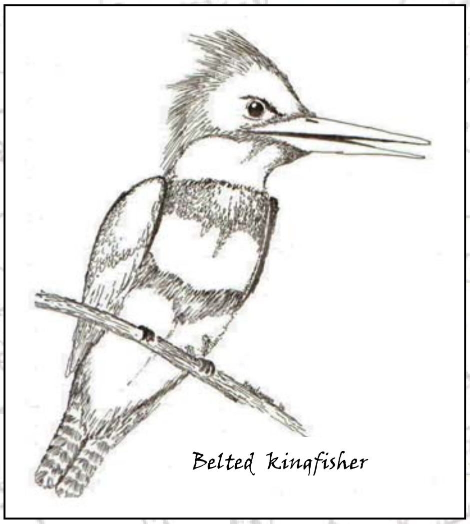
Belews Creek Watershed Management Plan



Prepared by

Jefferson County
Stormwater Management Division
and the
Belews Creek Watershed
Partnership

November 2008

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Missouri Department of Natural Resources

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Belews Creek Watershed Management Plan

Mission Statement

To create and implement a comprehensive and strategic watershed plan to prevent further degradation to the Belews Creek Watershed and to maintain the long-term quality of its water resources.

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Executive Summary

The Belews Creek watershed (HUC #07140104080007) is a 26 square-mile area located in the central portion of Jefferson County. The City of Hillsboro is at its southeastern border and the Big River borders it to the northwest. Two large lake developments, Raintree Plantation and Lake Tishomingo, are in the watershed.

The watershed is characterized by rugged hills, except along Belews Creek itself. The rugged portions of the area are occupied by either woodland or low-density residential development. Currently, there are about 5,300 land parcels with 1,600 houses in the watershed. The floodplain along Belews Creek is largely farmland. The watershed is lightly populated with much of the land still being used for agricultural purpose; however, it has pockets of high density population around its man-made lakes.

Belews Creek headwaters was originally formed by a natural spring near the intersection of First Street and State Highway 21in Hillsboro at an elevation of about 720 feet above mean sea level and flows in a northwesterly direction for roughly 9 miles to the confluence with the Big River near the intersection of Three B's Road and Highway BB. Belews Creek watershed spans 3 to 4 ½ miles in width and covers 16,500 acres.

Belews Creek is not a source of drinking water. Individual and public wells provide drinking water for the entire watershed. The ground water region for the Belews Creek watershed is The Ozarks. Characteristics of The Ozarks region are reflected in a Missouri Department of Natural Resources publication on ground water.

The Purpose of the Watershed Plan

The purpose of the Belews Creek Watershed Plan is to identify critical areas where pollution control practices should be implemented to help establish a healthy ecosystem. Water quality testing helped identify pollutant causes and sources within the watershed. The watershed management plan will also help to identify specific applications of various development methods, location and mix of associated land uses. As outlined in the Jefferson County Official Master Plan, it is imperative to identify important watershed areas and natural drainage ways in order to restrict the nature of development in those areas. To protect the buffer areas, the Master Plan promotes these areas as part of a parks and trail system.

The Beginning of the Watershed Study

Although Belews Creek itself is not on the EPA/DNR 303(d) list nor does it have a TMDL, (Total Maximum Daily Load) constraint issued by DNR, it is a Class 5 tributary to the Big River which is on the 303 (d) impaired list for lead contamination. Because of its connection to Big River, the Department of Natural Resources funded a grant to write this watershed plan for Belews Creek Watershed under Section 319 of the Clean Water Act.

A Belews Creek Watershed Partnership Committee was established to assist in the development of this watershed management plan. The committee members are identified on pages 4 and 5 of this plan.

Visual Assessment and Analysis

An evaluation of the current condition of the watershed was completed to determine the areas of concern and general condition of the watershed. This evaluation included a visual survey, water testing, species testing and an assessment of vulnerable conditions within the watershed. Analysis of the future condition of the watershed was based on projected changes in land usage.

The tasks completed for this assessment and analysis were as follows:

1. A visual survey was conducted by stakeholders to determine the areas of concern and general health of Belews Creek and its tributaries.

2. Water testing using Missouri Stream Team equipment and training was conducted along several areas of the creek to reveal pollutant loads. The results of a study of fish populations conducted by Missouri Department of Conservation in two areas of Belews Creek is an indicator of problematic influences.

3. Natural features and man-made influences that present vulnerable areas within and along the stream were evaluated.

4. Defining riparian corridors and the FEMA Floodplain which will affect where future development can occur in the watershed.

Mission Statement

The Belews Creek Watershed Partnership along with the staff of the Stormwater Management Division of Jefferson County completed an examination of the natural resources and critical areas within the watershed. The group wrote a mission statement with two primary goals for the Watershed Management Plan. The primary goals are:

> ***Prevent further degradation to Belews Creek***
> *The lack of and destruction of riparian corridors, increased development causing an increase in stormwater runoff, the floodplain, and failing septics are threats to Belews Creek.*
>
> ***Maintain the long-term quality of its water resources***
> *It is essential to protect Belews Creek by actively implementing and maintaining management objectives that address the causes and impacts of pollutant sources.*

Several issues should be addressed to accomplish these goals. The Watershed Partnership Committee developed the following list.

1. Evaluate stormwater runoff and its affect on the watershed.
2. Determine existing riparian corridors and educate landowners on the benefit of maintaining and/or establishing riparian corridors.
3. Encourage appropriate maintenance and repair of septic systems.
4. Encourage use of natural fertilizers, pesticides, herbicides, detergents, and eliminate yard waste dumping.
5. Minimize the runoff impact in areas of sinkholes and losing streams.
6. Prepare a Belews Creek Floodplain Study.
7. Evaluate the impact of existing and future dam designs.
8. Encourage building requirements for stream crossings (bridges).

Projections

Land use changes can significantly impact groundwater recharge, stormwater drainage, and water pollution. The Long-Term Hydrologic Impact Assessment (L-THIA) model was utilized to assess the water quality impacts of land use change twenty years from now. Based on community-specific climate data, L-THIA was utilized to estimate changes in recharge, runoff, and non-point source pollution resulting from current and proposed development.

The results of these projections will be used to generate community awareness of potential long-term problems and to support planning aimed at minimizing disturbance of critical areas. It is our goal to minimize the impact on Belews Creek Watershed's natural environment by evaluating the potential effects of land use change and identifying the best location of particular land uses.

The data used for these projections was based on the watershed's location within the 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. The current zoning and associated acreage for each management unit was determined using the County's GIS data. Utilizing the Watershed Partnership's knowledge of the Belews Creek watershed, projections were made as to where and what type of development might be anticipated in 20 years (2028).

The non-point pollution results from the L-THIA model were prioritized by Management Unit with the following areas of concern and associated actions identified.

MU3 – oil and grease, suspended solids and fecal coliform
MU4 – BOD, COD and fecal strep
MU6 – oil and grease and BOD
MU5 – suspended solids and fecal coliform
MU7 – suspended solids, fecal strep and BOD
MU8 – fecal strep, COD and BOD

MU1 – oil and grease, COD, BOD and fecal strep
MU2 – oil and grease, COD and BOD

Critical Issues and Actions

Non-point pollution from Stormwater runoff is a major concern to the Belews Creek watershed. This concern and impact will grow as new development and changes in land use occur.

Enforcing Jefferson County's Land Use and Stormwater Management policies required by Article 10 of the Unified Development Order will result in controlling the runoff associated with stormwater. The goal of these policies is to have no more runoff after development than before. Detaining stormwater on site will enable pollutants to settle out and replenish the groundwater before entering Belews Creek.

Low Impact Develop (LID), encouraged by Article 10, will distribute the control of runoff throughout a new development and more closely control it at the source. Rain gardens can accomplish similar benefits in a developed area.

The riparian buffer corridor requirements in Article 10 will provide an additional area to filter pollutants and re-charge the groundwater. The destructive forces from runoff will be stabilized and stream degradation minimized.

On-site septic systems in the watershed will continue to plague the water quality. A concerted effort to identify and repair/replace failing systems should be a priority.

Chemical fertilizers, pesticides, herbicides, detergents and yard waste can contribute to poor water quality. Educational material reflecting the importance of properly using these items and their impact on the Belews Creek watershed should be prepared and distributed to landowners. Presentations at homeowner associations and soliciting participation will have an impact on the quality of the water in Belews Creek.

Portions of the entire watershed have losing streams with sinkholes identified in Management Unit 3. The impact of polluted runoff on the groundwater and aquifer is not known and should be studied. Minimizing the non-point pollution entering these locations can be controlled as new development occurs. An awareness that these areas exist is critical in the review of proposed developments.

The Floodplain

The Belews Creek floodplain is a component in the understanding of the mechanics of the stream. Bank erosion and sedimentation transfer are associated with rain events. Documenting the FEMA floodplain and floodway will provide information that can be used when analyzing the fluvial geomorphology of Belews Creek. Proposing projects for bank stabilization and stream modifications, i.e., bridge crossing, will need to consider the entire watershed to understand the impact of the activity. An understanding of existing and proposed dams and their relationship in the watershed should be included in evaluations of Belews Creek.

Summary

The Belews Creek Watershed Management Plan documents the existing condition of the watershed and the anticipated influences growth and land use changes will have on non-point pollution and water quality. This plan is intended to be used as guidance when activity is proposed in the watershed. This is intended to be a working document that is reviewed yearly for proposed projects by the Watershed Partnership Committee and a source for seeking funds to assist in those projects.

Belews Creek Watershed Management Plan

Section 1 – Introduction to The Watershed

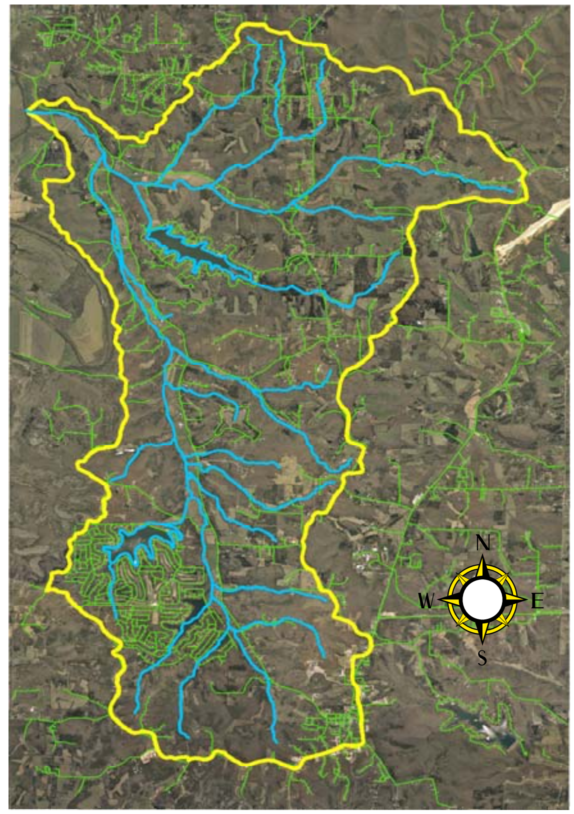


Figure 1 at the right shows a Jefferson County 2006 GIS aerial view of the Belews Creek Watershed depicting Belews Creek, its tributaries, roads, Lake Tishomingo, and Autumn Lake in Raintree Plantation.

The 26 square-mile watershed is located in the central portion of Jefferson County. The City of Hillsboro at its southeastern border and the Big River borders it to the northwest. In addition to Hillsboro, two large lake developments, Raintree Plantation and Lake Tishomingo, are part of the watershed.

The watershed is characterized by rugged hills, except along Belews Creek itself. The rugged portions of the area are occupied by either woodland or low-density residential development. Currently, there are about 5,300 land parcels with 1,600 houses in the watershed. The floodplain along Belews Creek is largely farmland. The watershed is lightly populated with much of the land still being used for agricultural purpose; however, it has pockets of high density population around its man-made lakes.

Belews Creek headwaters was originally formed by a natural spring near the intersection of First Street and State Highway 21in Hillsboro at an elevation of about 720 feet above mean sea level and flows in a northwesterly direction for roughly 9 miles to the confluence with the Big River near the intersection of Three B's Road and Highway BB. Belews Creek watershed spans 3 to 4 ½ miles in width and covers 16,500 acres.

The natural spring at Belews Creek headwaters, and its fertile valley with sandy clay loam and silty clay loam soils caught the attention of many early settlers. Many settlers bought two or more 40-acre tracts of land for farming and raising livestock. Among them was the John Huskey family who located here in 1803. Descendants still live on the original property making the Huskey Farm one of the oldest in Missouri. *(See Figure 9 for location.)*

The oldest home on the Jefferson County Assessor's Office records was built in 1908. The following table indicates the number of homes added during each ten-year census.

Year	*Homes*		*Year*	*Homes*
1910	4		1960	171
1920	7		1970	244
1930	20		1980	276
1940	16		1990	426
1950	69		2000 – 2005	320

Table 1: Shows the number of homes added at each ten-year census. Most recent growth is experienced around Lake Tishomingo and Raintree Plantation.

Belews Creek is not a source of drinking water. Individual and public wells provide drinking water for the entire watershed. The groundwater region for the Belews Creek watershed is The Ozarks.

Section 1.1 – The Purpose of the Watershed Plan

The purpose of the Belews Creek Watershed Plan is to identify critical areas where pollution control practices should be implemented to help establish a healthy ecosystem. Water quality testing helped identify pollutant causes and sources within the watershed. The watershed management plan will also help to identify specific applications of various development methods, location and mix of associated land uses. As outlined in the Jefferson County Official Master Plan, it is imperative to identify important watershed areas and natural drainage ways in order to restrict the nature of development in those areas. To protect the buffer areas, the Master Plan promotes these areas as part of a parks and trail system.

Section 1.2 – The Beginning of the Watershed Study

Although Belews Creek itself is not on the EPA/DNR 303(d) list nor does it have a TMDL, (Total Maximum Daily Load) constraint issued by DNR, it is a Class 5 tributary (see Section 11.1) to the Big River which is on the 303 (d) impaired list for lead contamination. Because of its connection to Big River, the Department of Natural Resources funded a grant to write this watershed plan for Belews Creek Watershed.

Jefferson County held its first stormwater educational program on November 30, 2004 where watershed management was introduced to the public. Post cards were sent to over 4,500 people who owned property within the watershed inviting them to attend this educational program. In

January 2005 subsequent meetings were held at Lake Tishomingo, Hillsboro City Hall and at Raintree Plantation. A total of 171 people attended the January meetings. Sixty-two people signed up to participate and assist in developing the Belews Creek Watershed Plan. Approximately 24 people regularly attended follow-up meetings and participated in a visual survey of the Belews Creek Watershed. *(See Section 11.3 for sample of form.)*

Stakeholders divided into four groups: Raintree, Lake Tishomingo, The "A" Team and the "BB" Team. Each chose their own spokesman. GIS maps were used to outline the watershed area. Each team chose specific areas of the watershed and walked the creek with a camera and a visual survey form to document their findings. Previous educational meetings and slide show presentations demonstrated what critical areas might look like. Team members learned the causes of some of the creek conditions and what may be sources of pollution.

The four groups spent a total of 325 hours surveying Belews Creek and its tributaries. The groups met monthly to turn in and discuss what they found. At the end of the discovery period, a meeting was held for all participants. A slide show presentation depicted all the critical areas found and the concerns of the stakeholders. Property owners expressed a variety of concerns and examples of critical areas within the watershed, especially in the general location of the creek and creek banks. Those are described in detail in Section Three.

