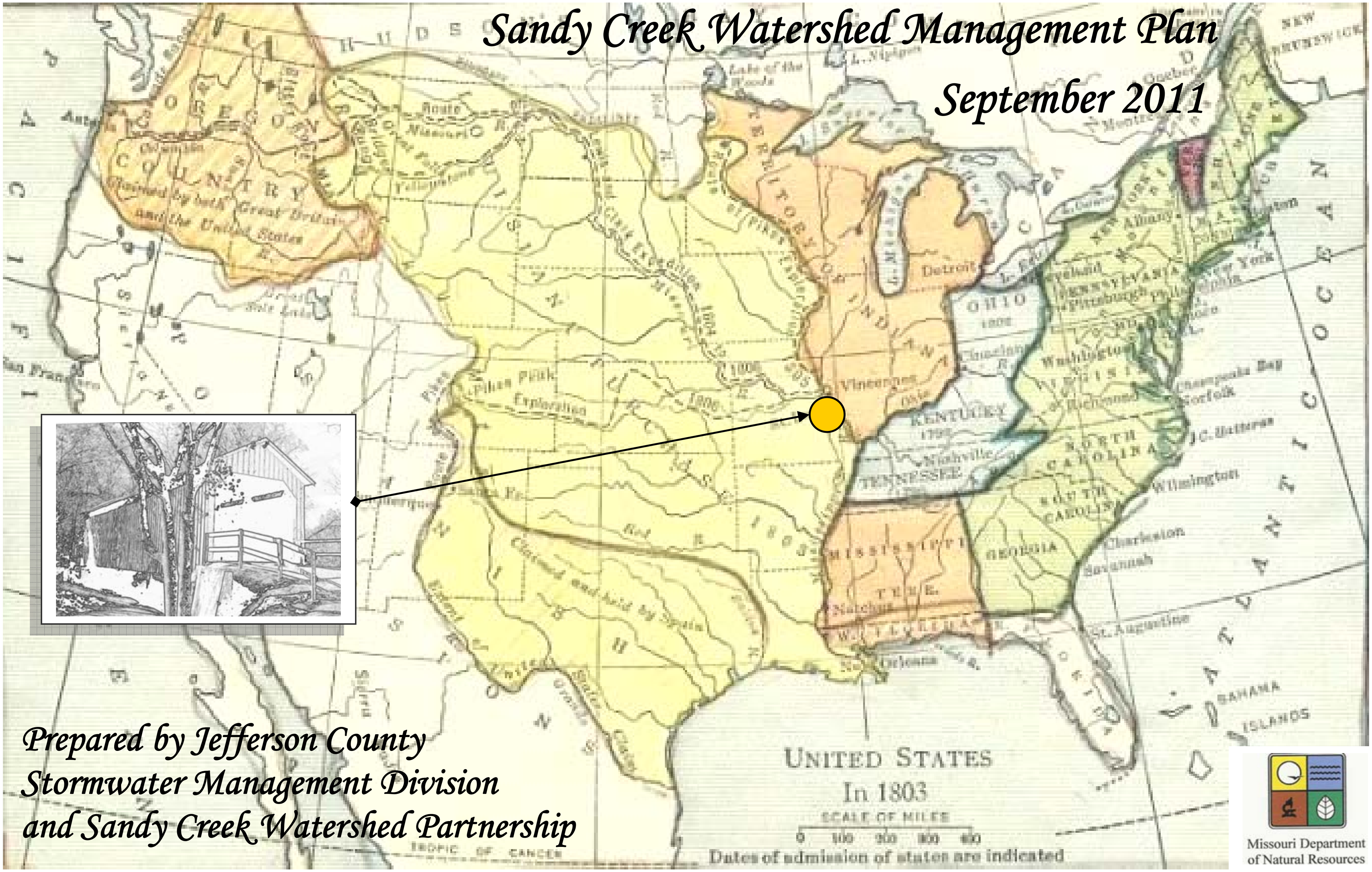
Sandy Creek Watershed Management Plan

September 2011



Prepared by Jefferson County Stormwater Management Division and Sandy Creek Watershed Partnership

Missouri Department of Natural Resources

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Contact Information:

Jefferson County
Stormwater Management Division

636-797-6228

Email: Stormwater@jeffcomo.org

Missouri Department of Natural Resources

JEFFERSON COUNTY 1818 MISSOURI

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Sandy Creek Watershed Partnership

Mission Statement

The mission of the Sandy Creek Watershed partnership is to improve and protect the water quality and natural resources of Sandy Creek by implementing a comprehensive watershed plan for the benefit of future generations.

꧁ Acknowledgments ꧂

The Sandy Creek Watershed Management Plan was made possible with the contribution of time, talent and support from the following individuals. It is with sincere appreciation that their effort is herein recognized.

City of Pevely:	
Happy Welch	for on-going support
Josh Whaley	for water quality testing and support
Churches:	
Zion Lutheran Church	for providing meeting rooms
Sandy Baptist Church	
Stream Team:	
Darlene Haun, MDC	for water quality monitoring
Scott Darrough	
Kevin Rice	
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Community Stakeholders:	
Ralph Schroeder	land owner and farmer
Bob Markham	subdivision trustee
Buzz Kaido	developer and landowner
Jane Jennewein	landowner and student
Dan McCarthy	politician and landowner
Jefferson County:	for supporting watershed plan development
Bill Aho, Consultant	for managing the completion of the plan
Pat Francis	section writing, research and plan design
Jay Rodenbeck	for GIS Map creation and input
Byron Guertzgen	for water quality testing activities
Missouri DNR/EPA:	for funding the grant project
Jane Davis	DNR Project Manager

Table of Contents

List of Figures, Charts, & Tables

Figures:

Charts:

Tables:

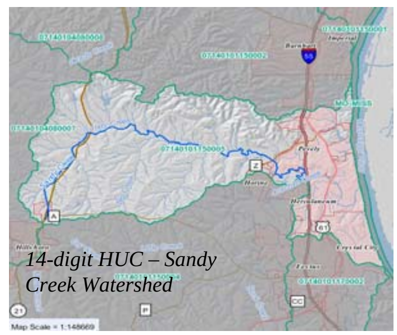
ACRONYMS

BMP	Best Management Practices
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
DFIRM	Digital Flood Insurance Rate Map
EFC	Environmental Financial Center
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
GIS	Geographic Information System
HUC	Hydrologic Unit Codes
IPM	Integrated Pest Management
L-THIA	Long-Term Hydrologic Impact Assessment
MDC	Missouri Department of Conservation
MDNR	Missouri Department of Natural Resources
MOU	Memorandum of Understanding
MS4s	Municipal Separate Storm Sewer Systems
MU	Management Unit
NPDES	National Pollutant Discharge Elimination System
NPS	Non-Point Source
QAPP	Quality Assurance Project Plan
SCWP	Sandy Creek Watershed Plan
SEMA	State Emergency Management Agency
SWPA	Source Water Protection Areas
UDO	Unified Development Order
USACE	U.S. Army Corps of Engineers
USGS	United States Geological Survey
WMP	Watershed Management Plan
WQ	Water Quality

EXECUTIVE SUMMARY

Jefferson County government fully supports watersheds studies as a means of identifying and improving water quality within the 12 major county watersheds. In addition, the Jefferson County Official Master Plan, adopted August 6, 2003, recognizes watershed plans as an important tool in managing new development in the county. Preparation of a watershed plan requires participation of stakeholders from the watershed such that their issues and concerns are properly reflected and that they take ownership of the plan.

Jefferson County applied for and received a minigrant (G09-NPS-09) from the Missouri Department of Natural Resources Water Protection Program to partially fund the study and preparation of this Sandy Creek Watershed Management Plan.



14-digit HUC – Sandy Creek Watershed

At the time of the application, and still today, the Sandy Creek Watershed boundary reflected on Jefferson County Watershed maps is the area associated with the 14-digit Hydrologic Unit Code (HUC).

Two years into the development of the Sandy Creek Watershed Management Plan it was recognized that the 12-digit Hydrologic Unit Code for Sandy Creek is a smaller area than the area that had been studied with a portion of the studied area now in the Lower Joachim Watershed and another portion in the Meissner Island-Mississippi River Watershed.

12-digit HUC – Sandy Creek Watershed

To revise the work that had been done on the Sandy Creek Watershed Management Plan to reflect the 12-digit area would require an extensive restudy and numerous new maps. Therefore, DNR authorized the completion of this plan based on the area in the 14-digit Hydrologic Unit Code. All future watershed studies in the Sandy Creek watershed and all revisions to this plan will only address the 12-digit HUC, which will eliminate some of the original area identified in this plan.

Sandy Creek is not on the Missouri 303(d) list of Impaired Waters, but the watershed is located in an area where growth can be anticipated and the intent of this watershed plan is to keep Sandy Creek from becoming an impaired body of water and to preserve its beneficial uses including aquatic life protection and whole body contact recreational use.

This Sandy Creek Watershed Management Plan was prepared in accordance with and incorporates the nine elements of watershed planning required by the U.S. Environmental Protection Agency. Guidance in preparing the plan was obtained through *U.S. EPA's Handbook for Developing Watershed Plans to Restore and Protect Our Waters.*

The nine elements and their location in the Plan are as follows:

Element a. – Identifying Impairment – Chapter 3
Element b. – Estimating Load Reductions – Chapter 4
Element c. – Management Measures – Chapter 5
Element d. – Technical & Financial Assistance – Chapter 6
Element e. – Public Information & Education – Chapter 7
Element f. – Schedule – Chapter 6
Element g. – Milestones – Chapter 8
Element h. – Performance – Chapter 9
Element i. – Monitoring – Chapter 10

The initial effort on developing the Sandy Creek plan started in April 2009 when five town meetings were held at various locations within the watershed to introduce residents to watershed management and invite them to participate in the watershed planning process for Sandy Creek.

The following statement reflects the citizen's (Sandy Creek Watershed Partnership) objective for their involvement in developing a watershed management plan:

"The mission of the Sandy Creek Watershed Partnership is to improve and protect the water quality and natural resources of Sandy Creek by implementing a comprehensive watershed plan for the benefit of future generations."

The Sandy Creek Watershed was subdivided into 8 Management Units (MU's) based upon drainage patterns that enabled a more detailed analysis of land use including urban and agricultural, soil type, and unique characteristics in each Management Unit. The diversity within the watershed is reflected in the results of Long-Term Hydrologic Impact Assessment tool.

The northern half of the watershed consists of hilly terrain with predominately deciduous forest and pasture/hay for land cover. Tributary distances to the main channel of Sandy Creek are shorter on the northern half which results in a higher velocity and shorter duration for stormwater runoff than that of the southern half of the watershed.

The southern half of the watershed has a gentler slope with a mixture of cultivated crops, pasture/hay and forest (both deciduous and evergreen) land cover. The land adjacent to the stream channels are classified as "prime" farmland with a significant portion of the watershed having farmland with a designation of "statewide importance".

An evaluation of the existing conditions within the Sandy Creek watershed was conducted to identify areas of concern and impairments as well as the general condition of the watershed. The evaluation included a visual survey, water quality testing, fish species inventory and an assessment of vulnerable conditions within the watershed.

The evaluations resulted in the following issues identified and prioritized by the watershed partnership. The majority of the issues focus on bacteria, nutrients, pesticides and sediment.

High Priority
- On-site septic issues and discharges
- Discharges from central sewer systems
- Creek bank erosion and disturbances
- Water Quality testing
- Riparian corridors
- Stormwater runoff
- Education
- Public involvement
- Wetlands and other sensitive areas

Medium Priority
- Future New Development - residential and commercial
- Sinkholes and karst topology
- Post construction stormwater maintenance (detention ponds)
- Maintenance of road ditches and right of way
- Trash

Lower Priority
- Sediment, sand, and rock in creek
- Drinking water and wells
- Unique vegetation/flowers/plants etc. (Fort Hill Area)
- Historical buildings/sites

The identified issues were summarized into the following management measures:

1. Evaluate stormwater runoff and its effect on the watershed
2. Provide public education and encourage public involvement
3. Encourage appropriate maintenance and repair of septic systems
4. Determine existing riparian corridors and educate landowners on the benefit of maintaining and/or establishing riparian corridors
5. Perform stream bank restoration
6. Perform water quality testing throughout the watershed
7. Encourage use of natural fertilizers, pesticides, herbicides, and detergents

8. Minimize the runoff impact in areas of sinkholes and losing streams

9. Update Floodplain study

Implementing the management measures will require capital and technical support through both public and private organizations. Financial assistance for the projects can be sought from multiple sources; many sources require the applicant be either a non-profit organization or a government agency. Subject to approval by the County Council, Jefferson County Stormwater Division is willing to sponsor projects providing the required match (in-kind services) is guaranteed by the watershed partnership.

Establishing milestones for the management measures requires an understanding of the proposed projects. Most of the projects are conceptual at this time and the milestones reflected in this plan represent an initial perception of the desired improvements and/or the desire to keep the water quality from deteriorating in the future. As specific projects are proposed and funding sought, more detailed milestones will be generated.

Implementing the goals and objectives associated with the management measures will need to be monitored to determine the effectiveness of the implementation. Monitoring can be accomplished through water quality testing which is one of the management measures or through spot checking, landowner participation, adoption of practices, and creation of database or other measurements. The tracking and monitoring should be an on-going activity.

The intent is for the citizens in the Sandy Creek watershed to take ownership of this Plan following acceptance by EPA and Missouri Department of Natural Resources. This plan is intended to be living document and should be reviewed and updated on a 5-year basis.

CHAPTER 1: INTRODUCTION

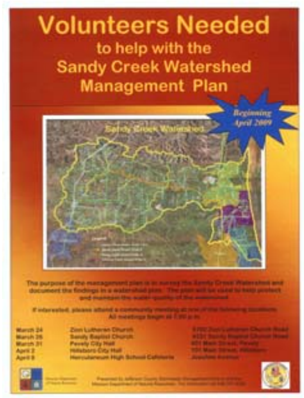
1.0 Project Overview

Jefferson County government fully supports watersheds studies as a means of identifying issues and concerns within a watershed as they provide an understanding of what is needed to maintain and improve water quality. Watershed studies also are a means of fulfilling the Stormwater Management requirements associated with the NPDES MS4s Phase II Permit issued to the County. The Jefferson County Official Master Plan, adopted August 6, 2003, recognizes watershed plans as an important tool in managing new development in the county.

Jefferson County applied for and received a minigrant (G09-NPS-09) from the Missouri Department of Natural Resources Water Protection Program to partially fund the study and preparation of this watershed plan for the Sandy Creek Watershed.

1.1 Building the Partnerships

Figure 1-1



In April 2009, five town meetings were held at various locations within the watershed. Meetings were held at Zion Lutheran Church in Hillsboro, Sandy Baptist Church in Hillsboro, Pevely City Hall in Pevely, Hillsboro City Hall in Hillsboro and Herculaneum High School in Herculaneum. Approximately 100 people in all attended these meetings. The purpose of these meetings was to introduce residents to watershed management and invite them to take part in the watershed planning process by participating in a visual survey, voicing concerns about critical areas of the watershed, establishing priorities, and gathering historical facts.

Figures 1-2 through 1-6

Zion Lutheran Church

Sandy Baptist Church

Pevely City Hall

Hillsboro City Hall

Herculaneum High School

In April 2009, a general session was held at the Jefferson County Administration Building. The agenda covered the issues of watershed quality, the benefits of participating in a watershed plan, and the volunteer roles and responsibilities of volunteers.

The Sandy Creek Watershed was divided into 8 Management Units (MU's) that would better reflect the diversity throughout the watershed. The objective was to have a group of volunteers representing all 8 MUs with this group then forming the nucleus for the Sandy Creek Watershed Partnership. The following volunteers agreed to participate in the initial activities:

Bob Markham	Betsy Irelan	Tiana Haun
Bill McConnell	Scott Darrough	Larry Linhorst
Buzz Kaido	Dan McCarthy	Darlene Haun
Jane Jennewein	Steve Martin	
Ralph Schroeder	Chris Irelan	

Volunteers were asked to do a visual survey in the MU in which they live. Over a period of months, volunteers inventoried their MU for critical areas, unique features and issues of concern. The results of these efforts are reflected in Chapter 2 – Identifying Impairments.

Any group who wanted to participate in an activity did so. The Hillsboro High School Ecology Club and Stream Team members contributed greatly by performing water quality testing at several sites along Sandy Creek and its tributaries.

One year into the project, the partnership wrote their mission statement:

"The mission of the Sandy Creek Watershed Partnership is to improve and protect the water quality and natural resources of Sandy Creek by implementing a comprehensive watershed plan for the benefit of future generations."

1.2 Describing the Watershed

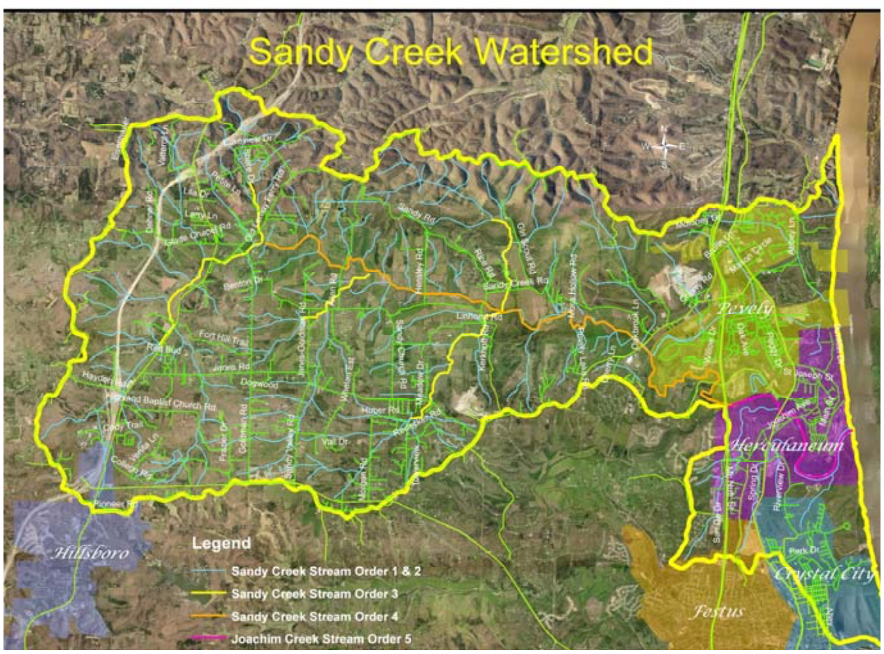
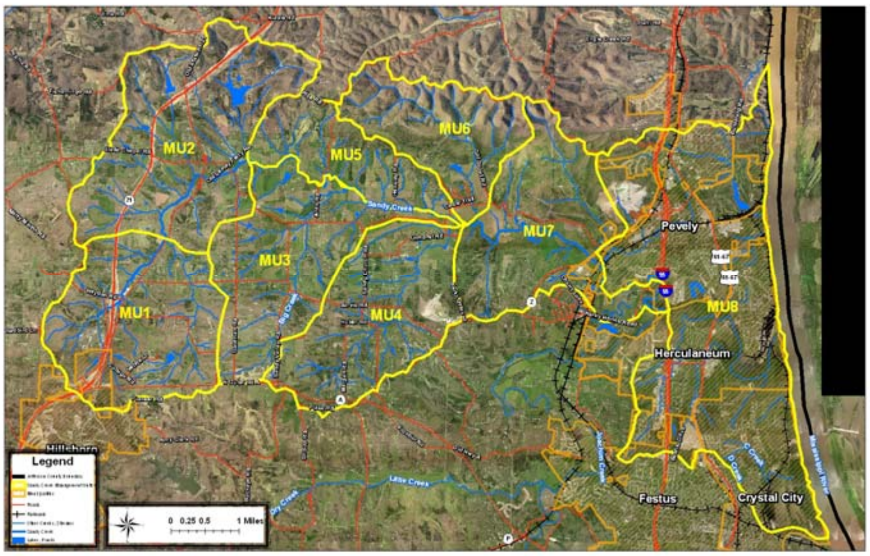


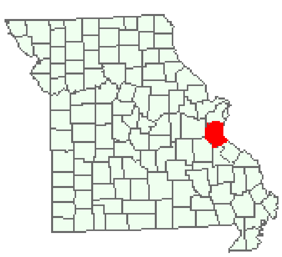
Figure 1-7 at the right shows the GIS aerial view of the Sandy Creek Watershed depicting its tributaries and roads.

The headwaters of the Sandy Creek Watershed are southwest of Jefferson College near new Highway 21in Hillsboro and run easterly to the mouth at the Mississippi River in Herculaneum. This watershed includes 28,884 acres and covers 45.2 square miles. The main channel of this stream order 4 runs 15.5 miles and converges with Joachim Creek for another 3.3 miles before entering the Mississippi River. A large tributary to Sandy Creek called Big Creek runs south to north about 3.9 miles. Portions of the cities of Pevely (3.7 sq. mi.), Herculaneum (3.0 sq. mi.), Crystal City (2.0 sq. mi.), Festus (0.3 sq. mi.), and Hillsboro (0.5 sq. mi.) are within this watershed.



The watershed was divided into 8 Management Units (MUs). The area of each MU is based on drainage patterns.

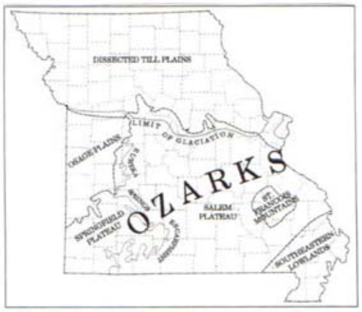
Figure 1-8: GIS view of Sandy Creek



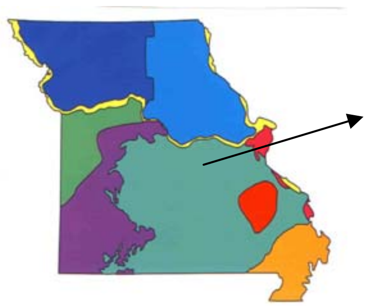
Figures 1-9 thru 1-11

Jefferson County waters drain into three major HUC 8 watersheds: Cahokia-Joachim of the Mississippi River, the Meramec River, and the Big River. The Sandy Creek Watershed is a sub-watershed of the Cahokia- Joachim Watershed (HUC 07140101) and is identified with the 14-digit HUC 07140101150005 (12-digit HUC 071401010803).

Figure 1-12



During the Ice Age, continental ice sheets advanced and retreated across northern Missouri. North of the limit of continental glaciation, glacial sand and gravel aquifers overlie bedrock aquifers in many places. The southern extent of glaciation roughly parallels the Missouri River in Missouri. It is apparent that Sandy Creek watershed was not within the limits of glaciation.



Salem Plateau Groundwater Province

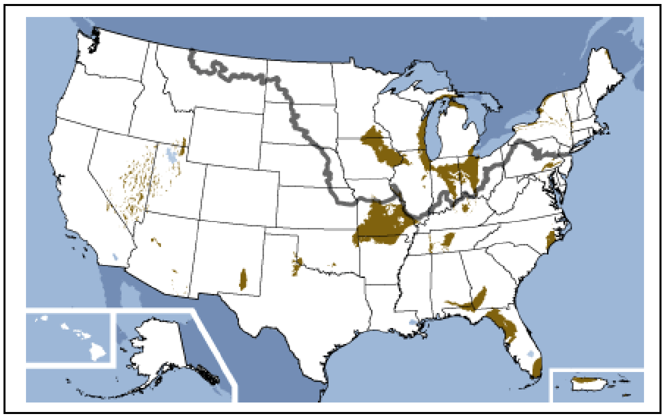
Figure 1-13: Data Source: Missouri Department of Natural Resources Groundwater Education

Sandy Creek lies in the Salem Plateau Groundwater Province. Thick Ordovician and Cambrian-age dolomite and sandstone units comprising the Ozark aquifer overlie the St. Francois confining aquifer. The Ozark aquifer, which is the major aquifer that underlies this area, consists of bedrock units from the top of the Kimmswick Limestone to the base of the Potosi Dolomite. The Ozark aquifer is generally 800 to 1,000 feet thick, but can reach thicknesses exceeding 2,000 feet.

Residual soils formed by the weathering of the mostly carbonate bedrock are very permeable allowing the Ozark aquifer to be recharged by precipitation. The principal post depositional change in carbonate rocks is the dissolution of part of the rock by circulating, slightly acidic groundwater. Solution openings in carbonate rocks range from small tubes and widened joints to caverns that may be tens of meters wide and hundreds to thousands of meters in length. Where they are saturated, carbonate rocks with well-connected networks of solution openings yield large amounts of water to wells that penetrate the openings, although the undissolved rock between the large openings may be almost impermeable. These openings create numerous karst groundwater-recharge features such as sink-holes and losing streams that allow very rapid movement of water from the surface into the subsurface. These features make groundwater particularly prone to contamination. Proper land use and waste disposal practices are important to protecting wells and springs in this region.

The brown sections show carbonate-rock aquifers at or near the land surface. The heavy gray line shows the limit of continental glaciation.

Figure 1-14: Source:http://water.usgs.gov/ogw/aquifer basics/carbrock.html



The Ozark aquifer supplies nearly all the water supply needs in the Sandy Creek Watershed. Depending on the well depth and location, private domestic wells a few hundred feet deep can produce water ample for domestic purposes. Generally groundwater quality is very good. The water is generally a moderately mineralized calcium-magnesium bicarbonate type, which reflects the dolomitic bedrock in the area.

1.2.1 Climate in the Watershed

During the summer months, temperatures in the watershed have a minimum average of 62 degrees and a maximum average of 86 degrees. During the winter months, the minimum average temperature is 21 degrees and the maximum average temperature is 43 degrees with an average snowfall of 15 inches. The average annual rainfall is between 38 and 40 inches.

1.2.2 Endangered Species

Figure 1-15: Gray Bat
Myotis Grisescens

The gray bat is on the state and federal endangered list. The gray bats prefer deep vertical caves along the river or larger streams.

These bats need cool caves averaging 40 degrees Fahrenheit and humidity ranges between 66% and 95%. After hibernation, gray bats will forage in the treetops along riparian forests and floodplains and lowlands.

Because their habitat has been altered by humans, the population of these bats is declining. Caves are being grated so bats, but not humans can enter. Changes are also being made to the airflow and temperature and humidity. Flooding of caves, timber removal, stream alteration, as well as increased use of pesticides have taken a toll on the hibernation state and demise of these creatures. These creatures need to be preserved for educational, ecological and scientific benefits and activities associated with implementing this watershed plan will be cognizant of the bat habitat concerns.

The Corps of Engineers, as well as the Missouri Department of Conservation, provide educational programs on restoration and management actions for bat conservation and habitat improvement. Some of these actions include:

1. Protection of maternity and wintering roost sites
2. Restoration of riparian habitats
3. Providing mature hardwoods as roost sites
4. Providing artificial roost sites
5. Bridge design modifications
6. Water management
7. Restoration of foraging habitat
8. Awareness of their benefits

1.2.3 Soils

The following maps reflect various geological conditions in the Sandy Creek Watershed and were used to analyze issues and concerns.

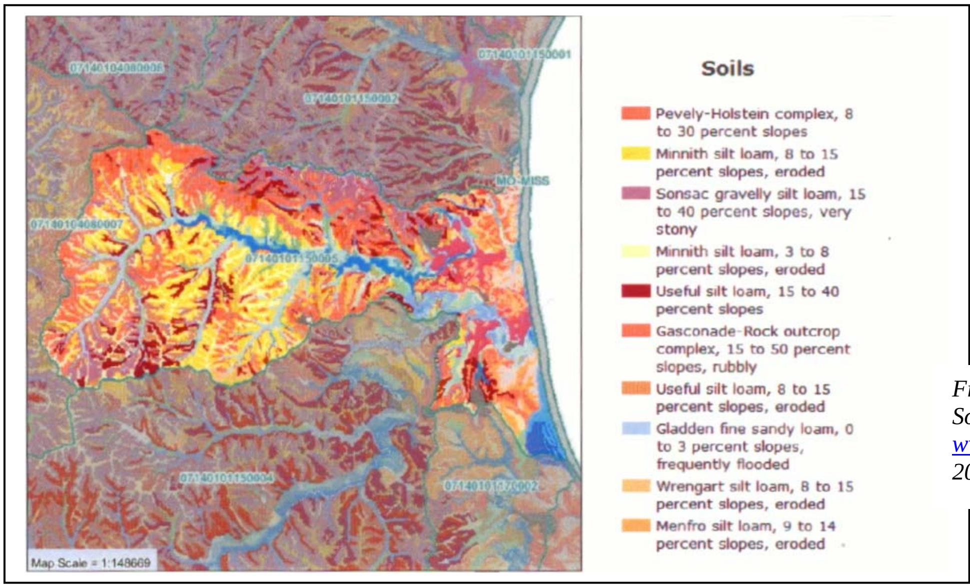


Figure 1-16
Source:
www.cares.missouri.edu
2011

Top 5 Soils	Acres	Percent
Pevely-Holstein Complex 8 to 30% slopes	3,484	14.97%
Minnith silt loam, 8 to 15% slopes, eroded	2,969	12.76%
Sonsac gravelly silt loan, 15 to 40% slopes, very stony	2,366	10.17%
Minnith silt loam, 3 to 8% slopes, eroded	2,313	9.94%
Gasconade-Rock outcrop complex, 15 to 50% slopes, rubbly	1,513	6.50%

Table 1-1

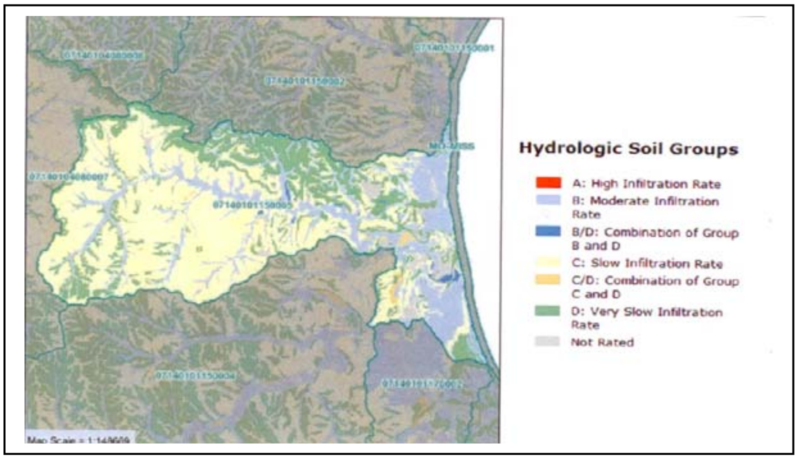
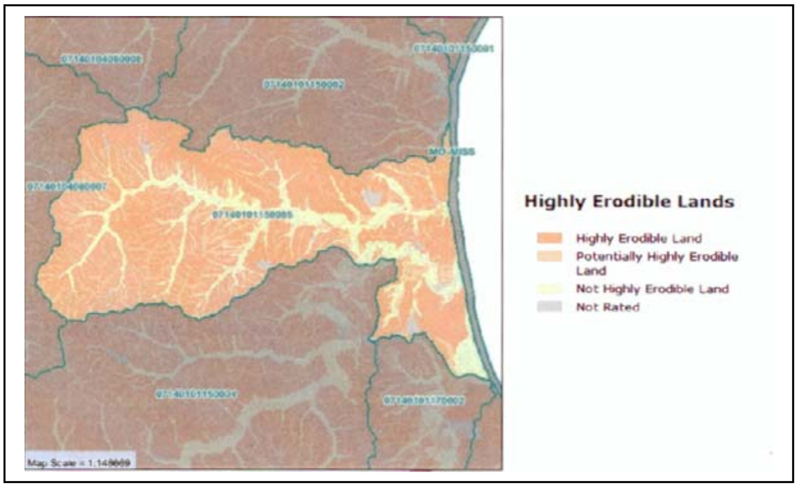
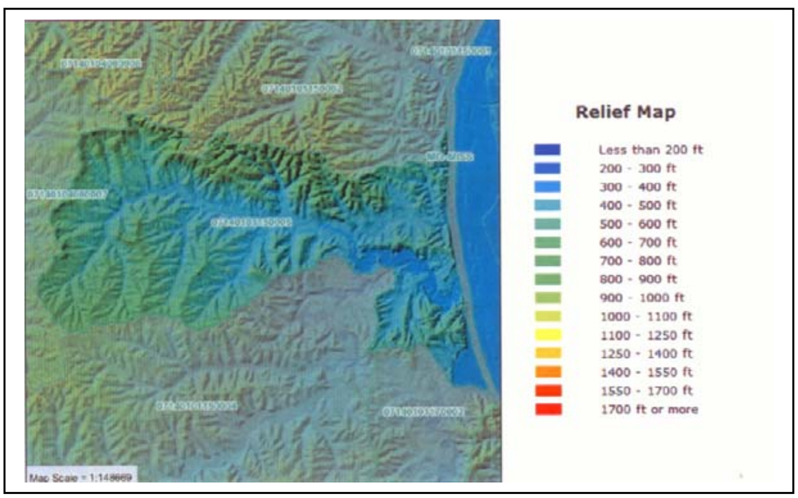


Table 1-2

Group Type	*Acres*	*%*
A	0	0
B	3,488	14.98%
B/D	74	0.32%
C	14,353	61.65%
C/D	105	0.45%
D	4,854	20.85%
Not Rated	406	1.75%





Figures 1-17: thru 1-19: Source: www.cares.missouri.edu

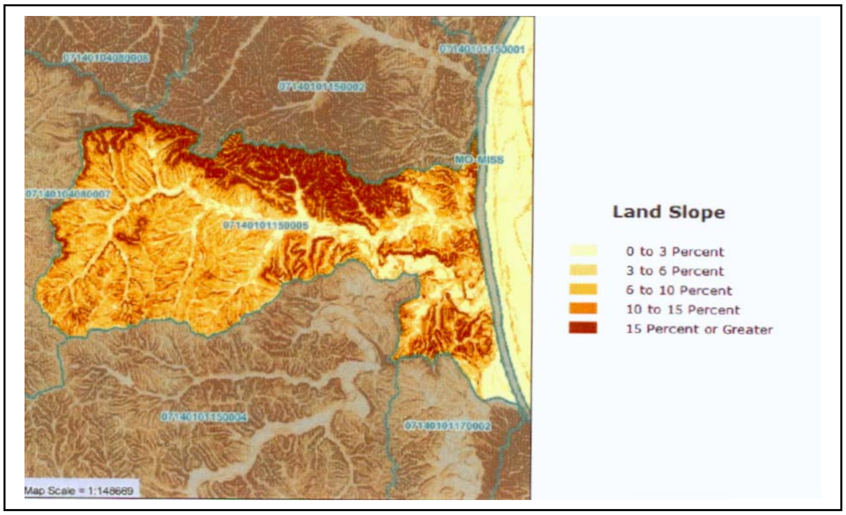


Figure 1-20: Source: www.cares.missouri.edu

Sandy Creek and its tributaries are defined by the hilly areas in the watershed. To the north, elevations range from 700 to 800 feet. The hilly region in the watershed is defined by the steep slopes to the north which are more susceptible to erosion and more gentle rolling hills to the south.

1.2.4 Floodplain

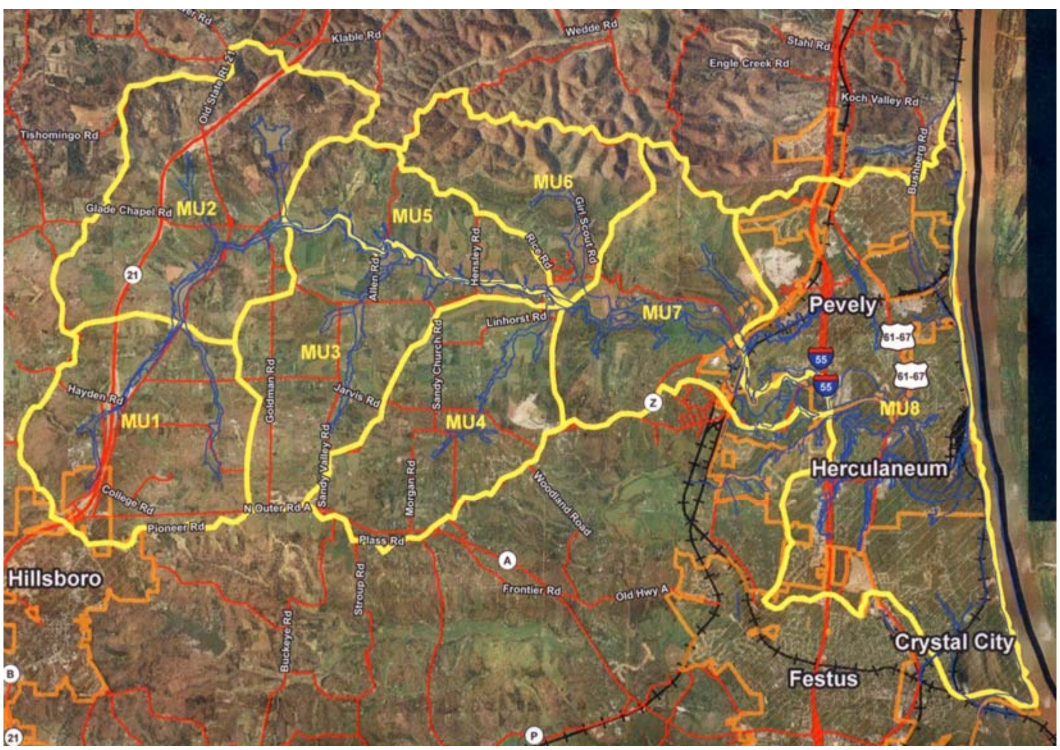
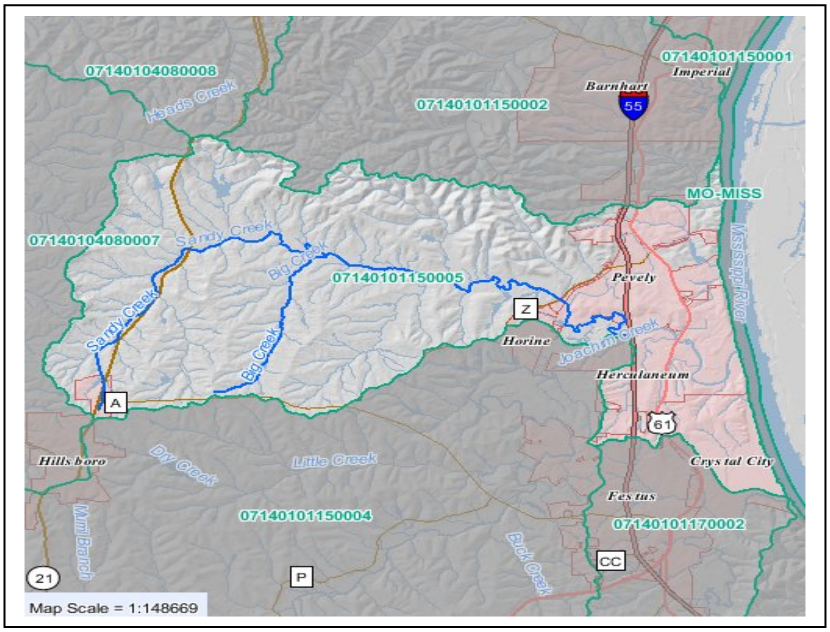


Figure 1-21: Source: Jefferson County Aerials and GIS.

