil consistency, depth to limiting layers, and depth to seasonal high water table, are utilized to determine suitability for on-site septic treatment. Septic tanks require soil characteristics that allow for gradual movement of wastewater from the surface into the groundwater. A variety of characteristics limit the ability for soils to adequately treat wastewater. High water tables, shallow soils, compact till, and coarse soil all limit soils abilities in their use as septic tank absorption fields (Peel, 2011). Karst soils do not have a high water table, making them suitable for septic system installation, but the low water table can also mask problems in septic systems as water drains away from septic effluent fields in karst soils, whether it is treated or untreated.

Table 7. – Septic System Suitability Soil Ratings for the Mill Creek-Blue River Watershed

Soil Rank	Percent of Watershed	Acres
Not rated	.39%	392
Somewhat limited	47.34%	47,234
Very limited	52.27%	52,158

As of January 1, 2011, the Indiana State Department of Health issued new residential onsite waste disposal guidelines. A significant change is the requirement that all new septic systems have an outlet filter installed. The idea behind this requirement being that the filter eliminates improper disposal of solids in the system. A perhaps unintended consequence of this requirement is that a homeowner becomes more attuned to their septic system's function by actively performing an annual or semi-annual maintenance activity on their septic system. This document also includes septic tank sizing chart to help regulate and continue flow (Table 8).

Table 8. - Required Minimum Capacities for Septic Tanks

Number of Bedrooms in Dwelling	Capacity of Tank(s) in Gallons	Minimum required daily flow capacity of the septic tank outlet filter
2 or less	750	1,125
3	1,000	1,500
4	1,250	1,875
5	1,500	2,250
5+	1,500 plus 150 multiplied by the number of bedrooms over 5	Capacity of tank(s) in gallons multiplied by 1.5

Figure 10. – Sewered Area in the Mill Creek-Blue River Watershed

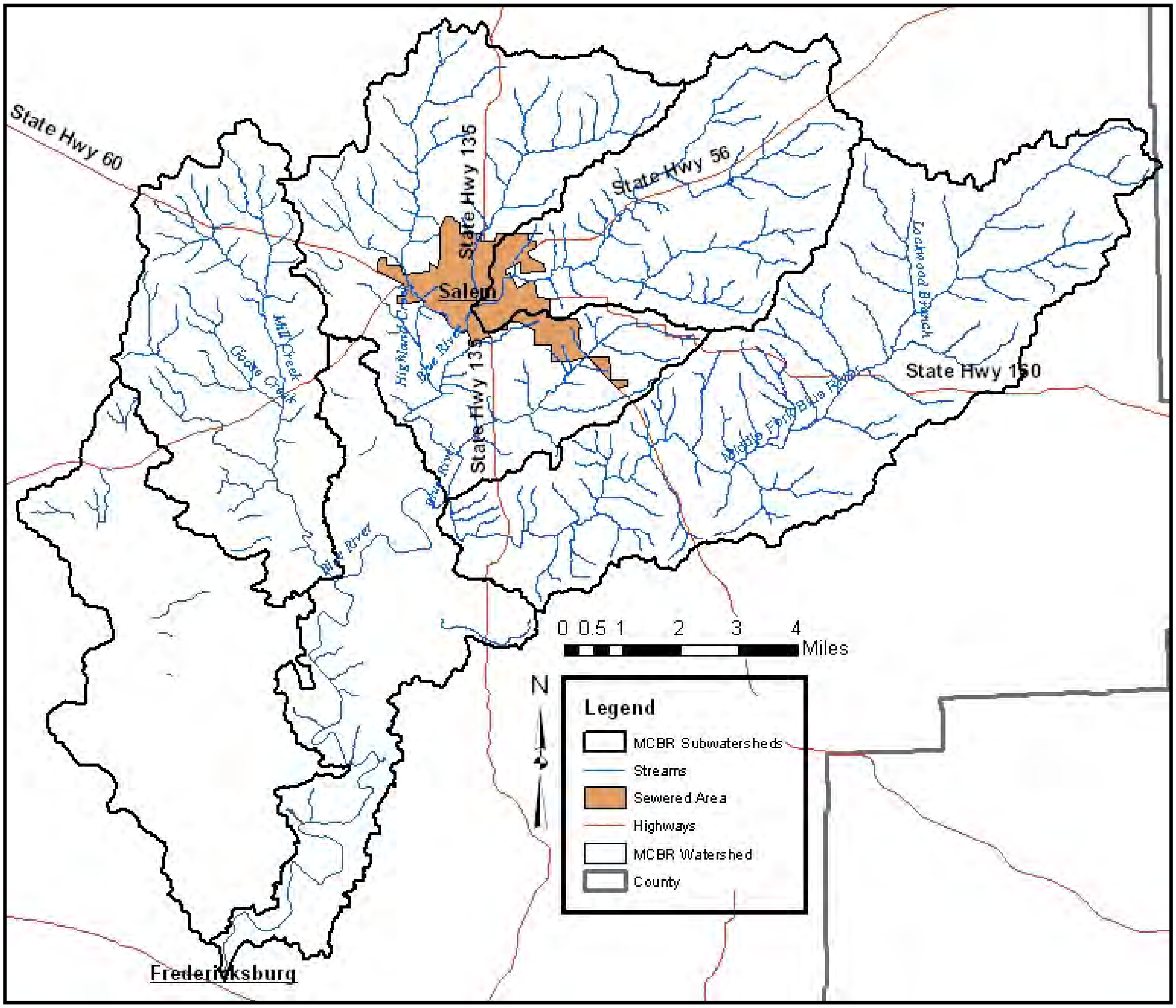
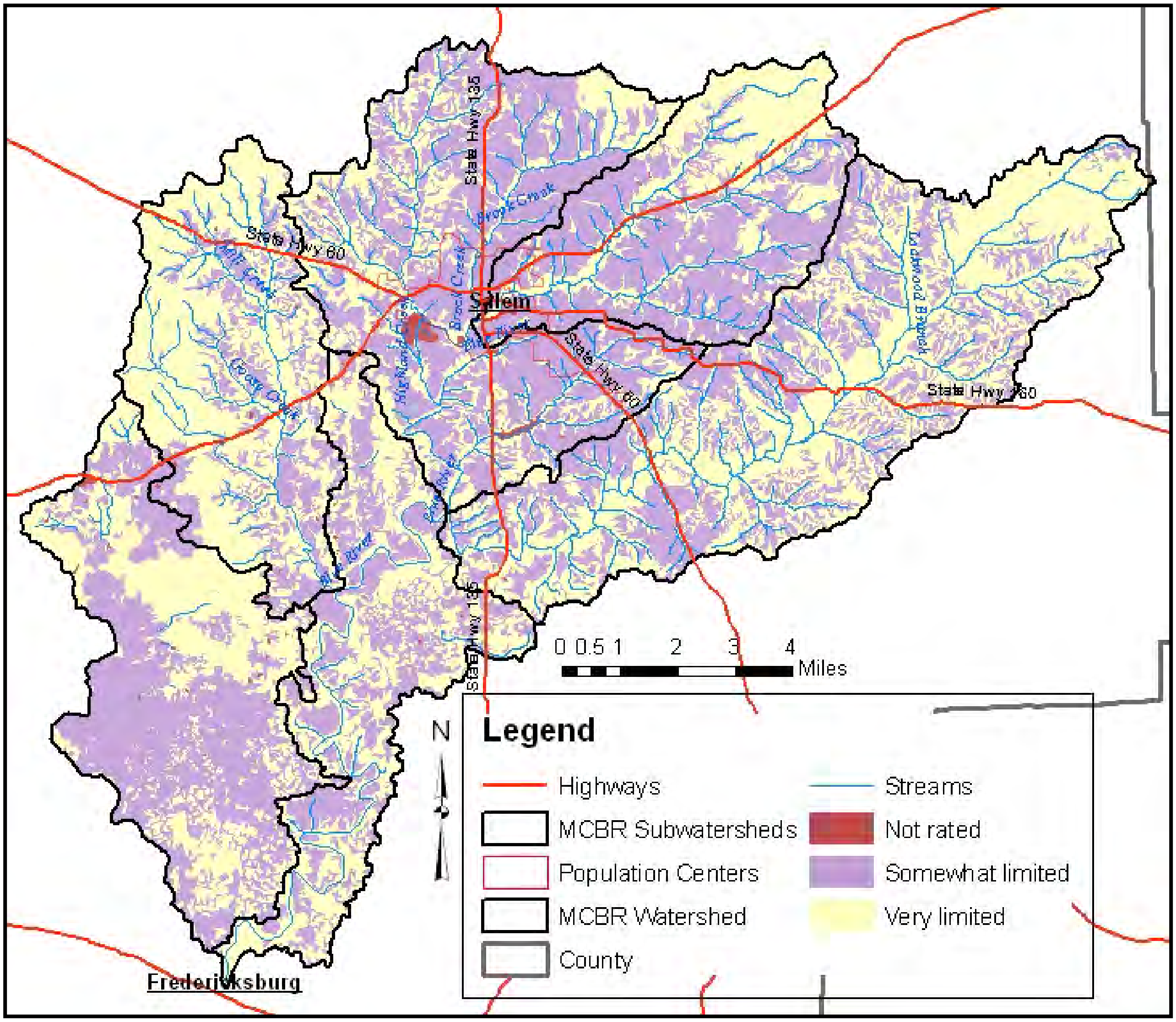


Figure 11. - Soil Septic System Suitability in the Mill Creek-Blue River Watershed



Tillage Transect

The tillage transect information for Washington County, Indiana was updated in June, 2011 (Table 9 and Table 10). The information was gathered using guidelines of description by the Indiana State Department of Agriculture (ISDA) for No-Till, Mulch Till, Reduced, and Conventional. No-Till is any direct seeding system, including site preparation, with minimal soil disturbance (includes strip & ridge till). Mulch till includes any tillage system leaving 30%-75% residue cover after planting, excluding no-till. Reduced includes any tillage system leaving 16%-30% residue cover after planting, and Conventional includes any tillage system leaving less than 15% residue cover after planting.

Table 9. - 2011 Cropland Tillage Data for Corn in Washington County

Tillage Type	Acres	% of County
No-Till	32,200	81%
Mulch Till	3,100	8%
Reduced Till	2,400	6%
Conventional Till	2,000	5%

Table 10. - 2011 Cropland Tillage Data for Soybeans in Washington County

Tillage Type	Acres	% of County
No-Till	34,100	83%
Mulch Till	2,000	5%
Reduced Till	3,700	9%
Conventional Till	1,200	3%

2.4 Land Use in MCBR

Current Land Use Trends

MCBR has many diverse and unique characteristics. MCBR total acreage is nearly all in Washington County, most of the access to water is on private land and it also contains a wide karst area. Pasture/hayland (36%), forest (29%), and cultivated crops (26.5%) are the major land uses in the watershed (Table 11, Figure 12).

Table 11. - Current Land Use in the Mill Creek-Blue River Watershed

Land Use	Acres	Percent
Barren Land; Rock; Sand; Clay	58	0.06
Cultivated Crops	26,417	26.47
Deciduous Forest	28,563	28.62
Developed Land	6,946	6.96
Emergent Herbaceous Wetland	.83	0.001
Evergreen Forest	416	0.42
Grassland	921	0.92
Mixed Forest	57	0.06
Open Water	176	0.18
Pasture/Hayland	35,978	36.12
Shrub Cover	258	0.06
TOTAL	**99,791**	100.00

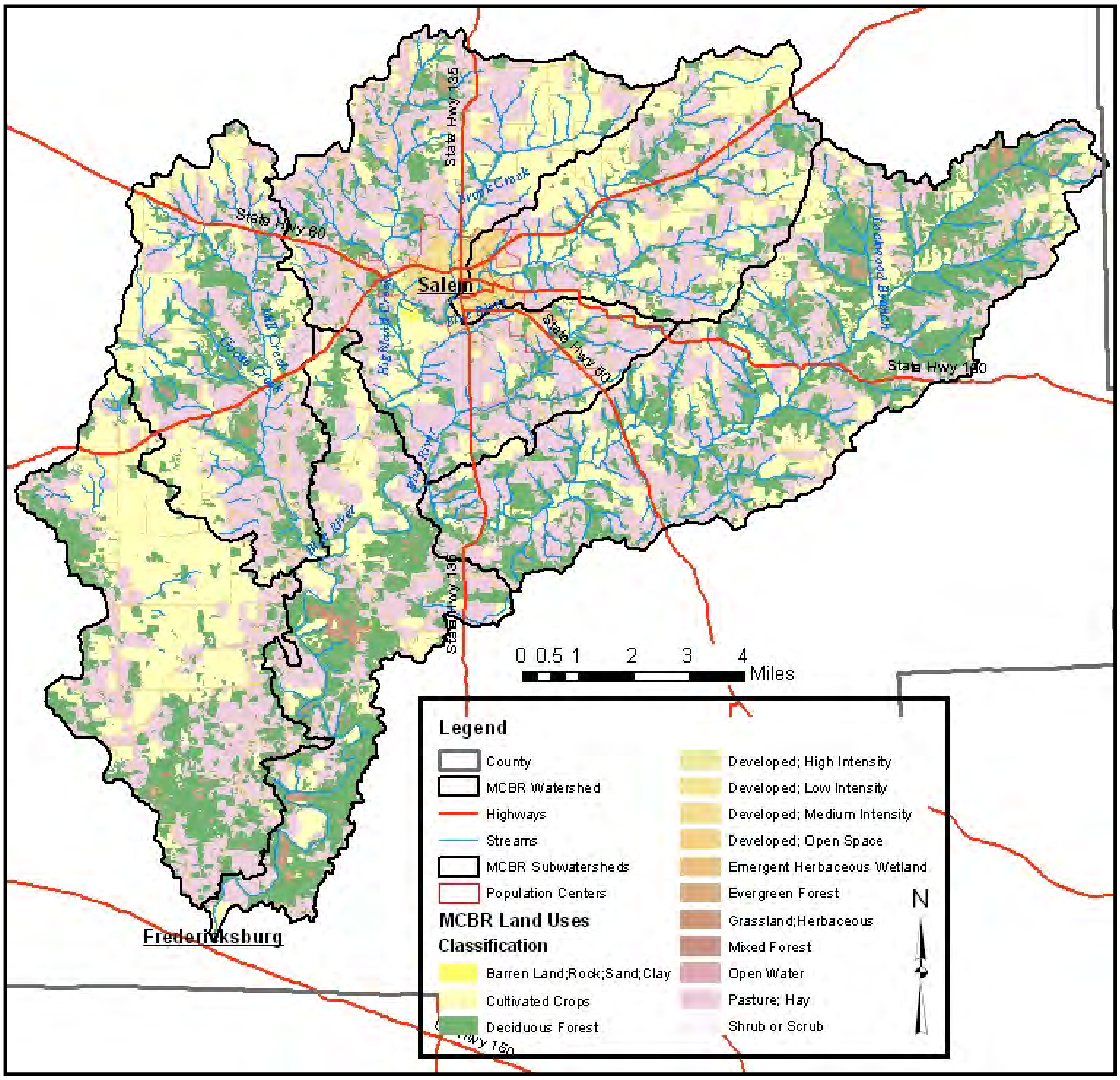
Within the national initiative of conservation, many incentives from local agencies, like NRCS and Farm Service Agency (FSA), provide landowners and producers with incentive funding to help the land. Best management practices, such as no-till and riparian buffers, have become part of the everyday vocabulary of many landowners in MCBR. These practices not only help promote water quality, but also directly reflect the quality of water found in the watershed.

Landowners and producers have participated in various workshops and field days to better understand new and current conservation implementations. This is a time when ideas, questions, and concerns can be expressed and shared.

Furthermore, MCBR stakeholders continue to be positive reinforcement in MCBR when serving on a town committee, attending public meetings, participating in local events, etc. and sharing information about the current watershed land uses with the community.

Stakeholders are concerned about sedimentation in the streams from soil erosion and streambank erosion. There was significant rainfall in the spring of 2011 and a new bypass is being constructed on the eastern one-third of the watershed (Figure 12).

Figure 12. – Land Uses in Mill Creek-Blue River Watershed



Fertilizer Uses
MCBR land is predominately used for agricultural production. Commodities, such as hay, corn, wheat, and soybeans, can turn-around into feed to maintain a self-sustaining farm. Inputs, like fertilizer, are used to supplement growth and nutritional value to increase production. This is also a basic management trend used to enhance a land's value.

Local residents also use fertilizer for the home use. Mostly, the common fertilizers are used for basic home amenities and hobbies for the lawn and gardens in town. This includes various pesticides, herbicides and other fertilizers that can be used for spraying the lawn for weeds and to brighten the green grass color, and the use of various combinations of fertilizer to promote plant growth in the garden and landscaping.

Fertilizer use on agriculture land changes due to current trends. As of 2011, 90% of agriculture land is used for corn and soybean rotation. The other 10% includes continuous corn or corn, soybeans, and wheat rotation. Tobacco is still produced, and some land is used for hay for producers with livestock. Organic fertilizer is commonly used in addition to commercial fertilizer. Current trends show producers have increased use of organic fertilizer due to the rise in commercial fertilizer prices.

Pet and Wildlife Waste
According to the 2008 US Census Bureau, there are approximately 10,828 households in Washington County, Indiana. Research conducted by the American Veterinary Medical Association in 2007 shows that 37.2 percent of Indiana households own dogs, with an average of 1.7 dogs per dog-owning household. That means there are approximately 4028 dog-owning households with 6,848 pets. Pets are estimated to leave about .33 pounds of waste each day. That number adds to about 485,172 pounds or 243 tons of dog waste per year in Washington County. If homeowners do not pick up after their pet at home or in a public setting, such as a park, the waste can easily be washed into storm drain, lakes or rivers in the watershed. This could be a particular issue in Salem.

Wildlife that uses the watershed depends on a good habitat and water quality to thrive and survive. Wildlife waste is recycled through the ecosystem and does not appear to threaten the watershed water quality. However, as some populations continue to rise, like the white-tail deer, it could lead to further waste pollution problems.

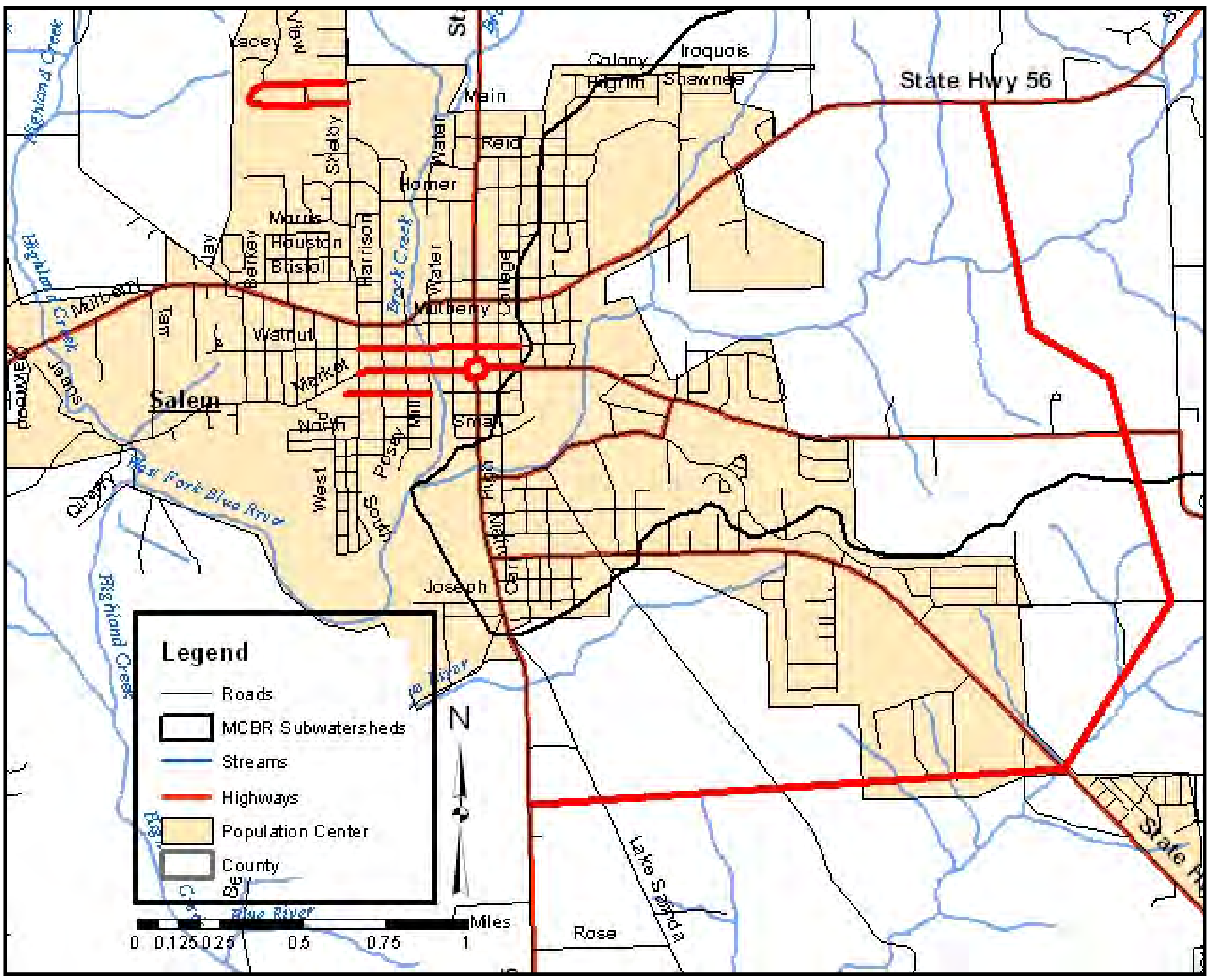
Also, evidence from a windshield survey show there is a large population of domesticated fowl in Mill Creek. This could initiate a higher population and cause further damage to the water quality in Mill Creek. Wildlife waste could be an issue in area outside of Salem city limits.

2.5 Planning Efforts in MCBR
Watershed stakeholders are concerned about non-point source pollution from storm drains affecting the aquatic habitat. New sections of the Salem storm water system were added in the summer 2011 to replace old and unmaintained pipe. This storm water runs directly to Brock Creek in the watershed. Storm drains and pipes were replaced to help maintain the flow of rain water. This was completed on High Street, Salem square round-about, and Highway 60 heading east, as shown in Figure 13. This is a water quality concern now. The velocity of the water will

increase and also carry nutrients and trash much faster into the water. This is also a concern of flooding to stakeholders. When the water is drained faster out of the City of Salem, it builds up downstream. Steering committee members are concerned that this will cause streambank erosion and high nutrients south of Salem. However, the Washington County Comprehensive Plan also comments on the benefit of additional stormwater control to prevent flooding and provide more recreation downstream north of Fredericksburg.

Also, a major highway is being developed east of Salem to bypass the town. Construction on this project started spring 2011. The bypass will connect Highway 56 and Highway 135. This area being constructed was too large for our county Rule 5 and is under Rule 5 enforcement by IDEM due to the size of the project. If there are any violations to be addressed, IDEM has full oversight of this project. Figure 13 shows a sketch of where the project is located outside of the City of Salem and is bolded in red.

Figure 13. - Current Planning Efforts in the Mill Creek-Blue River Watershed



Lake Salinda is an important waterbody to the community. The history of Lake Salinda and past water data is discussed more in Watershed Inventory II-A under Water Quality Information.

In 2012, Salem City Council and Mayor David Bower gathered a committee of entities in the community to provide insight and expertise to the public concern of Lake Salinda. Lake Salinda serves as back-up water source for the City of Salem. However, the water, at this time, cannot be used for a water source. Lake Salinda is also listed on the IDEM 2010 303(d) list of impaired waters for algae and taste and odor.

At this time, the committee is formed to address water quality concerns and find a way to fund the project to make Lake Salinda a usable water resource. Possibilities include, dredging the 88 acre lake of sedimentation to restore it to its original 146 acres, building a retention pond and clean-out sediment every 10-15 years so it does not enter the lake, and complete professional water testing after these activities to mark the quality of success after construction.

In 2012, a planning effort started for an airport expansion along Highway 56 west of Salem. The city is trying to work with the county to begin this endeavor. This is in the beginning stages of the planning efforts, but the steering committee is aware that this project will need much more paved surfaces. The airport is located near Mill Creek. Water quality education and efforts will need to be shared with those in the planning process.

City and County Master Plans

In 2010, Washington County adopted a Comprehensive Plan. A Plan Commission Committee was developed and meets monthly to continue progress on the comprehensive plan. At this time, the committee is reviewing and writing zoning efforts and establishing guidelines for poultry buildings that are proposed to being built in the upcoming years.

2.6 Identification of threatened and endangered plants and animals found in MCBR and the types of habitats they prefer.

The unique karst features of the Blue River watershed result in high species diversity from fish to mussels and from hellbenders to globally rare cave invertebrates. These animals have historically occurred in Blue River because of the stream habitat with a high enough gradient for riffles that support darters and limestone substrate conducive to hellbenders. High water quality also supports these animals, although some are beginning to decline in Blue River.

Biological life and habitat in the water is a stakeholder concern along Blue River. Once a common species, the Eastern hellbender for example, is not as frequently seen by the public and is becoming more endangered each year. In the Purdue Extension book Salamanders of Indiana, Williams, MacGown, Kingsbury and Walker write, “The Eastern Hellbender is considered rare and is listed as a state endangered species in Indiana. They are thought to be declining throughout most of their national range. Population declines are likely due to waterway impoundments, pollution, and siltation” (2006). Research and continuous study is being completed through the Natural Resources Department at Purdue University through many generous grants and passionate teachers and students continuing their education.

Many of the endangered, threatened, and rare species listed in Table 12 are found in cave areas. Moist areas with decaying matter will house and feed many invertebrate animals. Due to excess sediment, non point source pollution and lack of maintenance, these plants and animals try to survive in a poor habitat.

Table 12. - Endangered, Threatened, and Rare Species in the Mill Creek-Blue River Watershed

	Name	Vertebrate Animal (VA), Invertebrate Animal (IA), Vascular Plant (VP)	Native to Indiana
1	American Badger	VA	X
2	Barn Owl	VA	X
3	Barr's Commensal Cave Ostracod	IA	X
4	Blue River Cave Milliped	IA	X
5	Eastern Hellbender	VA	X
6	Fallen Springtail	IA	X
7	Henslow's Sparrow	VA	X
8	Illinois Hawthorn	VP	X
9	Indiana Bat	VA	X
10	Jeannel's Cave Copepod	IA	X
11	Marengo Cave Ground Beetle	IA	
12	Nixon's Springtail	IA	X
13	Northern Cavefish	VA	X
14	An Ostracod	IA	X
15	Packard's Cave Amphipod	IA	X
16	Pink Milkwort	VP	X
17	Popeye Shiner	VA	
18	Roundleaf Water-hyssop	VP	X
19	Royal Catchfly	VP	X
20	Secund Rush	VP	X
21	Sedge Wren	VA	X
22	Spotted Darter	VA	X
23	A Springtail	IA	X
24	Stemless Evening-primrose	VP	X
25	A Troglobitic Crayfish	IA	X
26	Young's cave ground beetle	IA	X

Below, the United States Fish and Wildlife Service (USFWS) shares about the endangered Indiana Bat, found in the caves of Mill Creek-Blue River Watershed.

"Indiana bats are extremely vulnerable to disturbance because they hibernate in large numbers in only a few caves (the largest hibernation caves support from 20,000 to 50,000 bats). Other threats that have contributed to the species decline include commercialization of caves, loss of summer habitat, pesticides and other contaminants, and most recently, the disease white-nose syndrome."

Another species in MCBR found in a cave habitat that is declining is the Northern Cavefish. The Nature Conservancy extends important information about their habitat and reasoning for decline.

"This species is limited to a small subset of caves and is naturally found in low densities in any one of those. Their habitat requirements are threatened by silting and flooding, the result of increased impervious surfaces, deforestation, and sinkhole disturbances. Cave rivers are simply underground versions of the surface streams we monitor for water quality. In its restricted habitat, it is easy to understand how one accidental spill or sinkhole disturbance could decimate an entire cave's population of cavefish. No one would think of dumping a ton of dirt directly into a surface stream, but sinkholes are a direct conduit for such activity when they are used as stormwater diversions and dumping grounds."

Also, the endangered Barn Owl occupies MCBR. Their habitat is fairly simple and similar to other birds; they enjoy open areas, such as grassy fields, old fields, wet meadows and wetland edges, around farms and rural towns. Daytime roost is usually an evergreen tree, belfry or barn.

However, "land use changes, particularly the decrease in the number of farms, have contributed to the decline of this species. Not only has foraging habitat been reduced, but the increased use of rodent poisons has resulted in a smaller food base. Natural nest sites in hollow trees are often limited, and human disturbance of the nest during incubation may cause nest abandonment. One common cause of mortality is predation of young barn owls by raccoons. Other mortality factors include exposure to harsh weather, electrocution by power lines, predation by dogs and great-horned owls, and accidental entanglement in farm and industrial machinery" (DNR, 2011).

A list of threatened and endangered species for Washington County, Indiana identified by the Indiana Department of Natural Resources (IDNR) is found in Appendix B.

2.7 Review of Relevant Relationships

Topography and Soil Type

Slope of the land in the MCBR watershed is consistently steep in most areas. The soil types sitting on these steep slopes tend to be more erodible. Weathering, such as rain and snow, create a higher velocity flow and could easily carry these soils away. Also, steep land that is used for animal and/or crop production creates higher risk of soil eroding.

Also, most of the soils in the watershed are classified as somewhat limited and very limited for septic system suitability. This is a concern not only because filtration may not be efficient, but also because of the high karst areas in the southwest of the watershed. The water is not always present on the surface due to the karst topography. Contaminated water could easily get into waterways and into groundwater sources. These sources are used for wildlife and livestock and could affect production, or worse, harm the animals.

Hydrology, Land Use and Population Centers

The center of the watershed, which includes the City of Salem, is the most populated area. Also, Blue River and Highland Creek flow through this area. This area will potentially notice development pressures and runoff from impervious surfaces from local businesses, roadways, driveways and more.

Development in the watershed has occurred more frequently each year. Many large farms have been divided into "mini-farms" making more home sites prevalent in the area. MCBR is about 40 miles from Louisville, Kentucky. Individuals who are interested in moving into a rural area seek out property similar to what is found here. The City of Salem is interested in more economic development and seeks to bring more people into this area for business, school, and more.

Sediment, Threatened/Endangered Species, Topography and Human Development

Salem is the only area in the watershed where there is a waste water treatment plant; therefore, the majority of the watershed utilizes septic fields. Failing systems, leaching, and poor treatment of septic systems could affect water quality. Also, due to the high amount of karst topography in the watershed, the water quality could easily be affected by septic systems. The surface water in the karst areas drain into the ground water. The cave systems' species could be in danger if the water quality is poor.

Native Woodland

Any disturbance by stakeholders in the forested native areas could increase soil erosion and decrease water quality. Washington County is ranked number one in woodland as designated by the last woodland census (2007) in the Indiana Agricultural Statistics book 2010-2011.

3.0 WATERSHED INVENTORY II -A – WATER QUALITY ASSESSMENT

The following information gives a clearer picture of the watershed at a smaller scale and features past efforts used to collect data. This information can be used to identify and explain stakeholder concerns at a more concise examination.

3.1 Water Quality Data and Targets

The Mill Creek-Blue River (MCBR) Watershed is unique in the fact that not a lot of data has been recorded and/or collected and shared for public use. A large part of this project is to collect chemical, biological and habitat results to make available to the stakeholders of MCBR. After researching past watershed data and retrieving a low amount of information and data, it was decided to try to collect at least one water sample per subwatershed. The sites were chosen after conducting windshield surveys around the watershed. Most sample sites are accessible from the highway and are on public land. A couple of sites that were chosen were approved by landowners for water quality testing for one year, April 2011-March 2012 (Figure 16). The MCBR project then assessed professional water testing results on samples collected monthly at twelve sites for one year, and the results collected from the volunteer water testing at one site for two years using the water quality benchmarks required by state water quality standards, water quality targets set by the steering committee, and where standards don't exist, values recommended by various sources. Water testing parameters used to evaluate water quality include flow, pH, dissolved oxygen, temperature, nitrate, turbidity, total suspended solids, total phosphorous, *Escherichia coli* (also labeled as *E.coli*), qualitative habitat evaluation index, index of biotic integrity, and macroinvertebrate index of biotic integrity. The recommended water quality target for nitrate was set by the steering committee (Table 13).

Data was also collected using windshield and desktop surveys. Members of the MCBR Steering Committee completed windshield surveys by visiting a site and collecting specific information about the watershed. Information included location latitude and longitude, date, temperature, land use, animals and/or crop present, the quality of water in the stream or creek, and any noted wildlife. A desktop survey was conducted on the internet using map features to locate certain areas or view a land use from an aerial view.

Past water monitoring has been completed in MCBR by the Indiana Department of Environmental Management (IDEM) on surface water for *E.coli*, Total Phosphorus, Ammonia Nitrogen, Nitrate+Nitrite, Total Suspended Solids, and Total Kjeldahl Nitrogen (TKN). This will be further discussed later in this section.

Table 13. – Water Quality Targets used to assess water quality in the Mill Creek-Blue River Watershed.

Parameter	Water Quality Targets	Required Value or Recommended Value	Source of Requirements or Recommendations
pH	6.0 to 9.0	Required Value	Indiana Administrative Code
Dissolved Oxygen	Min: 4.0 mg/L Max: 12.0 mg/L	Required Value	Indiana Administrative Code
Temperature	Monthly standard	Required Value	Indiana Administrative Code
Nitrate	4.0 mg/L	Recommended Value	IDEM draft nutrient criteria
Turbidity	<10.4 NTU	Recommended Value	U.S. EPA recommendation
Total Suspended Solids	≤25 mg/L	Recommended Value	Waters, T.F., 1995
Total Phosphorus	Max: 0.3 mg/L	Recommended Value	IDEM draft TMDL target
E.coli	<235 colonies/ 100mL	Required Value (single sample maximum)	Indiana Administrative Code
Qualitative Habitat Evaluation Index	>60 points	Recommended Value	Hoosier Riverwatch
Macroinvertebrate Index of Biotic Integrity	>36 points	Recommended Value	IDEM
Macroinvertebrate Index of Biotic Integrity (Pollution Tolerance Index)	>17 points	Recommended Value	Hoosier Riverwatch

3.2 Water Quality Information

Mill Creek and Blue River are tributaries of the Ohio River in southern Indiana. Blue River is recognized in Indiana Administrative Code as an "Outstanding State Resource" water body supporting many threatened and endangered aquatic animals. Although the Blue River watershed is relatively pristine, agricultural, urban, and commercial development is occurring rapidly and local environmental groups want to preserve Blue River's quality. Contaminants of concern in the watershed are E. coli, sediment, and nutrients. Potential sources of contaminants identified in the watershed include confined feeding operations, failing septic systems, and soil erosion from agriculture and construction. Lake Salinda, which is the backup drinking water source for the city of Salem, exhibits eutrophic conditions leading to taste and odor problems.

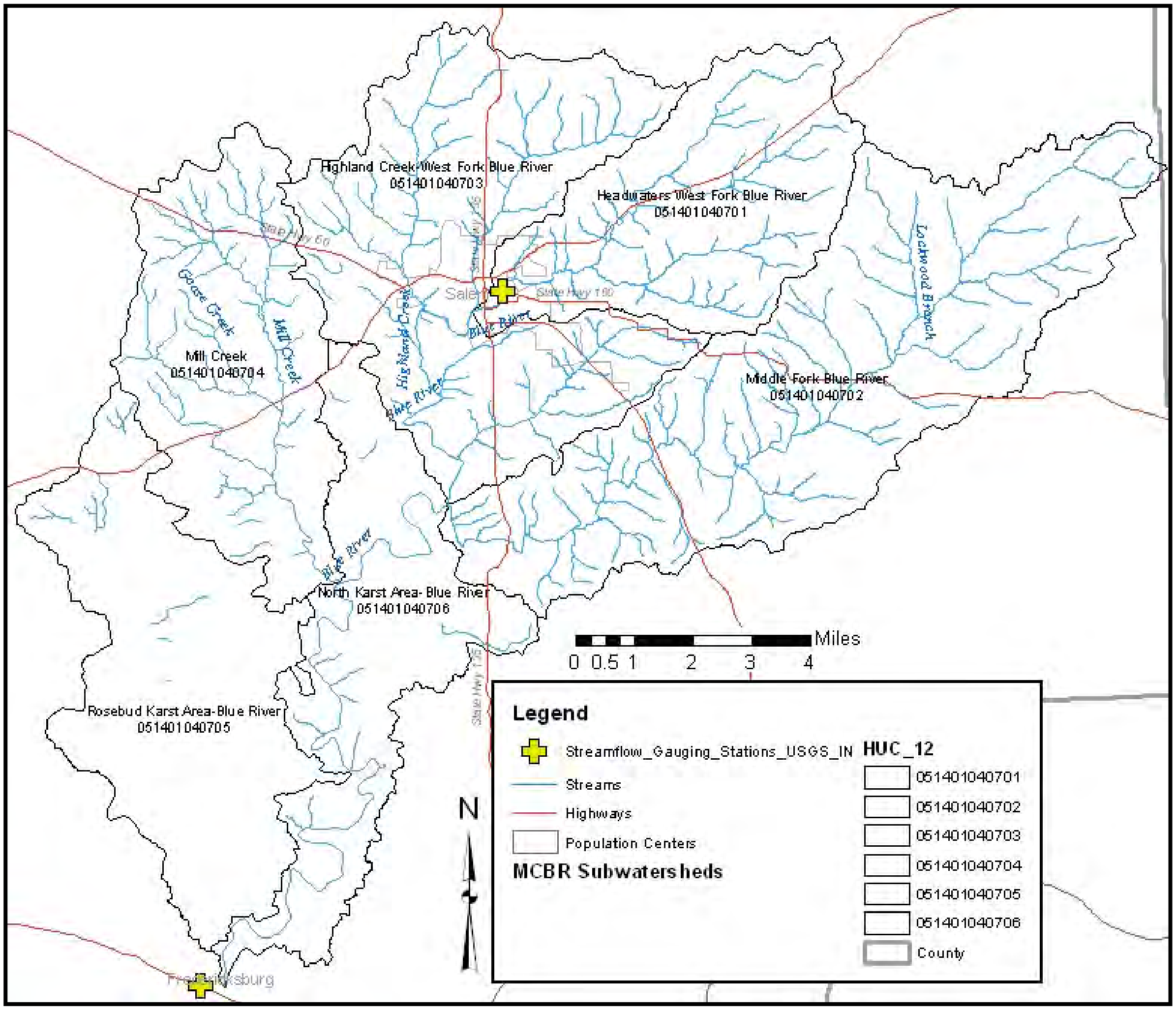
Historical water quality information for MCBR is slim; however, many documents give us insight to the development of MCBR Watershed and past development events.

United States Geological Survey (USGS) Streamgages
MCBR is benefited by the use and access of live information from two USGS gages in and near the watershed (Figure 14). The flow readings from the gages are available on USGS website and are available daily.

"Each streamgage provides historic and current stream and river data. Data are used for conducting flood studies and National Weather Service flood warnings and forecasts. Two basic elements of the data include stage (the height of the water surface above a reference elevation) and discharge (the volume of flow passing a specified point in a given amount of time). These measurements are available 24/7/365 and are accessible to the public. Uses of gage data include flood warnings and flood crest predictions, power plant operations, bridge and road design, floodplain mapping, recreational boating and a wide variety of environmental studies" (NRCS, 2009).

In MCBR, one USGS gage is located on West Fork Blue River at the Washington County Fairgrounds. Another gage, located just south of the watershed in Fredricksburg, was used to measure flow at the mouth of the watershed.

<u>**Figure 14. – USGS Streamflow Gauging Stations in Mill Creek-Blue River Watershed**</u>



Lake Salinda

Lake Salinda is located about one mile south of The City of Salem. A Lake and River Enhancement Program (LARE) study was completed on Lake Salinda in March of 1990.

The study found that Lake Salinda was experiencing sediment and nutrient loading from nonpoint source pollution. Sediment runoff had resulted in a 48% decrease in lake surface area. The primary source of the nonpoint source pollution was determined to be agricultural crop land, due to the highly erodible soils, tillage methods and cropping and fertilization practices. Recommendations included implementation of best management practices (BMPs) such as conservation tillage, contour farming, animal waste management, and livestock exclusion (Donan and Dearlove, 1990).

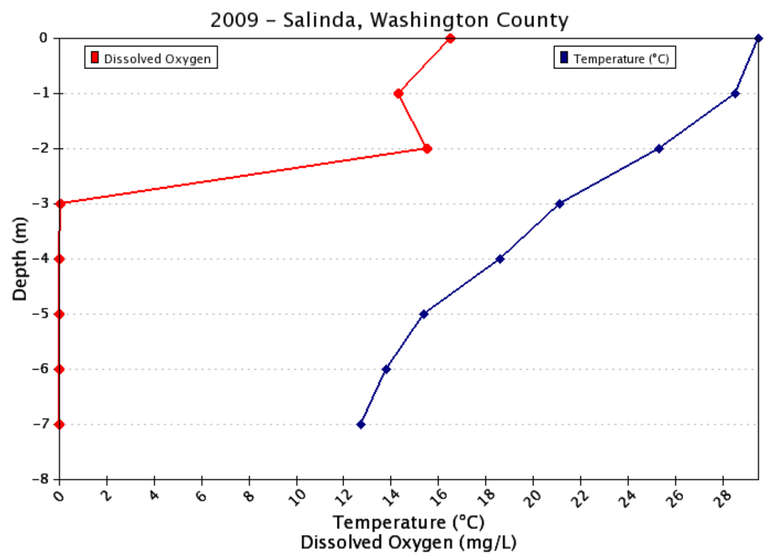
By 1964, it was proposed that there was a 14% loss of area due to sedimentation. Based on the 1979 and 1989 figures, Lake Salinda is losing about 2 acres per year of surface area. Also, the Division of Fish and Wildlife completed aquatic studies in 1964, 1971, 1974, 1979. The 1979 survey found a population of carp, as well as a healthy population of panfish and bass. Carp had not been reported in other surveys, but ranked fifth by number and first by weight.

In addition, the Indiana State Board of Health, Division of Sanitary Engineering, completed a survey in 1987. The survey "concluded that based on the soil texture and depth, stone line depth, seasonal high water table and geological conditions, comprehensive plans by a soil scientist and engineer would be necessary on a site-by-site basis before onsite sewage disposal permits could be considered by the Washington County Health Department for this area." Furthermore, it was shared by community members that Lake Salinda was shut down to the public due to the drainage of sewage waste in the 1980's from local trailer parks.

Lake Salinda was last tested in 2009 through the Indiana Clean Lake Program, a program within the Indiana Department of Environmental Management's (IDEM) Office of Water Quality. The program is administered through a grant to Indiana University's School of Public and Environmental Affairs (SPEA) in Bloomington. Public lakes that have navigable inlets and outlets to public land and that have boat trailer access from a public right-of-way are usually tested. Lake Salinda was tested in 1991, 1996, 2001, and 2009. Sampling usually occurs on one site of the lake, usually the deepest part of the lake. Parameters tested include phosphorus, nitrogen, light transmission, dissolved oxygen, Secchi disk transparency, plankton, and chlorophyll *a*. Figure 15 shows the results from the 2009 water test in Lake Salinda. Temperature and dissolved oxygen are important factors for aquatic life living in the water. Fish need at least 3-5mg/L of dissolved oxygen to survive (Interpreting Lake Data, pages 1-3).

According to IDEM's 2010 303(d) list of impaired waters, Lake Salinda remains impaired for algae and taste and odor. Current planning efforts for Lake Salinda are described in section 2.5.

Figure 15. – Clean Lakes Program Test Results for Dissolved Oxygen and Temperature on Lake Salinda, 2009



3.3 Project Data

A grant was awarded to the White River Resource and Conservation Development by Indiana Department of Environmental Management to prepare watershed management plan. One of the tasks in the project is to monitor water quality using biological and chemical methods to diagnose problems and propose solutions.

