Shoal Creek Watershed Improvement Group

Mission: Working together to improve water quality in upper Shoal Creek

Upper Shoal Creek Watershed
Non-Point Source (NPS) Watershed Management Plan

(Lower Woodward Creek, Shoal Creek Watershed, Barry County, Missouri)

December 2012

Missouri Department of Natural Resources

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Table of Contents

Acknowledgments.....1

Table of Contents.....2

List of Figures.....3

List of Tables.....4

List of Appendices.....5

Executive Summary.....6

Introduction.....12

Identification of Causes and Sources of Impairment.....15

Estimates of Pollutant Load Reduction.....17

Nonpoint Source Management Measures.....20

Technical and Financial Assistance Needed.....25-30

Information, Education/Outreach and Public Participation.....25-30

Implementation Schedule.....25-30

Interim Milestones.....25-30

Load Reduction Evaluation Criteria.....30

Water Quality Monitoring Component.....31

List of Figures

Figure 1 - Impaired streams addressed in 2007 TMDL for Shoal Creek Watershed.....7

Figure 2 - Watershed Planning Area for Upper Shoal Creek 8

Figure 3 - VWQMP Sampling Sites and Designated Uses WBC-A and WBC-B10.....11

Figure 4 - Land use in upper Shoal Creek watershed 13

Figure 5 - Fecal coliform sources comparing summer and winter sampling averages.....16

Figure 6 - Fecal coliform sources comparing summer and winter sampling averages.....16

Figure 7- Shoal Creek – Zerbert Branch Example Priority Area 22

Figure 8 - Joyce and Woodward Creeks headwater Example Priority Area for Poultry Litter....23

Figure 9 - Priority Areas for OWTS remediation 24

Figure 10 - Water Quality Monitoring Sites.....32

List of Tables

Table 1- Sub-watersheds and streams addressed by 2007 TMDL 6

Table 2 - Sub-watersheds, WBIDs and HUC-12s addressed by WMP 8

Table 3 - Summary of NPS Pollution Sources/Causes and Appropriate BMPs 10

Table 4 - *E. coli* Loads and Reduction Targets 11

Table 5 - Targeted streams and stream segments, TMDL 2007 13

Table 6 - Land use in upper Shoal Creek watershed and targeted sub-watersheds 14

Table 7 - Percentages of isolates identified in each host class during different seasons 17

Table 8 - Permitted facilities in upper Shoal Creek watershed 17

Table 9 - FAPRI study's modeling scenarios 18

Table 10 - Bacteria loadings from each source 19

Table 11 - Sub-watersheds targeted for Ag conservation practices & BMPs 21

Table 12 - Phase 1 Info Education/Outreach and Public Participation Activities/Schedule 25

Table 13 - Phase 1 Info Education/Outreach and Public Participation Evaluation 26

Table 14 - Phase 1 Costs for Info Education/Outreach and Public Participation 26

Table 15 - Phase 2 Info Education/Outreach and Public Participation Activities/Schedule 26

Table 16 – Phase 2 Info Education/Outreach and Public Participation Evaluation 27

Table 17 - Phase 2 Costs for Information, Education/Outreach and Public Participation 27

Table 18 - Phase 1 Implementation Schedule and Interim Milestones 28

Table 19 - Phase 2 Implementation Schedule and Interim Milestones 29

Table 20 – Phase 2 Costs for Watershed Management Plan Implementation 30

List of Appendices

Appendix 1 - Acronyms used in the upper Shoal Creek watershed management plan 33

Appendix 2 - EPA's nine-elements for watershed management planning 34

Appendix 3 - Community benefits of conservation practices and water quality BMPs 35

Appendix 4 - Cost-Share Practices – list and description 36

Appendix 5 - High priority critical stream buffer areas by HUC-12 watershed 37-40

Headwaters Shoal Creek sub-watershed – 110702070702.....37

Joyce Creek sub-watershed – 110702070701.....38

Capps Creek watershed – 110702070703 39

Zerbert Branch – Shoal Creek watershed – 110702070706.....40

Appendix 6 - References.....41

Executive Summary

During the 1960s-70s, water quality in Shoal Creek was considered very high by scientific standards, but water quality sampling in the 1990s indicated high levels of fecal coliform bacteria that exceeded state standards.[1]

Scientific investigations, beginning in 1999, confirmed findings of elevated bacteria levels in upper Shoal Creek, better defined the causes/sources of elevated bacteria levels in streams and noted high nutrient loads in surface and sub-surface waters.[2]

Water quality analysis conducted by the University of Missouri's Food Agriculture Policy Research Institute (FAPRI) from 2001-2003 also included creation of a committee of local agricultural producers and other stakeholders. This stakeholder group was intended to facilitate decision-making resulting in water quality improvements.[3]

In 2003, during development of a Total Maximum Daily Load (TMDL) for 13.5 miles of upper Shoal Creek, the Missouri Department of Natural Resources (MDNR) regularly with members of the stakeholder committee and encouraged the creation of a formal watershed organization.

In 2005, the Shoal Creek Watershed Improvement Group (SCWIG) became a 501 (c) (3) non-profit organization. SCWIG volunteers and cooperating partners immediately began implementing water quality improvement projects by promoting conservation practices and other best-management practices (BMPs) with the goal of restoring the watershed's streams to state water quality standards.

In 2007, the MDNR revised its TMDL[4] by adding another 11.5 miles of stream segments for a total of 25 stream miles within upper Shoal Creek watershed. The stream names, segment length and water body identification number of the 25 miles of streams included in the 2007 TMDL is depicted in the table below:

TABLE 1. Sub-watersheds and streams addressed by 2007 TMDL

Sub-watershed name	WBID	Length (miles)	HUC-12 Code
Shoal Creek-Zerbert Branch	3230	13.5	110702070706
Shoal Creek-Headwaters	3231	4.0	110702070702
Pogue Creek	3232	2.5	110702070702
Joyce Creek	3233	5.0	110702070701

The figure on the following page shows a topographic map of upper Shoal Creek watershed from MDNR's 2007 TMDL. This map identifies sub-watersheds that drain to streams and stream-segments addressed in the TMDL. This map DOES NOT include the entire area of the upper Shoal Creek watershed planning area addressed by this Nonpoint Source (NPS) Watershed Management Plan (WMP).

[1] MDNR's 2003 TMDL for 13.5 miles of Shoal Creek (see page 41 for Internet links for footnotes 1-4)
[2] USGS' Water Resources Reports: 01-4181; 03-4243; and, 02-4125
[3] FAPRI's Report 01_04 http://www.fapri.missouri.edu/outreach/publications/2004/FAPRI_UMC_Report_01_04.pdf
[4] MDNR's 2007TMDL for 25 miles of streams in Shoal Creek watershed

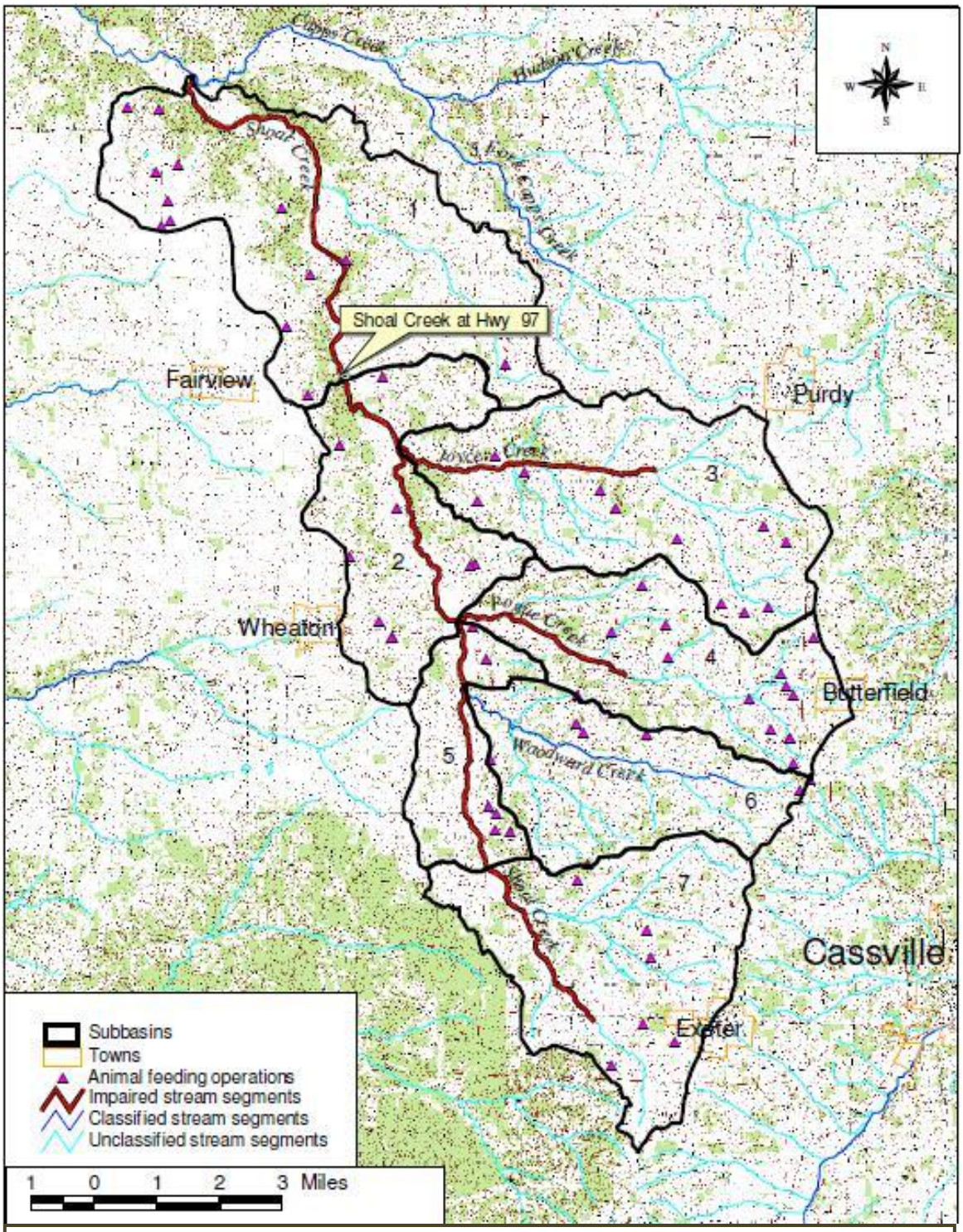


FIGURE 1. Impaired streams addressed in 2007 TMDL for Upper Shoal Creek Watershed

The figure below DOES include the entire watershed planning area of the WMP for upper Shoal Creek watershed. In addition to the portions of upper Shoal Creek watershed addressed by MDNR's 2007 TMDL, SCWIG's watershed planning area includes Capps Creek watershed and Shoal Creek approximately below impaired stream segments, roughly to the Hwy 60 Bridge.