Bob Buxton, a large parcel owner at the mouth of Belews Creek and active supporter of the watershed plan, expressed his feelings this way: " We have all developed a better understanding and appreciation of Belews Creek. For the majority, it is a beautiful, pristine stream and in good condition. We have a few areas of concern that could make it better."

After reviewing concerns, it became apparent that the watershed should be divided into Management Units to effectively address concerns unique to specific areas of the watershed. Eight Management Units were outlined based on drainage patterns for the watershed, and are reviewed in detail in Section Four of this plan.

Paul Krautmann, a large parcel owner and farmer in the watershed and an "A" Team member, designed the Belews Creek logo. The belted kingfisher makes its home along the banks of Belews Creek. Paul thought it an appropriate symbol to represent the watershed.

Figure 2: Paul Krautmann Creation of Belews Creek Logo

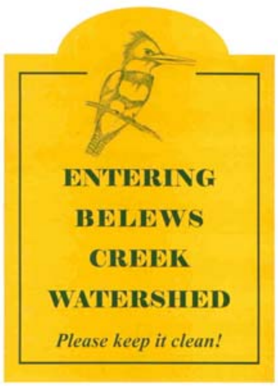


Figure 3: Design of Belews Creek Watershed sign.

Laminated posters similar to this have been posted in various locations throughout the watershed. Gery Marmaduke, City Administrator, for the city of Hillsboro has taken the lead on this project. We hope to place permanent, metal signs in the watershed in the near future.

Section 1.3 -- Watershed Plan Participants

The following table lists stakeholders that participated in the visual survey and follow-up meetings. They make up what we call the Belews Creek Watershed Partnership Committee.

Name of Participant	Interest	Group
Paul & Nancy Krautmann	Organic Farming	A Team
Chester Wolkowitz	Subdivision Representative	A Team
Bob Buxton	Agricultural Specialist and Descendent*	A Team
Nancy Luffy	Land Owner	A Team
Mark Wiley	Surveyor/Descendent*	BB
Michael Huskey	Land Owner/Descendent*	BB
Ellis and Susan Marsey	Land Owner	BB
David Huskey	Businessman, Farmer, Descendent*	BB
Gil Meyer	Land Owner	BB
Jim Clayman	Land Owner	BB
Jerry Uhlenbrock	Businessman	Lake Tishomingo
Ray Lauer	Subdivision Representative	Lake Tishomingo
Bill Svejkosky	Businessman	Raintree
Marilyn Meyer	Subdivision Trustee	Lake Tishomingo
Rich Hirsch	Subdivision Representative	Lake Tishomingo
Richard & Beverly Wendt	Retired P&Z Engineers	Raintree
Rich Lippit	Subdivision Representative	Lake Tishomingo
John & Susan Martin	Subdivision Representative	Raintree
Bob Blecha	Subdivision Representative	Raintree
Karen Oakes	Subdivision Representative	Raintree
Cliff and Mary Ann Brandt	Land Owner	BB

Table 2: List of active participants in field surveys and members of the Belews Creek Watershed Partnership Committee.

** These people are descendents of the original land owners.*

In addition to a Public Advisory Group with technical knowledge and expertise was established to assist in the development of this watershed plan. The groups and individuals are as follows:

Public Advisory Group

Groups and individuals forming the Public Advisory Group were selected for the input and expertise they can provide to this Watershed Plan. Members include:

Rosie Buchanan
Assistant Executive Director
Economic Development Corporation
636-797-6221

Paul Freeze, Urban Conservationist
USDA-NRCS
636-583-2303 Ext 3

Grant Butler, Soil Scientist
USDA-NRCS
636-583-2303 Ext 7

Dean Wilson
Missouri Extension Center
Hillsboro Missouri
636-797-5057

Traci Boaz, Community Conservation Planner
Missouri Department of Conservation
314-301-1506 Ext 2264

Danny Brown, Fishery Management Biologist
Missouri Department of Conservation
636-441-4554

Shannon Dean, District Technician/Info-Ed Specialist
Jefferson County Soil & Water Conservation District
636-789-2441 Ext 3

Section 2 – Historical Facts and Features of the Watershed

Belews Creek Watershed (HUC 07140104080007) is located about 25 miles south of St. Louis in central Jefferson County. The Belews Creek watershed discharges into the Lower Big River Watershed.

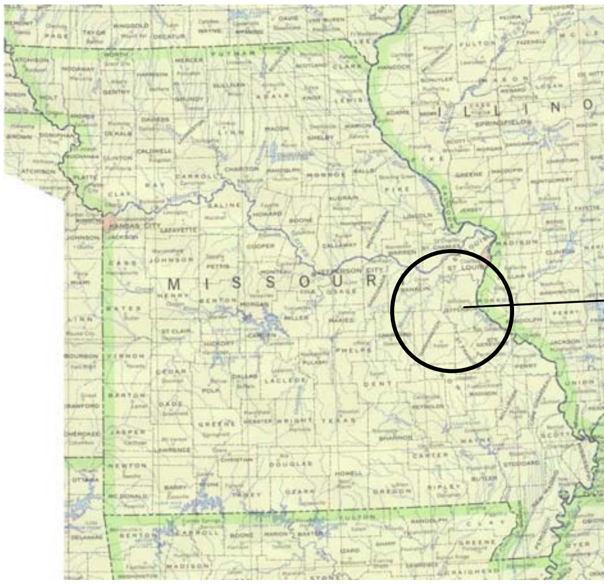
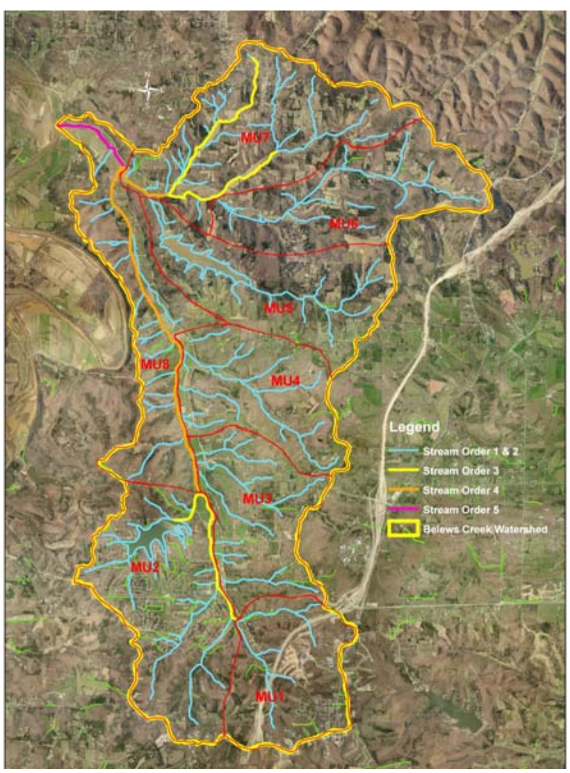


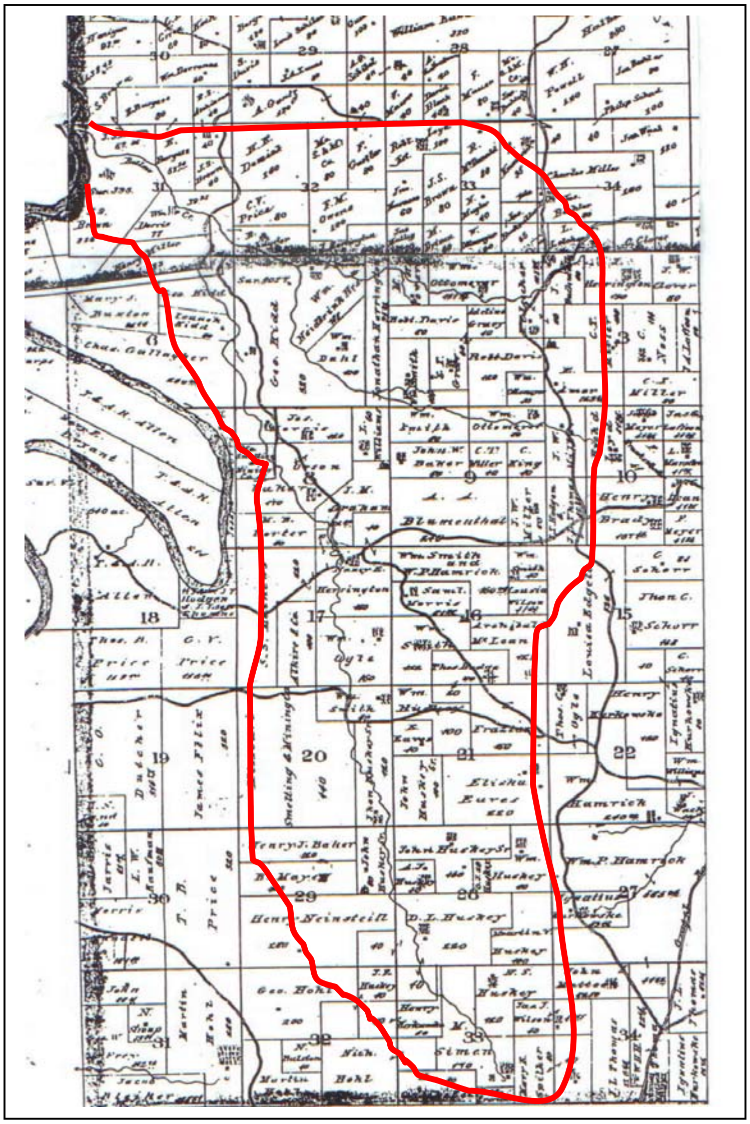
Figure 4: Missouri Maps Website

Figure 5: Map created by Jefferson County Stormwater Division



Belews Creek Watershed is represented at the left by Stream Orders. Belews Creek ranges from Stream Order 1 at its headwaters to Stream Order 5 at its mouth.

Figure 6: Jefferson County Stream Order Map
Source: Jefferson County Stormwater Division



Belews Creek Watershed is situated within the Central Township. Most of the watershed including its mouth lies in Township 41N, Range 4E, Earliest settlers were attracted to water courses and the rich soil in creek and river bottoms. In the northeast corner of Township 41, Range 4, David Boyle was one of the pioneers. He lived there with a wife and six children.

Belews Creek was named for William Belew who settled in the area around 1778. A post office located on Hillsboro House's Springs Road was named Belews Creek Post Office.

From the census of 1870 the Central Township had a population of 1,789 people – 1,763 white and 26 black. The census figures included 505 horses, 95 mules, 889 cattle, 1,122 sheep and 1,017 hogs.

The table below depicts some of the early patrons, their occupations and the approximate year they settled in the area.

The current population of the watershed is estimated at 5,200.

Figure 7 left: depicts a survey map of the Belews Creek area in 1876.

Figure 8 below: shows the census of Belews Creek in 1876. From the Illustrated Historical Atlas Map of Jefferson County, Missouri. .

TOWNSHIP No. 41. RANGE 4.

NAME.	POST-OFFICE.	RESIDENCE.	BUSINESS.	NATIVITY.	When Came to Co.	NAME.	POST-OFFICE.	RESIDENCE.	BUSINESS.	NATIVITY.	When Came to Co.
Burgess, Edward	Hillsboro	Sec. 6	Farmer	Jefferson Co, Mo	1850	Lanham, Benjamin	Hillsboro	Sec. 24	Farmer	Jefferson Co, Mo	1842
Clemens, D. L.	"	" 23	Farmer & Veterinary Surg'n	Pennsylvania	1870	McLean, Archibald	"	" 16	Farmer and Engineer	Glasgow, Scotl'd	1868
Hartwein, Louis	"	Sur. 2018	"	Prussia	1860	Miller, L. H.	Belews Creek	" 3	"	Brooke Co, W. V	1861
Hohl, Martin	"	Sec. 31	"	Switzerland	1854	McFrey, Geo. W.	Hillsboro	" 31	"	Jefferson Co, Mo	1842
Huskey, A. J.	"	" 28	"	Jefferson Co, Mo	1842	Neinsteil, Henry	"	" 29	"	Germany	1858
Huskey, John, Sen.	"	" 20	Farmer and Blacksmith	South Carolina	1804	Smith, William	"	" 20	"	Jefferson Co, Mo	1821
Herrington, Nancy E.	"	" 8	"	CrawfordCo, Mo	1856	Sunen, M.	"	" 33	"	Switzerland	1847
Kurtz, Mary	"	" 11	"	Hanover, Ger.	1875	Vreeland, Wm. K.	"	" 10	Farmer and Painter	St. Louis, Mo.	1865
Kurkowieky, Ignatny	"	" 29	Farmer and Blacksmith	Prussia	1843	Wilson, James J., Sen.	"	" 33	Farmer and Teacher	Tennessee	1867

TOWNSHIP 42. RANGE 4. EAST.

NAME.	POST-OFFICE.	RESIDENCE.	BUSINESS.	NATIVITY.	When Came to Co.	NAME.	POST-OFFICE.	RESIDENCE.	BUSINESS.	NATIVITY.	When Came to Co.
Bechler, Joseph	Belew's Creek	Sec. 34	Farmer and [illegible]	Baden, Germany	1854	Smith, John M.	House's Spr'gs	House's Spr'gs	Saloon Keeper	Jefferson Co, Mo	1851
Harness, John	House's Spr'gs	" 13	Farmer and Stock Raiser	Jefferson Co, Mo	1827	Weber, Ferdinand	" "	Sec. 10	Farmer	Bohemia, Ger.	1854
Meyer, Henry F.	Cedar Hill	" 19	Farmer and Blacksmith	" "	1849	Wilson, J. E. C.	" "	House's Spr'gs	Merchant	Jefferson Co, Mo	1831
Powell, W. H.	Belew's Creek	" 27	Farmer and Justice of Peace	London, Engl'd	1857						

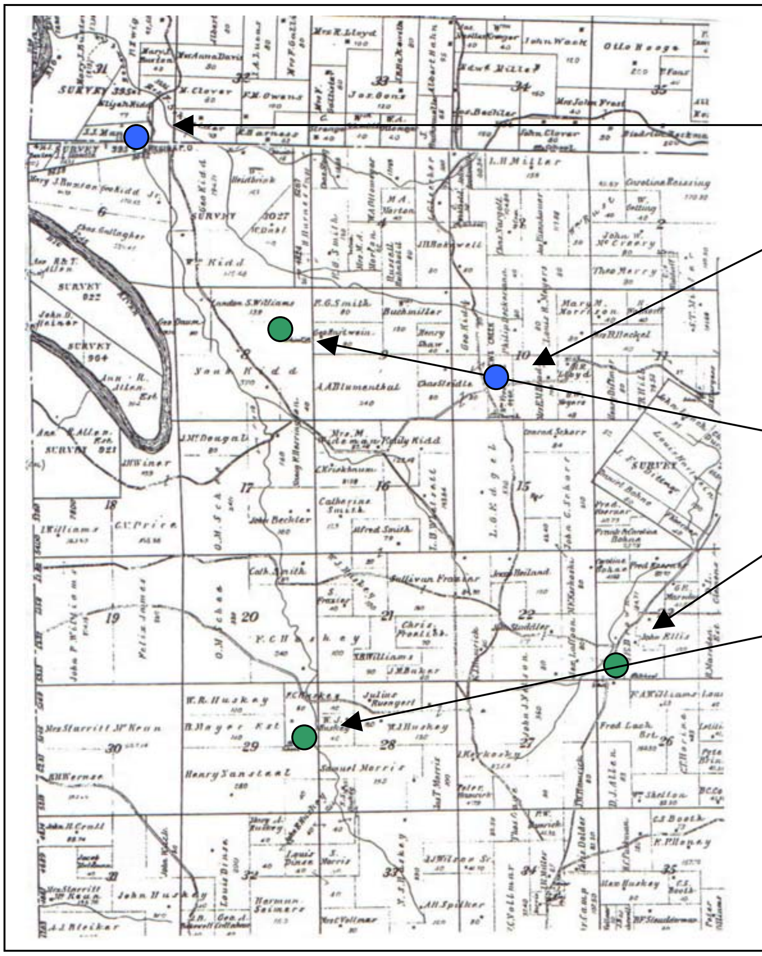


Figure 9: features some historic landmarks in the watershed.