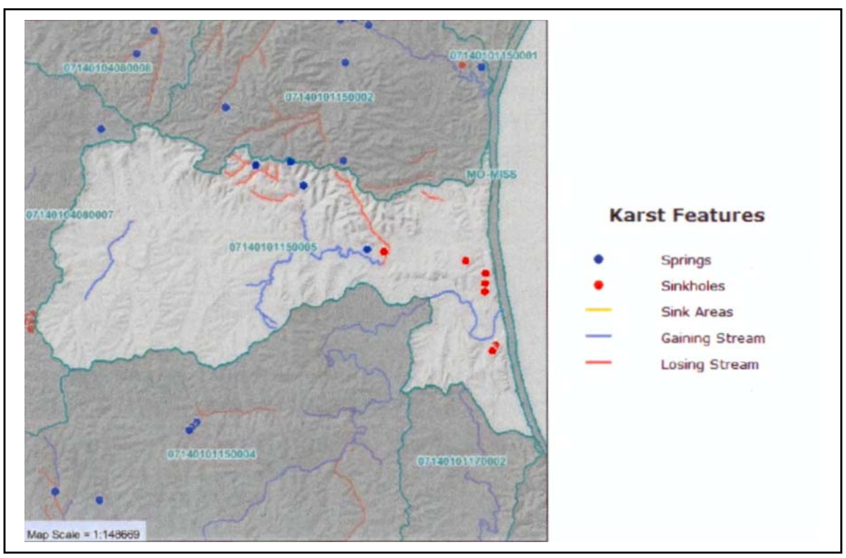
The picture above shows the FEMA floodplain in the Sandy Creek Watershed. A detailed view of the floodplain boundaries is available at www.FEMA.gov.

1.2.5 Hydrology



Stream Type	*Perennial*	*Intermittent*	*Canal/ Ditch*	*Other*	*Total*
Miles	18.9	118.8	0	10.6	148.3
Percent	12.77%	80.10%	0%	7.14%	100%

Table 1- 3



Sinkholes are prominent in karst topography and provide a direct connection to the groundwater system for anything, including stormwater runoff, that enters them.

Figures 1-22 thru 1-23: Source: www.cares.missouri.edu

	Gaining Streams	*Losing Streams*	*Sinkholes*	*Springs*
Number	9	8	9	4
Miles	19.26	8.07		

Tables 1- 4

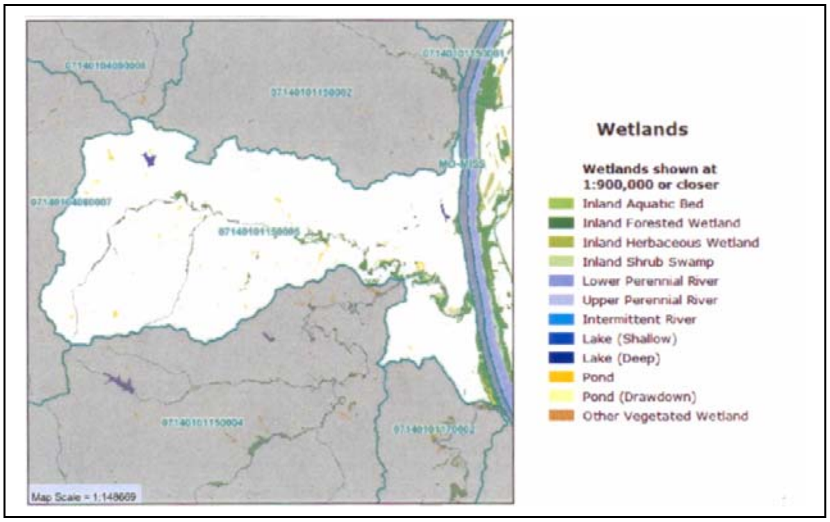


Figure 1.24 Source: www.cares.missouri.edu

	Lacustrine	*Palustrine*	*Riverine*	*Total*
Acres	62	1,243	122	1,427
%	4.35%	87.12%	8.53%	100%

Table 1.5

Inland forested wetlands are along the main channel of Sandy Creek and its tributaries. Ponds and pond drawdown areas have been identified throughout the watershed.

Since the watershed is made up of mostly large-acre parcels and farmland, private wells are common. Public and community wells serve the City of Hillsboro and developments in the watershed.

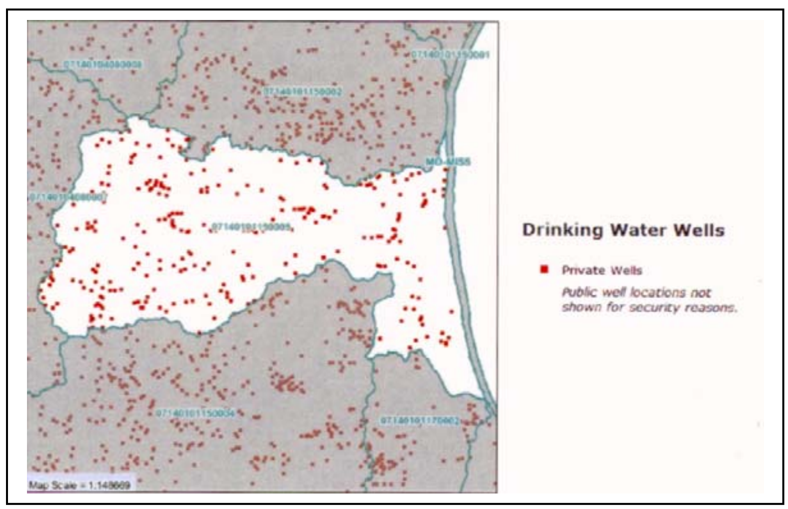
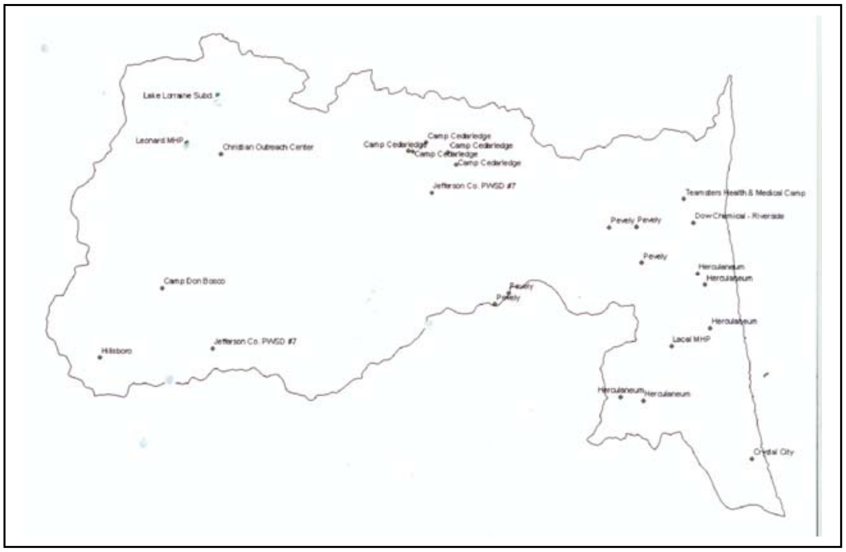


Figure 1- 25

Source: www.cares.missouri.edu

	Total	*Private*	*Public (Active)*	*Community*	*Transient Non-community*
# Wells	390	371	19	13	6

Table 1- 6



This map shows the location of public wells within Sandy Creek Watershed.

Figure 1-26 Source: GIS data compiled by the University of Missouri

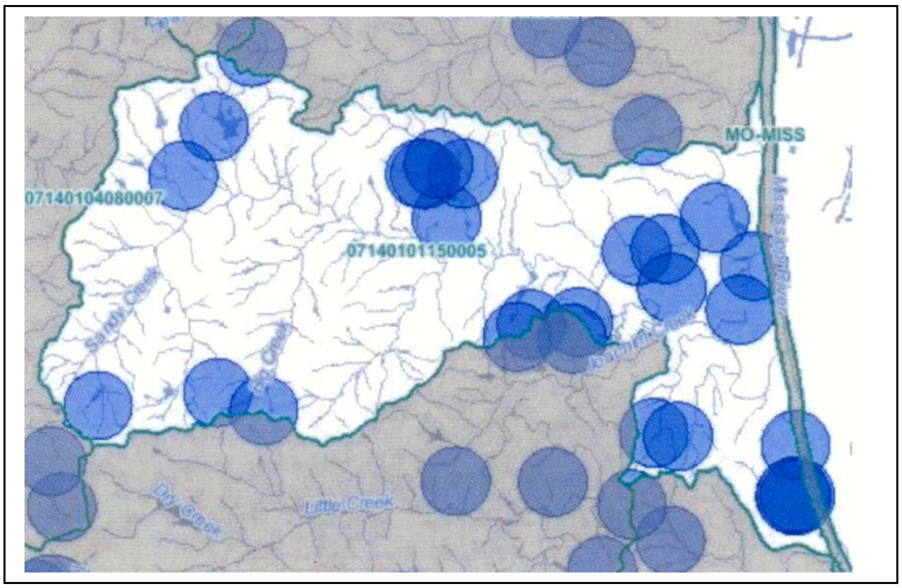


Figure -1-27 Source: www.cares.missouri.edu

Protected Water

Twenty-six Source Water Protection Areas (SWPA) have been identified in the Sandy Creek Watershed. This represents 27% of the watershed being in a SWPA.

1.2.6 Land Cover and Land Use

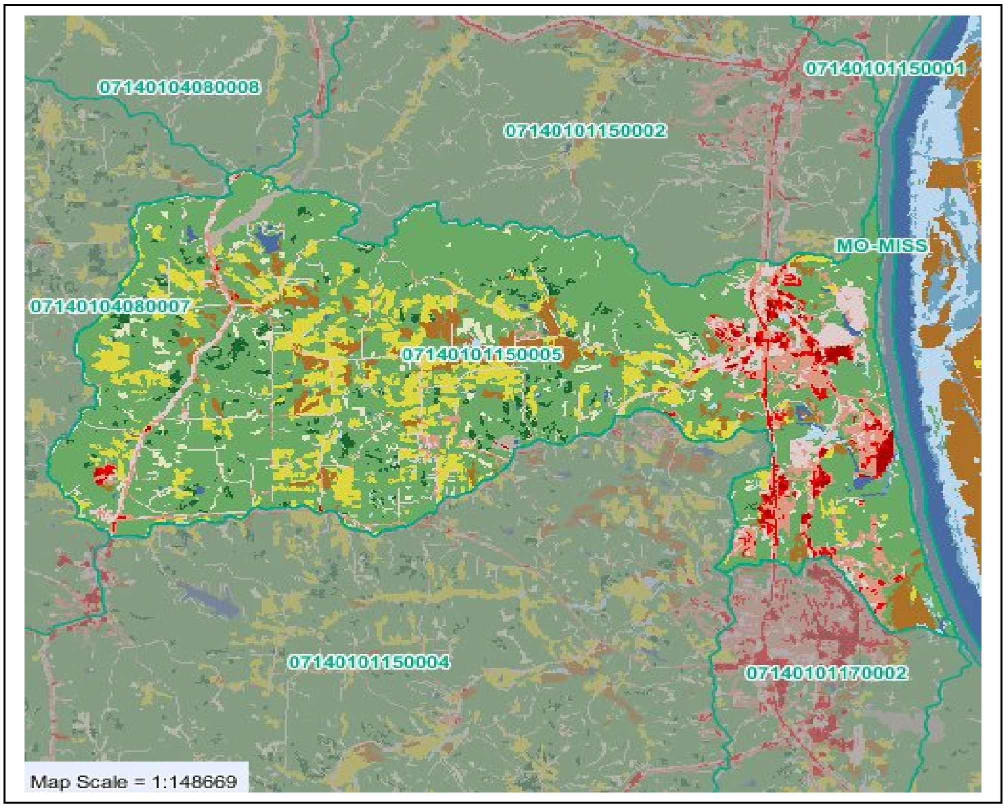


Figure 1-28:
Source: www.cares.missouri.edu

Table 1- 7 Source: U.S. Geological Survey National Land Cover Database, 2001.

	Cropland	*Grassland*	*Forest*	*Wetland*	*Developed*	*Water*
Acres	1,158	3,810	15,131	110	2,958	102
Percent	4,98%	16.37%	65.03%	0.47%	12.71%	0.44%

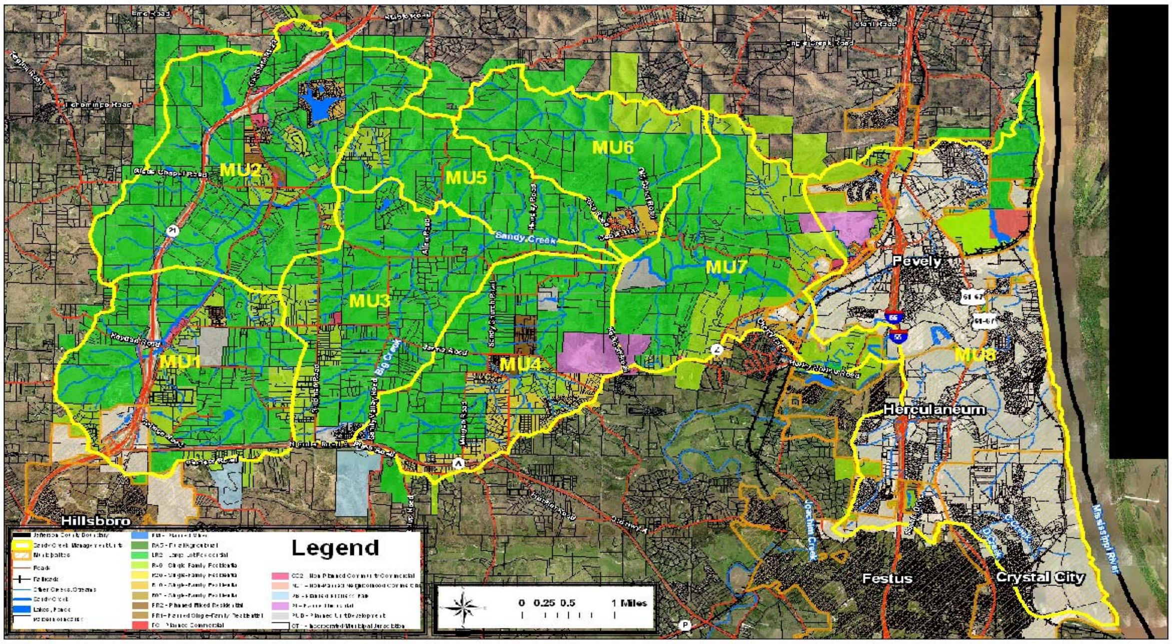


Figure 1-29
Source: Jefferson County Planning & Zoning by Jay Rodenbeck

	PM – Planned Mixed		PR1 – Planned Single Family Residential
	RA5 – Rural Agricultural		PC – Planned Commercial
	LR2 – Large Lot Residential		CC2 – Non Planned Mixed Community Commercial
	R40 – Single Family Residential		NC1 – Non Planned Neighborhood Commercial
	R20 – Single Family Residential		PB – Planned Business Park
	R10 – Single Family Residential		PI – Planned Industrial
	R07 – Single Family Residential		PUD – Planned Unit Development
	PR2 – Planned Mixed Residential		CTI – Incorporated Community Jurisdiction

Existing and future zoning is used in this watershed plan to analyze non-point pollutants associated with stormwater runoff.

1.3 Historical Events

In 1776 there was a need for a passage between St. Louis and Ste. Genevieve to expand settlements. A road called the El Camino Real (King's Trace) was built through the areas now known as Kimmswick, Sulphur Springs, Pevely, Horine, Festus, and Plattin Creek. The road passed through the very western edge of present day Herculaneum. This was the first road established in what was to become Jefferson County and linked the major trading posts in St. Louis and Ste. Genevieve.

Under regulations established by the governors and lieutenant governors of Upper Louisiana Territory, the Spanish government allowed settlers to establish homesteads. The grants along the Mississippi were generally confined to the riverfront and ranged from four to eight arpents in width and extended back from the river forty arpents. (An arpent is an old French measurement -- about 37,026 square feet.) Away from the river a larger quantity of land was generally granted and was based on the size of the family.

An important industry in Jefferson County was the dairy business. Along the Iron Mountain Railroad were many dairies with large quantities of milk, cream and butter shipped daily to St. Louis. The largest of these dairies, the Jersey Dale Dairy, was located along the railroad two miles west of Pevely had over one hundred registered jersey cattle.

On December 8, 1818, Jefferson County was created by an "Act of the Territory" when part St. Louis County and a part of Ste. Genevieve County were divided and formed a new county called "Jefferson" in honor of Thomas Jefferson, the third President of the United States and the Father of the Louisiana Purchase.

From the History of Jefferson County, Missouri by John Williams, S.C.E., the census of 1870 reveals statistics of the population within Joachim Township.

Table 1-8

Black	White	Horses	Mules	Cattle	Sheep	Hogs
243	1,622	628	124	1,572	727	1,054

Table 1-10 below depicts some of the early residents, their occupation, their place of origin and the year they came to live in the watershed. The table was taken from the Illustrated Historical Atlas Map of Jefferson County, Missouri, 1876.

Table 1-9

TOWNSHIP No. 41. RANGES 5 & 6, EAST.

NAME.	POST-OFFICE.	RESIDENCE.	BUSINESS.	NATIVITY.	When Came to Co.
Bruhn, P.	Pevely	Sur. 931	Farmer and Miller	Germany	1864
Baker, Isaac S.	"	" 420	Farmer and Surveyor	Pennsylvania	1854
Burrell, Arthur S.	Hanover	Sec. 36	Fruit Grower	Niagara, N. Y.	1863
Charles, Thos. A.	Pevely	Sur. 420	Farmer	St. Louis Co, Mo	1865
Coyle, W. L.	"	Pevely	Telegraph Operator	New York	1875
Creasey, J. A.	"	Sur. 420	Farmer	Harden Co, Ten	1854
Cadwallader, Chas.	"	" 420	" and Lawyer	Centre Co., Pa.	1829
Dyer, John H.	St. Louis	925 Amelia av.	" at Mercantile Library	St. Louis Co, Mo	1833
Douglass, D. & Son	Pevely	Sur. 421	Jersey Stock and Dairy	Vermont	1874
Foster, J. F.	"	" 420	Farmer	Jefferson Co, Mo	1815
Huber, William	Horine	Sec. 21	" and Stock Raiser	"	1854
Hicks, S. L.	Pevely	Sur. 420	Farmer and Carpenter	Ireland	1854
Kock, John	Sulphur Sp'ngs	Sec. 6	Farmer and Blacksmith	Germany	1852
Jeude, John	Pevely	Pevely	Salesman	"	1873
Jeude, John & G.	"	Sec. 7	Farmers and Blacksmiths	"	1842
Jeude, Wm.	"	Pevely	Merch't, Hot. & Saloon-kpr	"	1866
Jewett, Wm. S.	Crystal City	Sec. 32	Farmer and Fruit Grower	Monroe Co., Ill.	1856
McMurray, Robert E.	Pevely	Sur. 420	Iron Manufacturer	St. Louis Co, Mo	1846
McIlvaine, Emily S.	"	" 965	Farmer	Missouri	1841
Morgan, R. G.	Horine	Sec. 32	"	Illinois	1869
Moore, Aaron	Pevely	" 30	"	Butler Co., O.	1866
McMullin, J. L.	Hanover		"	Jefferson Co, Mo	1837
McNutt, I. Newton	Pevely	Pevely	Physician	Tennessee	1866
Naucke, Fritz	"	Sec. 30	Farmer	Germany	1873
Rankin, Chas. S.	"	Sur. 3028	Merchant	St. Louis Co, Mo	1808
Rankin, Augustus	"	Sec. 1	Farmer	Germany	1842
Swink, J. E.	Hanover		"	Franklin Co, [illegible]	1871
Spalding, J. S.	Pevely	Sur. 437	" and Stock Raiser	Jefferson Co, Mo	1850
Schafer, John	"	Pevely	Carpenter	Germany	1866
Vollmer, Edward	Horine	Horine	Hotel Merch't & Stati'n Agt	"	1853
Ware, Gilbert A.	Pevely	Sec. 2	Farmer and Fruit Grower	Massachusetts	1865
Weber, Stephen D.	"	" 1	Farmer & Lumber Merch't	Missouri	1865
Whitehead, R. M.	Hanover		" and Stock Raiser	Jefferson Co, Mo	1840

1.4 Demographic Characteristics

Total Population	14,577	
Persons/Sq Mile	322.99	
Age 0-4	1,087	7.46%
Age 5-17	2,974	20.40%
Age 18-64	8,887	60.97%
Age 65 and up	1,629	11.18%
College Degree	1,528	10.48%
Some College	2,067	14.18%
High School Only	3,581	24.57%
No High School	2,020	13.86%
Households	5,312	
Average Household Income	45,895	
% Income from Public Assistance		5.78%

Table 1-10

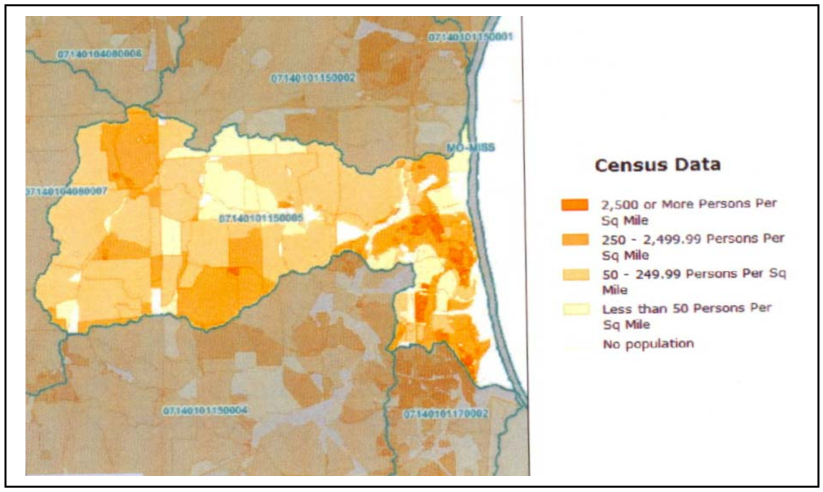
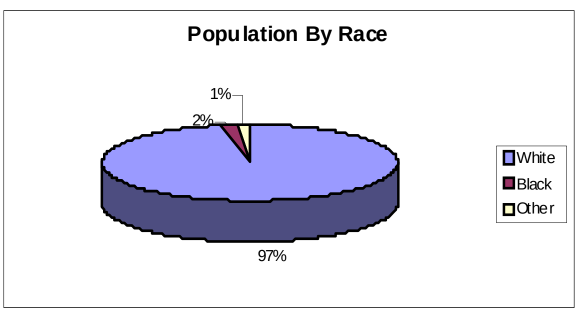


Figure 1-30: Source: www.cares.missouri.edu



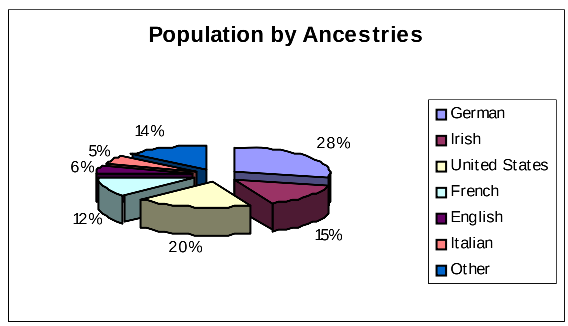


Chart 1-1 & 1-2: Source: www.city-data.com

1.4.1 Population Changes

Within the last 10 years, the communities within the watershed have experienced some growth as the table below shows.

City	2010	2000	Change	%
Crystal City	4,800	4,247	608	14
Festus	11,602	9,660	1,942	20
Herculaneum	3,468	2,805	663	24
Pevely	5,484	3,768	1,716	46
Hillsboro	2,821	1,675	1,146	68

Table 1-11 Source: 2010 U.S. Census Figures as quoted by "The Leader" newspaper.

Within the last 10 years, the Sandy Creek Watershed has experienced an explosion of residential and business developments:

Location	*Subdivision*	*Units/Lots Available*	
Herculaneum	The Prairies	238	
	Providence	706	
	Oak Hill	13	
	Lexington Place		Multi Family Units
	Stonewater	227	
Pevely	Hunters Glen	145	
	Southern Heights	243	
	Vinyards at Bushberg	135	
	Pevely Heights	114	
	Pevely Crossing	41	
	Tiara at the Abbey	125	
	Pevely Commons	5	
	Hardwood Hills	51	
	Pevely Pointe	256	Apartment/Condos
	Valle Creek	32+	Apartment/Condos
Pevely	Midwest Motorcycle	50 Employees	New Business
	Vicon	5 Employees	New Business
	Arrowhead Roofing	13	New Business
Festus	Truman Village	110	Residential
	Truman Village	5	Retirement Housing
	Truman Village	12	Commercial

Table 1-12

1.4.2 Area economics

The top industries in the watershed are manufacturing, educational, health/social services, retail trade, finance/real estate, and entertainment/recreation. (*http://factfinder.census.gov/home/saff/main.html?_lang=en*)

Herculaneum has seen developments such as gas stations, restaurants and small retail shops at the intersection of I-55 and McNutt. Toyota, GMC, and Ford car dealerships have also moved into the same vicinity.

Jefferson County Economic Development Office reports a Feasibility Analysis as the first step in exploring land redevelopment opportunities for sites along the Mississippi River in Herculaneum and Crystal City. The objective is to create a cluster of public port facilities, private port and waterfront developments as well as public-private partnership land redevelopment and economic development opportunities. Benchmarking the existing site conditions and the current cargo market in the greater St. Louis port region determined these parameters will support a


Figure 1-31: Mississippi River at Herculaneum

river terminal development. A second phase of the feasibility study will confirm land availability as well as perform environmental, permitting and economic analysis of the project. These port facilities are expected to bring 6,500 jobs to the area. The report is available via *www.jeffcountymo.org*.

CHAPTER 2: MANAGEMENT UNITS

2.0 Management Units

The Sandy Creek watershed was subdivided into management units based upon drainage patterns by stream order and geographical similarities to enable a more detailed understanding and analysis of conditions as they vary throughout the watershed. These management units can be used by the Sandy Creek Watershed Partnership as a means of citizen representation for the watershed.

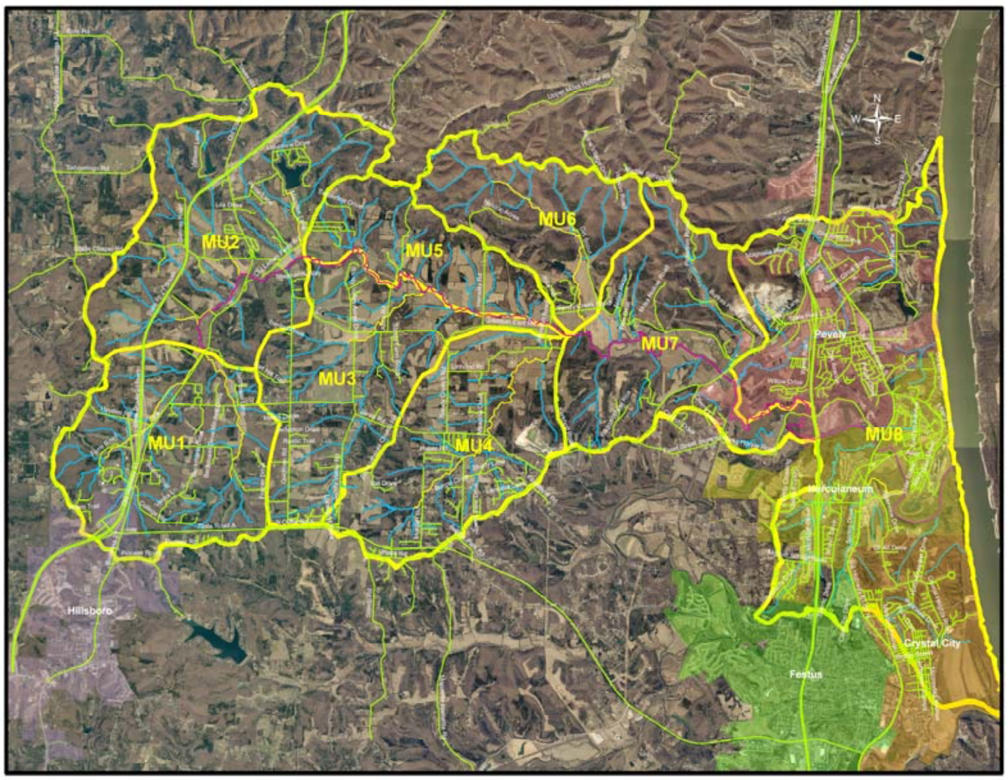


Figure 2-1 GIS Map of Sandy Creek Watershed

The northern half of the watershed consists of hilly terrain with predominately deciduous forest and pasture/hay for land cover. The steep land slope (15% or greater) and shorter distances to the main channel of Sandy Creek results in a higher velocity and shorter duration for stormwater runoff than that of the southern half of the watershed. The northern half also has soils classified as hydrologic soil group D (very slow infiltration rate) and when coupled with the highly erodible soils in the entire watershed can result in bank erosion and sediment transfer.

The southern half of the watershed has a gentler slope (<10%) with a mixture of cultivated crops, pasture/hay and forest (both deciduous and evergreen) land cover. The land adjacent to the stream channels are classified as "prime" farmland with a significant portion of the watershed having farmland with a designation of "statewide importance".

2.0.1 Growth in Sandy Creek Watershed

Just as the fertile valleys brought crop and dairy farmers to the area in the 18th century, it was industry that caused a real explosion in population to the Sandy Creek Watershed during the mid to late 1900s.

Tables 2-1 & 2-2

Housing Growth By Decade								
Pre 1930	1930 1940	1941 1950	1951 1960	1961 1970	1971 1980	1981 1990	1991 2000	2001 2010
182	**254**	**263**	**525**	**626**	**894**	**629**	**615**	**1,373**

WWII Baby Boomers Start Families	*Highway 55 Completion*	*Dow Chemical Opened*	*Chrysler Corporation Opened*	*McDonnell Douglas Merged*
1950s	**1964**	**1947**	**1959**	**1967**

Industry took off in the mid 20th century and with it came people willing to work. Jefferson County 30 miles south of St. Louis, but with the opening of Interstate 55, travel to jobs became easier. The country on a whole was on an upward swing. Baby Boomers were starting families and building homes. Jefferson County has a lot of open space and it was cheaper to live in Jefferson County.

In 1947, Dow Chemical in Pevely began the manufacture of plastic materials and synthetic resins. Plastic was formulated during World War II. Styrofoam is used in the building industry.

The Chrysler Corporation Assembly Plant located in Fenton opened its doors in 1959. It brought hundreds of good paying jobs to the area and many men found a job and a future with Chrysler.

McDonnell Aircraft and Douglas Aircraft merged in 1967 to form McDonnell Douglas – an aerospace manufacturer and defense contractor. As a result of the Vietnam War, and the space program, the new corporation received lots of defense contracts. People could get jobs and have a future with McDonnell Douglas.

Large industry out-sources many of the parts needed for its final product. For example, car seats for Chrysler Corporation were made by Lear Corporation. So, large industry made a market for many smaller family-owned machine and manufacturing shops that opened to meet the demand.

As people moved in to fill these jobs and take advantage of business opportunities, markets were created for grocery stores, clothing stores, shoe stores, restaurants, bakeries, banks, car dealerships, gas stations, shopping centers, lumber yards, etc.

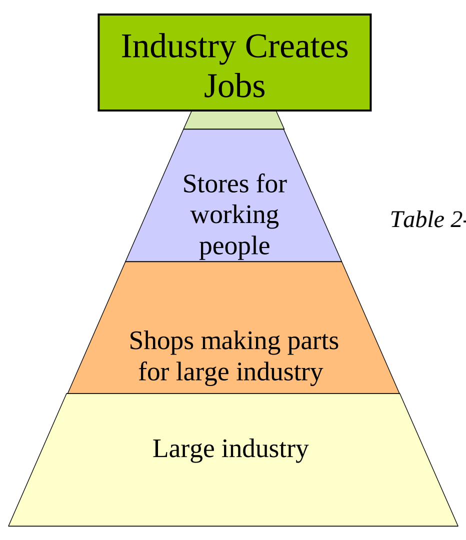
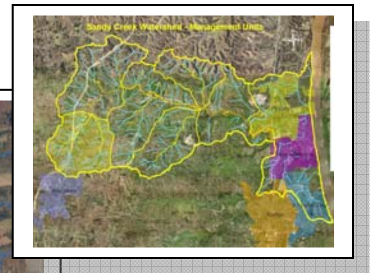
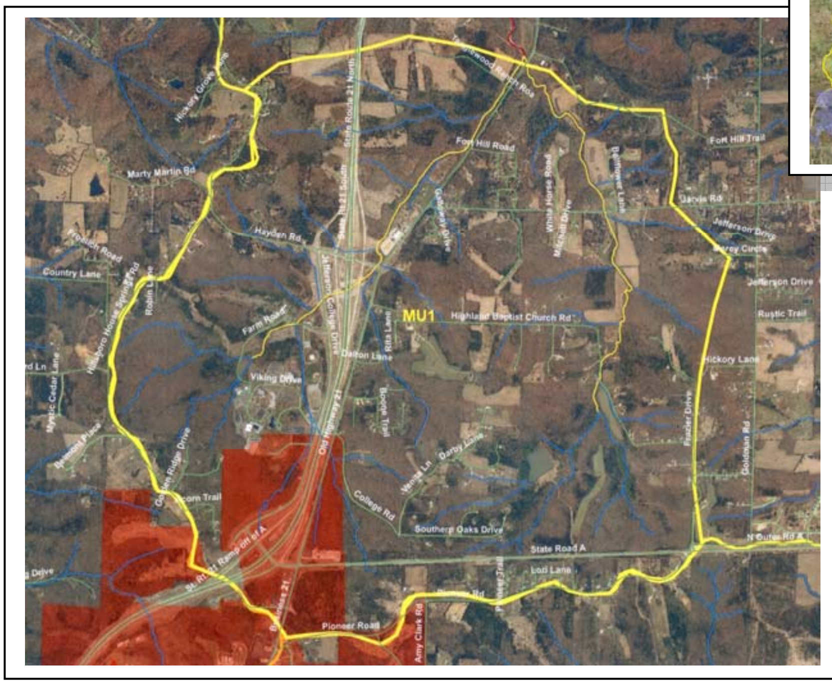


Table 2-3

2.1 Management Unit 1





Management Unit 1 is the headwaters of Sandy Creek and includes portions of the City of Hillsboro and Jefferson College. Two stream order 3 tributaries come together at the downstream border of the MU. New Highway 21 crosses the Management Unit.

Figure 2-2: Aerial Map – MU - 1

These pictures show some of the features of the Sandy Creek Watershed in MU-1.

Figure 2-3: Sandy Creek at New Highway 21

Figure 2-4: Looking West Towards Jefferson College

Figure 2-5: Sandy Creek at Tanglewood Ranch Road

2.1.1 Homes Built by Decade in Management Unit 1

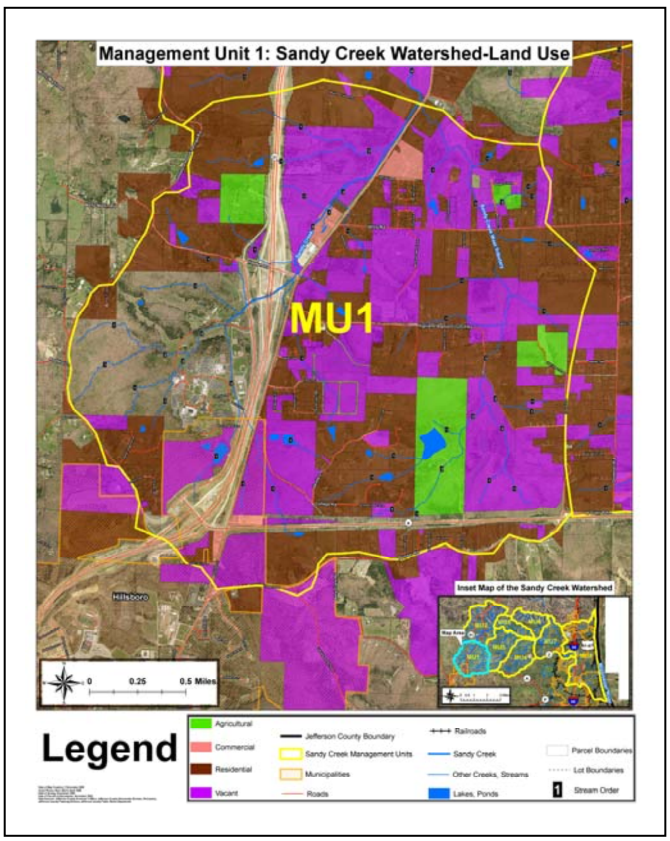
The following table represents the number of homes added by decade in Management Unit 1 with information and events reflective of conditions within the watershed.

Yr Built		MU 1
Pre 1930		7
1930 – 1940		6
1941 – 1950		6
1951 – 1960		16
1961 - 1970		25
1971 – 1980		53
1981 – 1990		81
1991 – 2000		79
2001 – 2010		41
Total Parcels with Homes		314
Parcels w/o Homes		193
Total Parcels		507

Growth throughout the Sandy Creek Watershed started in the 1950s and is reflected in MU1. To facilitate the growth, Jefferson College opened in 1964 and the county government offices in Hillsboro expanded.