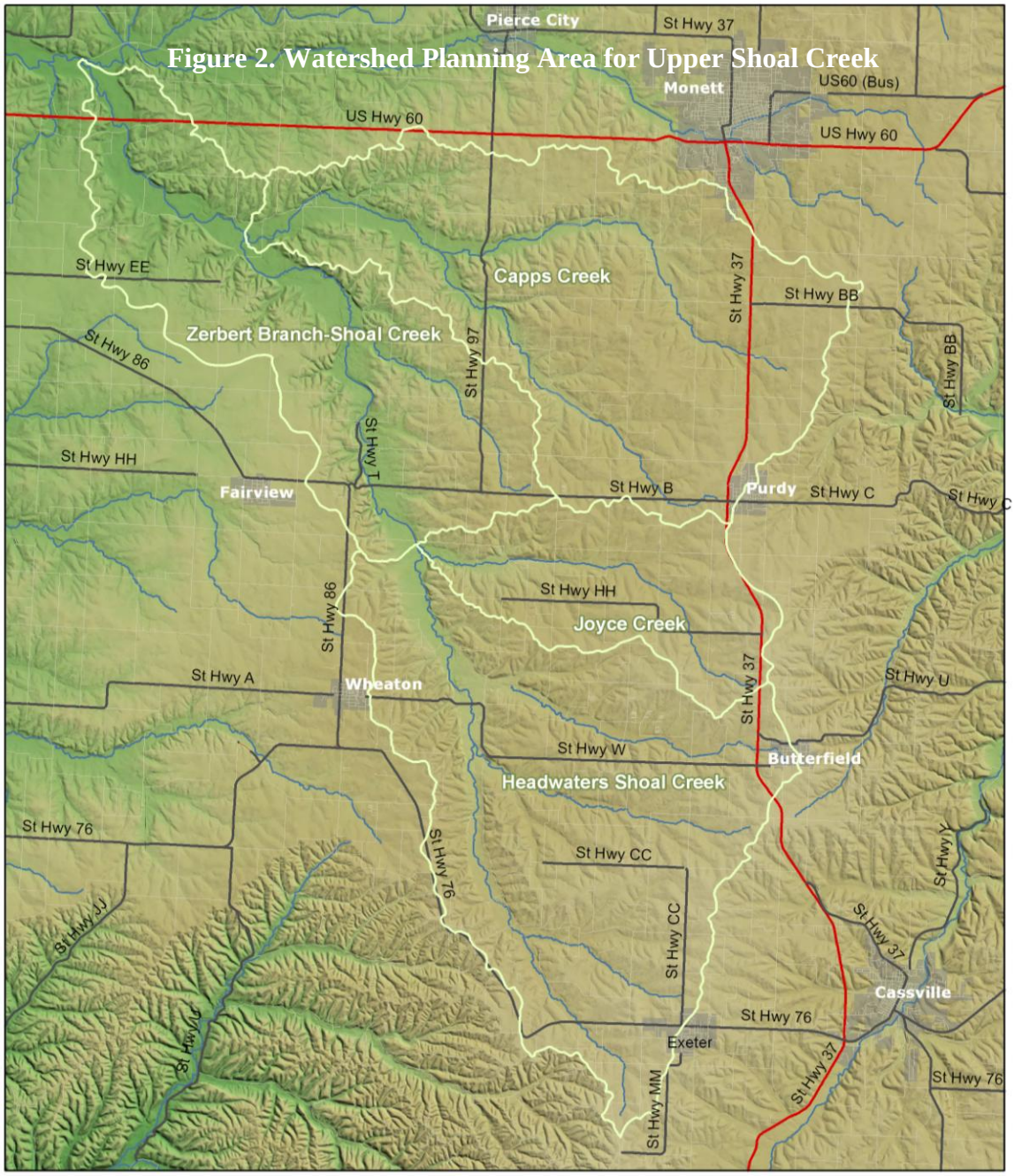


Figure 2. Watershed Planning Area for Upper Shoal Creek

The sub-watersheds and HUC-12 codes included in the WMP area are listed in the table below:

TABLE 2. Sub-watersheds, WBIDs and HUC-12s addressed by WMP		
Sub-watershed name	WBID	HUC-12 Code
Shoal Creek-Zerbert Branch	3230	110702070706
Capps Creek	3234	110702070703
Joyce Creek	3233	110702070701
Pogue Creek	3232	110702070702
Shoal Creek-Headwaters	3231	110702070702

The purpose of this WMP for upper Shoal Creek watershed is to create local strategies to achieve two water resource goals: 1) restoring streams to state water quality standards; and, 2) promoting wise-watershed stewardship practices throughout the upper Shoal Creek watershed planning area to reduce all sources of NPS pollutants. This WMP provides assessment and management information, including actions, participants and resources needed for WMP implementation. The WMP identifies sources contributing to NPS pollutants, identifies and prioritizes critical areas and recommends specific management measures necessary to achieve water resource goals.[5]

The previous scientific studies conducted by FAPRI and USGS have clearly identified the stressors and threats to stream water quality. A variety of BMPs and other conservation measures are needed to address the multiple causes and sources of water quality degradation in upper Shoal Creek watershed. Pasturelands and riparian zones are the critical areas in upper Shoal Creek watershed. The high-priority critical areas are the riparian zones, particularly un-vegetated riparian zones. Cattle standing in streams and runoff from pastures with cattle manure and poultry litter are believed to be the primary sources of bacteria NPS pollutant loadings.

These and other sources and causes of bacteria pollution are discussed in this WMP, along with recommended conservation measures and BMPs in the critical areas. In addition to landowner cost-share incentives, the WMP urges consideration of other opportunities (e.g., local initiatives, state-revolving loan funds, local ordinances, etc.). The WMP estimates the amount of technical and financial assistance needed to reach estimated bacteria pollutant load reductions in a two-phase approach over a 10-year timeframe.

Phase 1 (2009-2013) priorities of this WMP include:

- Building capacity of SCWIG as an effective watershed organization for water quality improvements in the upper Shoal Creek watershed and ensuring all interested stakeholders are represented (e.g., landowners, general public, local, state and federal governments);

- Implementing onsite wastewater treatment system (OWTS) maintenance, repair and replacement landowner cost-share projects and promoting landowner responsibility for ongoing maintenance and local government consideration of point-of-sale inspections of OWTSs;

- Promoting participation by landowners in other cost-share incentives for conservation measures targeting pasturelands and riparian zones, including creek pasture ponds;

- Conducting Volunteer Water Quality Monitoring Program (VWQMP) at six sites for monthly monitoring of *E.coli* to determine current baseline levels of bacteria and measure impacts on water quality in upper Shoal Creek watershed's streams;

- Updating the WMP to include BMP activities and water quality impacts/effectiveness of BMPs targeting critical areas; and,

[5] See Appendix 2 (page 34) for complete list and description of U.S. EPA's nine-essential elements for WMPs.

- Establishing online GIS mapping interface on all Phase 1 outputs and other layers to refine critical areas and show water quality impacts and WMP progress. See beta-version of GIS mapping application at this URL: www.i-maps.com/usc/map/upper-shoal-creek-map.htm.

Phase 2 (2014-2018) priorities include:

- Sustaining SCWIG's watershed stewardship and water quality improvement activities, expanding public participation and ensuring all interested stakeholders are represented;

- Promoting and documenting landowner participation in cost-share incentives for conservation practices and BMPs targeting high priority critical areas, including pasture acres and riparian zones;

- Updating WMP and content of interactive online GIS mapping application, tracking specific areas where BMPs are installed, identifying critical areas where BMPs are still needed;

- Expanding VWQMP water quality monitoring to additional monitoring sites, frequencies and parameters and expanding stream team and other volunteer activities.

The table below summarizes the upper Shoal Creek watershed's sources and causes of bacteria impairment, relative contributions of bacteria from various sources and BMPs needed to address excess bacteria reaching streams within the watershed.

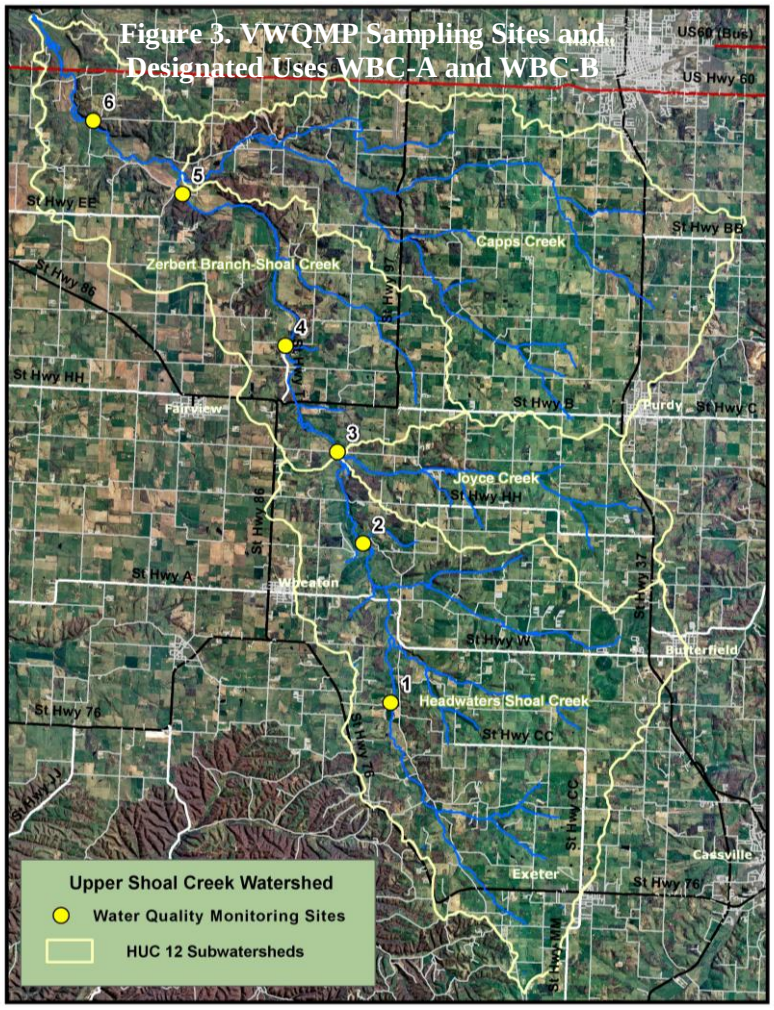
TABLE 3. Summary of NPS Pollution Sources/Causes and Appropriate BMPs

E. coli	Sources/Causes	Summer	Winter	Appropriate BMPs
Cattle	Cattle standing in streams and manure from pastures reaching streams during storm events	45%	27%	Off-stream watering systems/limiting stream access; riparian corridor restoration; grassy swales; vegetative filter strips; intensive grazing
Poultry	Land-applied poultry litter from pastures reaching streams during storm events	19%	17%	Adherence to setback requirements during litter application; riparian corridor restoration; grassy swales; vegetative filter strips
Human	Failing onsite wastewater treatment systems (OWTS)	11%	21%	Regular maintenance (pumping) of septic tanks; repair/replacement of failing OWTSs
Domestic animals	Horses, goats, sheep, hogs, dogs, etc. manure reaching streams during storm events	19%	11%	Off-stream watering systems; riparian corridor restoration; grassy swales; vegetative filter strips
Wildlife	Wildlife droppings reaching streams during storm events and/or directly deposited in streams	6%	25%	Riparian corridor restoration; grassy swales; vegetative filter strips

The table below summarizes current *E. coli* loads and load reduction targets at six water quality monitoring sites on upper Shoal Creek. These sites are sampled monthly through the VWQMP.

TABLE 4. *E. coli* Loads and Reduction Targets		
Sampling Site	Current Loads *	Reduction Target
1	715	<126 MPN
2	736	<126 MPN
3	794	<126 MPN
4	547	<126 MPN
5	326	<126 MPN
6	313	<126 MPN
* Geometric means of all samples collected at six sites in from 2009-2011 through the VWQMP/CSI (results stated in MPN colonies per 100 mL sample)		

State water quality standards are a geometric mean of 126 MPN/100mL for WBC-A (complete immersion, swimming) and 206 MPN/100mL for WBC-B (shallower waters suitable for wading). The figure below shows the location of the six sampling sites for current water quality monitoring activities. Shoal Creek above (upstream from) monitoring site #1 is designated for WBC-B (wading) while Shoal Creek below site #1 is designated WBC-A (swimming).



Introduction

Geographic Setting

Shoal Creek is a tributary of the Spring River that flows into the Grand Lake of the Cherokees in northeastern Oklahoma. The entire Shoal Creek watershed drains an area of approximately 440 square miles located in Barry, Newton and Lawrence counties in southwest Missouri. The Missouri portion of Shoal Creek is about 66 miles long and flows in a northwesterly direction from its headwaters in Barry County until entering the state of Kansas southwest of Joplin.

Largely spring-fed, upper Shoal Creek in its entirety is approximately 141 square miles located primarily in northwestern Barry County. Approximately 77 square miles of upper Shoal Creek watershed drain to streams and stream segments addressed by the MDNR's 2007 Total Maximum Daily Load (TMDL) and by this WMP.