Regina Post Office

Belew's Creek Post Office

There were three schools in the Belews Creek Watershed before 1906. All were on privately owned, large parcel property:

Hillcrest School (Baker) #34
T41,R4,Sec8 on J.M. Graham's property

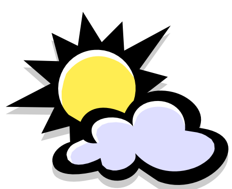
Highland School (Heiland) #42
T41,R4,Sec23 on Thompson Brown's property

Huskey School (Pleasant Hill) #41
T41,R4,Sec 29 on John Huskey's, property

1898 Standard Atlas of Jefferson County Missouri. Compiled and published by George Ogle & Company

Huskey Schoolhouse; Photo by Lisa K. Gendron

Figure 10 shows a typical schoolhouse in the watershed in the early 1900s.



The Climate in Belews Creek Watershed:

- Average temperature in the watershed is 65^{o} F with ranges from 18^{o} F to 95^{o} F.
- Precipitation average is 33 inches with most precipitation falling in the Spring and Fall months.
- During the morning hours the humidity averages about 81%; afternoon average is about 63%.
- Wind speed picks up in the winter months and declines during the summer. The average wind speed in the watershed is 10.5 mph.
- The average snowfall is about 5 inches during the winter months.
- Cloudy days occur mostly during the winter months. On the average 55% of winter days are cloudy or overcast.
- Over a one-year cycle, Belews Creek Watershed experiences sunny days about 55% of the time.

Section 2.2—Physical Description - Streams

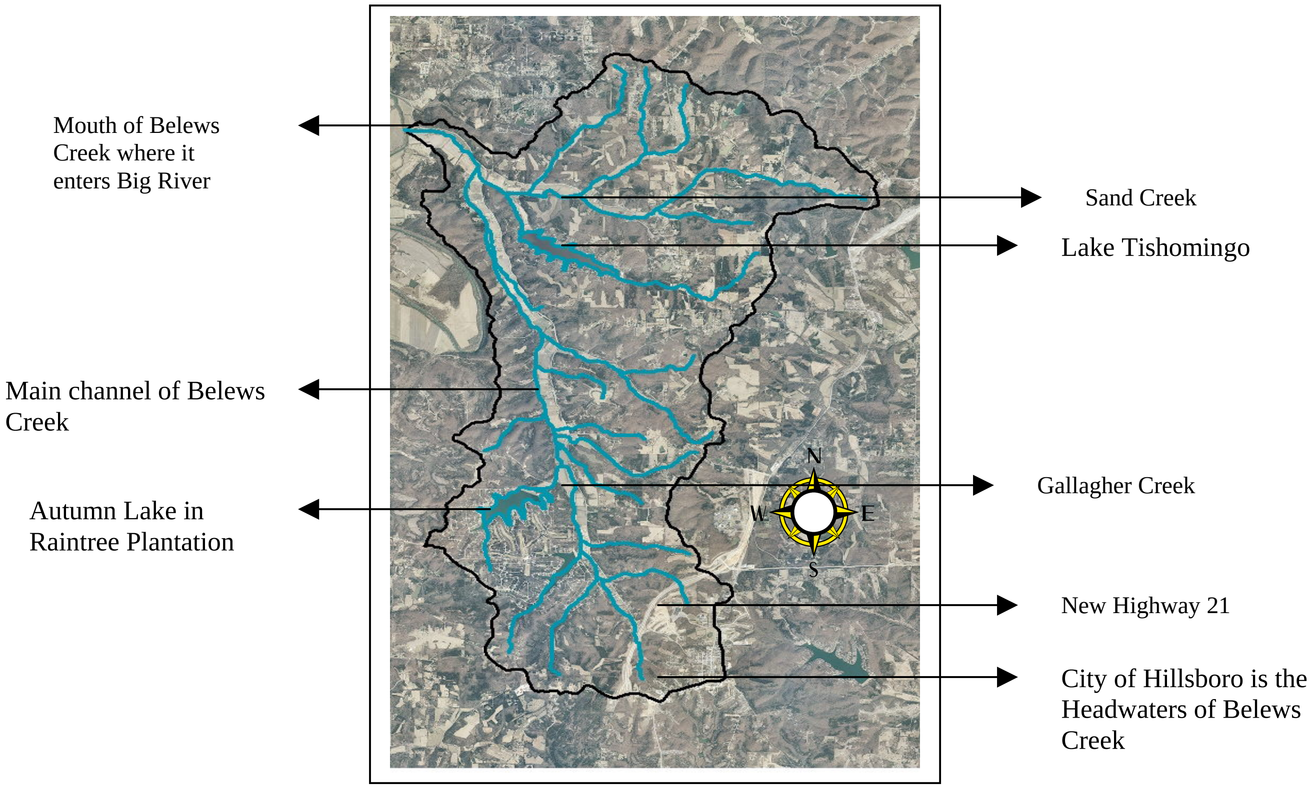


Figure 11 shows waterways in the watershed. Belews Creek is identified with its 14-digit HUC code: 07140104080007.

Belews Creek runs 9 miles through the watershed with two named tributaries: Gallagher Creek, which runs for 1.69 miles and Sand Creek which runs for 5 miles. There are no gaining streams in Belews Creek; however, there are 10 losing stream areas.

The minimum elevation is 452.6 feet; the maximum elevation is 974.8 feet. The main stream channel flows south to north.

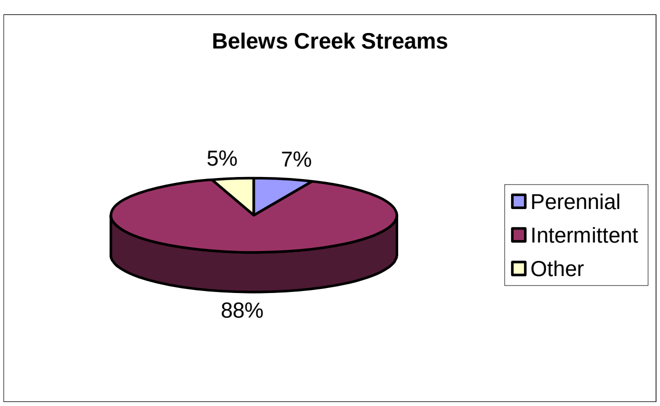


Chart 1 – Source: DNR
This is a description of the types of streams that make up the watershed. Streams that run continuously are *perennial* streams. Streams that have running water and dry sections and/or streams that have running water during the rainy season are called *intermittent* streams.

Section 2.3—Physical Description - Aquifers

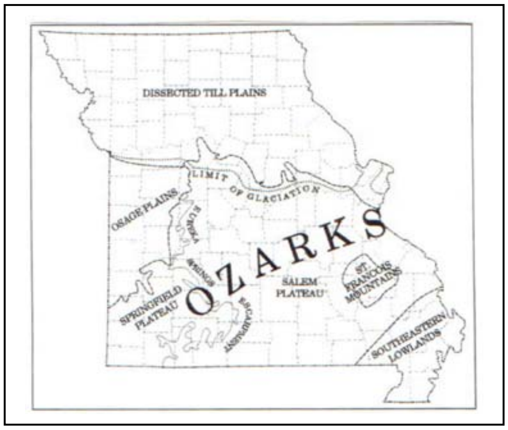


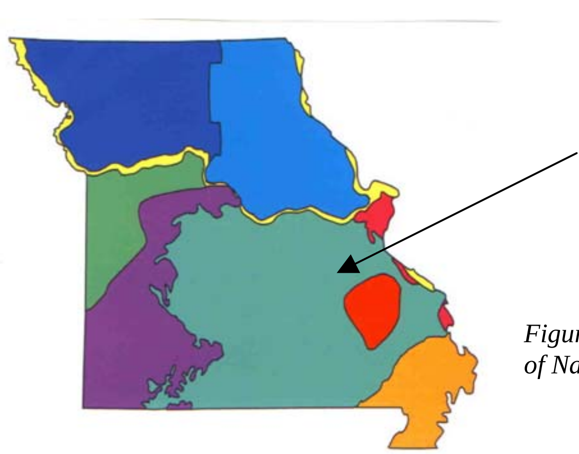
Figure 12- Data Source: USGS.Gov/aquifer basics

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 by Figure 10 that Belews Creek watershed was not within the limits of glaciation.

Belews Creek lies in the Salem Plateau Groundwater Province. (*See Figure 13.)* 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. In the Belews Creek Watershed area, the aquifer is about 1,400 feet thick.

Residual soils formed by the weathering of the mostly carbonate bedrock are very permeable allowing the Ozark aquifer to be recharged by precipitation. In addition, the surface and subsurface weathering of the carbonates has created 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.

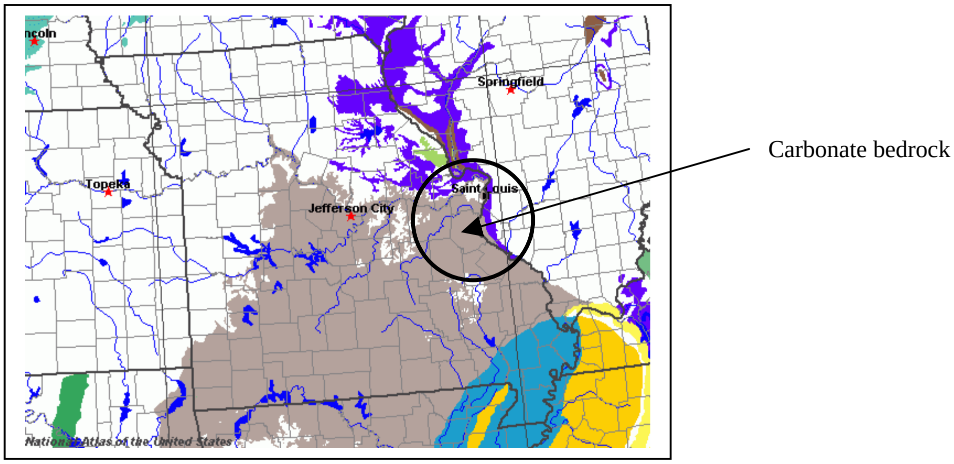
The Ozark aquifer supplies nearly all the water needs in this province. Depending on the well depth and location, private domestic wells a few hundred feet deep can produce water ample for domestic purposes. Generally groundwater quality is very good. The water is generally a moderately mineralized calcium-magnesium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



Salem Plateau Groundwater Province

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

Figure 14 – Data Source: USGS



Ancient caves developed over huge spans of time, starting with the dissolving action of slightly acidic groundwater on fractured bedrock. The sea deposited Missouri's oldest cavernous rocks around 500 million years ago during the Cambrian Period.
The Gasconade Dolomite of the Ordovician Period (around 450 million years ago) is the most cavernous rock formation in Missouri. The mineral dolomite is a calcium-magnesium carbonate, $CaMg(CO_3)_2$. It contains variable amounts of sand, silt, and clay. Dolomite layers make up about half of the bluff-forming Roubidoux Formation. The Salem Plateau is considered a cave factory, with the oldest caves in the Gascondade dolomites.

Ordovician age rocks are carbonates and thin shales, along with three distinctive sandstone layers: the Gunter at the base of the column, the red and white Roubidoux, used as a building stone and the St. Peter glass sand. St. Peter sandstone is very white and crumbles in your hand. It is 98% pure quartz sand with exposures near Crystal City Missouri.

Figure 15 –Data Source: watersheds.org. Trilobite fossils found in Missouri Ordovician aged rocks are evidence of the kind of life forms that existed millions of years ago.

Figure 16 – Gray dolomite. Data Source: watersheds.org

Section 2.4—Physical Description-Geology

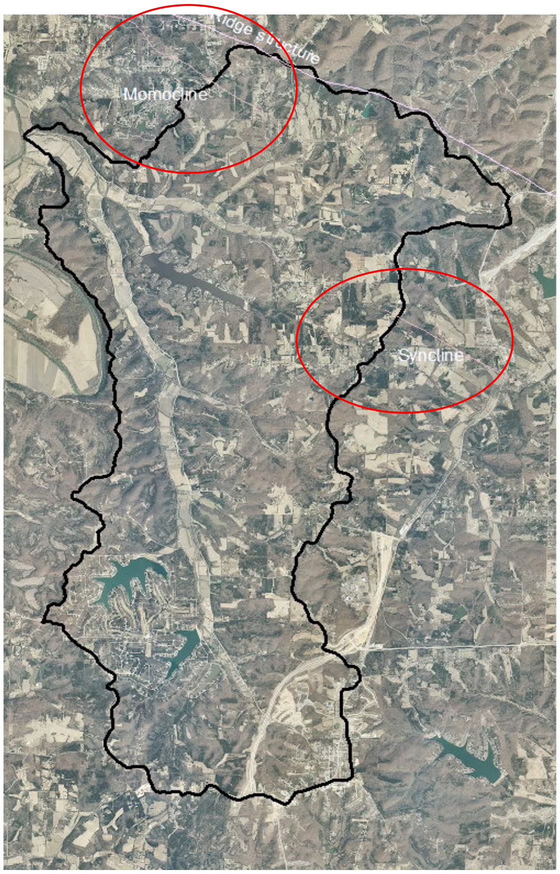
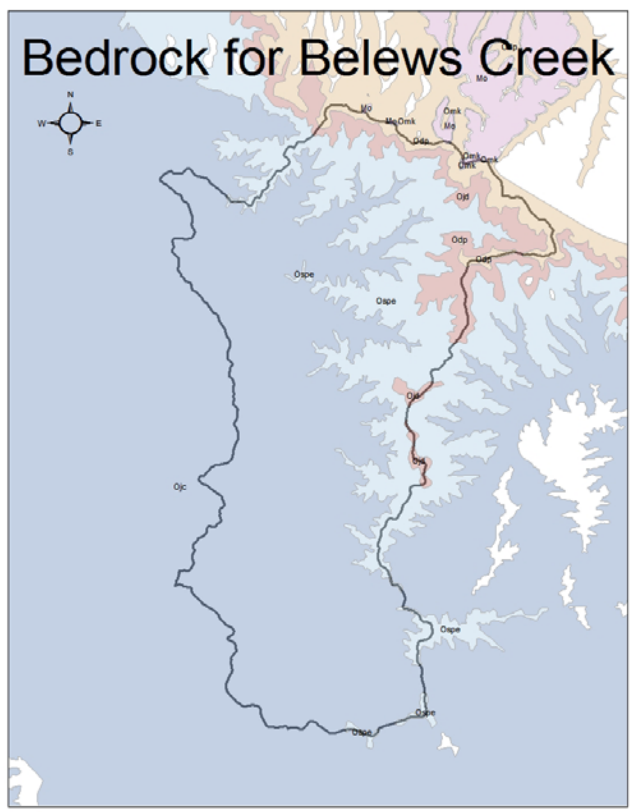


Figure 17: Belews Creek Fault Lines. Data Source: USGS

This figure shows two fault lines within the limits of Belews Creek Watershed. A monocline fault line is shown in the upper left. This fault line is the gentle stepping of a bed or stratum of sedimentary rocks.