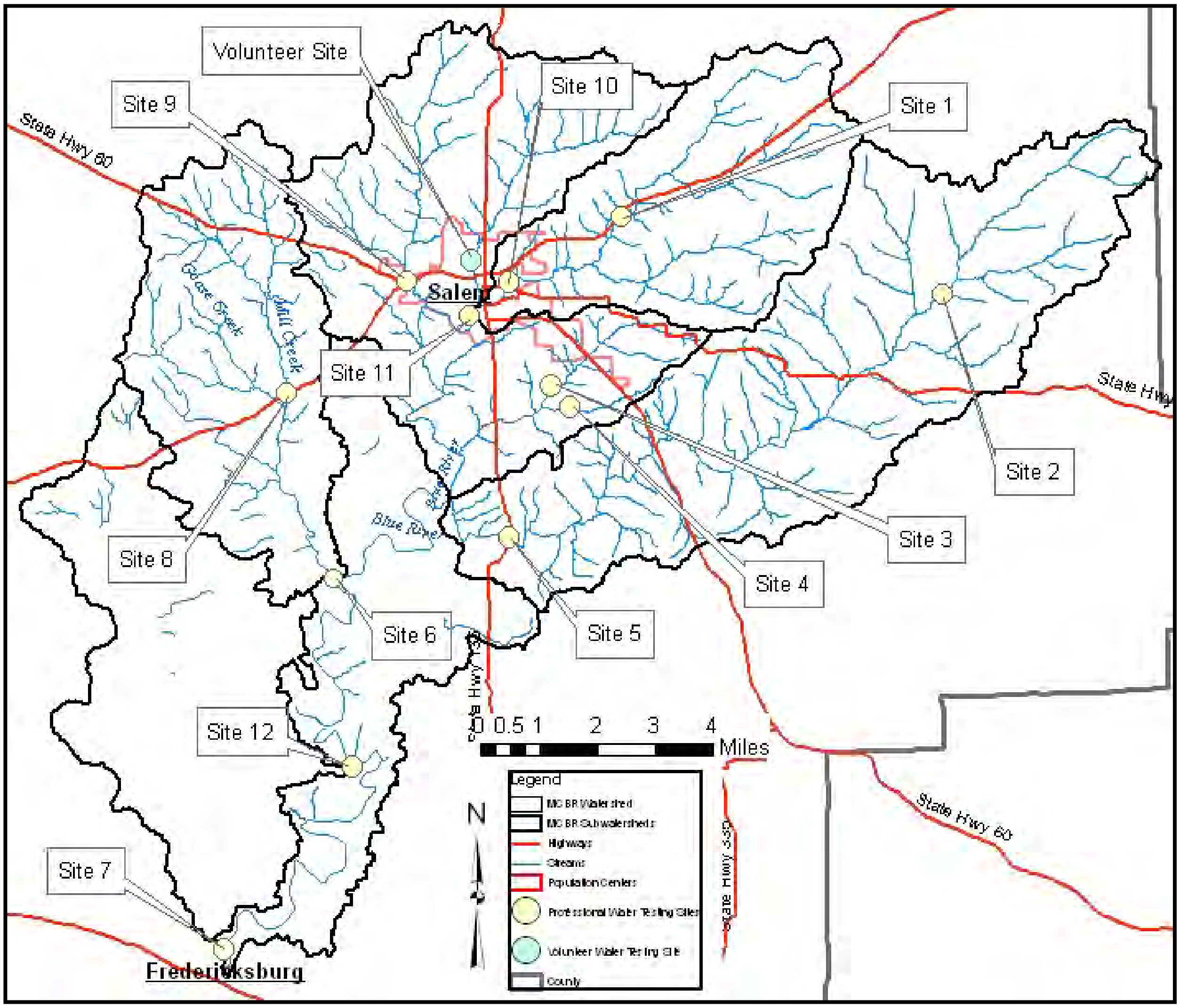
Study Sites:

Twelve sites were chosen for study. The sites are listed below and shown graphically in Table 14 and Figure 16.

Table 14. – Site Number and Location of Professional and Volunteer Water Monitoring Sites in Mill Creek-Blue River Watershed.

Site Number	Location	Latitude	Longitude
1	West Fork of Blue River at Hwy 56	38.37.62	86.03.17
2	Middle Fork of Blue River	38.35.87	85.57.71
3	Tributary into Lake Salinda	38.34.52	86.04.64
4	Tributary into Lake Salinda	38.34.82	86.04.69
5	Middle Fork Blue River south of Salem	38.32.60	86.05.63
6	Mill Creek at Becks Mill	38.32.22	86.09.27
7	Blue River on Fredricksburg Rd.	38.26.15	86.11.71
8	Mill Creek at Hwy 60	38.34.75	86.09.89
9	Highland Creek at Old Hwy 60	38.36.56	86.07.52
10	East Fork of Blue River at the fairgrounds	38.36.37	86.05.69
11	Blue River at Joseph Street	38.36.01	86.06.28
12	Blue River at Grandview Road	38.29.47	86.08.87
Volunteer	Brock Creek at Homer Street	38.61097	86.10401

Figure 16 . – Professional and Volunteer Water Testing Sites for the Mill Creek-Blue River Watershed Project



Methods:
Water Chemistry

The following parameters were measured once each month for 12 months at each of the twelve sampling sites. All results are included in Appendix D.

Table 15. – Water Chemistry Parameters for Macroinvertebrate Study for the Mill Creek-Blue River Watershed Project

Parameter	**Method**	**Detection Limit**	**Analysis Type**
Nitrate	SM 4500 NO3	0.5 mg/L	Lab
Total Phosphorus	SM 4500 P F	0.03 mg/L	Lab
Total Suspended Solids	SM 2540 B	1.0 mg/L	Lab
pH	SM 4500 H+	0.1 SU	Field
Temperature	Thermocouple	0.1 degree	Field
Conductivity	SM 2510 A	I uS	Lab
Turbidity	SM 2130 B	1 NTU	Lab
Dissolved Oxygen	SM 4500 O G	0.1 mg/L	Field
Flow	Velocity meter	N/A	Field
E.coli	SM 9223 B	1 MPN/100 mL	Lab

Habitat Analysis:

Habitat analysis was conducted according to Ohio EPA methods (Ohio EPA, 1987). In this technique, various characteristics of a stream and its watershed are assigned numeric values. All assigned values are added together to obtain a Qualitative Habitat Evaluation Index (QHEI). The highest value possible with this habitat assessment technique is 100, with higher values indicating better habitat.

Macroinvertebrates:

Because they are considered to be more sensitive to local conditions and respond relatively rapidly to environmental change (Hynes, 1970), benthic (bottom-dwelling) organisms were also used to document the biological condition of each stream. The U.S. Environmental Protection Agency (EPA) has developed a rapid bioassessment protocol (Plafkin et al., 1989) which has been shown to produce highly reproducible results that accurately reflect changes in water quality. We used the most recent Indiana Department of Environmental Management procedure (IDEM, 2010) to conduct this study. This method requires a standardized multi-habitat collection technique, a standardized subsampling technique, and identification of at least 100 animals from each site to the genus or species level. Collections were made on August 8, 10, 11, and 24, 2011.

Following identification of the animals in the sample, twelve "metrics" are calculated for each site. These metrics are based on knowledge about the sensitivity of each species to changes in environmental conditions and how the benthic communities of unimpacted ("reference") streams are usually organized (Table 16). For example, mayflies and caddisflies are aquatic insects that are known to be more sensitive than most other benthic animals to degradation of environmental conditions. A larger proportion of these animals in a sample receive a higher score. The sum of all twelve metrics provides an individual "biotic score" for each site.

The metrics used in this study were proposed by the Indiana Department of Environmental Management (2010).

Table 16. - Scoring Values for Metrics

	5 points	3 points	1 point
Total Taxa	>41	21-41	<21
Total Individuals	>258	129-258	<129
# EPT Taxa	Dependent on stream drainage area		
% Orthoclads & Tanytarsids	<24	24-47	>47
% Non-insects	<18	18-35	>35
# Diptera Taxa	>14	7-14	<7
% Intolerant Species	>32	16-32	<16
% Tolerant Species	<13	13-25	>25
% Predators	>36	18-36	<18
% Shredders & Scrapers	>20	10-20	<10
% Collector/Filterers	<10	10-20	>20
% Sprawlers	<3	3-6	>6

The scores for each metric (1 to 5) added (12 metrics) to calculate a mIBI score for each site (a range of scores from 12 to 60).

Results:
Chemistry (Raw data is located in Appendix D).

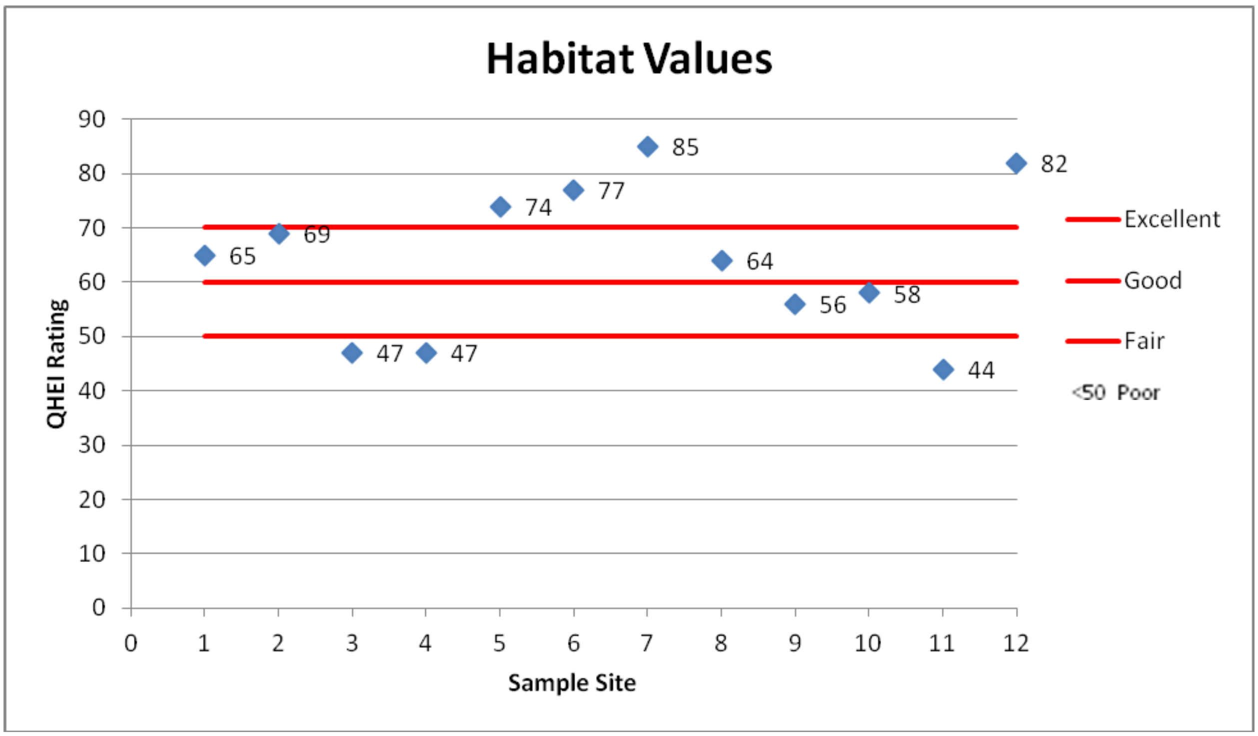
At most sites, water clarity was high and total phosphorus levels were quite low. Dissolved oxygen, conductivity, and pH levels fell within normal ranges during most sampling periods. The measured parameters which were often higher than Indiana water quality standards or draft guidelines included nitrate and E.coli. Average nitrate exceeded the draft nutrient criteria of 4 mg/L at sites 6 and 11. Average E.coli counts exceeded the Indiana water quality standard for “whole body recreation” (235 cfu/100 mL) at seven of the twelve sites (3, 4, 6, 8, 9, 10, and 11). Sites 9, 10, and 11 exceeded the standard by a factor of 2.

Habitat:
Table 17 and Figure 17 show the habitat values for the study sites. The highest score was 85 (Site 7), while the lowest was 44 (Site 11). Four sites had “excellent” habitat, three had “good” habitat, two had “fair” habitat, and three had “poor” habitat. Habitat is scored by ratings of excellent (>70), good (60-70), fair (50-60), and poor (<50) habitat qualities. The component scores that were summed to obtain the QHEI values for each site are listed in the appendix.

Table 17. - Habitat (QHEI) scoring by site number.

SITE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12
Substrate (20)	13	14	16	16	18	19	19	15	14	12	12	19
Cover (20)	11	11	2	2	12	10	13	11	9	11	4	11
Channel (20)	16	17	13	13	16	18	18	13	13	13	11	18
Riparian (10)	6	8	9	9	7	9	9	6	5	4	2	8
Pool/Current (12)	8	8	0	0	10	8	11	8	5	8	5	11
Riffle/Run (8)	5	5	3	3	5	5	7	5	4	4	4	7
Gradient (10)	6	6	4	4	6	8	8	6	6	6	6	8
Total (100)	**65**	**69**	**47**	**47**	**74**	**77**	**85**	**64**	**56**	**58**	**44**	**82**

Figure 17. - Qualitative Habitat Evaluation Index (QHEI) values for study sites.



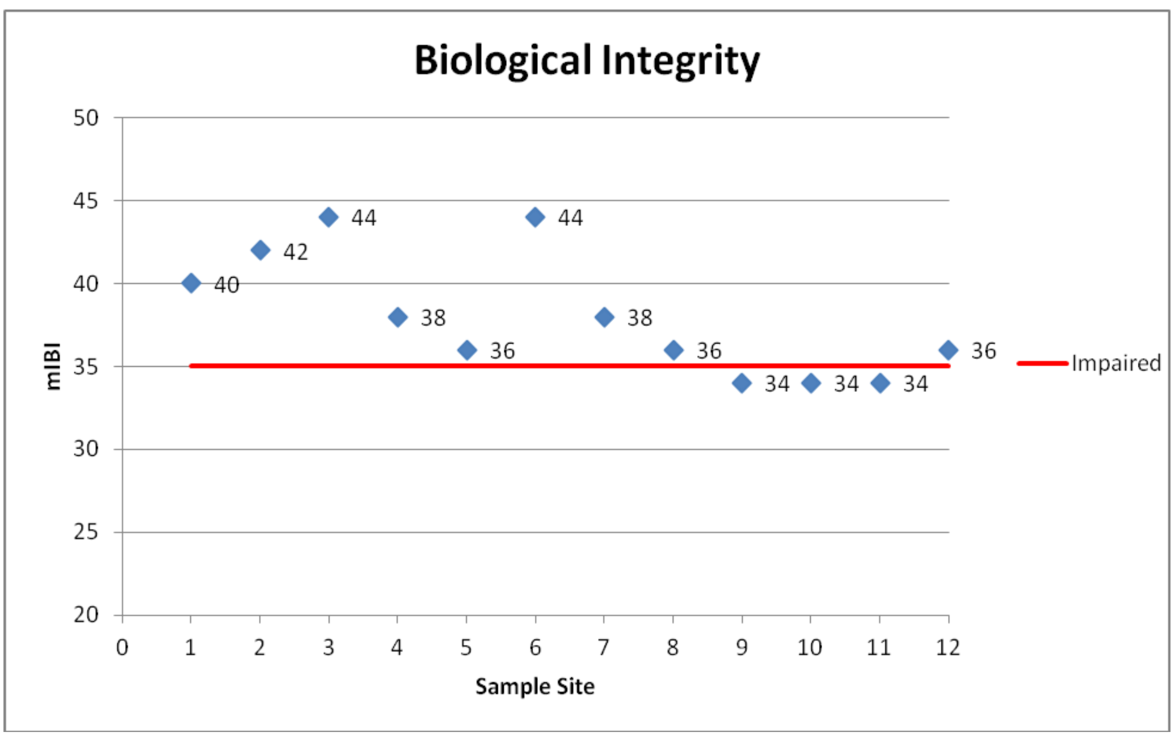
Macroinvertebrates:
A total of 70 macroinvertebrate taxa were identified. Dominant forms included small minnows and mayflies (*Baetis* sp.), common net-spinning caddisflies (*Cheumatopsyche* sp.), and riffle beetles (*Stenelmis* sp.).

Table 18 and Figure 18 show the biotic integrity scores for each study site. The Indiana Department of Environmental Management defines "impaired conditions" as a mIBI score of less than or equal to 35. Sites 9, 10, and 11 had scores of 34 and would be considered impaired by this definition.

Table 18. – Macroinvertebrate Index of Biotic Integrity (mIBI) scores by site number.

	1	1dpl.	2	3	4	5	6	7	8	9	10	11	12
Total number of taxa	3	3	3	1	1	1	3	3	1	1	1	1	1
Total number of individuals	5	5	5	5	5	5	5	5	5	5	5	5	5
# EPT taxa	5	5	5	5	5	5	5	3	3	3	3	1	5
%orthoclads & tanytarsids	5	5	5	5	5	5	5	5	5	5	5	5	5
% non-insects	5	5	5	5	5	5	5	5	5	5	5	5	5
# Diptera taxa	3	3	3	3	1	1	1	1	1	1	1	1	1
% Intolerant	1	1	1	1	1	1	3	1	1	1	1	1	1
% Tolerant	3	5	5	5	5	5	5	5	5	5	5	5	5
% Predators	3	1	3	3	1	1	1	1	1	1	1	1	1
% Shredders & Scrapers	3	3	5	5	5	3	5	5	3	3	5	5	5
% Collector filterers	3	1	1	5	3	1	3	1	1	1	1	3	1
% Sprawlers	1	1	1	1	1	3	3	3	5	3	1	1	1
mIBI	**40**	**38**	**42**	**44**	**38**	**36**	**44**	**38**	**36**	**34**	**34**	**34**	**36**

Figure 18. - Macroinvertebrate Index of Biotic Integrity (mIBI) scores by site number. Possible range of scores is from 0 to 60; less than or equal to 35 is considered impaired.



Discussion:

One of the most useful aspects of biological monitoring is that information on the way aquatic animals respond to different types of stress can be used to diagnose a problem. For example, degraded biotic integrity can often be directly related to degraded habitat. Macroinvertebrates cannot thrive where habitat is lacking. When the two values are graphed in relation to each other, they form a straight line (Plafkin et al., 1989). A measurement error of plus or minus 10% can be added to the graph to give a range in which biotic integrity degradation is explained simply by a lack of adequate habitat. When values fall outside this range, however, water quality problems are suspected. A comparison of biotic integrity to habitat is shown in Figure 19. The mIBI scores in this graph were standardized from a scale of 0-60 to a scale of 0-100 to match the QHEI scale.

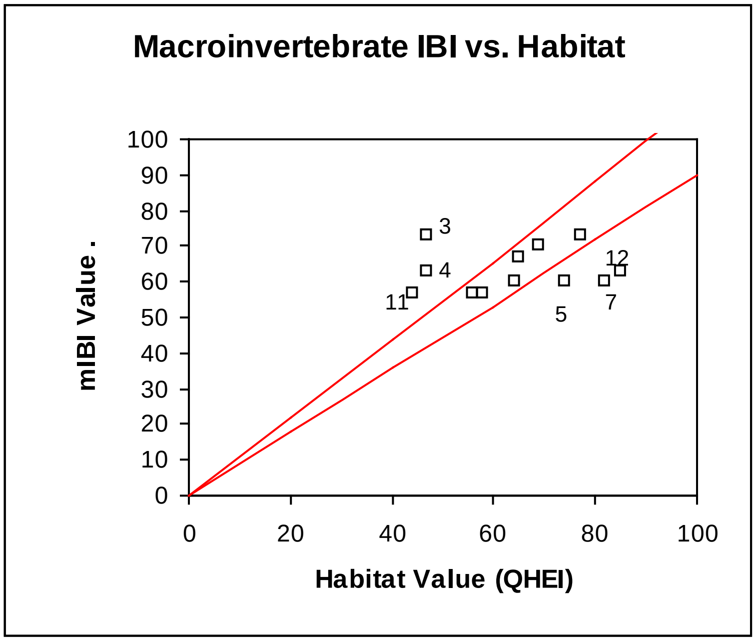
Sites 9 (Highland Creek), 10 (Blue River at Fairgrounds), and 11 (Brock Creek) all had mIBI scores less than or equal to 35, meaning they were "not supportive of aquatic life" as defined by the Indiana Department of Environmental Management. These three sites all had low numbers of macroinvertebrate taxa that are pollution intolerant, and had the highest average E. coli counts of all the study sites. Sites 9 and 10 had "fair" habitat.

In addition to high E. coli counts, Site 11 (Brock Creek) also had elevated levels of phosphorus and nitrate, and had the lowest number of macroinvertebrate taxa of all the study sites. Its habitat was rated as "poor" and the most abundant macroinvertebrate found there was the tolerant midge *Polypedilum convictum*. It also needs to be noted this is the site where the Salem Wastewater Treatment Plant discharges water after treatment. Even though weekly tests are conducted, it is a concern that this site exceeds water quality targets and standards for the watershed project.

Sites 5 (Middle Fork Blue River at Hwy 135), Site 7 (Blue River at Grandview Road), and Site 12 (Blue River at Fredericksburg Road) all had "excellent" habitat but mIBI scores that were less than what would be expected based on habitat. Site 7 had the best habitat (QHEI of 85) of all the study sites, but its mIBI score was only 63% of the total possible. The most abundant animal was the relatively tolerant caddisfly *Cheumatopsyche* sp., and diversity of caddisflies and dipterans was low. The caddisfly *Cheumatopsyche* was also dominant at Site 5, comprising 47% of the organisms sampled. Site 12 had lower than expected diversity of macroinvertebrates, especially dipterans and intolerant forms (Table 18).

Sites 3 and 4 (south and north inlets to Lake Salinda) both had "poor" habitat. At these sites, the macroinvertebrate community had relatively abundant numbers of riffle beetles (*Stenelmis* sp. and *Macronychus glabratus*) and water pennies (*Psephenus herricki* and *Ectopria* sp.). These organisms feed by scraping attached algae from the substrate, and increases in their abundance may indicate nutrient enrichment leading to enhanced growth of algae.

Figure 19. - A comparison of habitat values and normalized mIBI values (Best possible score for both is 100). Sites outside the expected range are labeled with site numbers.



IDEM Water Quality Data
Some water sampling data is available from IDEM from 2000 and 2010 for *E.coli* (MPN/100mL), Nitrogen (Nitrate+Nitrite) (mg/L), Total Phosphorus (mg/L), Total Suspended Solids (TSS) (mg/L) that is comparative to our data collected (Table 22, Figure 20).

Results show the Phosphorus levels were high at one site in 2000 IDEM water monitoring results and exceeded the target in the Mill Creek subwatershed. Results from water monitoring in the MCBR watershed from 2011-2012 show improvement of phosphorus levels. See sections 4.4 Mill Creek Subwatershed – HUC 051401040704 for more information.

E.coli results for sites in the Mill Creek and North Area Karst-Blue River subwatershed during the 2010 testing exceed the state standard. Macroinvertebrate (Table 20) and fish community testing were conducted in 2000 and 2010 (Table 21). The site in the Mill Creek subwatershed scored just below the target mIBI level, making it an impaired site. The fish community had good results. We did not test fish during the 2011-2012 testing and will consider the 2010 results in our decisions.

The Hilsenhoff Biotic Index (HBI), is a metric developed to measure organic pollution in streams, to accurately describe variance in stream properties based on watershed land use. Table 19 below shows the values compared to water quality values. MCBR did not use this parameter for their study.

Table 19. - Hilsenhoff Biotic Index (HBI) Water Quality Target, 1987

Biotic Index	Water Quality	Degree of Organic Pollution
0.00-3.50	Excellent	No apparent organic pollution
3.51-4.50	Very good	Possible slight organic pollution
4.51-5.50	Good	Some organic pollution
5.51-6.50	Fair	Fairly significant organic pollution
6.51-7.50	Fairly poor	Significant organic pollution
7.51-8.50	Poor	Very significant organic pollution
8.51-10.00	Very poor	Severe organic pollution

Table 20. – IDEM Macroinvertebrate Water Monitoring 2000, 2010.

Waterbody Name	HUC Unit Name	Station Description	Sample Site ID	Sample Date	MIBI	MIBI Rating	QHEI	HBI_SCORE	HBI Rating
Middle Fork Blue River	Middle Fork Blue River	Church Rd	OBS1200001	7/26/2000	3.8	moderately impaired	70	4.67	Good
Middle Fork Blue River	Middle Fork Blue River	Church Rd	OBS1200001	7/26/2000	3.6	moderately impaired	--	4.89	Good
Mill Creek	Mill Creek	SR 56	OBS1200015	9/8/2010	40	fair	55	--	--
Blue River	North Karst Area-Blue River	Becks Mill Rd	OBS1200016	7/27/2010	42	fair	70	--	--

Table 21. – IDEM Fish Community Water Monitoring Results 2000, 2010.

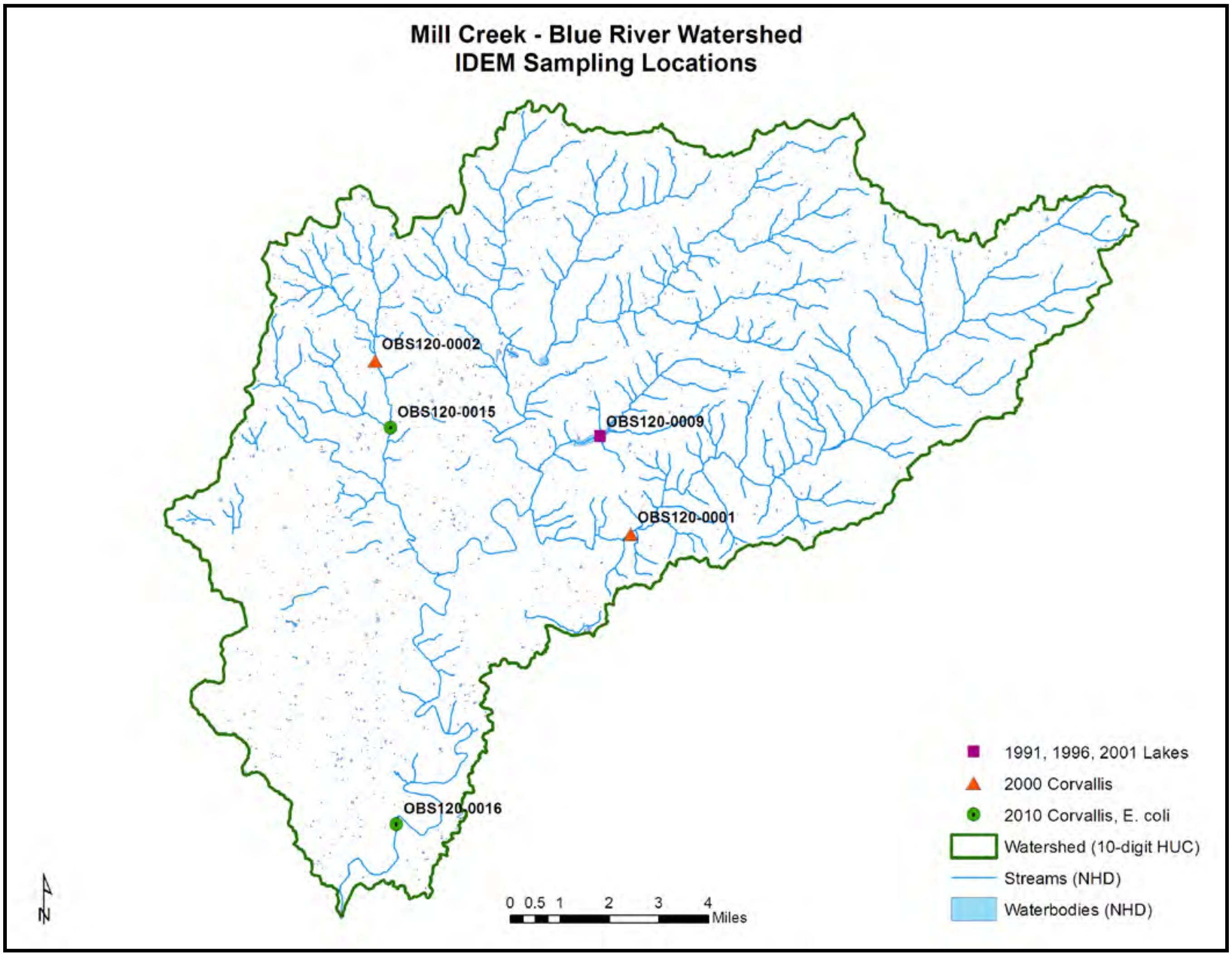
Waterbody Name	HUC Unit Name	Station Description	Sample Site ID	Sample Date	IBI	IBI Rating	QHEI
Middle Fork Blue River	Middle Fork Blue River	Church Rd	OBS1200001	7/26/2000	48	good	70
Mill Creek	Mill Creek	SR 56	OBS1200015	6/7/2010	38	fair	65
Blue River	North Karst Area-Blue River	Becks Mill Rd	OBS1200016	7/27/2010	54	excellent	74

Table 22. - IDEM Water Monitoring Data 2000, 2010 for *E.coli*, Nitrogen,

Phosphorus, and TSS.

Waterbody Name	HUC Unit Name	Station Description	Sample Site ID	Sample Date	E_ Coli (MPN/100mL)	Nitrogen, Nitrate+Nitrite (mg/L)	Phosphorus, Total (mg/L)	Solids, Suspended Total, (TSS) (mg/L)
Middle Fork Blue River	Middle Fork Blue River	Church Rd	OBS1200001	5/17/2000		2.2	0.051	< 4
Middle Fork Blue River	Middle Fork Blue River	Church Rd	OBS1200001	7/26/2000		0.65	0.083	9
Middle Fork Blue River	Middle Fork Blue River	Church Rd	OBS1200001	9/26/2000		2.4	0.078	15
Mill Creek	Mill Creek	Hitchcock Rd	OBS1200002	5/17/2000		4.3	3.2	< 4
Mill Creek	Mill Creek	Hitchcock Rd	OBS1200002	8/1/2000		3.3	0.048	< 4
Mill Creek	Mill Creek	Hitchcock Rd	OBS1200002	9/26/2000		3	0.11	15
Mill Creek	Mill Creek	SR 56	OBS1200015	6/9/2010	461.1			
Mill Creek	Mill Creek	SR 56	OBS1200015	6/16/2010	920.8			
Mill Creek	Mill Creek	SR 56	OBS1200015	6/3/2010	1413.6			
Mill Creek	Mill Creek	SR 56	OBS1200015	5/19/2010	1203.3			
Mill Creek	Mill Creek	SR 56	OBS1200015	5/26/2010	517.2			
Mill Creek	Mill Creek	SR 56	OBS1200015	6/7/2010		3.4	< 0.05	1
Mill Creek	Mill Creek	SR 56	OBS1200015	9/8/2010		0.04	< 0.05	4
Mill Creek	Mill Creek	SR 56	OBS1200015	7/28/2010		2.3		3
Blue River	North Area Area-Blue River	Becks Mill Rd	OBS1200016	6/3/2010	344.8			
Blue River	North Area Area-Blue River	Becks Mill Rd	OBS1200016	6/9/2010	> 2419.6			
Blue River	North Area Area-Blue River	Becks Mill Rd	OBS1200016	6/16/2010	290.9			
Blue River	North Area Area-Blue River	Becks Mill Rd	OBS1200016	5/19/2010	547.5			
Blue River	North Area Area-Blue River	Becks Mill Rd	OBS1200016	5/26/2010	201.4			
Blue River	North Area Area-Blue River	Becks Mill Rd	OBS1200016	6/7/2010		2.3	< 0.05	10
Blue River	North Area Area-Blue River	Becks Mill Rd	OBS1200016	9/13/2010		0.45	< 0.05	6
Blue River	North Area Area-Blue River	Becks Mill Rd	OBS1200016	8/2/2010		1.5	< 0.05	6

Figure 20. – IDEM Water Sampling Locations in MCBR.



IDEM 2010 303(d) list of Impaired Waterbodies
The impaired waterbody in MCBR include Lake Salinda (Figure 21). It is listed for taste and odor and algae. Lake Salinda is located about one mile south of Salem and in the Highland Creek-West Fork Blue River Subwatershed.

Water Quality Data at Salem Wastewater Treatment Facility
Stakeholders are concerned if the wastewater treatment facility in Salem is releasing effluent with good water quality. The wastewater treatment plant is mandated to collect water samples weekly for *E.coli* and nutrient parameters and keep the results available for monthly evaluation. The water testing results are compliant and are available at the facility upon request.

The capacity of the facility has recently increased from 900,000 gallons of water per day to 2,000,000 million gallons of water per day. This will improve the water treatment process and prevent overflows for wastewater.

Extent of Invasives in the Watershed
Stakeholders are concerned about invasive species, both aquatic and terrestrial, affecting the water quality in the watershed. Invasive species can invade and ruin a habitat for another species that helps maintain the betterment of the watershed. Invasive weed and plant species have been identified by the Southern Indiana Cooperative Weed Management Area (SICWMA) to help educate about current invasive weed trends and their location. Weeds, such as, bush honeysuckle and tree of heaven are eradicating all other plants and invading all space around it, killing off native plants and other beneficial vegetation in the same area.

Steering Committee Member and Salem High School Science Teacher, John Calhoun, has helped develop many projects within the Salem School Corporation property to effectively use open land and improve the water quality. Salem High School, Middle School and Elementary School are located directly on Brock Creek. It is important to not only protect this land, which lies in the City of Salem, but also educate students and the public about the need to protect the water quality in Brock Creek. The Salem Science Club started a project in the spring of 2012 of removing invasive trees and plants, including bush honeysuckle and tree of heaven. These plants were extremely invasive and ruining the habitat along Brock Creek. The Salem Science Club cut down and removed a very large brush pile worth of vegetation. A local district forester donated his time and resources to spray herbicide on existing stumps, in hopes to dissipate the invasive species.

Figure B. Removing invasive species, bush honeysuckle, on Brock Creek.

3.4 Land Use Information
MCBR Watershed is a rural area and contains a lot of open space. The watershed is mainly used for agriculture, but also contains open areas in the City of Salem. This is discussed below.

Industry and Areas Slated for Development
According to the Washington County Comprehensive Plan that was released in October 2010, under Chapter 7, Economic Development, manufacturing, agriculture, and housing development in Washington County are projected to rise in the upcoming years. A majority of the open space in Washington County includes agriculture production. Recently, a number of poultry contracts have been submitted to expand or begin new businesses in the agriculture sector.

Also, the number of residents in Washington County is projected to rise. Also included in the comprehensive plan is anticipated growth in housing along Indiana Highway 60 on available land near Salem and New Pekin, and a possibility for growth along U.S. Highway 150 near Fredricksburg.

Land Use Trends
In the Washington County Comprehensive Plan, Land Use Trends are also identified through the county and examined for future use.

The comprehensive plan describes the county's rural heritage still being intact with the land mostly not intensely developed. Agriculture remains an important part of the community, but recently the number of local farms has dropped.

Except for high density around Salem, there is no clear pattern for local land use. This includes the mix of commercial and residential properties. Commercial developments, businesses and scattered housing are commonly seen randomly located throughout the area. This can make it difficult for a business to locate or a home to be built due to the uncertainty of the future land use nearby.

Brownfields Sites
"Generally, a brownfield is a property where redevelopment is complicated due to actual or potential environmental contamination. Indiana defines a brownfield as:

- a parcel of real estate that is abandoned or inactive; or may not be operated at its appropriate use;
- and on which expansion, redevelopment, or reuse is complicated;
- because of the presence or potential presence of a hazardous substance, a contaminant, petroleum, or a petroleum product that poses a risk to human health and the environment" (IDEM, 2011).

In MCBR, there are two sites identified as brownfields sites, Blue River Motors/Visual Arts Building and Manufacturing Wood Finishing. Both sites are located in Salem (Figure 21).

Leaking Underground Storage Tank (LUST) Sites
"Underground storage tanks (known as USTs) are big containers placed underground to hold large quantities of liquids or gases. USTs also have piping and a pump station to move the tank contents to where they are used. About 95% of all USTs store petroleum products like gasoline or oil. Tanks may hold industrial chemicals, pesticides, or even food products."

“Since 1989, approximately 4,300 sites have been cleaned up where USTs leaked. The Leaking Underground Storage Tank Section is working to address about 3,500 more sites contaminated by leaking tanks. With so many spills to address, sites are prioritized to ensure that the spills with the greatest chance of impacting people are cleaned up first. Spills are placed into one of three categories: high, medium, or low priority” (IDEM, 2011).

- High Priority Sites:
  - Vapors are in buildings with people
  - Drinking water may be impacted
  - Tank contents are present in pools
  - Utility conduits (such as sewer lines) are affected
  - Environmentally sensitive areas are impacted
- Medium Priority Sites:
  - No high priority conditions present; and
  - In addition to soil, possible ground water contamination.
- Low Priority Sites:
  - Only soil impacted by the tank contents.

“For safety, tanks containing petroleum products and other substances are placed underground to lessen the risk of explosion. Unfortunately, this placement makes it difficult to detect leaks that can enter ground water supplies.” The most common places to find USTs are gas stations, dry cleaners, service stations, airports and truck fleet refueling services, and homes (IDEM, 2011).

In MCBR, there are eleven locations identified as LUST sites (Figure 21) with 24 incidents. Included on IDEM’s UST report at http://www.in.gov/idem/5065.htm, the current status of LUST sites in MCBR include 4 low priority, 10 medium priority, 8 high priority and 2 spills.

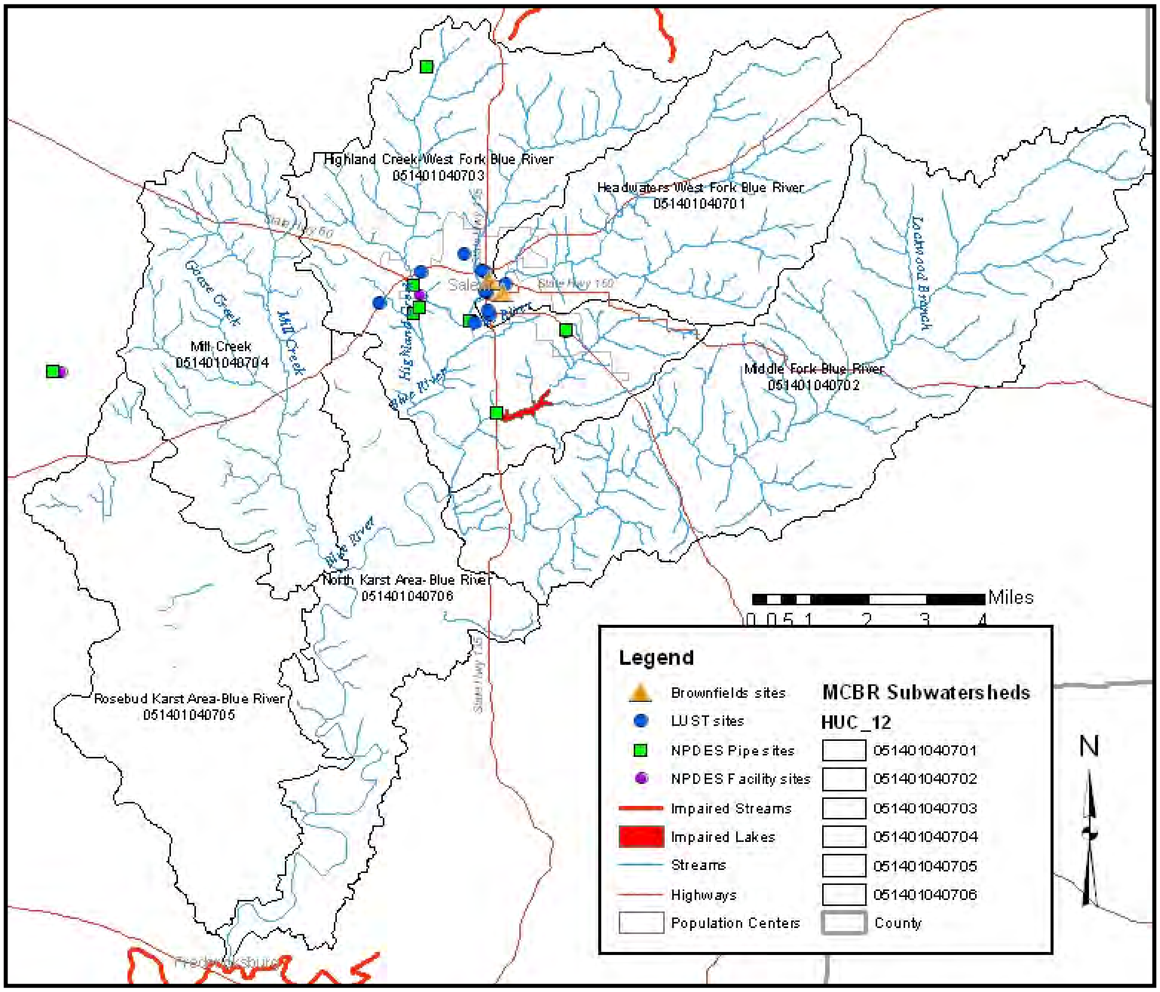
National Pollution Discharge Elimination System (NPDES) Facilities and Permit Compliance
“The purpose of the NPDES permit is to control the point source discharge of pollutants into the waters of the State such that the quality of the water of the State is maintained in accordance with the standards.”

“These permits place limits on the amount of pollutants that may be discharged to waters of the State by each discharger. These limits are set at levels protective of both the aquatic life in the waters which receive the discharge and protective of human health.”

“There are several different types of permits that are issued in the NPDES permitting program, including, municipal (state or public), industrial (wastewater generated by producing a product, and wet weather” (IDEM, 2011).

In MCBR, there are four locations where NPDES facilities are permitted to discharge in compliance with the Clean Water Act (Figure 21). NPDES facility sites are located in the Highland Creek-West Fork Blue River Subwatershed and are compliant. These sites include Salem Waste Water Treatment Plant, Lake John Hay Water Plant, Tecumseh Products Company and Hanson Aggregates, Salem.

Figure 21. –LUST, Brownsfields, NPDES, Impaired Streams and Lakes in Mill Creek-Blue River Watershed

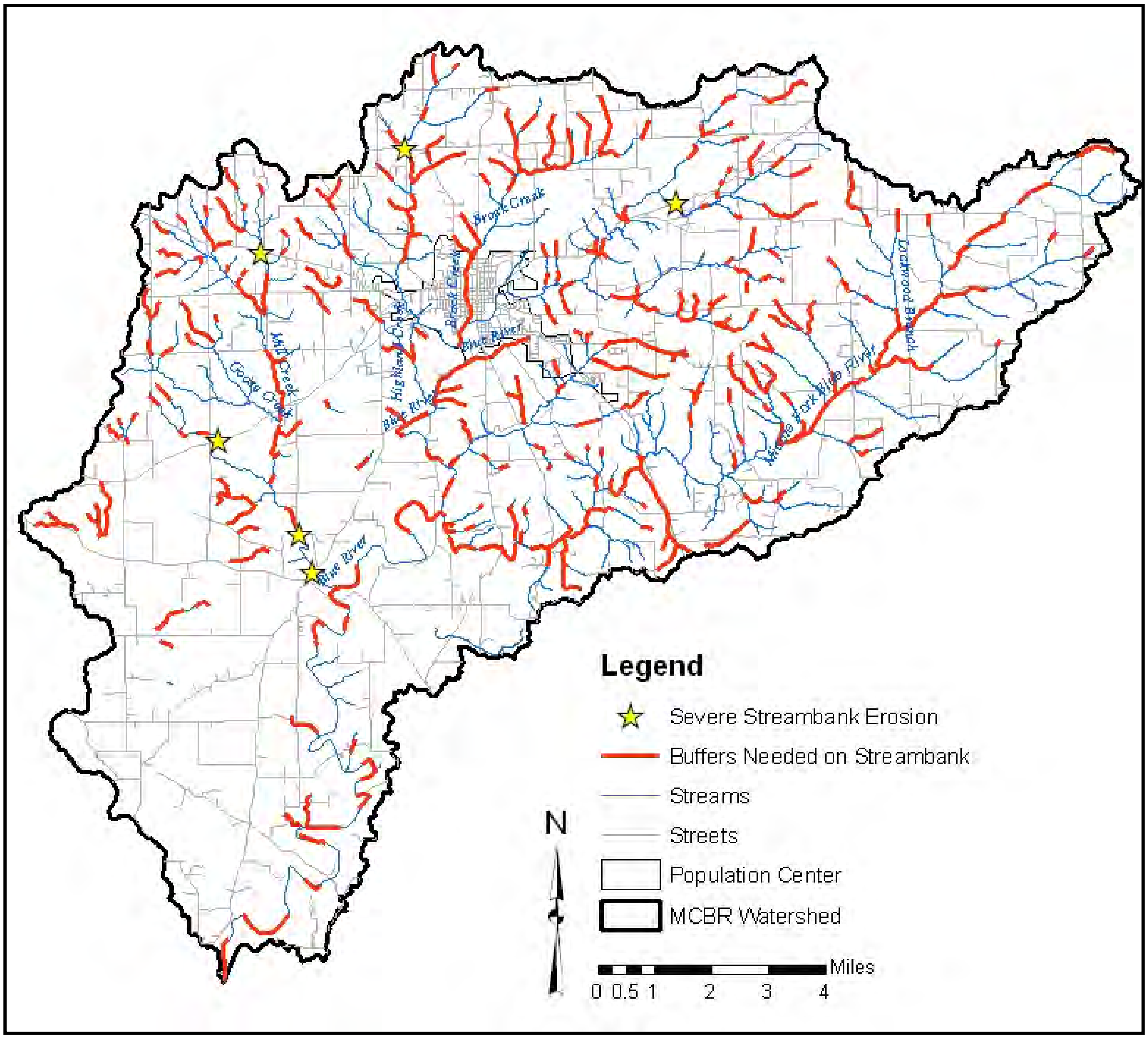


Streambank Needing Stabilization and Stream Miles Needing Buffers

Desktop and windshield surveys were conducted to determine the need to stabilize streambanks and approximate the number of miles needing buffers in the watershed. After these surveys were evaluated, it was concluded that about 98 miles of streams in MCBR have moderate or severe streambank erosion and/or need streambank buffers (Figure 22). Buffers that did not estimate at least 20 ft. were considered to need a buffer. Streambank erosion was determined by using the bank erosion hazard index (BEHI) guidance in the Monitoring Water in Indiana for Nonpoint Source Project in Indiana.