Bedrock outcrops are common along the banks of Shoal Creek, including chert glades that are unique to this stream. According to the Missouri Department of Conservation (MDC), the upper Shoal Creek watershed is home to several species of conservation concern including the Ozark cavefish, bristly cave crayfish, Arkansas darter and Neosho mucket. Shoal Creek is an important source of drinking water supply for the cities of Joplin and Neosho, Missouri.

Water Quality: Past and Present

In November 2003, MDNR completed an Environmental Protection Agency (EPA) Region 7 approved TMDL for 13.5 miles of upper Shoal Creek. According to the TMDL, studies performed prior to 1980 indicated excellent water quality in Shoal Creek. Also referenced in the 2003 TMDL was a 1992 U.S. Geological Survey (USGS) report in which Shoal Creek was described as a:

> …true Ozarkian stream with rolling Ozark hills, picturesque mill dams, bedrock riffles, gently eddying pools and long shaded reaches.

Studies conducted between 1992 and 1999, indicated concentrations of fecal coliform bacteria in upper of Shoal Creek averaging more than 5,000 colonies per 100 mL. Nutrients, specifically total nitrite plus nitrate as nitrogen at base-flow concentrations, were significantly higher compared to other Missouri streams. A 13.5 mile segment of upper Shoal Creek was placed on the 1998 303 (d) list and the 2003 TMDL's goal was to restore upper Shoal Creek to the Water Quality Standard of 200 col/100mL of fecal coliform.

In 2007, two tributaries to upper Shoal Creek (Pogue and Joyce Creeks), plus an additional segment of upper Shoal Creek were added to the 303(d) list due to high bacteria levels. Since all three of these streams and stream segments are located in the watershed addressed in the original Shoal Creek TMDL, MDNR revised it to include specific references to and load allocations for these additional stream segments. For more information on MDNR, revised TMDL, see link: http://www.epa.gov/region07/water/pdf/mo_shoal_joyce_pogue_creeks_tmdl.pdf. Information

on the impaired streams and stream segments within upper Shoal Creek Watershed, including sub-watershed sizes in acres and stream lengths in miles is displayed in the table below.

TABLE 5. Targeted streams and stream segments, TMDL 2007			
Water Body	WBID	Size (acres)	Length (miles)
Shoal Creek (lower end)	3230	19,010	13.5
Shoal Creek (headwaters)	3231	19,095	4.0
Pogue Creek	3232	7,504	2.5
Joyce Creek	3233	9,954	5.0

In 2009, Missouri water quality standards were revised to replace fecal coliform with *E. coli* as the standard fecal indicator organism. Measured bacteria levels in upper Shoal Creek and its tributaries also tended to exceed this new standard. The new standard is a geometric mean (calculation must include 5 samples from one recreational season) of 126 MPN/100mL for streams designate WBC-A (swimming) and 206 MPN/100mL for streams designated WBC-B (wading). Meeting or exceeding these standards is a water resource goal of this WMP.

Land Use

Upper Shoal Creek watershed is primarily rural farmland and woodland. Land use in the watershed is approximately 89 percent grassland (hay, pasture, and farm land enrolled in CRP-

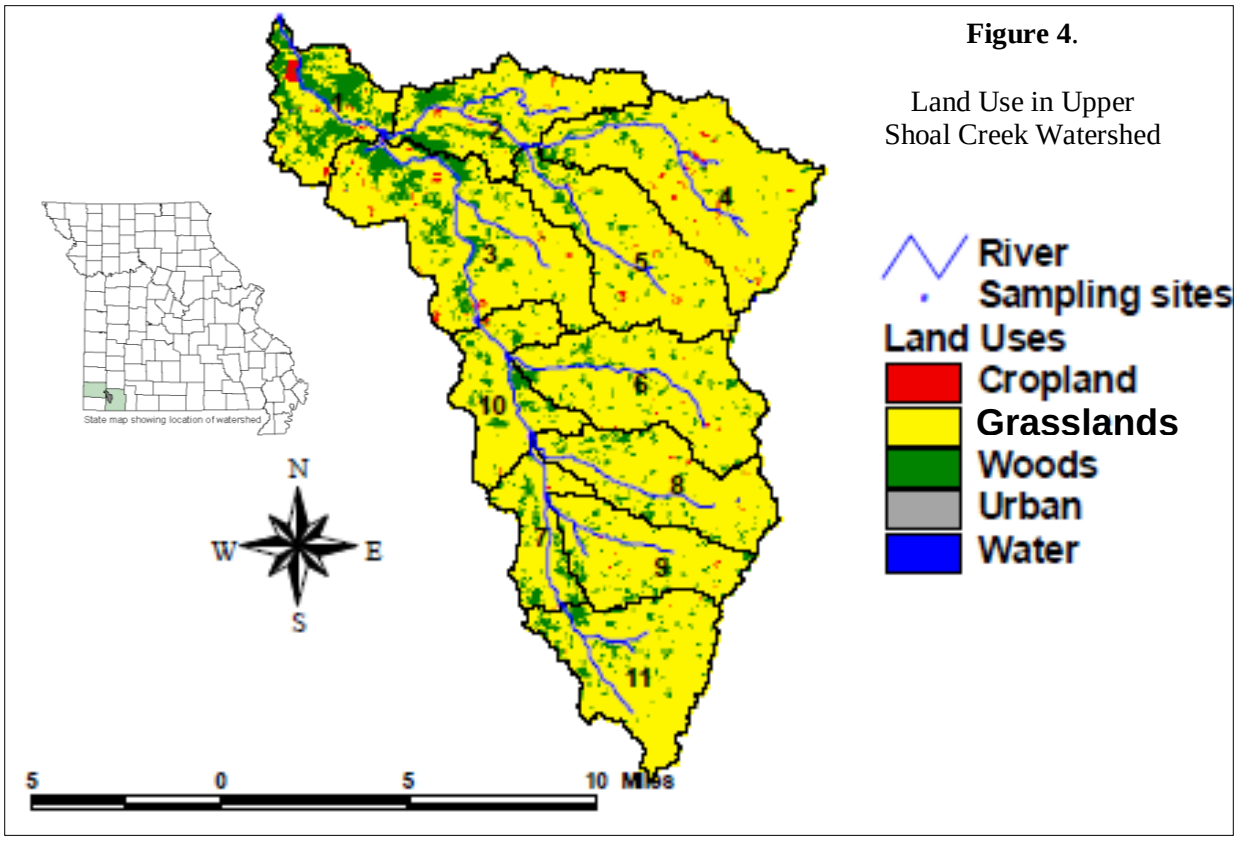


Figure 4.

Land Use in Upper Shoal Creek Watershed

Conservation Reserve Program), 11 percent wooded, less than one percent row crop and less than one percent urban land use. The land use map in the figure above is from the FAPRI study that further divided the four HUC-12 watersheds into sub-watersheds are numbered 1-11. The towns of Butterfield, Exeter, Purdy and Wheaton are located on the edges of the boundaries of upper Shoal Creek watershed, but mainly drain away from Shoal Creek to adjacent Flat Creek, Big Sugar Creek and Indian Creek watersheds.

The highlighted sub-watersheds in the table below are the areas that drain to impaired streams and stream segments in upper Shoal Creek watershed. These grasslands are the critical areas targeted for highest priority for conservation practices and other BMPs to reduce bacteria within the upper Shoal Creek watershed.

TABLE 6. Land use in upper Shoal Creek watershed and sub-watersheds targeted

	Sub-watershed number corresponding to sub-watershed land use map (Figure 4, above)											%
	1	2	3	4	5	6	7	8	9	10	11	
Forest (%)	39	17	16	0	6	8	14	8	8	12	10	11
Grassland (%)	61	83	84	100	94	92	86	92	91	88	90	89
Area (acres)	5667	7247	13175	12731	9297	9954	3936	7504	6247	5835	8912	90505

Citizen-based Watershed Planning and Water Quality Improvement Efforts

Citizen involvement in watershed planning began with the formation of a stakeholder steering committee by FAPRI for its Shoal Creek watershed assessment from 2000-2003. The steering committee consisted of 13 members, including poultry and cattle producers, a veterinarian, Barry County Soil and Water Conservation District (SWCD) board members and local Natural Resources Conservation Service (NRCS) personnel. According to FAPRI, the steering committee was interested in developing a locally-driven WMP to address bacteria issues. The steering committee requested additional baseline data on water quality conditions and information on the decision-making process for identifying economically sound alternatives.

In the late-1990s, MDNR began targeting federal and state grant funds for conservation practices and other BMPs within the Elk River and Shoal Creek watersheds, including upper Shoal Creek watershed. To cite two examples, from 1997-2002 a Barry County SWCD AgNPS Special Area Land Treatment (SALT) project provided education and assistance to landowners on nutrient management issues. From 2002-04, the McDonald County SWCD's Elk River/Shoal Creek Restoration 319 Project implemented best management practices and provided technical and financial assistance to landowners in Elk River and Shoal Creek watersheds.

During development of MDNR's original TMDL, public availability sessions and subsequent monthly meetings were conducted in cooperation with the MDNR. A core group of community leaders, including a few original FAPRI steering committee members, organized what would become the Shoal Creek Watershed Improvement Group (SCWIG). In 2006, SCWIG became a recognized 501(c) (3) non-profit organization with the following mission statement: To improve and protect water quality in the upper Shoal Creek watershed.

SCWIG's initial priority action steps included cost-share beginning to address bacteria in streams related to failing OWTSs and off-stream watering sources for cattle. SCWIG's early focus on eliminating human contributors of bacteria to streams while involving more local stakeholders in efforts to promote volunteer, citizen-led watershed stewardship included the following:

- 2005-2009. MDC grant awarded to the Southwest Missouri RC&D on behalf of SCWIG for partial reimbursement of landowner expenses for septic tank maintenance (pumpouts). The project resulted in over 80 septic tanks being pumped and inspected, primarily in close proximity to Shoal Creek and within Shoal Creek's headwaters and Zerbert Branch HUC-12 sub-watersheds.

- 2006-2012. Southwest Missouri Water Quality Improvement Project (WQIP) included septic system maintenance, repair and replacement landowner cost-share projects, as well as, creek pasture pond demonstration projects within upper Shoal Creek watershed.

- 2008-2012. 319 Subgrant agreement entered with MDNR in November 2008 provides for SCWIG to complete a nine-element WMP, expand OWTS remediation activity, conduct volunteer water quality monitoring, implement public education/outreach activities and create GIS maps for public education and watershed management planning.

In summary, water quality within upper Shoal Creek watershed has been thoroughly studied laying a foundation for community-based watershed management. Numerous conservation practices and other BMPs implemented from 2000-2009, however, were not geo-located or quantified for specific water quality impacts.

An NRCS has a web-based tool for extracting past information on various conservation practices at http://ias.sc.egov.usda.gov/prshome/index.aspx. SCWIG has yet been able to extract past information, but is seeking NRCS assistance to add important information and documentation of progress to address water quality and of remaining high-priority critical areas to be addressed. The development and initial implementation of this WMP during SCWIG's current 319 Subgrant includes coordinating with Barry County NRCS and SWCD to better document the location, number/type and water quality benefits of recently installed agricultural BMPs.

(a) Identification of Causes and Sources of Impairment

The USGS study, *Water Quality in the Upper Shoal Creek Basin, Southwestern Missouri, 1999-2000,* documented fecal coliform bacteria densities at several locations exceeding the state's previous water quality standard for fecal coliform in "whole body contact recreation" designated use streams (200 col/100mL).

This was the study that determined Shoal Creek's total nitrite plus nitrate as nitrogen at base-flow concentrations was significantly higher than other Missouri streams. This study also determined that there was no significant difference in base-flow total phosphorus concentrations between the upper Shoal Creek watershed and other Missouri streams. This USGS study was the first to include DNA research to identify whether bacteria cattle, human or "other" sources.

FAPRI's study, *Upper Shoal Creek Watershed Water Quality Analysis, 2001-2003,* found fecal coliform bacteria concentrations varying mostly between 100 and 800 colonies per 100 mL. Concentrations higher than 1000 col/100 mL were frequently associated with higher flow conditions, even when flow increases were small or moderate. In addition, FAPRI's research analyzed sources of nutrients affecting water quality. Nutrient sources included agricultural NPS (cattle manure and land-applied poultry litter during storm water events), as well as, road/building construction, commercial fertilizers, chemicals and natural vegetation.