The syncline fault line is shown on the right. A syncline is defined as a synclinal fold inclining upward on both sides from an axis – like a rolling fold in the strata. Belews Creek is one of the few watersheds in Jefferson County that have documented fault lines.

Figure 18: Types of Bedrock in Belews Creek Watershed. Data Source: USGS



Belews Creek consists of five bedrock types:

Ojc – (blue) Jefferson City dolomite-clayey soil.
Ospe – (light blue) Everton sandy dolomite
Ojd – (pink) Dutchtown limestone/dolomite
Odp – (pink) Plattin Limestone
Omk – (tan) Orchard Creek limestone-clayey soil

Section 2: Geology - Soils

Figure 19: Detailed Soils Map of Belews Creek Watershed
Data Source: USGS

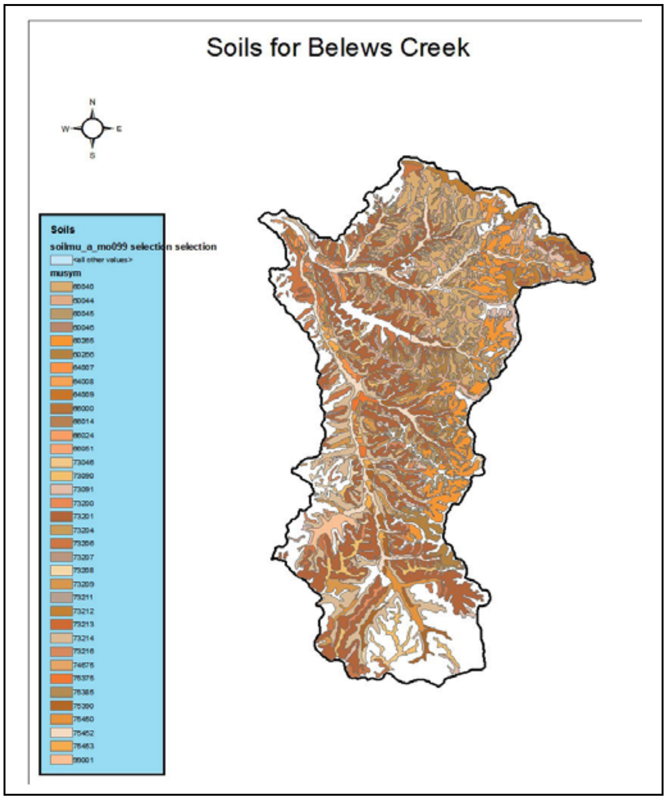
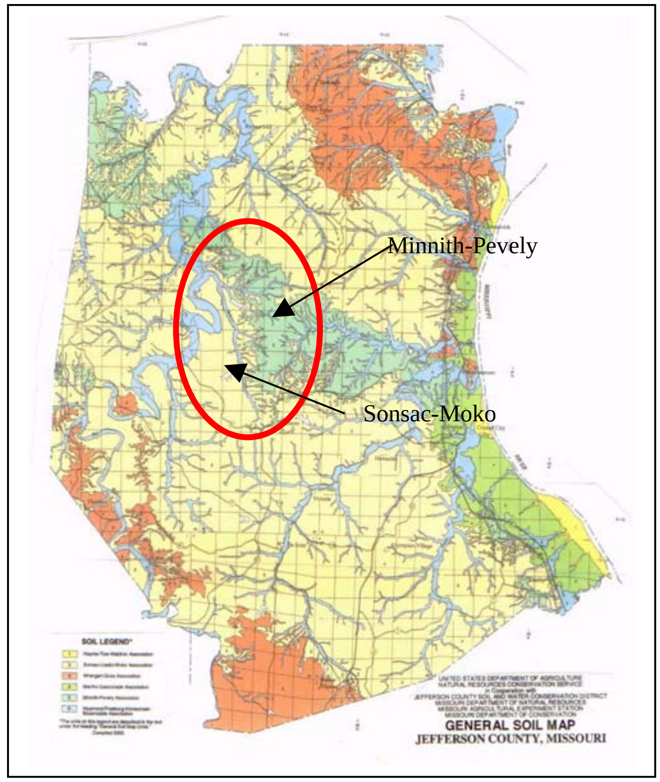


Figure 20: General Soils Map of Belews



Predominant Soils in Belews Creek Watershed			
Type	% Slope	Comments	% Land Area
Sonsac Gravelly silt loam	15 – 40	very stony	28 %
Minnith silt loam	3 – 8	eroded	7.7%
Pevely loam	15 – 40		7.5%
Moko-Rock outcrop complex	15 – 50	extremely stony	7%
Pevely-Holstein complex	8 – 30	slopes	6.5%

Table 3: Soils information from the USDA Soil Survey of Jefferson County, Missouri

Figure 20 and Soil Descriptions Data Source: General Soil Map: USDA, NRCS, Jefferson County Soil & Water Conservation District, MDC, Soil Survey of Jefferson County Missouri

General Soil Types:

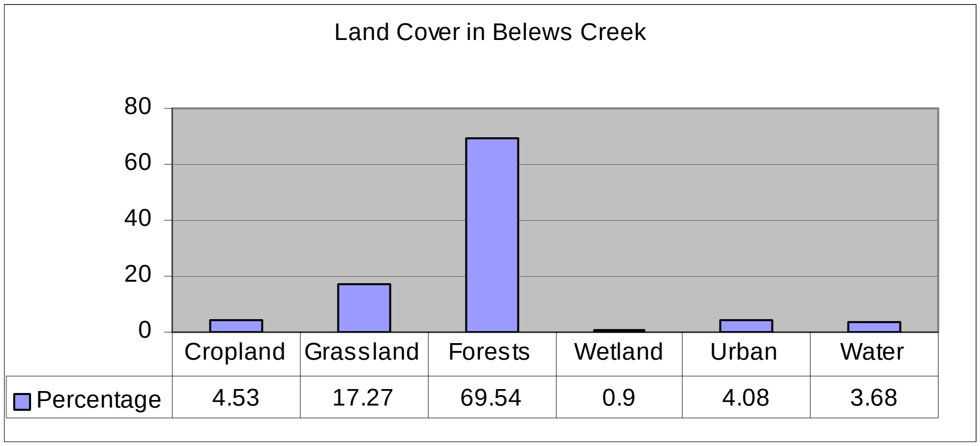
Sonsac-Moko Blend is predominant in the Belews Creek Watershed.
Sonsac is described as moderately deep, well drained, moderately permeable. It is formed from dolostone and limestone. Texture is gravelly silt loam and can be found on summits and backslopes of uplands.

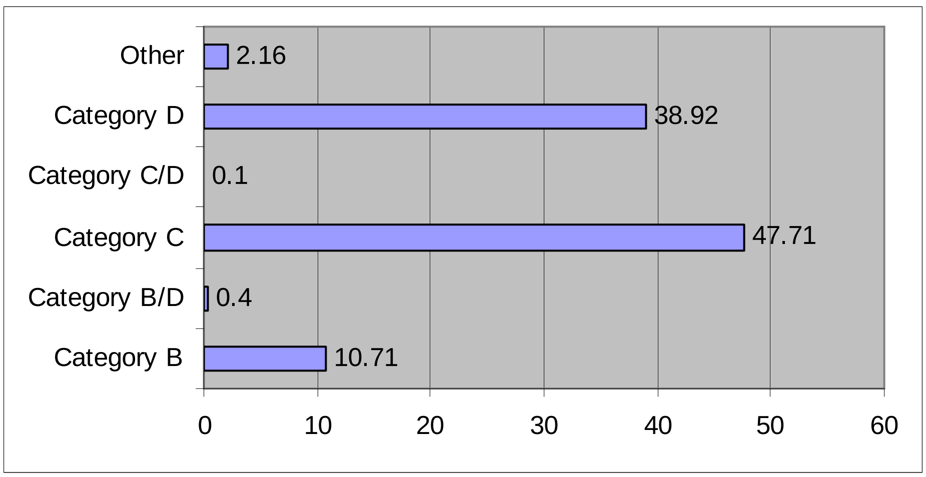
Minnith-Pevely Blend is the second general soil type found in Belews Creek Watershed. *Minnith* is well drained, moderately, slowly permeable soils. It can be found on summits and backslopes of uplands. The texture is fine and silty. *Pevely* is well drained, rapidly permeable soil. It is weathered from limestone on summits and backslopes of uplands. The texture is fine and loamy.

2.5 - Physical Description - Soils

Chart 2 at the right describes the variety of land cover in the Belews Creek Watershed. Most of the watershed is rural with larger land parcels and is agricultural in nature.

Data Source: DNR





Hydrologic Soil Types in Belews Creek Watershed

Chart 3 Data Source: DNR This chart shows the percent of various hydrologic soil types in the watershed.

Category A: Sand loamy sand or sandy type of soils - It has low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained soils and gravels and have a high rate of water transmission.

Category B: Silt loam or loam **-** It has a moderate infiltration rate when thoroughly wetted and is moderately deep, moderately well drained soils with moderately fine to course textures.

Category C: Sandy clay loam **-** They have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine structure.

Category D: Clay loam, silty clay loam, sandy clay, silty clay or clay **-** This soil type has the highest runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface and shallow soils over nearly impervious material.

Other: This soil type has not yet been rated.

Belews Creek Watershed contains soil types that vary in the degree of erosion potential. The chart depicts the percentages of those soil types.

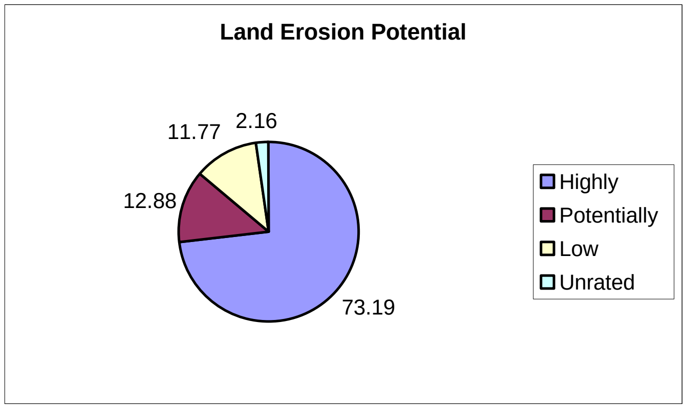


Chart 4 Data Source: DNR

2.6—Physical Description-Sink Holes

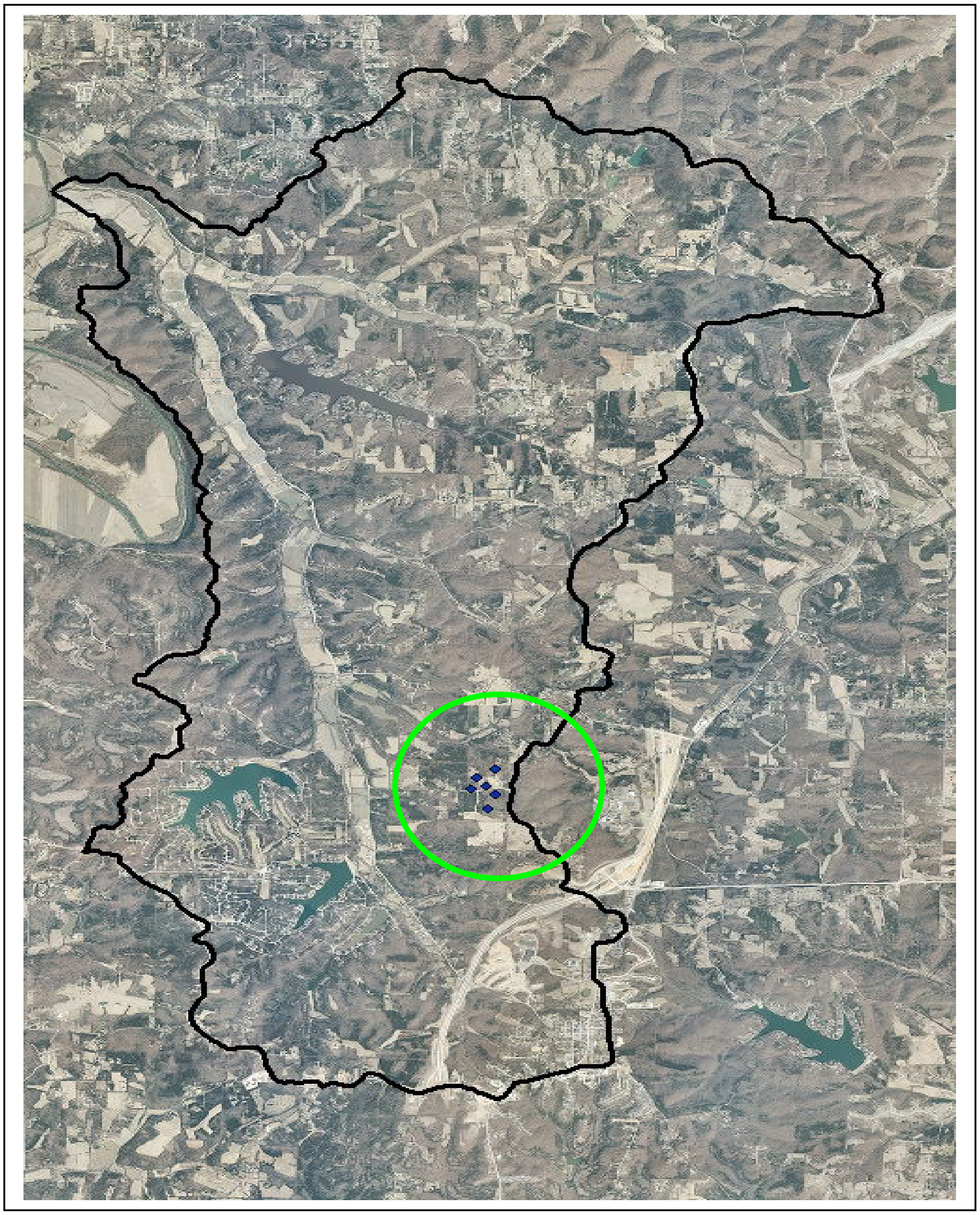


Figure 21- Data Source: DNR through the University of Missouri - Columbia

Sink holes are located in the southeast corner of the watershed covering about 6 acres. It is important to know the location of sink holes within this watershed in order to keep sources of contamination away from them. Contamination from development, septic systems, etc., that is allowed to seep through the sink holes carries polluted water directly into aquifers and drinking water supplies. Needless to say, this will have a bearing on how land is used in the area of sink holes.