Table 2-4 Source:
Jefferson County Assessor's Records

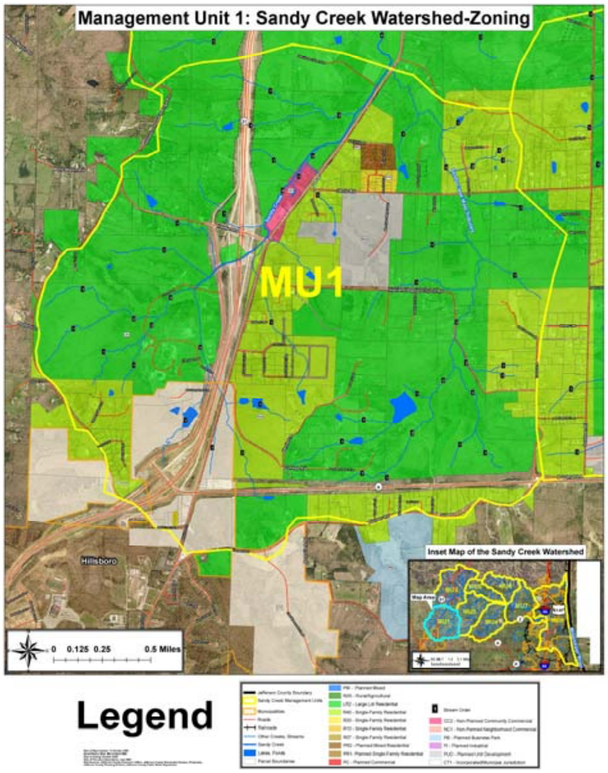
2.1.2 Land Use in Management Unit 1



Management Unit 1 is 66% forest cover and 10% agricultural. Approximately 40% of the parcels are vacant.

Figure 2-6
Source: Jefferson County GIS
Jay Rodenbeck

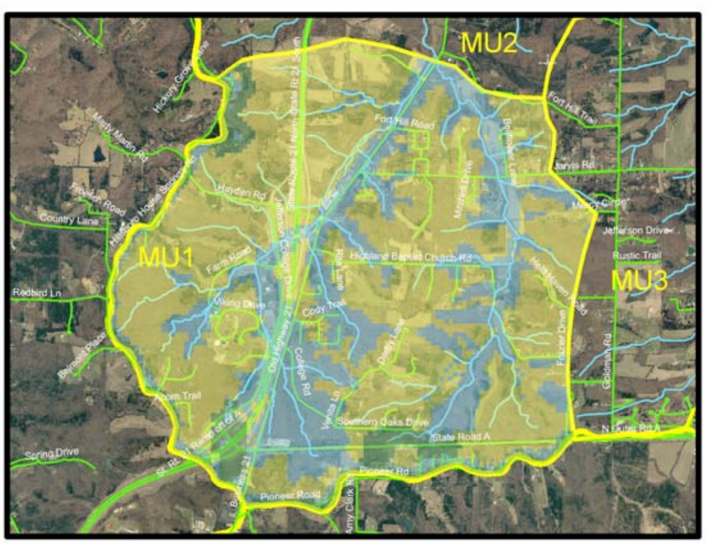
2.1.3 Jefferson County Zoning - Management Unit 1



Current (2011) zoning is predominately Rural/Agricultural. The residential parcels are classified as large lot and single family residential.

Figure 2-7
Source: Jefferson County GIS
Jay Rodenbeck

2.1.4 Soil Type in Management Unit 1



Legend	
Color	***Hydrologic Soil Group***
Blue	B
Yellow	C
Green	D
B - Silty Loam - Moderate infiltration	
C - Sandy Clay Loam - Low infiltration	
D - Clay Loam - Very slow infiltration	

Figure 2-8 Source:
www.cares.missouri.edu
Customized bv Jav Rodenbeck

2.1.5 Allocation of Land Use and Soil Type in Acres - Management Unit 1

Land Use	Hydrologic Soil Group	Area (acres)
Commercial	B	68
Commercial	C	34
Residential 1/2 acre	C	113
Residential 2 acre	C	227
Paved/Parking	D	170
Water/Wetlands	B	68
Agricultural	C	340
Forest	C	1683
Forest	D	700
	Total Acres	3403

Table 2-5 Source: L-THIA input data

The above table reflects existing conditions in Management Unit 1 and when used with the L-THIA (Long-Term Hydrologic Impact Assessment) model (see Chapter 4) yields the following results:

Average Annual Runoff Volume – 7.05 inches and an Average Annual Concentration (in parts per million) for:

BOD	9.566	Fecal Coliform	748.017	Oil & Grease	2.562
Cadmium	0.00084	Fecal Strep	1051.294	Phosphorus	0.325
Chromium	0.007	Lead	0.006	Suspended Solids	34.094
COD	35.929	Nickel	0.003	Zinc	0.060
Copper	0.009	Nitrogen	1.501		
For acceptable amounts under specific conditions, refer to MDNR water quality standards, 10 CSR 20-7.031 Table A (pages 19-29).					

Table 2-6 Source: L-THIA Output Data

2.1.6 Expressed Concerns in Management Unit 1

Chapter 3 of this watershed plan reflects issues and concerns common throughout the entire Sandy Creek watershed. Concerns expressed by citizens unique to Management Unit 1 are sinkholes and their impact on water quality and preserving history such as a stagecoach trail and an area known as Buffalo Hide Tree.

2.2 Management Unit 2

Management Unit 2 drains the northwest portion of the Sandy Creek Watershed. Sandy Creek is a stream order 4 in MU-2.

Figure 2-9: Aerial Map – MU- 2

These pictures show some of the features of the Sandy Creek Watershed in MU-2.

Figure 2-10: Sandy Creek Covered Bridge

Figure 2-11: Lake Lorraine

Figure 2-12: Tributary at Glade Chapel Road

2.2.1 Homes Built by Decade in Management Unit 2

The following table represents the number of homes added by decade in Management Unit 2 with information and events reflective of conditions within the watershed.

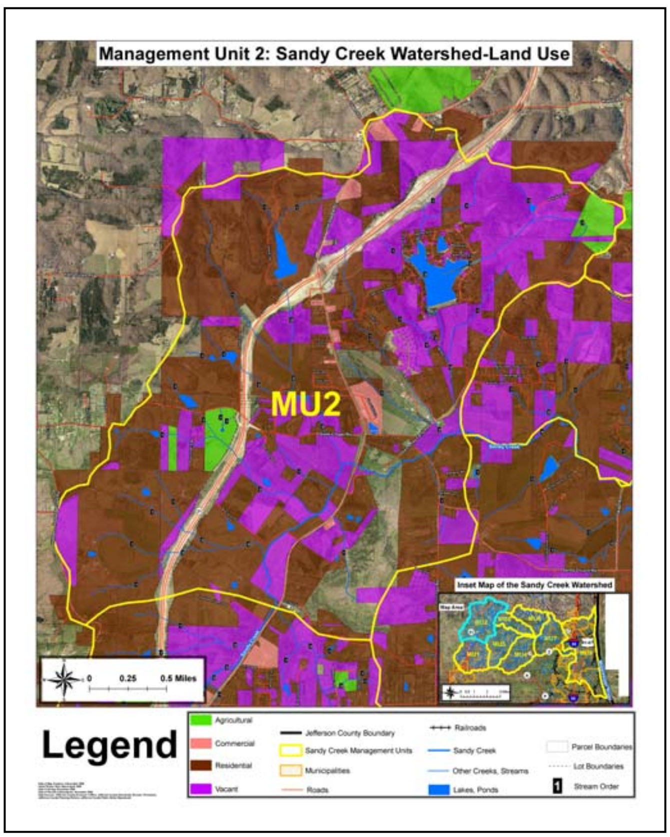
Yr Built		**MU 2**
Pre 1930		14
1930 – 1940		6
1941 – 1950		8
1951 – 1960		49
1961 - 1970		63
1971 – 1980		90
1981 – 1990		54
1991 – 2000		32
2001 – 2010		85
Total Parcels with Homes		401
Parcels w/o Homes		237
Total Parcels		638

Management Unit 2 reflects significant growth in the 1950s. A portion of this is the result of Lake Lorraine which was built in 1957.

MU-2 has convenient access to Highway 21 and has attracted trailer parks and subdivision development.

Table 2-7 Source:
Jefferson County Assessor's Records

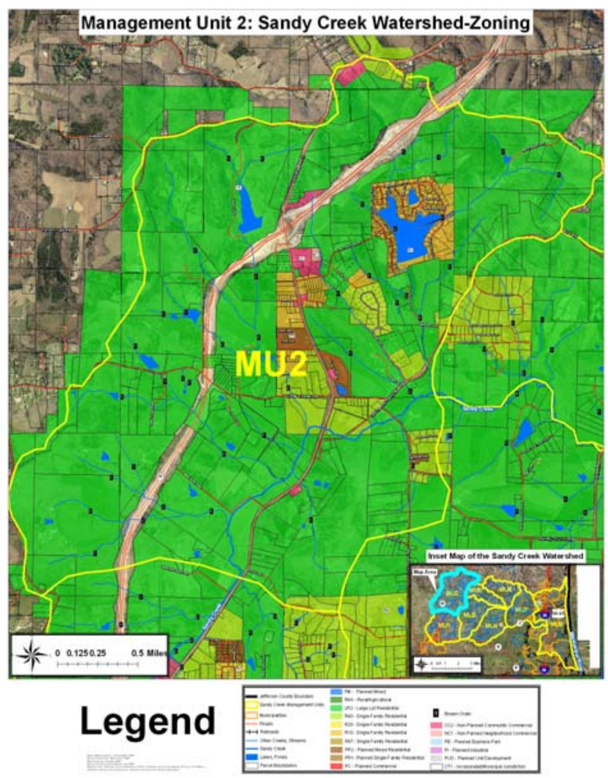
2.2.2 Land Use in Management Unit 2



MU-2 land use is predominately residential with homes on approximately 2/3 of the parcels. Hilly terrain in the MU is a restriction to using the land for agriculture.

Figure 2-13 Source: Jefferson County GIS
Jay Rodenbeck

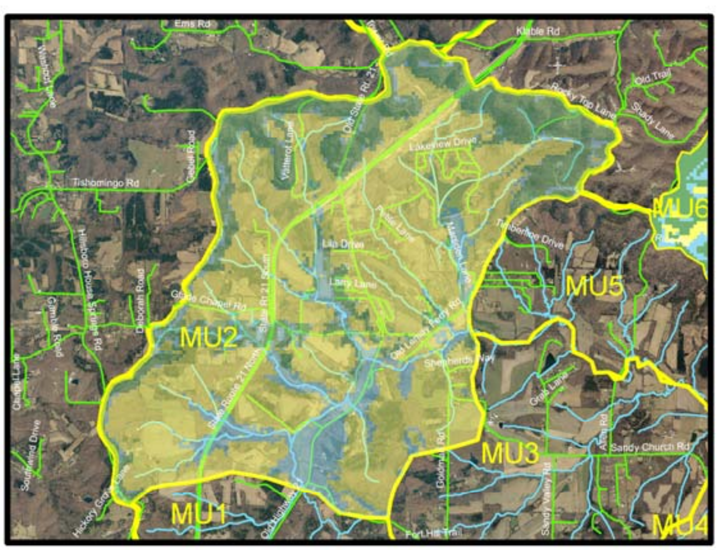
2.2.3 Jefferson County Zoning- Management Unit 2



Jefferson County Zoning (2011) reflects large lot residential for approximately 80% of the MU with single family and planned mixed residential reflected around Lake Lorraine and trailer courts.

Figure 2-14
Source: Jefferson County GIS
Jay Rodenbeck

2.2.4 Soil Type in Management Unit 2



Legend	
Color	***Hydrologic Soil Group***
Blue	B
Yellow	C
Green	D
B - Silty Loam - Moderate infiltration	
C - Sandy Clay Loam - Low infiltration	
D - Clay Loam - Very slow infiltration	

Figure 2-15
Source: www.cares.missouri.edu
Modified by Jay Rodenbeck

2.2.5 Allocation of Land Use and Soil Type by Acres - Management Unit 2

Land Use	Hydrologic Soil Group	Area (acres)
Commercial	C	224
Residential 1/4 acre	C	109
Residential 2 acre	C	428
Paved/Parking	D	224
Water/Wetlands	B	134
Agricultural	C	760
Forest	D	2594
	Total Acres	4473

Table 2-8

The above table reflects existing conditions in Management Unit 2 and when used with the L-THIA (Long-Term Hydrologic Impact Assessment) model (see Chapter 4) yields the following results:

Average Annual Runoff Volume – 8.79 inches and an Average Annual Concentration (in parts per million) for:

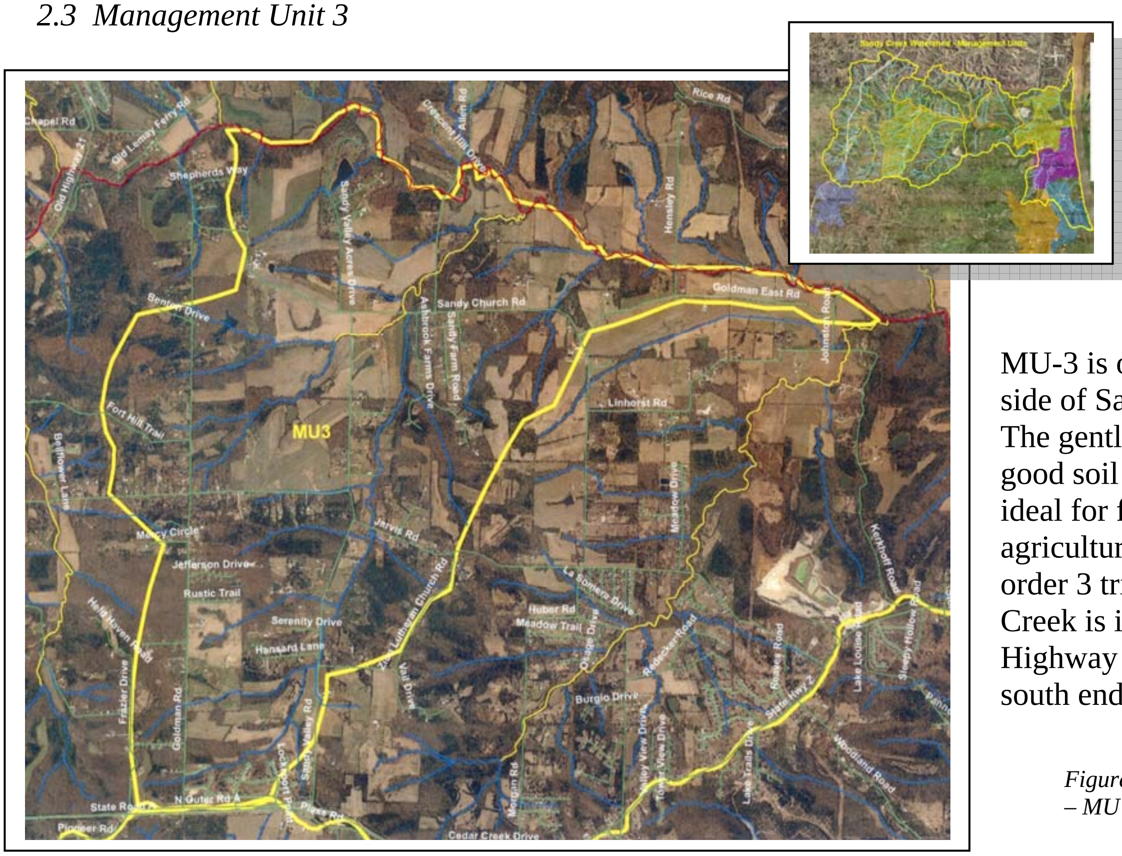
Table 2-9

BOD	9.899	Fecal Coliform	876.651	Oil & Grease	2.643
Cadmium	0.00093	Fecal Strep	1056.443	Phosphorus	0.392
Chromium	0.007	Lead	0.006	Suspended Solids	39.791
COD	36.910	Nickel	0.003	Zinc	0.062
Copper	0.009	Nitrogen	1.689		
For acceptable amounts under specific conditions, refer to MDNR water quality standards, 10 CSR 20-7.031 Table A (pages 19-29).					

2.2.6 Expressed Concerns in Management Unit 2

Chapter 3 of this watershed plan reflects issues and concerns common throughout the entire Sandy Creek watershed. Concerns expressed by citizens unique to Management Unit 2 are lagoons associated with a mobile home park, water quality of stream supplying Lake Lorraine and the discharge from the lake, sediment and runoff erosion from new developments in MU, and bank erosion on tributaries and main channel of Sandy Creek.

2.3 Management Unit 3



MU-3 is on the south side of Sandy Creek. The gentle slopes and good soil types make it ideal for farming and agriculture. A stream order 3 tributary, Big Creek is in MU-3. Highway A is on the south end of the MU.

Figure 2-16: Aerial Map – MU - 3

These pictures show some of the features of Sandy Creek Watershed in MU-3.

Figure 2-17: Sandy Creek at Allen Road

Figure 2-18: Big Creek Tributary at Allen Road

Figure 2-19: Lockport Landing Subdivision

2.3.1 Homes Built by Decade in Management Unit 3

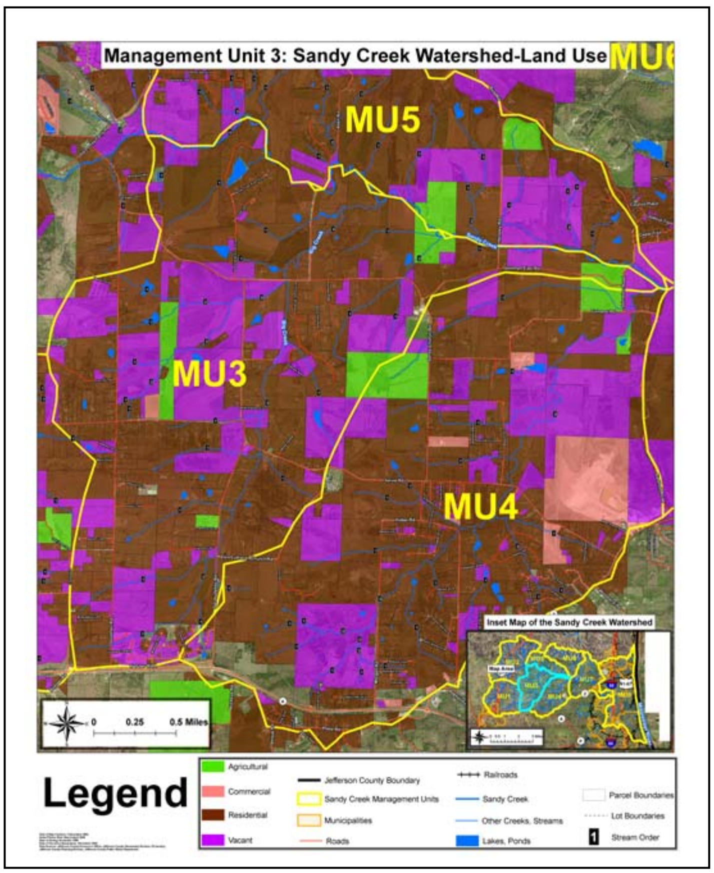
The following table represents the number of homes added by decade in Management Unit 3 with information and events reflective of conditions within the watershed.

Yr Built		MU 3
Pre 1930		6
1930 – 1940		5
1941 – 1950		10
1951 – 1960		18
1961 - 1970		21
1971 – 1980		71
1981 – 1990		77
1991 – 2000		64
2001 – 2010		87
Total Parcels with Homes		359
Parcels w/o Homes		178
Total Parcels		537

Table 2-10

Significant growth in MU-3 started in the 1970s when residential development along Goldman and Jarvis Roads became attractive to individuals who wanted to get away from St. Louis but still be able to commute there for employment.

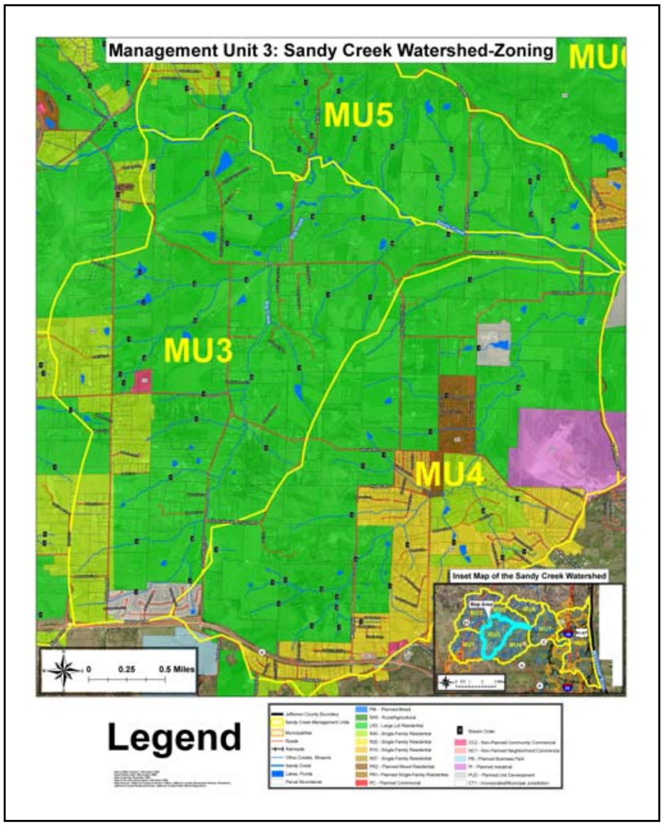
2.3.2 Land Use in Management Unit 3



Land use in MU-3 reflects significant residential usage which represents families living on large acreage parcels and farming the land.

Figure 2-20
Source: Jefferson County GIS by Jay Rodenbeck

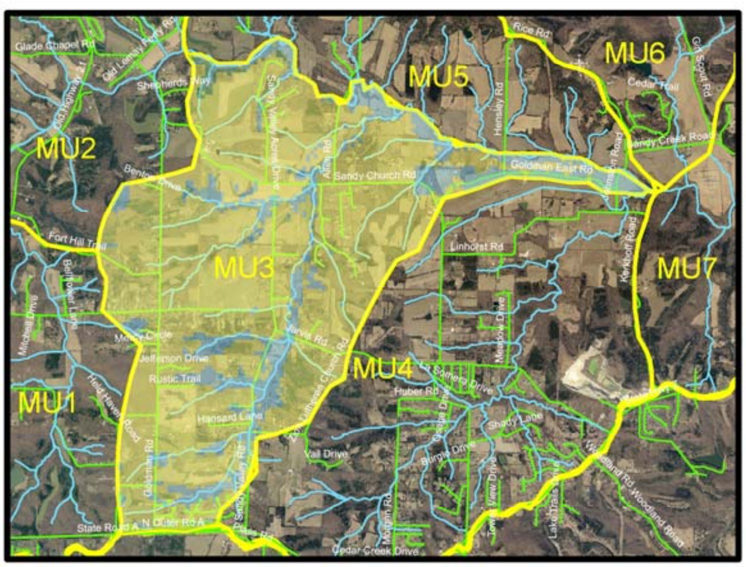
2.3.3 Jefferson County Zoning - Management Unit 3



Jefferson County Zoning (2011) reflects Large Lot residential, consistent with Land Use for most of MU-3. Single family residential is reflected on the western side of the MU and new development has occurred on the southern side along Highway A.

Figure 2-21
Source: J.C. GIS

2.3.4 Soil Type in Management Unit 3



Legend	
Color	***Hydrologic Soil Group***
Blue	B
Yellow	C
Green	D
B - Silty Loam - Moderate infiltration	
C - Sandy Clay Loam - Low infiltration	
D - Clay Loam - Very slow infiltration	

Figure 2-22
Source: www.cares.missouri.edu
Jay Rodenbeck

2.3.5 Allocation of Land Use and Soil Type by Acres - Management Unit 3

Land Use	**Hydrologic Soil Group**	**Area (acres)**
Commercial	C	32
Residential 2 acre	C	348
Paved/Parking	D	32
Water/Wetlands	B	63
Agricultural	B	400
Agricultural	C	1086
Forest	C	958
Forest	D	244
	Total Acres:	3,163

Table 2-11
Source: L-THIA Input Data

The above table reflects existing conditions in Management Unit 3 and when used with the L-THIA (Long-Term Hydrologic Impact Assessment) model (see Chapter 4) yields the following results:

Average Annual Runoff Volume – 7.07 inches and an Average Annual Concentration (in parts per million) for:

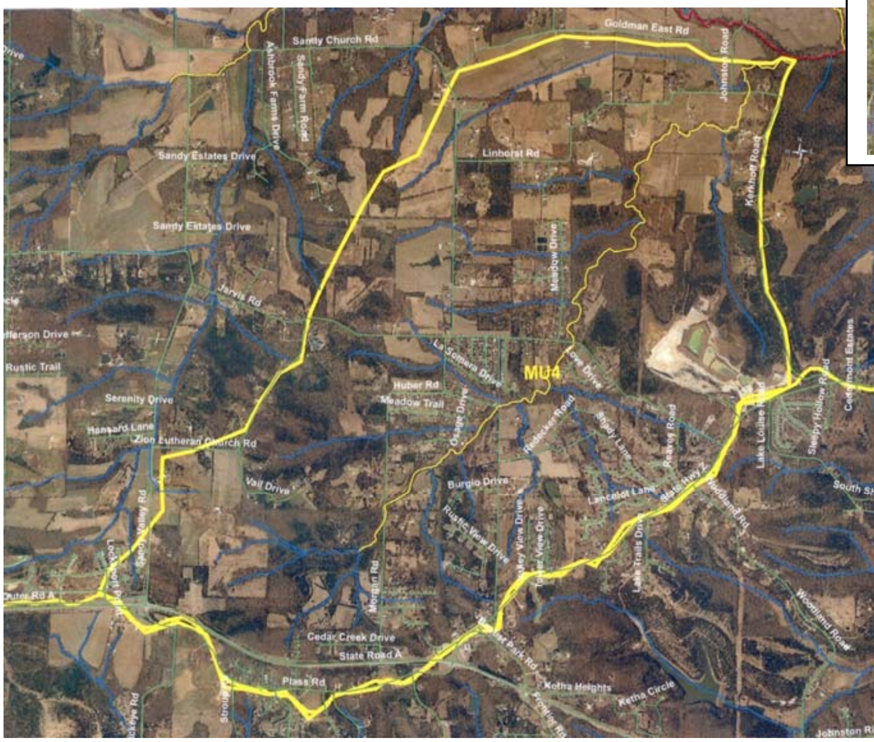
BOD	6.747	Fecal Coliform	1743.819	Oil & Grease	0.801
Cadmium	0.00091	Fecal Strep	714.320	Phosphorus	0.833
Chromium	0.008	Lead	0.003	Suspended Solids	70.112
COD	13.286	Nickel	0.001	Zinc	0.031
Copper	0.004	Nitrogen	3.005		
For acceptable amounts under specific conditions, refer to MDNR water quality standards, 10 CSR 20-7.031 Table A (pages 19-29).					

Table 2-12
Source: L-THIA Output Data

2.3.6 Expressed Concerns in Management Unit 3

Chapter 3 of this watershed plan reflects issues and concerns common throughout the entire Sandy Creek watershed. Concerns expressed by citizens unique to Management Unit 3 are the water quality of the Big Creek tributary as it drains residential development on the western side of the MU, surface runoff from development along Highway A, and bank erosion occurring at the Hensley Road bridge.

2.4 Management Unit 4



MU-4 includes the Mapaville area along Highway Z and Highway A. A stream order 3 drains this area to Sandy Creek. Mining operations are significant on the eastern side of the MU.

Figure 2-23: Aerial Map – MU-4

These pictures show some of the features of Sandy Creek Watershed in MU-4.

Figure 2-24: Tributary at Kerkoff Road

Figure 2-25: Mining Operation

Figure 2-26: Antonio Villa Winery

2.4.1 Homes Built by Decade in Management Unit 4

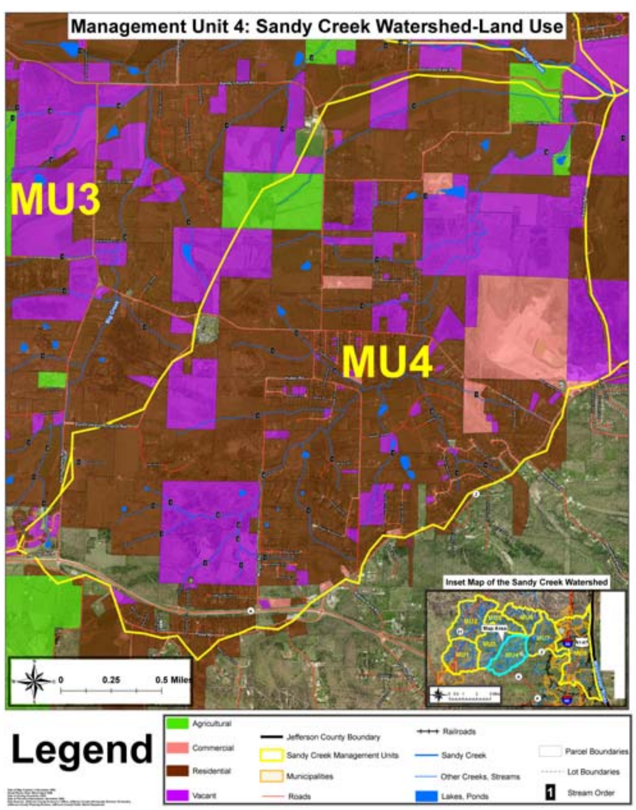
The following table represents the number of homes added by decade in Management Unit 4 with information and events reflective of conditions within the watershed.

Yr Built		MU 4
Pre 1930		6
1930 – 1940		7
1941 – 1950		7
1951 – 1960		26
1961 - 1970		54
1971 – 1980		135
1981 – 1990		101
1991 – 2000		86
2001 – 2010		168
Total Parcels with Homes		590
Parcels w/o Homes		266
Total Parcels		856

Table 2-13

Via both Highway Z and A, MU-4 is convenient to Interstate 55 which opened in 1964. Residential development in the Mapaville area made this area attractive to commuters to the St. Louis area. The gentle sloping terrain in portions of MU-4 made residential development feasible and economically attractive.

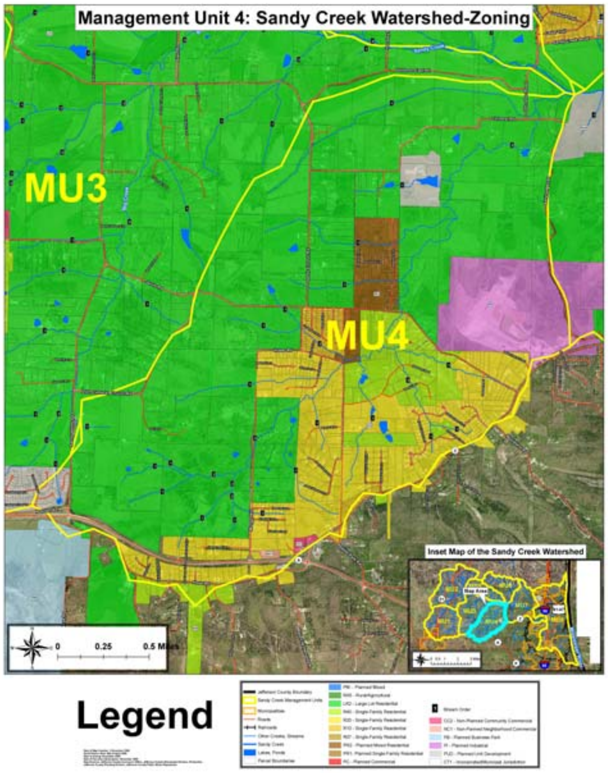
2.4.2 Land Use in Management Unit 4



Residential land use is predominant in MU-4 with commercial use reflecting the mining operations shown on the east side of the MU.

Figure 2-27
Source: J.C. GIS
Jay Rodenbeck

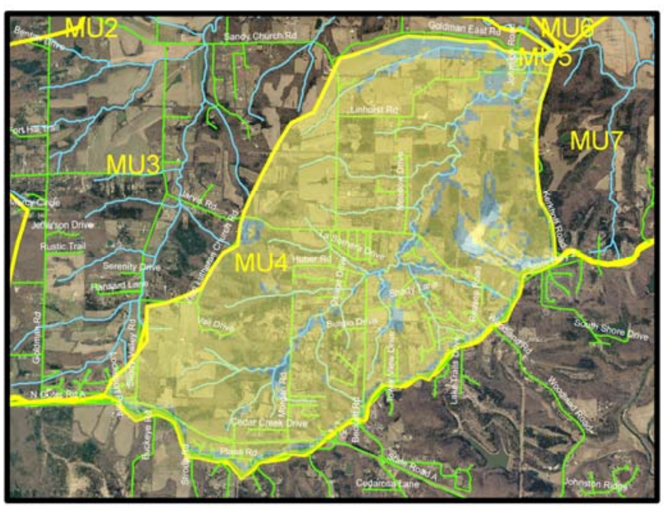
2.4.3 Jefferson County Zoning - Management Unit 4



A significant portion of MU-4 is shown as single family residential (along Highways A and Z) with large lot residential zoned parcels being the predominant zoning. Farming and agriculture is occurring on the large lot parcels.

Figure 2-28
Source: J.C. GIS
Jay Rodenbeck

2.4.4 Soil Type in Management Unit 4



Legend	
Color	***Hydrologic Soil Group***
Blue	B
Yellow	C
Green	D
B - Silty Loam - Moderate infiltration	
C - Sandy Clay Loam - Low infiltration	
D - Clay Loam - Very slow infiltration	

Figure 2-29
Source: www. cares.missouri.edu
Jay Rodenbeck

2.4.5 Allocation of Land Use and Soil Type by Acres - Management Unit 4

Land Use	Hydrologic Soil Group	Area (acres)
Commercial	C	307
Residential 1/2 acre	C	133
Residential 2 acre	C	174
Paved/Parking	D	31
Water/Wetlands	B	31
Agricultural	B	218
Agricultural	C	1165
Forest	D	1014
	Total Acres	3073

Table 2-14: Source: L-THIA Input Data

The above table reflects existing conditions in Management Unit 4 and when used with the L-THIA (Long-Term Hydrologic Impact Assessment) model (see Chapter 4) yields the following results:

Average Annual Runoff Volume – 9.86 inches and an Average Annual Concentration (in parts per million) for:

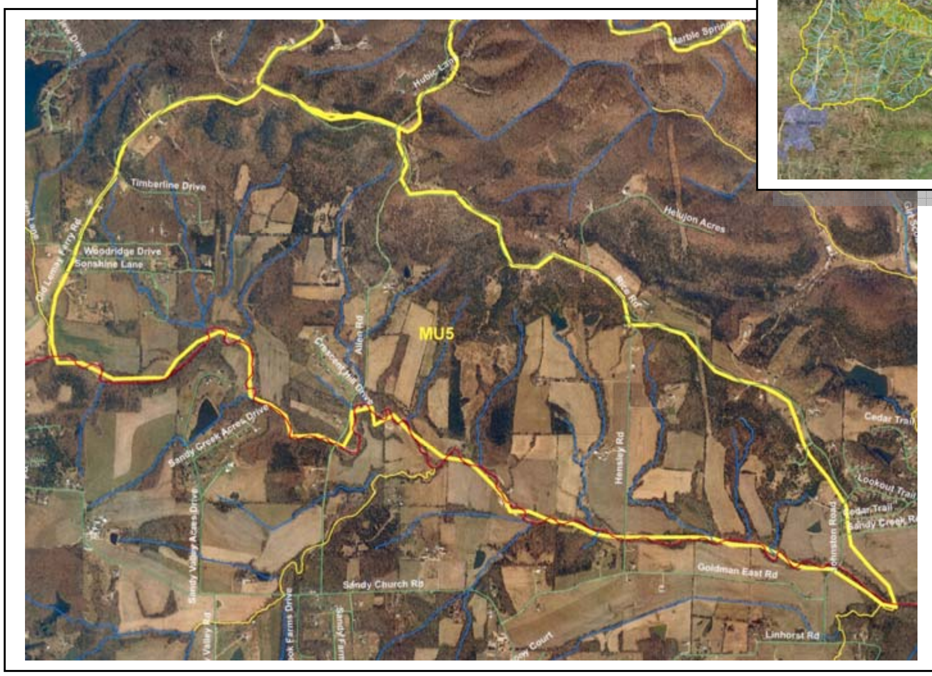
BOD	8.452	Fecal Coliform	539.988	Oil & Grease	2.477
Cadmium	0.00060	Fecal Strep	887.702	Phosphorus	0.233
Chromium	0.005	Lead	0.005	Suspended Solids	26.457
COD	34.044	Nickel	0.003	Zinc	0.056
Copper	0.008	Nitrogen	1.095		
For acceptable amounts under specific conditions, refer to MDNR water quality standards, 10 CSR 20-7.031 Table A (pages 19-29).					

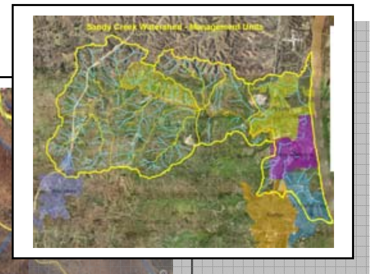
Table 2-15 Source: L-THIA Output Data

2.4.6 Expressed Concerns in Management Unit 4

Chapter 3 of this watershed plan reflects issues and concerns common throughout the entire Sandy Creek watershed. Concerns expressed by citizens unique to Management Unit 4 are the water quality of the tributary draining the developments in the Mapaville area and the mining operations and extensive bank erosion along Sandy Creek.

2.5 Management Unit 5





MU-5 is located on the north side of Sandy Creek and has slopes >15% with tributaries shorter in length than those the south of the creek.

Figure 2-30: Aerial Map – MU - 5

These photos show features of the Sandy Creek Watershed in MU-5.

Figure 2-31: Sandy Creek at Hensley Road looking downstream (MU5 on left – MU3 on right)

Figure 2-32: Sandy Creek Watershed from Rice Road looking southwest

Figure 2-33 Looking southeast from Rice Road

2.5.1 Homes Built by Decade in Management Unit 5

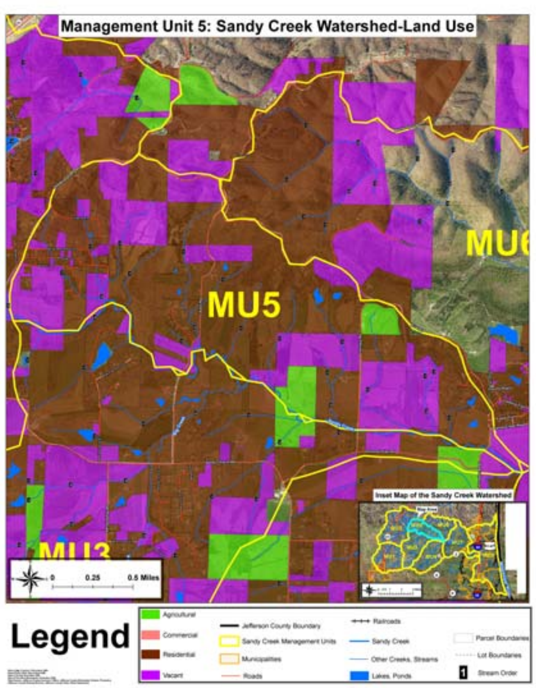
The following table represents the number of homes added by decade in Management Unit 5 with information and events reflective of conditions within the watershed.