FAPRI's analysis also sampled for specific species. A more precise DNA source tracking technique linked DNA sources of bacteria from collected samples to DNA of known sources. The study determined bacteria in upper Shoal Creek come from cattle, poultry, humans, domestic animals and wildlife. Human-source bacteria were identified in 65 out of the 85 samples in proportions from 5 percent to 66 percent of the isolates in the samples. The causes of various sources of fecal coliform bacteria were identified as:

- Cattle standing in and directly depositing manure in streams;
- Cattle manure on pasture lands reaching streams during stormwater runoff events;
- Poultry litter applied on pasture lands reaching streams during stormwater runoff events;
- Domestic animals (e.g., horses, dogs, and pigs) manure reaching streams during stormwater runoff events;
- People's failing septic systems reaching shallow groundwater and streams;
- Wildlife droppings reaching streams during stormwater runoff events.

The figures below display relative proportions of specific sources of fecal coliform from FAPRI's analysis. These figures provide a comparison of summer and winter sampling averages, as well as, a comparison of summer storm and base flow sampling averages (Baffaut, 2009).

FIGURE 5.

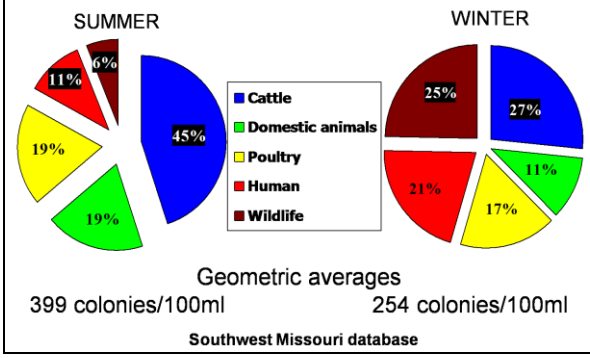
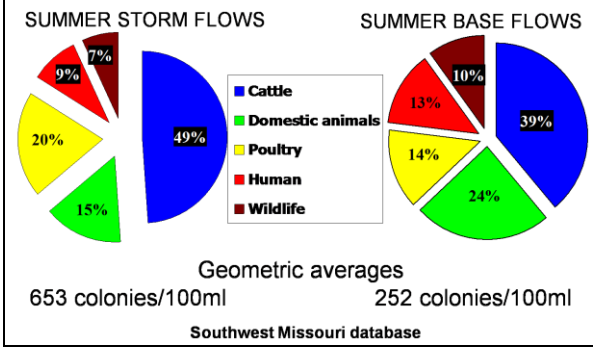


FIGURE 6.



The table below displays variations in the percentages of DNA source tracking host classes from season to season in FAPRI's study.

TABLE 7. Percentages of isolates identified in each host class during different seasons					
Host class	% Cattle	% Domestic animals	% Poultry	% Human	% Wildlife
Winter 2001-2002	19	3	10	27	41
2002 recreation season	40	16	31	6	7
Winter 2002-2003	35	20	25	13	7
2003 recreation season	51	22	6	15	6

Although previous studies focused on (and the TMDL is written for) fecal coliform, the Shoal Creek Watershed NPS WMP will monitor the indicator bacteria - *Eschericia coli* (*E. coli*). The *E. coli* sampling/testing method utilized in this WMP is approved by the EPA and MDNR and is considered an effective and efficient indicator of fecal contamination.

E .coli is one of many bacteria species living in the intestines of warm-blooded animals. *E. coli* aids digestion in their host animals, for example in cattle, *E. coli* helps breakdown forage and feed. *E .coli* can live and grow a limited time outside of the gut in warm, nutrient-rich environments.

There are hundreds of different strains of *E. coli.* Some are harmful, but most are not. The O157:H7 is one strain responsible for making people and animals sick when ingested. The forms of *E. coli* that can cause illness are known as pathogenic. Not all *E. coli* are pathogenic.

There are three wastewater treatment plants located within upper Shoal Creek watershed that are permitted by the MDNR and may be potential sources of bacteria and nutrient loads in streams. The table below summarizes information on these facilities.

TABLE 8. Wastewater treatment plants in upper Shoal Creek watershed				
Facility Name	Permit #	Facility Type	Effective Date	Expiration Date
Village of Butterfield	12692	Re-circulating sand filter, chlorination, de-chlorination, sludge disposal by contract hauler	5/16/2008	5/15/2013
Camp Barnabas	125164	Re-circulating sand filter, chlorination, sludge disposal by contract hauler	3/13/2009	1/29/2014
George's Processing	108618	No-discharge storage & irrigation system (design capacity 2.8 mgd)	6/20/2008	6/19/2013

In summary, extensive previous scientific studies have clearly identified the causes and sources of water quality impairments, stressors and threats within upper Shoal Creek watershed. These studies suggest a variety of conservation measures and best management practices are needed to address the multiple causes and sources of water quality degradation in the watershed.

(b) Estimates of Pollutant Load Reduction

The TMDL for upper Shoal Creek watershed was completed for fecal coliform bacteria and approved by U.S. EPA (MDNR 2007). The TMDL establishes stream load capacity, waste load

allocation, load allocation and the margin of safety of fecal coliform for the upper Shoal Creek (main stem), Joyce Creek, Pogue Creek and Shoal Creek Headwaters. The TMDL also determined the load reduction results that are necessary to meet the water quality standards.

The 2004 FAPRI study evaluated the potential affect of various management practices on fecal coliform bacteria concentrations in the upper Shoal Creek watershed using the Soil and Water Assessment Tool (SWAT) model. This analysis and approach was later adopted and incorporated by the state of Missouri in the TMDL for the upper Shoal Creek (MDNR, 2007). The SWAT modeling examined four scenarios with varying degrees of alternative management practice implementation strategies to determine which level of BMP implementation was necessary to respect water quality standards. The four scenarios evaluated are detailed in the table below.

TABLE 9. FAPRI study's modeling scenarios

Scenario	% Reduction in Septic Discharge	% Reduction in Cattle in Streams	% Reduction in NPS Load
# 1	100%	50%	50%
# 2	100%	100%	50%
# 3	100%	50%	66%
# 4	100%	100%	66%

The SWAT modeling indicated that by removing all septic discharge sources of bacteria, at least 50 percent of the cattle from the stream and achieving a 66 percent reduction in nonpoint surface loading would result in meeting water quality standards (scenarios 3 and 4). If implemented, then these scenarios would result in 85 to 90 percent of the samples being less than the 200 col/100 ml of fecal coliform.

Since the completion of the upper Shoal Creek TMDL, Missouri has updated water quality standards for protection of whole body contact and secondary contact recreation from fecal coliform bacteria to *E. coli* bacteria. This change does not affect the analysis since these two forms of bacteria commonly occur together and the methods of reducing them are similar. Therefore, using the TMDL analysis and SWAT modeling to project estimated load reductions in are appropriate. Water quality criteria for *E. coli* bacteria are levels below the whole-body contact standard of 126 col/100mL water as a geo-mean of at least five (5) samples or 235 col/100mL water for a single, one-time sample.

The Watershed Management Plan Approach

To help establish bacteria load reduction goals and to assist in determining the type and number of conservation practices needed for bacteria load reduction, FAPRI's Scenario #3 has been selected. Effective implementation of BMPs recommended under Scenario #3 would reduce bacteria levels below the water quality criteria for whole body contact recreation and satisfy MDNR's TMDL.

Scenario #3: *100% reduction in septic discharge*
50% reduction of cattle standing in the streams
66 % reduction of the nonpoint source load

Nonpoint source loads:

There are numerous potential NPS pollutants in the upper Shoal Creek watershed, including cattle, poultry litter, failing OWTSs, other domestic animals and wildlife. The FAPRI study isolated and quantified these various NPS pollutant contributions through DNA source tracking. The table below shows the relative contribution of fecal bacteria loads from various NPS at different stream flow levels.

TABLE 10. Bacteria loadings from each source

Flow type	Base flow	Medium flow	Storm flow
Cattle in streams	82	31	1
Sanitary sewage	17	6	0
Grazing cattle	1	63	28
Poultry litter	0	0	71
All sources	100%	100%	100%

Cattle Load Contributions

According to the Barry County NRCS field office, there are an estimated 5,000 cattle and 300 horses located in the upper Shoal Creek watershed (NRCS, 2009-2012). These livestock estimates are similar to the estimates used in the 2004 FAPRI study and in the 2007 TMDL for upper Shoal Creek watershed.

The FAPRI analysis separated nonpoint contributions from cattle into two categories: 1) direct input with cattle wading in streams; and, 2) indirect input from grazing cattle by runoff. The DNA source tracking combined with FAPRI's analysis indicated that 82 percent of the bacteria loading during base flow were attributed to cattle standing and wading in the stream.

It is estimated that 10 percent of the total watershed cattle population (500 cattle) had stream access during the recreational season and three percent of the cattle (150 cattle) had access during the winter. Grazing cattle contribution to the bacteria load was most substantial during periods of storm water runoff. It was estimated that grazing cattle contributed 28 percent of the total bacteria load during storm events and a surprising 63 percent during flows between storm flows and base flow.

Poultry Load Contributions

Another significant bacteria source is from land-applied poultry litter. According to the Barry County NRCS field office, there are an estimated 1.1 million poultry located in the upper Shoal Creek watershed. FAPRI's analysis noted poultry litter contributions to streams were particularly apparent during storm events, where overland runoff delivers these contributions to streams. There are approximately 80 poultry producers in the watershed ranging in size from only one poultry house to Class 1B Concentrated Animal Feeding Operation (CAFO) poultry operations (14 to 30 poultry houses). There are approximately 325 poultry houses in the watershed which have been inventoried by MDNR. Each poultry house produces as estimated 120-125 tons of litter per year.

FAPRI also noted the southern portion (upstream section) of the watershed had the highest poultry litter application rates. Poultry litter contributions were largest during storm flow events when it contributed an estimated 71 percent of the bacteria load. According to the Barry County NRCS field office, nearly one-half the poultry litter generated in upper Shoal Creek watershed is exported to croplands to the north and outside of the Shoal Creek watershed. In most instances, state regulations require soil testing as a requirement of land application of poultry litter to grasslands.

Septic Tank Load Contributions

The Missouri Office of Social and Economic Analysis (OSEDA) estimates that there are 35,881 people currently living in Barry County. The 2000 Census for Barry County indicates that there were 15,964 housing units of which 13,398 were occupied. These housing units were estimated to be occupied by 2.51 people on average. An estimated 67 percent of these households are not connected to the public sewage system, representing 9,030 housing units. Assuming an even distribution of these housing units, the number of OWTSs in upper Shoal Creek watershed is estimated at 1,642.

According to the Barry County Health Department (BCHD), there are approximately 500-750 failing OWTSs in the upper Shoal Creek watershed. Many OWTSs in the watershed are believed to be the original, 500-gallon steel septic tanks with under-sized lateral/soil treatment fields installed in the 1950s-60s and -1970s. These original OWTSs, and those that have not been maintained for decades, result in failure of these systems. Failing systems, especially those located near streams, are responsible for the human source bacteria loadings in streams. The exact number of OWTSs in the upper Shoal Creek watershed located near streams has not been determined.

(c) Nonpoint Source Management Measures

The water resource goals of this WMP (restoring streams to state water quality standards; and, promoting wise-watershed stewardship practices throughout the entire upper Shoal Creek watershed planning area), will be achieved by implementing a variety of conservation practices to address the multiple causes of water quality degradation. Recommended NPS management measures and implementation strategies for the primary sources of NPS bacteria load are discussed below.

Appendix 5 (pages 37-40) displays maps of each of the four HUC-12 watersheds identifying 100 ft. stream buffers with vegetated and un-vegetated riparian zones. The high-priority critical areas of this WMP are the un-vegetated riparian zones within the 100 ft. stream buffers. In each of the HUC-12 watersheds, there are additional priority areas for reducing NPS bacteria loads from cattle, poultry and humans that will be addressed as landowners sign-up for conservation measures and as technical and financial resources are made available for implementation.