2.7—Physical Description-Certified Wells

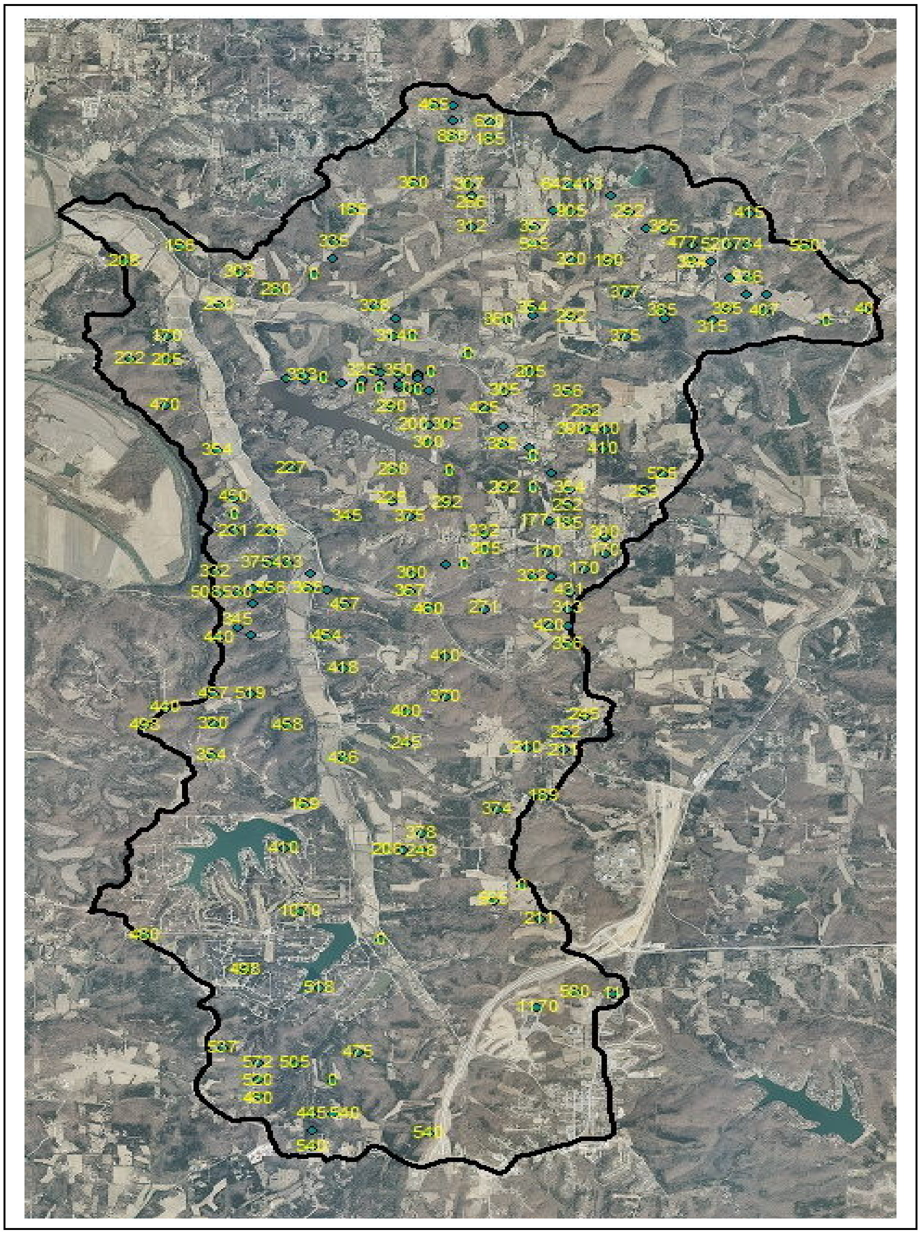


Figure 22 Data Source: DNR through the University of Missouri - Columbia

There are approximately 240 certified wells within the Belews Creek watershed. The depth ranges from 100 feet to 1,170 feet with an average depth of between 300 to 500 feet.

There are also 4 public wells located in the watershed. Depths of these wells are between 1,010 to 1,314 feet. Two are located in the Raintree Plantation Subdivision and the other two are located in the city of Hillsboro.

Location of wells is important in case of contamination as well as land use issues.

Section 2.8 Physical Description-Endangered Species - Animals

Gray Bat
Myotis Grisescens

Figure 23 - Data Source: DNR

Indiana Bat
Myotis sodalist

Figure 24 - Data Source: DNR

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

The Indiana bat is located in the far southwest corner of Belews Creek. These bats need cool caves averaging 40 degrees Fahrenheit and humidity ranges between 66% and 95%. After hibernation, Indiana 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 has taken its toll on the hibernation state and demise of these creatures. These creatures need to be preserved for their educational, ecological and scientific benefits.

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

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

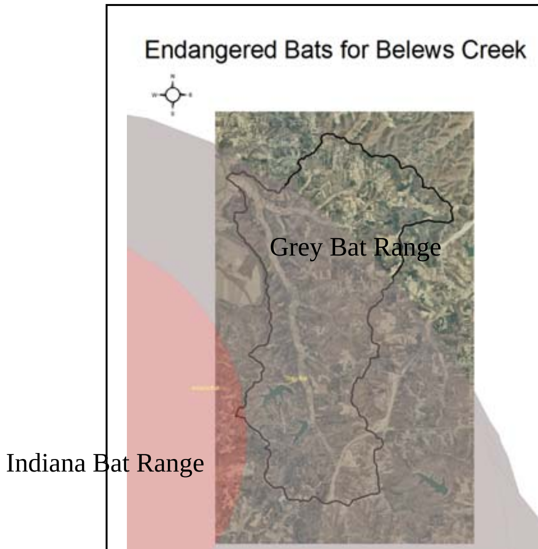


Figure 25 Data Source: DNR

Section 2.9 — Physical Description- Endangered Species – Plants

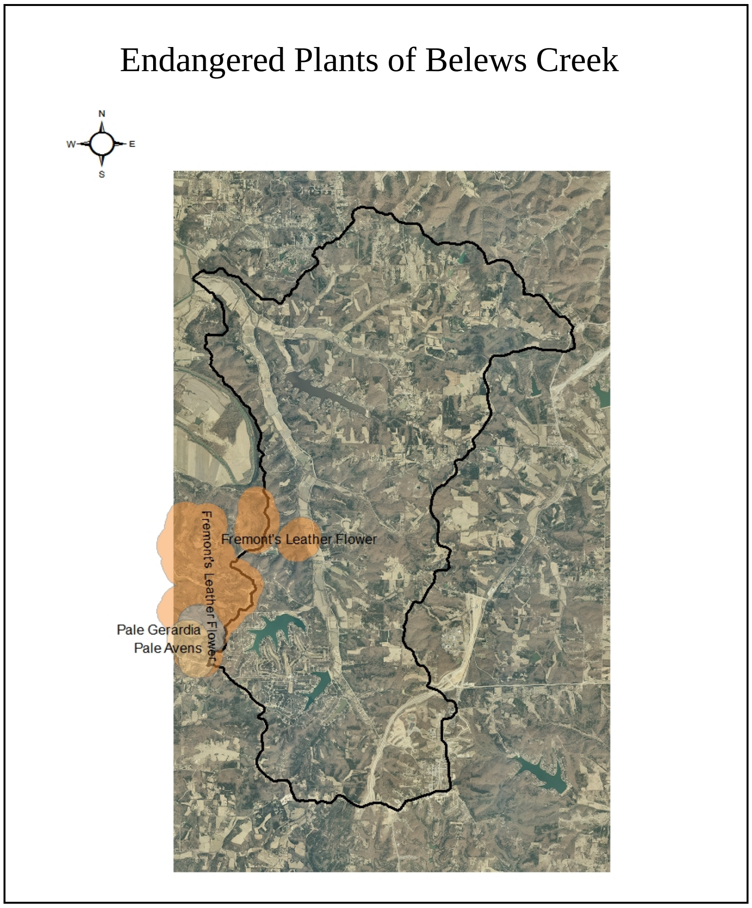


Figure 26 - Data Source: DNR

Figure 27:
Fremont's Leather Flower
Clematis fremontii

Fremont's Leather flower plants occur naturally in dolomite glades in Kansas, Missouri and Nebraska. Stalks grow up to two feet tall with bell shaped lavender and white flowers. They grow wild but can be planted and are excellent for a rock garden. Their endangerment in the watershed is partially caused by disturbance of their habitat due to changes in land use.

Figure 28:
Pale Gerardia
Agalinis Skinneriana

Pale gerardia is a hemiparasite, meaning that it attains some of its nutrients by attaching its roots to those of other nearby species. The plant occurs in small, scattered populations throughout Ohio to Missouri and Louisiana. It grows in different habitats, from sand to mesic prairies and from rocky open glades to moist thickets. The major threat to this species is destruction of habitat for development and from degradation due to invasive plant species.

Pale gerardia ranges in height from 4 inches to 2 feet. On its slender, pale green stems are small, oppositely arranged leaves. Pale pink flowers form on a raceme with corollas. Flowering generally occurs from August to September.

Section 3 – Watershed Assessment and Analysis

An evaluation of the current condition of the watershed was completed to determine the areas of concern and general condition of the watershed. This evaluation included a visual survey, water testing, species testing and an assessment of vulnerable conditions within the watershed. Analysis of the future condition of the watershed was based on projected changes in land usage.

The tasks completed for this assessment and analysis were as follows:

1. A visual survey was conducted by stakeholders to determine the areas of concern and general health of Belews Creek and its tributaries.

2. Water testing using Missouri Stream Team equipment and training was conducted along several areas of the creek to reveal pollutant loads. The results of a study of fish populations conducted by Missouri Department of Conservation in two areas of Belews Creek is an indicator of problematic influences.

3. Natural features and man-made influences that present vulnerable areas within and along the stream were evaluated.

4. Defining riparian corridors and the FEMA floodplain which will affect where future development can occur in the watershed.

3.1 – Visual Survey

The sources of water within the Belews Creek watershed were determined using the USGS Quad maps. The topographical map used was obtained from NCRS-EPA as image 336486_05 MDRGNRCS and reflects blue lines and intermittent blue lines beginning at first order streams.

Belews Creek and its tributaries were assigned a number scheme based upon mileage from the convergence with the Big River (mouth) upstream. Looking upstream, tributaries to the left were assigned an L and those to the right an R. For example the convergence of Sand Creek with Belews Creek occurs 1 mile upstream from the mouth and comes in from the left. This tributary was assigned a 1L with tributaries to it assigned a 1L plus mile from the convergence with Belews Creek and a left or right.

See Section 11.4 for the Field Survey index that reflects the entire watershed and individual maps providing more detail for specific areas. The citizen volunteers for the watershed were trained on how to conduct a visual survey of the stream and tributaries and provided a form to record findings. Individuals volunteered to accept the responsibility to conduct the visual surveys for all of the numbered tributaries. Ideally the surveys would be conducted when the leaves were off of the trees and the stream corridor could be observed at the same time.

The detailed maps for each of the tributaries contained aerial photography in enough detail that structures could be identified. The parcel boundaries with ownership were overlaid on the aerials. The volunteers were instructed to make contact with land owners and obtain permission to cross their land when conducting the surveys.

Specific laterals that were assigned but were not surveyed in this initial effort were

Belews Creek from 7.5R to End
4L, 4.0L1L and 4.0L1R
5.2L
7L
7.6L (shown on maps as 7.6R)

The location where the above unsurveyed laterals intersect with Belews Creek were visited during the initial effort and nothing of concern was found. These laterals should be included in future field survey efforts.

The field survey findings and areas of concerns are as follows:

Bridges and minor stream crossings: Many bridge crossings are in need of repair. This includes both private and County bridges. The angle of the County bridges crossing the creek has changed the flow and direction of the water—causing water to shoot directly into the bank. Bridges with multiple piers obstruct water flow during heavy rains. Most private bridges built in the 1960s are in need of repair. County bridges were built in the 1980s.

It is recommended that the County Public Works Department set minimum design standards for future bridge construction (both public and private) so crossings do not restrict flow or direct flow into the bank. Another recommendation is to accurately size bridges and culverts.

Dams: There are two dams that have recently been built within 50-feet of Sand Creek. Both are on tributaries to Sand Creek. Both have spillways made of clay and small rock with water seeping from the dam bottoms. Because of this water seepage, silt from one dam is being washed into Sand Creek. The spillway of the other dam is starting to erode. Both dams can create flooding problems in the future.

Sediment, sand, and rocks: Another critical area the watershed team discovered is the huge amount of sediment and rocks that has collected in the channel of the creek. Trees that have taken root in this sediment have caused some concern about this channel blockage causing over-the-bank flooding during a heavy, rainy period.

One possible solution is clearing the creek channel of sediment and rocks with front-end loaders and cutting out vegetation in the creek channel to clear the path for water flow. This activity would require COE approval. Bank stabilization would also be necessary to help prevent or delay future sedimentation.

Creek bank disturbance: Disturbance of the creek bank is evident along Belews Creek. One property owner has removed dirt from the creek bank to put on other areas of his property. In another area, ATVs have been driven across the creek destroying vegetation on both sides of the creek. In yet another area, cattle are being fed along the banks of Belews Creek causing destruction of the vegetation along the creek banks. In yet another area near an old homestead that sits on the banks of Sand Creek, old bottles, glass, and trash that has accumulated for years is being washed into Sand Creek during heavy rains. Trash piles killed bank vegetation causing major erosion in the same area.

Trash: It appears that during the last major flood trash was washed into Sand Creek. Everything from furniture, tires, construction material, carpet, etc. was found in the creek. About two truckloads of roofing shingles were located in the tributaries of Belews Creek.

Two "Waste Management" dumpsters washed into Belews Creek during the last major flood. The two dumpsters were removed during the November Clean Stream cleanup and Waste Management did pick them up. Due to their location, nothing will prevent the replacement dumpsters and any contents from washing into the creek during the next flooding event.

Behind the Hillsboro Water Treatment Plant and ball fields, posts set in concrete, fencing and trash was discovered. It appears trash from the uncovered and untethered ball field trash cans washed into the creek during a heavy rain event.

Public education and participation seems to be the solution to creek bank disturbance and trash dumping. Replacing the stream bank vegetation and creating a riparian border as well as establishing cattle feeding lots away from the stream bank would help solve the problems. Several Clean Stream events would help with trash removal.

Decaying vegetation: At the discharge into Sand Creek of the stream from Lake Tishomingo, surveyors noted a sewage-type odor after wading in the water. Considerable decaying plant and organic material was observed in this area.

Sewer and Septic Discharge: Overflow of the Raintree Plantation Sewer System has caused illicit discharge into Gallagher Creek that runs into Belews Creek. Raintree Plantation is in the process of replacing its sewage collection and treatment system with a much larger one to handle the present and anticipated volume. There are privately owned septic systems in the Lake Tishomingo development that are leaking.

3.2--Testing in Belews Creek

Chemical testing in the Belews Creek watershed was performed in accordance with Missouri Stream Team training using stream team provided testing equipment. Six site locations were selected based upon discharges from a Hillsboro sewage treatment plant (Site 2), discharges from the Raintree subdivision sewage treatment plant (Site 3), two miles downstream of the convergence of the two treatment plants (Site 1), outflow from Lake Tishomingo (Site 4), accumulated flow of Sand Creek (Site 5), and the last road access point on Belews Creek before the Big River (Site 6). Continued testing at these locations should be performed with results used in future analysis. See Section 11.5 for site locations.

Kevin Meneau, Fisheries Management Biologist with the Department of Conservation, presented data from two test sites along Belews Creek. In the area of the Hillsboro Ball Field/Hillsboro Sewage Treatment Plant, data showed a low fish species diversity. Testing results indicated that something is impacting the water in that area. Only four species of fish were found in their sampling as shown in the following table.

Downstream near Beverly Road, a similar sampling discovered 20 species of fish. Although the relative abundance of species was disappointing, the site was much improved over the Hillsboro Ball Field testing site as shown below.