Yr Built		MU 5
Pre 1930		5
1930 – 1940		6
1941 – 1950		4
1951 – 1960		5
1961 - 1970		2
1971 – 1980		23
1981 – 1990		10
1991 – 2000		14
2001 – 2010		30
Total Parcels with Homes		99
Parcels w/o Homes		53
Total Parcels		152

Subdivisions off of Old Lemay Ferry Road built in the 1970s contributed to growth recognized during that period. MU-5 is rural in nature with limited road access and has not developed as fast as other MUs in the watershed.

Table 2-16
Source: J.C. Assessor's Records

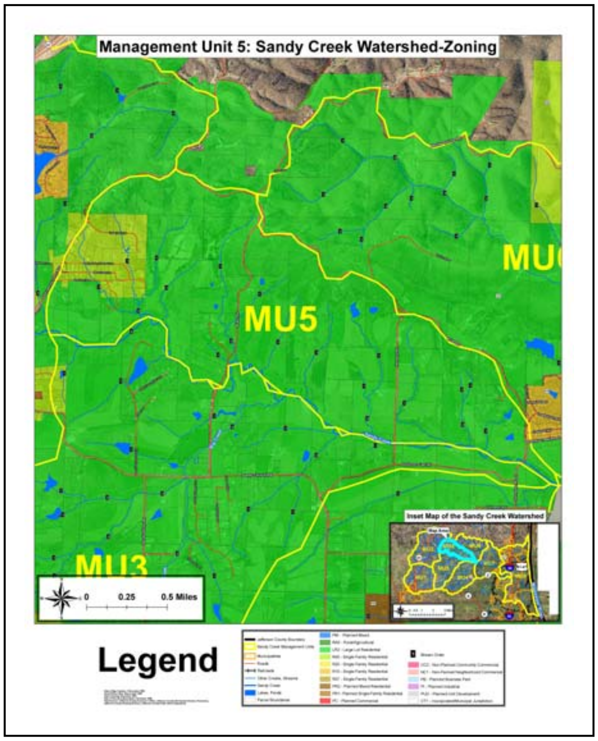
2.5.2 Land Use in Management Unit 5



Land use in MU-5 is predominately shown as residential which reflects families living on the land they are farming.

Figure 2-34
Source: J.C. GIS
Jay Rodenbeck

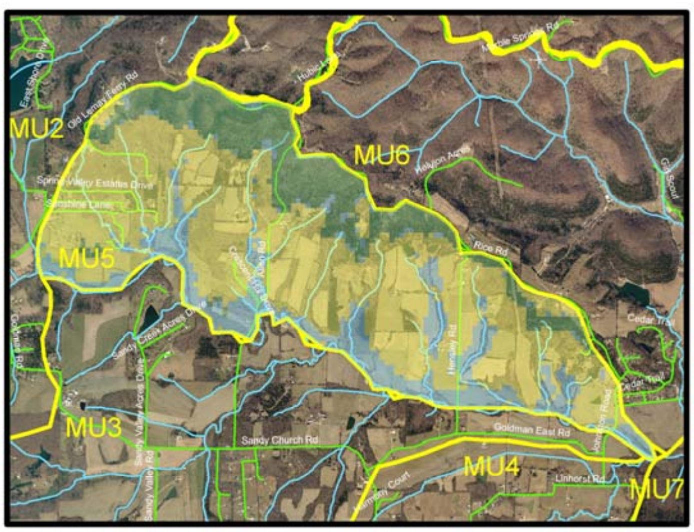
2.5.3 Jefferson County Zoning- Management Unit 5



Jefferson County 2011 Zoning reflects large lot residential for the majority of MU-5 with the single family residential reflected in the subdivisions off of Old Lemay Ferry Road.

Figure 2-35
Source: J.C. GIS
Jay Rodenbeck

2.5.4 Soil Type in Management Unit 5



Legend	
Color	***Hydrologic Soil Group***
Blue	B
Yellow	C
Green	D
B - Silty Loam - Moderate infiltration	
C - Sandy Clay Loam - Low infiltration	
D - Clay Loam - Very slow infiltration	

The northern edge of MU-5 has a very slow infiltration rate.

Figure 2-36
Source: www.cares.missouri.edu
Jay Rodenbeck

2.5.5 Allocation of Land Use and Soil Type by Acres - Management Unit 5

Land Use	Hydrologic Soil Group	Area (acres)
Residential 1/2 acre	C	166
Paved/Parking	D	17
Water/Wetlands	B	83
Agricultural	B	157
Agricultural	C	523
Forest	C	538
Forest	D	176
	Total Acres	1660

Table 2-17 Source: L-THIA Input Data

The above table reflects existing conditions in Management Unit 5 and when used with the L-THIA (Long-Term Hydrologic Impact Assessment) model (see Chapter 4) yields the following results:

Average Annual Runoff Volume – 6.74 inches and an Average Annual Concentration (in parts per million) for:

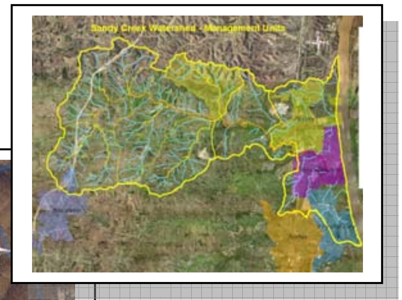
BOD	6.309	Fecal Coliform	1652.987	Oil & Grease	0.530
Cadmium	0.00093	Fecal Strep	641.611	Phosphorus	0.780
Chromium	0.007	Lead	0.0045	Suspended Solids	16.660
COD	10.303	Nickel	0.001	Zinc	0.012
Copper	0.004	Nitrogen	2.853		
For acceptable amounts under specific conditions, refer to MDNR water quality standards, 10 CSR 20-7.031 Table A (pages 19-29).					

Table 2-18 Source: L-THIA Output Data

2.5.6 Expressed Concerns in Management Unit 5

Chapter 3 of this watershed plan reflects issues and concerns common throughout the entire Sandy Creek watershed. The citizens did not reflect any specific concerns to MU 5 but with the steep slopes and very slow infiltration, erosion and sediment runoff could be issues in the tributaries of MU 5.

2.6 Management Unit 6



Management Unit 6 consists of hilly and tree covered terrain with the Girl Scout property occupying a large portion of the MU. Sandy Creek Road and Rice Road are the main roads in the MU.

Figure 2-37: Aerial Map – MU - 6

This photo shows a feature of the Sandy Creek Watershed in MU-6.

Figure 2-38: Farm along Sandy Creek Road

Figure 2-39 Girl Scout Property

Figure 2-40 Sandy Creek from Johnston Road MU6 on left and MU4 on right.

2.6.1 Homes Built by Decade in Management Unit 6

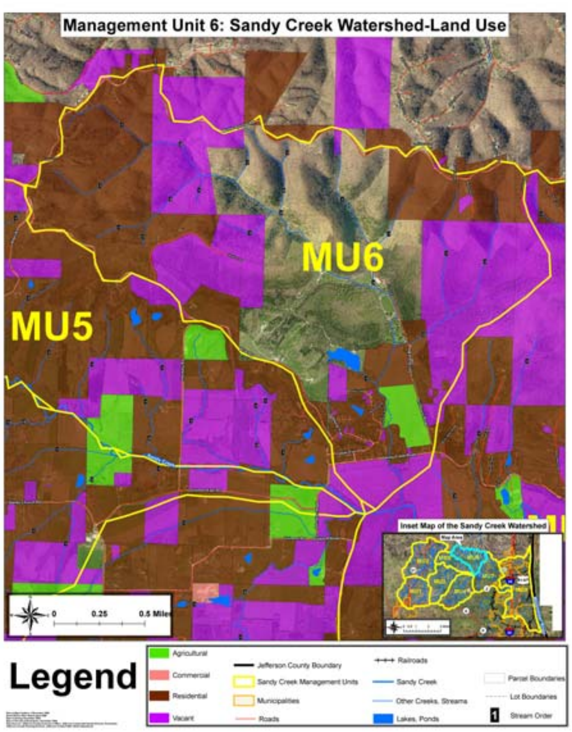
The following table represents the number of homes added by decade in Management Unit 6 with information and events reflective of conditions within the watershed.

Yr Built		MU 6
Pre 1930		4
1930 – 1940		1
1941 – 1950		5
1951 – 1960		13
1961 - 1970		21
1971 – 1980		27
1981 – 1990		11
1991 – 2000		10
2001 – 2010		15
Total Parcels with Homes		107
Parcels w/o Homes		93
Total Parcels		200

Subdivision developments along Sandy Creek Road contributed to some growth in MU-6 in the 1970s and 80s. Otherwise on an average only one new home was built per year. If the Girl Scout property remains as it is, very little growth can be expected in MU-6.

Table 2-19
Source: J.C. Assessor's Records

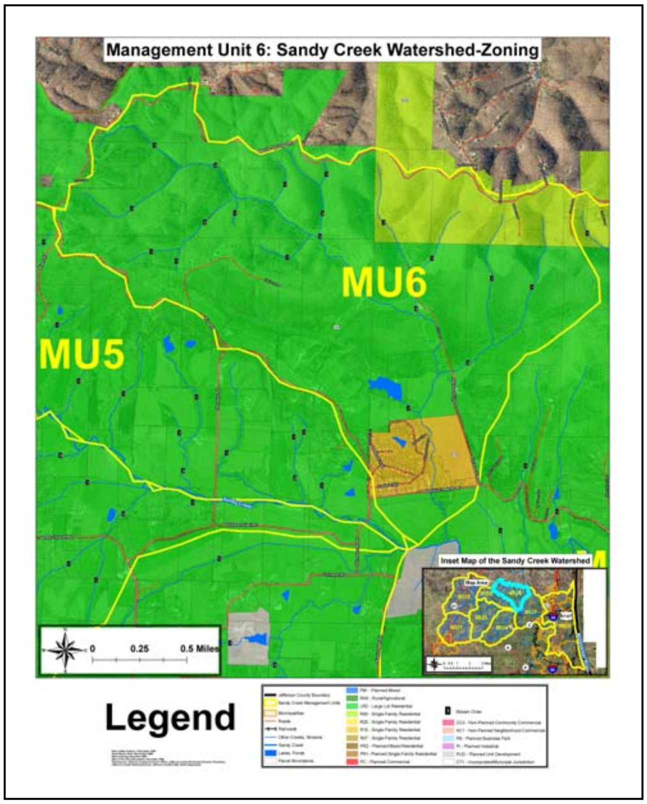
2.6.2 Land Use in Management Unit 6



The Girl Scout property occupies approximately 40% of MU-6. The remaining land use is mostly residential with large segments shown as vacant.

Figure 2-41
Source: J.C. GIS
Jay Rodenbeck

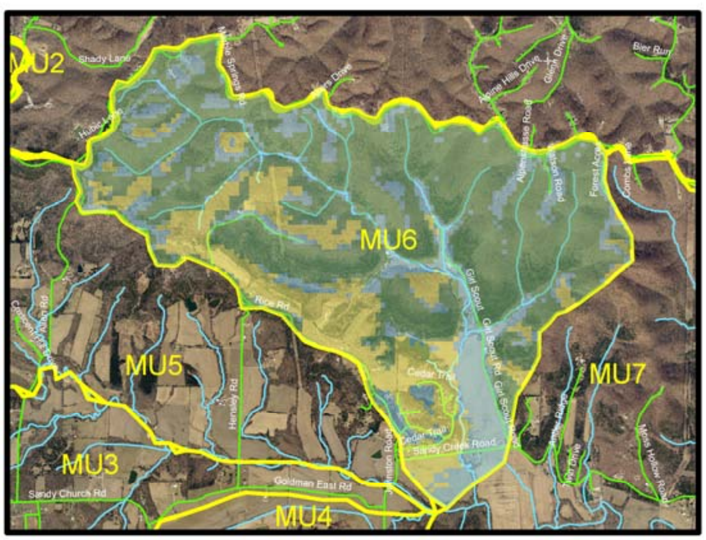
2.6.3 Jefferson County Zoning - Management Unit 6



The entire MU-6 is zoned as residential with the majority being large lot and the developments along Sandy Creek Road shown as single family.

Figure 2-42
Source: J.C. GIS
Jay Rodenbeck

2.6.4 Soil Type in Management Unit 6



Legend	
Color	***Hydrologic Soil Group***
Blue	B
Yellow	C
Green	D
B - Silty Loam - Moderate infiltration	
C - Sandy Clay Loam - Low infiltration	
D - Clay Loam - Very slow infiltration	

A significant portion of MU-6 is shown as very slow infiltration.

Figure 2-43 Source: www.cares.missouri.edu
Jay Rodenbeck

2.6.5 Allocation of Land Use and Soil Type by Acres - Management Unit 6

Land Use	**Hydrologic Soil Group**	**Area (acres)**
Residential 2 acre	C	216
Paved/Parking	D	22
Water/Wetlands	B	22
Agricultural	B	308
Agricultural	C	16
Forest	C	211
Forest	D	1367
	Total Acres	2162

Table 2-20 Source: L-THIA Input Data

The above table reflects existing conditions in Management Unit 6 and when used with the L-THIA (Long-Term Hydrologic Impact Assessment) model (see Chapter 4) yields the following results:

Average Annual Runoff Volume – 6.54 inches and an Average Annual Concentration (in parts per million) for:

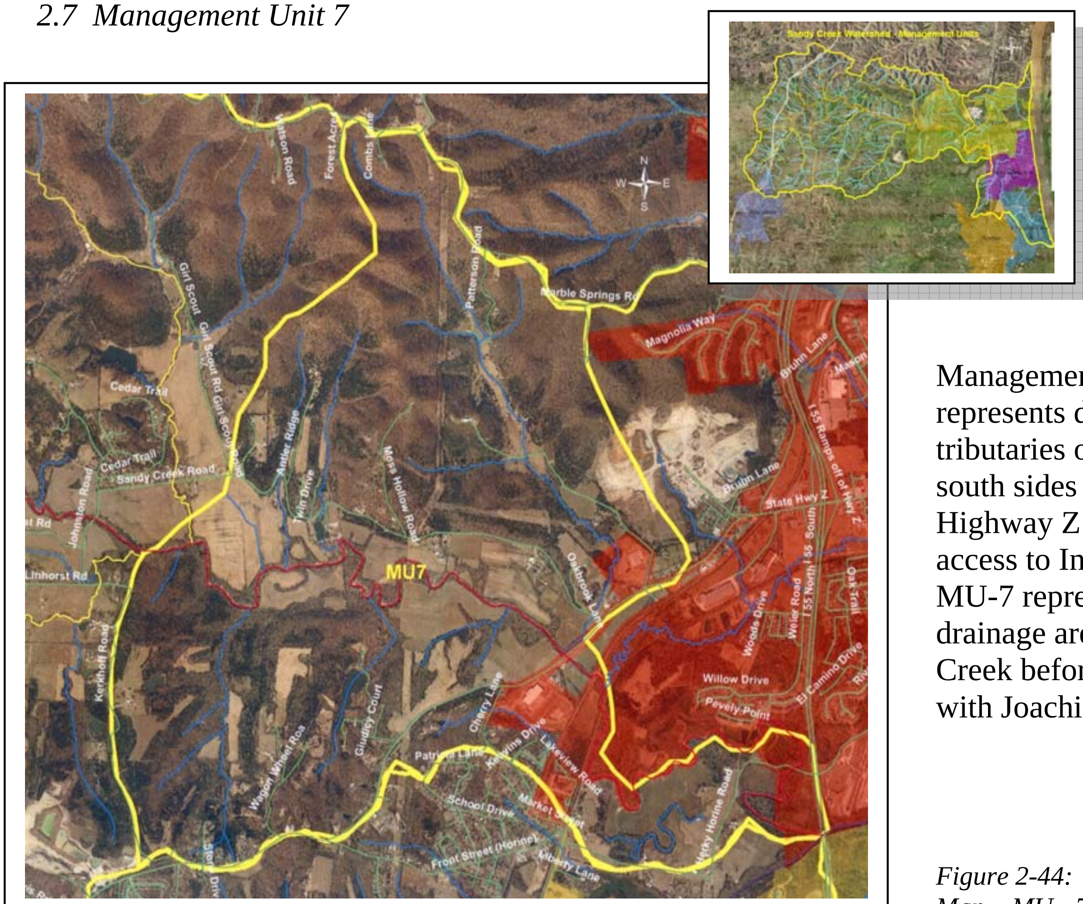
BOD	4.501	Fecal Coliform	616.064	Oil & Grease	0.526
Cadmium	0.00095	Fecal Strep	649.228	Phosphorus	0.264
Chromium	0.006	Lead	0.004	Suspended Solids	22.501
COD	9.685	Nickel	0.001	Zinc	0.021
Copper	0.008	Nitrogen	1.382		
For acceptable amounts under specific conditions, refer to MDNR water quality standards, 10 CSR 20-7.031 Table A (pages 19-29).					

Table 2-21 Source: L-THIA Output Data

2.6.6 Expressed Concerns in Management Unit 6

Chapter 3 of this watershed plan reflects issues and concerns common throughout the entire Sandy Creek watershed. There we no citizen expressed concerns with MU 6. With the Girl Scouts owning a large portion of MU 6, water quality issues should be minimal.

2.7 Management Unit 7



Management Unit 7 represents drainage from tributaries on the north and south sides of Sandy Creek. Highway Z provides easy access to Interstate 55. MU-7 represents the last drainage area of Sandy Creek before the confluence with Joachim Creek.

Figure 2-44: Aerial Map – MU - 7

These pictures show features of Sandy Creek Watershed in MU-7.

Figure 2-45: Covered Spring along Sandy Creek Road

Figure 2-46: Sandy Creek at Highway Z looking downstream

Figure 2-47: Sandy Creek at Highway Z looking downstream

2.7.1 Homes Built by Decade in Management Unit 7

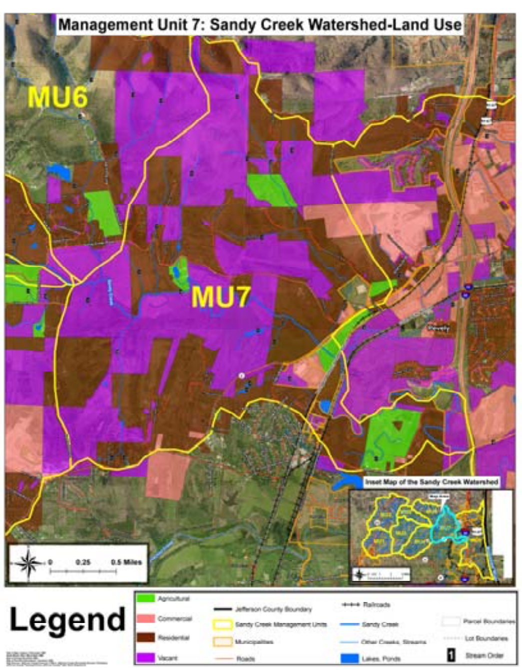
The following table represents the number of homes added by decade in Management Unit 7 with information and events reflective of conditions within the watershed.

Yr Built		MU 7
Pre 1930		5
1930 – 1940		8
1941 – 1950		11
1951 – 1960		35
1961 - 1970		25
1971 – 1980		23
1981 – 1990		30
1991 – 2000		25
2001 – 2010		21
Total Parcels with Homes		183
Parcels w/o Homes		163
Total Parcels		346

Growth in MU-7 correlates with the opening of the Dow chemical plant in Pevely in 1947 and the Chrysler plant in 1959. the completion of Interstate 55 in 1964 and convenient accesss to it via Highway Z resulted in consistent growth in MU-7 throughout the remainder of the 1900s.

Table 2-22
Source: J.C. Assessor's Records

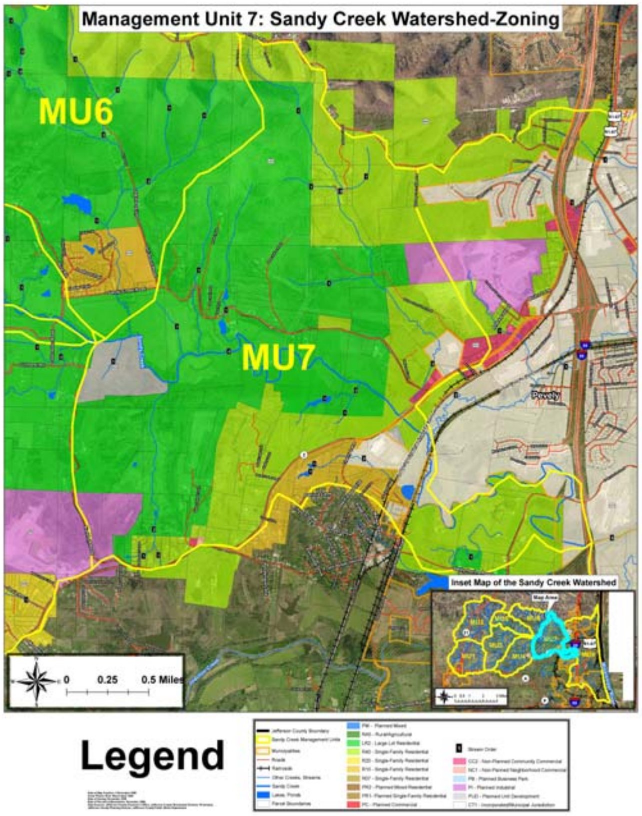
2.7.2 Land Use in Management Unit 7



Small segments of commercial and agricultural land use are reflected along the east side of MU-7. Residential land use is predominate in this Management Unit with large portions shown as vacant.

Figure 2-48
Source: J.C. GIS
Jay Rodenbeck

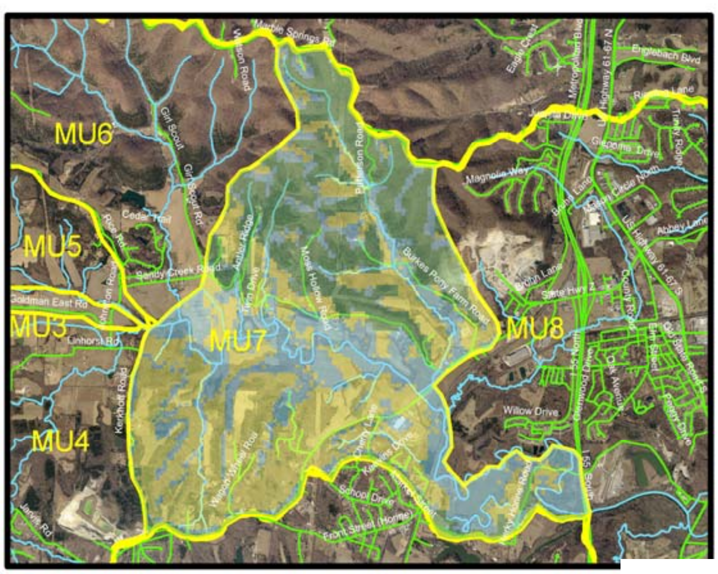
2.7.3 Jefferson County - Management Unit 7



Large lot residential represents approximately 50% of the zoning in MU-7 with single family residential reflected along the eastern side of the MU. A planned unit development is shown on the west side of the MU bordering Sandy Creek on the south.

Figure 2-49
Source: J.C. GIS
Jay Rodenbeck

2.7.4 Soil Type in Management Unit 4



Legend	
Color	***Hydrologic Soil Group***
Blue	B
Yellow	C
Green	D
B - Silty Loam - Moderate infiltration	
C - Sandy Clay Loam - Low infiltration	
D - Clay Loam - Very slow infiltration	

The portion of MU-7 north of Sandy Creek has very slow infiltration whereas the south side has slow infiltration soils.

Figure 2-50
Source: cares.missouri.edu
Jay Rodenbeck

2.7.5 Allocation of Land Use and Soil Type by Acres - Management Unit 7

Land Use	Hydrologic Soil Group	Area (acres)
Commercial	C	167
Residential 1/4 acre	C	50
Residential 2 acre	C	283
Paved/Commercial	D	33
Water/Wetlands	B	233
Agricultural	B	767
Forest	C	899
Forest	D	901
	Total Acres	3333

Table 2-23 Source: L-THIA Data Input

The above table reflects existing conditions in Management Unit 7 and when used with the L-THIA (Long-Term Hydrologic Impact Assessment) model (see Chapter 4) yields the following results:

Average Annual Runoff Volume – 6.49 inches and an Average Annual Concentration (in parts per million) for:

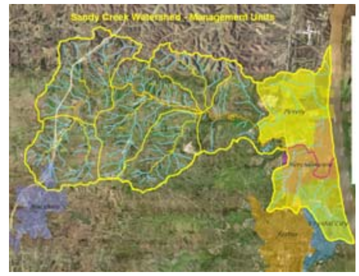
BOD	8.983	Fecal Coliform	935.418	Oil & Grease	2.148
Cadmium	0.00089	Fecal Strep	1013.168	Phosphorus	0.418
Chromium	0.007	Lead	0.005	Suspended Solids	40.253
COD	30.824	Nickel	0.003	Zinc	0.053
Copper	0.008	Nitrogen	1.774		
For acceptable amounts under specific conditions, refer to MDNR water quality standards, 10 CSR 20-7.031 Table A, (pages 19-29).					

Table 2-24 Source: L-THIA Data Output

2.7.6 Expressed Concerns in Management Unit 7

Chapter 3 of this watershed plan reflects issues and concerns common throughout the entire Sandy Creek watershed. Concerns expressed by citizens unique to Management Unit 7 include failing on-site septic systems in the Horine area and bank erosion along the north side of Sandy Creek.

2.8 Management Unit 8



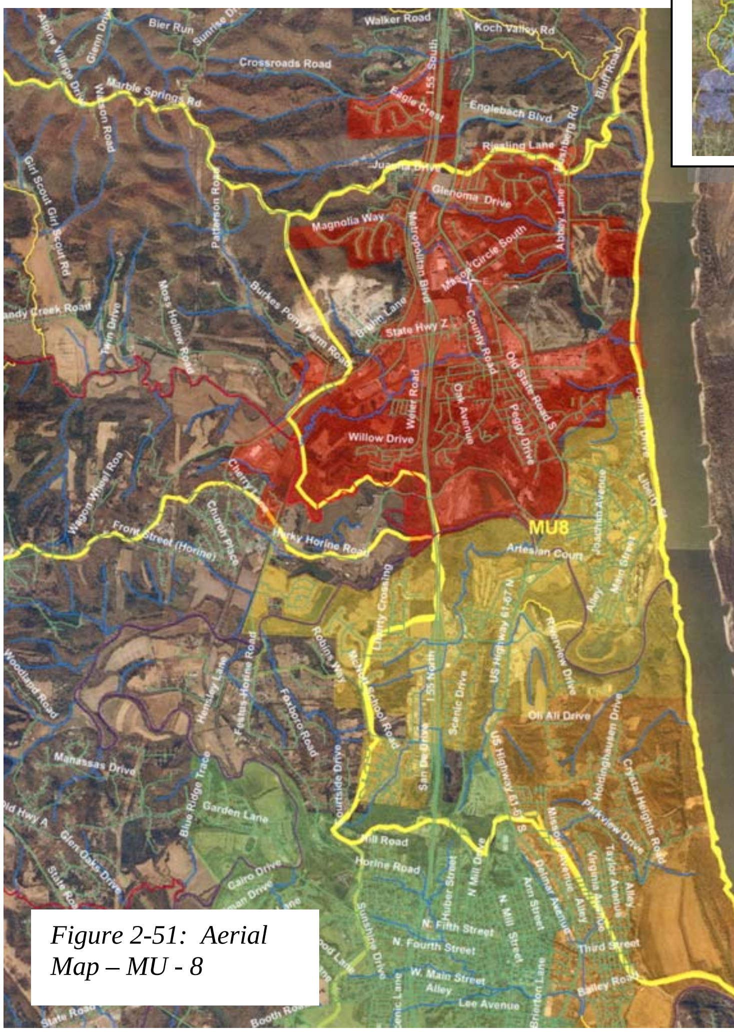


Figure 2-51: Aerial Map – MU - 8

Figure 2-52: Joachim River near the Mississippi River

Figure 2-53: New Bridge over Joachim Creek in Herculaneum

These photos show features of the Sandy Creek Watershed in MU-8.

Figure 2-54: Mouth of Sandy Creek at Herky-Horine Road

Figure 2-55: Overlooking the Mississippi River from Herculaneum

2.8.1 Homes Built by Decade in Management Unit 8

The following table represents the number of homes added by decade in Management Unit 8 with information and events reflective of conditions within the watershed.

Yr Built		**MU 8**
Pre 1930		135
1930 – 1940		215
1941 – 1950		212
1951 – 1960		363
1961 - 1970		415
1971 – 1980		472
1981 – 1990		265
1991 – 2000		305
2001 – 2010		926
Total Parcels with Homes		3308
Parcels w/o Homes		1377
Total Parcels		4685

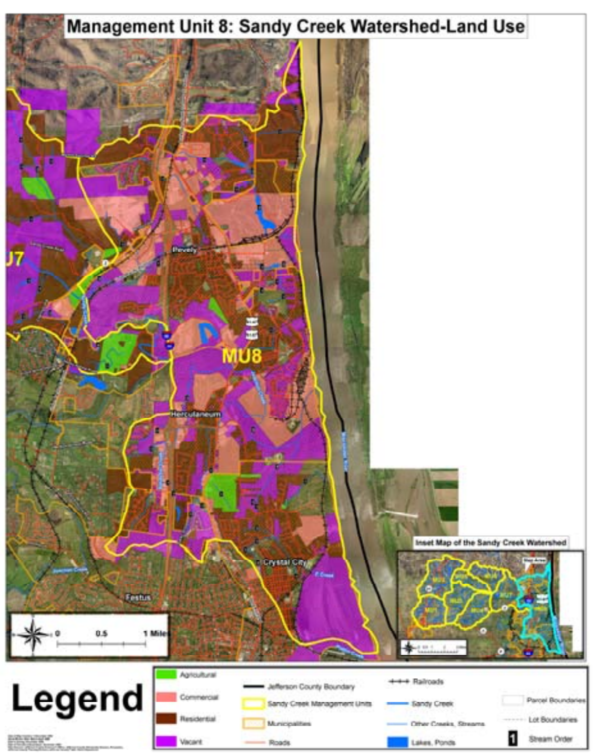
Management Unit 8 represents the drainage into Joachim Creek downstream of the confluence with Sandy Creek. Portions of the cities of Herculaneum, Pevely, Crystal City and Festus are in MU-8.

Steady growth is reflected in MU-8 starting in the 1930s and can be attributed to growth factors reflected for the watershed. (See 2.0.1)

The significant growth shown from 2001-2010 reflects new subdivisions constructed along the I-55 corridor.

Table 2-25 Source: J.C. Assessor's Records

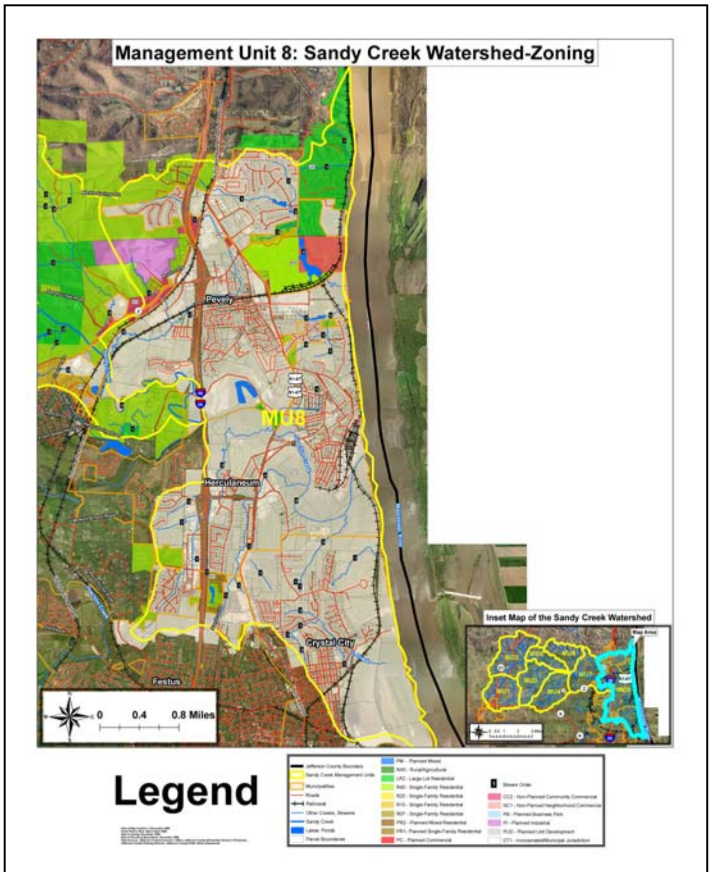
2.8.2 Land Use in Management Unit 8



The land use in MU-8 is consistent with a small city environment. Commercial and residential usage is reflected throughout MU-8.

Figure 2-56
Source: J.C. GIS
Jay Rodenbeck

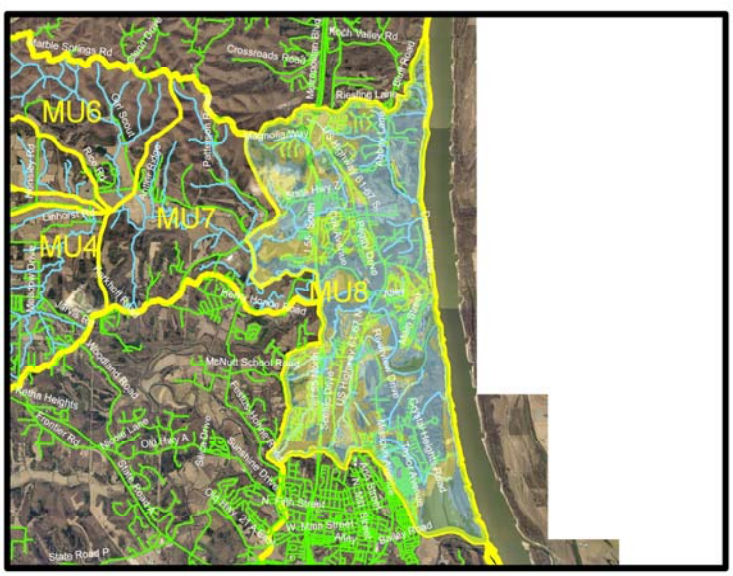
2.8.3 Jefferson County Zoning - Management Unit 8



The majority of MU-8 is in the cities of Herculaneum, Pevely, Crystal City and Festus and is reflected in gray on Jefferson County Zoning maps. The portion of MU-8 that is in the county is shown as large lot and single family residential.

Figure 2-57
Source: J.C. GIS
Jay Rodenbeck

2.8.4 Soil Type in Management Unit 8



Legend	
Color	***Hydrologic Soil Group***
Blue	B
Yellow	C
Green	D
B - Silty Loam - Moderate infiltration	
C - Sandy Clay Loam - Low infiltration	
D - Clay Loam - Very slow infiltration	

Figure 2-58
Source: www.cares.missouri.edu
Jay Rodenbeck

2.8.5 Allocation of Land Use and Soil type by Acres in Management Unit 8

Land Use	Hydrologic Soil Group	Area (acres)
Commercial	B	1000
Commercial	C	520
Residential 1/8 acre	B	1503
Residential 1/8 acre	C	497
Residential 1/2 acre	C	279
Commercial	D	760
Water/Wetlands	B	532
Forest	C	2506

Table 2-26 Source: L-THIA output data

Total Acres 7597

The above table reflects existing conditions in Management Unit 8 and when used with the L-THIA (Long-Term Hydrologic Impact Assessment) model (see Chapter 4) yields the following results:

Average Annual Runoff Volume – 11.63 inches and an Average Annual Concentration (in parts per million) for:

BOD	21.344	Fecal Coliform	1020.607	Oil & Grease	5.702
Cadmium	0.00077	Fecal Strep	2775.926	Phosphorus	0.365
Chromium	0.007	Lead	0.010	Suspended Solids	44.967
COD	82.245	Nickel	0.009	Zinc	0.129
Copper	0.012	Nitrogen	1.433		
For acceptable amounts under specific conditions, refer to MDNR water quality standards, 10 CSR 20-7.031 (pages 19-29).					

Table 2-27 Source: L-THIA Output Data

2.8.6 Expressed Concerns in Management Unit 8

Water quality concerns expressed by citizens unique to Management Unit 8 include the possible illicit discharges into tributaries, stormwater detention at existing subdivisions, stormwater runoff and associated sedimentation at existing and with new developments, and existing on-site septic systems that are failing.

This Sandy Creek Watershed Plan is based on the old 14-digit HUC and includes an area that is not in the 12-digit HUC. Existing impairments have been identified in a Mississippi River TMDL (WB1D1707) and for lead and zinc in Joachim Creek from the Herculaneum smelter.

Chapter 3: Element a. - Identifying Impairment

Sandy Creek itself is not on the Missouri 303(d) list of Impaired Waters and the intent of this watershed partnership is to keep it from becoming an impaired waterway. An evaluation of the existing conditions within the Sandy Creek watershed was conducted to identify areas of concern and impairments as well as the general condition of the watershed. The evaluation included a visual survey, water quality testing, fish species inventory and an assessment of vulnerable conditions within the watershed.

The tasks that were completed for identifying impairments, assessments and analysis were as follows:

1. A visual survey and watershed knowledge was conducted by volunteers/stakeholders to determine the areas of concern and the general condition of Sandy Creek and its tributaries.

2. Water Quality Monitoring by Missouri Stream Teams has been performed at various locations in the watershed. Results of testing at the Covered Bridge are available starting in 2003.

3. Fish species inventory conducted by Missouri Department of Conservation.

4. An analysis of the existing nonpoint pollutants in the watershed as reflected in the Long-Term Hydraulic Impact Analysis model.

5. Identifying and locating within the subwatersheds (Management Units) point source stressors permitted by Missouri Department of Natural Resources.