As more monitoring and watershed assessment work is conducted, the WMP will be revised to incorporate the number and types of BMPs needed to achieve targeted pollutant load reductions.

Cattle Contributions

E. coli bacteria contributions from cattle have been identified to come from two primary sources: livestock wading in streams; and, surface runoff from nearby pastures. These sources will be addressed by agricultural producers participating in a variety of conservation practices. See Appendix 4 (page 36) for a list and description of many cost-share practices available to agricultural producers.

Specifically, the goal of this WMP regarding livestock bacteria contributions is to remove 50 percent of cattle (250 head) from the stream and to reduce 66 percent of the bacteria load from cattle grazing in nearby pastures. These load reductions will be accomplished by landowner education, implementation of conservation measures and practices and development of innovative, relatively inexpensive approaches to watershed stewardship. Conservation measures and other BMPs will help reduce both base flow and storm flow bacteria loads to streams caused by livestock. Conservation measures and cost-share practices available from state and federal government agencies include the following:

- Vegetative Filter Strips
- Field Border
- Riparian Forest Buffer
- Planned Grazing Systems
- Nutrient Management Plans
- Stream Protection - Livestock Exclusion
- Alternative Water Sources

The upper Shoal Creek watershed is composed of four 12-digit HUC sub-watersheds all of which have impaired streams segments listed for bacteria (see table below). These four sub-watersheds are dominated by grassland and are believed to be critical areas for targeting the implementation of conservation practices by livestock producers to reduce bacteria pollutant loads.

TABLE 11. Sub-watersheds targeted for ag conservation practices & other BMPs

Land use in acres & stream miles	HUC-12 sub-watersheds				
	Shoal Creek Zerbert Branch	Shoal Creek Headwaters	Pogue Creek	Joyce Creek	Totals
Forest	2,808.20	1,442.24	600.32	79,632.00	84,482.76
Grassland	16,201.80	11,406.00	6,903.68	9,157.68	43,669.16
Total (acres)	19,010.00	12,848.24	7,504.00	88,789.68	128,151.92
Stream miles	13.5	4	2.5	5	25

Several of the conservation practices listed above would have a positive impact on water quality for bacteria loads from livestock. Some of these practices would help reduce both direct (livestock wading in streams) and indirect sources (via runoff) bacteria.

Other practices would involve moving cattle either out of or further away from streams and/or the construction of inexpensive runoff abatement practices that capture and filter runoff before entering streams. An innovative success of SCWIG has been the use of shallow creek-pasture

ponds which capture and store surface runoff while serving as off-stream water supplies for livestock. Many of these conservation practices provide additional community benefits (see Appendix 3 – page 35).

The figure below shows tracts of primarily pastureland located in the upper portion of Shoal Creek – Zerbert Branch HUC-12 watershed. In 2012, a large portion of this land (northeast of Wheaton between Hwy 97 and Farm Road 1090) is being enrolled into the EQIP program for planned grazing systems and removal of cattle access to Shoal Creek. There are similar sites in this and other HUC-12 watersheds that are appropriate locations for conservation measures and other cost-share practices.

Figure 7. Shoal Creek-Zerbert Branch Example Priority Area for Cattle Exclusion

The offices of the Barry County and Newton County NRCS and SWCD provide specific technical and financial assistance to eligible landowners in portions of the upper Shoal Creek watershed. Current SWCD priorities for landowner assistance include practices related to establishing/improving vegetative cover, intensive grazing systems and waterway erosion/water control.

A relatively new practice, WQ10 Stream Protection/Livestock Exclusion, provides for permanent fences along streams to exclude livestock, pipeline, pressure system, pump and well needed to get water for livestock and $500 per acre incentive to exclude livestock and allow riparian area to regenerate naturally.

Ultimately, the amount of acres receiving conservation practices and other BMPs, as well as, the number and type of those practices, will depend on landowner willingness to participate and the availability of technical and financial assistance from state and federal agencies.

Poultry Contributions

Sampling and watershed modeling show that the bacteria load contribution from poultry litter is particularly significant during storm events. However, the overall poultry litter contribution might be overestimated since FAPRI applied a relatively high bacteria count for poultry litter in their modeling to estimate a worst-case scenario.

Specifically, the goal of this WMP regarding poultry litter bacteria contributions is to remove 66 percent of poultry litter bacteria load from entering streams. This will be accomplished by landowner education and implementation of various conservation practices that target reducing bacteria concentration in litter and reducing storm flow runoff.

Much work has already been accomplished in upper Shoal Creek watershed to address poultry litter contributions and conditions have likely changed since completion of the TMDL. Over the past decade significant progress has included educating and training poultry producers in nutrient management, manure composting, determining land application rates through soil tests and exporting litter out of the watershed. Practices such as litter composting greatly reduces bacteria concentrations entering streams.

Figure 8. Joyce and Woodward Creeks headwater Example Priority Area for Poultry Litter

It is unlikely that poultry contributions have been completely addressed, so further reductions of bacteria contribution will require careful adherence to sound practices for storage and land application. MDNR permit restrictions normally include separation distances for land application of litter that must be strictly observed.

These separation distances are listed below:

- 300-ft from losing streams, sinkholes, caves, wells, abandoned wells, water supply structures or impoundments
- 100-ft from permanent flowing streams
- 50-ft from intermittent flowing streams
- 50-ft from property lines
- 100-ft from a privately owned impoundment not used as a water supply
- 150-ft from dwellings or public use areas if applied with spray irrigation systems
- 50-ft from dwellings or public use areas if application is by tank wagon or solid spreader

Septic System Load Contributions

The bacteria contributions from human-source *E. coli* bacteria will be addressed through the removal and remediation failing OWTSs. To begin addressing this issue, SCWIG implemented a landowner cost-share program targeting unmaintained and failing OWTSs. Specifically, cost-share is offered for partial reimbursement of costs associated with having septic tanks pumped and inspected for repairs, as well as, for conducting major repairs or replacements of failing systems. The figure below displays locations of previous septic tank pumpouts. The majority of septic system maintenance and remediation projects are in close proximity to impaired streams.

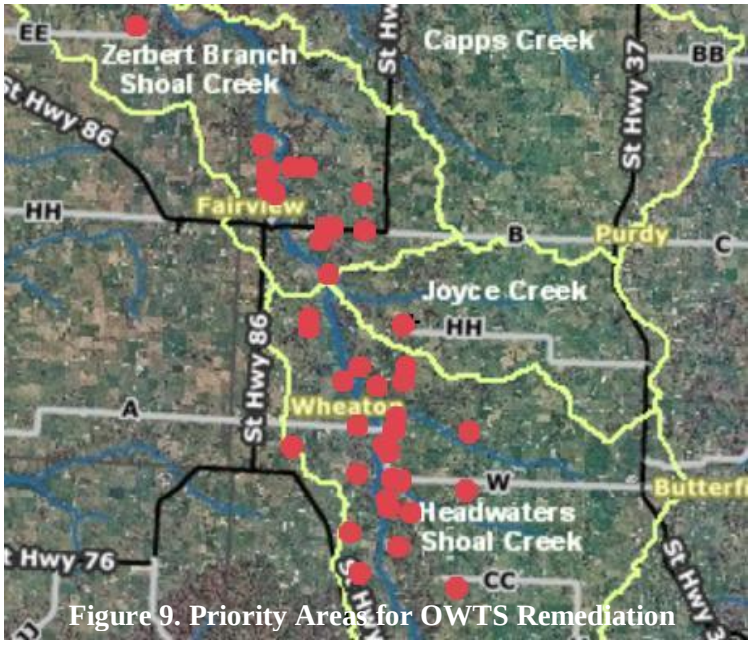


Figure 9. Priority Areas for OWTS Remediation

Prioritizing target areas for addressing septic system load contribution are: 1) one half-mile from impaired streams and Karst features; 2) one half-mile from any classified stream.

(d) Technical and Financial Assistance Needed
(e) Information, Education/Outreach and Public Participation
(f) Implementation Schedule and
(g) Interim Milestones

The next four elements of the WMP have been combined since they are linked as overall strategies for water quality improvements within upper Shoal Creek watershed. Significant amounts of technical and financial assistance will be needed over the course of the eight year implementation timeframe.

For agricultural producers and riparian landowners, technical assistance will come primarily from state and federal agencies, such as Barry County NRCS/SWCD and MDC, as part of cost-share assistance available to landowners establishing BMPs and other conservation practices. SCWIG professional staff will provide organizational support to SCWIG, as well as, technical assistance to landowners related to OWTS maintenance and remediation cost-share assistance programs.

Information, Education/Outreach and Public Participation

The success of the WMP for upper Shoal Creek watershed will depend on effective information, education/outreach and public participation activities. The table below displays Phase 1 information, education/outreach and public participation priorities and schedule for implementation. The majority of short-tem information, education/outreach and public participation activities are included in SCWIG's 319 Subgrant from November 2008 through December 2012.

TABLE 12. Phase 1 Information, Education/Outreach and Public Participation Activities/Schedule

Activities	Schedule
Landowner and community stakeholder meetings, direct mailings	Semi-annually
Newsletters, press releases, website and GIS map updates	Quarterly or semi-annually
Stream Team formation and other volunteer activities	Annually, ongoing
Promote conservation practices and other BMPs to agricultural producers, riparian landowners and poultry litter spreaders	Annually, ongoing
Promote consideration of revisions to BCHD ordinance for inspections at real estate transactions	Annually, ongoing

Evaluation of Phase 1 information, education/outreach and public participation activities will be conducted both quantitatively and qualitatively. The table on the following page summarizes evaluation of these activities:

TABLE 13. Phase 1 Information, Education/Outreach and Public Participation Evaluation	
Activities	Evaluation measures
Landowner and community stakeholder meetings at least annually	Public participation at landowner and community stakeholder meetings
Regular media releases, news articles, direct mailings, website and GIS map updates	Number of published news articles, direct mailings to landowners and number of website updates and website traffic
Stream Team and other volunteer activities	Amount of Volunteer participation in stream team and related activities
Promote conservation practices to agricultural producers and riparian landowners	Communications and meetings with Barry County NRCS and SWCD
Promote consideration of revisions to BCHD ordinance for inspections at real estate transactions	Communications and meetings with Barry County Health Department and Barry County Commission

Phase 1 Costs. The costs for Phase 1 information, education/outreach and public participation activities are estimated to be approximately $20,000-$25,000 per year. These estimated costs are outlined in the table below:

TABLE 14. Phase 1 Costs for Information, Education/Outreach and Public Participation	
Activities	Estimated Costs
Professional staff (one watershed manager employee ¼ FTE)	$17,500 per year
Mileage estimated at $200 per month	$2,400 per year
Supplies, printing, postage	$2,100 per year
*Training seminars on nutrient and manure management and stream dynamics f*or room rental, supplies	$1,500 per year

Phases 2 (2014-2018) information, education/outreach and public participation activities will include bacteria and other NPS pollutants. Implementation activities and schedule for Phase 2 information, education/outreach and public participation are outlined the table below:

TABLE 15. Phase 2 Information, Education/Outreach and Public Participation Activities/Schedule	
Activities	Schedule
Landowner and community stakeholder meetings, direct mailings	Semi-annually
Newsletters, press releases, website and GIS map updates	Quarterly or semi-annually
Stream Team and other volunteer activities	Annually, ongoing
Targeted training seminars for agricultural producers, riparian landowners and poultry litter spreaders on conservation practices	Annually, ongoing
Promote conservation practices and other BMPs to agricultural producers, riparian landowners	Annually, ongoing
Voluntary documentation of amounts of poultry litter land-applied locally and amounts transported out of the upper Shoal Creek watershed	Annually, ongoing

Evaluation of Phase 2 information, education/outreach and public participation activities will be conducted both quantitatively and qualitatively. The table below summarizes evaluation of these activities.