Private land that could not be accessed for a windshield survey to determine estimated values was then evaluated using a desktop survey using aerial maps from 2010. A number of locations along the streams in the watershed could not be evaluated for streambank erosion due to this issue.

Figure 22. – Streambanks Needing Stabilization and Stream Miles Needing Buffers in MCBR Watershed.



Animal Feeding Operations (AFO), Concentrated Animal Feeding Operations (CAFO), and Confined Feeding Operations (CFO)

As defined by the Environmental Protection Agency (EPA), "Animal Feeding Operations (AFOs) are agricultural operations where animals are kept and raised in confined situations. AFOs congregate animals, feed, manure and urine, dead animals, and production operations on a small land area. Feed is brought to the animals rather than the animals grazing or otherwise seeking feed in pastures, fields, or on rangeland." Regulated AFOs are split into two categories, Concentrated Animal Feeding Operations (CAFO) and Confined Feeding Operations (CFO).

In Indiana, an animal feeding operation with 300 or more cattle, 600 or more swine or sheep, 30,000 or more poultry, or 500 horses in confinement (less than 50% available vegetation) is a CFO. A person must request and receive IDEM approval before starting construction of a CFO, or starting expansion of a CFO to increase animal population or manure storage capacity.

The terms CFO and CAFO relate to the size of the CFO. A Concentrated Animal Feeding Operation (CAFO) is a CFO that meets the threshold animal numbers for large CAFO in the chart below (Table 23). Many of the program's requirements apply to CFO's of all sizes. Some requirements apply only to CAFOs.

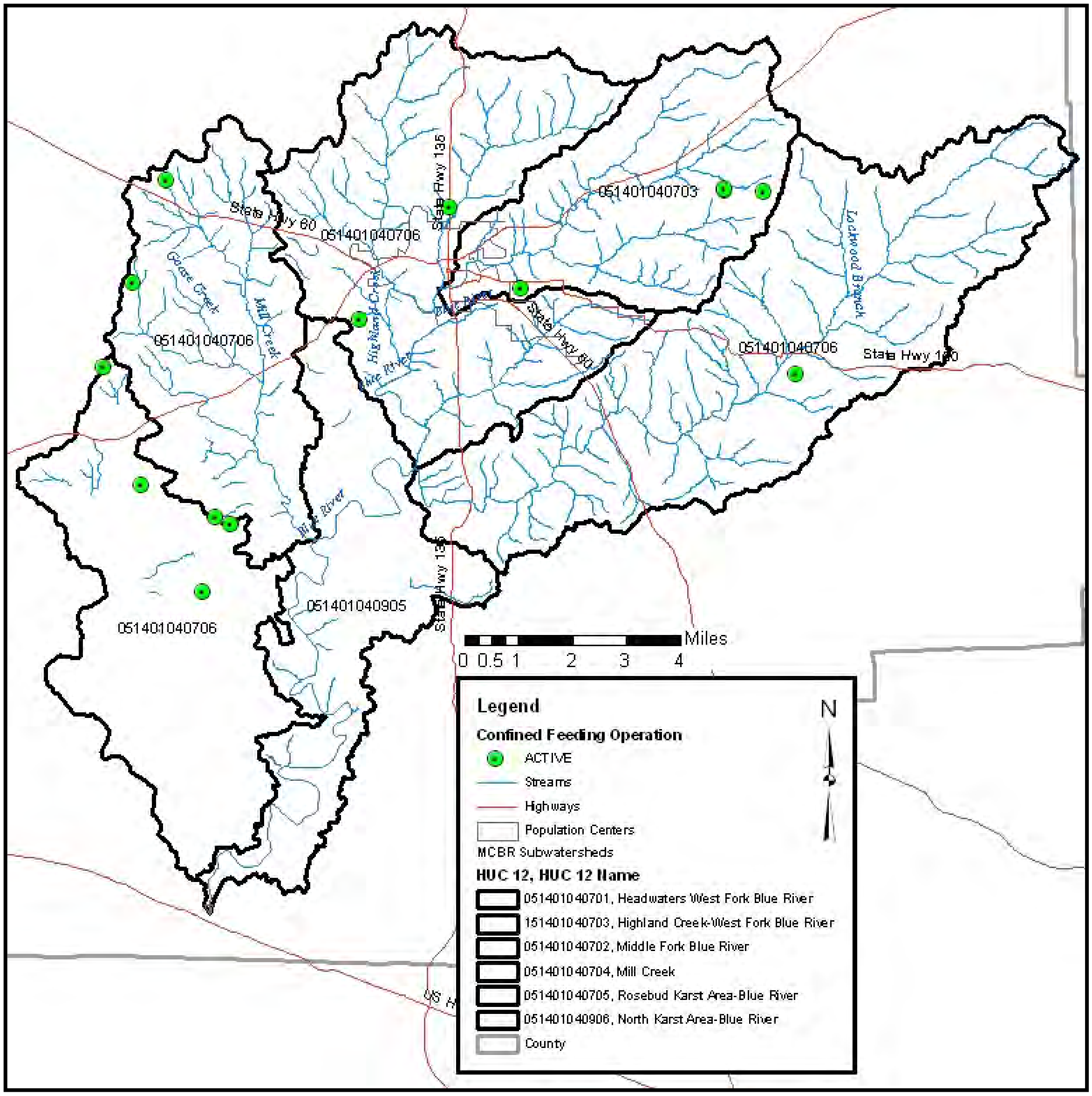
Currently, there are not any CAFOs in MCBR Watershed. MCBR, however, does contain 12 CFO locations, with approximately 9 CFOs located on or near a river or stream in the watershed (Figure 23). According the 2010-2011 Indiana Agricultural Statistics, Washington County was number one in beef production, number seven is all cattle production, number eight in turkey production, number eight in chicken production and number nine in sheep production. Even though these farms are smaller and do not qualify as a CAFO, they are important to water quality. Also, since the watershed project started in 2011, there has been a large number of chicken and turkey operations started in the watershed. The number of facilities is uncertain, but the water quality impact is a concern. A large amount of manure from the animals and water runoff from these facilities will make an impact on our rivers.

Stakeholders are concerned that livestock with access to streams could cause water contamination. Potential sources of non-point source pollution from livestock in or near a stream include contamination of stream from livestock waste, contaminated rain or water runoff from livestock waste, contamination of runoff or from decomposing livestock, and streambank erosion caused by disturbed soil, just to name a few. Recommended land practices to prevent possible non-point sources of pollution from CFOs and non-regulated AFOs are listed under 4.0 Watershed Inventory II-B.

Table 23. - CAFOs and CFO Threshold

CAFO and CFO Threshold Numbers:		
Species/Sector	**CAFO**	**CFO**
Beef:		
Cattle	1,000	300
Cow/Calf pairs	1,000	
Dairy:		
Mature Dairy Cow	700	300
Other than Mature Dairy Cow (dairy heifers, dairy calves, veal calves)	1,000	
Swine:		
Finishers/Growers/Sows (Greater than 55lbs)	2,500	600
Nursery Pig (Less than 55lbs)	10,000	
Chickens:		
Layers/Boilers (liquid manure handling system)	30,000	30,000
Chickens other than Layers (not in a liquid manure handling system)	125,000	
Layers (not in a liquid manure handling facility)	82,000	
Ducks:		
Liquid Manure System	5,000	30,000
Not in a Liquid Manure System	30,000	
Others:		
Turkeys	55,000	30,000
Horses	500	500
Sheeps/Lambs	10,000	600

Figure 23. – Confined Feeding Operations (CFO's) in Mill Creek-Blue River Watershed



Fertilizer Use on Non Urban/Suburban Land Uses

The majority of land in MCBR is considered to be non urban and is used for agricultural use. Agricultural operations primarily include row crop, pasture, and livestock operations.

Recently, input costs, such as fertilizer, have risen tremendously in the current years. This has led a number of land owners and operators to seek other ways to add nutrients to the land. Some operations are using manure from the livestock produced or, simply, are using less inputs to try and produce a quality crop.

In July 2010, the Indiana State Chemists office released the total fertilizer and nutrients used in the county. In Washington County, the total amount of fertilizer used January 2010 to June 2010 equaled 9,958.15 pounds. This amount includes 2,112.35 pounds of Nitrogen (N), 1,067.52 pounds of Phosphorus (P_2O_5), and 1,304.80 pounds of Potassium (K_2O).

Hobby Farms
Hobby farms are recognized for running a farm for the means of a hobby and not for the means to make a living. Although there is not a specific number documented, it is suggested there is a large number of hobby farms in MCBR.

Hobby farms in MCBR can be identified as many different types of livestock, crops, or specialty animal or crop production. MCBR is the home to many animals including cattle, hogs, sheep, goats, horses, and chickens as seen through windshield surveys and identified by stakeholders. Also, a variety of crops are grown including hay, corn, soybeans, wheat, and a wide-variety of garden crops. The livestock and crops are produced on much smaller scale.

Two farmer's markets have been established in Washington County and one is located in MCBR at the Washington County Fairgrounds from April thru October. This has increased the number of smaller sized operations in the community and has opened the door to more or new business for the local producer.

Training, educational workshops and free education materials are available throughout the year to these producers from Soil & Water Conservation District, Natural Resource Conservation Service, Purdue Extension and MCBR.

Application of Municipal Wastewater Sludge
At this time, the waste water treatment plant in Salem does not sell or give wastewater sludge to landowners for application. All sludge is taken to the landfill. Application of municipal sludge has been used in the past, but no plans are in place at this time for it to be available again.

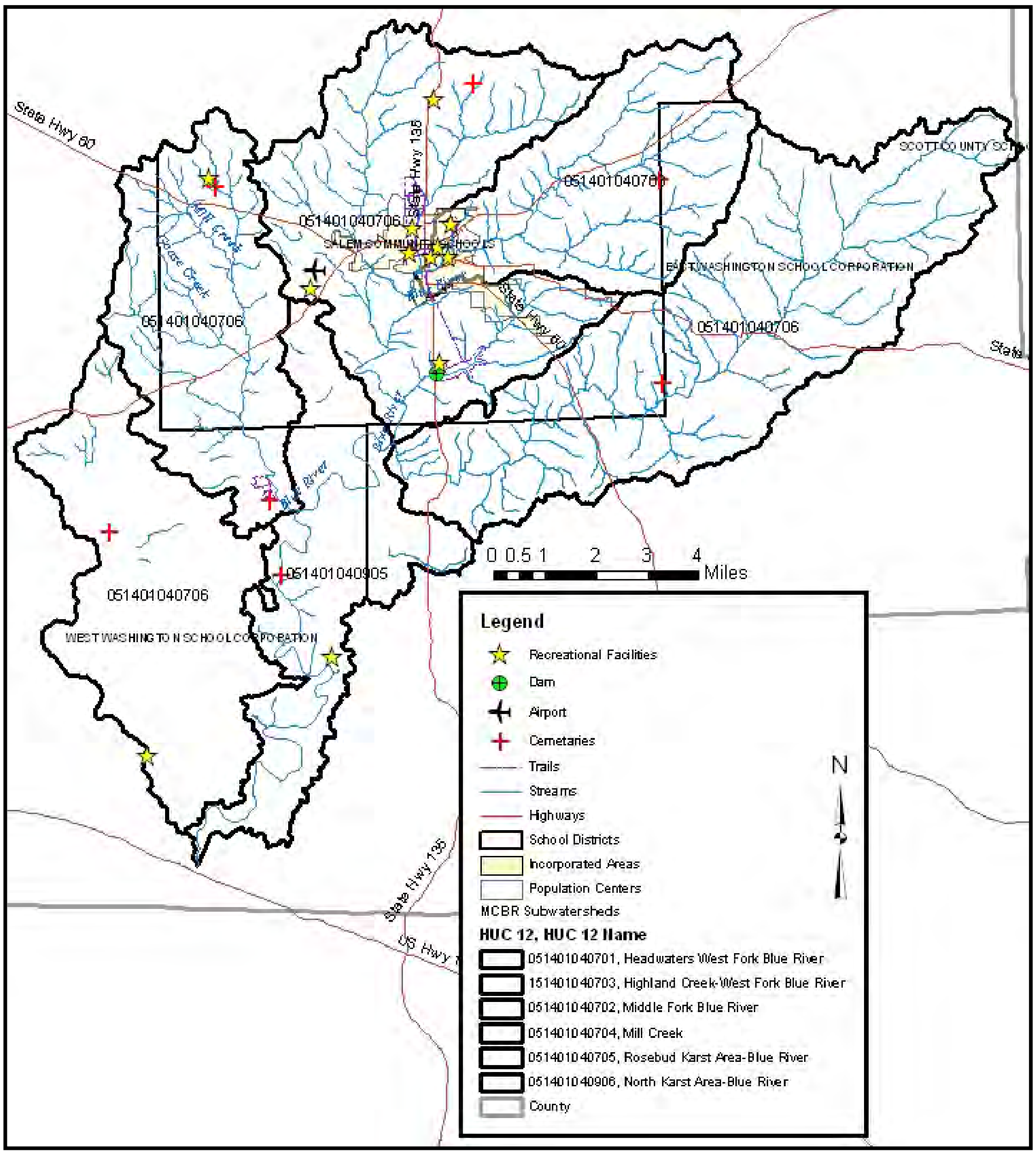
If landowners in the watershed use municipal wastewater sludge, it is brought in from outside of the watershed. Nearby locations include Corydon and Bloomington.

4.0 WATERSHED INVENTORY II-B – Land-use Information for Subwatersheds of Mill Creek-Blue River Watershed.

Land-use Information

The Mill Creek-Blue River Watershed contains six-subwatersheds. Each subwatershed is unique, but also similar in characteristics and lay of the land. Each subwatershed holds some amount of water, at least one cemetery, includes school corporation bus routes, and scenic window views. Other public land uses shown in Figure 24 include the Salem Airport, hiking trails, dam reservoir at Lake Salinda, parks and recreation sites and incorporated areas in Salem. Figure 24 gives insight to the watershed land use as a whole, but each subwatershed will discussed more thoroughly in this section.

Figure 24. – Public use areas and structures in Mill Creek-Blue River Subwatersheds



4.1 Headwaters West Fork Blue River Subwatershed – HUC 051401040701

Headwaters West Fork Blue River subwatershed is located in the northeast of MCBR. A small southwest portion includes The City of Salem; however the rest of the subwatershed is rural community. It covers 12,516 acres and contains about 37 miles of water. The main stream in this subwatershed is West Fork Blue River with numerous unnamed tributaries flowing into it.

Headwaters West Fork Blue River subwatershed major land uses include cultivated crops (35.47%), pasture (34.78%), forest (17.54%), and some developed space (12.05%) (Figure 25, Figure 26).

Information from windshield and desktop surveys show this subwatershed consisting of a small portion of commercial property and mainly containing livestock and crop farming operations. Evidence of livestock with access to the stream was observed at two locations and runoff from rain events are located by streets and highways next to West Fork Blue River in Salem city limits (Table 24).

Water Quality and Habitat Data Summary

Water testing sites 1 and 10 are located in the Headwaters West Fork Blue River subwatershed. Table 25 lists the average of the tested parameters and those exceeding water quality standards or targets are identified in bold.

Water testing parameters that exceeded targets and standards for Sites 1 and 10 included *E.coli*, nitrate and pH. *E.coli* exceeded the target in three months at Site 1 and six times at Site 10 in the 12-month period. The results at Site 1 include the minimum reading of 20.1 colonies/100mL, a maximum reading of 816.4 colonies/ 100mL, and the average of the collected samples equaled 195.38 colonies/100mL. At Site 10, the minimum reading was 60.2 colonies/100mL, the maximum reading was 2,419.6 colonies/100mL, and the average result was 511.6 colonies/100mL.

Nitrate results exceeded the target five times at Site 1 and four times at Site 10. The results of Site 1 include a minimum reading of <0.05mg/L, a maximum reading of 5.88 mg/L, and an average of 3.30 mg/L. The results of Site 10 include a minimum reading of <0.05 mg/L, a maximum reading of 6.64 mg/L, and an average reading of 3.36 mg/L.

Results for pH exceeded only one time at site 1, at 9.05 and site 10, at 9.24. The results at Site 1 include the minimum reading of 7.08, a maximum reading of 9.05, and an the average of 7.93. At Site 10, the minimum reading was 7.16, the maximum reading was 9.24, and the average was 7.93.

The mIBI indicated that Site 10 is impaired with a score of 34 and the QHEI showed this site with a “fair” habitat. It had a low number of macroinvertebrate taxa that are pollution intolerant, and had one of the highest *E.coli* counts within the study sites.

Figure 25. – Headwaters West Fork Blue River Subwatershed Land Uses

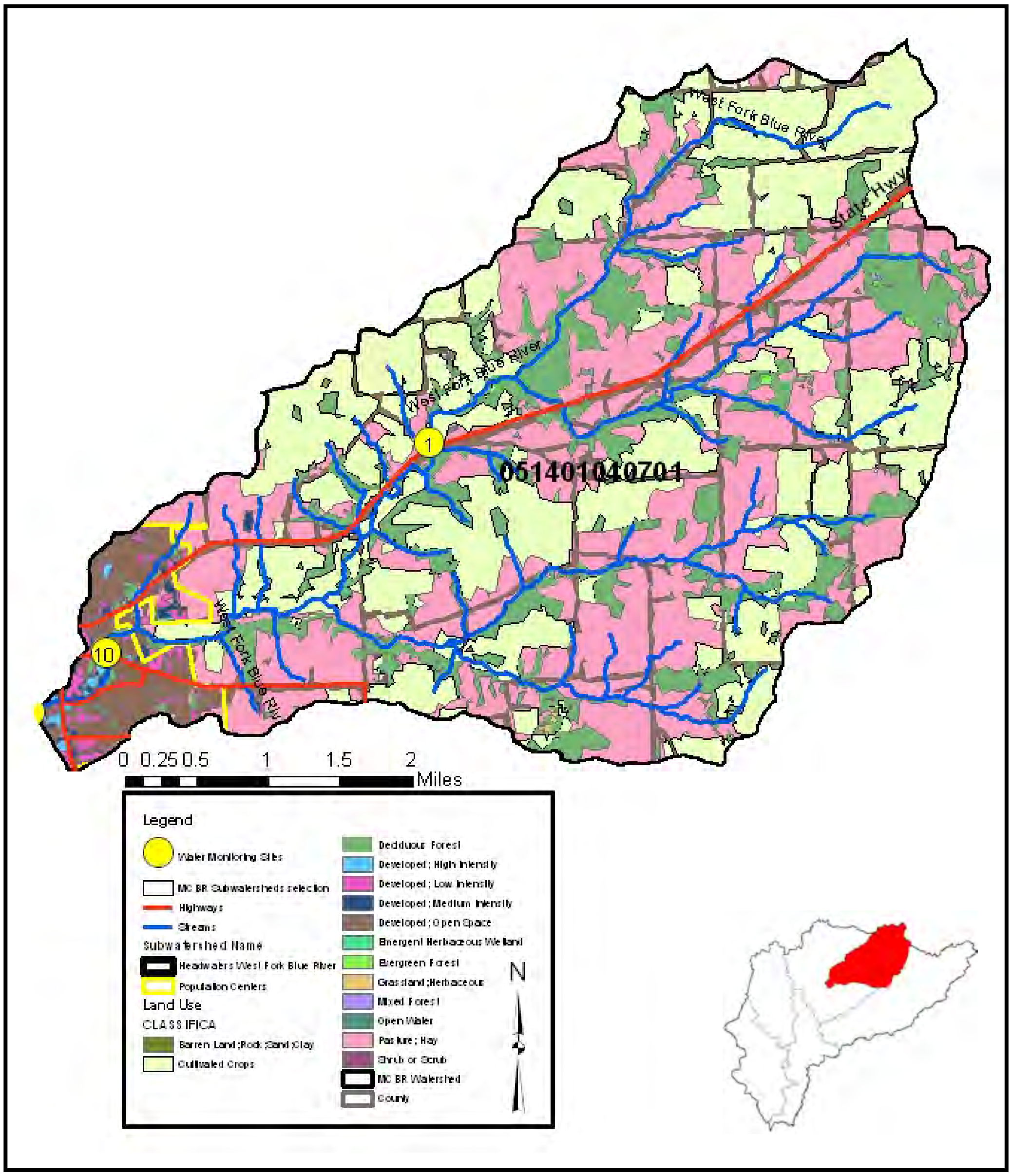


Figure 26. - Headwaters West Fork Blue River Subwatershed Land Uses by Percent

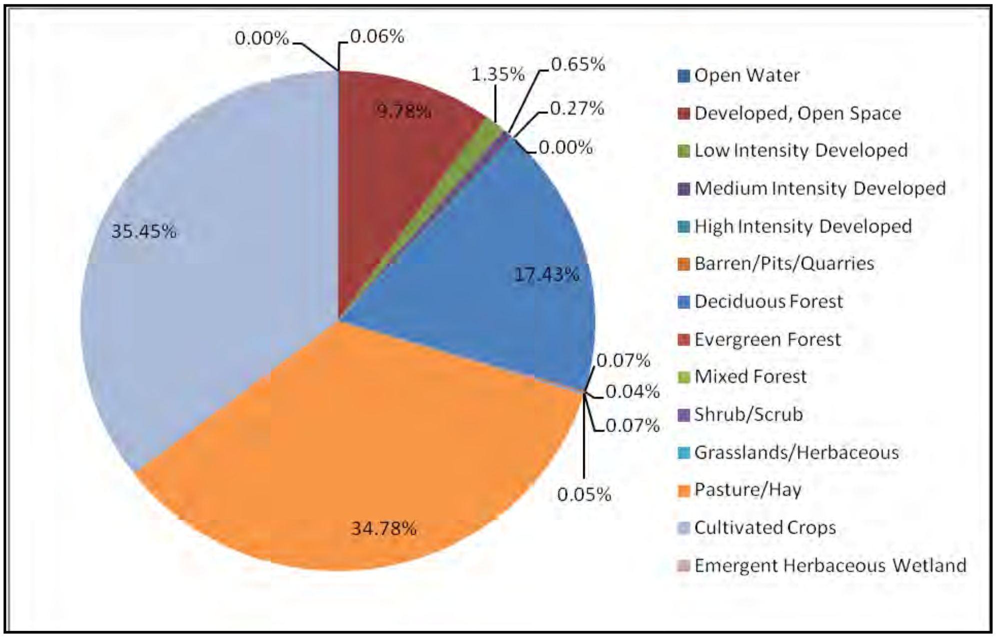


Table 24. – Headwaters West Fork Blue River Subwatershed Windshield/Desktop Surveys

Potential Negative Water Quality Influence	BMP Needed	Location	Survey Type	Observer
Livestock with access to the stream (no livestock present)	Fencing/alternative watering source	Unnamed tributary east of West Fork Blue River one half mile north where Howell and Elliott Road meet.	Windshield	Steering Committee
Livestock with access to stream (no livestock present)	Fencing/alternative watering source	Unnamed tributary east of West Fork Blue River where Howell and Canton Road meet	Windshield	Steering Committee
Large amount of impervious surface water runoff by stream in Salem	Storm-water retention pond	Along West Fork Blue River in City of Salem	Windshield	Steering Committee

Table 25. - Headwaters West Fork Blue River Subwatershed Data Exceeding Water Quality Standards or Targets.

	pH	DO	Temp. ºC	Nitrate (as N)	Turbidity	TSS	Total Phosphorus	*E.coli*	QHEI	mIBI
Site 1 Average	7.93	7.85 mg/L	13.58	3.30 mg/L	1.56 NTU	2.67 mg/L	<0.05 mg/L	179.18 colonies/ 100mL	65	40
Min/Max	7.08/ 9.05	11/ 7.85	3/ 24.1	0.993/ 5.88	0.425/ 2.79	1/6	0/0	20.1/ 816.4	-	-
# times exceeded target	**1**	**-**	**-**	**5**	**-**	**-**	**-**	**3**	**-**	**-**
Site 10 Average	7.93	7.87 mg/L	13.78	3.36 mg/L	1.89 NTU	4.33 mg/L	0.059 mg/L	**511.6 colonies/ 100mL**	58	**34**
Min/Max	7.16/ 9.24	4/11	1.8/ 24.3	0.108/ 6.64	0.784/ 3.03	1/13	0.059/ 0.059	60.2/ 2,419.6	-	**-**
# times exceeded target	**1**	**-**	**-**	**4**	**-**	**-**	**-**	**6**	**-**	**-**

4.2 Middle Fork Blue River Subwatershed – HUC 051401040702
Middle Fork Blue River subwatershed is located in the east of MCBR. It covers 25,733 acres and contains about 84 miles of water. The main stream found in this subwatershed is Blue River Middle Fork, Lockwood Branch and contains many unnamed tributaries that drain into it. The main land uses include cultivated crops (18.78%), pasture/hay (34.13%), and forest (41.12%) (Figure 27, Figure 28).

Information from the windshield and desktop surveys show the subwatershed is used for commercial, residential and agriculture uses. Evidence of stream bank erosion was documented at two sites and row cropping less than 50 feet from the stream was located at three different locations. Also, this subwatershed is suggested to have a higher number of septic systems and contains a majority of very limited soils rating for septic system suitability. This could result in poor water quality results if a system is not maintained or fixed if it is a failed septic system (Table 26).

Water Quality and Habitat Data Summary
Site 2 and Site 5 were two sample sites that were established in the Middle Fork Blue River subwatershed as part of this study. Table 27 states the parameters that were tested. There was no parameter average that exceeded water quality standards or targets.

Water testing parameters exceeding targets and standards for Sites 2 and 5 included *E.coli* and nitrate. *E.coli* exceeded the target during three different months at Site 2 and two different months at Site 5. The results at Site 2 include the minimum reading of 15.6 colonies/100mL, a maximum reading of 1203.3 colonies/100mL, and an average of 224.08 colonies/100mL. At Site 5, the minimum reading was 17.1 colonies/100mL, the maximum reading of 579.4 colonies/100mL, and the average result was 117.35 colonies/100mL.

Nitrate results exceeded the target two times at Site 2 and one time at Site 5. The results of Site 2 include a minimum reading of <0.05mg/L, a maximum reading of 5.88 mg/L, and an average of 1.92 mg/L. The results of Site 5 include a minimum reading of <0.05 mg/L, a maximum reading of 4.22 mg/L, and an average reading of 1.88 mg/L.

The QHEI indicated Site 2 as “good” and Site 5 as “excellent” habitat, however, the mIBI score at Site 5 was lower than what would be expected based on the habitat.

Figure 27. - Middle Fork Blue River Subwatershed Land Uses

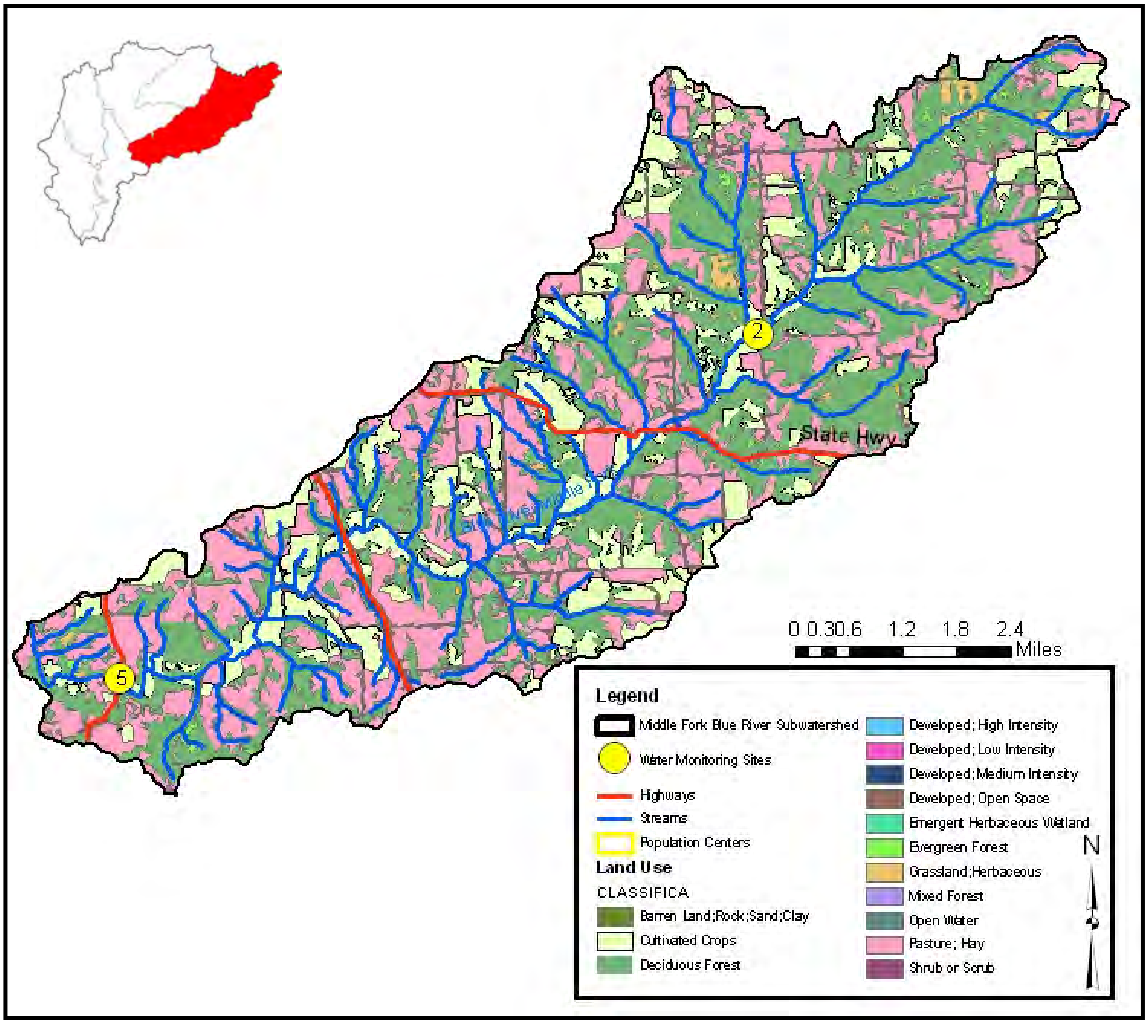


Table 26. – Middle Fork Blue River Subwatershed Windshield/Desktop Surveys

Potential Negative Water Quality Influence	BMP Needed	Location	Survey Type	Observer
Streambank Erosion	Tree/Shrub Establishment, Streambank and Shoreline Protection, Riparian Herbaceous Cover, Critical Area Planting	Middle Fork Blue River on bridge by intersection of Fallen Barn and Blue River Chapel Road	Windshield	Steering Committee
Streambank Erosion	Tree/Shrub Establishment, Streambank and Shoreline Protection, Riparian Herbaceous Cover, Critical Area Planting	Middle Fork Blue River north of intersection of Temple and Martinsburg Road	Windshield	Steering Committee
Home site fertilizer runoff/poor septic system drainage and maintenance	Tree/Shrub Establishment, Streambank and Shoreline Protection, Riparian Herbaceous Cover, Critical Area Planting	Unnamed tributary south of Middle Fork Blue River on Farabee Road	Windshield	Steering Committee
Row crop within 10 feet of stream bank	Filter Strip/Riparian buffer	Unnamed tributary south of Middle Fork Blue River on Farabee Road	Windshield	Steering Committee
Row crop with 20 feet of stream bank	Filter Strip/Riparian buffer	Unnamed tributary southeast of Middle Fork Blue River on Wathen Road	Windshield	Steering Committee
Cropland within 50 feet of stream	Filter strip widened/riparian buffer enhancement	Unnamed tributary south of Middle Fork Blue River on the bridge on Old Blue River Chapel Road	Windshield	Steering Committee

Figure 28. – Middle Fork Blue River Subwatershed Land Uses by Percent

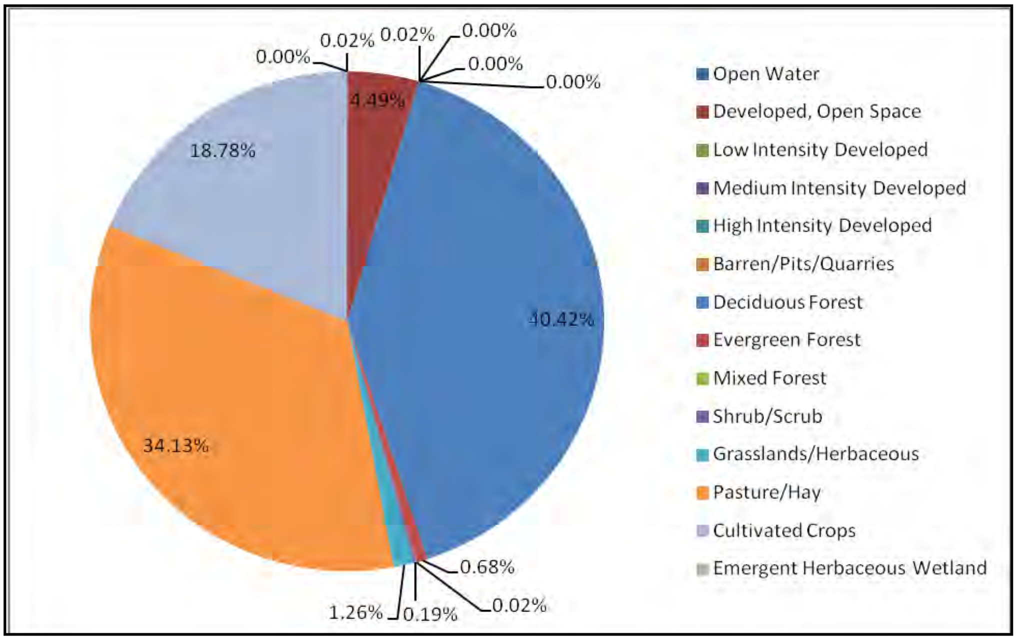


Table 27. - Middle Fork Blue River Subwatershed Data Exceeding Water Quality Standards or Targets.

	pH	DO	Temp. ºC	Nitrate (as N)	Turbidity	TSS	Total Phosphorus	*E.coli*	QHEI	mIBI
Site 2 Average	7.29	7.91 mg/L	13.14	1.92 mg/L	1.57 NTU	4.5mg/L	0.071 mg/L	224.08 colonies/ 100mL	69	42
Min/Max	6.61/ 8.37	5.4/ 10.6	1.6/ 23.9	<0.05/ 5.88	0.0589/ 2.79	3/5	0.061/ 0.081	15.6/ 1,203.3	-	-
# times exceeded target	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**-**	**-**
Site 5 Average	7.84	7.9 mg/L	16.39	1.88 mg/L	3.51 NTU	4.40mg/L	<0.05 mg/L	126.82 colonies/ 100mL	74	35
Min/Max	6.04/ 8.77	4.5/11	3.6/25	<0.05/ 4.22	1.23/ 7.73	1/8	0/0	17.1/ 579.4	-	-
# times exceeded target	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**2**	**-**	**-**

4.3 Highland Creek-West Fork Blue River Subwatershed – HUC 05140104703

Highland Creek-West Fork Blue River subwatershed is located in the northern section of MCBR. It covers 19,885 acres and contains 57 miles of water. The main streams in this subwatershed included Brock Creek, Hoggatt Branch, Highland Creek and Blue River.

The main land uses include cultivated crops (22.56%), pasture (46.52%), forest (17.42%), developed open space (9.55%), and a small section of grassland (0.29%) (Figure 29, Figure 31). This subwatershed also includes the west half of the populated City of Salem and the IDEM 303(d) impaired waterbody, Lake Salinda (Figure 30).

Information from windshield and desktop surveys show this subwatershed is used for industrial, commercial, residential, and agricultural uses. Evidence of trash and litter has been spotted numerous times along roads and stream banks in The City of Salem. The MCBR Project cooperated with The City of Salem, Rotary Club and Salem High School Community Service Club to host stream and street clean up days each year to minimize the amount of trash (Figure C).

Figure C. Volunteers Removing Debris from West Fork Blue River near Salem Center Peace.

Other resource concerns have been identified by the steering committee in windshield surveys including row crops being planted less than 20 feet from stream bank, gully erosion from overused pastureland, construction sites and impervious runoff from large parking lots in Salem.

It is suggested that residents who reside in the north part of this subwatershed likely use a septic system. This area is rated as somewhat limited for septic system suitability. This could result in poor water quality results if a system is not maintained or fixed if it is a failed septic system (Table 28).

Water Quality and Habitat Data Summary

Sites 3, 4, 9 and 11 were established for water testing in the Highland Creek-West Fork Blue River subwatershed. Table 29 shows the average for water monitoring results and testing parameters exceeding water quality standards or targets are identified in bold.

Water testing parameters that exceeded targets and standards for Sites 3, 4, 9 and 11 included *E.coli*, nitrate, total phosphorus, and pH. *E.coli* exceeded testing parameters during six times at Site 3, four times at Site 4, seven times at Site 9 and twelve times at Site 11.

The *E.coli* results at Site 3 include the minimum reading of 29.2 colonies/100mL, a maximum reading of 770.1 colonies/100mL, and an average of 295.87 colonies/100mL. At Site 4, the minimum reading was 10.9 colonies/100mL, the maximum reading was 1413.6 colonies/100mL, and the average result was 263.96 colonies/100mL. At Site 9, the minimum reading was 66.3 colonies/100mL, the maximum reading was 2419.6 colonies/100mL, and the average result was

513.31 colonies/100mL. At Site 11, the minimum reading was 248.1 colonies/100mL, the maximum reading was 2419.6 colonies/100mL, and the average result was 1146.89 colonies/100mL.

Nitrate results exceeded the target one time at Site 3, two times at Site 4, one time at Site 9 and nine times at Site 11. The results of Site 3 include a minimum reading of 0.07 mg/L, a maximum reading of 5.88 mg/L, and average of 2.19 mg/L; results of Site 4 include a minimum reading of 0.279 mg/L, a maximum reading of 4.71 mg/L, and an average reading of 2.13 mg/L; results of Site 9 include a minimum reading of 5.00 mg/L, a maximum reading of 24.2 mg/L, and an average reading of 14.81 mg/L; and results of Site 11 include a minimum reading of 5.8 mg/L, a maximum reading of 25.6 mg/L, and an average reading of 15.21 mg/L.

Total phosphorus results exceeded the target at Site 11 four different months. The results show a minimum reading of 0.078mg/L, maximum reading of 1.041mg/L, and average reading of 0.32mg/L.

The pH results exceeded the water quality target one time at each site. Site 3 included a minimum reading of 6.88, a maximum reading of 9.75, and an average reading of 8.25; Site 4 included a minimum reading of 6.08, a maximum reading of 9.34, and an average reading of 7.99; Site 9 included a minimum reading of 7.26, a maximum reading of 9.22, and an average reading of 8.10; and Site 11 included a minimum reading of 7.2, a maximum reading of 9.5, and an average reading of 8.16.

The QHEI indicated Sites 3, 4, and 11 as “poor” and Site 9 as “fair” habitat and Site 9 and 11 rated a score of 34 on the mIBI scale, meaning they were “impaired” as defined by Indiana Department of Environmental Management.

It is also important to note that site 11 is directly below of the Salem Waste Water Treatment Plant. The effluent that is testing by the company states the water quality meets their standards. However, according to our water monitoring from April 2011-March 2012, our watershed project sees this site in “poor” for impaired habitat, macroinvertebrate communities (mIBI), exceeding nitrate and exceeding *E.coli* target.

The volunteer (V) water monitoring site is located along Brock Creek in front of Salem School Corporation. Each month, volunteers from Salem High School and the Salem Science Club have tested along Brock Creek to learn the basics of water monitoring as well as collect the data for the Hoosier Riverwatch program. Each month, Mr. John Calhoun, Salem High School Science Teacher, has submitted the water monitoring data onto the Hoosier Riverwatch database and has submitted activity reports. The monitoring has been done at this site for over twenty years, but data was officially submitted online after QAPP approval for this watershed project (March 2011) and official training by the Hoosier Riverwatch program. This site has continually shown improvement and no concern for poor quality or habitat for

Figure D. High school students volunteer to complete water monitoring along Brock Creek in April 2011.

chemical, biological or habitat evaluation. Brock Creek has not dried up completely in the past three years, but was too low to test all water monitoring parameters in July, August and September 2012.

Figure 29. – Highland Creek-West Fork Blue River Subwatershed Land Uses

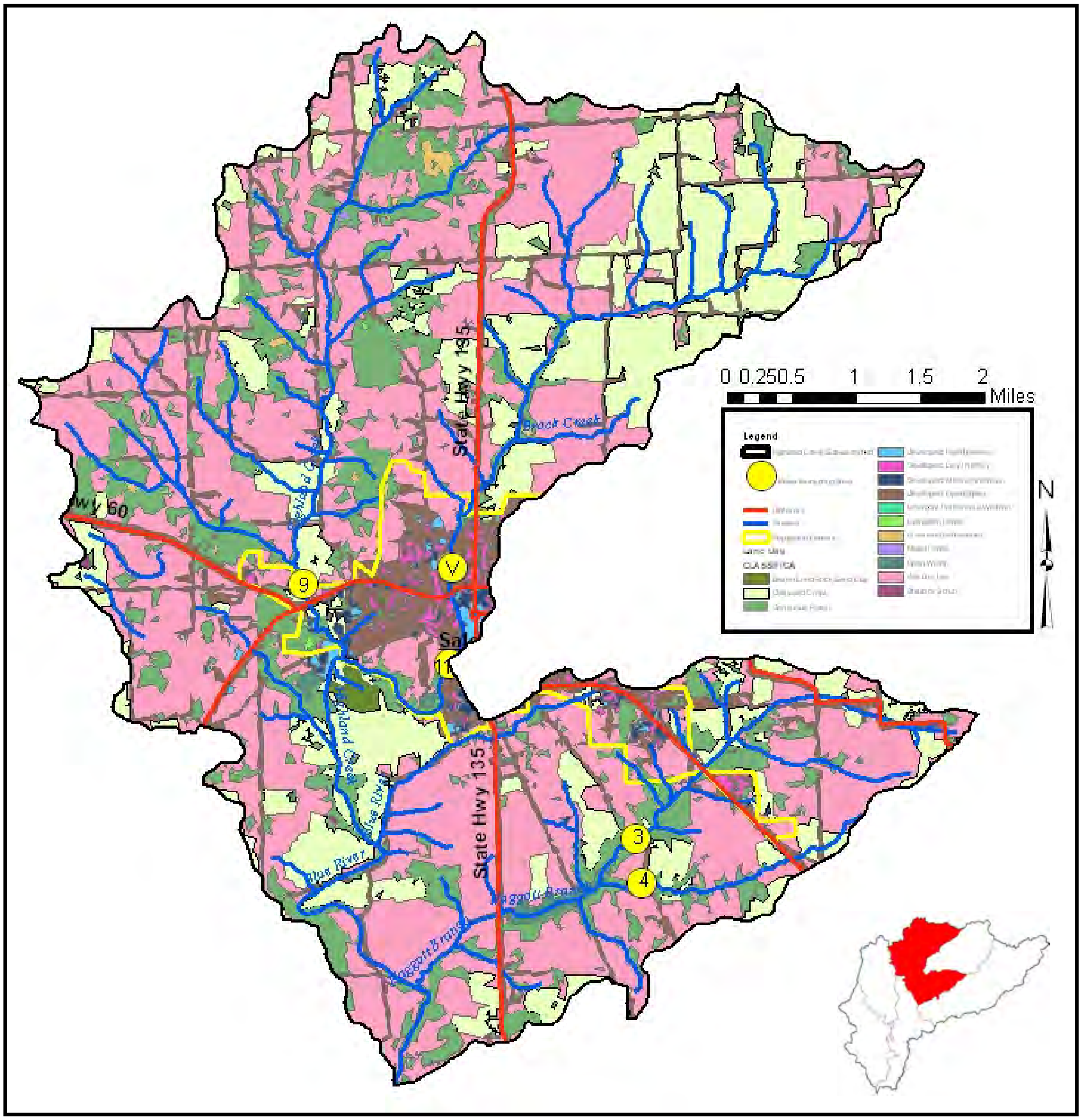


Figure 30. IDEM Impaired 303(d) Waterbody in Highland Creek-West Fork Blue River Subwatershed in MCBR.