3.1 Nonpoint Source Stressors

The following concerns reflect issues identified by citizens (volunteers and stakeholders) with an interest in the Sandy Creek Watershed. These concerns are applicable to all Management Units:

<u>High Priority</u>
- On-site septic issues and discharges
- Discharges from central sewer systems (see point source stressors)
- Creek bank erosion and disturbances
- Water Quality testing
- Riparian corridors
- Stormwater runoff from both agriculture (row crops and pasture) and urban lands
- Education
- Public involvement
- Wetlands and other sensitive areas

<u>Medium Priority</u>
- Future New Development - residential and commercial
- Sinkholes and karst topology
- Post construction stormwater maintenance (detention ponds)
- Maintenance of road ditches and right of way
- Trash

<u>Lower Priority</u>
- Sediment, sand, and rock in creek
- Drinking water and wells
- Historical buildings/sites

3.2 Water Quality Monitoring

Missouri Stream Teams have performed water quality monitoring at various locations within the Sandy Creek Watershed. The following map reflects these locations:

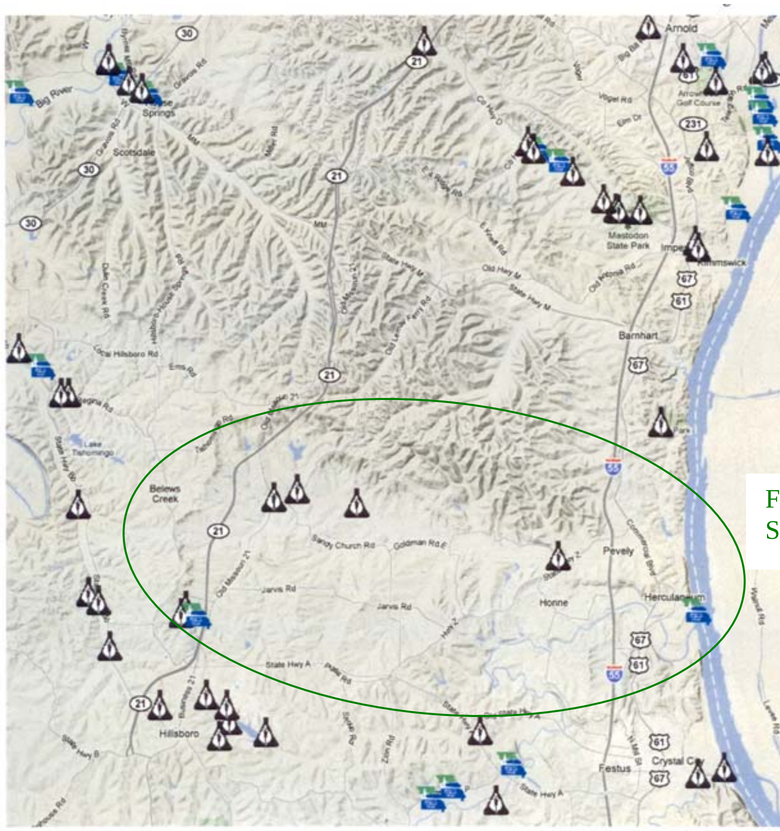


Figure: 3.1
Sandy Creek Watershed

The results of the Stream Team testing through 2010 are reflected in the Appendix to this watershed plan. The latest results can be obtained from the Stream Team website: http://www.mostreamteam.org/

Macroinvertebrate data water quality ratings for one of the testing location which is 1000 yards downstream of the covered bridge (Stream Team reference no. 4696) is as follows:

Table 3.1

Date	Water Quality Rating
1/21/2009	31
4/21/2007	36
7/2/2006	28
5/9/2005	35
7/5/2004	20
4/2/2004	25
8/9/2003	26

Table 3.2

Water Quality References

< 12 = Poor
12 – 17 = Fair
18 – 23 = Good
> 23 = Excellent

Stream Team chemical data for this same location is as follows:

Table 3.3

Chemical Data for Agency Reference Number 4696:

Date Sampled	Stream Team Number	Site Number	Time Sampled	Water Temp (^0C)	Air Temp (^0C)	Dissolved Oxygen (mg/L)	Oxygen Saturation %	pH	Nitrate as N (mg/L)	Ammonia as N (mg/L)	Phosphate PO4 (mg/L)	Conduct-ivity (umhos/cm)	Turbidity (JTU)	Level of Training
9/15/2007	1639	66	230	18	20	13	138	8.6	1	No Data	No Data	646	10	1
4/13/2006	1857	2	1205	17	30	12	124	9.3	0.125	0	0.23	490	10	2
8/19/2005	1857	2	920	25	26	8	97	7.9	0.125	0.01	0.17	500	12	2
5/9/2005	1857	2	945	17	22	10	104	8.3	0.125	0	0.29	540	10	2
7/5/2004	1857	2	1640	25	25	12	146	8.2	0.125	No Data	No Data	No Data	No Data	2
4/2/2004	1857	2	1505	15	20	15	149	9.8	0.125	No Data	No Data	477	33	2

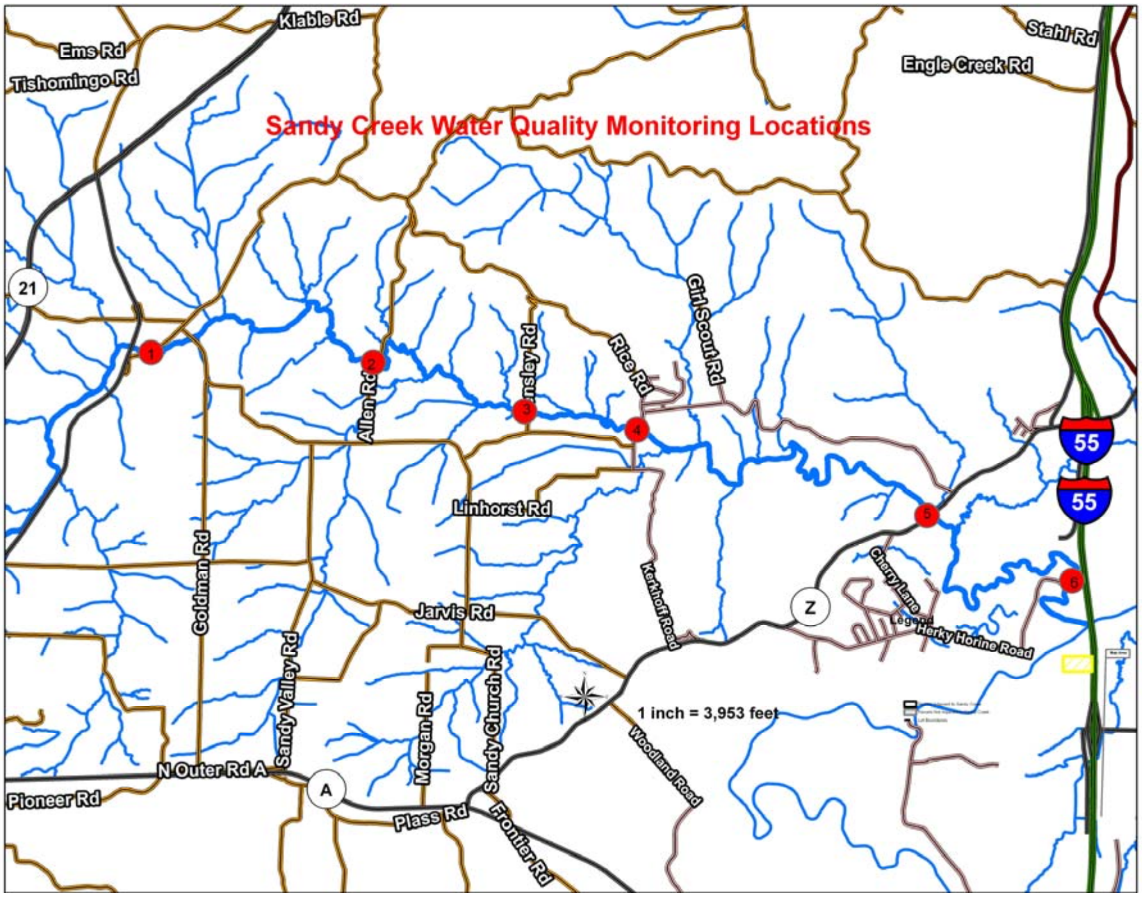
Table 3.4

Stream Team acceptable ranges for chemical parameters are as follows:

Water Temperature: 0º - 34º C is within the normal range
Dissolved Oxygen: 5 – 15 mg/L is within the normal range
pH: 6.5 – 9.0 is within the normal range
Nitrate (NO3–N) Nitrogen: an unusual reading for most streams is one greater than 2 mg/L. If a sampling site is less than 2 miles downstream of a wastewater treatment plant discharge, an unusual reading would be one greater than 10 mg/L.
Ammonia (NH3-N): an unusual reading for most streams is one greater than 2 mg/L. If a sampling site is less than 2 miles downstream of a wastewater treatment plant discharge, an unusual reading would be one greater than 3 mg/L.

In addition to the Stream Team monitoring locations, volunteers working on this Sandy Creek watershed management plan identified locations in the watershed that should be monitored on a regular basis to establish meaningful base data that will enable isolating issues and permit additional investigation into sources of the issues. The six locations along the main channel of Sandy Creek are: (1) Covered Bridge, (2) Allen Road, (3) Hensley Road, (4) Johnston Road, (5) Highway Z, and (6) Herky-Horine Road.

Figure 3-2 Proposed Monitoring Locations



3.3 Fish Inventory

The results of the fish inventory conducted by the Missouri Department of Conservation on Sandy Creek at Highway 21 and Highway Z in July 2002 and July of 2007 are in the Appendix to this watershed plan. Significant findings in these inventories include:

Table 3-5 July 2002

<u>7/3/2002 – Sandy Creek at Highway 21</u>
IBI Score 70 Native Species found 22
With most predominate being:
Stonerollers – 41.9%
Bluntnose minnow – 17.2%
Bluegill – 10.1%

Table 3-6 July 2007

<u>7/2/2007 – Sandy Creek at Highway 21</u>
IBI Score 80 Native Species found 24
With most predominate being:
Stonerollers – 54.9%
Bluegill – 7.6%
Green Sunfish – 7.1%

Table 3-7 July 2002

<u>7/1/2002 – Sandy Creek at Highway Z</u>
IBI Score 57 Native Species found 18
With most predominate being:
Sand Shiner – 35.1%
Bigeye Chub – 33.2%
Red Shiner – 10.0%

Table 3-8 July 2007

<u>7/2/2007 – Sandy Creek at Highway Z</u>
IBI Score 75 Native Species found 32
With most predominate being:
Bigeye Chub – 30.4%
Red Shiner – 18.9%
Stonerollers – 13.0%

Index of Biological Integrity (IBI) refers to biological criteria for streams of Missouri in: "A final report to the Missouri Department of Natural Resources from Missouri Cooperative Fish and Wildlife Research Unit – November 1997"

3.4 Estimating Existing Nonpoint Pollutants from L-THIA

The Long Term Hydraulic Impact Analysis computer program, described in Chapter 4, can be used to estimate the amount of existing nonpoint pollutants in a management unit based upon existing land use and soil type. The L-THIA output reflects the losses in pounds of 12 nonpoint pollutants that might be released in a year based upon average rainfall by management unit. For fecal coliform and fecal strep the losses are reflected in million of coliform. Based upon the acreage of management units, the losses are then converted into an average annual concentration in parts per million for the twelve nonpoint pollutants and in number per 100ml for the coliforms.

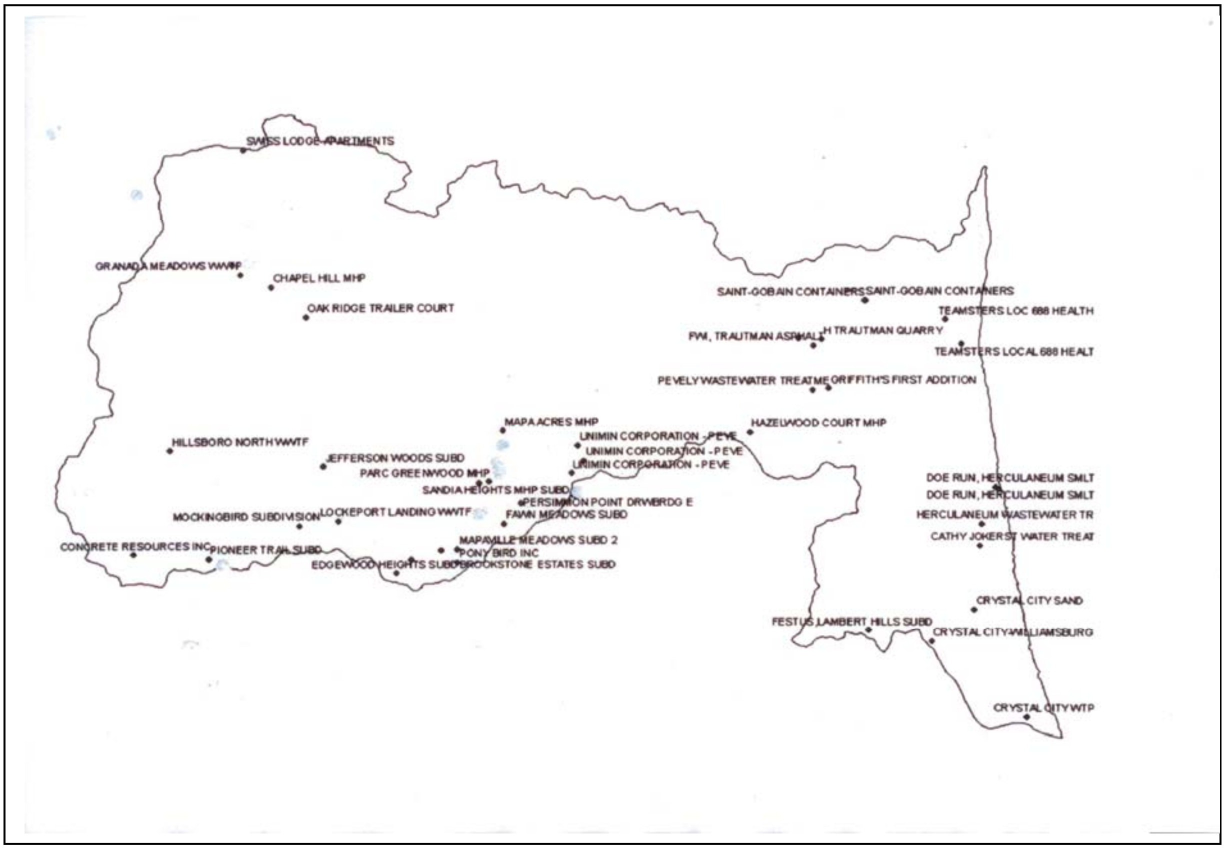
The nonpoint pollutants and the management unit with the highest average annual concentration are reflected below. The output and nonpoint pollutants for each management unit are in the Appendix to this watershed plan.

BOD – MU8
Cadmium – MU6
Chromium – MU3
COD – MU8
Copper – MU8
Lead – MU8
Nickel – MU8
Nitrogen – MU3
Oil & Grease – MU8
Phosphorous – MU3
Suspended Solids – MU3
Zinc – MU8
Fecal Coliform – MU3
Fecal Strep – MU8

3.5 Identifying Point Source Stressors

The following map reflects the point source stressors in the Sandy Creek Watershed. The locations identified have permits issued by the Missouri Department of Natural Resources for discharges into the watershed.

Figure 3-3



MU 1 Concrete Resources Inc.
Pioneer Trail Subdivision
Hillsboro North WWTF

MU 2 Swiss Lodge Apartments
Granada Meadows WWTP
Chapel Hill Mobile Home Park
Oak Ridge Trailer Court

MU 3 Mockingbird Subdivision
Lockeport Landing WWTF
Jefferson Woods Subdivision

MU 4 Edgewood Heights Subdivision
Brookstone Estates Subdivision
Pony Bird Inc
Mapaville Meadows Subdivision

MU 4 Fawn Meadows Subdivision
Persimmon Point Drawbridge E
Sandia Heights Mobile Home Pk
Parc Greenwood Mobile Home Pk
Mapa Acres Mobile Home Pk
Unimin Corporation (3 permits)

MU 7 Hazelwood Court Mobile Home Park

MU 8 Saint Gobain Containers
Teamsters Local 688 (2 permits)
H Trautman Quarry
FWI Trautman Asphalt
Pevely WWTF
Griffiths First Addition
Doe Run – Herculaneum Smelter (2 permits)
Herculaneum WWTF
Cathy Jokerst WWTF
Crystal City Sand
Festus Lambert Hills Subdivision
Crystal City, Williamsburg
Crystal City WWTP

Chapter 4: Element b. - Estimating Load Reductions

The Sandy Creek Watershed is predominately a rural environment with urban development adjacent to Interstate 55 and east to the Mississippi River. The urban area includes the cities of Herculaneum and Pevely and portions of Crystal City and Festus. Estimating and modeling load reductions for this type of watershed can be accomplished with the Long-Term Hydrologic Impact Assessment model.

Land use changes can significantly impact groundwater recharge, stormwater drainage, and water pollution. The Long-Term Hydrologic Impact Assessment (L-THIA) model http://cobweb.ecn.purdue.edu/~sprawl/LTHIA7 was developed as an accessible online tool to assess the water quality impacts of land use change. Based on community-specific climate data, L-THIA estimates changes in recharge, runoff, and nonpoint source pollution resulting from past or proposed development. L-THIA's results can be used to generate community awareness of potential long-term problems and to support planning aimed at minimizing disturbance of critical areas. L-THIA is an ideal tool to assist in the evaluation of potential effects of land use change and to identify the best location of a particular land use so as to have minimum impact on a community's natural environment.

In the basic model of L-THIA, users only need to input:

- their location (state and county);
- the type of soil in the area where the land use change is to occur; and
- the type and size of land use change that will occur (e.g., 100 acres of agricultural land converted to 50 acres high-density residential and 50 acres commercial).

L-THIA will generate estimated runoff volumes and depths, and expected nonpoint source pollution loadings to waterbodies, based on the information provided. Results can be displayed in tables, bar graphs, and pie charts.

L-THIA results can be used to minimize the water quality impacts of land use changes. The same land use located on a different hydrologic soil type can have a different impact. Because the amount of runoff generated by different land uses is a function of the hydrologic soil type and the land use, relocating land uses based on the hydrologic soil type can in some cases significantly reduce the long-term impact of the development.

Figure 4-1 Flooding impact from development

The results of the L-THIA modeling on the existing conditions in Sandy Creek, by Management Unit, are shown in the Appendix to this watershed plan. These results can be used to evaluate proposed land use changes (scenarios) and the impact of proposed Best Management Practices (BMPs) implementation including Low Impact Development (LID).

Chapter 5: Element c. - Management Measures

Existing and potential impairments in the Sandy Creek watershed were identified through a visual survey and knowledge of the watershed by volunteers assisting in the development of this watershed plan, water quality monitoring and modeling. The results of these activities were summarized and prioritized by the volunteers into the following management measures with associated goals and objectives.

1. Evaluate stormwater runoff and its effect on the watershed
2. Provide public education and encourage public involvement
3. Encourage appropriate maintenance and repair of septic systems
4. Determine existing riparian corridors and educate landowners on the benefit of maintaining and/or establishing riparian corridors
5. Perform stream bank restoration
6. Perform water quality testing throughout the watershed
7. Encourage use of natural fertilizers, pesticides, herbicides, and detergents
8. Minimize the runoff impact in areas of sinkholes and losing streams

5.1 Evaluate Stormwater Runoff and its Effect on the Watershed

The Long Term Hydrologic Impact Assessment (L-THIA) modeling provides anticipated amounts of nonpoint pollutants associated with stormwater runoff based upon land use and soil types. The existing conditions results of the modeling by management unit are reflected in the Appendix to this watershed plan. Analyzing the results of the modeling reveals the following issues and concerns that need to be addressed.

The **Average Annual Runoff Depth** in inches is based upon the Total Annual Volume in acre-feet per land use type. The predominately urban area of MU8 reflects significantly more average annual runoff depth (11.63 inches) than the other management units: MU1 = 7.05”, MU2 = 8.79”, MU3 = 7.07”, MU4 = 9.86”, MU5 = 6.74”, MU6 = 6.54” and MU7 = 6.49”.

Impervious cover associated with development is the main contributing factor to this runoff depth. Enforcement of both city and county stormwater management ordinances, including encouraging low-impact design techniques, will help reduce the runoff depth.

Figure 5-1
GIS Aerial MU8

Biochemical oxygen demand (**BOD)** is a chemical procedure for determining the amount of dissolved oxygen needed by aerobic biological organisms in a body of water to break down organic material present in a given water sample at certain temperature over a specific time period. The average annual concentration of BOD in parts per million is highest in MU8 (21.344 ppm) with the next being MU2 at 9.899 ppm.

Chemical oxygen demand (**COD**) test is commonly used to indirectly measure the amount of organic compounds in water. Most applications of COD determine the amount of organic pollutants found in surface water (e.g. lakes and rivers), making COD a useful measure of water quality. The average annual concentration of COD is highest in MU8 at 82.245 ppm with the next being MU2, MU1, MU4 and MU7 with concentrations ranging from 30 to 36 ppm. There is a significant drop between these and those of MU3, MU5 and MU6 which are in the 9 to 13 ppm range.

The presence of **fecal coliform** bacteria in aquatic environments indicates that the water has been contaminated with the fecal material of man or other animals. The presence of fecal contamination is an indicator that a potential health risk exists for individuals exposed to this water. Fecal coliform bacteria may occur in ambient water as a result of the overflow of domestic sewage or nonpoint sources of human and animal waste.
The L-THIA modeling reflects high levels of **fecal coliform** in MU3 (1744 ppm) followed by MU5 (1653 ppm).

The **fecal streptococcus** group consists of a number of species of the genus *Streptococcus,* such as *S.faecalis, S.faecium, S.avium, S.bovis, S.equinus,* and *S.gallinarum.* The normal habitat of fecal streptococcus is the gastrointestinal tract of warm-blooded animals. *S. faecalis* and *S.faecium* once were thought to be more human specific than other *Streptococcus* species. Other species have been observed in human feces but less frequently. Similarly, *S.bovis, S.equinus*, and *S.avium* are not exclusive to animals, although they usually occur at higher densities in animal feces. The L-THIA modeling reflect MU8 with an average annual concentration of Fecal Streps of 2776 ppm which is roughly 2.5 times higher than the next MU (MU2 is 1056 ppm).

Oil & Grease is a nonpoint pollutant transported in stormwater runoff. The source for oil and grease is vehicles and motor equipment, gasoline, synthetic detergents, pesticides, herbicides, wood preservatives and certain industrial products. MU8 with its urban environment has the highest average annual concentration in the L-THIA modeling with 5.702 ppm. The other MUs are less than half that amount.

Nitrogen and **Phosphorous** are reflected in the model as more significant in MU3 and MU5 when compared to the other Management Units. Nitrogen and phosphorous can come from sources such as wastewater, industrial discharges, agricultural use of fertilizer and manure, concentrated animal feeding operations, urban runoff, septic systems, and atmospheric deposition from sources such as coal-fired power plants.

Suspended Solids are mineral and organic particles that remain suspended in water. They sink only very slowly or are easily re-suspended by water turbulence. Land erosion, mostly during rain events, can come from poorly protected construction sites, exposed landscape areas and gardens, and areas where runoff is channeled and scours exposed soils. Management Unit 3 is reflected in the modeling as having the highest average annual concentration of suspended solids with 70.112 ppm followed by MU5 with 64.641 ppm. All MUs are suseptible suspended solids in the Sandy Creek watershed.

Of the other nonpoint pollutants reflected in the L-THIA modeling, **Zinc** is more than two times higher in MU8 than in any other MU. Studies indicate that heavy metals are the most prevalent contaminant found in urban runoff and commonly found metals include zinc, lead, copper, iron and aluminum. Rainfall runoff from urban roadways often contains elevated amounts of heavy metals in both particulate and dissolved forms. Because metals do not degrade naturally, high concentrations of them in runoff can result in their accumulation in roadside soils.

In addition to the L-THIA modeling, additional methods/techniques should be used to evaluate stormwater runoff and its impact on the watershed. Jefferson County stormwater management ordinance, Chapter 505: Erosion and Sediment Control Stormwater Management Design Document, regulates new development with respect to design and maintenance of stormwater management systems. Compliance with these ordinances should minimize negative impacts on the watershed on a going forward basis.

5.2 Provide Public Education and Encourage Public Involvement

Outreach materials will be developed and used for communication and education among partnership members, and for distribution to the watershed community at large. The materials will be used to address the issues of concern outlined in this chapter by including more information on causes of concern and showing the community how they can participate in solving these problems. The plan of action includes the following:

1. Continued participation of the Watershed Partnership Committee
2. Development of a slide show or video outlining the major areas of concern and possible sources of pollutants
3. Creation of educational materials such as flyers, brochures, etc., and a community newsletter as a communication device
4. Workshops for exchanging ideas, designing educational programs, developing strategies and scheduling future events
5. Establishment of a website
6. Water quality monitoring activities
7. Development of a tabletop display that can be used at libraries, fairs, schools, etc.
8. Community participation in Stream Team and/or Adopt-A-Road programs

This goal is outlined in depth in Chapter 7.

5.3 Encourage Appropriate Maintenance and Repair of Septic Systems

Wastewater (sewage) in the Sandy Creek watershed is handled with central systems, where available, and on-site waste management septic systems. The central systems are controlled by Missouri Department of Natural Resources (DNR) through the permitting and reporting process and discharge into the Sandy Creek or its tributaries.

Illicit discharges from these central systems will impact the water quality within the watershed. If unusual odors or visual anomalies are observed or water quality monitoring detects pollutants that could be discharging from these sources, further investigation and, if appropriate, corrective action should be taken.

On-site septic systems can be a major contributor to pollution in a watershed. The extent and magnitude of this issue in the Sandy Creek watershed is not known at this time. It has been estimated that in Jefferson County, 50% of all on-site systems are failing or not functioning properly. These failures can be contributed to system design/ construction or the lack of proper maintenance. To minimize the impact of failing septic systems, educating homeowners is essential. Many homeowners have no idea what type of septic system is installed nor what is required to maintain the system.

Educating homeowners on the need for testing their existing system to verify that it is functioning properly is important. During this process they should be provided with a manual or set of procedures on how to maintain their system. The type of system they have installed and the location of its components, including drain field, should be documented.

The Jefferson County Code Enforcement Division inspects and approves the construction of on-site septic systems. The soil types and slopes in Jefferson County can provide a challenge in the design of on-site systems. Records of the new installations are tracked by the County as well as those of failed systems. The intent is to have a database of all on-site systems in the county and a log showing regular maintenance has been performed on these systems.

5.4 Determine Existing Riparian Corridors and Educate Landowners on the Benefit of Maintaining and/or Establishing Riparian Corridors

Section 505.170 B. (Erosion and Sediment Control/Stormwater Management Design Criteria – Buffer Strips) of the Jefferson County Code of Ordinances recognizes riparian corridors or buffer/ buffer strips as the area closest to a sensitive environmental site (e.g., wetland, waterbody, etc.) and in which certain human activities are limited to minimize the negative impacts from adjacent land uses (i.e. erosion, pollutants in runoff, disturbance to wildlife, etc.) to this area.

Jefferson County has classified all streams in the county based upon their stream order using the USGS Quad Maps as the source. The County Ordinance specifies a 50-foot buffer from top of bank be left undisturbed for stream orders 1 and 2 and a 100-foot buffer for stream orders 3 and above.

The value of having a riparian corridor/buffer strip has been recognized by the Sandy Creek Watershed Partnership as it stabilizes the stream bank and minimizes erosion, acts as a filter for pollutants contained in stormwater runoff, and enables groundwater infiltration which is an on-going source of water for the creek and its tributaries. Tree cover in the riparian corridor provides shade which results in a lower water temperature and a habitat and for wildlife.

Identifying locations where there is an insufficient riparian corridor is a goal of the Partnership. This can be accomplished using aerial photography available through the Jefferson County Stormwater Management Division. Identified areas will require close coordination with landowners to convey the benefits of maintaining or establishing the corridor and funding as needed.

Examples of areas where riparian corridors are missing or insufficient in the Sandy Creek watershed are shown in the following aerial photographs.

Figure 5-2 Sandy Creek at Old Hwy. 21 MU2

Figure 5-3 Sandy Creek at Goldman Road & Old Lemay Ferry Road MU2

Figure 5-4 Sandy Creek downstream of Old Lemay Ferry Road-MU2

Figure 5-5 Sandy Creek upstream of Sandy Valley Acres-MU3

Figure 5-6 Sandy Creek downstream of Allen Road-MU3

Figure 5-7 Sandy Creek upstream of Hensley Road - MU3 & MU5

Figure 5-8 Sandy Creek upstream of Johnston Road – MU3

5.5 Stream Bank Restoration

Under normal circumstances, streams exist in equilibrium with their watersheds and immediate surroundings – riparian zones. Streams are part of the slow erosion of the landscape. Overtime, streams move both laterally and vertically, transporting tons of rocks and soils and organic matter downstream, deepening and widening valleys along the way. In an undisturbed landscape, however, streams change gradually, moving but maintaining their basic structure and equilibrium with both the landscape and the ecosystems of which they are a part. Natural streams in undisturbed watersheds are, therefore, more predictable, in most cases, than disturbed streams, and tend to be self-maintaining. Streams whose equilibrium has been disrupted by changes in land use, however, lose that predictability and often become expensive liabilities to both human and natural communities.

The Sandy Creek watershed has areas where stream bank erosion has occurred and is continuing to occur. Many of these locations are associated with the lack of riparian corridors and restoration efforts will require not only the stabilization of the bank but the re-establishment of the riparian corridor.

Locations where bank erosion is significant are reflected in the following photographs.


Figures 5-9 & 5-10: Sandy Creek downstream of tributary coming from
Lake Lorraine – Management Unit 5


Figures 5-11 & 5-12: Sandy Creek between Allen Road and
Hensley Road – Management Unit 5


Figures 5-13 & 5-14: Sandy Creek at Hensley Road – Management Unit 3


Figures 5-16 & 5-17: Sandy Creek upstream of Johnston Road
– Management Unit 3

In addition to the above, other locations along Sandy Creek and its tributaries have been identified as having bank erosion. When a stream bank restoration project is considered, the entire reach of the project and its impact on the watershed needs to be evaluated.

5.6 Perform Water Quality Testing Throughout the Watershed

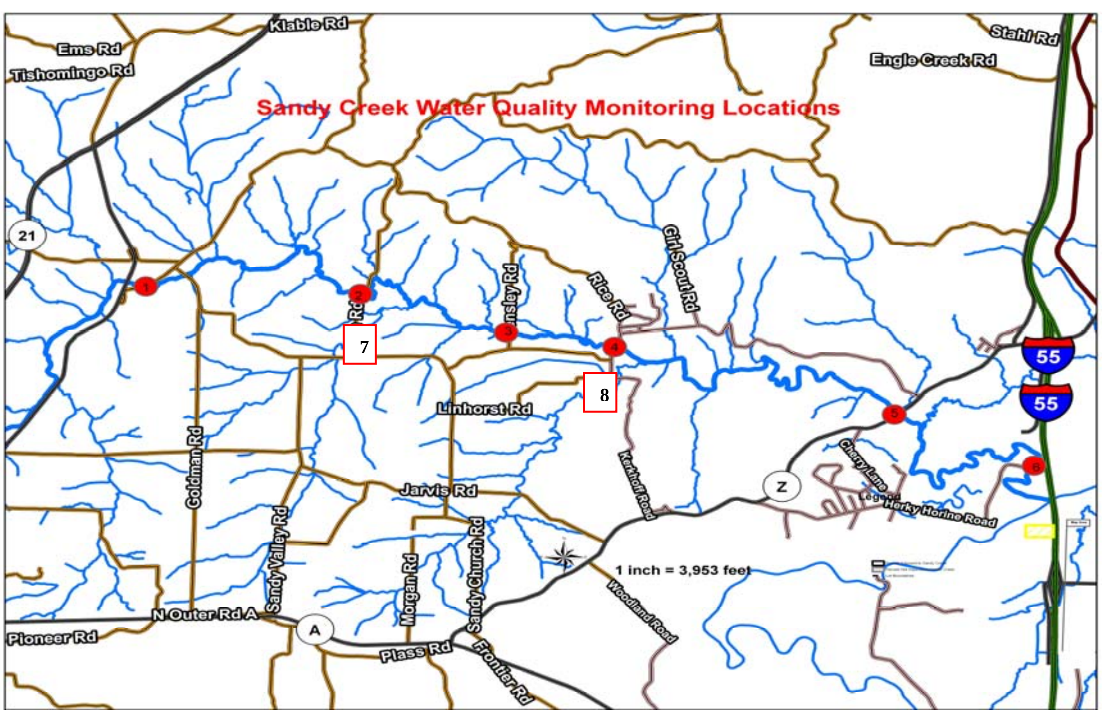
Portions of the Sandy Creek watershed has been adopted and tested by numerous stream teams with data and results going back to 2003 at the covered bridge location. At this location the macroinvertebrate data reflects an excellent (greater than 23) ranking on 6 of the 7 times this test was conducted and the water chemistry data shows all recorded tests within the normal/acceptable range.

Data for other locations in the watershed is limited and coordination between the Sandy Creek Watershed Partnership and Stream Team should occur so that future test sites reflect the entire watershed.

The Sandy Creek Watershed Partnership would like to perform water quality testing throughout the watershed on a regular basis, i.e. every six months. This would establish a benchmark that can be used to identify any changes (both degradation and improvement) that might occur as a result of new development and as well the implementation of BMPs and projects recommended with this watershed management plan.

Monitoring and testing locations have been identified by the watershed partnership and are reflected on the map below:

Figure 5-18: Proposed Water Quality Monitoring Locations



The six locations along the main channel of Sandy Creek are: (1) Covered Bridge, (2) Allen Road, (3) Hensley Road, (4) Johnston Road, (5) Highway Z, and (6) Herky-Horine Road.

In addition to the six locations on the main channel, two additional locations on tributaries should be tested. The first is a tributary named Big Creek (Management Unit 3) at Allen Road [7] and the second is an unnamed stream order 3 in Management Unit 4 at Kerkhoff Road [8].

These testing locations will enable any anomalies found in test results to be isolated to a specific area. Additional testing and/or research should assist in identifying the source of the issue or concern.

A QAPP (Quality Assurance Project Plan) will need to be developed for any proposed testing in the watershed. The QAPP will assure the testing procedures and results satisfy EPA and Missouri DNR requirements and that the same tests are performed and the same procedures are used each time.

Existing Stream Team monitoring is expected to continue in the watershed and possibly expand as new volunteers and teams are created. Citizen awareness and involvement in water quality issues should have an impact on the water quality of Sandy Creek.

5.7 Encourage Use of Natural Fertilizers, Pesticides, Herbicides, and Detergents

The goal of this management measure is to improve water quality and soil structure through the use of organic fertilizers, pesticides, herbicides and phosphorous-free detergents. Since most of the Sandy Creek Watershed is considered rural, and a few large-acre parcels have been farmed for generations, it is appropriate to communicate to the watershed community the use of natural products and practices to help protect Sandy Creek and the watershed ecosystem from becoming impacted by the over-use of synthetic products and harmful practices.

The objective is to encourage the use of natural products in everyday agricultural and backyard practices through the use of educational formats such as CDs, website resources, and printed material. The Missouri University Extension Center, USDA NRCS, Stream Team, and the Missouri Department of Conservation may be called upon for technical assistance.

Fertilizers:

It is well known that synthetic fertilizers, although convenient, fall short of being environmental responsibility. Synthetic fertilizers discourage natural self-sufficiency by destroying the soil ecosystem and biodegradation process. Plants wind up with a shallower root system as they become totally reliant on the fertilizer – so more fertilizer is used to sustain the plants. This process makes plants totally dependent on human intervention for their survival. Overuse of any fertilizer can also burn the roots of plants.

Plants need three components: nitrogen, phosphorous and potassium. Nitrogen is required by plants to promote foliage growth, phosphorous is needed to stimulate root development and flowering and potassium is important to the overall health of plants. Overuse of these components destroys the delicate balance of the land making it toxic and barren. Overuse also increases the amounts being washed into the waterways, which spurs on the dense over-growth of algae and phytoplankton. When these plants die, the decaying process starves the water of oxygen killing creatures in the aquatic ecosystem.

Selections for organic fertilizers include seaweed, grass clippings/mulch, animal manure, wood ash, beer, coffee grounds, compost or vermin-compost. Farmers who practice responsible no-till and residue management practices will increase the organic matter in soil thus improving soil structure.

Pesticides:

Understanding how pest management interrelates with climate, water management, crop management and soil management can be a stimulus to implementing strategies that will minimize environmental hazards related to off-site pesticide movement and its potential impacts on non-target plants, animals, humans and aquatic life. Improper use of pesticides can cause chemical stormwater runoff into streams and lead to resistance by certain pests.

Integrated Pest Management (IPM) is one of the best practices of pest management. With IPM the emphasis is on using proper landscape management, pest resistant plants alternative, natural predators and, if necessary, the application of least-toxic pesticides.

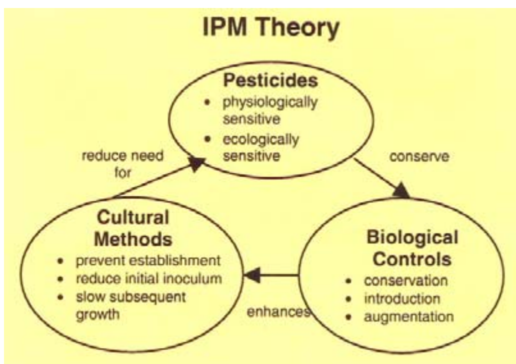


Figure 5-19

Detergents:

Detergents as well as other household cleaning products are considered hazardous chemicals. According to the book, <u>Prosperity Without Pollution</u>, the average American uses about 25 gallons of toxic products per year in their home. The EPA estimated that fumes from common household cleaners were three times more likely to cause cancer than other air pollutants. Not only are these products hazardous to people, but also to septic systems, the environment and to aquatic life.

Detergents with phosphates have a tendency to create algae blooms in surface waters. As mentioned earlier under fertilizers, an abundance of algae blooms in streams creates an unhealthy and even deadly environment for aquatic life. A better choice would be detergents that are phosphorous-free or laundry soap. Some detergents are slow to biodegrade such as those containing alkyl benezene sulfonate. The longer they remain potent, the better the chance they will pollute stormwater runoff. Detergents that biodegrade quickly are a better choice as well as detergents that are pH balanced. Borax, ammonia and baking soda are safe alternatives.

Homeowners can also use BMPs that will neutralize the effect of hazardous products. For example, washing your car on a grassy area so the runoff enters the ground where it is treated biologically by bacteria before it enters a stream from ground water or use a car wash that recycles its wash water. Soapy water that enters the storm drain runs directly into the nearest stream unfiltered.