TABLE 16. Phase 2 Information, Education/Outreach and Public Participation Evaluation	
Activities	Evaluation measures
Landowner and community stakeholder meetings at least annually	Public participation at landowner and community stakeholder meetings
Regular media releases, news articles, direct mailings, website and GIS map updates	Number of published news articles, direct mailings to landowners and number of website updates and website traffic
Stream Team and other volunteer activities	Amount of Volunteer participation in stream team and related activities
Targeted training seminars for agricultural producers, riparian landowners and poultry litter spreaders on conservation practices	Attendance/participation by targeted audiences and local resource agencies in targeted training seminars
Conservation practices implemented by agricultural producers and riparian landowners	Number/type of conservation measures installed by agricultural producers and riparian landowners NRCS, SWCD and MDC
Voluntary documentation of amounts of poultry litter land-applied locally and amounts transported out of the upper Shoal Creek watershed	Documentation of amounts and locations of poultry litter spread within and outside the watershed

Phase 2 (2014-2018) Costs. The costs of Phases 2 information, education/outreach and public participation activities are estimated to be approximately $20,000-$25,000 per year. These estimated costs are outlined in the table below:

TABLE 17. Phase 2 Costs for Information, Education/Outreach and Public Participation	
Activities	Estimated Costs
Professional staff (one watershed manager employee ¼ FTE)	$17,500 per year
Mileage estimated at $200 per month	$2,400 per year
Supplies, printing, postage	$2,100 per year
Training seminars on nutrient and manure management and stream dynamics for room rental, supplies	$1,500 per year

Phase 1 Implementation Schedule and Interim Milestones include several priority actions and activities, including the following:
1) to implement SCWIG 319 Subgrant landowner cost-share practices for OWTS maintenance and remediation of failing septic system;
2) to establish interactive online GIS mapping application to host WMP pollutant loads, load reductions goals and critical areas for targeted BMPs; and,
3) to conduct monthly water quality sampling at six sites along the main stem of upper Shoal Creek.

The schedule for Phase 1 WMP implementation and interim milestones are outlined in the table below:

TABLE 18. Phase 1 Implementation Schedule and Interim Milestones	
Interim Milestone	Implementation Schedule
Revise and update WMP, incorporating recent OWTS remediation projects, creek pasture ponds, water quality data	07/31/2013
Establish website and online GIS mapping application with website and interactive GIS base map with WQ data and WMP information online	07/31/2013
Train volunteers and conduct stream WQ monitoring for *E. coli* bacteria and other WQ parameters, work with stakeholders, MDNR, Crowder College, the Poultry Federation and Barry and Newton County Health Departments to design sample plan for collection of monthly sampling	07/31/2013
Seek funding to support additional OWTS maintenance and remediation projects and agricultural and riparian corridor BMPs and conservation practices	07/31/2013
Remediate failing OWTS with cost-share projects. Conduct 40 pumpouts and 30 replacements of failing systems	07/31/2013
Increase public participation, volunteer activities. Produce annual report summarizing WMP activity, levels of public involvement, landowners investments in BMPs and community support of stream water quality improvement	07/31/2013
Locate farms and encourage BMPs for removing cattle from the streams and reducing runoff from pasture lands. Work with Barry County SWCD, other state/federal agencies and landowners to remove 100 cattle from streams in the watershed	07/31/2013
Encourage conservation practices and other BMPS to riparian landowners. Identify riparian landowners and send semi-annual direct mailings	07/31/2013
Assist in the implementation of conservation practices to reduce NPS pollution from pasture lands. Work with area Barry County SWCD and landowners to install NPS controls on five separate pastures and fields	07/31/2013
Encourage conservation practices and other BMPS to agricultural producers through direct contact and through partnering agencies/organization. Promote vegetated filter strips, move livestock feeding areas away from the streams, localized fencing, improved pasture management, ponds/flood retention, CNMPs, soils tests/ nutrient management	07/31/2013

The majority of costs for Phase 1 implementation activities are included in SCWIG's 319 Subgrant from November 2008 through December 2012. The cost of the installation of agricultural BMPs will depend on the type and number of BMPs selected by willing landowners and the availability of technical and financial resources from NRCS/SWCD and MDC.

The Phase 2 (2014-2018) interim milestones and implementation schedule are largely continuation and expansion of priorities begun during Phase 1 (2009-2013). The table below provides more detail on Phase 2 interim milestones and implementation schedule

TABLE 19. Phase 2 Implementation Schedule and Interim Milestones	
Interim Milestone	Implementation Schedule
Revise and update WMP, incorporating recent OWTS remediation projects, creek pasture ponds, water quality data and other BMPs	06/30/2014 (annually)
Update website and online GIS mapping application with WQ data and WMP information	06/30/2014 (annually)
Seek funding to support additional OWTS maintenance and remediation projects and agricultural and riparian corridor BMPs and conservation practices	06/30/2014 (annually)
Increase public participation and volunteer activities. Produce annual reports summarizing WMP activity, levels of public involvement, landowners investments in BMPs and community support for WMP and stream water quality improvements	06/30/2014 (annually)
Locate farms and encourage BMPs for removing cattle from the streams and reducing runoff from pasture lands. Work with Barry County SWCD, other state/federal agencies and landowners to remove 100 cattle from streams in the watershed	06/30/2014 (annually)
Train volunteers and conduct stream WQ monitoring for *E. coli* bacteria and other WQ parameters, work with stakeholders, MDNR, Crowder College, the Poultry Federation and Barry and Newton County Health Departments to design sample plan for collection of monthly sampling by	06/30/2014 (annually)
Encourage conservation practices and other BMPS to riparian landowners. Identify riparian landowners and send semi-annual direct mailings	06/30/2014 (annually)
Assist in the implementation of conservation practices to reduce NPS pollution from pasture lands. Work with area Barry County SWCD and landowners to install NPS controls on five separate pastures and fields.	06/30/2014 (annually)
Encourage conservation practices and other BMPS to agricultural producers through direct contact and through partnering agencies/organization. Promote vegetated filter strips, move livestock feeding areas away from the streams, localized fencing, improved pasture management, ponds/flood retention, CNMPs, soils tests/ nutrient management	06/30/2014 (annually)

The costs for Phase 2 WMP implementation are expected to come primarily from NRCS, SWCD and MDC cost-share incentive programs for landowners choosing to install BMPs and other conservation measures. In addition, 319 incremental grant funds are anticipated for some of the costs associated with WMP updates and related WMP implementation activities.

The Phase 2 costs for watershed management plan implementation are listed in the table below:

TABLE 20. Phase 2 Costs for Watershed Management Plan Implementation	
Activities	Estimated Costs
Professional staff (one watershed manager employee ¼ FTE)	$17.500 per year
Mileage estimated at $200 per month	$2,400 per year
Supplies, printing, postage	$2,100 per year
Website and online GIS mapping application updates	$2,000 per year
NRCS/SWCD and MDC professional staff technical assistance targeting Shoal Creek watershed	$45,000 per year
Landowner cost-share incentives for agricultural BMPs and other conservation measures	$65,000 per year
Water quality monitoring (VWQMP/CSI)	$1,500 per year
Professional water quality monitoring	$12,000 per year for three year study

(h) Load Reduction Evaluation Criteria

The proposed load reduction of bacteria for upper Shoal Creek watershed will be evaluated through water quality monitoring. In Phase 1, this will be conducted by SCWIG's VWQMP/CSI water quality monitoring at six sites along Shoal Creek. The success of this WMP will depend on collecting quality monitoring data from which to measure progress toward attaining state water quality standards. The primary criterion for success will be based on having consistent *E.coli* sampling at or below state water quality standards.

Phase 1 – 2009-2013

- Trained volunteers will conduct water quality monitoring for *E.coli* at six sampling sites one time per month during the recreational season. Periodic macro-invertebrate sampling will add to temporal baseline data on nutrient loads and general stream health. The EPA-approved IDEXX technique to determine most probable number (MPN) of bacteria is being used in the short-term.
- Installation, maintenance, and effectiveness of conservation practices and other BMPs by landowners participating in the OWTS cost-share program will be documented qualitatively and quantitatively by SCWIG during the course of the 319 Subgrant.
- SCWIG will rely on tracking documentation and reporting from the Barry County offices of the NRCS, SWCD and MDC for conservation practices and other BMPs initiated by agricultural producers and riparian landowners participating in these respective cost-share assistance programs.

Bi-annual reviews of WMP progress and WMP updates will be done by a steering committee composed of interested stakeholders and representatives of local resources agencies. Opportunities for public input on WMP reviews and updates will include web-based information and traditional media outlets, such as newspaper articles.

Phase 2 – 2014-2018

- Volunteer water quality monitoring for *E.coli*, nutrients and other biological and chemical parameters will be expanded in frequency and the number of monitoring sites.
- Bacteria and nutrient load reduction criteria will be applied to specific conservation practices and BMPs implementation projects, such as vegetative filter strips, riparian buffer plantings and livestock exclusion installed on targeted pasture acres and riparian zones.

(i) Water Quality Monitoring Component

Initial determination of progress toward the goal of reducing bacteria pollutant loads to conform to state standards will be done through the current VWQMP being conducted in SCWIG's 319 project. The VWQMP provides a foundation for future water quality monitoring efforts. Future monitoring will be the basis for determining progress in reducing bacteria pollutant loads.

A final component of pollutant load reductions will be site-specific monitoring of management measures and practices that are installed during the implementation of SCWIG's 319 Subgrant. Whether related to replacement of failing OWTSs or creating off-stream watering sites for livestock, where practicable, monitoring will be conducted to document water quality improvements resulting from installation of specific management measures and practices.

The Quality Assurance Project Plan (QAPP) for the VWQMP will be available on the upper Shoal Creek watershed website, along with the final WMP, upon acceptance by MDNR of the WMP. This project involves a Cooperative Stream Investigation (CSI) volunteer water quality monitoring program as a means of developing the capacity within the local community to provide for on-going sampling and testing for *E.coli* bacteria.

The current VWQMP includes monthly water quality sampling at six monitoring sites displayed in the figure below. Two of the six monitoring sites (above Woodward Creek and at Highway 97 Bridge) were monitoring sites in previous water quality investigations. Continuing water quality monitoring at those two sites allows comparisons of past data with current sampling results.

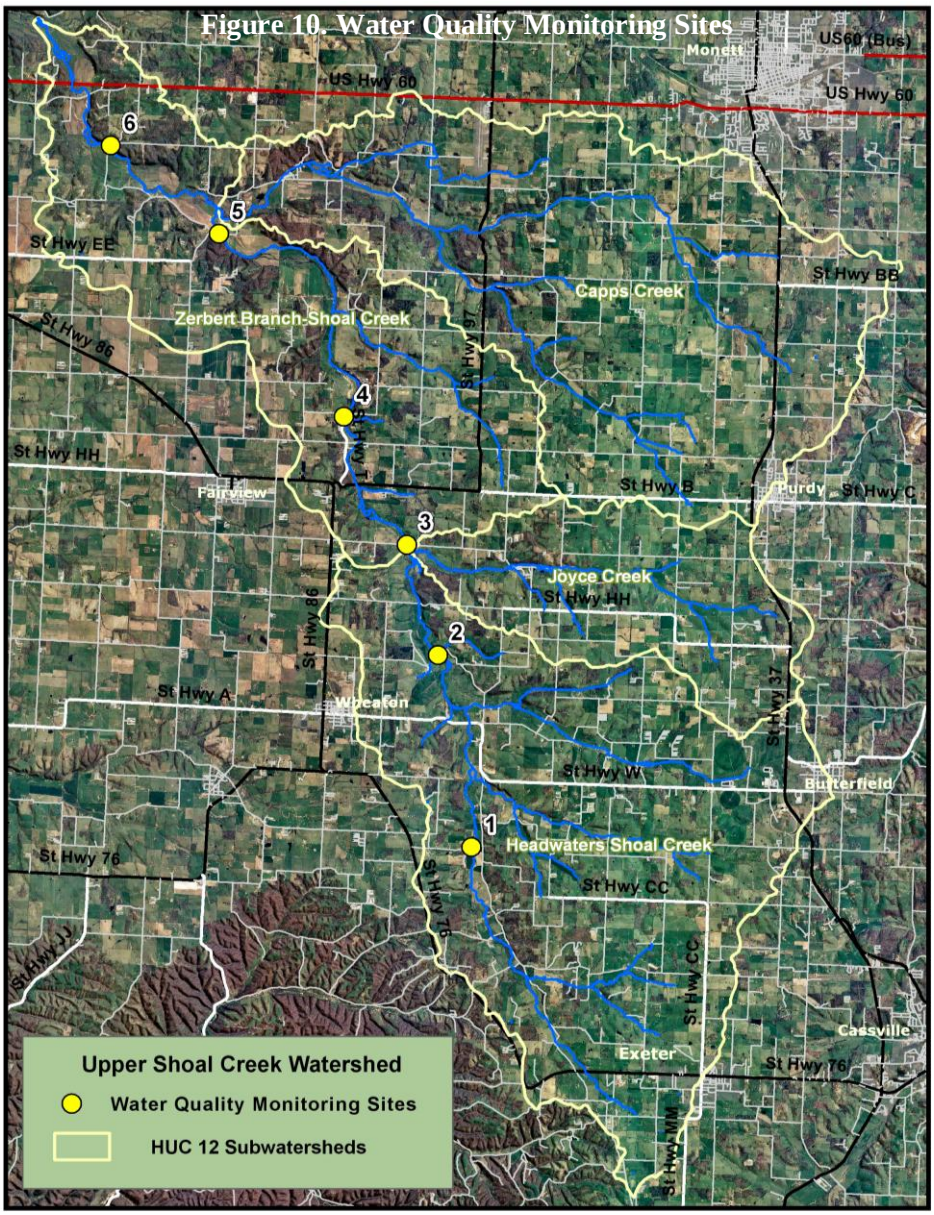
Bacterial Sampling: One-hundred milliliter grab samples shall be collected once/month during the recreational season (April 1-October 31), for the life of the project. Efforts will be made to sample a variety of flow conditions. Sampling will be conducted by a volunteer trained in the Volunteer Water Quality Monitoring - Cooperative Stream Investigation protocol.