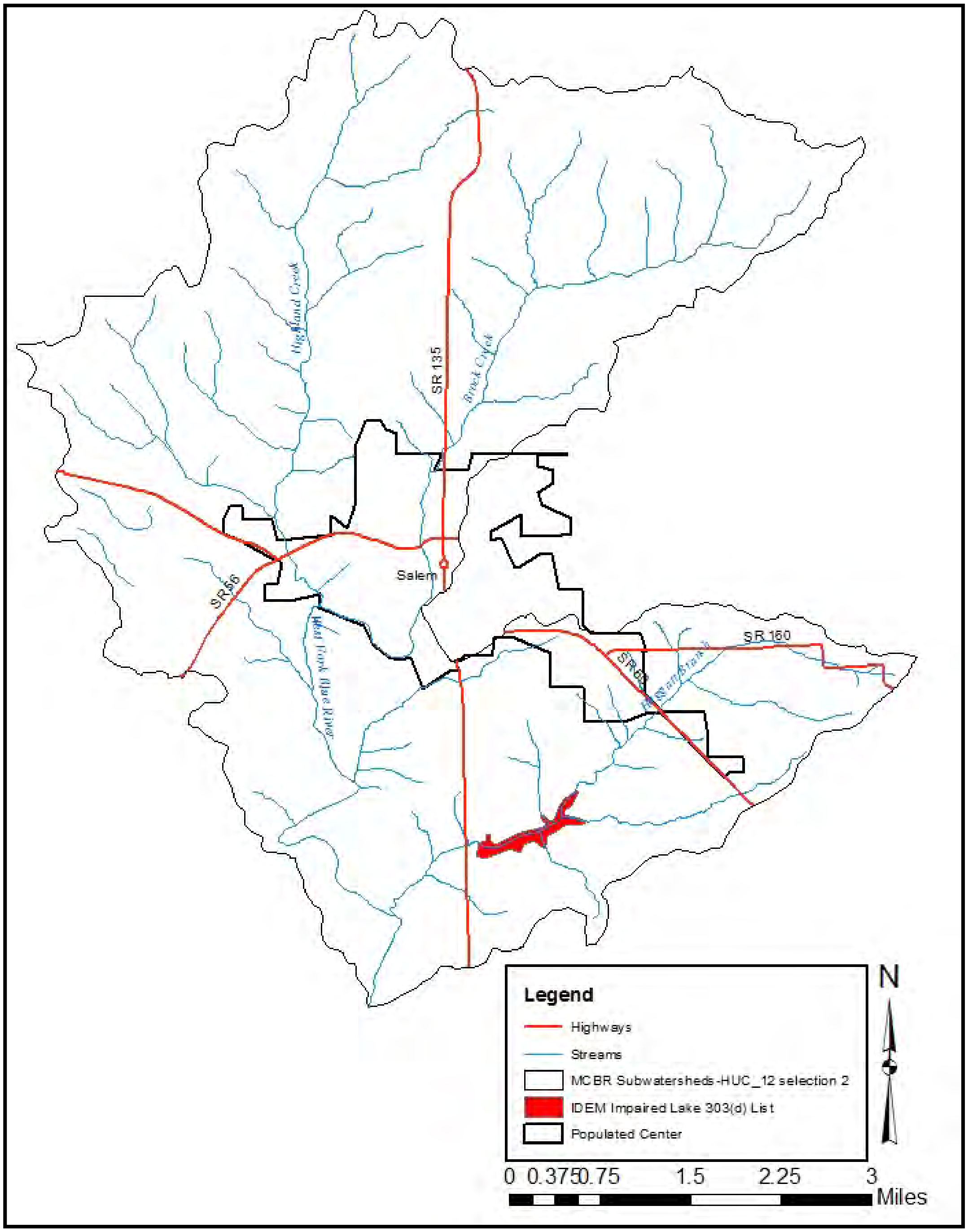


Figure 31. – Highland Creek-West Fork Blue River Subwatershed Land Uses by Percent

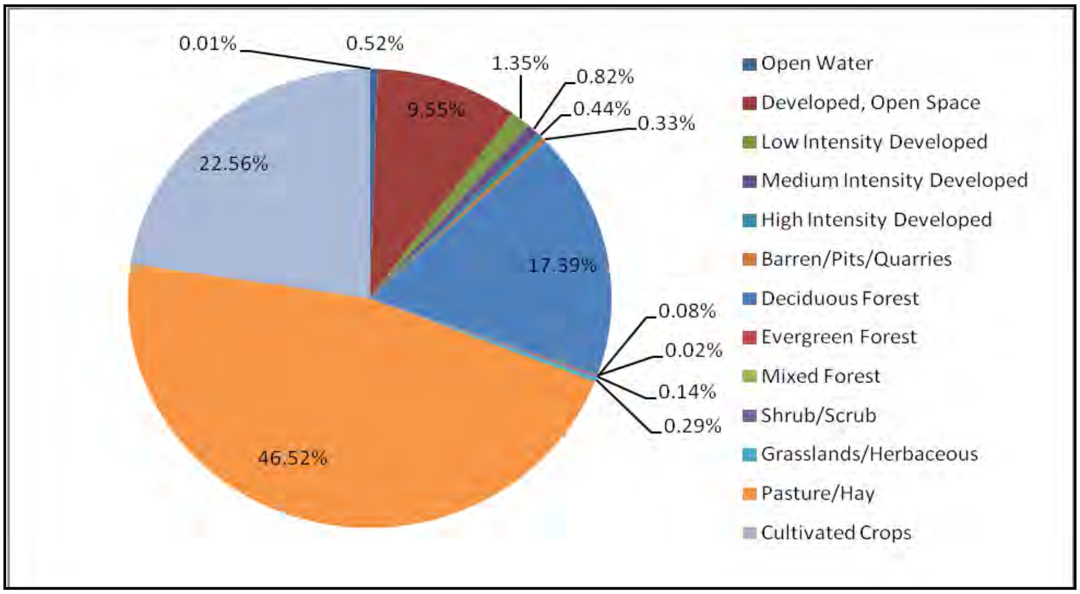


Table 28. – Highland Creek-West Fork Blue River Subwatershed Windshield/Desktop Surveys

Potential Negative Water Quality Influence	BMP Needed	Location	Survey Type	Observer
Trash and litter on stream bank; leaking home site septic system	Streambank clean up activity; More information needed	Unnamed tributary east of Blue River on Old 60	Windshield	Steering Committee
Row crops within 10-20 feet of stream bank; trash and litter in river and along stream bank	Filter strip/riparian buffer; Stream bank clean up activity	Blue River along Becks Mill Road south of GKN Industries	Windshield	Steering Committee
Gully erosion; impervious surface runoff from large commercial parking lots and residential area	Cover crop or riparian buffer; tree planting, rain garden, rain barrel	Along West Fork Blue River in Salem city limits and pastureland located along Brock Creek north of high school and hospital near Shelby Road	Windshield	Steering Committee

Table 29. - Highland Creek-West Fork Blue River Subwatershed Data Exceeding Water Quality Standards or Targets.

	pH	DO	Temp. ºC	Nitrate (as N)	Turbidity	TSS	Total Phosphorus	*E.coli*	QHEI	mIBI
Site 3 Average	8.25	7.99 mg/L	16.69	2.19 mg/L	3.85 NTU	5.00 mg/L	<0.05 mg/L	**295.87 colonies/ 100mL**	47	44
Min/Max	6.88/ 9.75	3.9/11	7.2/ 26.7	0.07/ 5.88	0.63/22.6	1/13	0/0	29.2/ 770.1	-	-
# times exceeded target	**1**	**-**	**-**	**1**	**-**	**-**	**-**	**6**	**-**	**-**
Site 4 Average	7.99	7.37 mg/L	16.44	2.13 mg/L	1.80 NTU	4.67 mg/L	<0.05 mg/L	**263.96 colonies/ 100mL**	47	38
Min/Max	6.08/ 9.34	1/11	0/20.4	0.279/ 4.71	0.467/ 3.81	1/6	0/0	10.9/ 1,413.6	-	-
# times exceeded target	**1**	**-**	**-**	**2**	**-**	**-**	**-**	**4**	**-**	**-**
Site 9 Average	8.10	8.61 mg/L	14.81	2.06 mg/L	3.12 NTU	3.5 mg/L	<0.05 mg/L	**513.31 colonies/ 100mL**	56	**34**
Min/Max	7.26/ 9.22	5.7/11	5/ 24.2	0.372/ 4.319	1.85/ 5.09	1/13	0/0	66.3/ 2,419.6	-	**-**
# times exceeded target	**1**	**-**	**-**	**1**	**-**	**-**	**-**	**7**	**-**	**-**
Site 11 Average	8.16	8.5 mg/L	15.21	**5.10 mg/L**	3.3 NTU	5.42 mg/L	**0.32 mg/L**	**1,146.87 colonies/ 100mL**	44	**34**
Min/Max	7.2/9.5	6.3/11	5.8/ 25.6	3.21/ 8.036	1.37/ 6.5	2/10	0.078/ 1.04	248.1/ 2,419.6	-	**-**
# times exceeded target	**1**	**-**	**-**	**9**	**-**	**-**	**4**	**12**	**-**	**-**

	pH	DO	Temp. ºC	Nitrate (as N)	Turbidity	TSS	Total Phosphorus	*E.coli*	QHEI	mIBI
Volunteer Average	7.37	7.93 mg/L	13.04	2.33 mg/L	**19.06 NTU**	-	0.02 mg/L	**333.09 colonies/ 100mL**	**-**	**-**
Min/Max	5.0/8.8	5.0/12	2.6/27	0.0/13.2	0.0/97	-	0.0/0.3	4.0/1194	**-**	**-**
# times exceeded target	**-**	**-**	**-**	**5**	**13**	**-**	**-**	**9**	**-**	**-**

4.4 Mill Creek Subwatershed – HUC 051401040704
The Mill Creek subwatershed is located in the northwest section of MCBR. It covers 13,413 acres and contains about 40 miles of water. Main streams found in this subwatershed include Goose Creek and Mill Creek.

The main land uses in the subwatershed include pasture (35.39%), forest (24.77%), and cultivated crops (33.22%). Some smaller sections include developed open space (5.07%) and grassland (0.63%) (Figure 32, Figure 33).

Information from windshield and desktop surveys confirm this subwatershed is used for recreation, home and agricultural purposes. Evidence from windshield surveys confirm that livestock have access to a stream in five locations in this subwatershed. Also, poor looking water quality and, floating algae, were noted. Row crops are being planted less than 15-20 feet from the stream or creek bank (Table 30).

Water Quality and Habitat Data Summary
Sites 6 and 8 were chosen in the Mill Creek subwatershed for this project. Table 31 depicts the average for the tested parameters and values exceeding the water quality standards and targets are identified in bold.

Water testing parameters that exceeded targets and standards for Sites 6 and 8 included *E.coli*, nitrate, and pH. *E.coli* values exceeded the target six times at Site 6, and five times at Site 8. The water testing information from IDEM's 2010 results on Mill Creek along State Route 56 also show *E.coli* samples exceeded the geometric mean standard of 125 cfu/100mL (See Table 22 in Section 3.3).

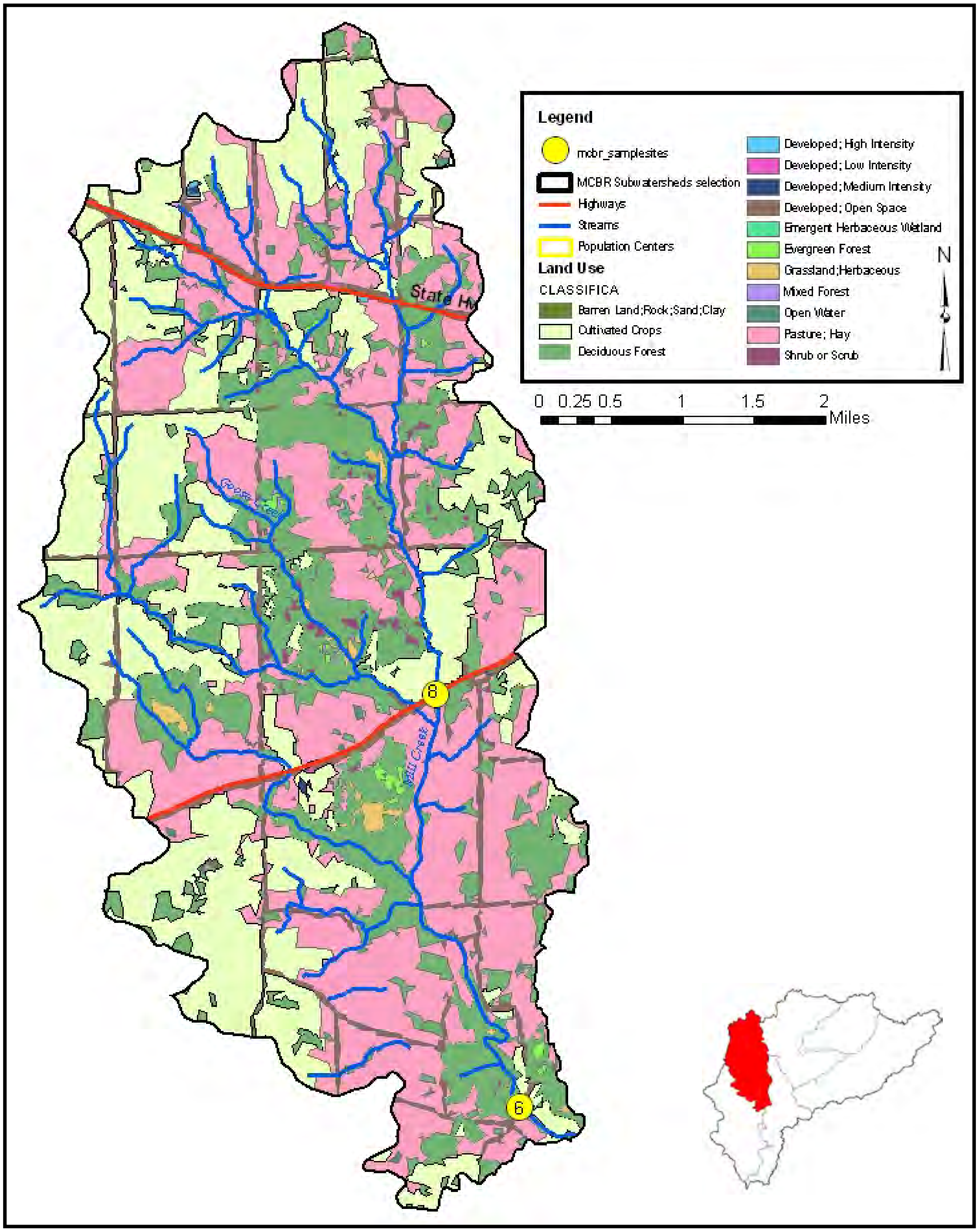
The *E.coli* results at Site 6 include the minimum reading of 51.2 colonies/100mL, a maximum reading of 1046.2 colonies/100mL, and an average equals 407.65 colonies/100mL. Site 8, the minimum reading was 79.4 colonies/100mL, the maximum reading was 1046.2 colonies/100mL, and the average result was 314.27 colonies/100mL.

Nitrate results exceeded the target six times at Site 6 and 5 times at Site 8. Site 6 showed a minimum reading of 2.222 mg/L, a maximum reading of 7.86 mg/L, and an average reading of 4.46 mg/L. Site 8 a minimum reading of 0.731 mg/L, a maximum reading of 7.36 mg/L, and an average reading of 3.66 mg/L.

The pH value exceeded the target one time at Site 8. The results at Site 8 showed a minimum reading of 6.59, maximum reading of 9.44, and average reading of 8.25.

The QHEI indicated Sites 6 as "excellent" and 8 as "good" habitat. Results from the mIBI study show both sites above 35, which means neither site is considered impaired.

Figure 32. – Mill Creek Subwatershed Land Uses



<u>Figure 33. – Mill Creek Subwatershed Land Uses by Percent</u>

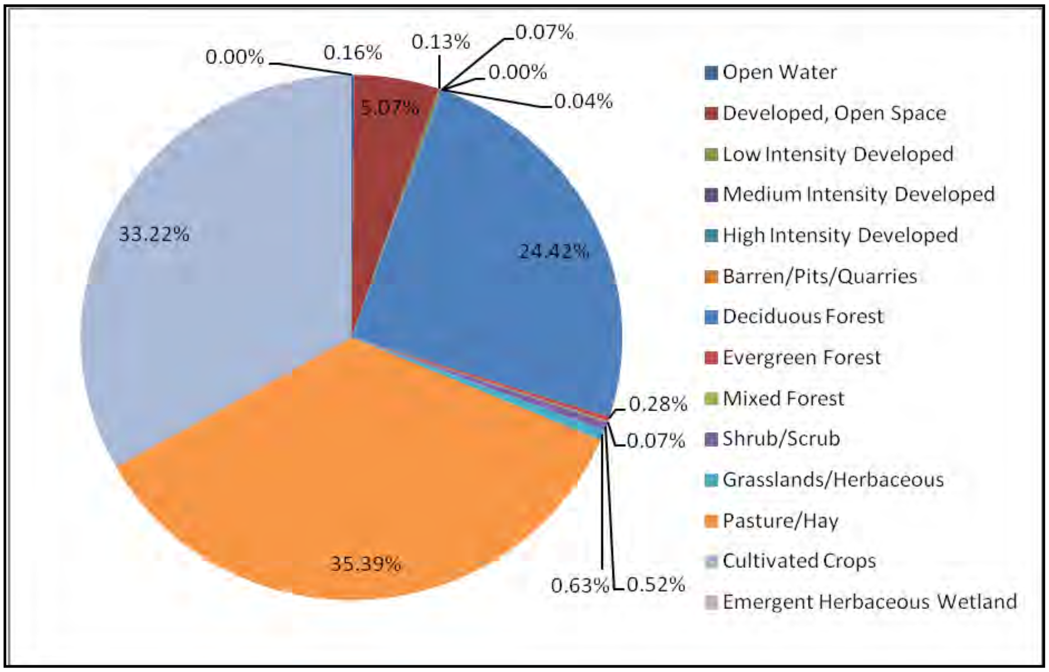


Table 30. – Mill Creek Subwatershed Windshield/Desktop Surveys

Potential Negative Water Quality Influence	BMP Needed	Location	Survey Type	Observer
Row crops within 15 feet of streambank; floating algae in the stream; stream bank erosion	Filter strip/riparian buffer; nutrient management	Unnamed tributary flowing to Mill Creek at intersection of State Road 60 and Hitchcock	Windshield	Steering Committee
Livestock with access to stream	Fencing/alternative water source	Unnamed tributary flowing to Mill Creek at intersection of Bee Line and Hitchcock	Windshield	Steering Committee
Row crops within 20 feet of streambank	Filter strip/riparian buffer	Unnamed tributary flowing to Mill Creek at intersection of Mount Tabor and Hitchcock	Windshield	Steering Committee
Row crop with 10 feet of streambank	Filter strip/riparian buffer	Goose Creek on Mount Tabor Road	Windshield	Steering Committee
Livestock with access to stream; Green and Murky water color	Fencing/alternative water source; Nutrient management	Unnamed tributary flowing to Mill Creek on Mount Tabor Road	Windshield	Steering Committee
Livestock with access to stream	Fencing/alternative water source	Unnamed tributary flowing to Mill Creek on Chastain Road	Windshield	Steering Committee
Livestock with access to stream	Fencing/alternative water source	Unnamed tributary flowing to Mill Creek at Dog Trot Road south of State Hwy 56	Windshield	Steering Committee
Livestock and domesticated wildlife with access to stream	Fencing/alternative water source	Mill Creek on Wilson Road	Windshield	Steering Committee

Table 31. - Mill Creek Subwatershed Data Exceeding Water Quality Standards or Targets.

Site	pH	DO	Temp. ºC	Nitrate (as N)	Turbidity	TSS	Total Phosphorus	*E.coli*	QHEI	mIBI
Site 6 Average	7.85	9.56 mg/L	15.19	**4.46 mg/L**	3.54 NTU	3.0 mg/L	0.057 mg/L	**407.65 colonies/ 100mL**	77	44
Min/Max	5.57/ 8.7	7.6/11	7.9/ 22.8	2.222/ 7.86	1.09/11.3	1/7	0.05/ 0.066	51.2/ 1,046.2	-	-
# times exceeded target	**-**	**-**	**-**	**6**	**-**	**-**	**-**	**6**	**-**	**-**
Site 8 Average	8.25	9.09 mg/L	14.76	3.66 mg/L	2.38 NTU	2.89 mg/L	<0.05 mg/L	**314.27 colonies/ 100mL**	64	36
Min/Max	6.59/ 9.44	7.1/11	5.4/ 24.5	0.731/ 7.36	0.701/ 5.62	1/6	0/0	79.4/ 1,046.2	-	-
# times exceeded target	**1**	**-**	**-**	**5**	**-**	**-**	**-**	**5**	**-**	**-**

4.5 Rosebud Karst Area-Blue River Subwatershed – HUC 051401040705

The Rosebud Karst Area-Blue River subwatershed is located in the southwest section of MCBR. It covers 15,813 acres and contains about 3 miles of water. Water in this subwatershed contains unnamed streams. However, this subwatershed is very unique because it contains over 6,100 acres of the karst area and houses most of the hydric soils of MCBR. Its topographical features are different because of the flatter lay of the land in some areas (Figure 34).

The main land uses in the subwatershed include cultivated crops (38.52%), forest (27.11%), pasture (28.94%), and small sections of developed open space (4.47%), and grassland (0.42%) (Figure 35).

Information from windshield and desktop surveys show this subwatershed is mainly used for agricultural and home uses. Resource concerns for this subwatershed were taken from personal testimonies by stakeholders and identified by windshield surveys. It is suggested that this area is mainly sewered by septic systems. This subwatershed is labeled somewhat limited and very limited for septic system suitability. This is also a major resource concern because of the karst topography that covers this area. Poor septic tanks or lack of maintenance could directly leach or drain into the sensitive karst terrain and negatively affect water quality and aquatic life.

Also, the karst area contains many sinkholes. It has been shared by stakeholders that many people still dump trash or other items and liquids into nearby sinkholes. MCBR has access to educational brochures to share with the public about sinkhole stabilization and non-point source pollution for sinkhole awareness (Table 32).

Water Quality and Habitat Data Summary

No sample site was chosen in the Rosebud Karst Area-Blue River Subwatershed due to the minimal amount of streams in this area.

Figure 34. – Rosebud Karst Area-Blue River Subwatershed Land Uses

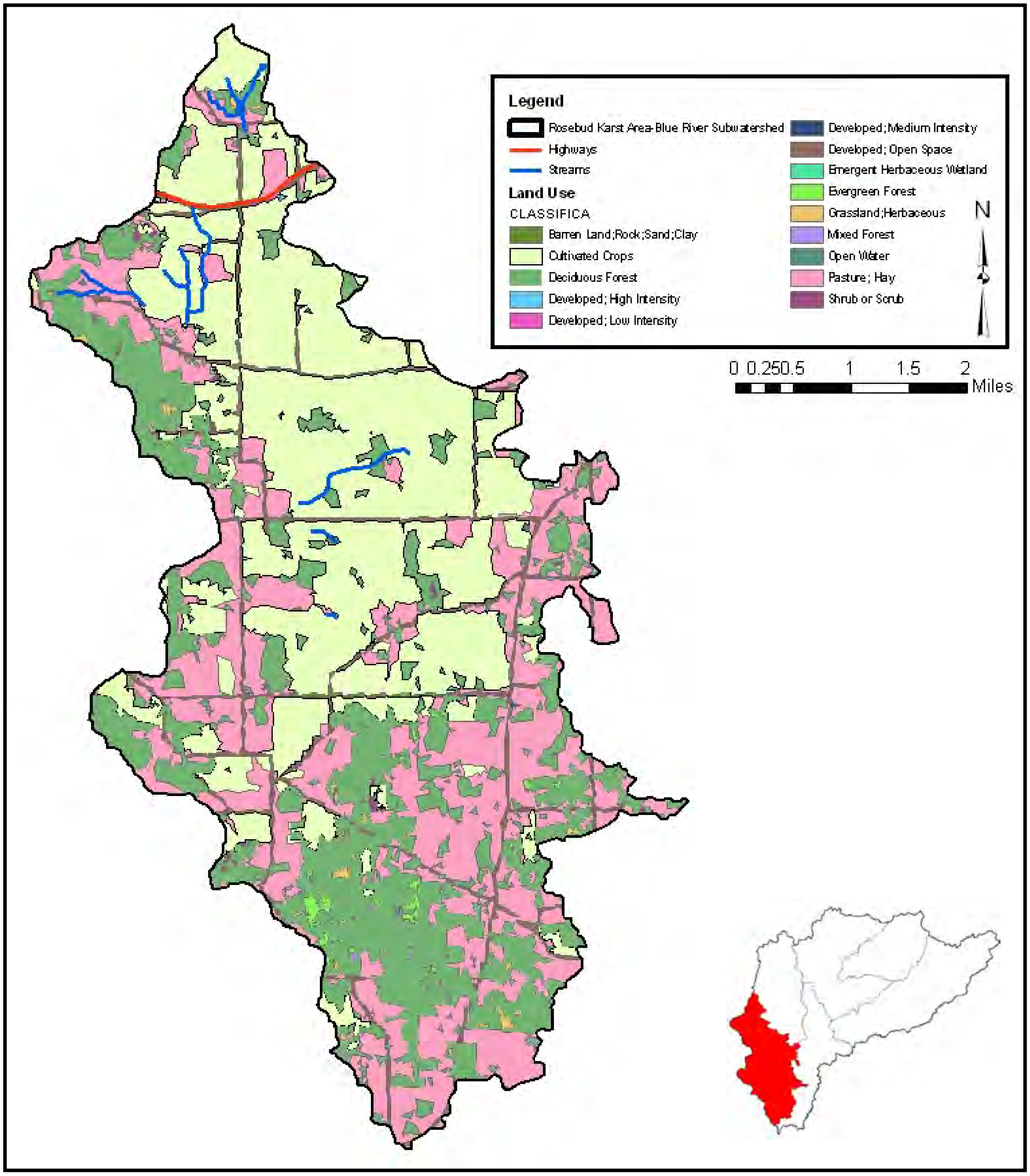


Figure 35. – Rosebud Karst Area-Blue River Subwatershed Land Uses by Percent

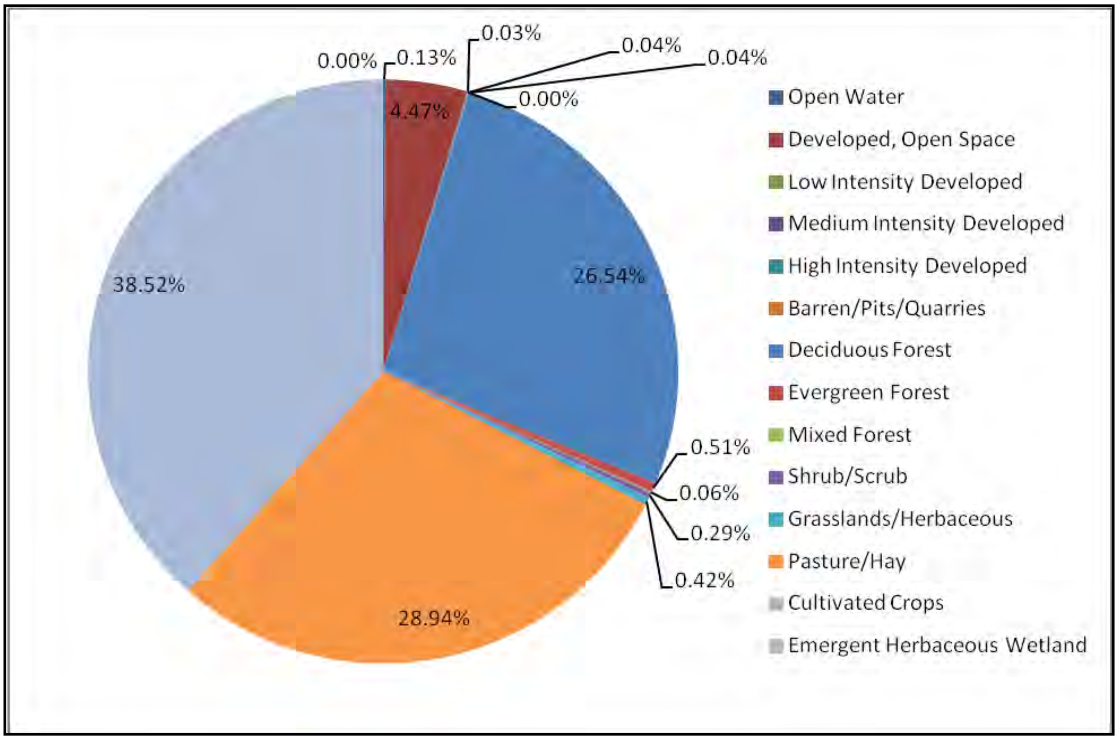


Table 32 . – Rosebud Karst Area-Blue River Subwatershed Windshield/Desktop Surveys

Potential Negative Water Quality Influence	BMP Needed	Location	Survey Type	Observer
Poor septic system drainage and maintenance	New or rehabbed septic tank and/or finger system to match site suitability	Near any karst feature	Desktop	Steering Committee
Trash and debris in sinkholes	Remove debris from sinkhole, dispose of trash properly	In or near any karst feature	Windshield	Steering Committee
Degrading Sinkholes	Sinkhole stabilization	Near any karst feature	Windshield	Steering Committee

4.6 North Karst Area-Blue River Subwatershed – HUC 051401040706

The North Karst Area-Blue River subwatershed is the located in the southeast half of the southern portion of MCBR and contains the northern section of the town of Fredricksburg. This subwatershed covers 12,493 acres and contains about 25 miles of streams. The main stream in this subwatershed is Blue River (Figure 36).

The main land uses in the subwatershed include forest (42.45%), cultivated crops (18.93%), pasture (32.03%), grassland (3.15%) and developed open space (3.09%) (Figure 37). This subwatershed also contains over 7,200 acres of karst area, and has the most karst cover in MCBR.

Information from windshield and desktop surveys show this subwatershed as mainly used for residential, highway travel, agricultural, home, and recreational uses. Documented resource concerns include planting row crops less than twenty feet from the streambank and streambank erosion. Also, the karst area contains many sinkholes. It has been shared by stakeholders that many people still dump trash or other items and liquids into nearby sinkholes. MCBR has access to educational brochures to share with the public about sinkhole stabilization and non-point source pollution for sinkhole awareness (Table 33).

Water Quality and Habitat Data Summary

Sites 7 and 12 were chosen in the North Karst Area-Blue River subwatershed for this study. Table 28 shows the average of the tested parameters. The average test results showed no parameter exceeded quality standard or target (Table 34).

Water testing parameters that exceeded targets and standards for Sites 7 and 12 included *E.coli*, nitrate and pH. *E.coli* exceeded the target four times at Site 7, and five times at Site 12.

The results at Site 7 include the minimum reading of 61.3 colonies/100mL, a maximum reading of 436.6 colonies/ 100mL, and an average of 194.13 colonies/100mL. At Site 12, the minimum reading was 18.7 colonies/100mL, the maximum reading was 410.6 colonies/100mL, and the average result was 195.73 colonies/100mL. The water testing information from IDEM's 2010 results on Blue River on Beck's Mill Road also show *E.coli* samples exceeded the geometric mean standard of 125 cfu/100mL (See Table 22 in Section 3.3).

Nitrate results exceeded the target three times at Site 7 and Site 12. Site 7 showed a minimum reading of 0.224 mg/L, a maximum reading of 6.28 mg/L, and an average reading of 2.81 mg/L. Site 12 showed a minimum reading of 0.724 mg/L, a maximum reading of 5.36 mg/L, and an average reading of 3.20 mg/L.

Results for pH exceeded the target during one event at Site 7 and Site 12. Site 7 showed a minimum reading of 5.99, a maximum reading of 9.28 and an average reading of 8.11. Site 12 showed a minimum reading of 7.67, a maximum reading of 9.3, and an average reading of 8.28.

The QHEI indicated Site 7 and 12 as "excellent" habitat, however, mIBI scores were less than what would be expected based on habitat. Site 7 had the best habitat of the test sites, but its mIBI score was only 63% of the total possible. Also, Site 12 had lower than expected diversity of macroinvertebrates.

<u>Figure 36. – North Karst Area-Blue River Subwatershed Land Uses</u>

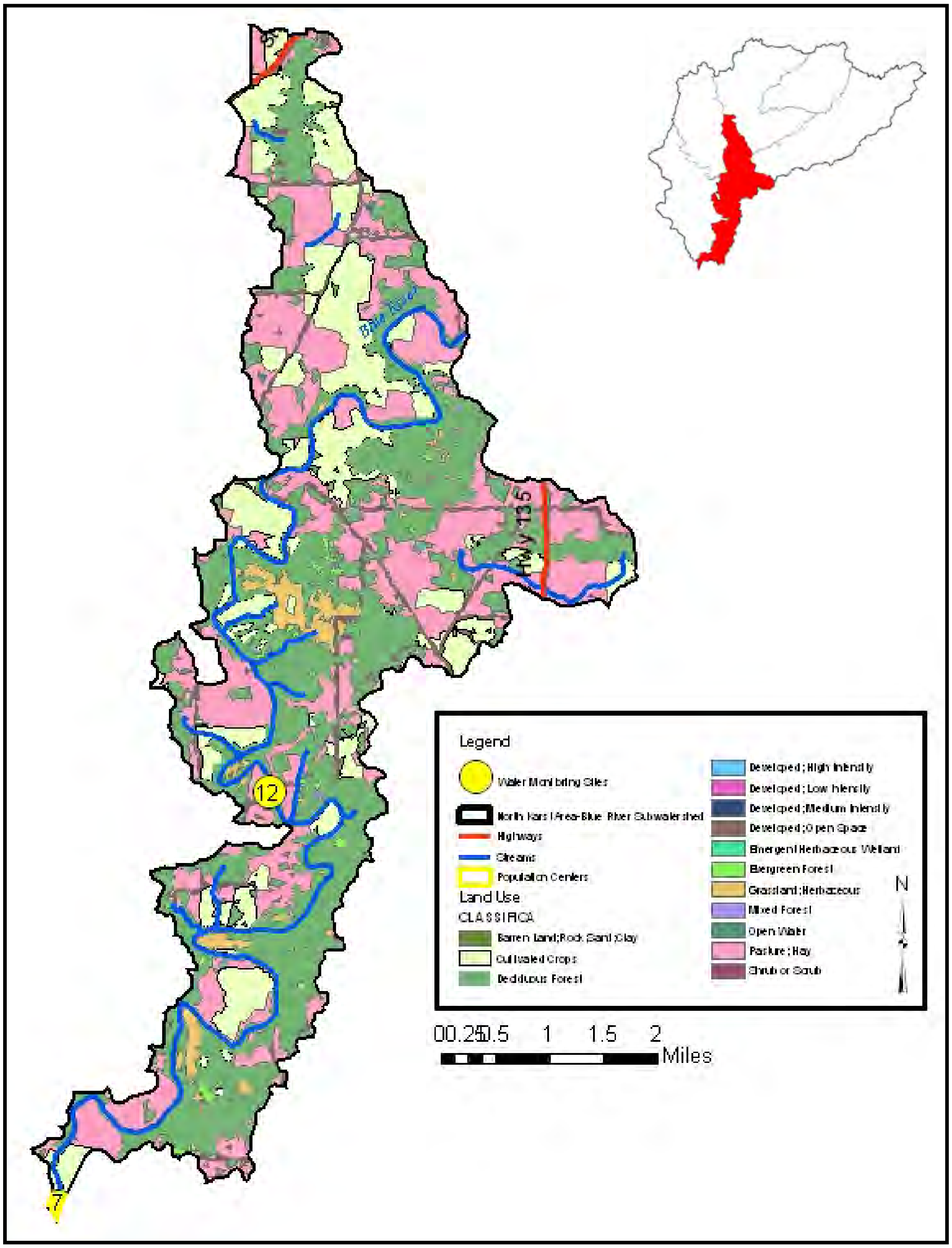


Figure 37. North Karst Area-Blue River Subwatershed Land Uses by Percent

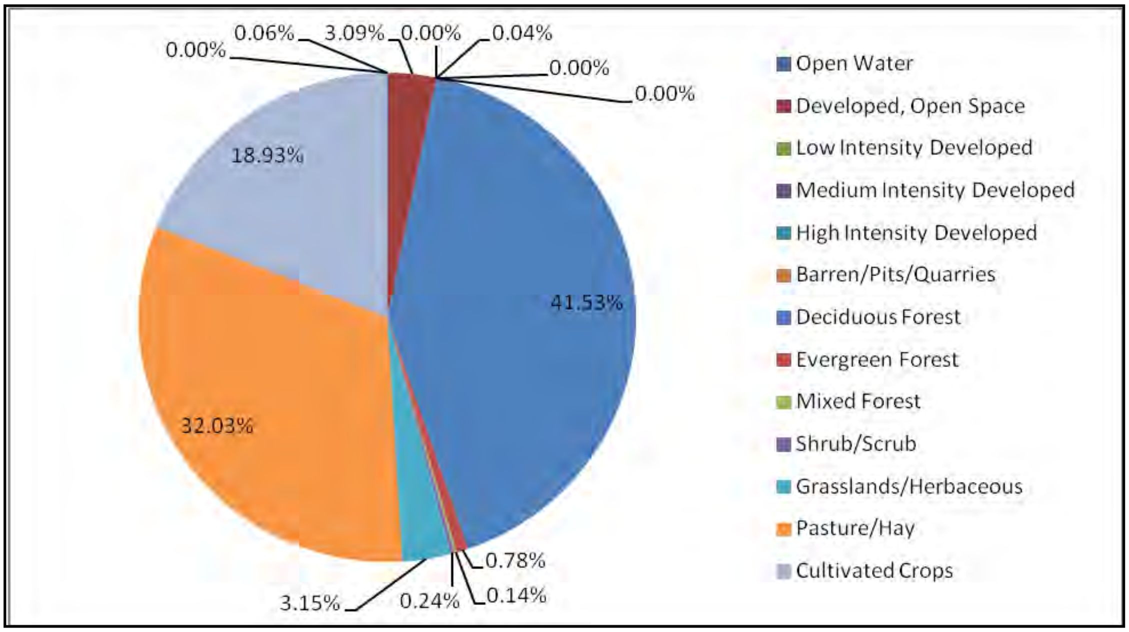


Table 33. – North Karst Area-Blue River Subwatershed Windshield/Desktop Surveys

Potential Negative Water Quality Influence	BMP Needed	Location	Survey Type	Observer
Row crops within 20 feet of streambank	Filter strip/riparian buffer	Blue River at bridge on Vincennes Trail	Windshield	Steering Committee
Streambank erosion	Tree/Shrub Establishment, Streambank and Shoreline Protection, Riparian Herbaceous Cover, Critical Area Planting	Mill Creek and Blue River merge near Vincennes Trail	Windshield	Steering Committee
Poor septic system drainage and maintenance		Near any karst feature	Desktop	Steering Committee
Trash and debris in sinkholes	Remove debris from sinkhole, dispose of trash properly	In or near any karst feature	Windshield	Steering Committee
Degrading Sinkholes	Sinkhole stabilization	Near any karst feature	Windshield	Steering Committee

Table 34.- North Karst Area-Blue River Subwatershed Data Exceeding Water Quality Standards or Targets.

	pH	DO	Temp. ºC	Nitrate (as N)	Turbidity	TSS	Total Phosphorus	*E.coli*	QHEI	mIBI
Site 7 Average	8.11	8.89 mg/L	16.72	2.81 mg/L	5.04 NTU	5.17 mg/L	0.062 mg/L	194.13 colonies/ 100mL	85	38
Min/Max	5.99/ 9.28	5.8/11	4.2/ 27.7	0.224/ 6.28	1.33/ 7.67	1/14	0.056/ 0.067	61.3/ 436.6	-	-
# times exceeded target	**1**	**-**	**-**	**3**	**-**	**-**	**-**	**4**	**-**	**-**
Site 12 Average	8.28	8.46 mg/L	16.34	3.20 mg/L	4.22 NTU	4.33 mg/L	0.055 mg/L	194.66 colonies/ 100mL	82	35
Min/Max	7.67/ 9.3	5.8/11	5.2/ 26.9	0.724/ 5.36	1.38/ 8.1	1/12	0.05/ 0.059	18.7/ 410.6	-	-
# times exceeded target	**1**	**-**	**-**	**3**	**-**	**-**	**-**	**5**	**-**	**-**

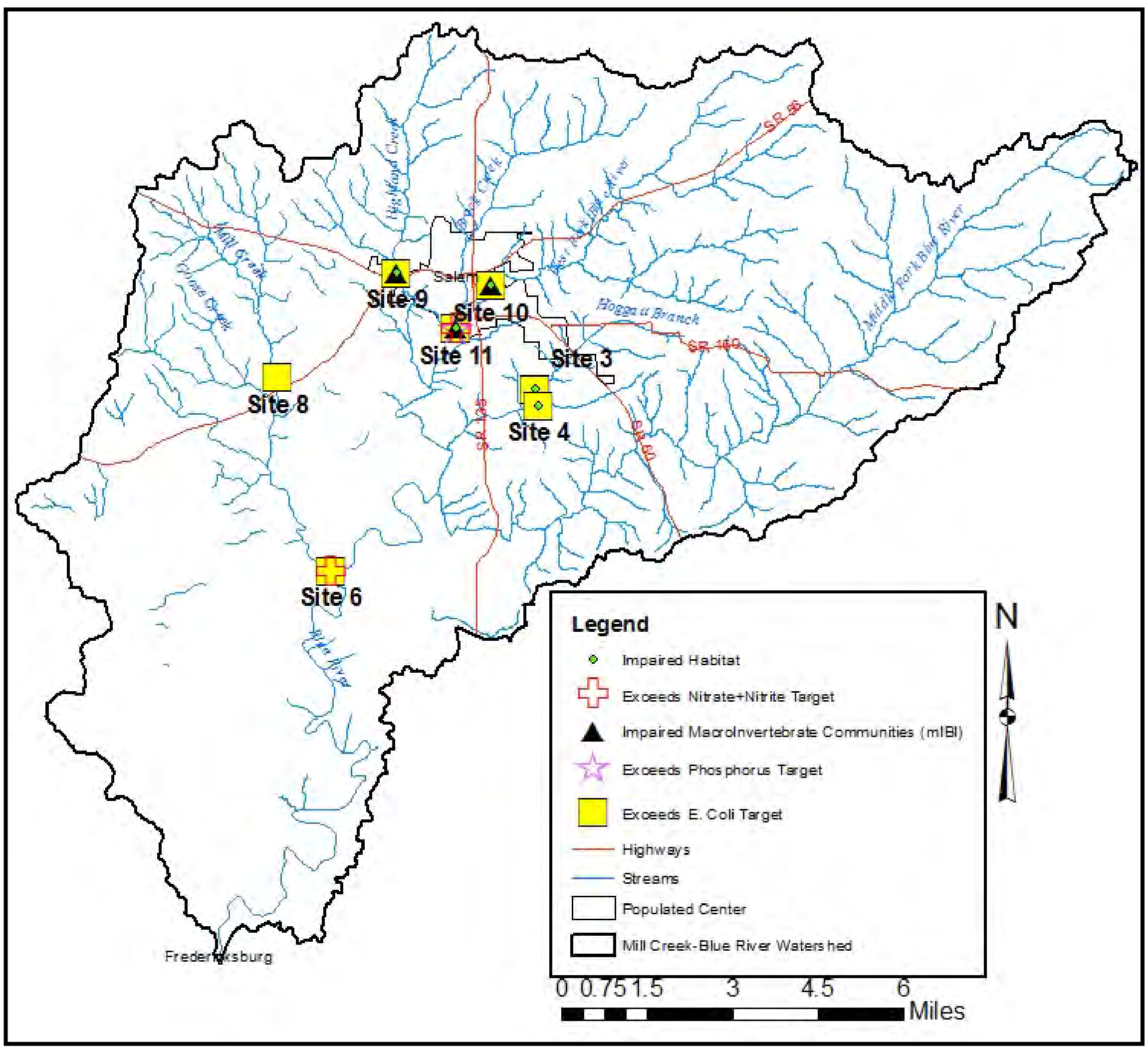
4.7 Water Quality Data Summary

Review of the recently collected water chemistry data shows impairments in Mill Creek-Blue River Watershed in parameters exceeding water quality standards and targets of *E.coli*, Phosphorus and Nitrate based on average values. The average of each water monitoring site show sites 3, 4, 6, 8, 9, 10, 11 are higher than the *E.coli* target of 235 colonies/100mL and sites 6 and 11 are higher than the Nitrate (as N) target of 4.0mg/L. Also, site 11 phosphorus levels exceeded the water quality target.

A few incidents of pH showed exceedances but were isolated and are of no concern.

Habitat and macroinvertebrate communities were sampled only one time during this project at each location in August 2011. Biotic communities that score ≤35 are considered to be in poor condition. Sites 9, 10, 11 scored at 34, which indicated the three sites were "poor". Sites with a QHEI score of <60 are considered poor habitat sites. This includes water monitoring sites 3, 4, 9, 10, and 11 (Figure 38). See section 3.0 WATERSHED INVENTORY II – Water Quality Assessment.