Belews Creek Watershed Species Testing Site -Hillsboro Ball Field Site		
Species	**Total**	**Relative Abundance**
Creek chub	4	13.79%
Southern redbelly dace	2	6.90%
Stoneroller	19	65.52%
Bluegill	4	13.79%
Totals	29	100.00%

Table 4: Fish Species Testing Site at Hillsboro Ball Field

Table 5: Fish Species Test Site at Beverly Road

Belews Creek Watershed Species Testing Site – Beverly Road		
Species	**Total**	**Relative Abundance**
Bigeye chub	9	0.91%
Bleeding shiner	19	1.93%
Bluntnose minnow	21	2.13%
Creek chub	26	2.64%
Hornyhead chub	28	2.84%
Ozark minnow	30	3.05%
Stoneroller	627	63.65%
Striped shiner	105	10.66%
Northern hogsucker	1	0.10%
White sucker	2	0.20%
Slender madtom	1	0.10%
Yellow bullhead	3	0.30%
Blackstripe topminnow	4	0.41%
Bluegill	20	2.03%
Green sunfish	17	1.73%
Hybrid sunfish	1	0.10%
Longear sunfish	25	2.54%
Greenside darter	2	0.20%
Orangethroat darter	42	4.26%
Rainbow darter	2	0.20%
Totals	985	100.00%

3.3—Natural & Man-made Features

Belews Creek and its tributaries have segments that are designated as Losing Streams. Missouri Department of Natural Resources database of losing and gaining streams reflect the locations of the losing streams in the watershed. (See Section 11.2). During a field visit, immediately downstream of the convergence of Belews Creek and Gallagher Creek running water totally disappears. A significant volume of water was flowing in both streams to this point with the major source for Belews Creek being Hillsboro's wastewater treatment plant and Gallagher Creek being Raintree's wastewater treatment plant. Downstream from the point of disappearing, the creek bed is solid bedrock with no visible water flow. This location and potentially others should be further studied. The effects of losing streams are unknown.

The Belews Creek watershed has an area with sinkholes designated on the Missouri DNR database. The area is on the north and south side of Redbird Lane near Hillsboro-House Springs Road. See Belews Creek Sinkholes map, Figure 21, for locations. The effects of sinkholes are unknown and should be further studied.

The mineral lead in its natural state is evident within the Belews Creek watershed. Raintree Plantation's Well #1 pumps water containing a level of lead that is within acceptable standards. When this well is used the water is blended with water from the second well and residents are informed. Records are maintained for these occasions.

Jefferson County Historical Atlas maps reflect areas within the watershed that were at one time owned by mining companies. The Missouri DNR database contains data on IMOP (Intermittent Mine Operations) that reflects mines in the watershed. Mining for lead is shown at three locations with one for each of barium, limestone, clay, and sand and gravel. Additional research should be conducted to understand if these mining operations had or are having any effect on the watershed.

Specific soil types found in the watershed have a bearing on erosion and subsequent sediment transfer. Field visits revealed heavy deposits of sand in the tributary feeding Lake Tishomingo. The volume of sand is so severe that the homeowners association purchased their own dredge to remove deposits from the lake. Immediately upstream from the bridge over the tributary the sand is 3 to 4 feet in depth. Further upstream the sand is not evident in the creek bed which indicates the sand is being carried with the stream flow to this location where it slows and settles out. The soils map for Belews Creek reflects a soil type of 60265 (Pevely-Holstein complex, 8 to 30 percent slopes) along the eastern side of the watershed. The parent material for Pevely (60%)is fine-loamy residuum weathered from sandstone and for Holstein (40%) is fine-loamy colluvium derived from sandstone. The soil erodibility factor (Kf) for Pevely is 0.28 which is in the mid range of Jefferson County soils. The wind erodibility index (an indication of the amount of soil lost in tons per year per acre) is 56 for Pevely and 86 for Holstein. These are on the high side when compared to other soils in the county.

Heavy sand and gravel deposits were found in Sand Creek west of the bridge at Regina Road and downstream of a Regina Road bridge over a tributary to Sand Creek In both cases, the soil upstream is also shown as 60265.

Significant erosion and soil transfer was also observed in a tributary feeding the smallest lake (designated as Winter Lake) in the Raintree subdivision. This lake slows the water flow and allows the sediment to settle out before going to an adjacent downstream lake (designated as Summer Lake) and then into Belews creek. The soil type in this area is designated as 75390 (Razort silt loam, 0 to 3 percent slopes) which has a parent material of fine-loamy alluvium over gravelly alluvium. Razort has a soil erodibility factor of 0.43 which is the highest of all soil types in the county and a wind erodibility of 56.

The Missouri DNR regulates the discharges from the two wastewater treatment plants located in the Belews Creek watershed. The Raintree treatment plant has exceeded the allowable limits and additional/new hookups to the system have been placed on hold until the plant capacity is increased. Proposed expansion has been designed and submitted to DNR for approval. When the work is completed, new hookups will once again be allowed and a significant increase in residential occupancy can be anticipated.

3.4-- Riparian Corridors

Riparian corridors are critical to the welfare of a stream's condition. Riparian corridors provide a buffer zone that filters pollutants carried with stormwater. Jefferson County's Land Disturbance and Stormwater Management regulations, Article 10 of the Unified Development Order, state that for new development a 100' buffer zone (from top of bank) must remain undisturbed and reserved for the riparian corridor for stream order 3 and above. For stream orders 1 and 2, the buffer zone is 50'. See Section 11.1 for a map reflecting Belews Creek Stream Order for the watershed. The stream order designation on this map will be followed for new development.

The existing riparian corridor is represented on a series of maps titled Belews Creek Riparian Corridors and FEMA Flood Hazard Boundaries (Section 11.6). The aerial photography used to generate these maps was from 2007 and with the scale of 1"=500' the width of the existing corridor can be approximated. It can be observed that the existing corridor varies from virtually no corridor in places, especially along fields that are being farmed, to 100's of feet at other locations. An on-going project for the Belews Creek Watershed Partnership would be to establish/re-establish corridors in those locations where they do not exist. New development in the watershed should comply with the buffer zone requirements.

3.5 – FEMA Flood Hazard Boundaries

The FEMA Flood Hazard Boundaries represent the 100 year (1% annual chance flood) floodway and floodplain from the mouth of Belews Creek upstream to the convergence of Belews and Sand Creek. From that point upstream only the floodplain is shown. When new development is proposed in an area where the floodway is not shown, the area must be studied and a floodway determined before the development can be reviewed. The Jefferson County Flood Damage Prevention Ordinance does not permit any development in the floodway.

Throughout the watershed the stream is still connected with the floodplain. When flood events occur and water reaches bank full, often referred to as Q2 (Quantity at a 2 year storm event), water is released into the floodplain relieving destructive forces and continued bank erosion.

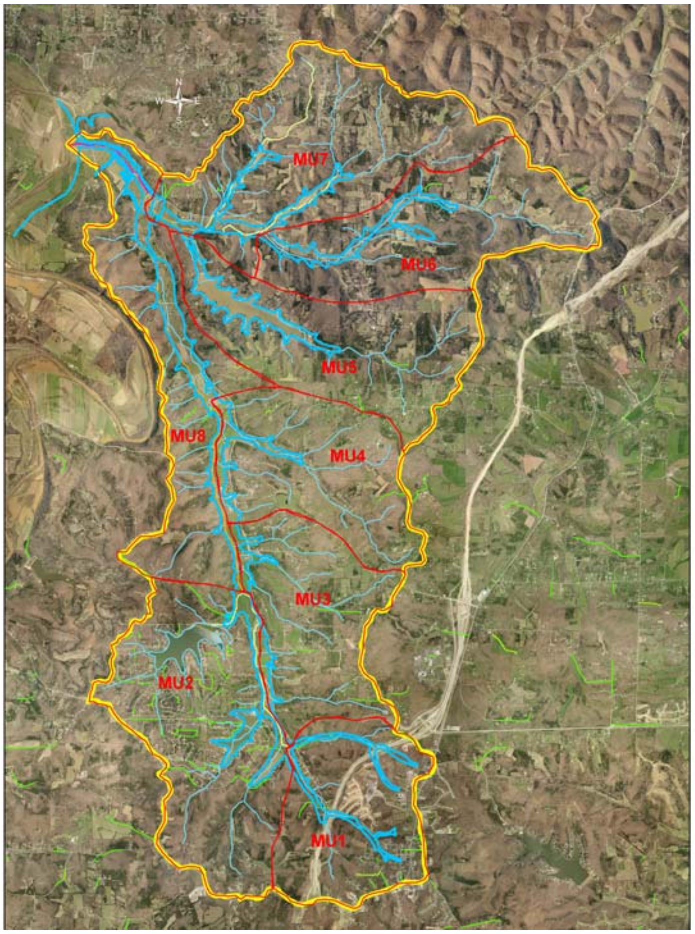


Figure 29 - Source: Jefferson County Stormwater Division. Depiction of FEMA Floodplain along Belews Creek.

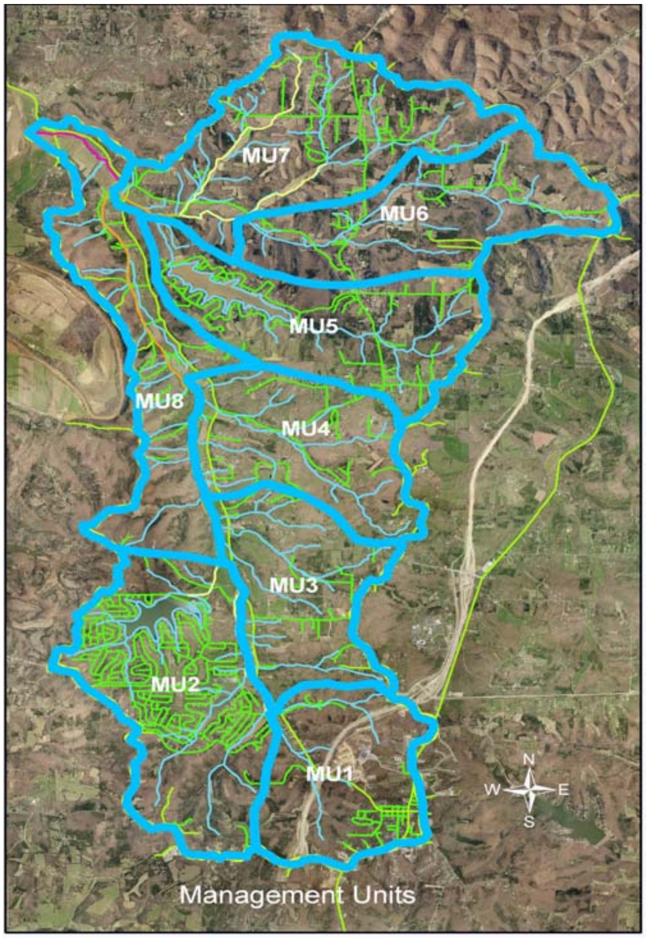


Figure 30: Belews Creek Management Units
Jefferson County GIS mapping

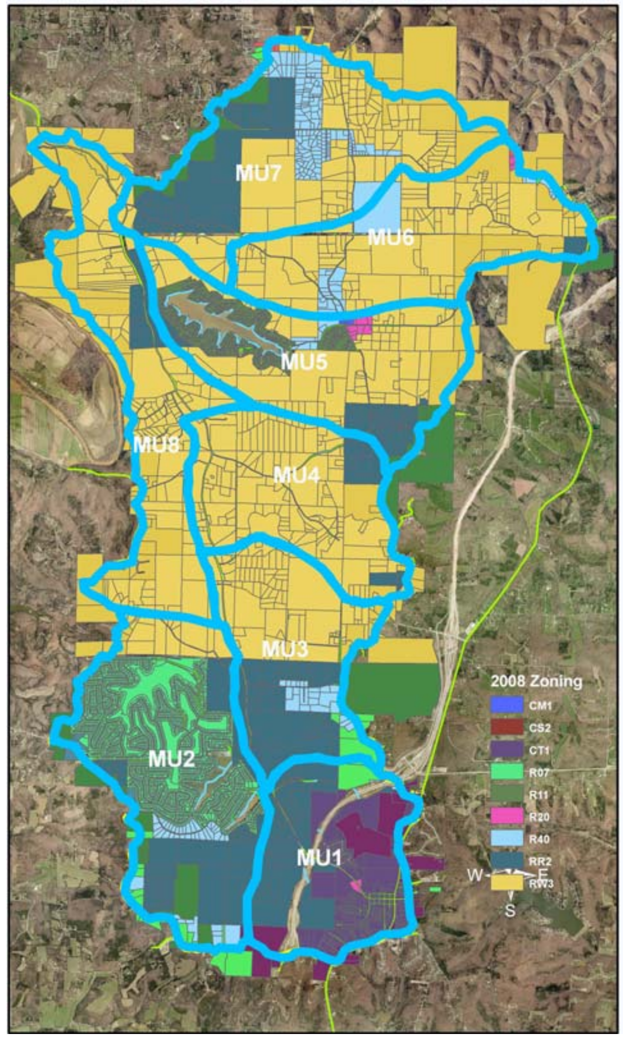


Figure 31: 2008 Belews Creek Zoning
Jefferson County GIS mapping

To best address characteristics and the critical issues of Belews Creek Watershed, the watershed was divided into eight Management Units based upon stream characteristics. The units are outlined as shown in Figure 30 above.

This section of the watershed plan will describe current zoning and projected zoning within each management unit. Figure 31 is the existing (2008) Zoning based on information from Jefferson County's Planning and Zoning Division. This map shows overlays of Management Units on the existing zoning data.

Legend of Zoning Codes

CM1	General Commercial District
CS2	Commercial Services District
CT1	City Limits of Hillsboro
R07	Residential – Min 7,000 sq. ft*
R11	Residential – Min. 11,000 sq. ft*
R20	Residential – Min. 20,000 sq. ft*
R40	Residential – Min. 40,000 sq. ft*
RR2	Rural Residential – Min. 2 acres
RW3	Rural Woodlands – Min. 3 acres

*with public sewers, otherwise minimum 2 acres with septic

4.1 Management Unit One

Management Unit One contains 1650 acres and includes the headwaters of Belews Creek as well as the City of Hillsboro. As the picture shows, new Highway 21 will intersect with Belews Creek. New development has already begun along the new Highway 21 corridor.

As the headwaters flow in a northerly direction, tributaries merge with the main stream. As a result, we have Stream Orders 1 and 2 in this Management Unit.

The chart below summarizes an analysis of Land Use in this Management Unit as it stands now and a projection of land usage in twenty years.

Figure 32: Management Unit One
Jefferson County GIS mapping

	2008		2028	
	Acreage	***Percent***	***Acreage***	***Percent***
City of Hillsboro	**750**	**45**	**1155**	**70**
R40	**165**	**10**	**85**	**5**
RR2	**650**	**40**	**85**	**5**
Commercial	**85**	**5**	**325**	**20**

Table 6: MU1 Projections

Figure 33 - View of Highway BB from New Highway 21 in MU1.

Figure 34: Belews Creek at Hillshire Road

Figure 35: Farm on Hillshire Road is representative of the rural landscape in MU1.

4.2 --Management Unit 2

Management Unit Two is made up of 2,650 acres. Within the boundaries of Management Unit Two is Raintree Plantation, a gated community with four lakes and a golf course. Over 600 houses are currently within Raintree. Gallagher Creek, (Stream Order 3) runs through Raintree and into Belews Creek.