During Phase 2 (2014-2018), water quality monitoring activities include expanded volunteer monitoring and possibly new professional scientific investigations. The volunteer water quality monitoring activity will be expanded in terms of frequency of sampling, sampling locations along upper Shoal Creek and main tributaries.

Specific sampling design of the future water quality investigations will be determined by the local stakeholders, including local resource agencies, but may include:

- Stream discharge, stream stage, precipitation (These measurements will help identify relationship between rainfall/stream level and *E.coli* counts;
- Physical and chemical parameters at least four times per year; and,
- Invertebrate sampling following MDNR sampling protocol (done in close proximity to physical and chemical sampling).

The figure below displays the monitoring sites for SCWIG's current voluntary water quality monitoring program.



Appendix 1 - Acronyms

BCHD	Barry County Health Department
BMPs	Best Management Practices
CSI	Cooperative Stream Investigation
EPA	U.S. Environmental Protection Agency
ERC	Environmental Resources Coalition
ERWIA	Elk River Watershed Improvement Association
FAPRI	Food Agriculture Policy Research Institute
MDC	Missouri Department of Conservation
MDNR	Missouri Department of Natural Resources
MPN	Most Probable Number
NPS	Non-Point Source
NRCS	Natural Resources Conservation Service
OSEDA	Missouri Office of Social and Economic Analysis
OWTS	Onsite Wastewater Treatment System (commonly known as a septic system)
QAPP	Quality Assurance Project Plan
RC&D	Southwest Missouri Resource Conservation and Development Council
RUSLE	Revised Universal Soil Loss Equation
SCWIG	Shoal Creek Watershed Improvement Group
SOP	Standard Operating Procedures
SWCD	Barry County Soil and Water Conservation District
TMDL	Total Maximum Daily Load
USGS	United States Geological Survey
VWQMP	Volunteer Water Quality Monitoring Program
WMP	Watershed Management Plan
WQIP	Southwest Missouri Water Quality Improvement Project

Appendix 2 - EPA's Nine-Elements of Watershed Management Planning

The nine elements of a comprehensive watershed plan per FY03 EPA Guidance include:

a. An identification of the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in this watershed-based plan.

b. An estimate of the load reductions expected for the management measures described under paragraph (c) below.

c. A description of the NPS management measures that will need to be implemented to achieve the load reductions estimated under paragraph (b) above and an identification (using a map or a description) of the critical areas in which those measures will be needed to implement this plan.

d. An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement this plan.

e. An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the NPS management measures that will be implemented.

f. A schedule for implementing the NPS management measures identified in this plan that is reasonably expeditious.

g. A description of interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented.

h. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standards and, if not, the criteria for determining whether this watershed-based plan needs to be revised or, if a NPS TMDL has been established, whether the NPS TMDL needs to be revised.

i. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (h) immediately above.

Appendix 3 - Community Benefits of Conservation Practices and Water Quality BMPs

Broader community benefits can be realized through citizen-based watershed management and water quality improvement efforts to reduce bacteria, nutrient loads and other NPS pollutants in streams.

Among the numerous water quality and other benefits include the following:

- Keeping nutrients on the land, instead of running off to neighbors land or to streams
- Providing for off-stream water sources for livestock
- Reducing stream bank erosion by reducing peak stream flows and velocities during storm events
- Reducing livestock watering demand on groundwater and increasing aquifer recharge
- Demonstration dry hole structure with storage tanks and watering tanks below
- Monitoring water quantity and quality coming into the structure and leaving the structure for nutrient removal (especially phosphorus & nitrogen)
- Demonstrating examples of nutrient removal rates with site-specific monitoring
- Increasing carbon sequestration in constructed wetlands that meet criteria for flooding frequency and duration
- Warm season grass plantings that tolerate flooding improve wildlife nesting while providing forage in summer months after nesting periods
- Providing ponds, alternative watering, or ephemeral pools protected by various fencing options and harvest or grazing by haying or flash-grazing after wildlife nesting
- Stabilizing road ditches with excessive erosion reducing sediment loads
- Providing water supplies for rural fire districts
- Improving insurance ratings with rural fire districts

Appendix 4 –Cost-Share Practices – list and description

DSL-1: Permanent Vegetative Cover Establishment. If eligible, cost-share assistance is authorized for lime and fertilizer (by soil test results), eligible seed, seeding operations and seedbed preparation. Cost-share assistance is limited to the minimum amount of lime, fertilizer and seed needed to establish adequate cover to control erosion.

DSL-2: Permanent Vegetative Cover Improvement. If eligible, cost-share assistance is authorized for seeding of legumes into permanent vegetation and for lime, fertilizer (by soil test results) and chemicals necessary to establish legumes. Cost-share assistance limited to the minimum amount of lime, fertilizer and seed to establish adequate cover to control erosion.

DSP-2: Permanent Vegetative Cover Enhancement. Cost-share is limited to 80 acres per landowner for this practice. If eligible, cost-share assistance is authorized for minimum and necessary legume seed, lime and fertilizer (by soil test results) needed to perform the practice. Practice applicable only to pastureland where vegetative cover is in poor or very poor condition with less than 30 percent legumes.

DSL-11: Permanent Vegetative Cover (Critical Areas). If eligible, cost-share assistance is applicable for critical areas such as gullies, banks, roadsides, field borders and similar problem areas on farms. Cost-share is authorized for measures needed to stabilize a source of sediment, such as grading, shaping and filling; the establishment (including lime and fertilizer) of grasses; mulching; trees or shrubs; or fencing to exclude livestock from new plantings.

DFR-5: Woodland Protection through Livestock Exclusion. This practice is designed to protect soil and plant resources from grazing by domestic livestock. If eligible, cost-share is authorized for plantings to correct immediate erosion problems, and the necessary seed or seedlings. Also, authorized is field fencing to exclude livestock from woodland that lies within an existing functional interior or property line fence.

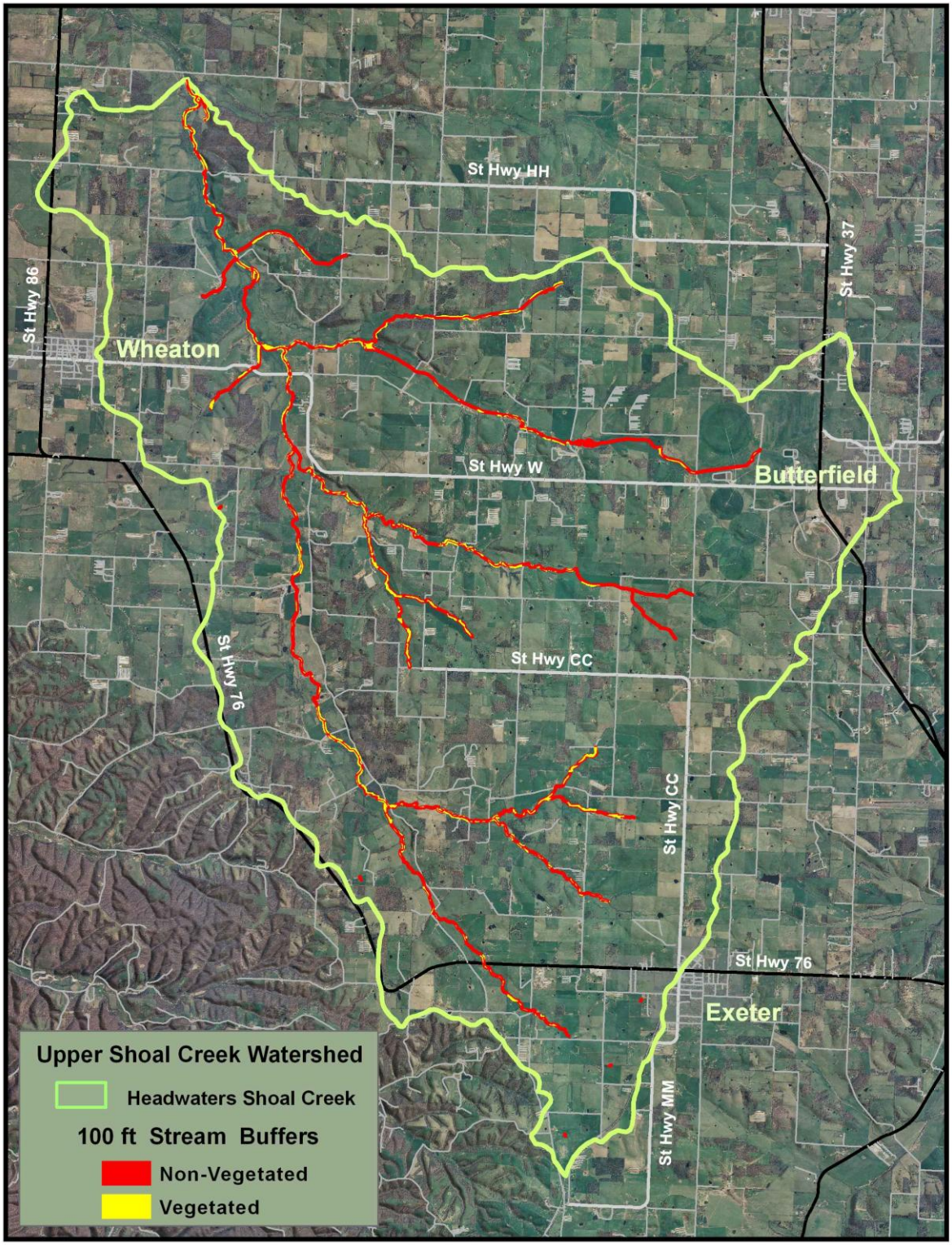
DSP-3: Planned Grazing Systems Practice. System manager must first attend a University of Missouri Grazing School before being eligible for cost-share assistance through this practice. The system manager is the person responsible for the day-to-day management of the grazing system. This manager may or may not include the landowner. If eligible, cost-share is authorized for interior fencing costs, rapid impulse fence charger or a solar energizer; solar panel and/or battery for the charger; pipeline installation from water source to water distribution point; components that provide access to a water source distribution system; components that directly provide water to livestock as needed; spring development; warm-season grass seed, drilling, seed bed preparation, broadcast seeding, rolling and chemicals; etc. Please see soil and water conservation district personnel for a complete listing.