Figure 38. – Suggested Sites Not Meeting Water Quality Standards and Targets based on average water monitoring values.



5.0 WATERSHED INVENTORY III: Summary and Analysis of Stakeholder Concerns

All stakeholder concerns generated through public outreach meetings, steering committee meetings and windshield surveys taken in the watershed are listed in Table 35. The steering committee determined whether each concern was supported by available data and the evidence supporting each concern. The steering committee also determined whether or not each concern was within their scope of consideration and whether or not it was a concern on which they wished to focus.

Table 35. – Stakeholder Concern Analysis

Concerns	Supported by our data?	Evidence	Quantifiable?	Outside the scope?	Group wants to focus on?
Streambank Erosion – sediment and nutrient loss	Yes	Photographs and locations descriptions supplied by landowners. Sandbar formation/ sedimentation.	Yes	No	Yes
Safeness of use of Lake Salinda	Yes	303(d) list	Yes	No	Yes
Trash along streets and in Blue River	Yes	Sightings by landowners throughout the year; annual city wide and river clean-up.	No	No	Yes
Log jams in Mill Creek and Blue River	Yes	Sightings by landowners throughout the year, photographs.	Yes	No	Yes
Decreasing population of Eastern White Hellbender	Yes	Current habitat conditions and mIBI impairments. Research by Purdue University Department of Natural Resources.	Yes	No	Yes
Negative impact of new wastewater treatment plant flowing into Blue River	Not Enough Data	Our current water monitoring results below the wastewater treatment plant show water quality concern at testing site.	Yes	No	Yes

Table 35. – Stakeholder Concern Analysis *Cont.*

Concerns	Supported by our data?	Evidence	Quantifiable?	Outside the scope?	Group wants to focus on?
Dumping trash, large debris, and waste into sinkholes	Yes	Sightings by landowners and operators throughout the year.	No	No	Yes
Construction of new bypass, erosion	No	RULE 5 strictly enforced.	Yes	No	No
Increase of water volume and speed due to impervious surfaces in Salem	Yes	Sightings by landowners and residents of potential flooding occurring south of high density area (Salem) more than 10 years ago.	No	No	Yes
Livestock with access to the stream	Yes	Windshield survey observations. Current *E.coli* water monitoring data.	Yes	No	Yes
Possible overuse of fertilizers in both urban and agriculture land	Yes	Lack of riparian buffers or vegetation to filter along streambank. Current water monitoring data.	No	No	Yes
Lack of filter strips along the river/creek	Yes	Windshield survey observations.	Yes	No	Yes
Build-up of sediment/gravel bars on Blue River	Yes	Sightings by landowners throughout the year with supportive photographs, added during collection phase	No	No	Yes
Water quality impairments due to unmaintained septic and sewer systems	Yes	Current *E.coli* water monitoring data. Lack of education of septic owners expressed by health department.	No	No	Yes

Table 35. – Stakeholder Concern Analysis *Cont.*

Concerns	Supported by our data?	Evidence	Quantifiable?	Outside the scope?	Group wants to focus on?
Fish population and habitat in river/creek	Yes	Current habitat and mIBI monitoring data show 5 sites suggested being impaired habitat.	No	No	Yes
Invasive species	Yes	Windshield survey observations. Sightings and current control by stakeholders.	No	No	Yes
Development/lack of maintenance in floodplain areas	Yes	Windshield survey observations. Reports from landowners of sloughing off of streambanks Log jams identified by stakeholders and steering committee members	No	No	Yes

6.0 IDENTIFICATION OF PROBLEMS AND CAUSES

The steering committee identified specific problems relating to each concern on which the group wished to focus. Problems were defined as issues that exist due to a concern. Identified problems build upon concerns by identifying a condition or actions that need to be changed, improved, or investigated in great depth. Specific problems were then consolidated into problem categories. Table 36 links stakeholder concerns to specific water quality problems and generalized water quality problem categories.

Table 36. – Identification of Problems and Causes

Concerns	Specific Problem	Problem Category
Streambank Erosion – sediment and nutrient loss	Sediment and nutrient inputs	Sediment High nutrient levels
Safeness of use of Lake Salinda	Reduced recreation potential	High *E.coli* levels Degraded aquatic habitat
Trash along streets and in Blue River	May contain hazardous materials; maintains behavior of community that trash on the street and dumping foreign material in storm drains is acceptable	Trash
Log jams in Mill Creek and Blue River	Poor drainage and causes backup of materials; streambank erosion; damage to structures (specifically bridges)	Sediment
Decreasing population of Eastern White Hellbender	Decrease in biodiversity	Decrease in biodiversity
Impact of new wastewater treatment plant flowing into Blue River	*E.coli* and nutrient inputs	High *E.coli* levels High nutrient levels
Dumping trash, large debris, and waste into sinkholes	May contain hazardous materials; potential hazard to aquatic and cave habitat, potential hazard to ground water and surrounding well water supply	High *E.coli* levels High nutrient levels Impaired aquatic habitat Degraded aquatic communities
Increase of water volume and speed due to impervious surfaces in Salem	Flooding; erosion/sediment	Flooding Sediment

Table 36. – Identification of Problems and Causes *Cont.*

Concerns	Specific Problem	Problem Category
Livestock with access to the stream	Degraded stream habitat; streambank erosion; *E.coli* and nutrient inputs	Sediment High nutrient level High *E.coli* levels
Possible overuse of fertilizers in both urban and agriculture land	Nutrient inputs; poor aquatic habitat	High nutrient levels
Lack of filter strips along the river/creek	Loss of sediment and nutrient inputs	Sediment High nutrient level Impaired aquatic habitat
Build-up of sediment/gravel bars on Blue River	Increase flooding potential; loss of sediment and nutrient inputs	Flooding Sediment High nutrient level
Water quality impairments due to unmaintained septic and sewer systems	*E.coli* and nutrient inputs	High *E.coli* levels High nutrient levels
Fish population and habitat in river/creek	Reduced recreation due to low fish population and water quality	Impaired aquatic habitat
Invasive species	Increased viability along streambanks, open land, and in forested areas and out-competing other safe pasture species used to raise livestock	Decrease in biodiversity
Development/lack of maintenance in floodplain areas	Buildup of log jams and other debris causing streambank erosion; loss of sediment and nutrients; poor aquatic habitat	Sediment High nutrient level Flooding Impaired aquatic habitat

Potential causes for each problem category were also identified. Table 37 links stakeholder concerns to water quality problems and potential causes of those problems. A cause is an event, agent, or series of actions that produce a problem. For the purpose of watershed management planning, causes of water quality problems are defined as specific pollutant parameters.

Table 37. – Problem Categories and Potential Causes

Problem Category	Potential Causes
Impaired aquatic habitat	Sediment, insufficient cover
Impaired macroinvertebrate communities (mIBI)	Sediment, high nutrient levels; insufficient cover
High stream nutrient levels	Nutrient levels exceed water quality target; lack of public understanding of nutrient sources; trash, and other materials in sinkholes, rivers, creeks and other water bodies
High stream *E.coli* levels	*E.coli* levels exceed water quality standards; lack of public understanding of *E.coli* sources
Sediment	Overuse of agriculture land by livestock and crop production; insufficient cover; impervious surfaces; gravel bars; log jams; lack of understanding of pollution consequences
Trash	Lack of public understanding of pollution consequences; negligence
Decrease in aquatic biodiversity	High nutrient and *E.coli* levels in streams; sediment; insufficient cover; lack of public understanding of pollution sources
Flooding	Impervious surfaces, log jams, gravel bars

7.0 IDENTIFICATION OF SOURCES AND CALCULATED LOADS

The steering committee linked identified water quality problems and causes of those problems to sources based on windshield survey data and other observations made in the watershed (Table 38). Sources can be an activity, material, or structure that result in a cause of non point source pollution.

Table 38. – Potential Pollutant Sources per Problem Category

Problem Category	Potential Causes	Potential Sources
Impaired aquatic habitat	Sediment, insufficient cover	• Increased impervious surfaces in high density areas from parking lots, industry, highways (Highland Creek-West Fork Blue River and Headwaters West Fork Blue River Subwatersheds) • Conventionally tilled land (Headwaters West Fork Blue River, Highland Creek-West Fork Blue River, and Middle Fork Blue River subwatersheds) • Livestock with access to the streams (3 pastures in Highland Creek-West Fork Blue River, North Karst Area-Blue River, and Mill Creek Subwatersheds) • Streams lacking riparian buffers (Headwaters West Fork Blue River, Highland Creek-West Fork Blue River, Mill Creek, Middle Fork Blue River, and North Karst Area-Blue River Subwatersheds)
Impaired macroinvertebrate communities (mIBI)	Sediment, High nutrient, *E.coli* levels, streams lacking buffers	• Increased impervious surfaces in high density areas from parking lots, industry, highways(Highland Creek-West Fork Blue River and Headwaters West Fork Blue River Subwatersheds) • Fertilizer application to farm land (all subwatershed) and commercial and residential properties (Highland Creek-West Fork Blue River and Headwaters West Fork Blue River Subwatersheds) • Septic system maintenance (all subwatersheds) • Livestock with access to the streams (3 pastures in Highland Creek-West Fork Blue River, North Karst Area-Blue River, and Mill Creek Subwatersheds)
High stream nutrient levels	Nutrient levels exceed water quality target; lack of public	• Livestock with access to the streams (two pastures in Highland Creek-West Fork Blue River Subwatershed) • Eroded sediments from streambanks (three identified

	understanding of nutrient sources	locations) and fields conventionally tilled cropland across all subwatersheds-approximately 2,000 acres (Headwaters West Fork Blue River, Highland Creek West Fork Blue River Subwatersheds) • Fertilizer leaching and/or runoff from agricultural land (all subwatersheds) • Failing and unmaintained septic systems outside of the City of Salem due to lack of maintenance, care, and education (all subwatersheds)
Sediment	Overuse of agriculture land by livestock and crop production; insufficient cover; impervious surfaces; gravel bars; log jams; lack of understanding of pollution consequences	• Livestock with access to the streams (two pastures in Highland Creek-West Fork Blue River Subwatershed) • Eroded sediments from streambanks (three identified locations) and fields conventionally tilled cropland across all subwatersheds-approximately 2,000 acres (Headwaters West Fork Blue River, Highland Creek West Fork Blue River Subwatersheds) • Failing and unmaintained septic systems outside of the City of Salem due to lack of maintenance, care, and education (all subwatersheds) • Increased impervious surfaces in high density areas from parking lots, industry, highways (Highland Creek-West Fork Blue River and Headwaters West Fork Blue River Subwatersheds) • Conventionally tilled land (Headwaters West Fork Blue River, Highland Creek-West Fork Blue River, and Middle Fork Blue River subwatersheds) • Streams lacking riparian buffers (Headwaters West Fork Blue River, Highland Creek-West Fork Blue River, Mill Creek, Middle Fork Blue River, and North Karst Area-Blue River Subwatersheds)
High stream *E.coli* levels	*E.coli* levels exceed water quality standards; lack of public understanding of *E.coli* sources	• Livestock with access to the streams (pastures in Highland Creek-West Fork Blue River, North Karst Area-Blue River, and Mill Creek Subwatersheds) • Failing and unmaintained septic systems (all subwatersheds) • Possible overuse of manure application fertilizer or application of manure fertilizer at the wrong time (all

		subwatersheds) • Pet and wildlife waste (all subwatersheds) including large population of domesticated fowl (one specific location in Mill Creek Subwatershed)
Trash	Lack of public understanding of pollution consequences; negligence	• Trash observed numerous times during windshield surveys • High volume of trash collected yearly during city wide clean-up day
Decrease in aquatic biodiversity	High nutrient, sediment and *E.coli* levels in streams; lack of public understanding of pollution sources	• Livestock with access to the streams (3 pastures in Highland Creek-West Fork Blue River, North Karst Area-Blue River, and Mill Creek Subwatersheds) • Failing and unmaintained septic systems (all subwatersheds) • Eroded sediments from streambanks (three identified locations) and fields conventionally tilled cropland across all subwatersheds sites (Headwaters West Fork Blue River, Highland Creek West Fork Blue River Subwatersheds) • Flooding • Fertilizer application to farm land (all subwatershed) and commercial and residential properties (Highland Creek-West Fork Blue River and Headwaters West Fork Blue River Subwatersheds)
Flooding	Impervious surfaces, log jams, gravel bars	• Fast water runoff and flow in the City of Salem (Highland Creek subwatershed) • Storm water runoff (all subwatersheds) • Streams lacking riparian buffers (Headwaters West Fork Blue River, Highland Creek-West Fork Blue River, Mill Creek, Middle Fork Blue River, and North Karst Area-Blue River Subwatersheds)

Calculated Loads
The water monitoring data collected during this project at each of the twelve sites was used to evaluate the water quality at that specific site throughout the year and also averaged to evaluate the yearly water quality effect at each location. By comparing the water monitoring results to the concentrations and targets previously set by the steering committee, the committee was able to identify areas of concern and prioritize goals for the watershed project.

The web-based LOAD Calculation using LOADEST, version 2012, was used to determine sediment and nutrient loads for the watershed by inputting stream flow data collected from USGS gauges and from water monitoring and concentration data from the twelve water monitoring sites chosen for this project (Table 40, Table 41). The streamflow gage located at Fredericksburg and water quality data from Site 7 (the site closest to the outlet of the watershed) was used to estimate loads for the watershed. This was used for *E.coli*, Nitrate/Nitrite, and Phosporus.

For TSS, data at the outlet indicated that loads were below target for the watershed as a whole, but reductions are still needed in subwatershed areas. Data from Site 10 and the gage on West Fork Blue River (Salem) indicate the need for at least a 9% reduction in TSS loads. This information is also found in Appendix H.

Jane Frankenberger says in a document provided at the Indiana Watershed Leadership Academy, "USGS has developed a tool called LOADEST for estimating the daily concentration and using it to calculate load. LOADEST estimate loads for each day, which you can sum to get total annual loads. The method is based on the assumption that concentration varies with flow. This works particularly well for phosphorus and suspended sediment concentration, which tend to be much higher during high flows. LOADEST is a powerful and complex tool, that has been validated and used in watersheds across the US and in many studies."

E.coli has no mass and its load is expressed as a concentration of colony forming units (cfu). The easiest way to summarize the *E.coli* concentration was averaging our monthly samples at each site (Table 39).

Table 39. – *E.coli* Concentration Reduction Needed to Achieve the Target Pollutant Load

***E.coli* Loads**	**Amount**
Current Load	365.02 cfu/100mL
Target Load	235 cfu/100mL
Reduction Needed	130.02 cfu/100mL - 36%

Table 40. –Nitrate/Nitrite Load Reduction Needed to Achieve the Target Pollutant Load

Nitrate/Nitrite Loads	**Amount**
Current Load	643.68 tons/yr of Nitrate/Nitrite
Target Load	13.30 tons/yr of Nitrate/Nitrite
Reduction Needed	630.37 tons/yr of Nitrate/Nitrite – 98%

Table 41. – TSS Load Reduction Needed to Achieve the Target Pollutant Load

TSS Loads	**Amount**
Current Load	1297.21 tons/yr of TSS
Target Load	1185.79 tons/yr of TSS
Reduction Needed	111.42 tons/yr of TSS – 9%

Table 42. – Phosphorus Load Reduction Needed to Achieve the Target Pollutant Load

Phosphorus Loads	**Amount**
Current Load	20.79 tons/yr of Phosphorus
Target Load	26.61 tons/yr of Phosphorus
Reduction Needed	0.00 tons/yr of Phosphorus

Based on these calculations, a 36% reduction in *E.coli* concentrations, a 98% reduction in Nitrate/Nirtrite loads, and a 9% reduction in TSS loads are needed to meet project water quality targets. At this time, phosphorus reductions are not needed to meet the target, but the project will track phosphorus reductions since many BMPs that reduce sediment and nitrogen also reduce phosphorus.

Also, the Spreadsheet Tool for Estimating Pollutant Loads (STEPL) and Region V Model was selected to model sediment and nutrient load reductions from selected BMPs.

8.0 FUTURE GOALS AND IDENTIFICATION OF CRITICAL AREAS

8.1 Goals and Indicators

Goals were developed to address the seven problem categories and improve water quality in the Mill Creek-Blue River Watershed. Identified problem categories include impaired aquatic habitat, impaired macroinvertebrate communities (mIBI), high stream nutrient levels, high stream *E.coli* levels, trash, decrease in aquatic biodiversity and flooding.

The four primary goals selected include a reduction in *E.coli* concentrations to below the state standard, a reduction in nutrient and sediment loads to below the water quality targets, flooding/stormwater runoff, and public awareness of water quality issues.

Some of the primary goals address more than one problem category. For example, reducing high stream nutrient levels will also create increased potential for an increase in aquatics biodiversity. Also, reducing *E.coli* levels in the stream will make it suitable for public use. Trash reaching streams and creeks in MCBR is expected to decrease as residents become more knowledgeable about water quality through the education efforts of public awareness about water quality issues.

High Stream Nutrient and Sediment Levels to Below Water Quality Target

Nutrient levels modeled for MCBR using LOADEST estimated a nitrogen load of 643.68 tons/year. The maximum annual load to meet the target that would still meet the water quality target is 13.30 tons/year. For nitrogen to meet the water quality target, an annual load reduction of 630.37 tons/year is needed.

TSS levels estimated a load of 1297.21 tons/year. The maximum annual load to meet the target that would still meet the water quality target is 1185.79 tons/year. For TSS to meet the water quality target, an annual load reduction of 111.42 tons/year.

The reduction goal for nitrogen and total suspended solid loading by 10% in 5 years (by 2018) and 30% in 30 years (by 2023) to meet the recommended water quality target of total nitrogen <4.0mg/L and total suspended solids <25mg/L. Table 43 lists goals to accomplish the primary goal and potential indicators for measuring progression toward the primary goal. Numerous goals for nutrient load reduction overlap with goals for sediment load and *E. coli* concentration reduction.

Table 43. – Nutrient and Sediment Reduction Goals and Objectives: Reduce Nitrogen and TSS loads by 10% in 5 years and 30% in 30 years.

Objectives	Indicators
Educate land owners so that they understand how their actions impact water quality, they believe changes are important, and they become willing to take action by implementing BMPs and supporting clean water initiatives.	• Number of BMPs implemented using cost-share practices • Measured reduction total nitrogen concentrations • Measured reduction of TSS concentrations • Measured decrease of impaired aquatic habitat and impaired mIBI • Measured increase of aquatic biodiversity • Number of people attending events • Number of people picking up animal waste • Number of parks and public businesses with pet waste containers/bags
Educate agricultural producers and livestock owners so that they believe/understand BMPs are beneficial practices for crop production and water quality, and they become willing to implement them.	
Educate pet owners so that they understand how pet wastes impact water quality, and install pet waste receptacles in public areas.	
Education and voluntary maintenance and upgrades are made to suitable onsite septic systems.	
Lake Salinda is removed from the 303(d) list of impaired waters taste and odor and algae.	

High Stream E.coli Levels below Water Quality Target
In the average *E.*coli results for each site, eight of the twelve sample sites exceeded the 235 cfu/100mL water quality standard set for *E.coli*. The goal is to reduce current *E.coli* loading to reach the IDEM standard of 235 colonies/100mL in 5 years (by 2018) in at least six sample sites and in 30 years (by 2043) all twelve sample sites. Table 44 lists goals and indicators for measuring progression toward this goal.

Table 44. –*E.coli* Reduction Objectives and Indicators

<table>
<tr><th>Objectives</th><th>Indicators</th></tr>
<tr><td>Educate homeowners so that they understand how failing septic systems impact water quality, they believe changes are important, and they become willing to take action by conducting regularly scheduled maintenance and necessary upgrades.</td><td rowspan="5">Number of BMPs implemented using cost-share
Measured reduction total E.coli concentrations
Measured decrease of impaired aquatic habitat and impaired mIBI
Measured increase of aquatic biodiversity
Number of people attending events
Number of septic complaints decreased
Number of residences upgrading on-site septic systems indicated by county permit trends
Increased septic system awareness and changing attitudes measured by survey data
Number of people picking up animal waste
Number of parks and public businesses with pet waste containers/bags</td></tr>
<tr><td>Educate agricultural producers and livestock owners so that they believe/understand BMPs are beneficial practices for water quality, and they become willing to take action and implement BMPs to exclude livestock access to streams.</td></tr>
<tr><td>Educate pet owners so that they understand how pet wastes impact water quality, and install pet waste receptacles in public areas.</td></tr>
<tr><td>Education and voluntary maintenance and upgrades are made to suitable onsite septic systems.</td></tr>
<tr><td>Implement local legislation regulating livestock access to waterbodies (Waters of the US).</td></tr>
</table>

Flooding

Flooding is a concern to many stakeholders in MCBR due to the amount of impervious surfaces, specifically in the City of Salem. The steering committee wishes to continue public awareness and water quality education; therefore, not see an increase of water volume in the stream and creeks south of Salem after rain events and a reduction of non-point source pollution runoff over the next 30 years. MCBR will track this information by the number of storm water BMPs installed. Table 45 lists goals and indicators for measuring progression of this goal.

Table 45. – Flooding Reduction Objectives and Indicators

<table>
<tr><th>Objectives</th><th>Indicators</th></tr>
<tr><td>Educate the public and businesses of green infrastructures to implement or develop that decreases the quantity or delays the speed at which stormwater reaches the streams.</td><td rowspan="4">• Number of BMPs implemented using cost-share
• Measured decrease of impaired aquatic habitat and impaired mIBI
• Measured increase of aquatic biodiversity
• Number of people attending events
• Number of public service announcements and newspaper articles</td></tr>
<tr><td>Implement stormwater BMPs.</td></tr>
<tr><td>Provide education to train the public about water conservation at home (i.e. rain barrels).</td></tr>
<tr><td>Implement local legislation to increase stormwater retention requirements for new developments.</td></tr>
</table>

Figure E. (04-23-11) Many streets are subject to flooding in Salem after large rain events. Pictured here is West Fork Blue River near the main street, Highway 135, in Salem.

Public Awareness of Water Quality Issues
The steering committee believes that many problems in MCBR Watershed come from the fact that the general public has an insufficient understanding of water quality issues and how their actions can make a difference. The steering committee wishes to gradually increase the general knowledge and understanding of water quality issues held by the general public in the watershed in the next 5 years with behavior changes occurring yearly and directly fulfilling the project goals in 30 years. This will be accomplished by hosting field days, workshops and providing education literature to residents in the watershed. Furthermore, Table 46 lists goals and indicators to accomplish for measuring progression toward this goal.

Table 46. – Increasing Public Awareness Objectives and Indicators

<table>
<tr><th>Objectives</th><th>Indicators</th></tr>
<tr><td>Implement a water quality education campaign including newspaper articles, educational materials included with utility bills, education packet for newly installed septic systems, school programs, radio commercials, etc.</td><td rowspan="5">• Number of BMPs implemented
• Number of education programs implemented
• Reduced quantity of waste removed in stream clean-ups
• Implement and have participation in hazardous waste collections
• Number of participants, rural and non-rural residents, in watershed activities
• Number of people at field days and workshops
• Survey data on public perception of water quality issues</td></tr>
<tr><td>Implement stormwater BMPs.</td></tr>
<tr><td>Establish plastic bag collection and other recyclables program in local grocery stores.</td></tr>
<tr><td>Regularly schedule stream and street clean up days.</td></tr>
<tr><td>Implement hazardous waste removal days and have free disposal of household hazardous waste and medicinal items.</td></tr>
</table>

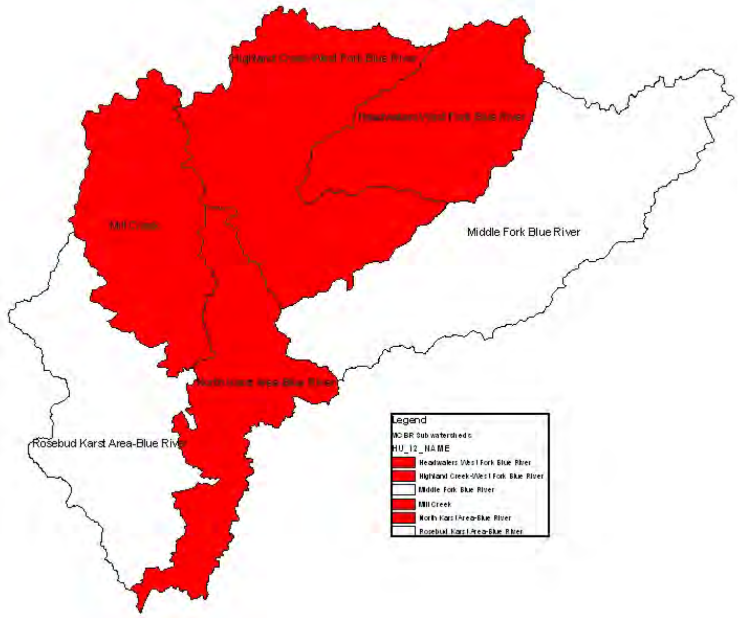
8.2 Critical Areas
A critical area as defined for watershed management planning is a place where implementation of watershed management plan guidance can remediate nonpoint source pollution in order to improve water quality or mitigate future pollutant sources to protect water quality. Critical areas were determined separately for urban and rural pollutant sources.

Critical areas are targeted areas in the watershed where the stressors/causes are causing the greatest damage and where applying treatment will have the greatest effect. The target areas should be feasible for the group to address; small enough to be addressed in 3 to 5 years; and considered for funding possibilities, willingness of landowners to participate, and whether the treatment can be measured.

***E.coli* Critical Areas**
To determine the critical areas polluted by *E.coli* the committee looked at monitoring data, livestock location, and septic systems.

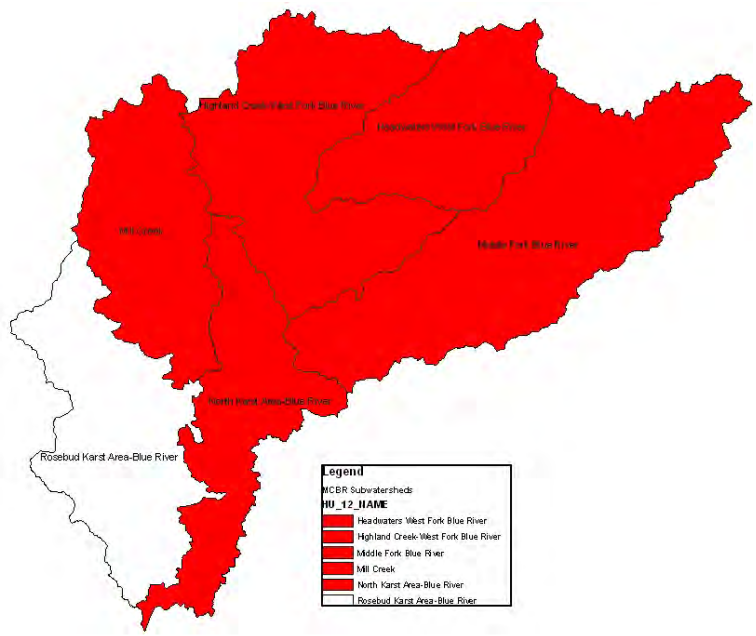
Monitoring Data
Every time a site's *E.coli* reading was over the state standard of 235cfu/100mL, it was given one point. The monitoring sites for each watershed were added together to get a total. If the total was greater than five, out of twelve, it was considered a critical area. Figure F identifies the critical areas using this criterion.

Figure F. *E.coli* Critical Areas in MCBR Watershed



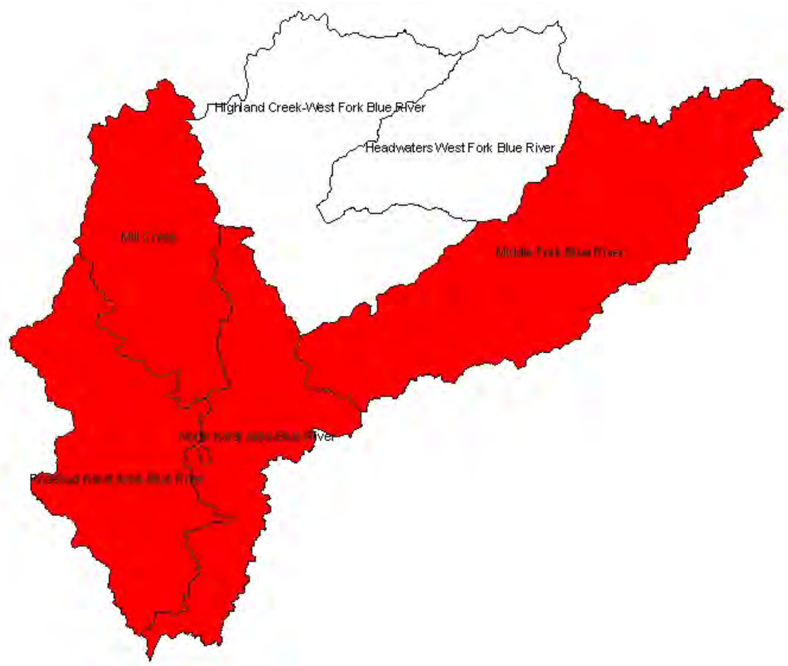
Livestock Location
It is difficult to pinpoint where livestock has access to the creek, however, our windshield and desktop surveys were able to identify a couple of locations. The subwatersheds that deemed to have 15 or more livestock locations were given the highest priority (Figure G).

Figure G. Critical Areas determined for Livestock Locations for *E.coli*



Septic Systems
Improperly working septic systems are known to be a source of *E.coli*. Since there is not a public document of failing septic systems and inspections are not made after a septic system is installed, the committee is concerned that every subwatershed could have at least one septic issue with potential of causes water quality issues. Since every subwatershed cannot be listed as a critical area, the committee chose to prioritize the subwatersheds from a desktop survey. Subwatersheds that do not include a wastewater treatment facility are listed as a priority. Every home or business outside of the Salem city limits uses a septic system to dispose waste. Soil types throughout the watershed are somewhat or very limited for septic system suitability, making the whole watershed unfavorable for traditional absorption septic fields (Figure H).

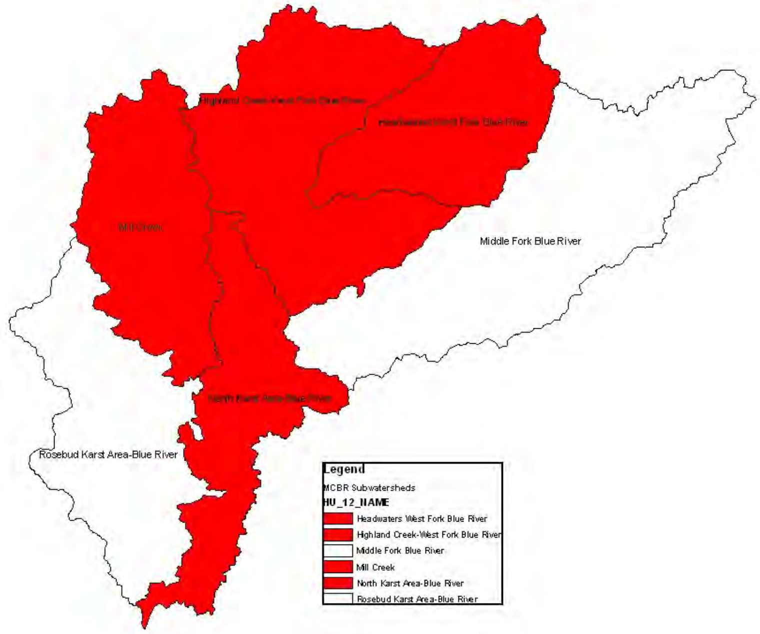
Figure H. Critical Areas determined for Septic Systems for *E.coli*



Sediment and Erosion
The critical areas for sediment and erosion were determined by looking at riparian buffers, livestock location, and streambank erosion (where stabilization of streambank was noted in windshield/desktop surveys).

Streambank Erosion
Many factors have combined to cause severe streambank erosion in MCBR. High volumes of water run through the City of Salem and drain into Blue River. Stated by MCBR stakeholders, this large amount of water, particularly after large rain events, cause the river to stir up sediment and move the flow of the river. This in turn causes the water to hit the streambanks with a high impact and then cause the sides of the bank to break and collapse. Also, visual inspection on agriculture crop lands show lack of a riparian buffer can cause problems (Figure I).

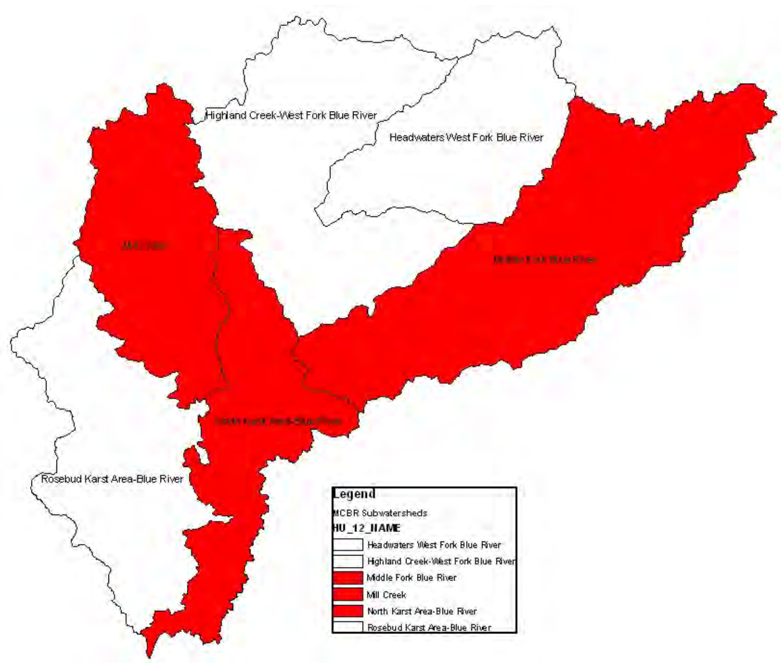
Figure I. Critical Areas determined for Streambank Erosion for Sediment and Erosion



Riparian Buffers

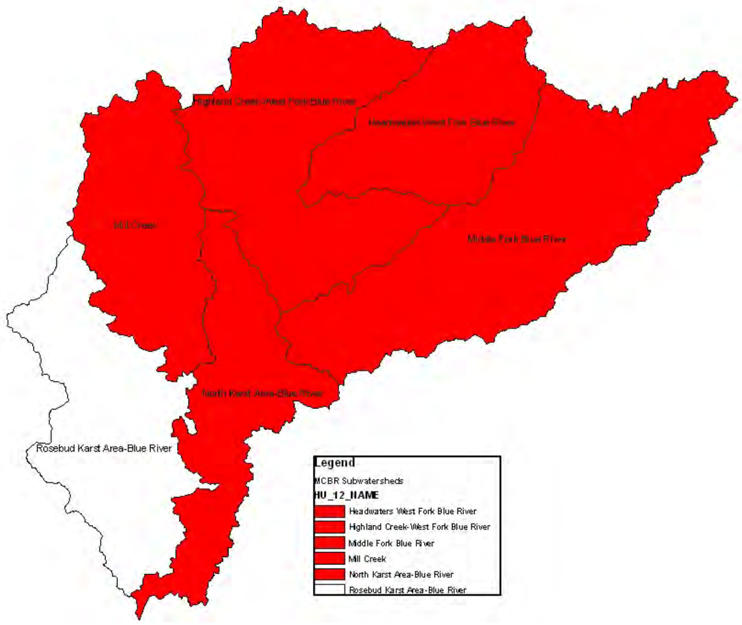
Evidence of windshield and desktop surveys show the need of riparian buffers along Mill Creek, Highland Creek, and Blue River. The committee also agrees that buffers are not sufficient in the watershed. They feel this is problem throughout the watershed but gave top priority to the top three subwatersheds that have the highest percentage of agricultural land (Figure J).

Figure J. Critical Areas determined for Riparian Buffers for Sediment and Erosion



Livestock Location
It is difficult to pinpoint where livestock has access to the creek, however, our windshield surveys were able to identify a couple of locations. The subwatersheds that have 15 or more livestock locations were given the highest priority (Figure K).

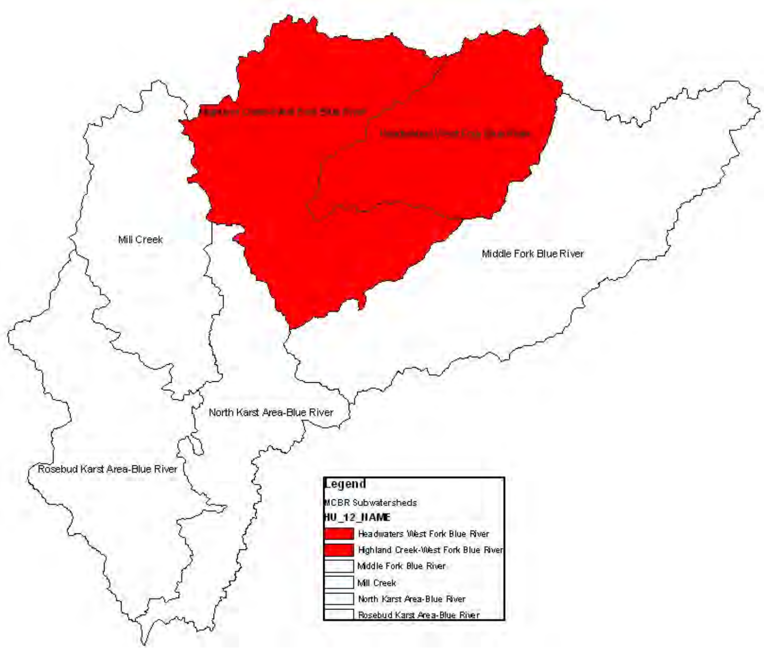
Figure K. Critical Areas determined for Livestock for Sediment and Erosion



Non-Point and Stormwater Runoff
Critical areas were determined by the committee as impervious area and areas of high fertilization (which the committee determined to be agricultural lands and lawns in high density residential areas).

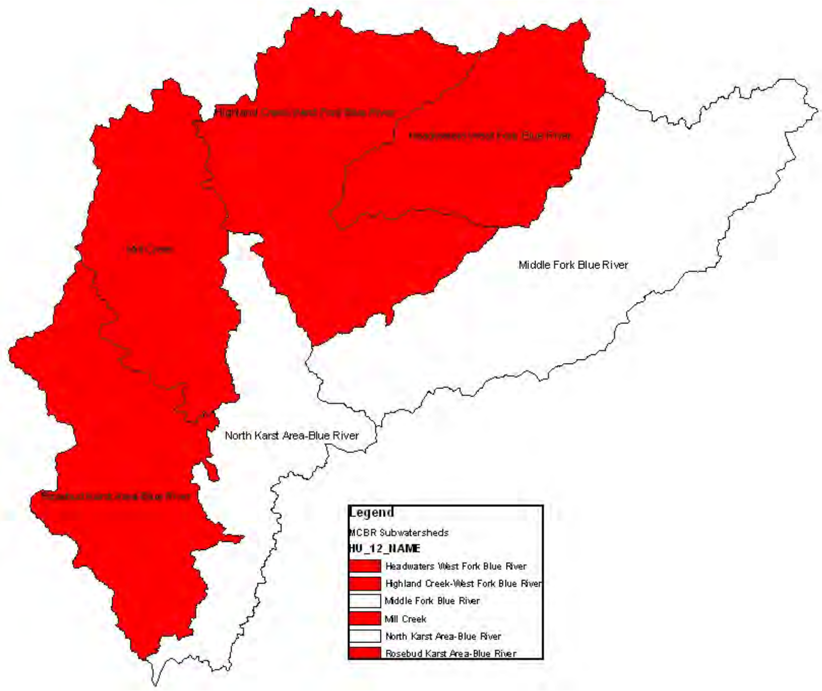
Impervious Areas
Knowing that the populated area of Salem is the highest area of impervious surface in MCBR, the committee chose the subwatersheds within this populated area (Figure L).

Figure L. Critical Areas determined for Impervious Surface for Non-Point Runoff



Fertilization
The committee knows that fertilizer is applied to agricultural land, including cropland and hayland, and also to residential yards and businesses. It is a concern that fertilizer, in any circumstance, is not applied as directed and potentially exceeding recommended rates. All areas of the watershed were considered when determining critical areas for fertilization. If the land use (agricultural, hayland, and high density) percentages for a subwatershed totaled more than 60% it was considered a critical area (Figure M).

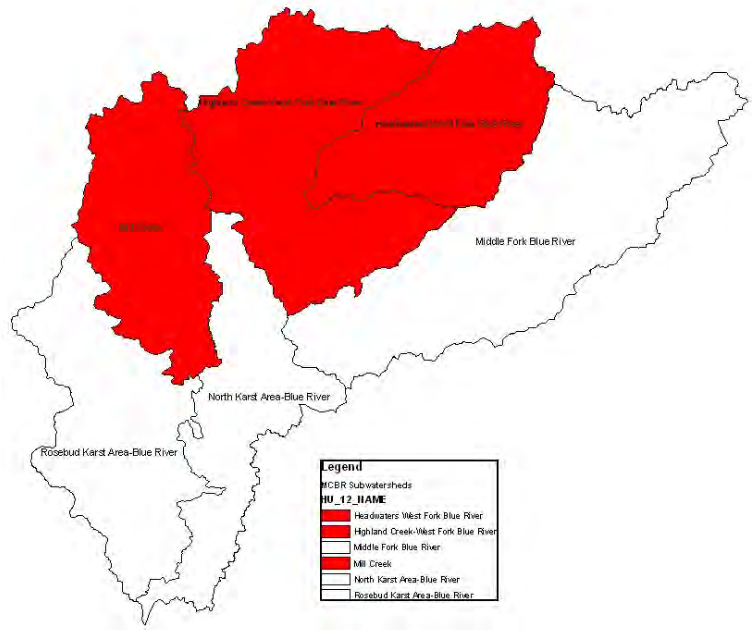
Figure M. Critical Areas determined for Fertilization for Non-Point Runoff



High Nutrient Content
High nutrient content critical areas were determined by looking at the monthly water quality data, livestock location, and agricultural lands. The committee is also concerned about residential run off, but decided to focus on agriculture land at this time.

Water Quality Data
After evaluating the nutrient water monitoring data, the committee saw that the parameter nitrate tested throughout the watershed exceeded the water quality target at least one time at each site. If the parameter exceeded 5 or more times it was considered a critical area for nutrient content (Figure N).

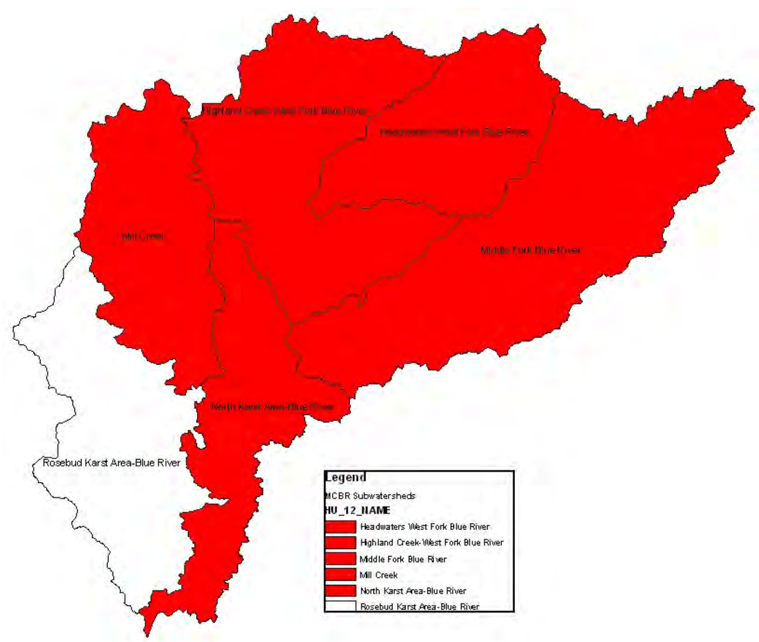
Figure N. Critical Areas determined for Water Quality Data for High Nutrient Content



Livestock Location

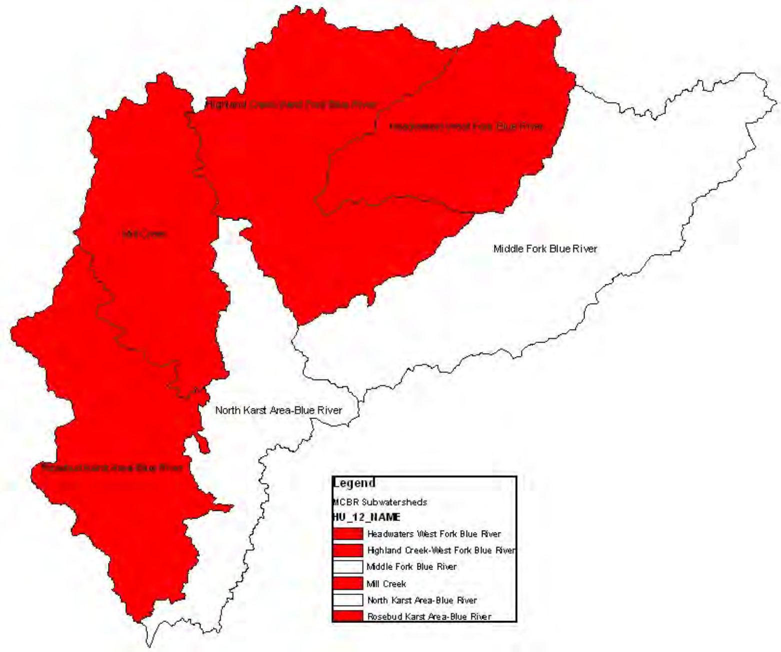
It is difficult to pinpoint where livestock has access to the creek, however, our windshield surveys were able to identify a couple of locations. The subwatersheds that have 15 or more livestock locations were given the highest priority (Figure O).