Sources: *http://en.allexperts.com/q/Organic-Gardens-728/Organic-Herbicide-1.htm*
www.greenlivingtips.com/articles/158/1/Natural-fertilizer.html
www.the-organic-gardener.com/weed-control.html

5.8 Minimize the Runoff Impact in Areas of Sinkholes and Losing Streams

The goal of this management measure is to educate the Sandy Creek watershed community on the sensitive nature of sinkholes and the need to protect them from pollutants. Sinkholes and losing streams are defined and protected through state regulation 10 CSR 20-7.

The objective is to prepare educational material regarding sinkholes by utilizing various media formats for conveying this information to the watershed community so citizens are able to identify sinkholes, understand the geologic and hydrologic process that form sinkholes, understand their connection to the aquifer (drinking water supply), and take action to protect sinkholes from pollutants by implementing BMPs and guidelines for development in the area of sinkholes.

Sinkholes and losing streams are created as a result of certain geologic conditions. In the United Sates, about 30% of the country is underlain by Karst terrain such as carbonate rock, limestone, gypsum and salt beds. As water circulates underground, it dissolves the rock creating spaces and caverns underground.

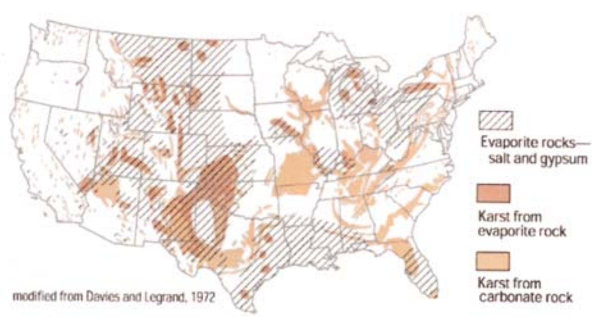


Figure 5-20 Karst terrain

Sinkholes can be dramatic because the surface land stays intact for a while until the underground spaces get too big. If there is not enough support for the land above the spaces, the land surface can suddenly collapse. Missouri is one of the seven states that experiences excessive damage from sinkholes.

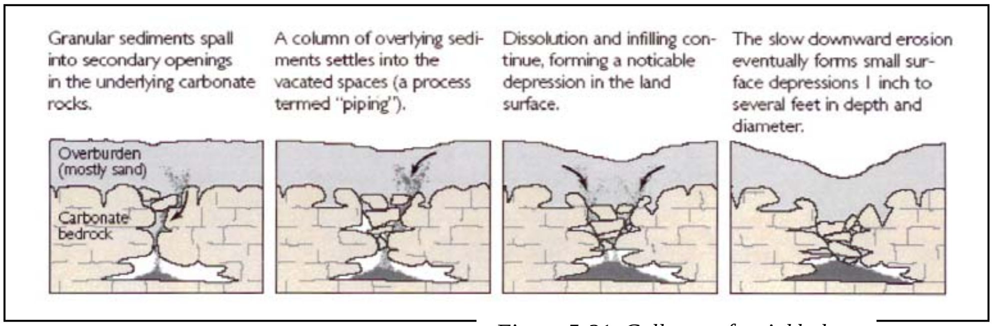


Figure 5-21 Collapse of a sinkhole

Sinkholes can vary from a few feet to hundreds of acres and from less than one to more than 100 feet deep. Some are shaped like shallow bowls or saucers whereas others have vertical walls; some hold water and form natural ponds.

Sinkholes collect surface water running off the surrounding land and the runoff goes directly into the groundwater carrying any pollutants that may be on the land surface. Drinking water and streams can be affected by the pollutants entering the aquifer through sinkholes.

There are 6 sinkholes shown in MU 8. Four appear to be in Herculaneum on Doe Run property and two between Herculaneum and Crystal City. In addition one sinkhole has been found on a farm in Pevely/Horine (MU 7) and two are shown in MU 1.

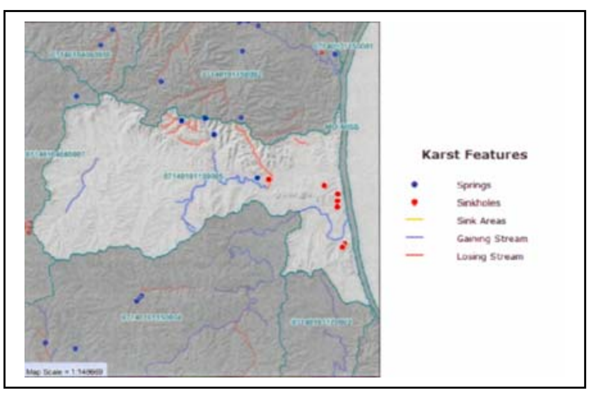


Figure 5-22 Location of karst features

	Gaining Streams	*Losing Streams*	*Sinkholes*	*Springs*
Number	9	8	9	4
Miles	19.26	8.07		

In the Sandy Creek Watershed, 8.07 miles of tributaries in Management Unit 6 have been identified as losing streams.

Sensitive areas like sinkholes and losing streams should be located in any development site plan. The plan submittal should show BMPs to minimize the impact of such areas. For example:

- Do not discharge untreated stormwater into sinkholes and other sensitive areas.
- Provide a buffer around sensitive areas.

- Preserve the existing stormwater flow path.
- Do not dump anything in or around a sinkhole or other sensitive area (wetland, pond).
- Practice Low Impact Development

Whatever BMPs are selected, they should be maintainable by the end user of the property.

Sources: http://ga.water.usgs.gov/edu/sinkholes.html
www.watersheds.org/earth/karst.htm
http://en.wikipedia.org/wiki/sinkhole
Site Design Guidance, MSD, April, 2009

Chapter 6: Element d. - Technical & Financial Assistance and Element f. - Schedule

Chapter 5 identified and described the management measures for the Sandy Creek watershed. Implementing the measures will require capital and technical support through both public and private organizations. Obtaining funding for these projects will require economic justification and effort by the citizens of the Sandy Creek watershed. Support and participation by the Jefferson County Stormwater Division will also be required.

Financial assistance for the projects should be sought from multiple sources. Most funding sources require the applicant be either a non-profit organization (see chapter 10 for recommendations applicable to the Sandy Creek Watershed Partnership) or a government agency. Subject to approval by the County Council, Jefferson County Stormwater Division is willing to sponsor projects providing the required match (in-kind services) is guaranteed by the watershed partnership.

Missouri Department of Natural Resources has indicated that implementation funding, through Section 319 of the Clean Water Act, can be applied for in watersheds with watershed plans through a competitive process.

The EPA Environmental Financial Center (EFC) at Boise State University has a watershed planning tool (Plan2Fund) that enables organizations like the Sandy Creek Watershed Partnership to develop and implement a long term financial strategy to meet strategic goals. The data developed in Plan2Fund can be used to search the EFC Network Directory of Watershed Resources database for funding sources.

Additional funding sources can be found on the U.S. Environmental Protection Agency (EPA) websites “Catalog of Federal Funding for Watershed Protection” and “Watershed Funding”.

The following information is an estimate of the financial and technical assistance (Element d. of a nine element watershed plan) required for each project and an implementation schedule (Element f.). The implementation start date shown is contingent on financial assistance being available at that time.

Table 6-1

Estimate of Financial and Technical Assistance by Project and Implementation Schedule					
Management Measures	***Lead Responsible Entity***	***Technical Assistance Required***	***Estimated Financial Requirements***	***Implementation***	
				Start	***Duration***
1. Evaluate stormwater runoff and its affect on the watershed *1.1 Evaluate L-THIA modeling nonpoint pollutants and determine what actions can be taken* Biochemical Oxygen Demand (BOD)-MU8 Chemical Oxygen Demand (COD) – MU8 Fecal Coliform – MU 3 & 5 Fecal Streptococcus – MU 8 Oil & Grease – MU 8 Nitrogen and Phosphorous – MU 3 & 5 Suspended Solids – MU 3 Zinc – MU 8 Other nonpoint pollutants	SCWP,SWM HERKY, PEVLY, CLCTY, FESTS	DNR, EPA, CWP, SWM	TBD	2012	2 YR
1.2 Understand Stormwater Management Ordinances New Construction Maintenance of existing stormwater systems	SWM, PW, P&Z	ENG/Developers Homeowner Assoc	Currently Funded Homeowner Fees	2012 2012	ON-GOING ON-GOING
1.3 Locate Wetlands and Determine Protection Identify locations with designated wetlands Coordinate with landowners/document protection	SCWP,SWM SCWP,SWM	COE, CARES, SWM		2012	1 YR
1.4 Identify locations where runoff is causing problems Identify locations Determine solutions	SCWP,SWM SCWP,SWM	GIS, DNR, NCRS	TBD	2012 2012	ON-GOING ON-GOING
1.5 Monitor point source discharges	SCWP,SWM	DNR	See Item 6	2012	ON-GOING
2. Provide public education and encourage public involvement *2.1 Install watershed signs throughout watershed* *2.2 Solicit watershed partnership membership* *2.3 Slide show/video-areas of concern & pollutants* *2.4 Community newsletter & educational material* *2.5 Workshops* *2.6 Establish website* *2.7 Public involvement in water quality monitoring* *2.8 Develop table top display* *2.9 Participation in Stream Team & Adopt-A-Road*	SCWP SCWP SCWP,SWM SCWP,SWM SCWP,SWM SCWP SCWP SCWP,SWM SCWP	CWP, DNR TBD ST ST,PW	$10,000 $2,000-mailings $5,000 $2,000-mailings TBD $500 TBD	2012 2012 2013 2012 2013 2012 2012 2013 2012	1 YR ON-GOING 1 YR ON-GOING ON-GOING 1 YR ON-GOING 1 YR ON-GOING
3. Encourage appropriate maintenance and repair of septic systems *3.1 Prepare maintenance manuals on septic systems* *3.2 Educate land owners on their type of system* *3.3 Cost share pump-out program*	SCWP,SWM BLDG, EMSO, Health Dept.	BLDG, EMSO	$20,000 TBD $250/pump-out	2013 2014 2014	1 YR ON-GOING 4 YR
4. Determine existing riparian corridors and educate landowners *4.1 Identify areas without sufficient riparian corridor* *4.2 Educate landowners on benefits of riparian corridor* *4.3 Re-establish riparian corridor*	SCWP,SWM SCWP,SWM SCWP,SWM	GIS, NCRS, MDC, SWD	TBD TBD $3,000/location	2012 2013 2013	ON-GOING ON-GOING ON-GOING
5. Perform stream bank restoration *5.1 Identify locations and property owner participation* *5.2 Design restoration project* *5.3 Build restoration project*	SCWP,SWM ENG SCWP,SWM	COE, DNR	$10,000/project $30,000/project	2012 2013 2013	ON-GOING ON-GOING ON-GOING

Management Measures	***Lead Responsible Entity***	***Technical Assistance Required***	***Estimated Financial Requirements***	***Implementation***	
				Start	***Duration***
6. Perform water quality testing					
6.1 Determine what pollutants to test for	SWM,SCWP	DNR,EPA		2013	ON-GOING
6.2 Prepare QAPP	SCWP,SWM		$10,000	2013	1 YR
6.3 Purchase testing equipment & reagents	SCWP,SWM		$10,000	2013	ON-GOING
6.4 Train participants on testing procedures	SCWP			2013	ON-GOING
6.5 Semi-annual testing at multiple locations	SCWP			2013	ON-GOING
7. Encourage use of natural fertilizers, pesticides, herbicides and detergents					
7.1 Create literature on impact and alternatives	SCWP,SWM	DNR, EPA	$5,000	2013	1 YR
7.2 Conduct presentations to homeowner assoc.	SCWP,SWM			2013	ON-GOING
8. Minimize runoff impact in areas of sinkholes and losing streams					
8.1 Identify sinkholes and losing streams	SCWP,SWM	DNR,SCWP		2013	ON-GOING
8.2 Determine impact of stormwater runoff	SWM		$5,000	2013	1 YR
8.3 Protect areas from polluted runoff	SWM,P&Z			2013	ON-GOING

Acronyms

Table 6-2

SCWP	Sandy Creek Watershed Partnership	HERKY	City of Herculaneum
CARES	Center for Applied Research and Environmental Systems	JCPSD	Jefferson County Public Sewer District
CLCTY	City of Crystal City	MDC	Missouri Department of Conservation
COE	Corps of Engineers	NRCS	Natural Resources Conservation Service
CONST	Construction	PEVLY	City of Pevely
CWP	Center for Watershed Protection	P&Z	Planning and Zoning Div of Jeff. County
DNR	Department of Natural Resources	PW	Public Works Department of Jeff. County
EDC	Economic Development Corporation	SEMA	State Emergency Management Agency
EMSO	Eastern Missouri Small Flows Organization	ST	Stream Team
ENG	Engineering Support	SWD	Soil and Water Conservation District
EPA	Environmental Protection Agency	SWM	Jefferson County Stormwater Management Division
FESTS	City of Festus	UMEC	University of Missouri Extension Center
GIS	Geographic Information System		

Chapter 7: Element e. - Public Information & Education

7.1 Establishing Goals and Objectives

Goals for the long-term operation and maintenance practices of the management measures outlined in Chapter 5 are two-fold. First, Jefferson County will support the watershed partnership, in its effort to educate the watershed community by establishing a plan-of-action, by helping choose the best media format for presentation of outreach material, and providing presentation guidance.

Second, the watershed partnership will create a time-line for the creation and presentation of information and educational opportunities through various media formats such as: educational programs and displays, informational CDs and power point presentations, mailings, flyers, neighbor-to-neighbor contact, annual events, brochures, follow-up meetings, and the establishment of a web-site. The message of educational material and information will cover the management measures addressed in Chapter 5 and will be presented by the watershed partnership to the citizens of the watershed community.

The objective of these goals is to educate and inform the watershed community about the areas if concern within their watershed, what caused the issues to occur, and what should be done to correct/improve these areas. Hopefully, landowners will understand and practice appropriate BMPs that will eliminate illicit discharges, establish and maintain riparian corridors, minimize bank erosion, protect sensitive areas, use natural fertilizers, pesticides, herbicides and detergents, use bioretention techniques, and petition future development to build out of the floodway and away from sensitive areas. The secondary objective is to get members of the watershed community actively involved in the watershed partnership.

7.2 Distributing the Message

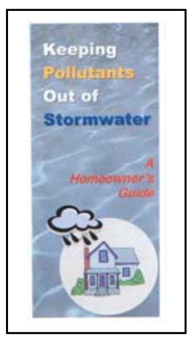
A systematic approach to the education and public information element is recommended. Grant funding or donations (discussed in Chapter 6) will be needed to finance some of the following:

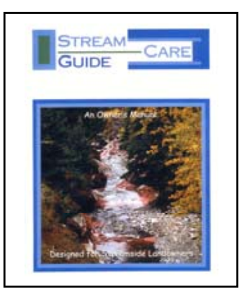
1. Continued participation and growth of the Watershed Partnership through outreach efforts. Set up monthly meetings to discuss implementation of measurement objectives. Discuss and apply for grant funding.
2. Development of a slide show or video outlining the major areas of concern within the watershed and evidence of pollutants and sources. Show presentation to the partnership and put on CDs for their individual use within the community. (Let your state representative know what you are doing and ask for support.)
3. Presentation of the slide show/video in each Management Unit. Also introduce the watershed plan document.
4. Recruit volunteers to establish and maintain a free website, participate in stream team and/or adopt-a road programs. Continue water quality monitoring.

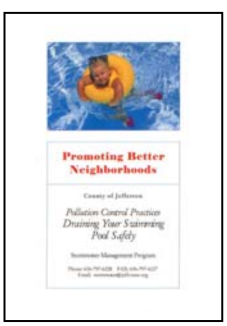
5. Create outreach materials such as flyers, brochures, newsletter and post on web-site or mail to citizens within the watershed with an invitation to join the partnership. Each flyer or brochure can address one or more BMP. Mention what progress is being made in your newsletter and web-site.
6. Set up a tabletop display for use in libraries, fairs, schools, etc.
7. Hold workshops within each management unit addressing one or two management measures and further emphasize BMPs. Post notices in public places.
8. Let the local newspapers know of progress being made. Write an article for publication in the local newspaper or invite a reporter to come to a meeting.

7.3 Evaluation of the Information/Education Program

In the early stages, the effectiveness of the information/education program can be determined by the number of presentations given, the number of community members attending the presentations, pre- and post surveys, number of website visits, and the number who become ongoing members of the watershed partnership. Second, activities of the watershed partnership should result in applications for grant funding, the creation of outreach material, a website, and communication to the individual management unit community members via scheduled workshops or presentations. Third, activities should be ongoing with contact to community members regarding BMPs, website activity, water quality monitoring, and the establishment of an annual community event.







Figures 7-1 thru 7-8: These pictures represent a sample of the educational brochures that can be used by the watershed partnership to convey information to the community.

Chapter 8: Element g. - Milestones

The management measures and goals identified in Chapter 5 were further delineated into specific tasks in Chapter 6 with technical and financial assistance reflected. An estimated implementation schedule was shown for each task.

Establishing milestones for the goals and tasks requires an understanding of the proposed projects. Many of the projects are conceptual at this time and the milestones reflected represent an initial perception of the desired improvements and/or desire to keep the water quality in the Sandy Creek watershed from deteriorating in the future. As specific projects are proposed and funding sought, more detailed milestones will be generated.

Table 8-1

Management Measures	***Milestones***
1. Evaluate stormwater runoff and its affect on the watershed *1.1 Evaluate L-THIA modeling nonpoint pollutants and determine what actions can be taken*	A. Identify pollutants by MU that can be reduced and what is the source(s). B. Identify and prioritize corrective actions by MU that will reduce pollutants.
1.2 Understand Stormwater Management Ordinances and their applicability to: New Construction	Stay informed of new developments in watershed and potential impact on water quality.
Maintenance of existing stormwater systems	Identify existing stormwater systems, i.e. detention ponds, and who is responsible for maintaining.
1.3 Locate Wetlands and Determine Protection Identify locations with designated wetlands	Locate and map by MU all designated wetlands.
Coordinate with landowners/document protection	A. Inform and educate landowner on value of wetlands. B. Provide landowner with options that will protect wetlands.
1.4 Identify locations where runoff is causing problems Identify locations	Through citizen input, record locations and problem(s) runoff is causing.
Determine solutions	Determine corrective action (s) and prioritize based upon cost to benefit ratios.

1.5 Know where point sources discharge	Record by MU all point source discharges and correlate test results with point source discharges.
2. Provide public education and encourage public involvement	
2.1 Install watershed signs throughout watershed	Identify locations where signs should be placed – order signs and install.
2.2 Solicit watershed partnership membership	Publicize existence of watershed partnership and solicit new member and volunteers for proposed projects.
2.3 Slide show/video-areas of concern & pollutants	Develop a video and/or slide show specific to Jefferson County showing watershed planning and what citizens can do for their watershed.
2.4 Community newsletter & educational material	Prepare a semi-annual newsletter on activities in watershed and post on website.
2.5 Workshops	Develop workshops on citizen involvement and present.
2.6 Establish website	Establish a watershed website.
2.7 Public involvement in water quality monitoring	Solicit citizen participation in water quality monitoring activities/events.
2.8 Develop table top display	Construct display reflecting impact of pollutants on watershed.
2.9 Participation in Stream Team & Adopt-A-Road	Participate in Stream Team events and In Adopt-A-Road program.
3. Encourage appropriate maintenance and repair of septic systems	
3.1 Prepare maintenance manuals on septic systems	Identify various types of on-site septic systems and develop maintenance manual for each.
3.2 Educate land owners on their type of system	Assist homeowners in identifying the type of system they have installed. Provide manual for their system.
3.3 Initiate cost share pump-out procedure	Solicit landowner participation in pump-out program.
4. Determine existing riparian corridors and educate landowners	
4.1 Identify areas without sufficient riparian corridor	Locate and map areas with insufficient riparian corridor/buffers.
4.2 Educate landowners on benefits of riparian corridor	Educate landowners of benefits of sufficient riparian corridors.
4.3 Re-establish riparian corridor	Determine corrective action needed to re-establish corridors and prioritize.

5. Perform stream bank restoration *5.1 Identify locations and property owner participation*	A. Identify and prioritize areas that are candidates for bank restoration. B. Verify property owner acceptance and participation.
5.2 Design restoration project	Design restoration project and determine cost.
5.3 Build restoration project	Obtain funding and resources needed to construct project.
6. Perform water quality testing *6.1 Determine pollutants to test*	Determine nonpoint pollutants are candidates for water quality testing.
6.2 Prepare QAPP	Develop Quality Assurance Project Plan for testing.
6.3 Purchase testing equipment & reagents	Determine cost of appropriate testing equipment and reagents and source of funding.
6.4 Train participants on testing procedures	Train and qualify participants on testing procedures.
6.5 Semi-annual testing at multiple locations	Perform and record water quality testing results at multiple locations in watershed – analyze results.
7. Encourage use of natural fertilizers, pesticides, herbicides and detergents *7.1 Create literature on impact and alternatives*	Develop literature on impact of fertilizers, pesticides, herbicides and detergents on the watershed and safer alternatives.
7.2 *Conduct presentations to homeowner assoc.*	Make literature available on website and conduct presentations to homeowner associations.
8. Minimize runoff impact in areas of sinkholes and losing streams *8.1 Identify sinkholes and losing streams*	Locate and map sinkholes and losing stream locations in watershed.
8.2 Determine impact of stormwater runoff	Study and document the impact of stormwater runoff entering areas.
8.3 Protect areas from polluted runoff	Determine appropriate BMPs that should be implemented to protect these areas.

Chapter 9: Element h. - Performance

Associated with implementing the management measures identified in Chapter 5, criteria is needed to determine whether load reductions are being achieved over time and if progress is being made towards attaining water quality standards. Sandy Creek is not on the Missouri 303(d) list of Impaired Waters and the intent is to keep it from becoming impaired.

The performance criteria reflected in the following table will be refined as specific projects are identified and funded to address the management measures. The criteria are based upon the milestones identified in Chapter 8.

Table 9-1

Management Measures	***Performance***
1. Evaluate stormwater runoff and its affect on the watershed *1.1 Evaluate L-THIA modeling nonpoint pollutants and determine what actions can be taken*	Nonpoint pollutants that can be reduced will be identified by MU and baseline data. Identify and prioritize corrective actions and estimated load reductions.
1.2 Understand Stormwater Management Ordinances and their applicability to: New Construction Maintenance of existing stormwater systems	Review all new construction projects for ordinance compliance. Identify existing systems and group responsible for maintaining.
1.3 Locate Wetlands and Determine Protection Identify locations with designated wetlands Coordinate with landowners/document protection	Wetlands and landowners will be identified using GIS mapping. Landowners will be contacted and options for protecting areas will be discussed.
1.4 Identify locations where runoff is causing problems Identify locations Determine solutions	Through citizen input, locations where stormwater runoff is causing problems will be identified. Corrective actions and associated cost will be identified and prioritized.
1.5 Know point source discharge	Point source discharges will be identified and associated with stream tributary by MU.

2. Provide public education and encourage public involvement	
2.1 Install watershed signs throughout watershed	Watershed signs will be installed.
2.2 Solicit watershed partnership membership	Existence of watershed partnership will be advertised and new members solicited.
2.3 Slide show/video-areas of concern & pollutants	Video and/or slide show will be developed.
2.4 Community newsletter & educational material	Sandy Creek watershed newsletter will be developed, distributed and posted on website.
2.5 Workshops	Citizen involvement workshops will be developed and presented at various locations in watershed.
2.6 Establish website	Website will be established.
2.7 Public involvement in water quality monitoring	On-going water quality monitoring in watershed will be conducted by citizens and data made available on website.
2.8 Develop table top display	Display reflecting impact of pollutants on the watershed will be developed.
2.9 Participation in Stream Team & Adopt-A-Road	Stream Team clean-ups and Adopt-A-Road program will have citizen participation.
3. Encourage appropriate maintenance and repair of septic systems	
3.1 Prepare maintenance manuals on septic systems	Maintenance manuals will be prepared for various types of on-site septic systems.
3.2 Educate land owners on their type of system & proper maintenance	Landowners will be provided a manual reflecting the maintenance requirement for their type of system.
3.3 Initiate cost share pump-out procedure	Landowner participation will be solicited.
4. Determine existing riparian corridors and educate landowners	
4.1 Identify areas without sufficient riparian corridor	Locations where riparian corridor is lacking and landowners will be identified.
4.2 Educate landowners on benefits of riparian corridor	The benefit of riparian corridors will be conveyed to landowners and their willingness to participate in a re-establishing project determined.
4.3 Re-establish riparian corridor	Projects and associated costs with re-establishing corridors will be identified and prioritized.

5. Perform stream bank restoration	
5.1 Identify locations and property owner participation	Areas that are candidates for stream bank restoration will be identified, property owner participation verified, associated costs determined, and projects prioritized.
5.2 Design restoration project	The design of the restoration project will be completed.
5.3 Build restoration project	Construction of the bank restoration project will be completed.
6. Perform water quality testing	
6.1 Determine pollutants to test	The nonpoint pollutants will be evaluated to determine if they are candidates for field testing, associated costs and equipment determined.
6.2 Prepare QAPP	Quality Assurance Project Plan documenting the testing procedures will be prepared and accepted by DNR.
6.3 Purchase testing equipment & reagents	Funding will be obtained to purchase test equipment and reagents.
6.4 Train participants on testing procedures	Participants who will perform water quality testing will be properly trained and certified.
6.5 Semi-annual testing at multiple locations	Testing will be performed a semi-annual basis at multiple locations with the results analyzed and corrective action determined.
7. Encourage use of natural fertilizers, pesticides, herbicides and detergents	
7.1 Create literature on impact and alternatives	Brochures and other literature has been developed reflecting the impact of fertilizers, pesticides, herbicides and detergents on the watershed and alternatives using natural products.
7.2 *Conduct presentations to homeowner assoc.*	Material developed is available on Sandy Creek website and presentations made to homeowner associations.
8. Minimize runoff impact in areas of sinkholes and losing streams	
8.1 Identify sinkholes and losing streams	Sinkholes and losing streams will be located by field visits and GIS and landowners notified.
8.2 Determine impact of stormwater runoff	The impact of stormwater entering sinkholes and losing streams will be

	studied and documented.
8.3 Protect areas from polluted runoff	New developments proposed in these areas will be reviewed and appropriate BMPs determined to protect water quality.

Chapter 10: Element i. - Monitoring

Implementing the goals and objectives associated with the management measures identified in Chapter 5 will need to be monitored to determine the effectiveness of the implementation.

Monitoring can be accomplished through water quality testing which is one of the management measures or through spot checking, landowner participation, adoption of practices, and creation of database or other measurements.

The following table reflects methods for monitoring the management measures. As specific projects are designed and funded, the monitoring methods shown should be evaluated for effectiveness and modified as needed. Tracking and monitoring should be an on-going activity for at least three to five years.

Table 10-1

Management Measures	***Performance***	*Monitoring*
1. Evaluate stormwater runoff and its affect on the watershed		
1.1 Evaluate L-THIA modeling nonpoint pollutants and determine what actions can be taken	Nonpoint pollutants Corrective actions	Water Quality Monitoring (WQM)
1.2 Understand Stormwater Management Ordinances and their applicability to:		
New Construction	Construction projects	Ordinances
Maintenance of existing stormwater systems	Existing stormwater systems	Spot Checking
1.3 Locate Wetlands and Determine Protection		
Identify locations with designated wetlands	Wetlands and landowners	GIS
Coordinate with landowners/document protection	Landowners	Create Log
1.4 Identify locations where runoff is causing problems		
Identify locations	Locations	Landowners
Determine solutions	Corrective actions	Create Log
1.5 Know where point sources discharge	Point source discharges Correlate to water quality issues.	DNR/GIS WQM
2. Provide public education and encourage public involvement		
2.1 Install watershed signs throughout watershed	Watershed signs	SC Partnership
2.2 Solicit watershed partnership membership	Partnership membership	SC Partnership
2.3 Slide show/video-areas of concern & pollutants	Video and/or slide show	SWM & SC Partnership
2.4 Community newsletter & educational material	Newsletter	
2.5 Workshops	Workshops	SC Partnership
2.6 Establish website	Website	SC Partnership
2.7 Public involvement in water quality monitoring	WQM by citizens	WQM
2.8 Develop table top display	Display on impact of pollutants	SWM
2.9 Participation in Stream Team & Adopt-A-Road	Stream Team and Adopt-A- Road program	SC Partnership
3. Encourage appropriate maintenance and repair of septic systems		
3.1 Prepare maintenance manuals on septic systems	Maintenance manuals	SC Partnership
3.2 Educate land owners on their type of system	Landowners	SC Partnership
3.3 Initiate cost share pump-out procedure	Home owner participation	SC Partnership
4. Determine existing riparian corridors and educate landowners		
4.1 Identify insufficient riparian corridor	Locations	GIS
4.2 Educate landowners on benefits	Benefits	SC Partnership
4.3 Re-establish riparian corridor	Projects	SC Partnership

5. Perform stream bank restoration *5.1 Identify locations and owner participation* *5.2 Design restoration project* *5.3 Build restoration project*	 Identification Design Construction	 SC Partnership Project Design SC Partnership
6. Perform water quality testing *6.1 Determine what pollutants to test* *6.2 Prepare QAPP* *6.3 Purchase testing equipment & reagents* *6.4 Train participants on testing procedures* *6.5 Semi-annual testing at multiple locations*	 Nonpoint pollutants Quality Assurance Project Plan Funding Participants Testing	 WQM SC Partnership SC Partnership SC Partnership WQM
7. Encourage use of natural fertilizers, pesticides, herbicides and detergents *7.1 Create literature on impact and alternatives* 7.2 *Conduct presentations to homeowner assoc.*	 Literature Presentations	 SWM & SC Partnership
8. Minimize runoff impact in areas of sinkholes and losing streams *8.1 Identify sinkholes and losing streams* *8.2 Determine impact of stormwater runoff* *8.3 Protect areas from polluted runoff*	 Sinkholes and losing streams Impact New developments and BMPs	 GIS SWM & SC Partnership Ordinances

Evaluating & Adapting the Plan

This Sandy Creek Watershed Management Plan was prepared in accordance with and incorporates the nine elements of watershed planning that are required by the U.S. Environmental Protection Agency. Guidance in preparing the plan was obtained through *U.S. EPA's Handbook for Developing Watershed Plans to Restore and Protect Our Waters.*

Jefferson County Stormwater Division initiated the effort to develop a watershed plan for Sandy Creek and applied for a minigrant to assist in the cost of development. The intent is for the citizens in the Sandy Creek watershed to take ownership of this Plan following acceptance by EPA and Missouri Department of Natural Resources.

Funding for implementing projects is generally only available to Non-Profit organizations or to government agencies. To this extent, it is recommended that the Sandy Creek Watershed Partnership apply for both State and Federal (501c3) non-profit status.

This watershed management plan is intended to be a living document and, therefore, should be reviewed and updated on a 5-year basis. New development and infrastructure will need to be considered as well as the implementation of proposed projects in the 5-year review. New issues and concerns (management measures) may arise and priorities may change.

APPENDIX

Exhibit A - List of Sources

Jefferson County GIS Aerials
MoDNR Groundwater Education (www.dnr.mo.gov)
USGS.gov
City-data.com
Missouri Department of Conservation (mdc.mo.gov)
cares.missouri.edu
University of Missouri GIS data
Jefferson County Planning & Zoning GIS data
Illustrated Historical Atlas Map of Jefferson County, 1876
Herculaneum Bicentennial History Book, 2008
History of Jefferson County Missouri, Howard C. Litton, June 1978
join-n.org/history
Standard Atlas of Jefferson County Missouri, George Ogle & Co., Chicago, IL, 1898
Midwest Paranormal.net
greatriverroad.com/stegen/jeffco/dunklin.htm
Sandy Creek Church Historical Records
mostateparks.com/sandybridge/
http://factfinder.census.gov/home/saff/main.html?_lang=en
jeffcountymo.org
Jefferson County Assessor's Records
Jefferson County Photos
Missouri Department of Natural Resources (www.dnr.mo.gov)
Sandy Creek Stakeholders
Missouri Stream Team (mostreamteam.org)
http://cobweb.ecn.purdue.edu/-sprawl/LTHIA7
EPA's *Engaging & Involving Stakeholders in Your Watershed*
EPA's *A Guide to Conducting Watershed Outreach Campaigns*
Jefferson County's Unified Development Order (jeffcomo.org)
http://en.allexperts.com/q/Organic-Gardens-728/Organic-Herbicide-1.htm
www.greenlivingtips.com/articles/158/1/Natural-fertilizer.html
www.the-organic-gardner.com/weed-control.html
http://ga.water.usgs.gov/edu/sinkholes.html
www.watersheds.org/earth/karst.htm
http://en.wikipedia.org/wiki/sinkhole
Site Design Guidance, MSD, April 2009 (stlmsd.com)
Jefferson County Flood Damage Prevention Ordinance (jeffcomo.org)
Jefferson County Educational Material (jeffcomo.org/Stormwater)
http://freepages.history.rootsweb.ancestry.com/~linhorst/ (A Historical Timeline of Sandy Mines and its Neighboring Community by John Linhorst, 2009 Second Edition)
EPA's *Handbook for Developing Watershed Plans to Restore and Protect Our Waters*
www.belews-creek.com

Exhibit B - Definitions

Aquifer: an underground porous water bearing geological formation composed of a layer of permeable rock, sand, or gravel that provides a groundwater reservoir.

Critical Areas: regions highly susceptible to erosion such as an area subjected to concentrated water flow.

Detention Pond: a low lying area that is designed to temporarily hold a set amount of water while slowly draining to another location.

Floodplain: a relatively level surface of stratified alluvium that adjoins a water course and is subject to periodic flooding.

HUC: Hydrologic Unit Codes identify all of the drainage basins in a nested arrangement from largest (regions) to smallest (cataloging units). A drainage basin is an area or region of land that catches precipitation that falls within that area and funnels it to a particular waterbody. Drainage basins are also called watersheds.

Hydrology: the science dealing with the distribution and movement of water.

Karst Topography: landscape characterized by numerous caves, sinkholes, fissures and underground streams. Karst topography usually forms in regions of plentiful rainfall where bedrock consists of carbonate-rich rock such as limestone, gypsum or dolomite that is easily dissolved.

Point Source Stressors: pollutant sources that are permitted to discharge at specific locations from pipes, outfalls and conveyance channels.

Riparian Corridor: undisturbed land adjacent to a sensitive environmental site (wetland or waterbody) in which human activities are limited in order to minimize the negative impacts from adjacent land uses (erosion, pollutants, disturbance of wildlife) affecting the sensitive environmental site.

Visual Survey: walking, driving or boating the watershed to observe water and land conditions, uses and changes to help identify pollutants, sources and causes.

Wetland: land area that is wet or flooded by surface or groundwater often enough and long enough to develop characteristic hydric soil properties and to support vegetation that will grow in saturated soil conditions.

Exhibit C - The Early Beginnings of Communities in the Sandy Creek Watershed

Early settlers of Jefferson County were frugal people. Corn, ground at Johnston's mill on Sandy Creek, was used for bread as only the wealthy grew wheat. The corn was soaked in water to soften it and then pounded and mashed into a meal which was baked into bread. Wild game provided meat. Sugar and syrup came from maple trees and spice wood and sassafras were used for tea. Cotton and flax were grown in the area and used for clothing. The cotton was picked by hand and spun and woven at home with flax worked into cloth the same way. Tobacco was grown locally and lead was mined and smelted in the watershed. The lead was used for bullets and barter. Gun powder was the only commodity for which the settlers depended upon others which was available in Ste. Genevieve and St. Louis. Lead and furs was used as currency.

The first agricultural efforts of the early settlers were made with crude tools. Up to 1815, two-wheeled carts, constructed entirely of wood were used for hauling and were drawn by oxen. The first four-wheeled vehicle came to the county from St. Louis in 1809. It was a common wagon with four wheels and iron tires, and was displayed at Ben Johnston's law office where it created great curiosity among the early settlers.

The following information relates the beginning of the communities in the Sandy Creek Watershed.

Pevely is twenty-seven miles from St. Louis on the St. Louis, Iron Mountain and Southern railroad. Near the town is a summit with an elevation rising above the surrounding country and providing an extensive view. The town was built on an old survey settled by Bartholomew Herrington in the fall of 1799. A spring and cave are in the vicinity. The place was first called Pevely Spring from an early inhabitant named Pevely, who resided there. From 1801 to 1804 settlements were made on the Sandy and Joachim Creeks. The lead deposits attracted attention, and some of the early settlers engaged in farming, and others in lead mining. David Boyle was one of the first settlers on Sandy Creek. Joshua Bartholomew recalls among the first settlers on Sandy Creek was John Johnston (about 1810). Captain William Moss was also an early settler on Sandy.

Pevely was laid out in September, 1860 by Judge Charles Rankin. The first hotel was built by Jack Broughton. Judge Rankin opened the first store and was the first postmaster, while John Herrington built a dwelling house and opened the first saloon. Louis Juede was the first blacksmith.

Figure EX 1: Judge Rankin's Home

Dairy farms were springing up to the west, south and north. The Kerchoff family in Sandy Valley started a dairy in St. Louis and named it Pevely Dairy. At one time, Pevely was the greatest shipping point in the country for milk and butter.

Pevely's first small subdivision made out of wooden structures was called "Slat Town". It was officially known as Oak Grove. In the 1850s Pevely had a growth of German people who came to the United States for religious freedom. Some of the most well known names in Pevely were those people. They build nice homes and some of the first stoves were built by them.

On the south side of Joachim Creek where the stream is now crossed by a bridge near Herculaneum, John Conner was the first settler.

The town of Herculaneum would come into existence in 1808 as Moses Austin and Samuel Hammond acquired enough land to establish the town. Herculaneum became an industrial mining town dominated by the French. One of the first settlers to the new town of Herculaneum was James Rankin who located there in 1808.

Moses Austin saw the need for a shipping port for his lead mining activities at the mouth of the Joachim Creek. In partnership with Lt. Colonel Samuel Hammond, Austin purchased several acres of land most of which was north of the Joachim Creek near its confluence with the Mississippi River. Austin proceeded to lay out and sell lots on his tract of land. He called the new town Herculaneum because of the rock-terraced cliffs and setting that were suggestive of Herculaneum, Italy.

Figures EX 2 & EX 3 : Limestone bluffs in Herculaneum overlooking the Mississippi River.