DWP-1 Sediment Retention, Erosion or Water Control Structures. If eligible, cost-share is authorized for sediment detention or retention structures. These include erosion control dams, de-silting reservoirs, sediment basins, debris basins or similar structures. Cost-share is also available for channel linings, chutes, drop spillways, drop pipes and tile. Also for fencing and vegetative cover needed to protect the structure.

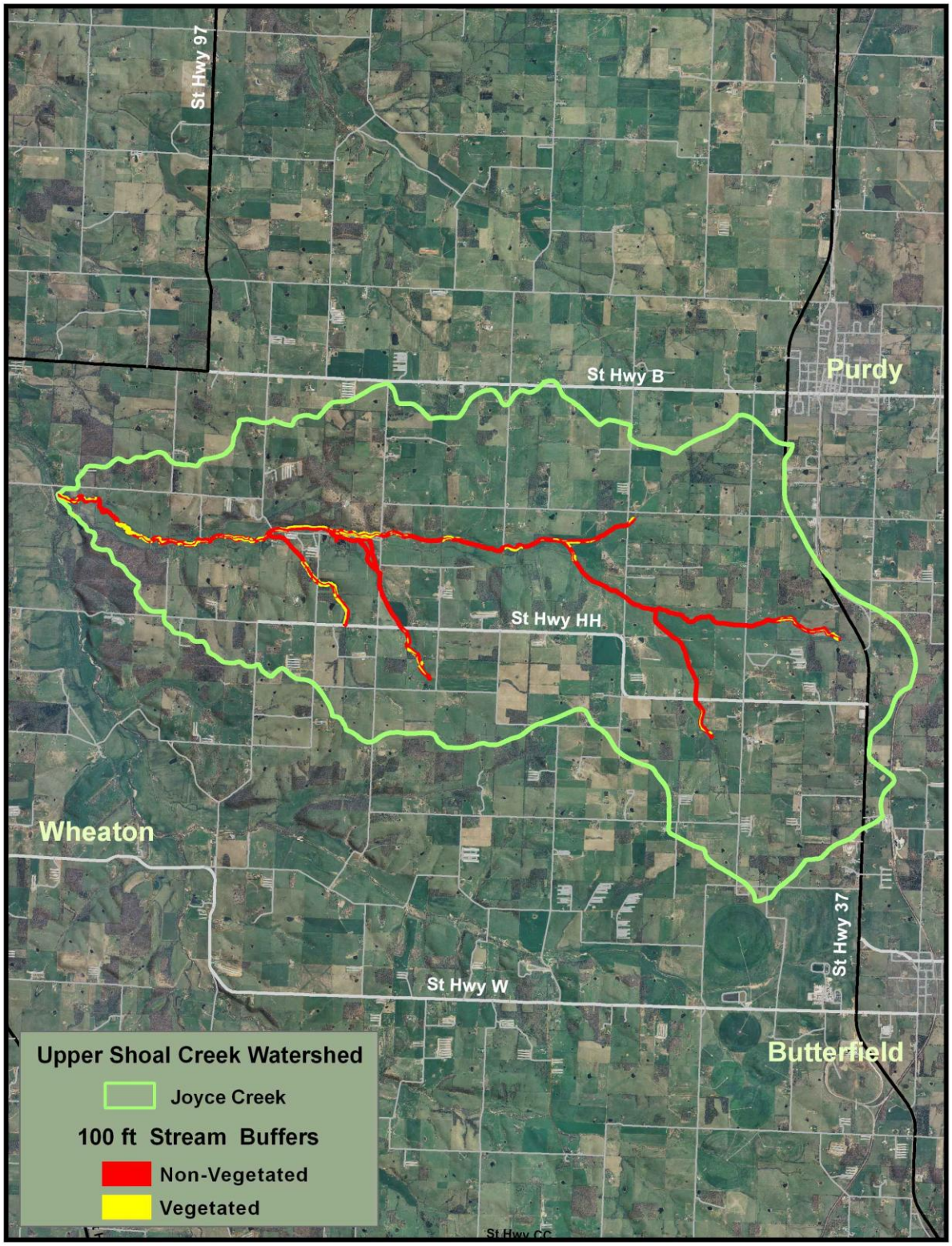
DWP-3: Sod Waterways. If eligible, cost-share assistance is authorized for site preparation, grading, shaping, filling and establishing permanent non-woody vegetative cover. Cost-share is also authorized for subsurface drains that are necessary for proper functioning of the waterway. Also, assistance can be provided for berm removal.

Appendix 5 – High priority critical stream buffers areas by HUC-12 watershed (Pages 37-40)

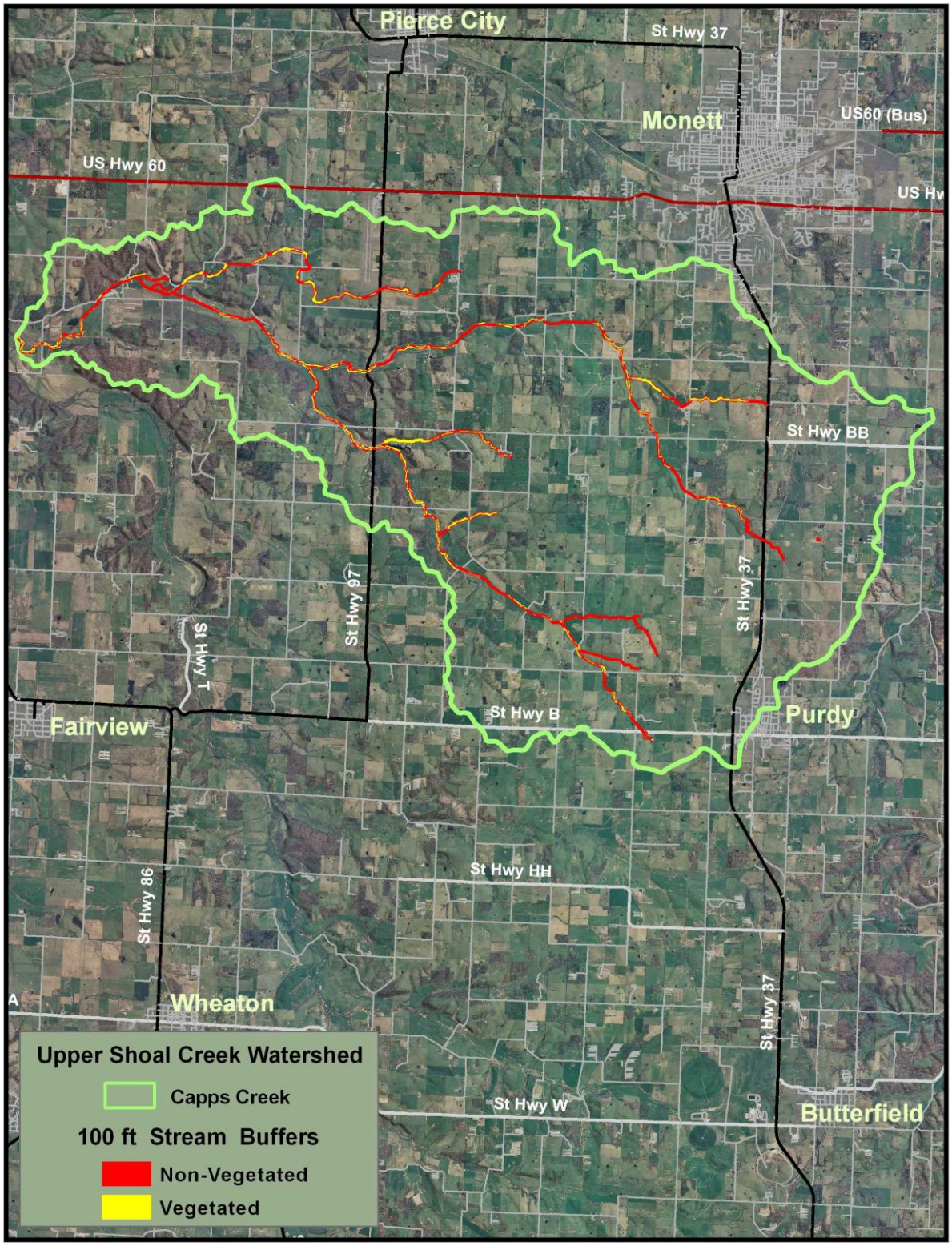
Headwaters Shoal Creek sub-watershed - 110702070702



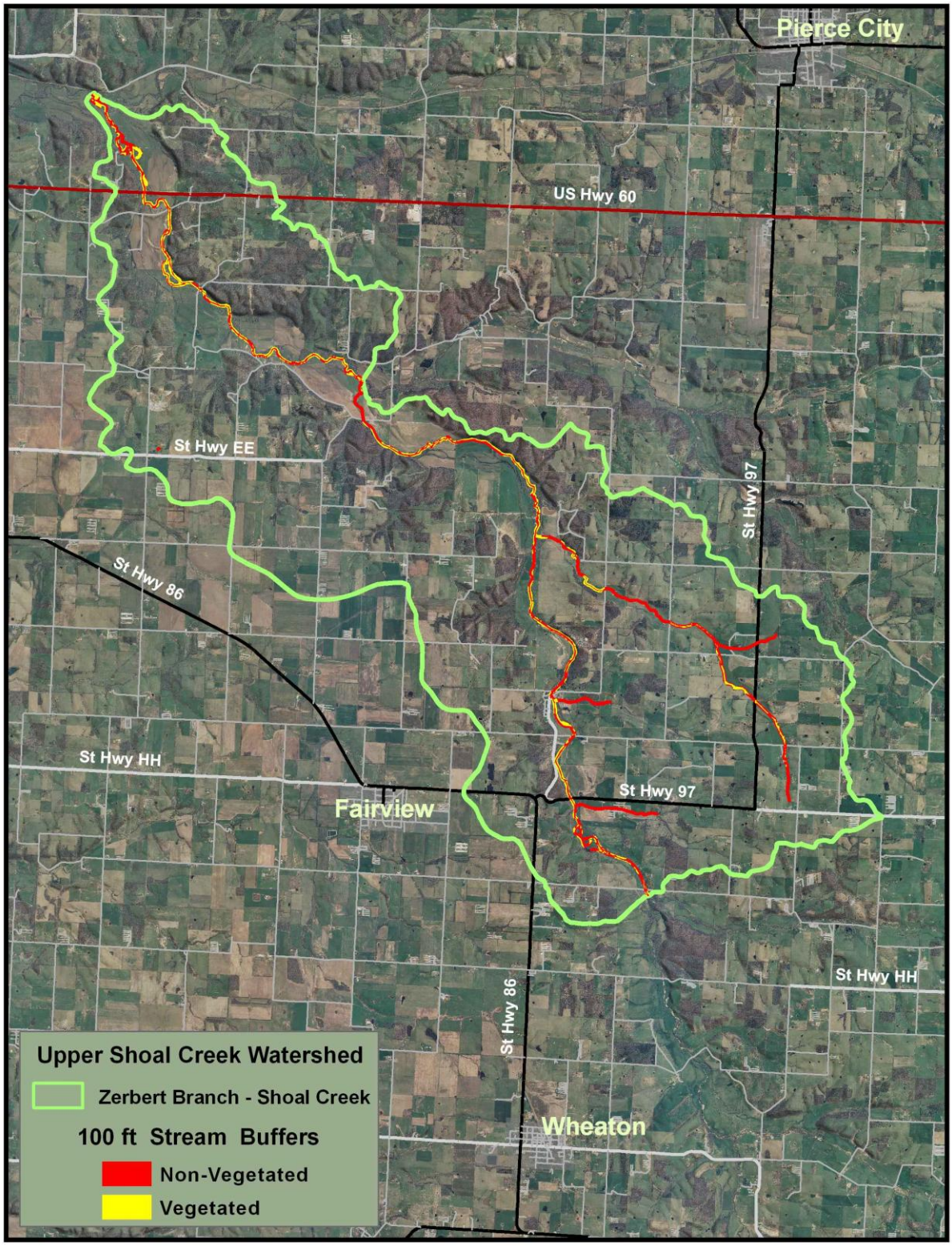
Joyce Creek sub-watershed – 110702070701



Capps Creek sub-watershed – 110702070703



Zerbert Branch – Shoal Creek sub-watershed – 110702070706



Appendix 6 – References

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