Figure O. Critical Areas determined for Livestock Location for High Nutrient Content



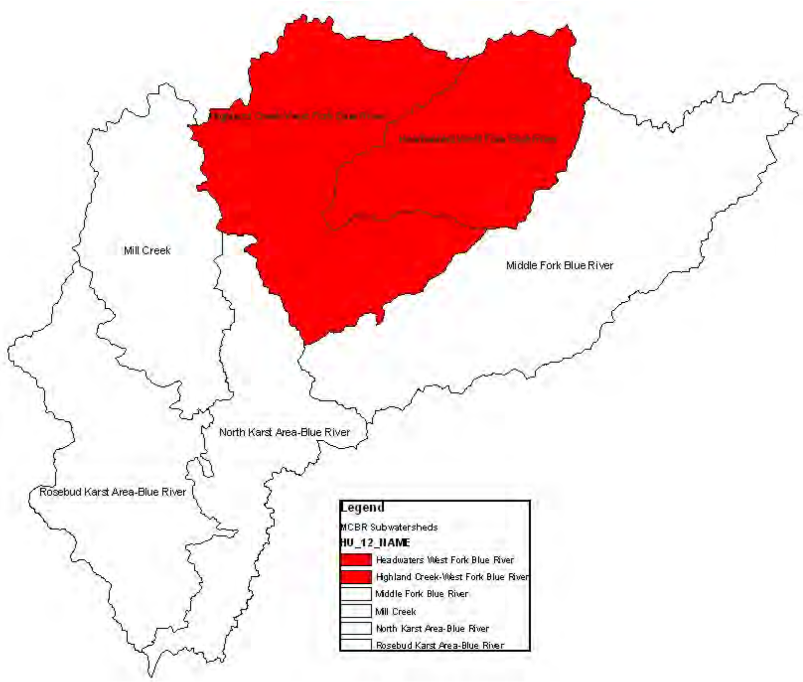
Agricultural Land
If a subwatershed has more than 60% agricultural land (Pasture/Hay and Cultivated Crops) it was given a high priority (Figure P).

Figure P. Critical Areas determined for Agricultural Land for High Nutrient Content



Biotic Communities
The committee used the macroinvertebrate data to determine the critical areas for biotic communities. The macroinvertebrate data (pages 41-43) show three water monitoring sites were impaired according to the mIBI scores for biotic integrity. The subwatersheds that included these impaired sites were chosen as critical areas (Figure Q).

Figure Q. Critical Areas determined for Biotic Communities for High Nutrient Content



Priority Ranking for Mill Creek-Blue River Watershed

All subwatersheds in the Mill Creek-Blue River Watershed have some type of impairment. To help prioritize the subwatersheds the committee gave a subwatershed one point each time it was designated as a critical area. Figure R shows the totals for subwatersheds. Based on these totals, the MCBR Steering Committee has determined that the implementation grant should focus on subwatersheds Headwaters West Fork Blue River (HUC 051501040701), Highland Creek-West Fork Blue River (HUC 051401040703), Mill Creek (HUC 051401040704), and North Karst Area-Blue River (HUC 051401040706). After installing best management practices in those areas, the emphasis would be moved to include Middle Fork Blue River. Rosebud Karst Area-Blue River (HUC 051401040705) will be the last subwatershed to receive attention due to the lack of water monitoring data. Although this subwatershed contains a majority of the sensitive karst area, the BMPs that are installed should improve the surface water quality near this subwatershed. An education component for this area will be included in the implementation phase (Figure 39).

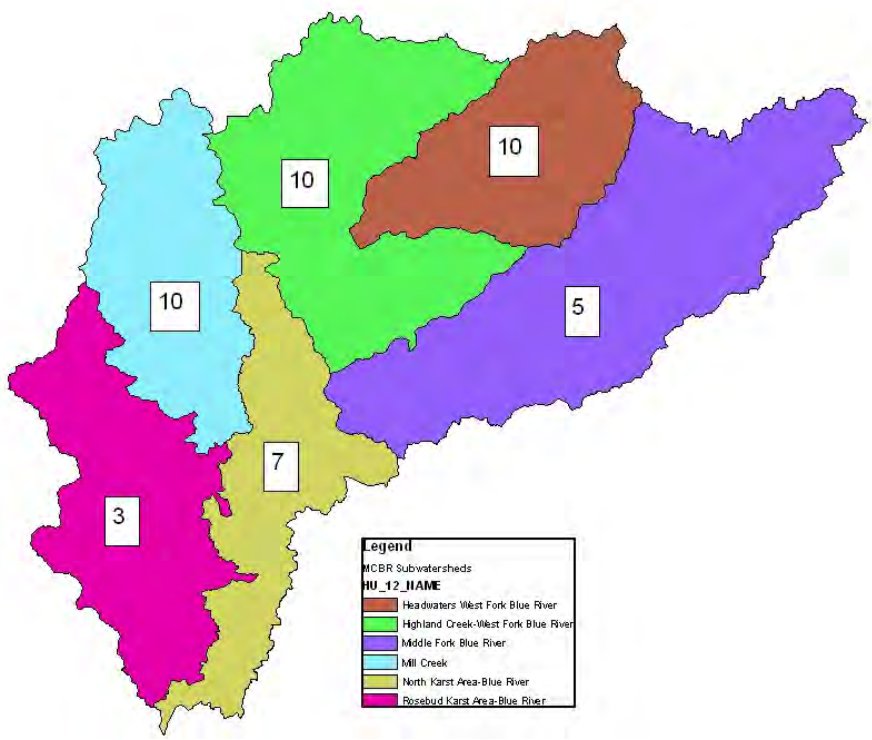
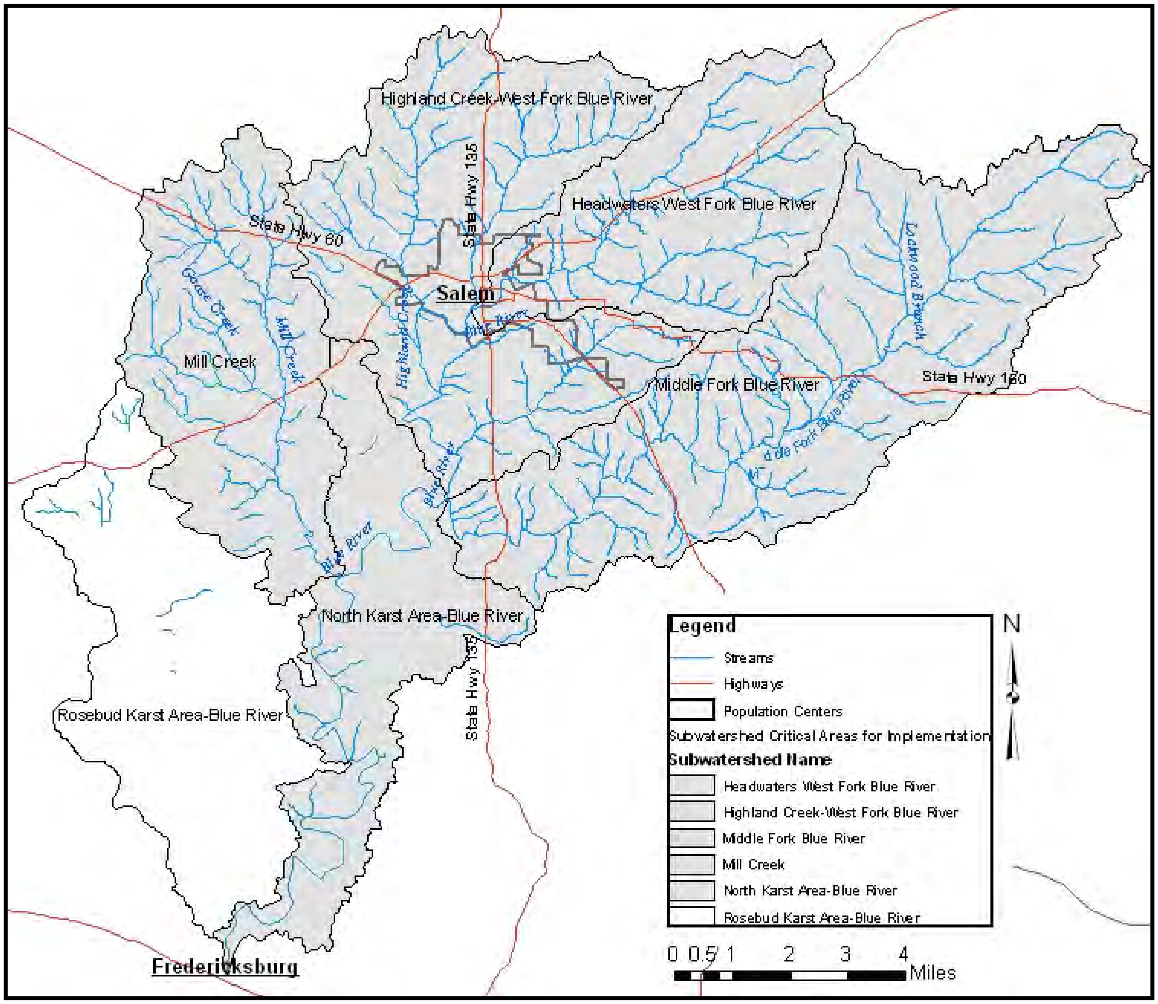


Figure R. Priority Point Total For Critical Areas in MCBR Watershed

Figure 39. – Critical Areas Where Implementation Will Be Needed in MCBR Watershed.



9.0 MEASURES AND BEST MANAGEMENT PRACTICES TO BE APPLIED

Numerous best management practices were selected by the steering committee for implementation in Mill Creek-Blue River Watershed to address the key issues as a result of this study. Recommended BMPs for agricultural land include Composting Facility, Cover Crop, Critical Area Planting, Drainage Water Management, Fence, Filter Strip, Grassed/Lined, Waterway, No-till (equipment modification or pre-emergent chemicals), Nutrient Management Plan, Mulching, Riparian Buffer, Roof Runoff Structure, Pipeline, Spring Development, Subsurface Drainage, Stream Crossing, Streambank Stabilization, Watering Facility, Waste Storage Facility, and Tree Planting. Definitions and a brief summary of each recommended BMP are located in Appendix H.

In addition to structural BMPs, multiple topics for education programming and potential local ordinances were recommended. Implementation of these recommendations should result in a demonstrable improvement in water quality and habitat condition in the watershed. Although no single recommendation will address all principle issues, it will be necessary a combination of most, if not all, in order to achieve the highest level of results.

The effectiveness to implement any one BMP will be affected by landowner participation, implementation costs and the overall expected water quality benefits given specific site conditions on which the BMP is implemented. Table 47 lists recommended BMPs in MCBR that were decided by the steering committee that would best address the goals of this study. Estimated costs for BMP implementation is listed in Table 48. Many complicating factors influence total BMP cost, and in many instances, the extra cost to implement a BMP may be offset by other attributes of the BMP.

Load Reduction Expectation for Best Management Practice Implementation

The load reduction expectations were determined by using STEPL and the Region V model to calculate phosphorus, nutrient, and sediment load reductions for BMPs in Headwaters West Fork Blue River, Highland Creek West Fork-Blue River, Mill Creek, North Karst Area-Blue River subwatersheds. The estimated load reductions for the BMP goals proposed will be enough for the project to meet its load reduction goals.

Table 47. – Best Management Practices or Measures that would be best to address goals in MCBR

Critical Area	Reason for being critical	BMP or Measure
Headwaters West Fork Blue River, Highland Creek West Fork-Blue River, Mill Creek and North Karst Area-Blue River subwatershed	High Nutrient Levels	-Composting Facility -Cover Crop -Critical Area Planting -Drainage Water Management -Fence -Filter Strip -Grassed/Lined Waterway -No-till (equipment modification or pre-emergent chemicals) -Nutrient Management Plan -Mulching -Riparian Buffer -Roof Runoff Structure -Pipeline -Spring Development -Subsurface Drainage -Waste Storage Facility -Waste Management Plan -Tree Planting
Headwaters West Fork Blue River, Highland Creek West Fork-Blue River, Mill Creek and North Karst Area-Blue River subwatershed	*E.coli*	-Septic System Maintenance Workshops -BMP Demonstration Plot Workshops -Drainage Water Management -Fencing/Alternative Watering -Grassed/Lined Waterway -Heavy Use Area Protection -Nutrient Management Plan -Riparian Buffer -Stream Crossing -Watering Facility
Headwaters West Fork Blue River, Highland Creek West Fork-Blue River, Mill Creek and North Karst Area-Blue River subwatershed	Sediment and Erosion	-BMP Demonstration Plot Workshops -Composting Facility -Cover Crop -Critical Area Planting -Drainage Water Management -Fencing/Alternative Watering -Grassed/Lined Waterway -Heavy Use Area Protection -Filter Strip -Mulching -Nutrient Management -Residue Management -Riparian Buffer -Roof Runoff Structure -Pipeline -Stream Crossing -Spring Development -Streambank Stabilization -Subsurface Drainage -Waste Storage Facility -Waste Management Plan -Tree Planting
Headwaters West Fork Blue River and Highland Creek West Fork-Blue River subwatersheds	Increased Water Flow due to impervious surfaces	-BMP Demonstration Plot Workshops

<u>**Table 48. - Load Reduction Expectation and Summary of Best Management Practices in MCBR Watershed.**</u>

BMP or Measure	**Estimated volume of BMP to be implemented**	**Estimated Load Reduction for BMP (using STEPL and Region V Model)**			**Estimated Implementation Cost**	**Maximum Allowable Cost-Share/BMP** (if all BMP/Measure was installed)
		Phosphorus lb/yr	Nitrogen lb/yr	Sediment tons/yr		
Composting Facility	6	50	62	115	$0.50 per sq. ft.	(i.e.50'X100'X6) $15,000
Cover Crop	7,800 ac	8,573	31,396	1,973	$25 per acre	$195,000
Critical Area Planting	10 ac.	100	630	111	$622 per acre	$6,220
Drainage Water Management	120 ac.	50	62	115	$20 per acre	$2,400
Fence	264,000 ft.	10,739	40,516	1,973	$.75 per linear ft. for temporary fence $1.00 per permanent linear ft.	$264,000
Filter Strip	10 ac.	11,572	37,393	1,710	$100 per acre – cool season; $195 per acre – warm season	$1,950
Grade Stabilization	10	2,700	5,400	2,700	$5,000/structure	$50,000
Grassed Waterway	5 ac.	135	270	135	$3,000/acre	$15,000
Heavy Use Area Protection	5 ac.	135	270	135	$1.00/sq. ft. gravel; $2.00/sq. ft. concrete	$435,600
Lined Waterway	1,500 ft.	135	270	135	$2.25 per linear ft.	$3,375
Mulching	20 ac	620	1,620	500	$225/ac natural material	$4,500
No-Till (equipment modification or pre-emergent chemicals)	7,800 ac	N/A	N/A	N/A	$22 per acre	$171,600
Nutrient Management	7,800 ac	N/A	N/A	N/A	$4 per acre basic; $15 per acre precision; TSP pay at 90% cost	$117,000
Pipeline	79,200 ft.	N/A	N/A	N/A	$2.50 per linear ft.	$198,000
Pumping Plant	6	N/A	N/A	N/A	$2,600/pump	$15,600
Residue Management	7,800 ac	8,573	31,396	1,973	$15 per acre	$117,000
Riparian Buffer	5 ac	11,572	37,393	1,710	$399 per acre forest buffer or 75% of vegetative cover	$1,995
Roof Runoff Management	20,000 ft.	1,165	1,376	27	$7 per linear ft.	$140,000

Spring Development	5	N/A	N/A	N/A	$2,600 per each	$13,000
Stream Crossing	10 at 100'/BMP	2,700	5,400	2,700	$2 per sq. ft.	$2,000
Streambank Stabilization	500 ft	10,739	40,516	1,973	$150 per linear ft.	$75,000
Subsurface Drainage	10,000 ft.	N/A	N/A	N/A	$1.75 per linear ft.	$17,500
Tree Planting	5 ac	22	57	20	$450 per acre	$2,250
Waste Management	7,800 ac	1,267	6,816	27	$15 per acre	$117,000
Waste Storage Facility	6 at (l*w*h) 50'X100'X25" /BMP	859	5,798	27	$1.75 per cubic ft.	$1,312,500
Watering Facility	20	1,267	6,816	27	Portable - $100 each Ball or Fountain tank - $700 each	$14,000
TOTAL	**-**	**72,973**	**253,457**	**18,086**		**$3,307,490**

Definitions and a brief summary of each recommended BMP is located in Appendix H. The reduction is expected to be higher since not all BMP reductions can be estimated before being implemented and it might not be feasible to achieve the reductions within the timeframe of the WMP.

10.0 ACTION OBJECTIVIES AND SCHEDULE

Goals and actions are listed for each critical area/issue according to the associated concern. The actions to be performed, when it will be completed, who is responsible for performing the action, what resources (monetary and technical resources) are required and the target audience to receive the action benefit is included for each goal.

Organizations or individuals named for performance or target of actions are based on the potential of the support, ability, and advice or management measure they may provide to the project goals. This list is not intended to be comprehensive or to exclude other entities from participation in the development and/or implementation of management measures. Participation by any volunteer or organization will be encouraged and utilized as appropriate.

GOALS

1. High Stream Nutrient Levels to Below the Water Quality Target

2. High Stream *E.coli* Levels Below the Water Quality Target

3. Flooding and/or Stormwater runoff

4. Public Awareness of Water Quality Issues

Table 49. – Action Register and Schedule for Goals in MCBR Watershed.

Goal 1 High Stream Nutrient Levels to Below the Water Quality Target					
Problem Statement: *The lack of riparian and vegetated buffers along rivers and streams could cause a higher level of nutrients and sediment to runoff during rain events in the following subwatersheds (12 digit HUC Headwaters West Fork Blue River 051501040701, Highland Creek-West Fork Blue River 05140104703, Mill Creek 051401040704, and North Karst Area-Blue River 051401040706).*					
Objective	**Target Audience**	**Milestone**	**Cost**	**Possible Partner (PP) and needed Technical Assistance (TA)**	**Goal Indicator**
Increase awareness of landowners and producers of nutrient management planning, no-till, BMPs with nutrient and sediment reduction benefits and the benefits of implementing vegetation along a stream or river.	Landowners, Agricultural Producers, General Public	Within 3 months of project, develop cost-share program	$500	PP=Steering Committee	Cost-share program approved by IDEM
		Every year, hold BMP workshop explaining and showing the water quality benefits of nutrient reduction BMPs.	$500	PP=Landowner with installed BMPs TA=NRCS, ISDA, SWCD, TNC, Purdue Extension	# of participants to attend field day/workshop
		By end of year 1 of BMP installation, display signage of BMP installation on stream or river.	$100	PP=Landowner with newly installed BMP(s)	# of participants in cost-share program implementing BMPs reducing nutrient runoff
		Every year, promote BMP installation in website, newsletter and brochures.	$100	PP=Landowners, SWCD, NRCS, TNC, Purdue Extension	# of publications distributed # of hits on website
		Every year, using all known funding sources, implement nutrient and sediment reducing BMPs on at least 6000 acres	TSP costs $700; $100-$400 per acre to implement BMP	PP=Steering Committee TA – ISDA, NRCS, TNC, Purdue Extension, TSP to write conservation plans	# of participants in cost-share program implementing BMPs reducing nutrient runoff Load reductions

Goal 1
High Stream Nutrient Levels to Below the Water Quality Target

Problem Statement: *Overuse of agricultural land for livestock and crop production increase sediment and nutrients in the streams in the following subwatersheds (12 digit HUC Mill Creek 051401040704, and North Karst Area-Blue River 051401040706).*

Objective	Target Audience	Milestone	Cost	Possible Partner (PP) and needed Technical Assistance (TA)	Goal Indicator
Increase awareness of landowners and producers of nutrient management planning, no-till, install BMPs with nutrient benefits; the benefits of not dumping foreign material into sinkholes; and the importance of sinkhole buffers/stabilization.	Landowners, Agricultural Producers, General Public	Within 3 months of project, develop cost-share program	$500	PP=Steering Committee	Cost-share program approved by IDEM
		Within year 1, hold BMP workshop explaining and showing the water quality benefits of nutrient reduction BMPs.	$500	PP=Landowner with installed BMPs TA=NRCS, ISDA, SWCD, TNC, Purdue Extension	# of participants to attend field day/workshop
		By end of year 1 of BMP installation, display signage of BMP installation on stream or river.	$100	PP=Landowner with newly installed BMP(s)	# of participants in cost-share program implementing BMPs reducing nutrient runoff
		By end of year 1 and year 2, promote BMP installation in website, newsletter and brochures.	$100	PP=Landowners, SWCD, NRCS, TNC, Purdue Extension	# of publications distributed # of hits on website
		Every year, using all known funding sources, implement nutrient and sediment reducing BMPs on at least 6000 acres	TSP costs $700; $100-$400 per acre to implement BMP	PP=Steering Committee TA – ISDA, NRCS, TNC, Purdue Extension, TSP to write conservation plans	# of participants in cost-share program implementing BMPs reducing nutrient runoff Load reductions

Goal 1 High Stream Nutrient Levels to Below the Water Quality Target					
Problem Statement: *Dumping of trash, large debris and waste into sinkholes decreasing water quality in the streams in the following subwatersheds (12 digit HUC Mill Creek 051401040704, and North Karst Area-Blue River 051401040706).*					
Objective	**Target Audience**	**Milestone**	**Cost**	**Possible Partner (PP) and needed Technical Assistance (TA)**	**Goal Indicator**
Increase awareness of landowners and producers of nutrient management planning, no-till, install BMPs with nutrient benefits; the benefits of not dumping foreign material into sinkholes; and the importance of sinkhole buffers/stabilization.	Landowners, Agricultural Producers, General Public	Within 3 months of project, develop cost-share program	$500	PP=Steering Committee	Cost-share program approved by IDEM
		Within year 1, hold BMP workshop explaining and showing the water quality benefits of nutrient reduction BMPs.	$500	PP=Landowner with installed BMPs TA=NRCS, ISDA, SWCD, TNC, Purdue Extension	# of participants to attend field day/workshop
		By end of year 1 of BMP installation, display signage of BMP installation on stream or river.	$100	PP=Landowner with newly installed BMP(s)	# of participants in cost-share program implementing BMPs reducing nutrient runoff
		By end of year 1 and year 2, promote BMP installation in website, newsletter and brochures.	$100	PP=Landowners, SWCD, NRCS, TNC, Purdue Extension	# of publications distributed # of hits on website
		Every year, using all known funding sources, implement nutrient and sediment reducing BMPs on at least 6000 acres	TSP costs $700; $100-$400 per acre to implement BMP	PP=Steering Committee TA – ISDA, NRCS, TNC, Purdue Extension, TSP to write conservation plans	# of participants in cost-share program implementing BMPs reducing nutrient runoff Load reductions

Goal 2 High Stream E.coli Levels Below the Water Quality Target					
<u>Problem Statement:</u> *Improper maintenance of septic systems leads to failure causing pathogens to enter nearby waterbodies and leads to health problems in humans and creates poor water quality (12-digit HUC Headwaters West Fork Blue River 051501040701, Highland Creek-West Fork Blue River 05140104703, Mill Creek 051401040704, and North Karst Area-Blue River 051401040706).*					
Objective	**Target Audience**	**Milestone**	**Cost**	**Possible Partner (PP) and needed Technical Assistance (TA)**	**Goal Indicator**
Educate the public about proper maintenance of septic systems	General Public	By end of year 1, develop a publication and distribute by mail and display on website of proper maintenance of septic systems	$150	PP=Steering Committee, TNC, Washington Co. Health Dept.	Reduction in number of reported failed septic systems.
		By end of year 2, hold septic system maintenance education workshop	$300	PP=Steering Committee, SWCD, TNC, Purdue Extension	# of participants at workshop
		By end of year 2, distribute septic system maintenance cards in yearly utility mailing encouraging homeowners to check their septic system every 3-5 years for maintenance	$500	PP=Steering Committee, SWCD, TNC, Purdue Extension	# of mailings distributed

Goal 2 High Stream E.coli Levels Below the Water Quality Target					
<u>Problem Statement:</u> *Livestock with access to streams may lead to an increase in bacteria and pathogens from animal waste and create poor streambank stabilization leading to erosion (12-digit HUC Headwaters West Fork Blue River 051501040701, Highland Creek-West Fork Blue River 05140104703, Mill Creek 051401040704, and North Karst Area-Blue River 051401040706).*					
Objective	**Target Audience**	**Milestone**	**Cost**	**Possible Partner (PP) and needed Technical Assistance (TA)**	**Goal Indicator**
Reduce untreated animal waste and soil erosion from livestock entering the stream.	Landowners, Agricultural Producers	Within 3 months of project, develop cost-share program	$500	PP=Steering Committee	Cost-share program approved by IDEM
		Within year 1, hold BMP workshop explaining and showing the water quality benefits of *E.coli* reduction BMPs.	$500	PP=Landowner(s) with installed BMPs TA=NRCS, ISDA, SWCD, TNC, Purdue Extension	# of participants to attend field day/workshop
		By end of year 1 of BMP installation, display signage of BMP installation on stream or river.	$100	PP=Landowner with newly installed BMP(s)	# of participants in cost-share program implementing BMPs reducing nutrient runoff
		By end of year 1 and year 2, promote BMP installation in website, newsletter and brochures.	$100	PP=Landowners, SWCD, NRCS, TNC, Purdue Extension	# of publications distributed # of hits on website
		Every year, using all known funding sources, implement BMPs to reduce livestock in the stream on 300 acres	TSP costs $700; $500-$20,000 to implement/ BMP	PP=Steering Committee TA – ISDA, NRCS, TNC, Purdue Extension, TSP to write conservation plans	# of participants in cost-share program implementing BMPs reducing nutrient runoff Load reductions Water quality data

Goal 3 Flooding and/or Stormwater runoff.					
<u>Problem Statement:</u> Landowners and producers using agricultural and residential land with lack of vegetation along streambanks can lead to excess soil loss and high nutrient runoff from crop fields, livestock pastures, lawns, driveways, and parking lots *(12- digit HUC Headwaters West Fork Blue River 051501040701, Highland Creek-West Fork Blue River 05140104703, Mill Creek 051401040704, and North Karst Area-Blue River 051401040706).*					
Objective	**Target Audience**	**Milestone**	**Cost**	**Possible Partner (PP) and needed Technical Assistance (TA)**	**Goal Indicator**
Increase the number of adequate streambank buffers in the watershed	Landowners, Agricultural Producers, General Public	Within 6 months, develop and distribute a brochure/newsletter that includes best management practices that can be used to address streambank erosion and nutrient runoff along streams and rivers.	$50	PP=Steering Committee, SWCD	# of brochures distributued
		Yearly, distribute brochures, newsletters, and website address to general public at local events about non-point source pollution.	$500	PP=Steering Committee, SWCD	# of publications distributed # of local events attended
		After year 1, promote cost-share practices that address streambank erosion and nutrient runoff to agricultural producers in the watershed including cover crops, critical area planting, filter strip, grade stabilization structure, grassed and lined waterways, mulching, riparian herbaceous cover, and tree and shrub establishment on 3000 acres.	TSP costs $700; $100-$20,000 to implement/ BMP	PP=Steering Committee TA – ISDA, NRCS, TNC, Purdue Extension, TSP to write conservation plans	# of participants in cost-share program implementing BMPs reducing soil erosion and nutrient runoff Load reductions

Goal 3 Flooding and/or stormwater runoff.					
Problem Statement: Lack of education by the general public concerning nonpoint source pollution and its effects on water quality *(12-digit HUC Headwaters West Fork Blue River 051501040701, Highland Creek-West Fork Blue River 05140104703, Mill Creek 051401040704, and North Karst Area-Blue River 051401040706).*					
Objective	**Target Audience**	**Milestone**	**Cost**	**Possible Partner (PP) and needed Technical Assistance (TA)**	**Goal Indicator**
Education of public about what non-point source pollution is and its impacts on water quality	General Public	Within 6 months, develop non-point source pollution lesson and teach students the importance of water quality (including but not limited to pet waste, native plants, invasive species, water conservation, and soil conservation).	$100	PP=Steering Committee, SWCD	# of students reached by non-point source pollution lesson
		Yearly, distribute brochures, newsletters, and website address to general public at local events about non-point source pollution.	$500	PP=Steering Committee, SWCD	# of publications distributed # of local events attended
		After year 1, install water quality BMP on public land and hold workshop at demonstration BMP plot at Lake Salinda, Salem school property, or City of Salem property.	Up to $20,000	PP=Steering Committee, City of Salem, Salem School Corporation, SWCD TA=ISDA, NRCS, SWCD, TNC, Purdue Extension	# of participants at workshop Use of allotted funds to install BMP on public land
		After year 2, develop social indicator survey and distribute to watershed stakeholders on their attitude and knowledge of water quality.	$5,000	PP=Steering Committee, SWCD, TNC, Purdue Extension,	# of surveys distributed in the watershed # of responses to survey

Goal 4
Public Awareness of Water Quality Issues

Problem Statement: Water quality tests show water quality targets exceeding *E.coli*, TSS, and nutrients in many testing sites throughout the watershed. This could cause water temperatures to increase through absorbed particles and lowering the dissolved oxygen. Also, aquatic life could be affected by clogging of the gills or smothering habitats *(12-digit HUC Headwaters West Fork Blue River 051501040701, Highland Creek-West Fork Blue River 05140104703, Mill Creek 051401040704, and North Karst Area-Blue River 051401040706).*

Objective	Target Audience	Milestone	Cost	Possible Partner (PP) and needed Technical Assistance (TA)	Goal Indicator
Improve water quality to increase the numbers and diversity of biotic communities	General Public, Agricultural Producers	Within 6 months, develop non-point source pollution lesson and teach students the importance of water quality in the classroom and/or through annual clean-up days (picking up trash, removing invasive species).	$100	PP=Steering Committee, SWCD	# of students reached by non-point source pollution lesson
		Within 1 year, hold Hoosier Riverwatch training in the watershed to train volunteers how to collect water samples and share the importance of water quality in our watershed.	$100	PP=Steering Committee, SWCD	# of volunteers who attend workshop training
		Within 2 years, develop article to print in newspapers, brochures, newsletters and website on the importance of biotic communities and their relevance to water quality.	$50	PP=Steering Committee, City of Salem, Salem School Corporation, SWCD	# of times article is printed in publications # of publication distributed Water quality data

Goal 4
Public Awareness of Water Quality Issues

Problem Statement: Native plants and animals could be threatened by invasive plants and animals by ruining habitat, choking and/or over populating *(12-digit HUC Headwaters West Fork Blue River 051501040701, Highland Creek-West Fork Blue River 05140104703, Mill Creek 051401040704, and North Karst Area-Blue River 051401040706).*

Objective	Target Audience	Milestone	Cost	Possible Partner (PP) and needed Technical Assistance (TA)	Goal Indicator
Increase awareness of landowners and producers of nutrient management planning, no-till, install BMPs with nutrient benefits; the benefits of not dumping foreign material into sinkholes; and the importance of sinkhole buffers/stabilization.	Landowners, Agricultural Producers, General Public	Within 6 months, develop non-point source pollution lesson and teach students the importance of water quality in the classroom and/or through annual clean-up days.	$100	PP=Steering Committee, SWCD, NRCS, TNC	# of students reached by non-point source pollution lesson
		Within 1 year, share awareness of invasive plants and animals to watershed stakeholders by brochure, website, field day, workshop or newsletter.	$100	PP=Steering Committee, SWCD, NRCS, TNC, ISDA, DNR, Washington County Weed Board, Southern Indiana Weed Council	# of volunteers who attend workshop training
		Within 2 years, develop article to print in newspapers, brochures, newsletters and website on the importance of native plants and animals.	$50	PP=Steering Committee, City of Salem, Salem School Corporation, SWCD, NRCS, TNC, ISDA, DNR, Washington County Weed Board, Southern Indiana Weed Council	# of times article is printed in publications # of publication distributed Water quality data

11.0 TRACKING EFFECTIVNESS

Tracking Effectiveness of Implementation Efforts Over Time

The overall success of a watershed management plan depends up on the implementation of action items as outlined by the watershed management plan goals. Below are success indicators or milestones which will help stakeholders in the Mill Creek-Blue River watershed track their progress and support in updating and revising the watershed management plan as goals, objectives, and strategies are met. Regular water quality monitoring, social indicator surveys, and tracking of administrative successes related with objectives and strategies is necessary to help recognize actual water quality targets. Indicators identified below will be tracked and reported on a quarterly basis.

Water Quality Monitoring

Water quality indicators will be tracked using the same methodology we used to collect water quality data monthly for this WMP; however parameters will be limited to those identified in our goals. Data collections will begin after the first phase of implementation ends and will be performed by our partners at the wastewater treatment plant, Hoosier Riverwatch volunteers and, if needed, securing funds from a grant for an estimated cost between $15,000-$20,000.

Social Indicators

Social indicators provide information about stakeholder awareness and behavior that directly affect water quality improvement and protection. Social indicators will be used to guage behavior change towards Mill Creek and Blue River, conservation on the land, and best management practices. Also anticipated are changes in attitudes towards actions and awareness of watershed activities, concerns, accomplishments, and participation in watershed and/or cost-share program activities.

Social indicator data will be tracked in a planning phase and post-implementation survey report. Surveys will be completed by watershed participants during field days/workshops, participation in cost-share program and a water quality awareness survey that will be distributed to all stakeholders three years after phase I implementation. Surveys will cost $20,000. Results will be reported to the steering committee when data is available.

Tracking of Administrative Successes

Administrative indicators will be tracked using a database in which date of activity, number of attendees/participants, and an activity description will be recorded. Installed practices will be tracked in a project database using Geographic Information Systems and tracking of load reductions. Administrative indicator tracking will occur as part of the cost-share and education programs and will be completed by the MCBR watershed coordinator. Data will be reported to the steering committee no less than annually with updates occurring quarterly.

12.0 FUTURE ACTIVITIES

Active water monitoring will continue to through Hoosier Riverwatch methods using the same parameters and methodology in the current WMP. Water quality participants will be aware of any BMP implementations to consider while evaluating data.

Grants and other sources of funding will continue to be sought after to help off-set project costs to improve water quality education. The SWCD will continue to educate urban and agriculture residents of best management practices to continue to protect and enhance water quality in MCBR. Also, after phase I of the implementation project, social indicator surveys will be given to stakeholders in MCBR to identify any changes in behavior and attitude in the watershed towards the importance of water quality.

Once the implementation of the cost-share project is completed, load reducation goals will be assesssed and updated in the WMP. The WMP is meant to be a living document and continue to progress. Revisions and updates will be added as stakeholders become more involved with the project and active in implementing the plan. The plan will be evaluated and updated after the implementation phases or earlier if needed as decided by the steering committee.

A second phase of implementation will be planned and recommended as needed by the coordinator, steering committee and local partners to determine the future water quality needs of MCBR, such as, revising the MCBR WMP, evaluate the success of installed BMPs with another round of professional water monitoring in MCBR, and share the project successes with stakeholders.

This plan may be adapted or blended with other watershed management plans to effectively create living documents which cover larger-scale projects and capitalize on potential shared resources.

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APPENDICES

APPENDIX A:
Geographic Information Systems Metadata

GIS data sources.
The following geographic information systems (GIS) data sources were used to create one or more of the maps in the Mill Creek-Blue River Watershed Management Plan as listed below:

(County Census Data, 2000) CENSUS_COUNTY_TIGER00_IN: Shows counties and contains 2000 census data regarding race, gender, age, families, and households. Data are from Census 2000 SF1 tables. 1:24,000 scale.

(EPA, 1995) WATER_QUALITY_OBSERVATIONS_EPA_IN: Provides general information on water-quality observations at monitoring stations. Unknown scale.

(IDEM, 2010) BROWNFIELDS_IDEM_IN: A brownfield site is a parcel of real estate that is abandoned or inactive, or may not be operated at its appropriate use, and on which expansion, redevelopment, or reuse is complicated because of the presence or potential presence of a hazardous substance, a contaminant, petroleum, or a petroleum product that poses a risk to human health and the environment. Unknown scale.

(IDEM, 2010) CONFINED_FEEDING_OPERATIONS_IDEM_IN: Shows swine, chicken, turkey, beef or dairy agribusinesses that have large enough numbers of animals that IDEM regulates for environmental concerns, as defined by IC 13-18-10 of the Indiana Code. Unknown scale.

(IDEM, 2006) IMPAIRED_STREAMS_IDEM_IN: Shows streams and rivers that do not meet water-quality standards under Section 303(d) of the Clean Water Act. Unknown scale.

(IDEM, 2010) LUST_IDEM_IN: Shows known sites with leaking underground storage tanks. Regulated underground storage tanks (USTs) contain regulated substances including petroleum and hazardous substances such as those typically found at gasoline stations, fleet fueling facilities, and industrial sites. If a release from a UST system is suspected or confirmed, the owner and operator must report it to the Indiana Department of Environmental Management. These sites are called Leaking USTs. Actions must be taken as described in the UST rules – 329 IAC 9-4 and 5. Unknown scale.

(IDEM, 2002) NPDES_FACILITY_IDEM_IN: Shows state-permitted wastewater facilities and provides associated information such as the name of the facility, contacts, and a variety of mailing addresses. Unknown scale.

(IDEM, 2002) NPDES_PIPE_IDEM_IN: Shows National Pollutant Discharge Elimination System (NPDES) Program pipe locations. Unknown scale.

(IDEM, 2010) UST_IDEM_IN: Shows regulated underground storage tank locations. Regulated underground storage tanks are those that have 10 percent or more of the tank and piping buried beneath the ground and contain a regulated substance. This data set generally contains the location of access points to managed sites, along with a unique identifier for each location. Unknown scale.

(IDEM, 2010) WASTE_INDUSTRIAL_IDEM_IN: Shows the locations of access points to industrial waste site locations, along with unique identifiers for each location. GPS points locate the entrance to facilities that generate and (or) manage hazardous waste, non-hazardous industrial waste, and solid waste. Unknown scale.

(IDNR, 2010) DAMS_IDNR_IN: Includes dams in Indiana that are under the jurisdiction of the Indiana Department of Natural Resources. Unknown scale.

(IDNR, 2004) FLOODPLAINS_DFIRM_IDNR_IN: Shows floodplains created from FEMA Flood Rate Insurance Maps (FIRM). The FIRM is the basis for floodplain management, mitigation, and insurance activities for the National Flood Insurance Program (NFIP). The Digital Flood Insurance Rate Map (DFIRM) Database is derived from Flood Insurance Studies (FIS), previously published Flood Insurance Rate Maps (FIRM), flood hazard analyses performed in support of the FIS's and FIRM's, and new mapping data, where available. 1:12,000 scale.

(IDNR, 2009) RECREATIONAL_FACILITIES_IDNR_IN: Shows outdoor recreation facilities, including facilities managed by federal, state, and local governments, as well as non-government organizations, private and commercial entities, and schools. It does not include sites that are private and not open to the public.1:24,000 scale.

(IDNR, 2011) TRAILS_IDNR_IN: Shows trails and associated attributes of public, off-road recreation, and transportation trails. It includes trails managed by federal, state, and local governments, as well as non-government organizations.1:24,000 scale.

(IDOE, 2010) SCHOOLS_POLIS_IDOE_IN: Shows locations for public and non-public schools in Indiana. Schools that are included are high schools, middle schools, elementary schools, primary schools, junior high schools, youth centers, and correctional facilities. Attributes include school ID, name, address, contact information, number of students, district, and other information. Unknown scale.

(IGS, 1997) KARST_CAVE_DENSITY_IN: Shows the density (i.e., number of entrances per square kilometer) of mapped cave entrances in Silurian, Devonian, and Mississippian rocks in southern Indiana. Locations of individual cave entrances are not shown. Unknown scale.

(IGS, 1997) KARST_MM65_IN: Shows sinkhole areas (SHA) and sinking-stream basins (SSB) associated with rocks of Silurian, Devonian, and Mississippian age in southern Indiana. Shows sinkhole areas larger than 80 acres. Some sinkholes may exist outside the delineated areas, and some sinkholes may exist within the areas designated as sinking-stream basins, but such areas are not shown in this layer. The data should not be used for site-specific data analysis. 1:126,720 scale.

(IGS, 1997) KARST_SPRINGS_MM65_IN: Shows the locations of springs in and around the karst region of south-central Indiana. The data should not be used for site-specific data analysis. 1:126,720 scale.

(IGS, 1988) PIPELINES_IGS_IN: Shows the locations and extents of known natural gas, crude oil, and refined products pipelines.1:63,360 scale.

(INDOT, 2005) AIRPORTS_PUBLIC_INDOT_IN: Obtained from the Indiana Department of Transportation, Aeronautics Section, Multi-Modal Transportation Division. Unknown scale.

(INDOT, 2006) BRIDGES_COUNTY_INDOT_IN: Attributes include National Bridge Inventory identification number. Data have been aligned to Digital Orthoquarterquads (DOQQs) of the U.S. Geological Survey. 1:2,000,000 scale.

(INDOT, 2004) HIGHWAYS_INDOTMODEL_IN: Shows Interstate, U.S., and State Highways. Attributes include route numbers and the number of lanes. 1:24,000 scale.

(INDOT, 2001) INCORPORATED_AREAS_INDOT_IN: Shows incorporated area boundaries for all cities and towns. No scale.

(INDOT, 2006) INDUSTRIAL_PARKS_INDOT_IN: Shows locations of industrial parks. Attributes include name, address, zoning designation, and total acreage. Unknown scale.

(INDOT, 2005) ROADS_2005_INDOT_IN: Shows roads, consisting of city streets, county roads, and U.S., state and interstate roads, and non-certified other roads.1:100,000 scale.

(IGS, 1998) LANDSURVEY_COUNTY_LINE_IN: This shapefile was created as a framework layer defining the county boundaries of Indiana in line format. The information is intended for geographic display or analysis at a scale of 1:24,000 or smaller.

(IGS, 1998) LANDSURVEY_STATE_LINE_IN: This shapefile was created as a framework layer defining the state boundary of Indiana in line format. The information is intended for geographic display or analysis at a scale of 1:24,000 or smaller.

(USDA, 1994) SOILS_PRIMEFARM_HYDRIC_STATSGO_IN: Shows the percentage of prime farmland or hydric soils occurring within soil map units. The actual boundary of specific prime farmland or hydric soils is NOT shown. 1:250,000 scale.

(USDA, 2006) SOILS_SSURGO_USDA_IN: Shows the most detailed level of soil geographic data available and provides information about the kinds and distribution of soils on the landscape. Attributes include soil map-units ("MAPUNIT_NA"), hydric rating ("HYDCLPRS"), drainage class ("DRCLASSDCD"), potential erosion hazard ("FORPEHRTDC"), and more. 1:12,000 scale.

(USDA, 1994) SOILS_STATSGO_IN: Shows generalized soil associations. Derived from the State Soil Geographic (STATSGO) data base, which is a digital general soil association map developed by the National Cooperative Soil Survey, U.S. Department of Agriculture. The soil maps for STATSGO are compiled by generalizing more detailed soil survey maps. 1:250,000 scale.

(USDA, 2009) WATERSHEDS_HUC08_2009_USDA_IN: Shows the most recent revision of watershed boundaries of 8-digit hydrologic accounting units. This data set, part of the Watershed Boundary Data set (WBD), is a complete digital hydrologic unit boundary layer to the Subbasin (8-digit) 4th level for the entire United States. Polygons are Attributed with hydrologic unit codes for 1st (Region), 2nd (Sub-Region), 3rd (Basin), and 4th (Sub-Basin) Hydrologic Unit Level codes, names, Sub-Basin acres and square miles. 1:24,000 scale.

(USDA, 2009) WATERSHEDS_HUC10_2009_USDA_IN: Shows the most recent revision of watershed boundaries of 10-digit hydrologic accounting units. This data set, part of the Watershed Boundary Data set (WBD), is a complete digital hydrologic unit boundary layer to the Watershed (10-digit) 5th level for the NRCS business areas in and around the state of Indiana. Polygons are attributed with hydrologic unit codes for 4th level sub-basins, 5th level watersheds, name, size, downstream hydrologic unit, type of watershed, noncontributing areas and flow modification. 1:24,000 scale.