This section of Belews Creek contains two sewage Treatment Plants – one for the City of Hillsboro and one for Raintree Plantation.

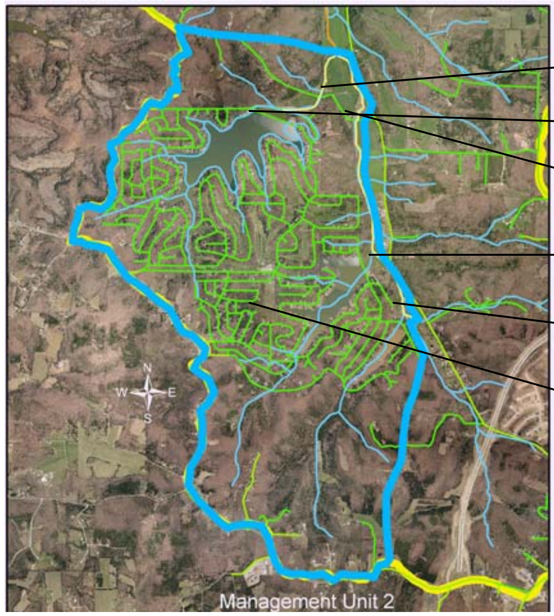


Figure 36: Management Unit Two Jefferson County GIS mapping

The chart below summarizes an analysis of Land Use in this Management Unit as it stands now and a projection of land usage in twenty years.

	2008		**2028**	
	Acreage	***Percent***	***Acreage***	***Percent***
R07	0	0	130	5
R11	2120	80	2120	80
R40	130	5	135	5
RR2	270	10	130	5
RW3	130	5	0	0
Commercial	0	0	135	5

Table 7: MU2 Projections

Figure 37: Gallagher Creek is a tributary to Belews Creek

Figure 38: Belews Creek at Klondike Road Bridge

Figure 39: Hillsboro Sewage Treatment Plant

4.3--Management Unit 3

Management Unit Three covers approximately 1,650 acres and can best be described as large parcel acreage in a rural environment. It sits in close proximity to new Highway 21 and Highway A. It is convenient to the Festus/Crystal City shopping area and I-55.

Sink holes have been identified in this MU as the map shows. The entire MU is on septic systems.

Figure 40: Manageament Unit Three Jefferson County GIS mapping

The chart below summarizes an analysis of Land Use in this Management Unit as it stands now and a comparative projection of land usage in twenty years.

	2008		2028	
	Acreage	***Percent***	***Acreage***	***Percent***
R07	0	0	85	5
R11	0	0	660	40
R40	165	10	165	10
RR2	990	60	495	30
RW3	495	30	80	5
Commercial	0	0	165	10

Table 8: MU3 Projections

Figure 41: View from Hillsboro House Springs Road

Figure 42: Hillsboro Ball Fields along Belews Creek

4.4 -- Management Unit 4

Management Unit Four contains approximately 1,750 acres that are predominately large acre parcels. Due to the location and proximity to new Highway 21, this MU contains parcels that are good candidates for development. The entire MU is on septic systems.

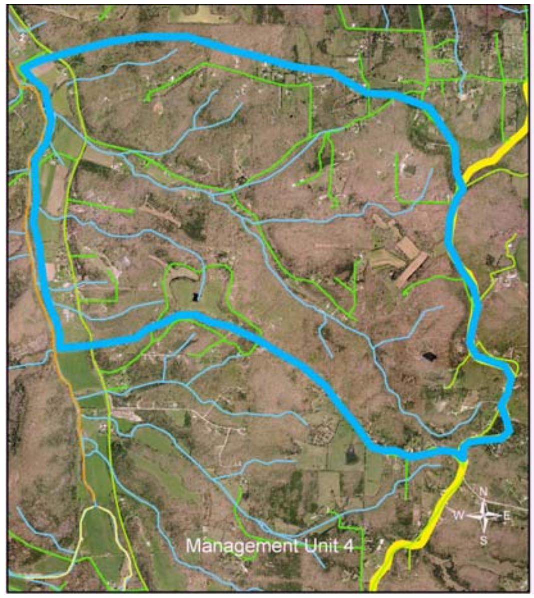


Figure 43: Management Unit Four
Jefferson County GIS mapping

The chart below summarizes an analysis of Land Use in this Management Unit as it stands now and a comparative projection of land usage in twenty years.

	2008		2028	
	Acreage	***Percent***	***Acreage***	***Percent***
R07	0	0	0	0
R11	0	0	525	30
R40	0	0	525	30
RR2	90	5	350	20
RW3	1660	95	350	20
Commercial	0	0	0	0

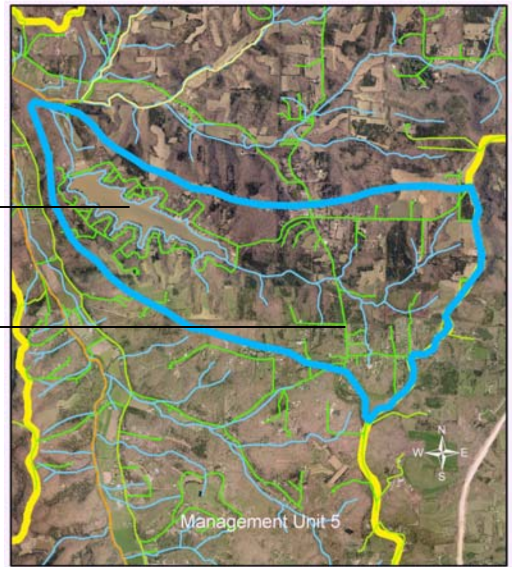
Table 9: MU4 Projections

Figure 44: Pictometry 2008 view of Management Unit 4 and its large acre tracts.

4.5 -- Management Unit 5

Lake Tishomingo

Belews Creek
Post Office &
Chapel



This Management Unit contains Lake Tishomingo – a 450-unit lake development as its most prominent feature. Tributaries feed into the lake.

Lake Tishomingo is impaired with sediment due to the naturally occurring highly erodable soil types in this area. Lake Tishomingo is currently on septic systems, but residents have discussed building a central sewer system for the development. There are approximately 2,100 acres in this MU.

Figure 45: Management Unit Five Jefferson County GIS mapping

The chart below summarizes an analysis of Land Use in this Management Unit as it stands now and a comparative projection of land usage in twenty years.

	2008		2028	
	Acreage	*Percent*	*Acreage*	*Percent*
R07	0	0	105	5
R11	420	20	840	40
R20	105	5	210	10
R40	105	5	420	20
RR2	210	10	210	10
RW3	1260	60	210	10
Commercial	0	0	105	5

Table 10: MU5 Projections

Figure 46: Belews Creek Post Office

Figure 47: View of Lake Tishomingo

Figure 48: Belews Creek Chapel

4.6 --Management Unit 6

Sand Creek, a tributary to Belews Creek, is the distinguishing characteristic of this Management Unit. Stream Orders 1 and 2 are tributaries of Sand Creek.

This MU contains large-acre parcels in close proximity to Highway 21. Because it lies close to new Highway 21, growth in this area is expected within the next 20 years. There are about 2,050 acres in this MU.

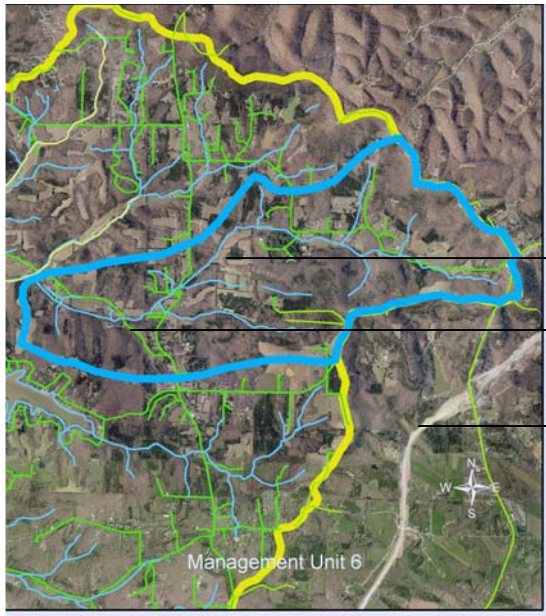


Figure 49: Management Unit Six Jefferson County GIS mapping

The table below reflects land use as it is now and projected land usage in twenty years.

	2008		2028	
	Acreage	***Percent***	***Acreage***	***Percent***
R07	0	0	0	0
R11	0	0	295	10
R20	0	0	410	20
R40	205	10	615	30
RR2	0	0	410	20
RW3	1845	90	310	15
Commercial	0	0	100	5

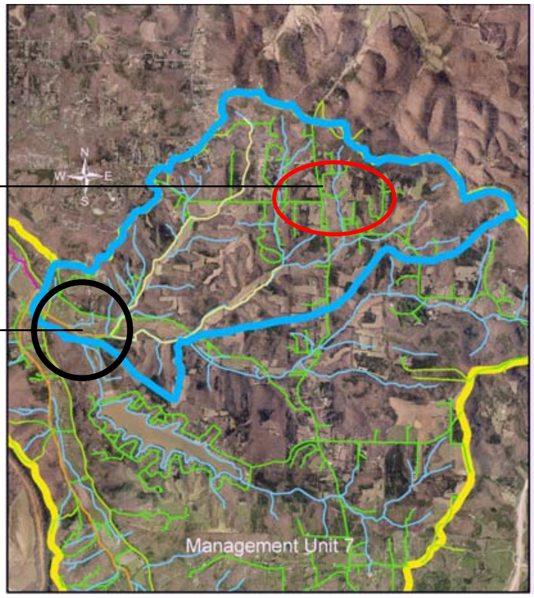
Table 11: MU6 Projections

Figure 50

Two views of Sand Creek, a tributary to Belews Creek, at Regina Road.

Figure 51

4.7 -- Management Unit 7



There are about 2,600 acres in this Management Unit. Two Stream Order 3's (in Yellow) form Stream Order 4 – Sand Creek (shown in Orange).

The existing road infrastructure in this Management Unit provides limited access to major highways.

Figure 52: Management Unit 7 Jefferson County GIS mapping

The table below reflects land use as it is now and projected land usage in twenty years for this section of Belews Creek Watershed.

	2008		2028	
	Acreage	***Percent***	***Acreage***	***Percent***
R07	0	0	0	0
R11	0	0	260	10
R20	130	5	520	20
R40	260	10	780	30
RR2	520	20	520	20
RW3	1690	65	390	15
Commercial	0	0	130	5

Table 12: MU7 Projections

Figure 53: "What A Life" in rural Jefferson County.

Figure 54: Beautiful rolling hills can be seen in this watershed.

Figure 55: Farms and large parcels are the norm in this watershed.

4.8 -- Management Unit 8

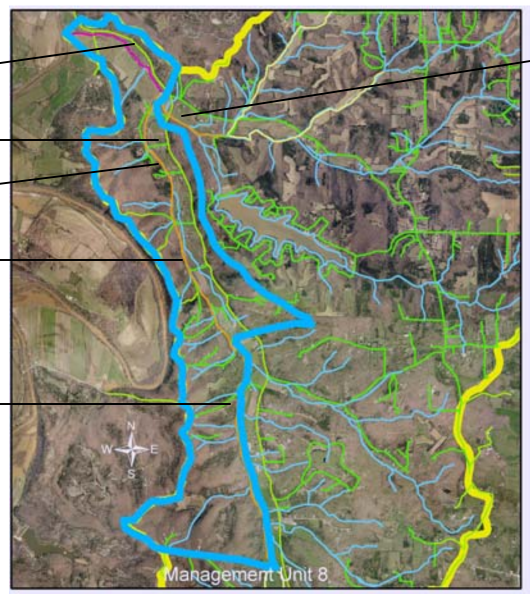


Figure 56: Management Unit Eight.   Jefferson County GIS mapping

This MU includes Stream Order 4 of Belews Creek followed by Stream Order 5 to the confluence with Big River. There is farming – including agriculture and livestock – along the Belews Creek corridor. The FEMA floodplain is prevalent in this area and will potentially affect the amount of development occurring in this area. There are approximately 2,050 acres in this section.

The table below reflects land use as it is now and projected land usage in twenty years for this section of Belews Creek Watershed.

	2008		**2028**	
	Acreage	***Percent***	***Acreage***	***Percent***
R07	0	0	0	0
R11	0	0	0	0
R20	0	0	205	10
R40	0	0	410	20
RR2	100	5	310	15
RW3	1,950	95	1,025	50
Commercial	0	0	100	5

Table 13: MU8 Projections

Figure 59: Bridge at Mimi Mountain crosses Belews Creek

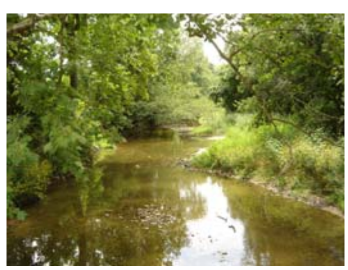


Figure 58: Belews Creek at Clayton Huskey Road

Figure 57: Pictometry 2008 view of MU 8.

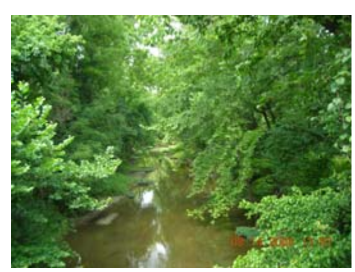


Figure 60: Belews Creek at Stump Hollow Road

Section 4.9 – L-THIA Projections

Land use changes can significantly impact groundwater recharge, stormwater drainage, and water pollution. The Long-Term Hydrologic Impact Assessment (L-THIA) model was utilized to assess the water quality impacts of land use change twenty years from now. Based on community-specific climate data, L-THIA was utilized to estimate changes in recharge, runoff, and non-point source pollution resulting from current and proposed development.

The results of these projections will be used to generate community awareness of potential long-term problems and to support planning aimed at minimizing disturbance of critical areas. It is our goal to minimize the impact on Belews Creek Watershed's natural environment by evaluating the potential effects of land use change and identifying the best location of particular land uses.

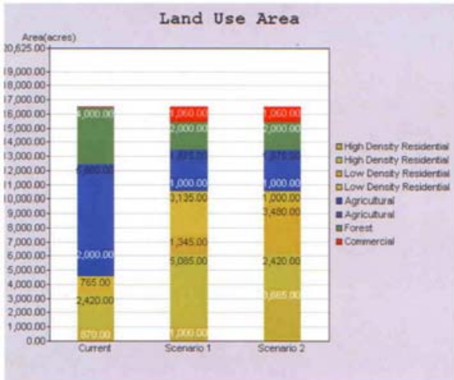
The data used for these projections was based on the watershed's location within the state and county, the type of soil in the area where the land use change is to occur, and the type and size of land use change that will occur. The current zoning and associated acreage for each management unit was determined using the County's GIS data. Utilizing the Watershed Partnership's knowledge of the Belews Creek watershed, projections were made as to where and what type of development might be anticipated in 20 years (2028). This information is reflected by Management Units in Section 4.1.

Based upon the land use categories in the L-THIA Model, the Jefferson County zoning was associated to high density residential, low density residential, agricultural, forest or commercial. Using the Jefferson County soils data, hydrologic soils groups A to D were assigned to reflect the current and 2028 acreage in each category. This data is reflected in the current and Scenario 1in the following Summary of Scenarios.