The high bluffs along the Mississippi River on both the north and south sides of the Joachim Creek proved suitable for the construction of shot towers. In 1809, John Maclot de Coligny, a French immigrant, built the first shot tower south of the creek and in 1810 Austin built the second shot tower on the north side of the creek. The ammunition manufactured here was considered critical to the American troops in the War of 1812.

Austin then built a road from Mine À Breton (Potosi) to the high limestone bluffs helping to make Herculaneum an important shipping point for the lead smelted at Valle Mines, Richwood, Old Mines, Potosi and other mines in Washington County. Prior to the construction of the Iron Mountain Railroad to Pilot Knob in 1858, products from lead mines were hauled by ox cart to Ste. Genevieve and Herculaneum and then transported on the Mississippi River.

Lead was discovered in Jefferson County in 1824 in an area that became known as Sandy Mines. This area is south of the covered bridge and east of old highway 21. Sandy Mines was so named after the type of soil found on the banks of the nearby creek. The ore that came out of the mine was sent by horse and wagon to nearby smelters for use in ammunition and shot, as well as other lead-based products. It has been estimated that 10 million pounds of lead were produced from this mine during its first 30 years. The mine continued operations into the early part of the twentieth century, but was eventually abandoned after the mine stopped producing the wealth of ore that it once did. In its day, the mine provided work for many of the early settlers in the watershed.

A detailed document titled "A Historical Timeline of Sandy Mines and its Neighboring Community in Jefferson County, Missouri" 2009 Second Edition was prepared by John Linhorst and provides information on the mining operations and individuals involved. The link to this document is shown in the Appendix under the List of Resources.

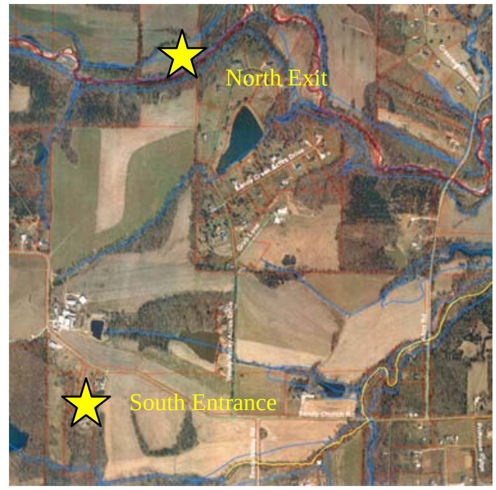


Figure EX 4: Sandy Mines Location

In 1887, Charles Bunyan Parsons, Superintendent of the St. Joseph Lead Company, chose Herculaneum as a lead smelting site. In 1890 construction began on the smelter and in 1892 the smelter begins operation.

In 1888 the Mississippi River and Bonne Terre Railroad was started near Bonne Terre and ran to Herculaneum. This railroad line intersected with the Iron Mountain Railroad at Riverside. These railroads made it possible to ship supplies and transport people to and from the communities. Growth was inevitable.

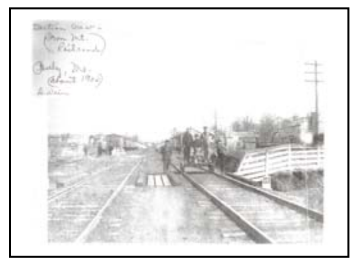


Figure EX 5: Iron Mountain Railroad Crew in Pevely about 1900. Source: D.

Five miles south of Herculaneum are the cities of Festus and Crystal City. Crystal City was established as a settlement along the roadway that was cut through the forests from St Louis to Ste. Genevieve. After it had been an actual settlement for many years, a party of scientists and surveyors came along to inspect the district. One of them noted the peculiar type of sand that was around the site and sent two casks of it to England to be analyzed. It was returned and the analysis showed that the sand was especially adapted for glass manufacture. As a result, a company was formed by Captain Ebenezer Ward of Detroit and called American Plate Glass Company. In May 1872, building began and workmen were recruited from surrounding farms. A town began to grow around the factory and though it was named "New Detroit", the people called it Crystal City, which is its present name. Despite the sand's high promise, the enterprise failed, and in 1877 the factory and land were sold to a new corporation, the Crystal Plate Glass Company of St. Louis. Eighteen years later the factory, town, and holdings were purchased by Pittsburgh Plate Glass Company. Crystal City was, until 1906 a real "company town" but, after that date, lots and other properties were sold by the company to private individuals for residences and business houses.

Festus was settled shortly after the establishment of Crystal City. After the establishment in 1878 by W.J. Adams, it was named "Tanglefoot" because several of its first businesses were saloons and men stumbled through the streets – just beyond the border of New Detroit. Officials of the glass company in "New Detroit" would not allow drinking nearer than one mile to the business. In later years, the nearby city was called "Limitville" but when it grew larger, a new name was sought. A preacher chose the name of Festus by opening his bible blindly and pointing to the name "Festus" in the Book of Acts. Festus was incorporated in 1888.

The headwaters of Sandy Creek are located in the community of Hillsboro near the grounds of the present day Jefferson College. Hillsboro was named in honor of President Thomas Jefferson's home, Monticello. Monticello roughly translated to English is "Hills" plus "borough" meaning town or village. The name was recorded as Hillsboro. Mr. Henson built the first house in Hillsboro in the late 1770s. He also opened the first brickyard and made the first brick in town. On February 8, 1839, Hillsboro became the county seat. Because travel to and from Hillsboro was difficult, persons elected to county office built many of the early homes. There was no public transportation until the late 1830s with the arrival of the stagecoach. Trains began to run to nearby Victoria in 1858.

From there, one rode horseback or walked the Hillsboro-Victoria Road to Hillsboro. Highway 21 was completed in 1940. Hillsboro is a small community.

Information was taken from
Herculaneum's Bicentennial History Book, 2008
History of Jefferson County, Missouri and Festus and Crystal City, Missouri, Howard C. Litton, June 1978.
http://www.join-n.org/history
An essay by Amelia C. Weier called "From 1799 to 1982 The Growth of a Village Into a Town and Now A City – Pevely History.
A Historical Timeline of Sandy Mines and its Neighboring Community in Jefferson County Missouri by John Linhorst, 2009.

Historic Resource Areas

The Rock House

The Rock House, also referred to as the Landmark House, located in Pevely, Missouri was built in 1850 by Dr. William Clark. He not only was a doctor, but also ran a dairy farm on the property. Also living in the home was Dr. Clark's wife, Lillie Ellis Clark and their slaves.

Clark died in 1865 and the home was sold in 1870 to a riverboat captain named Alexander "Buzz" Ziegler. The home was sold again around 1900 and changed hands many more times over the next few decades serving as a hospital, government offices and later separated as apartment housing for low income families and prostitutes. The home sold again in 1961 and sat vacant for 20 years. It was used only sporatically since that time. Much of the land is currently used as a mobile home park and a new subdivision has been built across the street covering the rumored location of the slave graveyard.

Figure EX6:
The Rock House
Information Source:
www.Midwest Paranormal.net

Governor Daniel Dunklin's Grave

Figure EX 7

Dunklin moved to Missouri from South Carolina in 1810 and lived near Potosi. In 1828 he was lieutenant governor. In 1832, he secured the Democratic gubernatorial nomination and was elected Missouri's fifth governor.
Dunklin is often called the father of Missouri's school system. He sought to establish public schools on a firm and stable basis. In 1835, the General Assembly passed a law establishing the public school system in Missouri

In 1840, Dunklin moved to the Herculaneum area. Dunklin's son, James, inherited his parent's estate upon the death of his mother. Part of the estate was reserved for a cemetery where Daniel and his wife, Emily are buried.

Figure EX 8

The Missouri State Park Board agreed on August 25, 1965, to accept the cemetery for the purpose of erecting and maintaining a memorial park in remembrance of Daniel Dunklin. The Department of Natural Resources oversees Dunklin's Grave. The site sits atop the limestone bluffs that overlook the Mississippi River.
(Information is from www.greatriverroad.com/stegen/jeffco/dunklin.htm)

Sandy Baptist Church & School

Sandy Baptist Church is the oldest Baptist Church and oldest Protestant Church in Jefferson County. It is also the 18th oldest Baptist Church west of the Mississippi River.

In 1816 Thomas Donahue came from Jackson, Missouri to preach to the residents of this area. The congregation officially became a church in 1824 and was known as the Sandy Creek Baptist Church. The first building was a log cabin. The second structure was a frame building built in 1843. The small building next to the cemetery was built in 1878 from bricks that were made from clay that was taken from the fields across the road from the church. The church members built the bricks themselves.

Because the church needed a new baptistry in 1956 a new church was in order. The church was built to seat 225 and was dedicated on June 6, 1966. It is being used today.

Figure EX 9: Sandy Baptist Church built in 1878.

After Sandy Baptist Church was established in 1824, it was deemed necessary to start a school in Jefferson County. Fleming Hensley decided that it needed to be close to the church, so he gave some land so that a school could be started. The Sandy School served as a place for education for over 100 years until the Hillsboro District was consolidated in 1950. (Information taken from Sandy Creek Church Historical Records.)

Figure EX 10: Sandy Creek School in 1950

The Covered Bridge

John Morse constructed The Sandy Creek Covered Bridge in 1872 as part of a countywide building program in Jefferson County after the civil war. The main purpose behind covering bridges was to protect the intricate structural network of iron and timber trusses from weather.

Sandy Creek Covered Bridge remained intact until the spring flood of 1886. In August of the same year, Henry Steffin rebuilt the bridge using some of the original timbers and abutments. In 1967, the Missouri Legislature passed a bill authorizing the Missouri State Park board to take possession of, repair, and preserve the bridge. The Department of Natural Resources currently maintains the site. The bridge was listed in the National Register of Historic Places in 1970. This historic site includes 205 acres of land adjoining the bridge.

Figure EX 11 - Sandy Creek Covered Bridge Information Source: www.mostateparks.com/sandybridge/

Because of its historical significance, the Sandy Creek Watershed Partnership has chosen it as their logo. It sits on the south end of Old Lemay Ferry Road just north of Hillsboro.

Exhibit D - Stream Team Testing Results

The results of testing on a tributary to Sandy Creek east of a nature trail at Jefferson College (Stream Team reference No. 6497) are shown below.

Table EX 1

Chemical Data for Agency Reference Number 6497:														
Date Sampled	Stream Team Number	Site Number	Time Sampled	Water Temp (⁰C)	Air Temp (⁰C)	Dissolved Oxygen (mg/L)	Oxygen Saturation %	pH	Nitrate as N (mg/L)	Ammonia as N (mg/L)	Phosphate PO4 (mg/L)	Conduct-ivity (umhos/cm)	Turbidity (JTU)	Level of Training
5/19/2009	2383	63	1130	14	23	9	87	8.2	0.25	No Data	1.47	780	10	1

The results of testing at 1000 yards downstream of the Sandy Creek Covered Bridge (Stream Team Reference #4696) are shown below and on the following two pages.

Figure EX 12

Table EX 2

Visual Data for Agency Reference Number 4696:												
Date	Stream Team Number	Site Number	Time	Land Use	Riparian Corridor	Stream Bank	Human Use	Bed Composition	Stream Bed Algae Coverage	Water Color	Water Odor	Comments
4/21/2007	1639	66	1343	Industrial: 0% Commercial: 0% Residential: 5% Pasture: 40% Row Crops: 0% Woods: 5% Other: STATE PARK%	Trees: 10% Grass: 25% Bare: 5% Paved: 5% Building: 5% Other: STATE PARK% Other %: 50%	Trees: 10% Grass: 40% Bare: 50% Bedrock: 0% Riprap: 0% Other: % Other %: 0%	TRASH, STATE PARK; FOOTPATHS	Silt/Mud: 0% Sand: 15% Gravel: 5% Cobble: 65% Boulder: 5% Bedrock: 20% Embeddedness: 0%	Algae Coverage: 80% Which is Close Growing: 50% Filamentous: 50%	CLEAR	NONE	AIR TEMPERATURE: 80F
7/2/2006	2891	1	1200	Industrial: 0% Commercial: 0% Residential: 0% Pasture: 0% Row Crops: 0% Woods: 70% Other: PARK AREA (MOWED GRASS)%	Trees: 60% Grass: 20% Bare: 5% Paved: 5% Building: 0% Other: BEDROCK% Other %: 10%	Trees: 10% Grass: 30% Bare: 20% Bedrock: 40% Riprap: 0% Other: % Other %: 0%	SWIMMING AREA US FROM RIFFLE.	Silt/Mud: 20% Sand: 60% Gravel: 0% Cobble: 10% Boulder: 0% Bedrock: 10% Embeddedness: %	Algae Coverage: 50% Which is Close Growing: 100% Filamentous: 0%	CLEAR WITH GREENISH CAST	NONE	No comments given
4/13/2006	1857	0	1222	Industrial: % Commercial: % Residential: % Pasture: % Row Crops: % Woods: % Other: %	Trees: 90% Grass: 8% Bare: 2% Paved: 0% Building: 0% Other: % Other %: 0%	Trees: 90% Grass: 8% Bare: 2% Bedrock: 0% Riprap: 0% Other: % Other %: 0%	TRASH, TRAILS	Silt/Mud: 0% Sand: 2% Gravel: 60% Cobble: 38% Boulder: 0% Bedrock: 0% Embeddedness: %	Algae Coverage: 75% Which is Close Growing: 100% Filamentous: 0%			No comments given
5/9/2005	1857	2	945	Industrial: 0% Commercial: 0% Residential: 0% Pasture: 0% Row Crops: 0% Woods: 0% Other: STATE HISTORIC SITE%	Trees: 40% Grass: 50% Bare: 10% Paved: 0% Building: 0% Other: % Other %: 0%	Trees: 30% Grass: 40% Bare: 5% Bedrock: 25% Riprap: 0% Other: % Other %: 0%	TRASH, PATHS, PHOTOGRAPHER AND HIKERS	Silt/Mud: 5% Sand: 5% Gravel: 30% Cobble: 40% Boulder: 20% Bedrock: 0% Embeddedness: 42%	Algae Coverage: 65% Which is Close Growing: 70% Filamentous: 30%	CLEAR	NONE	HEAVY FLOODING OCCURRED IN THIS W/S ONE WEEK PRIOR TO SAMPLING.
8/9/2003	1857	2	1315	Industrial: 0% Commercial: 0% Residential: 0% Pasture: 0% Row Crops: 0% Woods: 0% Other: state historic site%	Trees: 95% Grass: 5% Bare: 0% Paved: 0% Building: 0% Other: None% Other %: 0%	Trees: 60% Grass: 40% Bare: 0% Bedrock: 0% Riprap: 0% Other: None% Other %: 0%	trash, people walking	Silt/Mud: 0% Sand: 10% Gravel: 10% Cobble: 35% Boulder: 45% Bedrock: 0% Embeddedness: 24%	Algae Coverage: 100% Which is Close Growing: 100% Filamentous: %	sandy	None	Stream bank contains much sand.

Table EX 3

Invertebrate Data for Agency Reference Number 4696:

Date	Stream Team Number	Site Number	Water Quality Rating*	Level of Training	Comments
1/21/2009	1857	2	31	3	Fish present. Also found in net: darter, horse fly, 2 slugs, adult whirligig beetle, adult giant water bug, empty clams, 4 caddis cases, 1 aquatic caterpillar.
4/21/2007	1639	66	36	1	STREAM TEAM INTRODUCTORY LEVEL WORKSHOP.
7/2/2006	2891	1	28	1	No comments given
8/19/2005	1857	2	0	2	RECENT STORMS FELL TREES IN STREAMBED AND CAUSED INCREASED MUD IN THE COLLECTION NET AND TURBIDITY IN A NORMALLY CLEAR STREAM.
5/9/2005	1857	2	35	2	SAMPLING WAS ONE WEEK AFTER HEAVY FLOODING IN THE W/S; PLANARIANS ALSO NOTED IN SAMPLES.
7/5/2004	1857	2	20	2	No comments given
4/2/2004	1857	2	25	2	NETSETS[3]
8/9/2003	1857	2	25	1	Net sets = 3; Minnows present in each kick net; Caddisfly reported as 25+.

Exhibit E – Conservation Department Fish Data

Table EX 4

Stream	Site	Date
Joachim - Sandy	Hwy 21	7/3/2002
watershed area:		4984.9
order:		3
river mile:		
Sampled by:	D. Brown, B. Sehie	
EF Type	Backpack	
EF Time		1069
Seine Time		9:00
IBI score		70

Note: if only juveniles of a species were collected, it is noted next to the species name and marked as a 1 no matter how many were caught. If both juvenlies and adults were caught the only the number of adults is recorded

Species	#EF'd	#Seined	# Total	% Abund.	native spp	native family
bluntnose minnow	66	4	70	17.2%	1	1
southern redbelly dace	2	3	5	1.2%	1	
creek chub	1		1	0.2%	1	
bleeding shiner	1		1	0.2%	1	
sand shiner	10	1	11	2.7%	1	
stoneroller sp.	167	3	170	41.9%	1	
ozark minnow	3		3	0.7%	1	
white sucker (juv)	1		1	0.2%	1	1
slender madtom	4		4	1.0%	1	1
yellow bullhead	1		1	0.2%	1	
stonecat	1		1	0.2%	1	
northern studfish	4	4	8	2.0%	1	1
blackstripe topminnow	2	16	18	4.4%	1	
blackspotted topminnow		1	1	0.2%	1	
banded sculpin	2		2	0.5%	1	1
largemouth bass	1		1	0.2%	1	1
green sunfish	2		2	0.5%	1	
bluegill	15	26	41	10.1%	1	
orangethroat darter	21		21	5.2%	1	1
rainbow darter	29	1	30	7.4%	1	
fantail darter	12	1	13	3.2%	1	
johnny darter	1		1	0.2%	1	
Totals	346	60	406	100.0%	22	7

Table EX 5

Stream	Site	Date
Sandy Creek	Hwy 21	7/2/2007
watershed area:		4984.9
order:		3
river mile:		
Sampled by:	D. Brown	
EF Type	backpack	
EF Time		1588
Seine Time		4:13
IBI score		80

Note: if only juveniles of a species were collected, it is noted next to the species name and marked as a 1 no matter how many were caught. If both juvenlies and adults were caught the only the number of adults is recorded

species gained	species lost
red shiner	sand shiner
cyprinella sp.	slender madtom
golden redhorse (juv.)	stonecat
longear sunfish	blackstripe topminnow
redear sunfish	
bigeye shiner	

Species	#EF'd	#Seined	# Total	% Abund.	native spp	native family
bluntnose minnow	37	1	38	4.9%	1	1
ozark minnow	5	1	6	0.8%	1	
creek chub	5	1	6	0.8%	1	
bleeding shiner	2		2	0.3%	1	
bigeye shiner	2	1	3	0.4%	1	
stonerollers	421	3	424	54.9%	1	
southern redbelly dace	6		6	0.8%	1	
red shiner	6	2	8	1.0%	1	
cyprinella sp.	9		9	1.2%	1	
white sucker (juv.)	1		1	0.1%	1	1
golden redhorse (juv.)	1		1	0.1%	1	
yellow bullhead	2		2	0.3%	1	1
northern studfish	3	1	4	0.5%	1	1
blackspotted topminnow	8	1	9	1.2%	1	
banded sculpin	15		15	1.9%	1	1
largemouth bass	1		1	0.1%	1	1
longear sunfish	40		40	5.2%	1	
redear sunfish	14		14	1.8%	1	
hybrid sunfish	5		5	0.6%		
bluegill	59		59	7.6%	1	
green sunfish	55		55	7.1%	1	
rainbow darter	13		13	1.7%	1	1
johnny darter	1		1	0.1%	1	
orangethroat darter	20		20	2.6%	1	
fantail darter	30	1	31	4.0%	1	
Totals	761	12	773	100.0%	24	7

Table EX 6

Stream	Site	Date
Joachim - Sandy	Hwy Z	7/1/2002

watershed area:	20736.8
order:	3
river mile:	
Sampled by:	D. Brown, B. Sehie
EF Type	Backpack
EF Time	1202
Seine Time	6:32
IBI score	**57**

Note: if only juveniles of a species were collected, it is noted next to the species name and marked as a 1 no matter how many were caught. If both juvenlies and adults were caught the only the number of adults is recorded

Species	#EF'd	#Seined	# Total	% Abund.	native spp	native family
bluntnose minnow	14		14	5.2%	1	1
red shiner	12	15	27	10.0%	1	
golden shiner	3	3	6	2.2%	1	
bleeding shiner	1	1	2	0.7%	1	
sand shiner	72	23	95	35.1%	1	
stonerollers	5	1	6	2.2%	1	
bigeye chub	43	47	90	33.2%	1	
striped shiner		2	2	0.7%	1	
white sucker (juv)	1		1	0.4%	1	1
quillback (juv)		1	1	0.4%	1	
yellow bullhead	1		1	0.4%	1	1
blackstripe topminnow	1	7	8	3.0%	1	1
largemouth bass (juv)	1		1	0.4%	1	1
hybrid sunfish	1		1	0.4%		
longear sunfish	2		2	0.7%	1	
bluegill (juv)	1		1	0.4%	1	
logperch	4		4	1.5%	1	1
rainbow darter	1		1	0.4%	1	
johnny darter	7	1	8	3.0%	1	
Totals	170	101	271	100.0%	18	6

Stream	Site	Date
Sandy Creek	Hwy Z	7/4/2007

watershed area:	20736.8
order:	3
river mile:	
Sampled by:	D. Brown, S. Oakes
EF Type	backpack
EF Time	1753
Seine Time	2:05
IBI score	**75**

Note: if only juveniles of a species were collected, it is noted next to the species name and marked as a 1 no matter how many were caught. If both juvenlies and adults were caught the only the number of adults is recorded

species gained	species lost
ozark minnow	golden shiner
creek chub	bigmouth shiner
bigeye chub	quillback
rosyface shiner	blackstripe topminnow
cyprinella spp.	
northern hogsucker	
river carpsucker (juv.)	
smallmouth bufallo (juv.)	
freckled madtom	
channel catfish (juv.)	
blackspotted topminnow	
brook silverside	
smallmouth bass (juv.)	
green sunfish	
orangespotted sunfish	
orangethroat darter	
fantail darter	
walleye (juv.)	

Species	#EF'd	#Seined	# Total	% Abund.	native spp	native family
common carp (juv.)	1		1	0.1%		
bluntnose minnow	76	26	102	11.5%	1	1
ozark minnow		1	1	0.1%	1	
creek chub	2		2	0.2%	1	
bigeye chub	62	208	270	30.4%	1	
bleeding shiner	10	9	19	2.1%	1	
striped shiner	3	2	5	0.6%	1	
sand shiner	79	20	99	11.1%	1	
rosyface shiner		1	1	0.1%	1	
stonerollers	88	28	116	13.0%	1	
red shiner	73	95	168	18.9%	1	
cyprinella sp.		1	1	0.1%	1	
northern hogsucker	1		1	0.1%	1	1
river carpsucker (juv.)	1		1	0.1%	1	
smallmouth bufallo (juv.)	1		1	0.1%	1	
white sucker (juv.)	1		1	0.1%	1	
freckled madtom	1		1	0.1%	1	1
channel catfish (juv.)	1		1	0.1%	1	
yellow bullhead (juv.)	1		1	0.1%	1	
blackspotted topminnow	11	4	15	1.7%	1	1
brook silverside		1	1	0.1%	1	1
largemouth bass (juv.)	1		1	0.1%	1	1
smallmouth bass (juv.)	1		1	0.1%	1	
longear sunfish	9		9	1.0%	1	
bluegill	1		1	0.1%	1	
green sunfish	2		2	0.2%	1	
orangespotted sunfish	1	1	2	0.2%	1	
logperch	2		2	0.2%	1	1
rainbow darter	2		2	0.2%	1	
johnny darter	36	18	54	6.1%	1	
orangethroat darter	3		3	0.3%	1	
fantail darter	3		3	0.3%	1	
walleye (juv.)	1		1	0.1%	1	
Totals	474	415	889	99.9%	32	7

Table EX 7

L-THIA OUTPUT
Scenario Name : MU1-Sandy Creek
Total area : 3403 acres
State : Missouri
County : Jefferson

Average Annual Runoff Volume for Existing			
Land Use	**Hydrologic Soil Group**	**Area (acres)**	**Average Annual Runoff Volume (acre-ft)**
Commercial	B	68	109.55
Commercial	C	34	64.79
Residential 1/2 acre	C	113	78.40
Residential 2 acre	C	227	127.93
Commercial	D	170	347.67
Water/Wetlands	B	68	0
Agricultural	C	340	268.37
Forest	C	1683	610.44
Forest	D	700	394.49
	Total Annual Volume (acre-ft)	2001.66	
	Average Annual Runoff Depth (in)	7.05	

Average Runoff Depth For Hydrologic Soil Group And Landuse Combination			
Land Use	**Hydrologic Soil Group**	**Curve Number**	**Runoff Depth (in)**
Commercial	B	92	19.41
Commercial	C	94	22.96
Residential 1/2 acre	C	80	8.36
Residential 2 acre	C	77	6.79
Commercial	D	95	24.64
Water/Wetlands	B	0	0
Agricultural	C	82	9.51
Forest	C	70	4.37
Forest	D	77	6.79

Average Annual Rainfall Depth (in)	45.98

Table EX 8

Tables EX 9 - 14

MU1 - NPS Nitrogen losses

Land Use	Existing (lbs)
Commercial	399
Commercial	236
Residential 1/2 acre	388
Residential 2 acre	634
Commercial	1269
Water/Wetlands	0
Agricultural	3217
Forest	1164
Forest	752
Total/Scenario	8059

Avg Annual Concentration (ppm)	1.501

MU1 - NPS Lead losses

Land Use	Existing (lbs)
Commercial	3
Commercial	2
Residential 1/2 acre	1
Residential 2 acre	3
Commercial	12
Water/Wetlands	0
Agricultural	1
Forest	8
Forest	5
Total/Scenario	35

Avg Annual Concentration (ppm)	0.006

MU1 - NPS Phosphorous losses

Land Use	Existing (lbs)
Commercial	95
Commercial	56
Residential 1/2 acre	121
Residential 2 acre	198
Commercial	303
Water/Wetlands	0
Agricultural	950
Forest	16
Forest	10
Total/Scenario	1749

Avg Annual Concentration (ppm)	0.325

MU1 - NPS Copper losses

Land Use	Existing (lbs)
Commercial	4
Commercial	2
Residential 1/2 acre	1
Residential 2 acre	3
Commercial	13
Water/Wetlands	0
Agricultural	1
Forest	16
Forest	10
Total/Scenario	50

Avg Annual Concentration (ppm)	0.009

MU1 - NPS Suspended Solids losses

Land Use	Existing (lbs)
Commercial	16565
Commercial	9797
Residential 1/2 acre	8759
Residential 2 acre	14291
Commercial	52574
Water/Wetlands	0
Agricultural	78240
Forest	1663
Forest	1074
Total/Scenario	182963

Avg Annual Concentration (ppm)	34.094

MU1 - NPS Zinc losses

Land Use	Existing (lbs)
Commercial	53
Commercial	31
Residential 1/2 acre	17
Residential 2 acre	27
Commercial	170
Water/Wetlands	0
Agricultural	11
Forest	9
Forest	6
Total/Scenario	324

Avg Annual Concentration (ppm)	0.060

Tables EX 15 - 20

MU1 - NPS Cadmium losses

Land Use	Existing (lbs)
Commercial	0.286
Commercial	0.169
Residential 1/2 acre	0.160
Residential 2 acre	0.261
Commercial	0.909
Water/Wetlands	0
Agricultural	0.731
Forest	1
Forest	1
Total/Scenario	4.516

Avg Annual Concentration (ppm)	0.00084

MU1 - NPS BOD losses

Land Use	Existing (lbs)
Commercial	6865
Commercial	4060
Residential 1/2 acre	5447
Residential 2 acre	8888
Commercial	21787
Water/Wetlands	0
Agricultural	2924
Forest	831
Forest	537
Total/Scenario	51339

Avg Annual Concentration (ppm)	9.566

MU1 - NPS Chromium losses

Land Use	Existing (lbs)
Commercial	2
Commercial	1
Residential 1/2 acre	0.448
Residential 2 acre	0.731
Commercial	9
Water/Wetlands	0
Agricultural	7
Forest	12
Forest	8
Total/Scenario	40.179

Avg Annual Concentration (ppm)	0.007

MU1 - NPS COD losses

Land Use	Existing (lbs)
Commercial	34624
Commercial	20478
Residential 1/2 acre	10574
Residential 2 acre	17254
Commercial	109884
Water/Wetlands	0
Agricultural	0
Forest	0
Forest	0
Total/Scenario	192814

Avg Annual Concentration (ppm)	35.929

MU1 - NPS Nickel losses

Land Use	Existing (lbs)
Commercial	3
Commercial	2
Residential 1/2 acre	2
Residential 2 acre	3
Commercial	11
Water/Wetlands	0
Agricultural	0
Forest	0
Forest	0
Total/Scenario	21

Avg Annual Concentration (ppm)	0.003

MU1 - NPS Oil & Grease losses

Land Use	Existing (lbs)
Commercial	2686
Commercial	1588
Residential 1/2 acre	363
Residential 2 acre	592
Commercial	8525
Water/Wetlands	0
Agricultural	0
Forest	0
Forest	0
Total/Scenario	13754

Avg Annual Concentration (ppm)	2.562

Tables EX 21 – 22

MU1 - NPS Fecal Coliform losses

Land Use	Existing (millions of coliform)
Commercial	9361
Commercial	5536
Residential 1/2 acre	19421
Residential 2 acre	31687
Commercial	29710
Water/Wetlands	0
Agricultural	86417
Forest	1512
Forest	977
Total/Scenario	184621

Avg Annual Concentration (number per 100ml)	748.017

MU1 - NPS Fecal Streps losses

Land Use	Existing (millions of coliform)
Commercial	24421
Commercial	14444
Residential 1/2 acre	54380
Residential 2 acre	88725
Commercial	77504
Water/Wetlands	0
Agricultural	0
Forest	0
Forest	0
Total/Scenario	259474

Avg Annual Concentration (number per 100ml)	1051.294

L-THIA OUTPUT

Scenario Name : MU2-Sandy Creek
Total area : 4473 acres
State : Missouri
County : Jefferson

Average Annual Runoff Volume for Existing			
Land Use	**Hydrologic Soil Group**	**Area (acres)**	**Average Annual Runoff Volume (acre-ft)**
Commercial	C	224	426.87
Residential 1/4 acre	C	109	90.01
Residential 2 acre	C	428	241.20
Commercial	D	224	458.10
Water/Wetlands	B	134	0
Agricultural	C	760	599.89
Forest	D	2594	1461.90
	Total Annual Volume (acre-ft)		3277.99
	Average Annual Runoff Depth (in)		8.79

Average Runoff Depth For Hydrologic Soil Group And Landuse Combination			
Land Use	**Hydrologic Soil Group**	**Curve Number**	**Runoff Depth (in)**
Commercial	C	94	22.96
Residential 1/4 acre	C	83	9.95
Residential 2 acre	C	77	6.79
Commercial	D	95	24.64
Water/Wetlands	B	0	0
Agricultural	C	82	9.51
Forest	D	77	6.79
Average Annual Rainfall Depth (in)			45.98

Table EX 23

MU2 - NPS Nitrogen losses

Land Use	**Existing (lbs)**
Commercial	1558
Residential 1/4 acre	446
Residential 2 acre	1196
Commercial	1672
Water/Wetlands	0
Agricultural	7191
Forest	2788
Total/Scenario	14851

Avg Annual Concentration (ppm)	1.689

MU2 - NPS Phosphorous losses

Land Use	**Existing (lbs)**
Commercial	372
Residential 1/4 acre	139
Residential 2 acre	374
Commercial	399
Water/Wetlands	0
Agricultural	2124
Forest	39
Total/Scenario	3447

Avg Annual Concentration (ppm)	0.392

Tables EX 24 - 25

Tables EX 26 - 31

MU2 - NPS Suspended Solids losses

Land Use	Existing (lbs)
Commercial	64550
Residential 1/4 acre	10055
Residential 2 acre	26945
Commercial	69274
Water/Wetlands	0
Agricultural	174891
Forest	3983
Total/Scenario	349698

Avg Annual Concentration (ppm)	39.791

MU2 - NPS Lead losses

Land Use	Existing (lbs)
Commercial	15
Residential 1/4 acre	2
Residential 2 acre	5
Commercial	16
Water/Wetlands	0
Agricultural	2
Forest	19
Total/Scenario	59

Avg Annual Concentration (ppm)	0.006

MU2 - NPS Copper losses

Land Use	Existing (lbs)
Commercial	16
Residential 1/4 acre	2
Residential 2 acre	5
Commercial	18
Water/Wetlands	0
Agricultural	2
Forest	39
Total/Scenario	82

Avg Annual Concentration (ppm)	0.009

MU2 - NPS Zinc losses

Land Use	Existing (lbs)
Commercial	209
Residential 1/4 acre	19
Residential 2 acre	52
Commercial	224
Water/Wetlands	0
Agricultural	26
Forest	23
Total/Scenario	553

Avg Annual Concentration (ppm)	0.062

MU2 - NPS Cadmium losses

Land Use	Existing (lbs)
Commercial	1
Residential 1/4 acre	0.183
Residential 2 acre	0.492
Commercial	1
Water/Wetlands	0
Agricultural	1
Forest	3
Total/Scenario	6.675

Avg Annual Concentration (ppm)	0.00075

MU2 - NPS Chromium losses

Land Use	Existing (lbs)
Commercial	11
Residential 1/4 acre	0.515
Residential 2 acre	1
Commercial	12
Water/Wetlands	0
Agricultural	16
Forest	29
Total/Scenario	69.515

Avg Annual Concentration (ppm)	0.007

Tables EX 32 - 37

MU2 - NPS Nickel losses

Land Use	Existing (lbs)
Commercial	13
Residential 1/4 acre	2
Residential 2 acre	6
Commercial	14
Water/Wetlands	0
Agricultural	0
Forest	0
Total/Scenario	35

Avg Annual Concentration (ppm)	0.003

MU2 - NPS Oil & Grease losses

Land Use	Existing (lbs)
Commercial	10467
Residential 1/4 acre	416
Residential 2 acre	1117
Commercial	11233
Water/Wetlands	0
Agricultural	0
Forest	0
Total/Scenario	23233

Avg Annual Concentration (ppm)	2.643

MU2 - NPS BOD losses

Land Use	Existing (lbs)
Commercial	26750
Residential 1/4 acre	6254
Residential 2 acre	16758
Commercial	28708
Water/Wetlands	0
Agricultural	6537
Forest	1991
Total/Scenario	86998

Avg Annual Concentration (ppm)	9.899

MU2 - NPS COD losses

Land Use	Existing (lbs)
Commercial	134917
Residential 1/4 acre	12140
Residential 2 acre	32531
Commercial	144789
Water/Wetlands	0
Agricultural	0
Forest	0
Total/Scenario	324377

Avg Annual Concentration (ppm)	36.910

MU2 - NPS Fecal Coliform losses

Land Use	Existing (millions of coliform)
Commercial	36478
Residential 1/4 acre	22297
Residential 2 acre	59746
Commercial	39147
Water/Wetlands	0
Agricultural	193167
Forest	3621
Total/Scenario	354456

Avg Annual Concentration (number per 100ml)	876.951

MU2 - NPS Fecal Streps losses

Land Use	Existing (millions of coliform)
Commercial	95161
Residential 1/4 acre	62431
Residential 2 acre	167289
Commercial	102124
Water/Wetlands	0
Agricultural	0
Forest	0
Total/Scenario	427005

Avg Annual Concentration (number per 100ml)	1056.443

L-THIA OUTPUT

Scenario Name : MU3-Sandy Creek
Total area : 3163 acres
State : Missouri
County : Jefferson

Average Annual Runoff Volume for Existing			
Land Use	**Hydrologic Soil Group**	**Area (acres)**	**Average Annual Runoff Volume (acre-ft)**
Commercial	C	32	60.98
Residential 2 acre	C	348	196.12
Commercial	D	32	65.44
Water/Wetlands	B	63	0
Agricultural	B	400	199.53
Agricultural	C	1086	857.21
Forest	C	958	347.47
Forest	D	244	137.51
	Total Annual Volume (acre-ft)	1864.27	
	Average Annual Runoff Depth (in)	7.07	

Average Runoff Depth For Hydrologic Soil Group And Landuse Combination			
Land Use	**Hydrologic Soil Group**	**Curve Number**	**Runoff Depth (in)**
Commercial	C	94	22.96
Residential 2 acre	C	77	6.79
Commercial	D	95	24.64
Water/Wetlands	B	0	0
Agricultural	B	75	6.01
Agricultural	C	82	9.51
Forest	C	70	4.37
Forest	D	77	6.79

Average Annual Rainfall Depth (in)	45.98

MU3 –NPS Nitrogen Losses	
Land Use	**Existing (lbs)**
Commercial	222
Residential 2 acre	972
Commercial	238
Water/Wetlands	0
Agricultural	2392
Agricultural	10276
Forest	662
Forest	262
Total/Scenario	15024
Avg Annual Concentration (ppm)	3.005

MU3 - NPS Phosphorous Losses	
Land Use	**Existing (lbs)**
Commercial	53
Residential 2 acre	304
Commercial	57
Water/Wetlands	0
Agricultural	706
Agricultural	3036
Forest	9
Forest	3
Total/Scenario	4168
Avg Annual Concentration (ppm)	0.833

Tables EX 38 - 40

MU3 - NPS Suspended Solids Losses	
Land Use	**Existing (lbs)**
Commercial	9221
Residential 2 acre	21908
Commercial	9896
Water/Wetlands	0
Agricultural	58171
Agricultural	249910
Forest	946
Forest	374
Total/Scenario	350426
Avg Annual Concentration (ppm)	70.112

MU3 - NPS Zinc Losses	
Land Use	**Existing (lbs)**
Commercial	29
Residential 2 acre	42
Commercial	32
Water/Wetlands	0
Agricultural	8
Agricultural	37
Forest	5
Forest	2
Total/Scenario	155
Avg Annual Concentration (ppm)	0.031

MU3 - NPS Lead Losses	
Land Use	**Existing (lbs)**
Commercial	2
Residential 2 acre	4
Commercial	2
Water/Wetlands	0
Agricultural	0.815
Agricultural	3
Forest	4
Forest	1
Total/Scenario	16.815
Avg Annual Concentration (ppm)	0.003

MU3 - NPS Cadmium losses	
Land Use	**Existing (lbs)**
Commercial	0.159
Residential 2 acre	0.400
Commercial	0.171
Water/Wetlands	0
Agricultural	0.543
Agricultural	2
Forest	0.946
Forest	0.374
Total/Scenario	4.593
Avg Annual Concentration (ppm)	0.00091