(USDA, 2009) WATERSHEDS_HUC12_2009_USDA_IN: Shows the most recent revision of watershed boundaries of 12-digit hydrologic accounting units. This data set, part of the Watershed Boundary Data set (WBD), is a complete digital hydrologic unit boundary layer to the Subwatershed (12-digit) 6th level in and around the state of Indiana. Polygons are attributed with hydrologic unit codes for 4th level subbasins, 5th level watersheds, 6th level subwatersheds, name, size, downstream hydrologic unit, type of watershed, noncontributing areas and flow modification. 1:24,000 scale.

(U.S. Dept. of Commerce, 2000) POPULATED_AREA_TIGER00_IN: Shows all populated places identified by the U.S. Bureau of the Census. Attributes include city name, FIPS code, Census type, and selected demographic data. This file does not necessarily reflect the legal limits of any city, town, or incorporation. 1:100,000 scale.

(USGS, 2002) CEMETERIES_USGS_BLA_IN: Shows the locations of cemeteries. 1:24,000. Scale.

(USGS, 2008) HYDROGRAPHY_HIGHRES_FLOWLINE_NHD_USGS: Shows streams, rivers, canals, ditches, artificial paths, coastlines, connectors and pipelines in Indiana. 1:24,000 scale.

(USGS, 2008) HYDROGRAPHY_HIGHRES_WATERBODYDISCRETE_NHD_USGS: Shows lakes, ponds, reservoirs, swamps and marshes in watersheds in Indiana. 1:24,000 scale.

(USGS, 2008) HYDROGRAPHY_HIGHRES_WATERBODYLINEAR_NHD_USGS: Shows rivers, inundation areas, canals, ditches, submerged streams and other linear waterbody areas in watersheds in Indiana. 1:24,000 scale.

(USGS, 2001) LC2001USGS_IN: Shows fifteen categories of land use. 30-Meter Grid, Unknown scale.

(USGS, 2008) STREAMFLOW_GAUGING_STATIONS_USGS_IN: This layer shows locations of 179 streamflow gauges maintained by the United States Geological Survey (USGS) in Indiana. The gauges are part of a real-time national streamflow network. Unknown scale.

APPENDIX B:
WASHINGTON COUNTY THREATENED AND ENDANGERED SPECIES

06/01/2010

Indiana County Endangered, Threatened and Rare Species List
County: Washington

Species Name	Common Name	FED	STATE	GRANK	SRANK
Platyhelminthes (Flatworms)					
Sphalloplana weingartneri	Weingartner's Cave Flatworm		WL	G4	S4
Diplopoda					
Conotyla bollmani	Bollman's Cave Milliped		WL	G5	S4
Pseudotremia indianae	Blue River Cave Milliped		WL	G4	S4
Crustacean: Malacostraca					
Crangonyx packardi	Packard's Cave Amphipod		WL	G4	S4
Miktoniscus barri	Barr's Terrestrial Isopod		WL	G2G4	SNR
Orconectes inermis inermis	A Troglobitic Crayfish		WL	G5T4	S4
Crustacean: Copepoda					
Diacyclops jeanneli	Jeannel's Cave Copepod		ST	G3G4	S2
Crustacean: Ostracoda					
Dactylocythere susanae	An Ostracod		WL	G2G4	S3
Sagittocythere barri	Barr's Commensal Cave Ostracod		WL	G5	S3S4
Mollusk: Bivalvia (Mussels)					
Fusconaia subrotunda	Longsolid		SE	G3	SX
Lampsilis fasciola	Wavyrayed Lampmussel		SSC	G5	S3
Obovaria subrotunda	Round Hickorynut		SSC	G4	S1
Ptychobranchus fasciolaris	Kidneyshell		SSC	G4G5	S2
Simpsonaias ambigua	Salamander Mussel		SSC	G3	S2
Villosa lienosa	Little Spectaclecase		SSC	G5	S3
Mollusk: Gastropoda					
Carychium riparium SNR	Floodplain Thorn			G2G3	
Zonitoides kirbyi	Shadow Gloss			G2	SNR
Ellipluran: Collembola					
Arrhopalites ater	Black Medusa Cave Springtail		ST	G2	S2
Arrhopalites benitus	A Springtail		WL	G1	S1
Arrhopalites lewisi	Lewis' Cave Springtail		ST	GNR	S2
Folsomia prima	Primitive Springtail		WL	GNR	S4
Folsomides americanus	Small Springtail		SE	GNR	S1
Hypogastrura □ncarn	Bristly Springtail		WL	GNR	SNR
Isotoma anglicana	A Springtail		WL	GNR	SNR
Isotoma caeruleatra	Blue Springtail		WL	GNR	SNR

Indiana Natural Heritage Data Center
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Indiana Department of Natural Resources
This data is not the result of comprehensive county surveys.

Fed: LE = Endangered; LT = Threatened; C = candidate; PDL = proposed for delisting
State: SE = state endangered; ST = state threatened; SR = state rare; SSC = state species of special concern; SX = state extirpated; SG = state significant; WL = watch list
GRANK: Global Heritage Rank: G1 = critically imperiled globally; G2 = imperiled globally; G3 = rare or uncommon globally; G4 = widespread and abundant globally but with long term concerns; G5 = widespread and abundant globally; G? = unranked; GX = extinct; Q = uncertain rank; T = taxonomic subunit rank
SRANK: State Heritage Rank: S1 = critically imperiled in state; S2 = imperiled in state; S3 = rare or uncommon in state; G4 = widespread and abundant in state but with long term concern; SG = state significant; SH = historical in state; SX = state extirpated; B = breeding status; S? = unranked; SNR = unranked; SNA = nonbreeding status unranked

Species Name	Common Name	FED	STATE	GRANK	SRANK
Isotoma nigrifrons	Dark Springtail		WL	GNR	SNR
Isotoma nixoni	Nixon’s Springtail			WL	GNR SNR
Isotoma torildae			WL	GNR	SNR
Onychiurus casus	Fallen Springtail		WL	GNR	S4
Onychiurus reluctus	A Springtail		WL	GNR	S4
Pseudosinella collina	Hilly Springtail		SR	GNR	S2?
Pseudosinella fonsa	Fountain Cave Springtail		ST	G3G4	S2
Sinella alata	Springtail		WL	G5	S4
Sinella cavernarum	A Springtail		WL	G5	S4
Insect: Coleoptera (Beetles)					
Aleochara lucifuga	Rove beetle		WL	GNR	S4
Necrophilus pettiti	A Carrion Beetle		ST	GNR	S1?
Pseudanophthalmus tenuis	Cave Beetle		WL	G4	S4
Pseudanophthalmus youngi	Young’s cave ground beetle		SR	G3G4	S3
Insect: Lepidoptera (Butterflies & Moths)					
Erynnis martialis	Mottled Duskywing		ST	G3	S2S3
Arachnida					
Bathyphantes weyeri	A Cave Spider			G4	SNR
Cicurina arcuata	A Funnel-web Weaver			GNR	S1
Erebomaster flavescens	Golden Cave Harvestman		ST	G3G4	S2
Hesperochernes mirabilis	Southeastern Cave Pseudoscorpion		WL	G5	S4
Kleptochthonius packardi	Packard’s Cave Pseudoscorpion		SE	G2G3	S1S2
Fish					
Amblyopsis spelaea	Northern Cavefish		SE	G4	S1
Etheostoma maculatum	Spotted Darter		SSC	G2	S2S3
Etheostoma variatum	Variegate Darter		SE	G5	S1
Amphibian					
Acris crepitans blanchardi	Northern Cricket Frog		SSC	G5	S4
Cryptobranchus alleganiensis alleganiensis	Eastern Hellbender		SE	G3G4T3T4	S1
Reptile					
Clonophis kirtlandii	Kirtland’s Snake		SE	G2	S2
Nerodia erythrogaster neglecta	Copperbelly Water Snake	PS:LT	SE	G5T3	S2
Opheodrys aestivus	Rough Green Snake		SSC	G5	S3
Terrapene □ncarnat □ncarnat	Eastern Box Turtle		SSC	G5T5	S3
Bird					
Ammodramus henslowii	Henslow’s Sparrow		SE	G4	S3B
Buteo lineatus	Red-shouldered Hawk		SSC	G5	S3
Cistothorus platensis	Sedge Wren		SE	G5	S3B
Dendroica □ncarnat	Cerulean Warbler		SE	G4	S3B
Haliaeetus leucocephalus	Bald Eagle	LT,PDL	SE	G5	S2
Helmitheros vermivorus	Worm-eating Warbler		SSC	G5	S3B

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Species Name	Common Name	FED	STATE	GRANK	SRANK
Tyto alba	Barn Owl		SE	G5	S2
Wilsonia □ncarna	Hooded Warbler		SSC	G5	S3B
Mammal					
Corynorhinus rafinesquii	Rafinesque’s Big-eared Bat		SSC	G3G4	SH
Lynx rufus	Bobcat No Status		SSC	G5	S1
Myotis austroriparius	Southeastern Bat		SSC	G3G4	S1
Myotis lucifugus	Little Brown Bat		SSC	G5	S4
Myotis □ncarnat	Indiana Bat or Social Myotis	LE	SE	G2	S1
Pipistrellus subflavus	Eastern Pipistrelle		SSC	G5	S4
Taxidea taxus	American Badger		SSC	G5	S2
Vascular Plant					
Aconitum uncinatum	Blue Monkshood		SE	G4	S1
Bacopa rotundifolia	Roundleaf Water-hyssop		ST	G5	S1
Calamagrostis □ncarn ssp. Insperata	Reed Bent Grass		ST	G4T3	S1
Carex straminea	Straw Sedge		ST	G5	S2
Crataegus prona	Illinois Hawthorn		SE	G4G5	S1
Diervilla lonicera	Northern Bush-honeysuckle		SR	G5	S2
Eleocharis bifida			SE	G3G4	S1
Euphorbia obtusata	Bluntleaf Spurge		SE	G5	S1
Gonolobus obliquus	Angle Pod		SR	G4?	S2
Hexalectris spicata	Crested Coralroot		SR	G5	S2
Juncus secundus	Secund Rush		SE	G5?	S1
Lathyrus venosus	Smooth Veiny Pea		ST	G5	S2
Linum sulcatum	Grooved Yellow Flax		SR	G5	S2
Magnolia □ncarnate	Cucumber Magnolia		SE	G5	S1
Oenothera triloba	Stemless Evening-primrose		SX	G4	SX
Ophioglossum engelmannii	Limestone Adder’s-tongue		SR	G5	S2
Penstemon deamii	Deam Beardtongue		SR	G1	S1
Polygala □ncarnate	Pink Milkwort		SE	G5	S1
Polypodium polypodioides	Resurrection Fern		SR	G5	S2
Scirpus purshianus	Weakstalk Bulrush		SR	G4G5	S1
Silene regia	Royal Catchfly		ST	G3	S2
Thalictrum pubescens	Tall Meadowrue		ST	G5	S2
Tragia cordata	Heart-leaved Noseburn		WL	G4	S2
Waldsteinia fragarioides	Barren Strawberry		SR	G5	S2
Woodwardia areolata	Netted Chainfern		SR	G5	S2
High Quality Natural Community					
Barrens – bedrock limestone	Limestone Glade		SG	G4	S2S3
Barrens – bedrock siltstone	Siltstone Glade		SG	G2	S2
Barrens – chert	Chert Barrens		SG	G2	S1
Forest – upland dry-mesic	Dry-mesic Upland Forest		SG	G4	S4
Forest – upland mesic	Mesic Upland Forest		SG	G3?	S3
Primary – cave aquatic	Aquatic Cave		SG	GNR	SNR
Primary – cliff limestone	Limestone Cliff		SG	GU	S1

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APPENDIX C:
MACROINVERTEBRATE DATA BY SITE NUMBER

Macroinvertebrate Data by Site Number

	SITE	1	1dpl.	2	3	4	5	6
Diptera	Ablabesmyia mallochi		2					
	Nilotanypus fimbriatus						1	
	Thienemanninyia spp.	11	4	16	12	13	2	5
	Coryoneura spp.				1			
	Cricotopus bicinctus	1	7					
	Eukiefferiella claripennis							
	Nanocladius spp.				1			
	Orthocladius obumbratus		2					
	Rheocricotopus robacki		2				1	
	Thienemanniella xena			3				
	Chironomus spp.							
	Cryptochironomus fulvus					1		
	Dicrotendipes nervosus	2	1					
	Endochironomus nigricans							
	Microtendipes caelum	3	2					
	Polypedilum convictum	6	4	4	1	2	14	5
	Paratanytarsus spp.							
	Rheotanytarsus exiguus		1	2				
	Tanytarsus guerlus		7	1		7	1	1
	Simulium sp.	3	1	1	2		1	
	Hemerodromia sp.		1					
	Antocha sp.							
	Hexatoma sp.			1	5			
	Ormosia sp.			1	1			
	Tipula sp.	4	5					
	Tabanidae				1			1
Ephemeroptera	Baetis flavistriga	7	1	9	28	19	8	16
	B. hageni	26	3	8	5		2	6
	Centroptilum sp.	3	1	1				
	Stenomena femoratum	9	1	21	6	6		
	S. pulchellum	1					1	7
	S. vicarium	1		2			1	3
	Stenonema spp.							
	Heptagenia sp.					1	1	1
	Isonychia sp.		4				2	6
	Caenis sp.	6	1	2		1		
	Chloroterpes sp.			1				
	Paraleptophlebia sp.							1

Macroinvertebrate Data by Site Number, cont.

	SITE	1	1dpl.	2	3	4	5	6
Plecoptera	Acroneuria sp.					1		4
Trichoptera	Cheumatopsyche sp.	13	41	27	6	13	47	8
	Ceratopsyche bifida							
	Hydropsyche simulans			1				
	H. betteni						2	1
	Helicopsyche borealis							1
	Chimarra obscura						6	
	Ochrotrichia sp.		1					
	Polycentropis sp.							1
Coleoptera	Stenelmis sp.	4	4		1	16	6	9
	Macronychus glabratus					1		2
	Optioservus fastiditus							
	Psephenus herricki	1	3	3	19	12	4	4
	Ectopria sp.				1			
	Hydrophilidae			1				1
	Laccobius sp.	1	1					
Hemiptera	Gerridae	1						
	Veliidae			1	1	2		1
Odonata	Argia sp.	1						
	Hetaerina sp.	7						
	Boyeria sp.							
Megaloptera	Corydalus cornutus					1	1	4
Crustacea	Lirceus sp.				4	2		
	Gammarus sp.				2	1		10
	Decapoda			1	2	2		1
Mollusca	Physidae				1			
	Pleuroceridae							1
	Valvatidae							
	Corbicula fluminea							
	Sphaeridae							
Annelida	Oligochaeta							
Platyhelminthes	Turbellaria							
Total		111	100	107	100	101	101	100

Macroinvertebrate Data by Site Number, cont.

	SITE	7	8	9	10	11	12
Diptera	Ablabesmyia mallochi						
	Nilotanypus fimbriatus						
	Thienemanninyia spp.	5	1	6	8	13	8
	Coryoneura spp.						
	Cricotopus bicinctus						1
	Eukiefferiella claripennis		1				
	Nanocladius spp.			1			
	Orthocladius obumbratus						
	Rheocricotopus robacki						
	Thienemanniella xena						
	Chironomus spp.					1	
	Cryptochironomus fulvus						
	Dicrotendipes nervosus					2	
	Endochironomus nigricans	1					
	Microtendipes caelum						
	Polypedilum convictum	13	4	6	8	27	8
	Paratanytarsus spp.		1				
	Rheotanytarsus exiguus			3			
	Tanytarsus guerlus	3		5	2	2	
	Simulium sp.		2	1			3
	Hemerodromia sp.						
	Antocha sp.		1				
	Hexatoma sp.						
	Ormosia sp.						
	Tipula sp.						
	Tabanidae				1		
Ephemeroptera	Baetis flavistriga	6	33	5	18	9	35
	B. hageni	13		10			
	Centroptilum sp.						
	Stenomena femoratum				11		
	S. pulchellum	2					1
	S. vicarium		2	2		1	1
	Stenonema spp.				1		
	Heptagenia sp.	4	3		2		4
	Isonychia sp.	4					4
	Caenis sp.	1					
	Chloroterpes sp.				1		
	Paraleptophlebia sp.						

Macroinvertebrate Data by Site Number, con't

	SITE	7	8	9	10	11	12
Plecoptera	Acroneuria sp.	6					
Trichoptera	Cheumatopsyche sp.	24	17	41	35	15	15
	Ceratopsyche bifida	1					4
	Hydropsyche simulans		1	11			
	H. betteni		16	2			
	Helicopsyche borealis		3				
	Chimarra obscura	2			2		2
	Ochrotrichia sp.					1	
	Polycentropis sp.						
Coleoptera	Stenelmis sp.	22	6	12	8	23	16
	Macronychus glabratus	1	1	1			1
	Optioservus fastiditus						
	Psephenus herricki		3	1	1		1
	Ectopria sp.						
	Hydrophilidae			1			
	Laccobius sp.						
Hemiptera	Gerridae						
	Veliidae		2				
Odonata	Argia sp.					3	
	Hetaerina sp.					1	
	Boyeria sp.						
Megaloptera	Corydalus cornutus	4	7		1		4
Crustacea	Lirceus sp.					1	
	Gammarus sp.			2			
	Decapoda	1	3	1	1		
Mollusca	Physidae					1	
	Pleuroceridae	2	1				1
	Valvatidae	1					
	Corbicula fluminea	1					
	Sphaeridae				1		
Annelida	Oligochaeta	1			1		
Platyhelminthes	Turbellaria			1			
Total		118	108	112	102	100	109

Metrics Data by Site Number

	1	1dpl.	2	3	4	5	6	7	8	9	10	11	12
Total number of taxa	21	24	21	20	18	18	25	22	20	19	17	14	17
Total number of individuals	>258	>258	>258	>258	>258	>258	>258	>258	>258	>258	>258	>258	>258
# EPT taxa	8	8	9	4	6	9	12	10	7	6	7	4	8
%orthoclads & tanytarsids	1	19	6	2	7	2	1	2	2	8	2	2	1
% non-insects	0	0	0	7	3	0	11	4	1	3	2	2	1
# Diptera taxa	7	13	8	8	4	6	4	4	6	6	4	5	4
% Intolerant	1	4	1	0	2	10	23	15	9	0	4	0	10
% Tolerant	14	12	3	7	4	1	0	2	3	1	1	8	4
% Predators	19	8	18	19	17	4	17	13	9	6	10	17	11
% Shredders & Scrapers	18	13	24	28	36	13	28	27	18	14	23	25	23
% Collector filterers	14	46	27	8	13	57	15	27	33	49	37	15	26
% Sprawlers	15	8	20	14	15	3	5	5	2	6	8	13	7

Metrics Scoring by Site Number

	1	1dpl.	2	3	4	5	6	7	8	9	10	11	12
Total number of taxa	3	3	3	1	1	1	3	3	1	1	1	1	1
Total number of individuals	5	5	5	5	5	5	5	5	5	5	5	5	5
# EPT taxa	5	5	5	5	5	5	5	3	3	3	3	1	5
%orthoclads & tanytarsids	5	5	5	5	5	5	5	5	5	5	5	5	5
% non-insects	5	5	5	5	5	5	5	5	5	5	5	5	5
# Diptera taxa	3	3	3	3	1	1	1	1	1	1	1	1	1
% Intolerant	1	1	1	1	1	1	3	1	1	1	1	1	1
% Tolerant	3	5	5	5	5	5	5	5	5	5	5	5	5
% Predators	3	1	3	3	1	1	1	1	1	1	1	1	1
% Shredders & Scrapers	3	3	5	5	5	3	5	5	3	3	5	5	5
% Collector filterers	3	1	1	5	3	1	3	1	1	1	1	3	1
% Sprawlers	1	1	1	1	1	3	3	3	5	3	1	1	1
mIBI	40	38	42	44	38	36	44	38	36	34	34	34	36

APPENDIX D:
PROFESSIONAL WATER MONITORING RESULTS

Site 1													
	4/16/11	5/24/11	6/24/11	7/18/11	8/16/11	9/22/11	10/19/11	11/8/11	12/8/11	1/6/12	2/2/12	3/8/12	# of times exceeding target
pH	7.99	7.93	7.6	7.68	7.08	7.47	8.22	8.19	7.99	9.05	7.7	8.26	1
DO	10.4	8.2	8.3	7.3	6.5	4.9	4.7	7.6	7.9	7.7	9.7	11	-
Temp	15	20	18.4	24.1	20	17.1	11.3	12.2	5.5	3	8	8.3	-
Flow	21.1	5.4	17.9	2.8	1.5	6.1	6.5	0.5	38	29	29	27	-
Cond	373	342	359	384	401	0.21	548	523	347	357	330	332	-
N	5.88	2.98	5.85	3.25	0.993	<0.05	<0.05	1.045	5.628	4.85	5.07	3.983	5
Turb	2.79	1.25	1.53	1.02	1.09	2.11	0.437	0.425	2.72	1.12	2.76	1.41	-
TSS	5	6	2	<1.0	2	1	3	2	<1.0	<1.0	1	2	-
Total P	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-
E.coli	387.9	160.7	261.3	816.4	63.1	80.9	<1.0	20.1	110.6	100.8	56.8	90.6	3
Site 2													
	4/16/11	5/24/11	6/24/11	7/18/11	8/16/11	9/22/11	10/19/11	11/8/11	12/8/11	1/6/12	2/2/12	3/8/12	
pH	7.9	7.4	7.05	7.31	6.82	7.06	7.91	7.49	6.61	8.37	6.8	6.78	-
DO	9.9	8.4	8	6.8	6.6	6.1	5.4	8.3	7.3	7.7	10	10.6	-
Temp	15	19.5	19.5	23.9	19.4	16	11	10.5	4.5	1.6	9.2	7.1	-
Flow	22.9	6.6	1.1	0.9	0.7	6.9	2.5	1.5	13	5	6.5	14	-
Cond	142.7	168.5	187.7	196.6	229.5	269.3	302	268.8	130.5	134	115.8	123.1	-
N	5.88	0.832	4.25	0.84	0.621	0.534	<0.05	0.285	2.376	2.034	1.868	1.565	2
Turb	2.79	0.0589	1.57	0.652	1.05	2.21	1.11	0.368	2.62	0.907	2.43	2.52	-
TSS	5	<1.0	<1.0	<1.0	4	5	3	<1.0	<1.0	<1.0	<1.0	4	-
Total P	<0.05	<0.05	<0.05	<0.05	0.061	<0.05	0.081	<0.05	<0.05	<0.05	<0.05	<0.05	-
E.coli	416	119.8	129.6	307.6	121.1	70.8	1203.3	48	90.8	67.7	15.6	98.7	3
Site 3													
	4/16/11	5/24/11	6/24/11	7/18/11	8/16/11	9/22/11	10/19/11	11/8/11	12/8/11	1/6/12	2/2/12	3/8/12	
pH	6.88	8.15	8.23	8.12	7.27	7.61	8.35	8.52	9.05	9.75	8.27	8.76	2
DO	11	7.6	9.9	7.5	5.5	3.9	4	8.3	9	7.2	11	11	-
Temp	21	25.3	19.8	26.7	21.5	17.6	11.5	14.6	8.7	7.2	12.4	14	-
Flow	6.6	0.5	0.3	0.8	Stagnant	Stagnant	0	0.2	10	9	29	20	-
Cond	428	434	511	493	477	482	629	808	560	469	467	385	-
N	5.88	1.54	2.67	0.573	0.279	0.07	<0.05	1.319	3.584	3.014	2.41	2.786	1
Turb	2.79	1.82	2.78	2.26	3.61	1.1	0.842	0.63	2.94	1.85	22.6	3.02	-
TSS	5	3	2	3	6	3	1	<1.0	13	<1.0	11	3	-
Total P	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-

E.coli	387.9	88.4	501.2	648.8	61.3	387.3	770.1	75.4	298.7	160.7	29.2	141.4	6
Site 4													
	4/16/11	5/24/11	6/24/11	7/18/11	8/16/11	9/22/11	10/19/11	11/8/11	12/8/11	1/6/12	2/2/12	3/8/12	
pH	6.08	7.87	7.64	7.64	7.09	7.35	8.09	8.73	8.89	9.34	8.66	8.52	1
DO	11	8	8	5.9	3.1	3.1	1	7.1	10	9.2	11	11	-
Temp	21	23	20.6	25	21.9	18.5	12	15.9	9.3	6	11.1	13	-
Flow	20.4	3.2	2.3	0.9	Stagnant	Stagnant	0	0	20	9	10.5	10.5	-
Cond	451	461	554	592	477	841	811	691	451	539	405	439	-
N	2.27	1.1	4.71	0.463	0.279	0.748	<0.05	<0.05	4.031	2.774	2.846	2.09	2
Turb	1.33	1.13	2.82	2	3.61	0.876	0.467	0.741	3.81	1.18	2.77	3.45	-
TSS	2	2	1	3	6	<1.0	<1.0	5	4	<1.0	<1.0	6	-
Total P	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-
E.coli	137.4	55.4	135.4	344.1	24.3	1413.6	10.9	59.1	435.2	30.1	488.4	33.6	4
Site 5													
	4/16/11	5/24/11	6/24/11	7/18/11	8/16/11	9/22/11	10/19/11	11/8/11	12/8/11	1/6/12	2/2/12	3/8/12	
pH	6.04	7.81	7.72	7.88	7.4	7.48	8.33	8.77	8.76	8.2	7.63	8.02	-
DO	9.2	7.6	7.7	7.4	6.9	5	4.5	8.7	11	8.3	9.1	9.5	-
Temp	18	25	22.1	25	25	20.1	13	15.6	7.1	3.6	10.4	11.8	-
Flow	130.2	42.9	47.2	18.2	1.4	20.4	12	99	35	22	65	60	-
Cond	273.1	280.1	323	320	350	409	410	361	282.5	267.7	240.7	248.2	-
N	2.22	1.69	4.22	1.04	0.173	0.108	<0.05	0.172	3.481	2.734	2.574	2.308	1
Turb	4.07	1.51	3.66	2.97	4.79	7.73	4.09	1.6	3.22	1.23	2.88	4.34	-
TSS	5	2	8	2	4	8	5	3	1	1	<1.0	6	-
Total P	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-
E.coli	64.4	40.8	248.9	579.4	<1.0	19.7	31.3	17.5	209.8	17.1	39.3	22.6	2
Site 6													
	4/16/11	5/24/11	6/24/11	7/18/11	8/16/11	9/22/11	10/19/11	11/8/11	12/8/11	1/6/12	2/2/12	3/8/12	
pH	5.57	8.03	7.7	7.81	7.12	7.63	8.39	8.6	8.7	8.31	8.23	8.15	-
DO	10.8	9.4	8.8	8.8	9.5	8.1	7.6	11	9.8	9	11	10.9	-
Temp	19	22.6	18.6	22.8	19.6	18.3	11.5	12.6	7.9	7.9	9.5	12	-
Flow	117	207.4	88.7	13.5	5.1	25.3	26	18.5	65	33	150	110	-
Cond	462	442	480	488	522	528	604	600	436	480	426	391	-
N	4.08	3.93	7.86	4.59	3.27	3.136	2.222	2.808	4.735	6.732	4.877	5.248	6
Turb	2.43	1.76	3.48	2.41	2.52	2.12	1.21	1.09	5.82	3.88	4.44	11.3	-
TSS	2	3	4	<1.0	1	<1.0	2	<1.0	3	3	2	7	-
Total P	<0.05	0.065	0.056	<0.05	0.055	0.052	0.053	<0.05	0.066	<0.05	<0.05	0.05	-
E.coli	344.8	146.7	816.4	980.4	1046.2	248.1	95.9	143.9	816.4	115.3	86.5	51.2	6

Site 7													
	4/16/11	5/24/11	6/24/11	7/18/11	8/16/11	9/22/11	10/19/11	11/8/11	12/8/11	1/6/12	2/2/12	3/8/12	
pH	5.99	8.3	8.01	8.15	7.72	7.95	8.46	8.48	8.75	9.28	8.05	8.13	1
DO	11	9.2	7.5	8	8.7	7.7	5.8	11	9.6	8.4	10.3	9.5	-
Temp	21	22.8	21.5	27.7	24.5	19.3	11.7	16.6	8	4.2	11.7	11.6	-
Flow	748	185	230	60	6.3	23	13	32	1020	252	538	638	-
Cond	405	400	429	426	472	484	557	541	407	424	382	344	-
N	3.33	2.59	6.28	3.12	1.359	0.745	0.224	0.69	4.311	4.16	3.874	3.079	3
Turb	5.79	2.68	7.67	5.64	4.63	3.6	1.34	1.33	6.12	2.81	7.59	7.43	-
TSS	2	2	8	9	5	1	1	2	14	2	3	13	-
Total P	<0.05	<0.05	0.056	<0.05	<0.05	<0.05	<0.05	<0.05	0.067	<0.05	<0.05	<0.05	-
E.coli	186	83.6	285.1	436.6	81.6	148.3	307.6	67.6	435.2	86.7	61.3	150	4
Site 8													
	4/16/11	5/24/11	6/24/11	7/18/11	8/16/11	9/22/11	10/19/11	11/8/11	12/8/11	1/6/12	2/2/12	3/8/12	
pH	6.59	8.5	7.97	8.21	7.74	7.85	8.62	8.82	8.68	9.44	8.16	8.45	1
DO	11	9.4	8.6	7.3	8	7.3	8.1	10.3	10.2	7.1	11	10.8	-
Temp	18	21	18.2	24.5	21.6	17.7	10.9	13.1	8	5.4	9.2	11.5	-
Flow	52	25.4	28.8	6	4.1	5.4	20	20	40	30	30	29	-
Cond	460	469	485	515	513	527	592	627	460	472	432	403	-
N	4.17	3.66	7.36	3.48	2.739	1.237	0.731	2.676	4.634	5.038	4.496	3.668	5
Turb	1	1.4	3.11	2.85	2.5	1.78	1.53	0.701	5.62	2.14	2.98	2.08	-
TSS	2.19	2	1	3	6	2	<1.0	2	5	<1.0	<1.0	4	-
Total P	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-
E.coli	189.2	436	1046.2	648.8	<1.0	261.3	133.3	98.8	290.9	191.8	79.4	81.3	2
Site 9													
	4/16/11	5/24/11	6/24/11	7/18/11	8/16/11	9/22/11	10/19/11	11/8/11	12/8/11	1/6/12	2/2/12	3/8/12	
pH	8.02	7.71	7.88	8.14	7.26	7.69	8.24	8.18	8.43	9.22	7.93	8.47	1
DO	11	11	8	8.4	7	6.6	5.7	6	9.3	9.5	11	9.8	-
Temp	16	19	18.6	23.3	24.2	16.9	12	15.3	8.5	5	8.7	10.2	-
Flow	22.4	22.5	15.3	2.7	1.6	4.2	18	22	24	16	24	25	-
Cond	489	511	511	549	659	696	758	720	484	508	449	419	-
N	2	1.67	4.26	1.89	1.413	1.082	0.372	0.792	2.946	2.258	4.319	1.7	1
Turb	4.23	1.94	5.09	2.43	2.47	1.94	4.97	3.5	4.4	1.85	2.8	1.86	-
TSS	4	3	1	4	1	<1.0	5	3	13	1	2	4	-
Total P	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-
E.coli	192.4	260.3	517.2	2419.6	365.4	648.8	228.2	66.3	387.3	105.6	866.4	102.2	7
Site 10													

	4/16/11	5/24/11	6/24/11	7/18/11	8/16/11	9/22/11	10/19/11	11/8/11	12/8/11	1/6/12	2/2/12	3/8/12	
pH	7.38	7.72	7.85	7.95	7.16	7.44	8.18	8.03	8.33	9.24	7.62	8.26	1
DO	11	6.7	7.8	6.9	5.9	5.3	4	11	6.9	8.1	9.8	11	-
Temp	17	20	19.1	24.3	20.3	17.5	11	12.2	5.8	1.8	7.8	8.6	-
Flow	43	9.7	37	6.1	1.9	9	2.2	1.2	23	1.3	31	36	-
Cond	392	369	390	394	456	557	539	559	392	387	356	348	-
N	4.56	2.94	6.64	3.2	0.513	0.108	<0.05	0.212	5.618	4.878	4.54	3.771	4
Turb	1.34	0.784	2.18	3.03	2.21	1.53	2.36	1.89	2.75	0.984	1.93	1.69	-
TSS	1	<1.0	3	1	6	1	5	6	13	<1.0	<1.0	3	-
Total P	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.059	<0.05	<0.05	<0.05	<0.05	<0.05	-
E.coli	357.8	416	727	2419.6	980.4	224.7	435.2	60.2	204.6	111.9	93.2	108.6	6
Site 11													
	4/16/11	5/24/11	6/24/11	7/18/11	8/16/11	9/22/11	10/19/11	11/8/11	12/8/11	1/6/12	2/2/12	3/8/12	
pH	8.41	7.68	7.78	7.87	7.2	7.52	8.2	8.38	8.4	8.9	9.5	8.08	1
DO	9.3	7.4	8.6	11	6.7	7.3	6.3	7.6	9.3	7.7	10.8	10.8	-
Temp	17	21	19.5	25.6	23	20.5	14.3	14.1	7	5.8	7.7	9.7	-
Flow	76.3	42.1	48.6	5.7	3.2	6.6	11	4.5	50	35	40	35	-
Cond	586	474	436	535	588	620	635	654	486	579	515	440	-
N	3.21	4.05	6.44	4.14	4.23	<0.05	8.036	4.016	5.87	4.376	6.789	4.942	9
Turb	5.67	1.37	2.37	2.26	2.78	6.5	4.24	1.51	2.67	2.32	5.84	2.05	-
TSS	8	2	3	4	4	10	9	2	5	2	9	5	-
Total P	0.485	0.079	0.143	0.25	0.43	0.704	1.04	0.297	0.078	0.249	0.119	0.08	4
E.coli	913.9	501.2	613.1	613.1	365.4	248.1	517.2	2419.6	2419.6	312.3	2420	2420	12
Site 12													
	4/16/11	5/24/11	6/24/11	7/18/11	8/16/11	9/22/11	10/19/11	11/8/11	12/8/11	1/6/12	2/2/12	3/8/12	
pH	7.73	8.29	7.95	8.16	7.67	7.92	8.44	9.3	8.91	8.64	8.02	8.1	1
DO	9.9	9.1	7.8	5.9	7.63	6.9	5.8	11	11	5.8	10.5	10.2	-
Temp	20	23.4	22.3	26.9	22.9	18.6	11.6	13.4	8.5	5.2	11.1	12.2	-
Flow	427	170	285.7	46.7	3.2	62.5	60	40	480	125	350	340	-
Cond	404	415	430	452	470	535	599	523	408	427	374	336	-
N	3.51	2.81	5.36	3.63	1.65	1.384	0.724	0.928	4.424	4.26	3.947	3.164	3
Turb	5.44	2.62	8.1	2.58	5.09	4.05	1.53	1.38	5.75	2.75	6	5.35	-
TSS	2	2	12	2	7	2	4	2	2	1	4	12	-
Total P	0.05	<0.05	0.059	<0.05	0.056	<0.05	<0.05	<0.05	0.056	<0.05	<0.05	<0.05	-
E.coli	344.8	139.6	365.4	169.8	68.9	93.3	78.9	18.7	410.6	307.6	113	238.2	5

APPENDIX E:
VOLUNTEER WATER MONITORING RESULTS

Volunteer	Apr-11	May-11	June-11	July-11	Aug-11	Sept-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12
pH	6	8.8	6.5	8.2	8.7	8.4	8.8	8	6.5	8	7	7.5
DO	8	12	8	6	9	8	6	7	7	9	10	12
Temp	10.3	17	18	24.2	27	12.4	12.7	11.2	6.2	3.3	5.6	14.4
Flow	59.5	17.22	51.58	-	280.8	20.3	20.3	735.08	232.41	14.86	8.26	188.43
N	0	0	4	13.2	0	0.2	0.25	0	7	10	2.5	10
Turb	12.2	2.5	10.5	12	3.4	12	30	5	0	7	12	40
Total P	0	0	0.3	0.1	0	0	0	0.1	0	0	0	0
E.coli	499.5	366.67	-	298	312	1194	527	-	-	14	312	10
BOD	0	1	-	0	1	-	-	-	-	0	-	-

Volunteer	Apr-12	May-12	June-12	July-12	Aug-12	Sept-12	Oct-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13
pH	6.5	7	6.6	8.1	8.7	8.4	8.8	8.3	6.5	8.8	5	5
DO	9	7	6	6	9	8	6	7	7	10	5	10
Temp	14.7	13	22	26	27	12.4	12.7	7	6.2	2.6	3	3.2
Flow	188.4	9.11	-	-	280.8	20.3	20.3	13.49	23.4	28.55	28.63	28
N	2	3.5	0	.25	0	0.2	0.25	0	7	2	0	0.5
Turb	97	11.6	5	19	3.4	12	30	23.9	0	9	60	9
Total P	0	0	0	0	0	0	0	0	0	0	0	0
E.coli	-	142.2	125	50	312	1194	527	4	-	-	-	-
BOD	-	0	-	1	1	-	-	-	-	-	-	-

Volunteer	Apr-13	May-13	June-13	July-13
pH	6	6	7	-
DO	8	8	6	-
Temp	6.5	14.6	18.8	-
Flow	1.215	3.68	-	-
N	0	0	0	-
Turb	60	13	15	-
Tota l P	0	0	0	-
E.coli	-	22.5	85.8	-
BOD	-	0	1	-

*Note – Cells with the dash (-) did not receive the data on that specific parameter or Brock Creek was dried up and volunteers could not complete water monitoring.

APPENDIX F: VOLUNTEER BIOLOGICAL MONITORING ON BROCK CREEK USING THE POLLUTION TOLERANCE INDEX (PTI)

DATE	GROUP 1 Intolerant	GROUP 2 Moderately Intolerant	GROUP 3 Fairly Intolerant	GROUP 4 Very Intolerant	PTI RATING
June 2011	28	6	4	2	**40**
Oct 2011	4	9	0	1	**14**
Nov 2011	8	12	2	1	**23**
Mar 2012	16	12	2	1	**31**
Apr 2012	20	9	4	1	**34**
July 2012	20	6	6	2	**34**
Nov 2012	12	12	2	0	**26**
Jan 2013	4	3	0	0	**7**
Apr 2013	8	3	2	1	**14**
May 2013	20	3	0	1	**24**
AVERAGE	**14**	**7.5**	**2.2**	**1**	**24.7**

PTI RATINGS:
Excellent: 23 or more
Good: 17-22
Fair: 11-16
Bad: 10 or Less

*Biological monitoring was completed with volunteers on Brock Creek throughout the year, but the recommended timeframe to test is July-Oct.

APPENDIX G:
MILL CREEK-BLUE RIVER WINDSHIELD SURVEY FIELD SHEET

MCBR Watershed Windshield Survey Field Sheet

Watershed Mill Creek-Blue River (MCBR) Site ID ____________

Date ____________ Location/GPS Coordinates ____________

Time ____________ Field Investigator(s) ____________

Weather (past 24 hours)
- ☐ Rain
  - ☐ Heavy
  - ☐ Steady
  - ☐ Intermittent
- ☐ Overcast
- ☐ Partly cloudy
- ☐ Clear

Weather (now)
- ☐ Rain
  - ☐ Heavy
  - ☐ Steady
  - ☐ Intermittent
- ☐ Overcast
- ☐ Partly cloudy
- ☐ Clear

Wildlife noted

Water Odors
check all that apply
- ☐ Normal
- ☐ Sewage
- ☐ Petroleum
- ☐ Chemical
- ☐ Other ____________

Water Color/Appearance
check all that apply
- ☐ Clear
- ☐ Green
- ☐ Brown
- ☐ Murky
- ☐ Oily Sheen
- ☐ Other ____________

Algae
check all that apply
- ☐ Floating
- ☐ Attached to Substrate
- ☐ Thick mats
- ☐ Limited growth
- ☐ Moderate growth
- ☐ Excessive growth

Stream Buffer
- ☐ Present
- ☐ Absent

Buffer Type
check all that apply
- ☐ Trees
- ☐ Shrubs
- ☐ Grasses
- ☐ Other ____________

Stream Buffer
- ☐ Natural
- ☐ Installed
- ☐ Unknown

Estimated Width of Buffer
____________ feet

Landuse adjacent to Buffer ____________

Land Use - *Check land uses that best apply*

- ☐ Residential
  - ☐ Single Family
  - ☐ Multi-family
  - ☐ Stormdrain marking present
  - ☐ Stormwater management practices
    - ☐ curb and gutter
    - ☐ retention basins
    - ☐ naturalized drainage systems
- ☐ Industrial
- ☐ Commercial (Strip malls, restaurants, etc)
- ☐ Forestry
- ☐ Mining

- ☐ Agricultural
  - ☐ Row Crop
  - ☐ Pasture
    - ☐ Stream access
    - ☐ Fenced from stream
  - ☐ Feedlot
    - ☐ Cattle (dairy)
    - ☐ Cattle (other)
    - ☐ Hogs
    - ☐ Oth ____________
    - Estimated size of operation ________
  - ☐ Tillage type
    - ☐ no-till
    - ☐ reduced till
    - ☐ conventional

APPENDIX H:
BEST MANAGEMENT PRACTICE DEFINITION AND GLOSSARY

Composting Facility – A facility located on the farm for the treatment or disposal of livestock and poultry carcasses. Animals must currently exist on the property (NRCS Code 317).

Cover Crop – Grasses, legumes, forbs, or other herbaceous plants established for seasonal cover and conservational purposes (NRCS Code 340).

Critical Area Planting – To stabilize the soil, reduce damages from sediment and runoff to downstream areas, and improve wildlife habitat and visual resources (NRCS Code 342).

Drainage Water Management – The process of managing water discharges from surface and/or subsurface agricultural drainage systems. The purpose of this practice is to reduce nutrient, pathogen, and/or pesticide loading from drainage systems into downstream receiving waters, Improve productivity, health, and vigor of plants, reduce oxidation of organic matter in soils, reduce wind erosion or particulate matter (dust) emissions and provide seasonal wildlife habitat (NRCS Code 554).

Fence – A constructed barrier to keep people and animals from entering the water body (NRCS Code 382).

Filter Strip – A strip or area of herbaceous vegetation situated between cropland, grazing land, or disturbed land (including forest land) and environmentally sensitive areas (NRCS Code 393).

Grade Stabilization – In areas where the concentration and flow velocity of runoff is sufficiently high, an engineered structure such as a rock chute or block chute is required to control the grade and head-cutting of natural or artificial channels, thereby preventing the advancement or formation of gullies. As with certain other practices, installation of these structures can result in a directed discharge of waterborne pollutants into receiving streams. For this reason, their construction should be accompanied by installation of appropriately designed filter strips which can trap sediment, nutrients, and pesticides upstream from the structure. These filter strips must be sized to allow for conformance with regulations pertaining to application setback for specific pesticides used in their vicinity (NRCS Code 410).

Grassed Waterway – A constructed shallow channel that is shaped and vegetated to provide for stable conveyance or runoff (NRCS Code 412).

Heavy Use Area Protection –To stabilize facility areas frequently and intensely used by people, animals, or vehicles (NRCS Code 561).

Lined Waterway – A waterway or outlet having an erosion-resistant lining of concrete, stone, synthetic turf, reinforcement fabrics, or other permanent material. This practice may be applied as part of a resource management system to support one or more of the following purposes: Provide for safe conveyance of runoff from conservation structures or other water concentrations without causing erosion or flooding, stabilize existing and prevent future gully erosion, or protect and improve water quality (NRCS Code 468).

Mulching – Applying plant residues or other suitable materials produced off site, to the land surface. This practice is used to conserve soil moisture, moderate soil temperature, provide erosion control, suppress weed growth, facilitate the establishment of vegetative cover, improve soil condition and/or reduce airborne particulates (NRCS Code 484).

No-Till – Assistance with the expenses of no-till practices, such as chaff spreader on combine, no-till coulter, row cleaners, split nitrogen applications, variable rate phosphorus, potassium and lime application (NRCS Code 329).

Nutrient Management – Managing the amount, source, placement, form and timing of the application of nutrients and soil amendments. Cost share includes implementation of the plan (NRCS Code 590).

Pipeline – To convey water from a source of supply to points of use for livestock, wildlife, or recreation (NRCS Code 516).

Pumping Plant – A facility that delivers water at a designed pressure and flow rate. Includes the required pump(s), associated power unit(s), plumbing, appurtenances, and may include on-site fuel or energy source(s), and protective structures. This practice may be applied as a part of a resource management system to achieve one or more of the following: delivery of water for irrigation, watering facilities, wetlands, or fire protection, removal of excessive subsurface or surface water, provide efficient use of water on irrigated land, transfer of animal waste as part of a manure transfer system, improvement of energy use efficiency or improvement of air quality (NRCS Code 533).