MU3 - NPS Copper losses	
Land Use	**Existing (lbs)**
Commercial	2
Residential 2 acre	4
Commercial	2
Water/Wetlands	0
Agricultural	0.815
Agricultural	3
Forest	9
Forest	3
Total/Scenario	23.815
Avg Annual Concentration (ppm)	0.004

MU3 - NPS Chromium losses	
Land Use	**Existing (lbs)**
Commercial	1
Residential 2 acre	1
Commercial	1
Water/Wetlands	0
Agricultural	5
Agricultural	23
Forest	7
Forest	2
Total/Scenario	40
Avg Annual Concentration (ppm)	0.008

MU3 - NPS Nickel losses	
Land Use	**Existing (lbs)**
Commercial	1
Residential 2 acre	5
Commercial	2
Water/Wetlands	0
Agricultural	0
Agricultural	0
Forest	0
Forest	0
Total/Scenario	8
Avg Annual Concentration (ppm)	0.001

MU3 - NPS Oil & Grease losses	
Land Use	**Existing (lbs)**
Commercial	1495
Residential 2 acre	908
Commercial	1604
Water/Wetlands	0
Agricultural	0
Agricultural	0
Forest	0
Forest	0
Total/Scenario	4007
Avg Annual Concentration (ppm)	0.801

MU3 - NPS BOD losses	
Land Use	**Existing (lbs)**
Commercial	3821
Residential 2 acre	13626
Commercial	4101
Water/Wetlands	0
Agricultural	2174
Agricultural	9342
Forest	473
Forest	187
Total/Scenario	33724
Avg Annual Concentration (ppm)	6.747

MU3 - NPS Fecal Coliform losses	
Land Use	**Existing (millions of coliform)**
Commercial	5211
Residential 2 acre	48578
Commercial	5592
Water/Wetlands	0
Agricultural	64250
Agricultural	276026
Forest	860
Forest	340
Total/Scenario	400857
Avg Annual Concentration (# per 100ml)	1743.819

MU3 - NPS COD losses	
Land Use	**Existing (lbs)**
Commercial	19273
Residential 2 acre	26451
Commercial	20684
Water/Wetlands	0
Agricultural	0
Agricultural	0
Forest	0
Forest	0
Total/Scenario	66408
Avg Annual Concentration (ppm)	13.286

MU3 - NPS Fecal Streps losses	
Land Use	**Existing (millions of coliform)**
Commercial	13594
Residential 2 acre	136020
Commercial	14589
Water/Wetlands	0
Agricultural	0
Agricultural	0
Forest	0
Forest	0
Total/Scenario	164203
Avg Annual Concentration (# per 100 ml)	714.320

L-THIA OUTPUT

Scenario Name : MU4-Sandy Creek
Total area : 3073 acres
State : Missouri
County : Jefferson

Average Annual Runoff Volume for Existing			
Land Use	**Hydrologic Soil Group**	**Area (acres)**	**Average Annual Runoff Volume (acre-ft)**
Commercial	C	307	585.04
Residential 1/2 acre	C	133	92.28
Residential 2 acre	C	174	98.06
Commercial	D	31	63.39
Parking/Paved Spaces	B	31	88.15
Agricultural	B	218	108.74
Agricultural	C	1165	919.56
Forest	D	1014	571.45
	Total Annual Volume (acre-ft)		2526.71
	Average Annual Runoff Depth (in)		9.86

Average Runoff Depth For Hydrologic Soil Group And Landuse Combination			
Land Use	**Hydrologic Soil Group**	**Curve Number**	**Runoff Depth (in)**
Commercial	C	94	22.96
Residential 1/2 acre	C	80	8.36
Residential 2 acre	C	77	6.79
Commercial	D	95	24.64
Parking/Paved Spaces	B	98	34.26
Agricultural	B	75	6.01
Agricultural	C	82	9.51
Forest	D	77	6.79
Average Annual Rainfall Depth (in)			45.98

MU4 - NPS Nitrogen losses

Land Use	Existing (lbs)
Commercial	2136
Residential 1/2 acre	457
Residential 2 acre	486
Commercial	231
Parking/Paved Spaces	1056
Agricultural	1303
Agricultural	1753
Total/Scenario	7422

Avg Annual Concentration (ppm)	1.095

MU4 - NPS Phosphorous losses

Land Use	Existing (lbs)
Commercial	510
Residential 1/2 acre	143
Residential 2 acre	152
Commercial	55
Parking/Paved Spaces	312
Agricultural	385
Agricultural	25
Total/Scenario	1582

Avg Annual Concentration (ppm)	0.233

Tables EX 53 - 55

Tables EX 56 - 61

MU4 - NPS Suspended Solids losses

Land Use	Existing (lbs)
Commercial	88469
Residential 1/2 acre	10309
Residential 2 acre	10954
Commercial	9587
Parking/Paved Spaces	25699
Agricultural	31703
Agricultural	2505
Total/Scenario	179226

Avg Annual Concentration (ppm)	26.457

MU4 - NPS Zinc losses

Land Use	Existing (lbs)
Commercial	286
Residential 1/2 acre	20
Residential 2 acre	21
Commercial	31
Parking/Paved Spaces	3
Agricultural	4
Agricultural	15
Total/Scenario	380

Avg Annual Concentration (ppm)	0.056

MU4 - NPS Lead losses

Land Use	Existing (lbs)
Commercial	20
Residential 1/2 acre	2
Residential 2 acre	2
Commercial	2
Parking/Paved Spaces	0.360
Agricultural	0.444
Agricultural	12
Total/Scenario	38.804

Avg Annual Concentration (ppm)	0.005

MU4 - NPS Cadmium losses

Land Use	Existing (lbs)
Commercial	1
Residential 1/2 acre	0.188
Residential 2 acre	0.200
Commercial	0.165
Parking/Paved Spaces	0.240
Agricultural	0.296
Agricultural	2
Total/Scenario	4.089

Avg Annual Concentration (ppm)	0.00060

MU4 - NPS Copper losses

Land Use	Existing (lbs)
Commercial	23
Residential 1/2 acre	2
Residential 2 acre	2
Commercial	2
Parking/Paved Spaces	0.360
Agricultural	0.444
Agricultural	25
Total/Scenario	54.804

Avg Annual Concentration (ppm)	0.008

MU4 - NPS Chromium losses

Land Use	Existing (lbs)
Commercial	15
Residential 1/2 acre	0.528
Residential 2 acre	0.561
Commercial	1
Parking/Paved Spaces	2
Agricultural	2
Agricultural	18
Total/Scenario	39.089

Avg Annual Concentration (ppm)	0.005

Tables EX 62 - 67

MU4 - NPS Nickel losses

Land Use	Existing (lbs)
Commercial	18
Residential 1/2 acre	2
Residential 2 acre	2
Commercial	2
Parking/Paved Spaces	0
Agricultural	0
Agricultural	0
Total/Scenario	24

Avg Annual Concentration (ppm)	0.003

MU4 - NPS Oil & Grease losses

Land Use	Existing (lbs)
Commercial	14346
Residential 1/2 acre	427
Residential 2 acre	454
Commercial	1554
Parking/Paved Spaces	0
Agricultural	0
Agricultural	0
Total/Scenario	16781

Avg Annual Concentration (ppm)	2.477

MU4 - NPS BOD losses

Land Use	Existing (lbs)
Commercial	36662
Residential 1/2 acre	6411
Residential 2 acre	6813
Commercial	3973
Parking/Paved Spaces	960
Agricultural	1185
Agricultural	1252
Total/Scenario	57256

Avg Annual Concentration (ppm)	8.452

MU4 - NPS Fecal Coliform losses

Land Use	Existing (millions of coliform)
Commercial	49994
Residential 1/2 acre	22858
Residential 2 acre	24289
Commercial	5417
Parking/Paved Spaces	28385
Agricultural	35016
Agricultural	2277
Total/Scenario	168236

Avg Annual Concentration (number per 100ml)	539.988

MU4 - NPS COD losses

Land Use	Existing (lbs)
Commercial	184908
Residential 1/2 acre	12446
Residential 2 acre	13225
Commercial	20037
Parking/Paved Spaces	0
Agricultural	0
Agricultural	0
Total/Scenario	230616

Avg Annual Concentration (ppm)	34.044

MU4 - NPS Fecal Streps losses

Land Use	Existing (millions of coliform)
Commercial	130421
Residential 1/2 acre	64004
Residential 2 acre	68010
Commercial	14133
Parking/Paved Spaces	0
Agricultural	0
Agricultural	0
Total/Scenario	276568

Avg Annual Concentration (number per 100ml)	887.702

L-THIA OUTPUT

Scenario Name : MU5-Sandy Creek
Total area : 1660 acres
State : Missouri
County : Jefferson

Average Annual Runoff Volume for Existing			
Land Use	**Hydrologic Soil Group**	**Area (acres)**	**Average Annual Runoff Volume (acre-ft)**
Residential 1/2 acre	C	166	115.18
Commercial	D	17	34.76
Water/Wetlands	B	83	0
Agricultural	B	157	78.31
Agricultural	C	523	412.81
Forest	C	538	195.13
Forest	D	176	99.18
		Total Annual Volume (acre-ft)	935.41
		Average Annual Runoff Depth (in)	6.76

Average Runoff Depth For Hydrologic Soil Group And Landuse Combination			
Land Use	**Hydrologic Soil Group**	**Curve Number**	**Runoff Depth (in)**
Residential 1/2 acre	C	80	8.36
Commercial	C	94	24.64
Water/Wetlands	B	0	0
Agricultural	B	75	6.01
Agricultural	C	82	9.51
Forest	C	70	4.37
Forest	D	77	6.79
Average Annual Rainfall Depth (in)			45.98

MU5 - NPS Nitrogen losses

Land Use	**Existing (lbs)**
Residential 1/2 acre	571
Commercial	126
Water/Wetlands	0
Agricultural	938
Agricultural	4949
Forest	372
Forest	189
Total/Scenario	7137

Avg Annual Concentration (ppm)	2.849

MU5 - NPS Phosphorous losses

Land Use	**Existing (lbs)**
Residential 1/2 acre	178
Commercial	30
Water/Wetlands	0
Agricultural	277
Agricultural	1462
Forest	5
Forest	2
Total/Scenario	1952

Avg Annual Concentration (ppm)	0.779

MU5 - NPS Suspended Solids losses

Land Use	Existing (lbs)
Residential 1/2 acre	12867
Commercial	5257
Water/Wetlands	0
Agricultural	22832
Agricultural	120352
Forest	531
Forest	270
Total/Scenario	161750

Avg Annual Concentration (ppm)	64.641

MU5 - NPS Zinc losses

Land Use	Existing (lbs)
Residential 1/2 acre	25
Commercial	17
Water/Wetlands	0
Agricultural	3
Agricultural	17
Forest	3
Forest	1
Total/Scenario	64

Avg Annual Concentration (ppm)	0.026

MU5 - NPS Lead losses

Land Use	Existing (lbs)
Residential 1/2 acre	2
Commercial	1
Water/Wetlands	0
Agricultural	0.320
Agricultural	1
Forest	2
Forest	1
Total/Scenario	732

Avg Annual Concentration (ppm)	0.002

MU5 - NPS Cadmium losses

Land Use	Existing (lbs)
Residential 1/2 acre	0.235
Commercial	0.090
Water/Wetlands	0
Agricultural	0.213
Agricultural	1
Forest	0.531
Forest	0.270
Total/Scenario	2.333

Avg Annual Concentration (ppm)	0.00093

MU5 - NPS Copper losses

Land Use	Existing (lbs)
Residential 1/2 acre	2
Commercial	1
Water/Wetlands	0
Agricultural	0.320
Agricultural	1
Forest	5
Forest	2
Total/Scenario	11.32

Avg Annual Concentration (ppm)	0.004

MU5 - NPS Chromium losses

Land Use	Existing (lbs)
Residential 1/2 acre	0.659
Commercial	0.947
Water/Wetlands	0
Agricultural	2
Agricultural	11
Forest	3
Forest	2
Total/Scenario	19.541

Avg Annual Concentration (ppm)	0.007

MU5 - NPS Nickel losses

Land Use	Existing (lbs)
Residential 1/2 acre	3
Commercial	1
Water/Wetlands	0
Agricultural	0
Agricultural	0
Forest	0
Forest	0
Total/Scenario	4

Avg Annual Concentration (ppm)	0.001

MU5 - NPS Oil & Grease losses

Land Use	Existing (lbs)
Residential 1/2 acre	533
Commercial	852
Water/Wetlands	0
Agricultural	0
Agricultural	0
Forest	0
Forest	0
Total/Scenario	1327

Avg Annual Concentration (ppm)	0.552

MU5 - NPS BOD losses

Land Use	Existing (lbs)
Residential 1/2 acre	8002
Commercial	2178
Water/Wetlands	0
Agricultural	853
Agricultural	4499
Forest	265
Forest	135
Total/Scenario	15784

Avg Annual Concentration (ppm)	6.352

MU5 - NPS Fecal Coliform losses

Land Use	Existing (millions of coliform)
Residential 1/2 acre	28530
Commercial	291
Water/Wetlands	0
Agricultural	25218
Agricultural	132929
Forest	483
Forest	245
Total/Scenario	190173

Avg Annual Concentration (number per 100ml)	1650.558

MU5 - NPS COD losses

Land Use	Existing (lbs)
Residential 1/2 acre	15534
Commercial	10988
Water/Wetlands	0
Agricultural	0
Agricultural	0
Forest	0
Forest	0
Total/Scenario	25773

Avg Annual Concentration (ppm)	10.575

MU5 - NPS Fecal Streps losses

Land Use	Existing (millions of coliform)
Residential 2 acre	64883
Commercial	7750
Water/Wetlands	0
Agricultural	0
Agricultural	0
Forest	0
Forest	0
Total/Scenario	72105

Avg Annual Concentration (number per 100ml)	759.795

L-THIA OUTPUT

Scenario Name : MU6-Sandy Creek
Total area : 2162 acres
State : Missouri
County : Jefferson

Tables EX 83 - 85

Average Annual Runoff Volume for Existing			
Land Use	**Hydrologic Soil Group**	**Area (acres)**	**Average Annual Runoff Volume (acre-ft)**
Residential 2 acre	C	216	121.73
Commercial	D	22	44.99
Water/Wetlands	B	22	0
Agricultural	B	308	153.63
Agricultural	C	16	12.62
Forest	C	211	76.53
Forest	D	1367	770.40
	Total Annual Volume (acre-ft)		1179.92
	Average Annual Runoff Depth (in)		6.54

Average Runoff Depth For Hydrologic Soil Group And Landuse Combination			
Land Use	**Hydrologic Soil Group**	**Curve Number**	**Runoff Depth (in)**
Residential 2 acre	C	77	6.79
Commercial	D	95	24.64
Water/Wetlands	B	0	0
Agricultural	B	75	6.01
Agricultural	C	82	9.51
Forest	C	70	4.37
Forest	D	77	6.79

Average Annual Rainfall Depth (in)	45.98

MU6 - NPS Nitrogen losses

Land Use	**Existing (lbs)**
Residential 2 acre	603
Commercial	164
Water/Wetlands	0
Agricultural	1841
Agricultural	151
Forest	145
Forest	1469
Total/Scenario	4373

Avg Annual Concentration (ppm)	1.382

MU6-NPs Phosphorous losses

Land Use	**Existing (lbs)**
Residential 2 acre	189
Commercial	39
Water/Wetlands	0
Agricultural	544
Agricultural	44
Forest	2
Forest	20
Total/Scenario	838

Avg Annual Concentration (ppm)	0.264

Tables EX 86 - 91

MU6 - NPS Suspended Solids losses

Land Use	Existing (lbs)
Residential 2 acre	13598
Commercial	6803
Water/Wetlands	0
Agricultural	44791
Agricultural	3681
Forest	208
Forest	2099
Total/Scenario	71180

Avg Annual Concentration (ppm)	22.501

MU6-NPS Zinc losses

Land Use	Existing (lbs)
Residential 2 acre	26
Commercial	22
Water/Wetlands	0
Agricultural	6
Agricultural	0.550
Forest	1
Forest	12
Total/Scenario	67.55

Avg Annual Concentration (ppm)	0.021

MU6 - NPS Lead losses

Land Use	Existing (lbs)
Residential 2 acre	2
Commercial	1
Water/Wetlands	0
Agricultural	0.627
Agricultural	0.051
Forest	1
Forest	10
Total/Scenario	14.678

Avg Annual Concentration (ppm)	0.004

MU6 - NPS Cadmium losses

Land Use	Existing (lbs)
Residential 2 acre	0.248
Commercial	0.117
Water/Wetlands	0
Agricultural	0.418
Agricultural	0.034
Forest	0.208
Forest	2
Total/Scenario	3.025

Avg Annual Concentration (ppm)	0.00095

MU6 - NPS Copper losses

Land Use	Existing (lbs)
Residential 2 acre	2
Commercial	1
Water/Wetlands	0
Agricultural	0.627
Agricultural	0.051
Forest	2
Forest	20
Total/Scenario	25.678

Avg Annual Concentration (ppm)	0.008

MU6 - NPS Chromium losses

Land Use	Existing (lbs)
Residential 2 acre	0.696
Commercial	1
Water/Wetlands	0
Agricultural	4
Agricultural	0.344
Forest	1
Forest	15
Total/Scenario	22.04

Avg Annual Concentration (ppm)	0.006

Tables EX 92 - 97

MU6 - NPS Nickel losses

Land Use	Existing (lbs)
Residential 2 acre	3
Commercial	1
Water/Wetlands	0
Agricultural	0
Agricultural	0
Forest	0
Forest	0
Total/Scenario	4

Avg Annual Concentration (ppm)	0.001

MU6 - NPS Oil & Grease losses

Land Use	Existing (lbs)
Residential 2 acre	563
Commercial	1103
Water/Wetlands	0
Agricultural	0
Agricultural	0
Forest	0
Forest	0
Total/Scenario	1666

Avg Annual Concentration (ppm)	0.526

MU6 - NPS BOD losses

Land Use	Existing (lbs)
Residential 2 acre	8457
Commercial	2819
Water/Wetlands	0
Agricultural	1674
Agricultural	137
Forest	104
Forest	1049
Total/Scenario	14240

Avg Annual Concentration (ppm)	4.501

MU6 - NPS Fecal Coliform losses

Land Use	Existing (millions of coliform)
Residential 2 acre	30152
Commercial	3844
Water/Wetlands	0
Agricultural	49472
Agricultural	4066
Forest	189
Forest	1908
Total/Scenario	89631

Avg Annual Concentration (number per 100ml)	616.064

MU6 - NPS COD losses

Land Use	Existing (lbs)
Residential 2 acre	16417
Commercial	14220
Water/Wetlands	0
Agricultural	0
Agricultural	0
Forest	0
Forest	0
Total/Scenario	30637

Avg Annual Concentration (ppm)	9.685

MU6 - NPS Fecal Streps losses

Land Use	Existing (millions of coliform)
Residential 2 acre	84426
Commercial	10030
Water/Wetlands	0
Agricultural	0
Agricultural	0
Forest	0
Forest	0
Total/Scenario	94456

Avg Annual Concentration (number per 100ml)	649.228

Tables EX 98 - 100

L-THIA OUTPUT
Scenario Name : MU7-Sandy Creek
Total area : 3333 acres
State : Missouri
County : Jefferson

Average Annual Runoff Volume for Existing			
Land Use	**Hydrologic Soil Group**	**Area (acres)**	**Average Annual Runoff Volume (acre-ft)**
Commercial	C	167	318.24
Residential 1/4 acre	C	50	41.29
Residential 2 acre	C	283	159.49
Paved/Commercial	D	33	67.48
Water/Wetlands	B	233	0
Agricultural	B	767	382.60
Forest	C	899	326.07
Forest	D	901	507.77
	Total Annual Volume (acre-ft)		1802.97
	Average Annual Runoff Depth (in)		6.49

Average Runoff Depth For Hydrologic Soil Group And Landuse Combination			
Land Use	**Hydrologic Soil Group**	**Curve Number**	**Runoff Depth (in)**
Commercial	C	94	22.96
Residential 1/4 acre	C	83	9.95
Residential 2 acre	C	77	6.79
Paved/Commercial	D	95	24.64
Water/Wetlands	B	0	0
Agricultural	B	75	6.01
Forest	C	70	4.37
Forest	D	77	6.79

MU7 - NPS Nitrogen losses

Land Use	**Existing (lbs)**
Commercial	1161
Residential 1/4 acre	204
Residential 2 acre	790
Commercial	246
Water/Wetlands	0
Agricultural	4586
Forest	621
Forest	968
Total/Scenario	8576
Avg Annual Concentration (ppm)	1.774

MU7 - NPS Phosphorous losses

Land Use	**Existing (lbs)**
Commercial	277
Residential 1/4 acre	64
Residential 2 acre	247
Commercial	58
Water/Wetlands	0
Agricultural	1355
Forest	8
Forest	13
Total/Scenario	2022
Avg Annual Concentration (ppm)	0.418

MU7 - NPS Suspended Solids losses

Land Use	Existing (lbs)
Commercial	48125
Residential 1/4 acre	4612
Residential 2 acre	17816
Commercial	10205
Water/Wetlands	0
Agricultural	111543
Forest	888
Forest	1383
Total/Scenario	194572
Avg Annual Concentration (ppm)	40.253

MU7 - NPS Zinc losses

Land Use	Existing (lbs)
Commercial	156
Residential 1/4 acre	9
Residential 2 acre	34
Commercial	33
Water/Wetlands	0
Agricultural	16
Forest	5
Forest	8
Total/Scenario	261
Avg Annual Concentration (ppm)	0.053

MU7 - NPS Lead losses

Land Use	Existing (lbs)
Commercial	11
Residential 1/4 acre	1
Residential 2 acre	3
Commercial	2
Water/Wetlands	0
Agricultural	1
Forest	4
Forest	6
Total/Scenario	28
Avg Annual Concentration (ppm)	0.005

MU7 - NPS Cadmium losses

Land Use	Existing (lbs)
Commercial	0.832
Residential 1/4 acre	0.084
Residential 2 acre	0.325
Commercial	0.176
Water/Wetlands	0
Agricultural	1
Forest	0.888
Forest	1
Total/Scenario	4.305
Avg Annual Concentration (ppm)	0.00089

MU7 - NPS Copper losses

Land Use	Existing (lbs)
Commercial	12
Residential 1/4 acre	1
Residential 2 acre	3
Commercial	2
Water/Wetlands	0
Agricultural	1
Forest	8
Forest	13
Total/Scenario	40
Avg Annual Concentration (ppm)	0.008

MU7 - NPS Chromium losses

Land Use	Existing (lbs)
Commercial	8
Residential 1/4 acre	0.236
Residential 2 acre	0.912
Commercial	1
Water/Wetlands	0
Agricultural	10
Forest	6
Forest	10
Total/Scenario	36.148
Avg Annual Concentration (ppm)	0.007

Tables EX 107 - 112

MU7 - NPS Nickel losses

Land Use	Existing (lbs)
Commercial	10
Residential 1/4 acre	1
Residential 2 acre	4
Commercial	2
Water/Wetlands	0
Agricultural	0
Forest	0
Forest	0
Total/Scenario	17
Avg Annual Concentration (ppm)	0.003

MU7 - NPS BOD losses

Land Use	Existing (lbs)
Commercial	19943
Residential 1/4 acre	2868
Residential 2 acre	11081
Commercial	4229
Water/Wetlands	0
Agricultural	4169
Forest	444
Forest	691
Avg Annual Concentration (ppm)	8.983

MU7 - NPS COD losses

Land Use	Existing (lbs)
Commercial	100585
Residential 1/4 acre	5569
Residential 2 acre	21510
Commercial	21330
Water/Wetlands	0
Agricultural	0
Forest	0
Forest	0
Total/Scenario	148994
Avg Annual Concentration (ppm)	30.824

MU7 - NPS Oil & Grease losses

Land Use	Existing (lbs)
Commercial	7804
Residential 1/4 acre	191
Residential 2 acre	738
Commercial	1654
Water/Wetlands	0
Agricultural	0
Forest	0
Forest	0
Total/Scenario	10387
Avg Annual Concentration (ppm)	2.148

MU7 - NPS Fecal Coliform losses

Land Use	Existing (millions of coliform)
Commercial	27195
Residential 1/4 acre	10227
Residential 2 acre	39505
Commercial	5767
Water/Wetlands	0
Agricultural	123199
Forest	807
Forest	1257
Total/Scenario	207957
Avg Annual Concentration (number per 100ml)	935.418

MU7 - NPS Fecal Streps losses

Land Use	Existing (millions of coliform)
Commercial	70945
Residential 1/4 acre	28638
Residential 2 acre	110614
Commercial	15045
Water/Wetlands	0
Agricultural	0
Forest	0
Forest	0
Total/Scenario	225242
Avg Annual Concentration (number per 100ml)	1013.168

L-THIA OUTPUT

Tables EX 113 - 115

Scenario Name : MU8-Sandy Creek
Total area : 7597 acres
State : Missouri
County : Jefferson

Average Annual Runoff Volume for Existing

Land Use	Hydrologic Soil Group	Area (acres)	Average Annual Runoff Volume (acre-ft)
Commercial	B	1000	1611.03
Commercial	C	520	990.95
Residential 1/8 acre	B	1503	1419.64
Residential 1/8 acre	C	497	684.76
Residential 1/2 acre	C	279	193.59
Commercial	D	760	1554.29
Water/Wetlands	B	532	0
Forest	C	2506	908.95
	Total Annual Volume (acre-ft)		7363.22
	Average Annual Runoff Depth (in)		11.63

Average Runoff Depth For Hydrologic Soil Group And Landuse Combination

Land Use	Hydrologic Soil Group	Curve Number	Runoff Depth (in)
Commercial	B	92	19.41
Commercial	C	94	22.96
Residential 1/8 acre	B	85	11.38
Residential 1/8 acre	C	90	16.6
Residential 1/2 acre	C	80	8.36
Commercial	D	95	24.64
Water/Wetlands	B	0	0
Forest	C	70	4.37
Average Annual Rainfall Depth (in)			45.98

MU8 - NPS Nitrogen losses

Land Use	Existing (lbs)
Commercial	5881
Commercial	3618
Residential 1/8 acre	7039
Residential 1/8 acre	3395
Residential 1/2 acre	960
Commercial	5674
Water/Wetlands	0
Forest	1733
Total/Scenario	28300

Avg Annual Concentration (ppm)	1.433

MU8 - NPS Phosphorous losses

Land Use	Existing (lbs)
Commercial	1404
Commercial	864
Residential 1/8 acre	2204
Residential 1/8 acre	1063
Residential 1/2 acre	300
Commercial	1355
Water/Wetlands	0
Forest	24
Total/Scenario	7214

Avg Annual Concentration (ppm)	0.365

MU8 - NPS Suspended Solids losses

Land Use	Existing (lbs)
Commercial	243617
Commercial	149850
Residential 1/8 acre	158589
Residential 1/8 acre	76495
Residential 1/2 acre	21626
Commercial	235037
Water/Wetlands	0
Forest	2476
Total/Scenario	887690

Avg Annual Concentration (ppm)	44.967

MU8 - NPS Zinc losses

Land Use	Existing (lbs)
Commercial	790
Commercial	486
Residential 1/8 acre	309
Residential 1/8 acre	149
Residential 1/2 acre	42
Commercial	762
Water/Wetlands	0
Forest	14
Total/Scenario	2552

Avg Annual Concentration (ppm)	0.129

MU8 - NPS Lead losses

Land Use	Existing (lbs)
Commercial	57
Commercial	35
Residential 1/8 acre	34
Residential 1/8 acre	16
Residential 1/2 acre	4
Commercial	55
Water/Wetlands	0
Forest	12
Total/Scenario	213

Avg Annual Concentration (ppm)	0.010

MU8 - NPS Cadmium losses

Land Use	Existing (lbs)
Commercial	4
Commercial	2
Residential 1/8 acre	2
Residential 1/8 acre	1
Residential 1/2 acre	0.395
Commercial	4
Water/Wetlands	0
Forest	2
Total/Scenario	15.395

Avg Annual Concentration (ppm)	0.00077

MU8 - NPS Copper losses

Land Use	Existing (lbs)
Commercial	63
Commercial	39
Residential 1/8 acre	34
Residential 1/8 acre	16
Residential 1/2 acre	4
Commercial	61
Water/Wetlands	0
Forest	24
Total/Scenario	241

Avg Annual Concentration (ppm)	0.012

MU8 - NPS Chromium losses

Land Use	Existing (lbs)
Commercial	43
Commercial	27
Residential 1/8 acre	8
Residential 1/8 acre	3
Residential 1/2 acre	1
Commercial	42
Water/Wetlands	0
Forest	18
Total/Scenario	142

Avg Annual Concentration (ppm)	0.007

MU8 - NPS Nickel losses

Land Use	Existing (lbs)
Commercial	51
Commercial	31
Residential 1/8 acre	38
Residential 1/8 acre	18
Residential 1/2 acre	5
Commercial	49
Water/Wetlands	0
Forest	0
Total/Scenario	192

Avg Annual Concentration (ppm)	0.009

MU8 - NPS Oil & Grease losses

Land Use	Existing (lbs)
Commercial	39505
Commercial	24300
Residential 1/8 acre	6575
Residential 1/8 acre	3171
Residential 1/2 acre	896
Commercial	38114
Water/Wetlands	0
Forest	0
Total/Scenario	112561

Avg Annual Concentration (ppm)	5.702

MU8 - NPS BOD losses

Land Use	Existing (lbs)
Commercial	100958
Commercial	62100
Residential 1/8 acre	98634
Residential 1/8 acre	47576
Residential 1/2 acre	13450
Commercial	97402
Water/Wetlands	0
Forest	1238
Total/Scenario	421358

Avg Annual Concentration (ppm)	21.344

MU8 - NPS Fecal Coliform losses

Land Use	Existing (millions of coliform)
Commercial	137670
Commercial	84682
Residential 1/8 acre	351639
Residential 1/8 acre	169613
Residential 1/2 acre	47952
Commercial	132822
Water/Wetlands	0
Forest	2251
Total/Scenario	926629

Avg Annual Concentration (number per 100ml)	1020.607

MU8 - NPS COD losses

Land Use	Existing (lbs)
Commercial	509182
Commercial	313200
Residential 1/8 acre	191467
Residential 1/8 acre	92354
Residential 1/2 acre	26109
Commercial	491249
Water/Wetlands	0
Forest	0
Total/Scenario	1623561

Avg Annual Concentration (ppm)	82.245

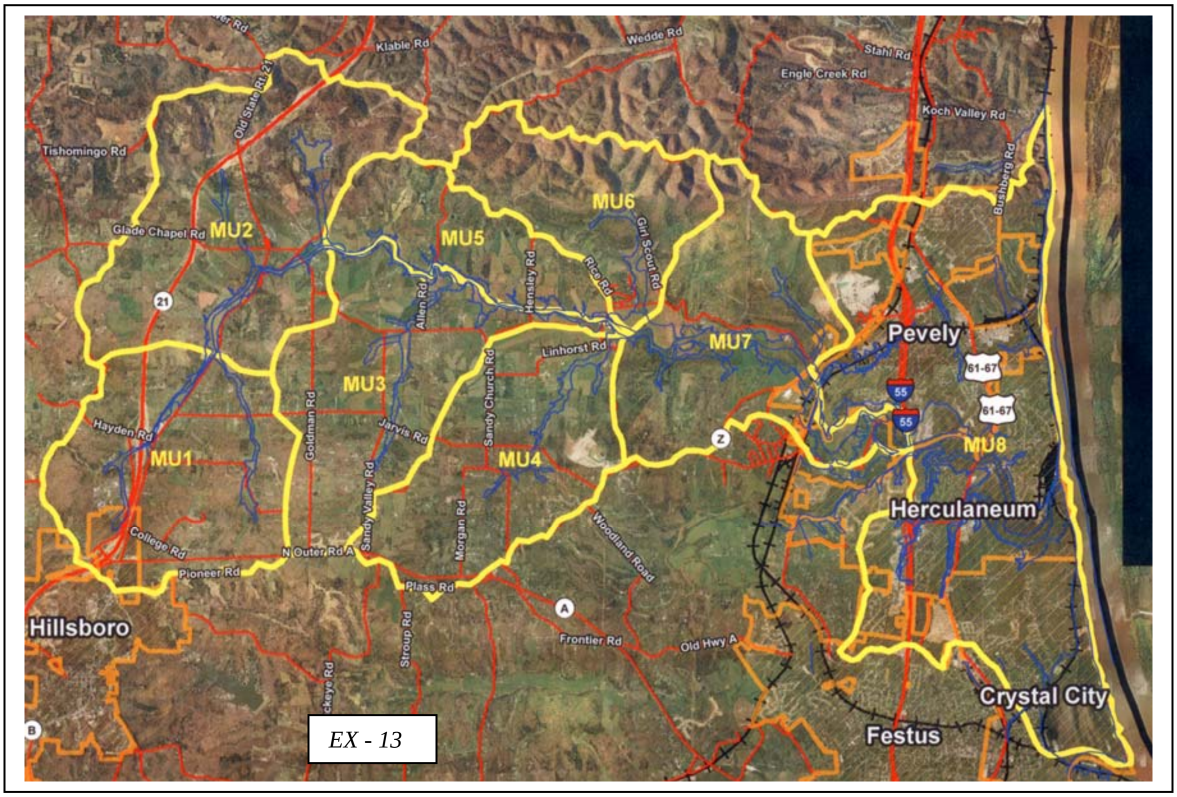
MU8 - NPS Fecal Streps losses

Land Use	Existing (millions of coliform)
Commercial	359140
Commercial	220909
Residential 1/8 acre	984591
Residential 1/8 acre	474918
Residential 1/2 acre	134265
Commercial	346492
Water/Wetlands	0
Forest	0
Total/Scenario	2520315

Avg Annual Concentration (number per 100ml)	2775.926

Exhibit G - Sandy Creek Floodplain

The floodplain within the Sandy Creek watershed is reflected on the FEMA Flood Insurance Rate Maps (FIRM) dated April 5, 2006. This 2006 version of the maps is in digital format (DFIRM) and available for detailed viewing on the FEMA website or with mapping systems such as GIS. When the maps were converted to the digital format they were not updated with current flood studies. The hydrologic and hydraulic analyses for the countywide study reflected in the maps were performed by McDonald & Warger, Inc. for FEMA and completed in April 2000.



The limits of the detailed flood insurance study are as follows:

Sandy Creek – from the confluence with Joachim Creek to approximately 1,150 upstream of Hayden Road.

Big Creek – from the confluence with Sandy Creek to approximately 2,140 feet upstream of Jarvis Road.

Sandy Creek East Tributary – from the confluence with Sandy Creek to approximately 2,010 feet upstream of Sandy Church Road.

Sandy Creek West Tributary – from the confluence with Sandy Creek to approximately 2,800 feet upstream of Jarvis Road.

Unnamed Tributary to Sandy Creek – from the confluence with Sandy Creek to approximately 70 feet upstream of State Highway Z.

Within the floodplain is an area that has been studied and designated as the floodway. If all of the floodwater at a given location were to be channeled, the resulting area is called the floodway.

Jefferson County restricts development in the floodway and has specific requirements for development in the floodplain. These restrictions are documented in the Jefferson County Flood Damage Prevention Ordinance.

The Sandy Creek Watershed Partnership would like the floodplain study for Sandy Creek and its tributaries to be updated. An updated study would reflect the current conditions in the watershed and be helpful in assuring new development is in accordance with FEMA and Jefferson County requirements.

Exhibit H – Natural Pest and Plant Control Methods

An excellent way to combat harmful insects is with natural predators, i.e. insects like ladybugs, lacewings and praying mantis. Bordering the lawn with native trees and plants will attract birds and insects that will keep harmful insect populations under control. Planting flowerbeds with native plants in the yard will also help. Beneficial insects will control bugs as much as 50 yards away from their source of nectar.

Soapy water is very effective against harmful insects like aphids, earwigs, tent caterpillars and leafhoppers. Use plants that repel harmful insects. Some garden shops provide alternative products such as hot pepper spray.

Plants That Repel Pests

Pest	*Plant*
Ant	Mint, tansy, pennyroyal
Aphids	Mint, garlic, chives, coriander, anise
Bean leaf beetle	Potato, onion, turnip
Codling moth	Common oleander
Colorado potato bug	Green beans, coriander, nasturtium
Cucumber beetle	Radish, tansy
Flea beetle	Garlic onion, mint
Imported cabbage worm	Mint, sage, rosemary, hyssop
Japanese beetle	Garlic,larkspur, tansy, rue,geranium
Leaf hopper	Geranium, petunia
Mexican bean beetle	Potato, onion, garlic,radish, petunia, marigolds
Mice	Onion
Root knot nematodes	French marigolds
Slugs	Prostrate rosemary wormwood
Spider mites	Onion, garlic cloves, chives
Squash bug	Radish, marigolds, tansy, nasturtium
Stink bug	Radish
Thrips	Marigolds
Tomato hornworm	Marigolds sage, borage
Whitefly	Marigolds, nasturtium

Plants That Attract Beneficial Insects & Birds
Dogwood
Viburnum
Queen Ann's Lace
Daisies
Caraway
Coriander
Fennel
Black-eyed Susans
Buttercups
Strawflowers
Sunflowers
Yarrow
Serviceberry

Tables EX 128 - 129

Weeds grow in spots that grass can't handle, i.e., areas that are too shady, wet, dry compacted, under fertilized, over fertilized, or are mown too close. Correction of these problems will erase most of the weed problems.

Synthetic or artificial weed killers began as a "quick and dirty" way to handle agricultural weeding and soon became a product used in the domestic yard. However, not only is the gardener who sprays chemical herbicides at risk, but also aquatic life – frogs, newts, etc., are especially susceptible to the ill effects of artificial herbicides.

Natural weed killers are substances that destroy plant life for a short period. But, when applied in big doses the results are devastatingly obvious in a very short time. Examples of natural weed killers include salt, vinegar, weak organic acids, fatty acid weed killers, alcohol, heat from steam, boiling water, mulch, gardening tools plus rotavator, and weed flamers. They act at the point they are used and do not enter the food chain.

Recipe for Organic Weed Killer

4 cups white vinegar
¼ cup salt
2 teaspoons liquid dishwashing detergent

Combine ingredients and pour into a sprayer and apply to weeds.

Figure EX 14

Other methods used to prevent weeds from growing or spreading are:

- Prevent seed distribution by cutting down problem areas before they seed.
- Control adjacent areas to prevent reinfestation.
- Don't compost weeds directly. Place perennials with overwintering underground parts out to dry in the sun before composting.