Residue Management - Managing the amount, orientation and distribution of crop and other plant residues on the soil surface year-round, while growing crops in narrow slots, or tilled or residue free strips in soil previously untilled by full-width inversion implements (NRCS Code 329).

Riparian Buffer – Establishment or management of grasses and forbs, tolerant of intermittent flooding or saturated soils, in the transitional zone between terrestrial and aquatic habitats (NRCD Code 390).

Roof Runoff Structure – Structures that collect, control, and transport precipitation from roofs (NRCS Code 558).

Spring Development – Collection of water from springs or seeps to provide water for a conservation need. Used to improve the quantity and/or quality of water for livestock, wildlife or other agricultural uses (NRCS Code 574).

Stream Crossing – A trail or travel way constructed across a stream to allow livestock, equipment, or vehicles to cross with minimal disturbance to the stream ecosystem. This practice is used in conjunction with fencing (NRCS Code 578).

Stream Channel Stabilization – Stabilizing the channel of a stream with suitable structures. This practice is used to control aggradation or degradation in a stream channel (NRCS Code 584).

Subsurface Drainage – A conduit, such as corrugated plastic tubing, tile, or pipe, installed beneath the ground surface to collect and/or convey drainage water (NRCS Code 606).

Tree Planting – The establishment of a stand of trees to help to control erosion, conserve soil, and retain moisture. This can aid in flood reduction, sedimentation control, and wildlife habitat improvement. Water quality benefits can derived from plantings adjacent to streams which provide shade and act as a food source, and reduce streambank erosion. Mature trees can also serve as barriers to erosion-causing winds. Professional assistance regarding species selection and planting regimes can be solicited from IDNR district foresters or private consulting foresters, and is encouraged (NRCS Code 612).

Waste Storage Facility – Temporary storage of liquid or solid wastes as part of a pollution control system to conserve nutrients and protect the environment. A comprehensive nutrient management plan must be completed before commencing construction. A waste storage facility cannot be constructed for a new facility (NRCS Code 313).

Watering Facility - A permanent or portable device to provide an adequate amount and quality of drinking water for livestock and/or wildlife. This practice is used to provide access to drinking water for livestock and/or wildlife in order to meet daily water requirements and improve animal distribution (NRCS Code 614).

APPENDIX I:
LOADEST LOADS FOR TSS, NITRATE/NITRITE, AND PHOSPHORUS

LOADEST
BLUE RIVER SITE 7 N 4ML

Constituent Output File Part Ia: Calibration (Load Regression)

Number of Observations : 12
Number of Uncensored Observations: 12
"center" of Decimal Time : 2011.738
"center" of Ln(Q) : 4.2398
Period of record : 2011-2012

Model Evaluation Criteria Based on AMLE Results

Model #	AIC	SPPC
1	2.055	-12.815
2	1.273	-8.365
3	2.220	-14.045
4	2.261	-14.535
5	1.449	-9.666
6	1.145	-8.083
7	2.341	-15.260
8	1.350	-9.554
9	1.442	-10.346

Model # 6 selected

Selected Model:

Ln(Load) = a0 + a1 LnQ + a2 LnQ^2 + a3 Sin(2 pi dtime) + a4 Cos(2 pi dtime)

where:
Load = constituent load [kg/d]
LnQ = Ln(Q) - center of Ln(Q)
dtime = decimal time - center of decimal time

Model Coefficients

	a0	a1	a2	a3	a4
AMLE	6.5532	1.7750	-0.3797	-0.1685	0.6497
MLE	6.5532	1.7750	-0.3797	-0.1685	0.6497
LAD	6.5014	1.7999	-0.3529	-0.1890	0.5900

AMLE Regression Statistics

R-Squared [%] : 98.66
Prob. Plot Corr. Coeff. (PPCC) : 0.9461
Serial Correlation of Residuals: -.2485

Coeff.	Std.Dev.	t-ratio	P Value
a0	0.2032	32.25	9.032E-15
a1	0.1413	12.57	7.398E-10
a2	0.0859	-4.42	6.362E-05
a3	0.1504	-1.12	1.593E-01

a4	0.3109	2.09	1.586E-02

Correlation Between Explanatory Variables

Explanatory variable corresponding to:

	a1	a2	a3
a2	0.0000		
a3	0.1495	0.3326	
a4	-0.8440	0.2467	0.0161

Additional Regression Statistics

	Residual Variance	Turnbull-Weiss Stat	DF	PL
AMLE	0.121	3.59	1	5.811E-02
MLE	0.121	3.59	1	5.811E-02

Constituent Output File Part Ib: Calibration (Concentration Regression)

AMLE Regression Statistics

Model # 6 was selected for the load regression (PART Ia) and is used here:

Ln(Conc) = a0 + a1 LnQ + a2 LnQ^2 + a3 Sin(2 pi dtime) + a4 Cos(2 pi dtime)

where:
Conc = constituent concentration
LnQ = Ln(Q) - center of Ln(Q)
dtime = decimal time - center of decimal time

Concentration Regression Results

R-Squared [%] : 92.01
Residual Variance : 0.1213

Coeff.	Value	Std.Dev.	t-ratio	P Value
a0	1.4187	0.2032	6.98	6.036E-07
a1	0.7750	0.1413	5.49	7.691E-06
a2	-0.3797	0.0859	-4.42	6.362E-05
a3	-0.1685	0.1504	-1.12	1.593E-01
a4	0.6497	0.3109	2.09	1.586E-02

Constituent Output File Part IIa: Estimation (test for extrapolation)

Load Estimates for 20110416-20120308

Streamflow Summary Statistics [cfs]

Data	Mean	Minimum	10th Pct	25th Pct	Median	75th Pct	90th Pct	Maximum
Cal.	180.	9.	10.	16.	126.	317.	552.	600.
Est.	338.	5.	8.	15.	94.	316.	735.	6225.

WARNING: The maximum estimation data set steamflow exceeds the maximum calibration data set streamflow. Load estimates require extrapolation.

Maximum Estimation Streamflow : 6.2250E+03
Maximum Calibration Streamflow: 6.0000E+02

Constituent Output File Part IIb: Estimation (Load Estimates)

Load Estimates for 20110416-20120308

Load Estimates [LBS/DAY]

AMLE Load Estimates

	N	Mean Load	95% Conf.Intervals Lower	Upper	Std Error Prediction	Standard Error
Est. Period	328	3527.	2227.	5318.	793.	786.
Season 1	54	5090.	2376.	9605.	1873.	1853.
Season 2	92	2396.	1349.	3947.	668.	647.
Season 3	91	1436.	641.	2792.	558.	541.
Season 4	91	5836.	3547.	9067.	1418.	1394.
Apr. 2011	15	4706.	1081.	13522.	3377.	3340.
May 2011	31	5175.	2944.	8461.	1419.	1370.
June 2011	30	5012.	2571.	8848.	1621.	1554.
July 2011	31	2155.	1201.	3577.	612.	567.
Aug. 2011	31	105.02	67.04	156.95	23.06	19.86
Sep. 2011	30	293.26	107.33	649.03	142.04	126.12
Oct. 2011	31	43.11	27.71	64.07	9.32	7.85
Nov. 2011	30	4017.	1754.	7934.	1606.	1551.
Dec. 2011	31	9465.	4890.	16622.	3028.	2961.
Jan. 2012	31	5643.	3466.	8694.	1342.	1285.
Feb. 2012	29	2162.	1319.	3349.	521.	489.
Mar. 2012	8	5480.	2790.	9724.	1790.	1647.

MLE Load Estimates

	N	Mean Load	Standard Error
Est. Period	328	3529.	783.
Season 1	54	5097.	1833.
Season 2	92	2396.	647.
Season 3	91	1436.	540.
Season 4	91	5838.	1393.
Apr. 2011	15	4721.	3278.
May 2011	31	5180.	1359.

June 2011	30	5013.	1554.
July 2011	31	2155.	567.
Aug. 2011	31	105.03	19.77
Sep. 2011	30	293.28	126.08
Oct. 2011	31	43.11	7.82
Nov. 2011	30	4019.	1548.
Dec. 2011	31	9469.	2958.
Jan. 2012	31	5644.	1284.
Feb. 2012	29	2162.	489.
Mar. 2012	8	5481.	1646.

LAD Load Estimates

	N	Mean Load	Standard Error
Est. Period	328	4043.	1900.
Season 1	54	6440.	2021.
Season 2	92	2637.	970.
Season 3	91	1588.	1231.
Season 4	91	6498.	3539.
Apr. 2011	15	7098.	4501.
May 2011	31	6075.	914.
June 2011	30	5768.	2452.
July 2011	31	2147.	528.
Aug. 2011	31	97.48	12.36
Sep. 2011	30	278.17	165.44
Oct. 2011	31	39.21	10.27
Nov. 2011	30	4499.	3561.
Dec. 2011	31	10572.	8468.
Jan. 2012	31	6388.	3811.
Feb. 2012	29	2260.	2059.
Mar. 2012	8	6618.	2472.

Summary Statistics - Estimated Loads [LBS/DAY]

	Min.	25th Pct	Med.	75th Pct	90th Pct	95th Pct	99th Pct	Max.
AMLE	2.	71.	1804.	6400.	9535.	11426.	13408.	14925.
MLE	2.	71.	1805.	6401.	9535.	11430.	13408.	14925.
LAD	2.	66.	2142.	7444.	10406.	12818.	17199.	17826.

Summary Statistics - Estimated Concentrations [MG/L]

	Min.	25th Pct	Med.	75th Pct	90th Pct	95th Pct	99th Pct	Max.
AMLE	0.009	0.678	2.495	4.335	6.086	7.070	8.051	9.220
MLE	0.010	0.678	2.495	4.335	6.086	7.070	8.051	9.220
LAD	0.075	0.704	2.595	4.382	6.052	7.122	8.156	8.861

LOADEST
BLUE RIVER SITE 7 TSS 25ML

Constituent Output File Part Ia: Calibration (Load Regression)

Number of Observations : 12
Number of Uncensored Observations: 12
"center" of Decimal Time : 2011.738
"center" of Ln(Q) : 4.2398
Period of record : 2011-2012

Model Evaluation Criteria Based on AMLE Results

Model #	AIC	SPPC
1	2.725	-16.837
2	2.897	-18.112
3	2.885	-18.037
4	2.936	-18.588
5	3.065	-19.361
6	3.098	-19.798
7	2.284	-14.919
8	2.522	-16.585
9	2.746	-18.172

Model # 7 selected

Selected Model:

Ln(Load) = a0 + a1 LnQ + a2 Sin(2 pi dtime) + a3 Cos(2 pi dtime) + a4 dtime

where:
Load = constituent load [kg/d]
LnQ = Ln(Q) - center of Ln(Q)
dtime = decimal time - center of decimal time

Model Coefficients

	a0	a1	a2	a3	a4
AMLE	6.2235	1.7876	-1.5133	1.1001	3.5946
MLE	6.2235	1.7876	-1.5133	1.1001	3.5946
LAD	6.2474	1.9403	-1.6419	1.3232	3.1661

AMLE Regression Statistics

R-Squared [%] : 94.81
Prob. Plot Corr. Coeff. (PPCC) : 0.9789
Serial Correlation of Residuals: -.0481

Coeff.	Std.Dev.	t-ratio	P Value
a0	0.1877	33.15	6.469E-15
a1	0.2422	7.38	3.294E-07
a2	0.4533	-3.34	7.229E-04
a3	0.5139	2.14	1.396E-02
a4	1.1548	3.11	1.242E-03

Correlation Between Explanatory Variables

Explanatory variable corresponding to:

	a1	a2	a3
a2	0.1495		
a3	-0.8440	0.0161	
a4	0.0664	0.8145	-0.0032

Additional Regression Statistics

	Residual Variance	Turnbull-Weiss Stat	DF	PL
AMLE	0.379	1.36	1	2.437E-01
MLE	0.379	1.36	1	2.437E-01

Constituent Output File Part Ib: Calibration (Concentration Regression)

AMLE Regression Statistics

Model # 7 was selected for the load regression (PART Ia) and is used here:

Ln(Conc) = a0 + a1 LnQ + a2 Sin(pi dtime) + a3 Cos(2 pi dtime) + a4 dtime

where:
Conc = constituent concentration
LnQ = Ln(Q) - center of Ln(Q)
dtime = decimal time - center of decimal time

Concentration Regression Results

R-Squared [%] : 72.82
Residual Variance : 0.3790

Coeff.	Value	Std.Dev.	t-ratio	P Value
a0	1.0890	0.1877	5.80	4.334E-06
a1	0.7876	0.2422	3.25	8.894E-04
a2	-1.5133	0.4533	-3.34	7.229E-04
a3	1.1001	0.5139	2.14	1.396E-02
a4	3.5946	1.1548	3.11	1.242E-03

Constituent Output File Part IIa: Estimation (test for extrapolation)

Load Estimates for 20110416-20120308

Streamflow Summary Statistics [cfs]

Data	Mean	Minimum	10th Pct	25th Pct	Median	75th Pct	90th Pct	Maximum

Cal.	180.	9.	10.	16.	126.	317.	552.	600.
Est.	338.	5.	8.	15.	94.	316.	735.	6225.

WARNING: The maximum estimation data set steamflow exceeds the maximum calibration data set streamflow. Load estimates require extrapolation.

Maximum Estimation Streamflow : 6.2250E+03
Maximum Calibration Streamflow: 6.0000E+02

Constituent Output File Part IIb: Estimation (Load Estimates)

Load Estimates for 20110416-20120308

Load Estimates [LBS/DAY]

AMLE Load Estimates

	N	Mean Load	95% Conf.Intervals Lower	Upper	Std Error Prediction	Standard Error
Est. Period	328	26399.	3347.	98788.	27786.	27554.
Season 1	54	63045.	10812.	208078.	55203.	53467.
Season 2	92	11664.	1755.	40732.	11084.	10658.
Season 3	91	7802.	468.	37342.	12298.	11921.
Season 4	91	38146.	2750.	173182.	54686.	53937.
Apr. 2011	15	92526.	13173.	330601.	90929.	86477.
May 2011	31	47695.	5748.	181990.	51693.	48274.
June 2011	30	31297.	4112.	115492.	32261.	30893.
July 2011	31	3982.	1326.	9334.	2112.	1932.
Aug. 2011	31	345.99	150.63	684.59	138.77	126.42
Sep. 2011	30	457.	129.	1181.	281.	233.
Oct. 2011	31	100.78	44.99	196.05	39.21	36.14
Nov. 2011	30	23106.	1333.	111752.	37142.	35994.
Dec. 2011	31	74379.	2921.	395148.	144862.	142700.
Jan. 2012	31	32712.	8487.	88242.	21419.	19571.
Feb. 2012	29	5222.	1434.	13660.	3268.	2514.
Mar. 2012	8	67249.	14237.	201232.	51154.	43890.

MLE Load Estimates

	N	Mean Load	Standard Error
Est. Period	328	26448.	27396.
Season 1	54	63065.	53429.
Season 2	92	11670.	10650.
Season 3	91	7823.	11831.
Season 4	91	38286.	53367.
Apr. 2011	15	92545.	86436.
May 2011	31	47719.	48211.
June 2011	30	31312.	30861.
July 2011	31	3984.	1922.
Aug. 2011	31	346.30	124.27
Sep. 2011	30	457.35	232.24
Oct. 2011	31	100.87	35.48

Nov. 2011	30	23168.	35718.
Dec. 2011	31	74780.	140700.
Jan. 2012	31	32722.	19543.
Feb. 2012	29	5224.	2503.
Mar. 2012	8	67258.	43858.

LAD Load Estimates

	N	Mean Load	Standard Error
Est. Period	328	51482.	41100.
Season 1	54	130165.	113307.
Season 2	92	23579.	18023.
Season 3	91	15115.	14282.
Season 4	91	69367.	64388.
Apr. 2011	15	202897.	192570.
May 2011	31	110918.	99509.
June 2011	30	66045.	52277.
July 2011	31	5692.	3012.
Aug. 2011	31	370.12	172.68
Sep. 2011	30	558.85	434.40
Oct. 2011	31	85.72	51.04
Nov. 2011	30	45200.	42920.
Dec. 2011	31	162418.	154790.
Jan. 2012	31	36923.	36764.
Feb. 2012	29	4581.	3599.
Mar. 2012	8	68376.	75739.

Summary Statistics - Estimated Loads [LBS/DAY]

	Min.	25th Pct	Med.	75th Pct	90th Pct	95th Pct	99th Pct	Max.
AMLE	31.	238.	1612.	11982.	48026.	110088.	615681.	904038.
MLE	31.	238.	1614.	11987.	48036.	110098.	618879.	911896.
LAD	24.	240.	1613.	14533.	57420.	190299.	1542351.	2440492.

Summary Statistics - Estimated Concentrations [MG/L]

	Min.	25th Pct	Med.	75th Pct	90th Pct	95th Pct	99th Pct	Max.
AMLE	0.96	2.26	3.76	7.58	13.87	18.03	36.95	44.33

WARNING: Maximum estimated concentration exceeds twice the maximum calibration concentration of 14.000 MG/L

MLE	0.96	2.26	3.76	7.58	13.88	18.03	37.25	44.36

WARNING: Maximum estimated concentration exceeds twice the maximum calibration concentration of 14.000 MG/L

LAD	0.75	2.00	3.88	8.83	18.52	30.04	95.47	107.09

WARNING: Maximum estimated concentration exceeds twice the maximum calibration concentration of 14.000 MG/L

LOADEST
BLUE RIVER SITE 7 PHOSPHORUS

Constituent Output File Part Ia: Calibration (Load Regression)

Number of Observations : 12
Number of Uncensored Observations: 12
"center" of Decimal Time : 2011.738
"center" of Ln(Q) : 4.2398
Period of record : 2011-2012

Model Evaluation Criteria Based on AMLE Results

Model #	AIC	SPPC
1	-1.979	11.388
2	-1.981	11.158
3	-1.795	10.045
4	-3.919	22.545
5	-1.782	9.721
6	-3.702	21.002
7	-3.806	21.626
8	-3.583	20.045
9	-3.378	18.571

Model # 4 selected

Selected Model:

Ln(Load) = a0 + a1 LnQ + a2 Sin(2 pi dtime) + a3 Cos(2 pi dtime)

where:
Load = constituent load [kg/d]
LnQ = Ln(Q) - center of Ln(Q)
dtime = decimal time - center of decimal time

Model Coefficients

	a0	a1	a2	a3
AMLE	2.1466	1.1039	-0.0102	0.1997
MLE	2.1466	1.1039	-0.0102	0.1997
LAD	2.1415	1.1017	0.0072	0.1984

AMLE Regression Statistics

R-Squared [%] : 99.98
Prob. Plot Corr. Coeff. (PPCC) : 0.9725
Serial Correlation of Residuals: -.0697

Coeff.	Std.Dev.	t-ratio	P Value
a0	0.0088	244.50	4.385E-25
a1	0.0110	99.96	2.235E-20
a2	0.0121	-0.84	3.126E-01
a3	0.0235	8.49	1.465E-07

Correlation Between Explanatory Variables

Explanatory variable corresponding to:

	a1	a2
a2	0.1495	
a3	-0.8440	0.0161

Additional Regression Statistics

	Residual Variance	Turnbull-Weiss Stat	DF	PL
AMLE	0.001	2.41	1	1.209E-01
MLE	0.001	2.41	1	1.209E-01

Constituent Output File Part Ib: Calibration (Concentration Regression)

AMLE Regression Statistics

Model # 4 was selected for the load regression (PART Ia) and is used here:

Ln(Conc) = a0 + a1 LnQ + a2 Sin(2 pi dtime) + a3 Cos(2 pi dtime)

where:
Conc = constituent concentration
LnQ = Ln(Q) - center of Ln(Q)
dtime = decimal time - center of decimal time

Concentration Regression Results

R-Squared [%] : 92.14
Residual Variance : 0.0008

Coeff.	Value	Std.Dev.	t-ratio	P Value
a0	-2.9879	0.0088	-340.32	8.010E-27
a1	0.1039	0.0110	9.41	4.593E-08
a2	-0.0102	0.0121	-0.84	3.126E-01
a3	0.1997	0.0235	8.49	1.465E-07

Constituent Output File Part IIa: Estimation (test for extrapolation)

Load Estimates for 20110416-20120308

Streamflow Summary Statistics [cfs]

Data	Mean	Minimum	10th Pct	25th Pct	Median	75th Pct	90th Pct	Maximum
Cal.	180.	9.	10.	16.	126.	317.	552.	600.
Est.	338.	5.	8.	15.	94.	316.	735.	6225.

WARNING: The maximum estimation data set steamflow exceeds the maximum calibration data set streamflow. Load estimates require extrapolation.

Maximum Estimation Streamflow : 6.2250E+03
Maximum Calibration Streamflow: 6.0000E+02

Constituent Output File Part IIb: Estimation (Load Estimates)

Load Estimates for 20110416-20120308

Load Estimates [LBS/DAY]

AMLE Load Estimates

	N	Mean Load	95% Conf.Intervals Lower	Upper	Std Error Prediction	Standard Error
Est. Period	328	113.90	108.63	119.35	2.73	2.69
Season 1	54	321.55	305.25	338.49	8.48	8.13
Season 2	92	32.04	30.59	33.54	0.75	0.72
Season 3	91	32.39	30.25	34.64	1.12	1.05
Season 4	91	154.94	147.12	163.06	4.07	3.95
Apr. 2011	15	597.98	564.86	632.53	17.26	16.04
May 2011	31	226.28	213.62	239.48	6.60	5.97
June 2011	30	74.54	70.71	78.52	1.99	1.87
July 2011	31	19.12	18.44	19.81	0.35	0.32
Aug. 2011	31	3.84	3.73	3.96	0.06	0.05
Sep. 2011	30	4.32	4.17	4.48	0.08	0.07
Oct. 2011	31	2.95	2.86	3.05	0.05	0.04
Nov. 2011	30	90.88	84.48	97.62	3.35	3.15
Dec. 2011	31	264.67	246.77	283.51	9.37	9.03
Jan. 2012	31	155.23	149.09	161.55	3.18	2.94
Feb. 2012	29	37.33	35.98	38.71	0.70	0.63
Mar. 2012	8	172.42	165.65	179.39	3.50	2.71

MLE Load Estimates

	N	Mean Load	Standard Error
Est. Period	328	113.90	2.69
Season 1	54	321.55	8.13
Season 2	92	32.04	0.72
Season 3	91	32.39	1.05
Season 4	91	154.94	3.95
Apr. 2011	15	597.98	16.04
May 2011	31	226.28	5.97
June 2011	30	74.54	1.87
July 2011	31	19.12	0.32
Aug. 2011	31	3.84	0.05
Sep. 2011	30	4.32	0.07
Oct. 2011	31	2.95	0.04
Nov. 2011	30	90.88	3.15
Dec. 2011	31	264.67	9.03

	N	Mean Load	Standard Error
Jan. 2012	31	155.23	2.94
Feb. 2012	29	37.33	0.63
Mar. 2012	8	172.42	2.71

LAD Load Estimates

	N	Mean Load	Standard Error
Est. Period	328	113.51	19.87
Season 1	54	317.03	49.47
Season 2	92	31.41	4.30
Season 3	91	32.68	8.19
Season 4	91	156.58	30.88
Apr. 2011	15	589.29	99.52
May 2011	31	222.48	35.89
June 2011	30	72.98	11.56
July 2011	31	18.78	1.61
Aug. 2011	31	3.80	0.19
Sep. 2011	30	4.32	0.36
Oct. 2011	31	2.98	0.04
Nov. 2011	30	91.73	24.51
Dec. 2011	31	267.43	70.31
Jan. 2012	31	156.95	21.84
Feb. 2012	29	37.70	2.19
Mar. 2012	8	172.92	10.50

Summary Statistics - Estimated Loads [LBS/DAY]

	Min.	25th Pct	Med.	75th Pct	90th Pct	95th Pct	99th Pct	Max.
AMLE	1.	4.	25.	94.	230.	446.	1929.	2267.
MLE	1.	4.	25.	94.	230.	446.	1929.	2267.
LAD	1.	4.	25.	95.	232.	444.	1930.	2231.

Summary Statistics - Estimated Concentrations [MG/L]

	Min.	25th Pct	Med.	75th Pct	90th Pct	95th Pct	99th Pct	Max.
AMLE	0.040	0.048	0.051	0.056	0.063	0.066	0.077	0.082
MLE	0.040	0.048	0.051	0.056	0.063	0.066	0.077	0.082
LAD	0.041	0.048	0.051	0.056	0.063	0.066	0.078	0.083

LOADEST
WEST FORK BLUE RIVER SITE 10 N 4ML

Constituent Output File Part Ia: Calibration (Load Regression)

Number of Observations : 12
Number of Uncensored Observations: 12
"center" of Decimal Time : 2011.738
"center" of Ln(Q) : 1.8951
Period of record : 2011-2012

Model Evaluation Criteria Based on AMLE Results

Model #	AIC	SPPC
1	2.693	-16.640
2	2.585	-16.240
3	2.826	-17.680
4	2.869	-18.185
5	2.757	-17.511
6	2.878	-18.482
7	3.033	-19.413
8	3.077	-19.916
9	2.897	-19.079

Model # 2 selected

Selected Model:

Ln(Load) = a0 + a1 LnQ + a2 LnQ^2

where:
Load = constituent load [kg/d]
LnQ = Ln(Q) - center of Ln(Q)

Model Coefficients

	a0	a1	a2
AMLE	3.5622	1.8394	-0.2036
MLE	3.5622	1.8394	-0.2036
LAD	3.8340	1.8867	-0.3086

AMLE Regression Statistics

R-Squared [%] : 95.85
Prob. Plot Corr. Coeff. (PPCC) : 0.9576
Serial Correlation of Residuals: 0.1255

Coeff.	Std.Dev.	t-ratio	P Value
a0	0.4272	8.34	3.420E-07
a1	0.1285	14.31	7.007E-10
a2	0.1157	-1.76	5.955E-02

Correlation Between Explanatory Variables

Explanatory variable corresponding to:

	a1
a2	0.0000

Additional Regression Statistics

	Residual Variance	Turnbull-Weiss Stat	DF	PL
AMLE	0.605	1.86	1	1.721E-01
MLE	0.605	1.86	1	1.721E-01

Constituent Output File Part Ib: Calibration (Concentration Regression)

AMLE Regression Statistics

Model # 2 was selected for the load regression (PART Ia) and is used here:

Ln(Conc) = a0 + a1 LnQ + a2 LnQ^2

where:
Conc = constituent concentration
LnQ = Ln(Q) - center of Ln(Q)

Concentration Regression Results

R-Squared [%] : 83.57
Residual Variance : 0.6050

Coeff.	Value	Std.Dev.	t-ratio	P Value
a0	0.7724	0.4272	1.81	5.380E-02
a1	0.8394	0.1285	6.53	4.661E-06
a2	-0.2036	0.1157	-1.76	5.955E-02

Constituent Output File Part IIa: Estimation (test for extrapolation)

Load Estimates for 20110416-20120308

Streamflow Summary Statistics [cfs]

Data	Mean	Minimum	10th Pct	25th Pct	Median	75th Pct	90th Pct	Maximum
Cal.	25.	1.	1.	1.	16.	48.	76.	84.
Est.	48.	0.	1.	1.	12.	41.	109.	1080.

WARNING: The maximum estimation data set steamflow exceeds the maximum calibration data set streamflow. Load estimates require extrapolation.

Maximum Estimation Streamflow : 1.0800E+03
Maximum Calibration Streamflow: 8.4000E+01

Constituent Output File Part IIb: Estimation (Load Estimates)

Load Estimates for 20110416-20120308

Load Estimates [LBS/DAY]

AMLE Load Estimates

	N	Mean Load	95% Conf.Intervals Lower	Upper	Std Error Prediction	Standard Error
Est. Period	323	722.	1.	4883.	6502.	6502.
Season 1	54	1234.	0.	7219.	29238.	29238.
Season 2	92	361.	2.	2428.	1766.	1764.
Season 3	86	139.82	4.75	766.03	292.43	287.33
Season 4	91	1334.	20.	8329.	4135.	4132.
Apr. 2011	15	1790.	1.	10501.	41813.	41810.
May 2011	31	792.	0.	4056.	31822.	31821.
June 2011	30	858.	3.	5851.	5416.	5412.
July 2011	31	238.60	90.44	516.58	111.52	85.95
Aug. 2011	31	1.52	0.46	3.79	0.89	0.60
Sep. 2011	25	12.42	2.36	39.14	10.18	5.57
Oct. 2011	31	1.35	0.43	3.22	0.74	0.53
Nov. 2011	30	389.	12.	2159.	840.	825.
Dec. 2011	31	1786.	6.	12184.	11407.	11402.
Jan. 2012	31	1532.	174.	5971.	1715.	1689.
Feb. 2012	29	641.	276.	1278.	261.	221.
Mar. 2012	8	1908.	574.	4744.	1107.	906.

MLE Load Estimates

	N	Mean Load	Standard Error
Est. Period	323	726.32	5395.31
Season 1	54	1249.	23853.
Season 2	92	362.55	1564.10
Season 3	86	140.26	285.26
Season 4	91	1338.	3550.
Apr. 2011	15	1824.	35828.
May 2011	31	800.13	25143.93
June 2011	30	863.37	4797.75
July 2011	31	238.90	84.09
Aug. 2011	31	1.53	0.59
Sep. 2011	25	12.43	5.49
Oct. 2011	31	1.35	0.52
Nov. 2011	30	390.33	819.27
Dec. 2011	31	1792.	9599.
Jan. 2012	31	1535.	1683.
Feb. 2012	29	642.15	216.33
Mar. 2012	8	1909.	896.

LAD Load Estimates

	N	Mean Load	Standard Error
Est. Period	323	800.43	604.00
Season 1	54	1408.	1326.
Season 2	92	421.61	276.60
Season 3	86	145.62	137.64
Season 4	91	1442.	989.
Apr. 2011	15	2012.	2940.
May 2011	31	963.06	697.37
June 2011	30	957.44	746.06
July 2011	31	322.84	201.66
Aug. 2011	31	1.82	0.90
Sep. 2011	25	18.49	11.67
Oct. 2011	31	1.55	0.77
Nov. 2011	30	400.43	394.89
Dec. 2011	31	1840.	1455.
Jan. 2012	31	1612.	1171.
Feb. 2012	29	833.45	512.67
Mar. 2012	8	2000.	1268.

Summary Statistics - Estimated Loads [LBS/DAY]

	Min.	25th Pct	Med.	75th Pct	90th Pct	95th Pct	99th Pct	Max.
AMLE	-206.845	2.846	196.728	1210.264	2535.877	2866.462	3039.944	3061.332
MLE	-91.701	2.850	231.245	1211.997	2543.867	2868.646	3039.951	3061.896
LAD	0.000	3.757	411.291	1509.651	2440.387	2604.632	2677.930	2686.235

Summary Statistics - Estimated Concentrations [MG/L]

	Min.	25th Pct	Med.	75th Pct	90th Pct	95th Pct	99th Pct	Max.
AMLE	-0.036	0.359	2.969	5.636	6.393	6.521	6.549	6.550
MLE	-0.016	0.359	2.971	5.639	6.400	6.529	6.558	6.558
LAD	0.000	0.371	3.874	6.837	7.761	7.885	7.925	7.928

LOADEST
WEST FORK BLUE RIVER SITE 10 TSS 25ML

Constituent Output File Part Ia: Calibration (Load Regression)

Number of Observations : 12
Number of Uncensored Observations: 12
"center" of Decimal Time : 2011.738
"center" of Ln(Q) : 1.8951
Period of record : 2011-2012

Model Evaluation Criteria Based on AMLE Results

Model #	AIC	SPPC
1	2.949	-18.179
2	2.303	-14.547
3	3.059	-19.079
4	2.960	-18.731
5	2.453	-15.686
6	2.409	-15.665
7	3.158	-20.158
8	2.528	-16.625
9	2.419	-16.211

Model # 2 selected

Selected Model:

Ln(Load) = a0 + a1 LnQ + a2 LnQ^2

where:
Load = constituent load [kg/d]
LnQ = Ln(Q) - center of Ln(Q)

Model Coefficients

	a0	a1	a2
AMLE	2.5675	0.9116	0.3441
MLE	2.5675	0.9116	0.3441
LAD	2.6174	0.9084	0.3282

AMLE Regression Statistics

R-Squared [%] : 89.71
Prob. Plot Corr. Coeff. (PPCC) : 0.9538
Serial Correlation of Residuals: 0.2350

Coeff.	Std.Dev.	t-ratio	P Value
a0	0.3710	6.92	2.550E-06
a1	0.1116	8.17	4.292E-07
a2	0.1005	3.42	1.555E-03

Correlation Between Explanatory Variables

Explanatory variable corresponding to:

	a1
a2	0.0000

Additional Regression Statistics

	Residual Variance	Turnbull-Weiss Stat	DF	PL
AMLE	0.456	0.68	1	4.097E-01
MLE	0.456	0.68	1	4.097E-01

Constituent Output File Part Ib: Calibration (Concentration Regression)

AMLE Regression Statistics

Model # 2 was selected for the load regression (PART Ia) and is used here:

Ln(Conc) = a0 + a1 LnQ + a2 LnQ^2

where:
Conc = constituent concentration
LnQ = Ln(Q) - center of Ln(Q)

Concentration Regression Results

R-Squared [%] : 57.86
Residual Variance : 0.4563

Coeff.	Value	Std.Dev.	t-ratio	P Value
a0	-0.2223	0.3710	-0.60	4.933E-01
a1	-0.0884	0.1116	-0.79	3.686E-01
a2	0.3441	0.1005	3.42	1.555E-03

Constituent Output File Part IIa: Estimation (test for extrapolation)

Load Estimates for 20110416-20120308

Streamflow Summary Statistics [cfs]

Data	Mean	Minimum	10th Pct	25th Pct	Median	75th Pct	90th Pct	Maximum
Cal.	25.	1.	1.	1.	16.	48.	76.	84.
Est.	48.	0.	1.	1.	12.	41.	109.	1080.

WARNING: The maximum estimation data set steamflow exceeds the maximum calibration data set streamflow. Load estimates require extrapolation.

Maximum Estimation Streamflow : 1.0800E+03
Maximum Calibration Streamflow: 8.4000E+01

Constituent Output File Part IIb: Estimation (Load Estimates)

Load Estimates for 20110416-20120308

Load Estimates [LBS/DAY]

AMLE Load Estimates

	N	Mean Load	95% Conf.Intervals Lower	Upper	Std Error Prediction	Standard Error
Est. Period	323	7108.	0.	12511.	4742162.	4742162.
Season 1	54	20520.	0.	27616.	24297559.	24297557.
Season 2	92	4988.	0.	19527.	469242.	469232.
Season 3	86	1186.	23.	7151.	3244.	3190.
Season 4	91	6888.	0.	17330.	2034056.	2034054.
Apr. 2011	15	77926.	0.	208372.	19875514.	19875496.
May 2011	31	-2328.	NaN	NaN	33012832.	33012830.
June 2011	30	15187.	0.	59297.	1439008.	1438977.
July 2011	31	80.75	36.30	156.36	31.16	22.71
Aug. 2011	31	26.50	8.21	64.80	15.00	14.53
Sep. 2011	25	33.84	0.00	176.05	1285.96	1285.95
Oct. 2011	31	29.09	4.91	96.65	25.72	25.37
Nov. 2011	30	3341.	68.	20013.	8939.	8777.
Dec. 2011	31	13736.	0.	29300.	5963742.	5963738.
Jan. 2012	31	6260.	138.	37092.	16180.	16022.
Feb. 2012	29	238.03	103.92	470.12	95.16	69.32
Mar. 2012	8	1418.	447.	3434.	791.	634.

MLE Load Estimates

	N	Mean Load	Standard Error
Est. Period	323	11208.	4081090.
Season 1	54	39351.	20773640.
Season 2	92	5872.	430516.
Season 3	86	1190.	3161.
Season 4	91	9371.	1800943.
Apr. 2011	15	102512.	17583870.
May 2011	31	18579.	27933980.
June 2011	30	17897.	1320249.
July 2011	31	80.81	22.28
Aug. 2011	31	26.51	14.51
Sep. 2011	25	35.42	1138.24
Oct. 2011	31	29.12	25.33
Nov. 2011	30	3352.	8721.
Dec. 2011	31	21003.	5279006.
Jan. 2012	31	6283.	15902.
Feb. 2012	29	238.19	68.21
Mar. 2012	8	1419.	631.

LAD Load Estimates

	N	Mean Load	Standard Error
Est. Period	323	132894.	118799.
Season 1	54	592915.	536344.
Season 2	92	34683.	29296.
Season 3	86	1678.	1048.
Season 4	91	83212.	72819.
Apr. 2011	15	857759.	748853.
May 2011	31	617420.	571885.
June 2011	30	106250.	89828.
July 2011	31	80.33	14.35
Aug. 2011	31	27.00	3.93
Sep. 2011	25	89.26	38.74
Oct. 2011	31	31.86	5.59
Nov. 2011	30	4702.	2968.
Dec. 2011	31	235362.	208393.
Jan. 2012	31	8687.	5362.
Feb. 2012	29	233.89	58.92
Mar. 2012	8	1377.	513.

Summary Statistics - Estimated Loads [LBS/DAY]

	Min.	25th Pct	Med.	75th Pct	90th Pct	95th Pct	99th Pct	Max.
AMLE	-409393.	25.	65.	569.	5376.	35932.	293828.	370870.
MLE	19.	25.	66.	569.	5718.	37441.	446796.	493028.
LAD	19.	26.	75.	575.	5820.	50473.	6135001.	********

Summary Statistics - Estimated Concentrations [MG/L]

	Min.	25th Pct	Med.	75th Pct	90th Pct	95th Pct	99th Pct	Max.
AMLE	-70.279	1.233	2.543	7.266	20.380	42.394	98.518	182.837

WARNING: Maximum estimated concentration exceeds twice the maximum calibration concentration of 13.000 MG/L

	Min.	25th Pct	Med.	75th Pct	90th Pct	95th Pct	99th Pct	Max.
MLE	0.93	1.24	2.57	7.43	21.20	44.89	118.66	222.83

WARNING: Maximum estimated concentration exceeds twice the maximum calibration concentration of 13.000 MG/L

	Min.	25th Pct	Med.	75th Pct	90th Pct	95th Pct	99th Pct	Max.
LAD	0.98	1.28	2.53	7.34	23.62	72.03	1697.18	3969.29

WARNING: Maximum estimated concentration exceeds twice the maximum calibration concentration of 13.000 MG/L

LOADEST
WEST FORK BLUE RIVER SITE 10 PHOSPHORUS

Constituent Output File Part Ia: Calibration (Load Regression)

Number of Observations : 12
Number of Uncensored Observations: 12
"center" of Decimal Time : 2011.738
"center" of Ln(Q) : 1.8951
Period of record : 2011-2012

Model Evaluation Criteria Based on AMLE Results

Model #	AIC	SPPC
1	-3.182	18.610
2	-3.082	17.767
3	-3.006	17.309
4	-2.847	16.111
5	-2.885	16.343
6	-2.692	14.941
7	-2.648	14.678
8	-2.467	13.347
9	-2.201	11.511

Model # 1 selected

Selected Model:

Ln(Load) = a0 + a1 LnQ

where:
Load = constituent load [kg/d]
LnQ = Ln(Q) - center of Ln(Q)

Model Coefficients

	a0	a1
AMLE	-0.1891	0.9889
MLE	-0.1891	0.9889
LAD	-0.2060	1.0000

AMLE Regression Statistics

R-Squared [%] : 99.94
Prob. Plot Corr. Coeff. (PPCC) : 0.8281
Serial Correlation of Residuals: -.3463

Coeff.	Std.Dev.	t-ratio	P Value
a0	0.0132	-14.28	1.339E-09
a1	0.0075	132.00	2.969E-21

Additional Regression Statistics

Residual Variance	Turnbull-Weiss Stat	DF	PL

AMLE	0.002	2.91	1	8.798E-02
MLE	0.002	2.91	1	8.798E-02

Constituent Output File Part Ib: Calibration (Concentration Regression)

AMLE Regression Statistics

Model # 1 was selected for the load regression (PART Ia) and is used here:

Ln(Conc) = a0 + a1 LnQ

where:
Conc = constituent concentration
LnQ = Ln(Q) - center of Ln(Q)

Concentration Regression Results

R-Squared [%] : 18.13
Residual Variance : 0.0021

Coeff.	Value	Std.Dev.	t-ratio	P Value
a0	-2.9789	0.0132	-224.89	4.662E-24
a1	-0.0111	0.0075	-1.49	1.213E-01

Constituent Output File Part IIa: Estimation (test for extrapolation)

Load Estimates for 20110416-20120308

Streamflow Summary Statistics [cfs]

Data	Mean	Minimum	10th Pct	25th Pct	Median	75th Pct	90th Pct	Maximum
Cal.	25.	1.	1.	1.	16.	48.	76.	84.
Est.	48.	0.	1.	1.	12.	41.	109.	1080.

WARNING: The maximum estimation data set steamflow exceeds the maximum calibration data set streamflow. Load estimates require extrapolation.

Maximum Estimation Streamflow : 1.0800E+03
Maximum Calibration Streamflow: 8.4000E+01

Constituent Output File Part IIb: Estimation (Load Estimates)

Load Estimates for 20110416-20120308

Load Estimates [LBS/DAY]

AMLE Load Estimates

	N	Mean Load	95% Conf.Intervals Lower	Upper	Std Error Prediction	Standard Error
Est. Period	323	12.75	12.08	13.43	0.34	0.33
Season 1	54	33.37	31.30	35.53	1.08	1.00
Season 2	92	6.15	5.81	6.51	0.18	0.15
Season 3	86	2.50	2.36	2.65	0.07	0.05
Season 4	91	16.86	16.05	17.71	0.42	0.40
Apr. 2011	15	67.21	62.65	72.00	2.39	2.11
May 2011	31	21.64	20.12	23.25	0.80	0.64
June 2011	30	15.96	14.96	17.01	0.52	0.42
July 2011	31	2.58	2.49	2.67	0.05	0.04
Aug. 2011	31	0.22	0.21	0.23	0.01	0.00
Sep. 2011	25	0.38	0.36	0.40	0.01	0.01
Oct. 2011	31	0.21	0.20	0.22	0.00	0.00
Nov. 2011	30	6.64	6.23	7.07	0.21	0.16
Dec. 2011	31	26.15	24.64	27.71	0.78	0.68
Jan. 2012	31	17.90	17.03	18.80	0.45	0.40
Feb. 2012	29	5.83	5.62	6.04	0.11	0.09
Mar. 2012	8	15.33	14.57	16.12	0.40	0.30

MLE Load Estimates

	N	Mean Load	Standard Error
Est. Period	323	12.75	0.33
Season 1	54	33.37	1.00
Season 2	92	6.15	0.15
Season 3	86	2.50	0.05
Season 4	91	16.86	0.40
Apr. 2011	15	67.21	2.11
May 2011	31	21.64	0.64
June 2011	30	15.96	0.42
July 2011	31	2.58	0.04
Aug. 2011	31	0.22	0.00
Sep. 2011	25	0.38	0.01
Oct. 2011	31	0.21	0.00
Nov. 2011	30	6.64	0.16
Dec. 2011	31	26.15	0.68
Jan. 2012	31	17.90	0.40
Feb. 2012	29	5.83	0.09
Mar. 2012	8	15.33	0.30

LAD Load Estimates

	N	Mean Load	Standard Error
Est. Period	323	13.19	0.19
Season 1	54	34.75	0.51
Season 2	92	6.34	0.09
Season 3	86	2.57	0.04
Season 4	91	17.36	0.26
Apr. 2011	15	70.17	1.04

May 2011	31	22.54	0.33
June 2011	30	16.52	0.24
July 2011	31	2.59	0.04
Aug. 2011	31	0.22	0.00
Sep. 2011	25	0.38	0.01
Oct. 2011	31	0.21	0.00
Nov. 2011	30	6.84	0.10
Dec. 2011	31	27.05	0.40
Jan. 2012	31	18.40	0.27
Feb. 2012	29	5.90	0.09
Mar. 2012	8	15.67	0.23

Summary Statistics - Estimated Loads [LBS/DAY]

	Min.	25th Pct	Med.	75th Pct	90th Pct	95th Pct	99th Pct	Max.
AMLE	0.014	0.391	3.273	11.029	28.946	59.267	215.298	279.944
MLE	0.014	0.391	3.273	11.029	28.946	59.267	215.298	279.944
LAD	0.014	0.383	3.285	11.223	29.782	61.480	226.682	295.630

Summary Statistics - Estimated Concentrations [MG/L]

	Min.	25th Pct	Med.	75th Pct	90th Pct	95th Pct	99th Pct	Max.
AMLE	0.048	0.050	0.051	0.052	0.052	0.052	0.053	0.054
MLE	0.048	0.050	0.051	0.052	0.052	0.052	0.053	0.054
LAD	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051