Scenario 2 reflects the same land use categories used in Scenario 1 and the incorporation of stormwater management practices throughout the watershed by Management Unit. To model Scenario 2, the soil types were modified to reflect no greater runoff after construction than in a pre-construction environment and riparian corridors meeting Jefferson County requirements.

Stormwater runoff is the major contributor to non-point pollution. Based upon Jefferson County rainfall data in the L-THIA Model, anticipated annual runoff volume and runoff depth by land use are reflected in the following section – Results of Runoff Analysis.

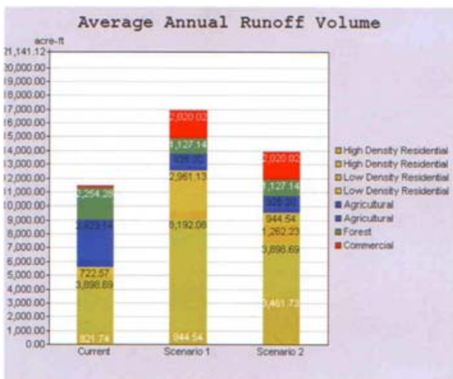
4.9.1 – L-THIA Results of Runoff Analysis



SUMMARY OF SCENARIOS
State: Missouri
County: Jefferson

View as: Bar graph

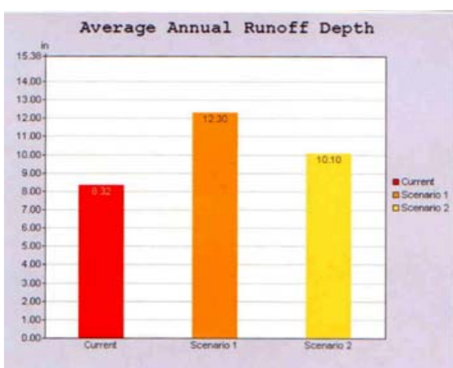
Land Use	Hydrologic Soil Group	Current	acres Scenario 1	Scenario 2
High Density Residential	B	870	1000	3665
High Density Residential	D	2420	5085	2420
Low Density Residential	B	500	1345	3480
Low Density Residential	D	765	3135	1000
Agricultural	A	2000	1000	1000
Agricultural	B	5860	1875	1875
Forest	D	4000	2000	2000
Commercial	C	85	1060	1060



RUNOFF RESULTS
Avg. Annual Runoff Volume (acre-ft)

View as: Select

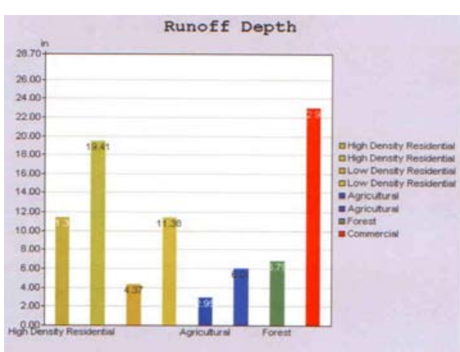
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	821.74	944.54	3461.73
High Density Residential	3898.69	8192.08	3898.69
Low Density Residential	181.35	487.84	1262.23
Low Density Residential	722.57	2961.13	944.54
Agricultural	489.7	244.85	244.85
Agricultural	2923.14	935.30	935.30
Forest	2254.28	1127.14	1127.14
Commercial	161.98	2020.02	2020.02
Total Annual Volume (acre-ft)	11453.47	16912.92	13894.51



Avg. Annual Runoff Depth (in)

View as: Select

Current	Scenario 1	Scenario 2
8.32	12.30	10.10



Avg. Runoff Depth by Landuse

View as: Select

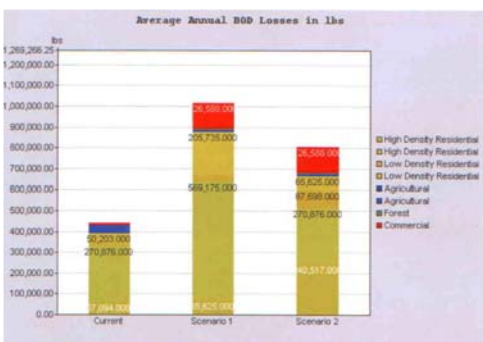
Land Use	Hydrologic Soil group	Curve Number	Runoff Depth (in)
High Density Residential	B	85	11.38
High Density Residential	D	92	19.41
Low Density Residential	B	70	4.37
Low Density Residential	D	85	11.38
Agricultural	A	64	2.95
Agricultural	B	75	6.01
Forest	D	77	6.79
Commercial	C	94	22.96
Average Annual Rainfall Depth (in)			45.98

Section 4.9.2 – Results of Non-Point Source Pollutant Analysis

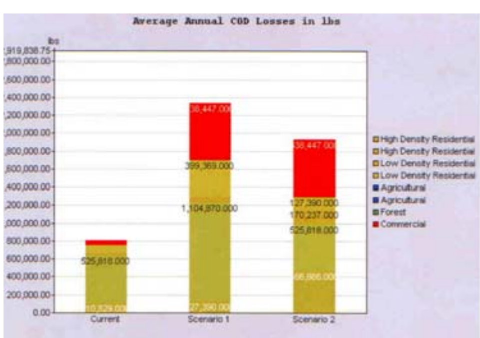
The Long-Term Hydrologic Impact Assessment results for non-point pollutants are reflected in the following tables and bar graphs. The current scenario reflects existing conditions in 2008. Scenario 1 (2028) is an indication of what might be expected in the Belews Creek Watershed as growth and land use changes occur and if no Stormwater Management BMP's were implemented. The increase in BOD - 130%, COD - 188%, Oil & Grease - 259%, Suspended Solids - 24%, Fecal Coliform - 46% and Fecal Strep - 133% are significant.

Scenario 2 reflects utilizing Stormwater Management Best Method Practices (BMP's) as required in the Jefferson County Stormwater Ordinance will result in post construction runoff being no greater than pre-construction. Visit the Jefferson County Stormwater website at www.jeffcomo.org/ludce/stormwater to review the Stormwater Ordinance. Complying with the Jefferson County riparian corridor requirements and using Low Impact Design (LID) will allow runoff to stay on-site and penetrate into the ground. LID is a land planning and engineering approach to managing stormwater runoff. LID emphasizes conservation and use of on-site natural features to protect water quality. This approach replicates pre-development hydrologic regime of watersheds through infiltration, filtering, storing, evaporating and detaining runoff close to its source.

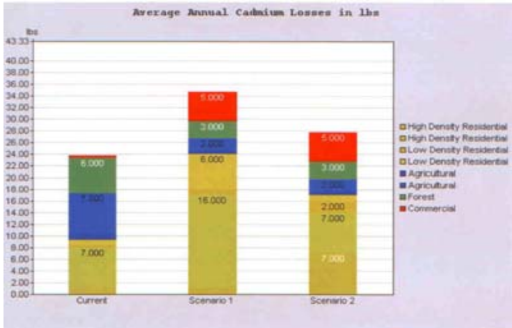
To model Scenario 2 the soil types for each Management Unit were modified to soils that will provide a lower runoff potential and higher infiltration rate that that used in Scenario 1. These results reflect an increase in BOD over current to be 82% vs. 130%, COD – 138% vs. 188%, Oil & Grease – 213% vs. 259%, Suspended Solids – 4% vs 24%, Fecal Coliform – 16% vs 46%, and Fecal Strep – 80% vs. 133%.



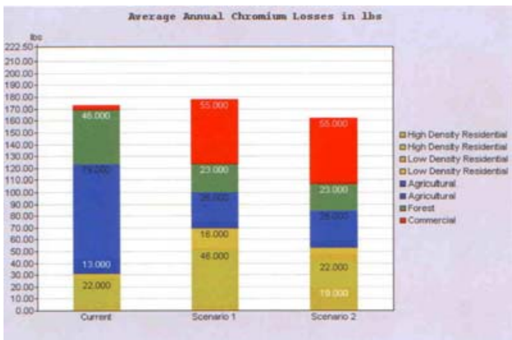
BOD (lbs)		View as: Select	
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	57094	65625	240517
High Density Residential	270876	569175	270876
Low Density Residential	12600	33894	87698
Low Density Residential	50203	205735	65625
Agricultural	5337	2668	2668
Agricultural	31858	10193	10193
Forest	3071	1535	1535
Commercial	10150	126588	126588
Total	441189	1015413	805700



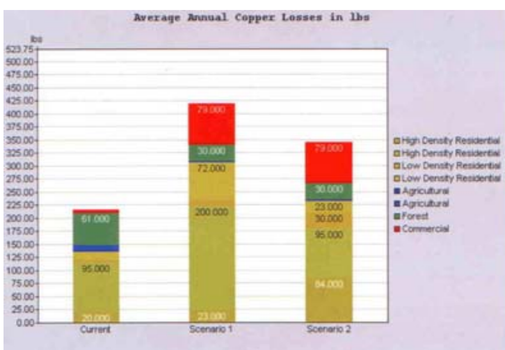
COD (lbs)		View as: Select	
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	110829	127390	466886
High Density Residential	525818	1104870	525818
Low Density Residential	24459	65795	170237
Low Density Residential	97453	399369	127390
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	51196	638447	638447
Total	809755	2335871	1928778



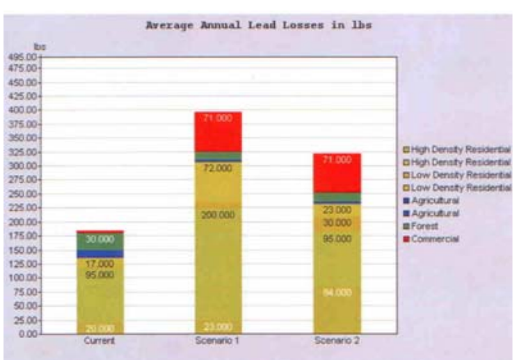
Cadmium (lbs)		View as: Select	
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	1	1	7
High Density Residential	7	16	7
Low Density Residential	0.370	0.996	2
Low Density Residential	1	6	1
Agricultural	1	0.667	0.667
Agricultural	7	2	2
Forest	6	3	3
Commercial	0.423	5	5
Total	23.793	34.663	27.667



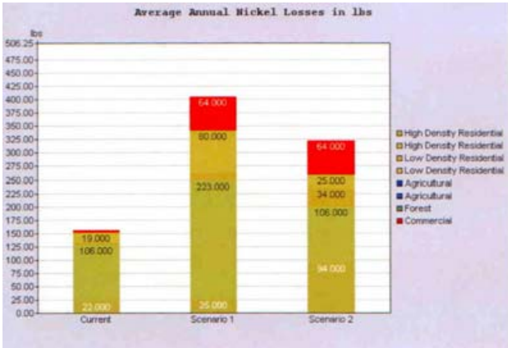
Chromium (lbs)		View as: Select	
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	4	5	19
High Density Residential	22	46	22
Low Density Residential	1	2	7
Low Density Residential	4	16	5
Agricultural	13	6	6
Agricultural	79	25	25
Forest	46	23	23
Commercial	4	55	55
Total	173	178	162



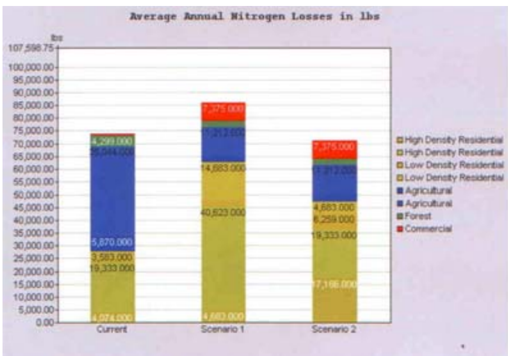
Copper (lbs)		View as: Select	
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	20	23	84
High Density Residential	95	200	95
Low Density Residential	4	11	30
Low Density Residential	17	72	23
Agricultural	2	1	1
Agricultural	11	3	3
Forest	61	30	30
Commercial	6	79	79
Total	216	419	345



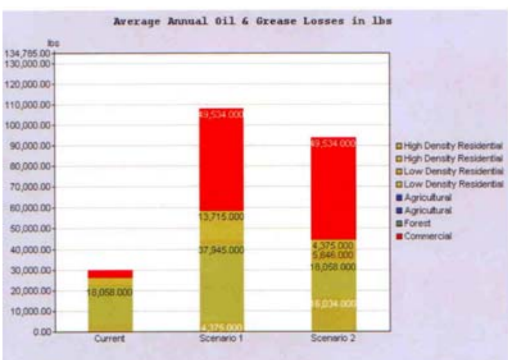
Lead (lbs)		View as: Select	
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	20	23	84
High Density Residential	95	200	95
Low Density Residential	4	11	30
Low Density Residential	17	72	23
Agricultural	2	1	1
Agricultural	11	3	3
Forest	30	15	15
Commercial	5	71	71
Total	184	396	322



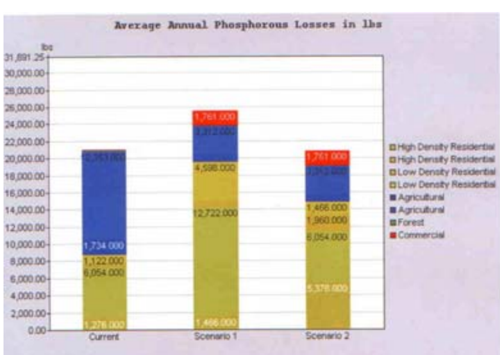
Nickel (lbs)		View as: Select	
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	22	25	94
High Density Residential	106	223	106
Low Density Residential	4	13	34
Low Density Residential	19	80	25
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	5	64	64
Total	156	405	323



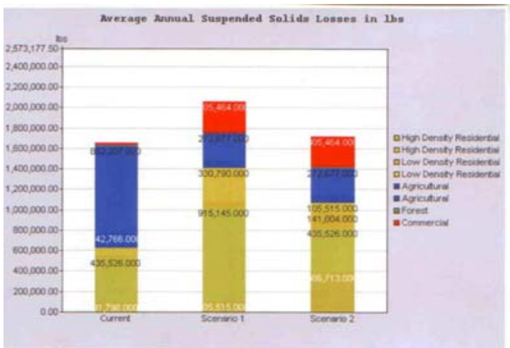
Nitrogen (lbs)		View as: Select	
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	4074	4683	17166
High Density Residential	19333	40623	19333
Low Density Residential	899	2419	6259
Low Density Residential	3583	14683	4683
Agricultural	5870	2935	2935
Agricultural	35044	11212	11212
Forest	4299	2149	2149
Commercial	591	7375	7375
Total	73693	86079	71112



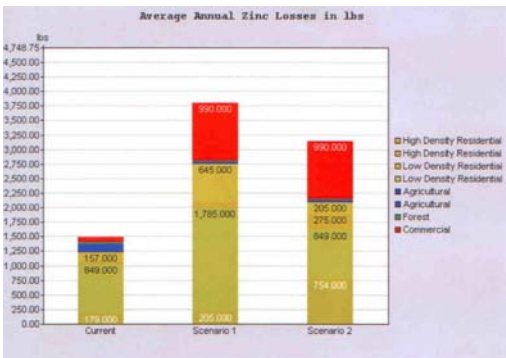
Oil & Grease (lbs)		View as: Select	
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	3806	4375	16034
High Density Residential	18058	37945	18058
Low Density Residential	840	2259	5846
Low Density Residential	3346	13715	4375
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	3972	49534	49534
Total	30022	107828	93847



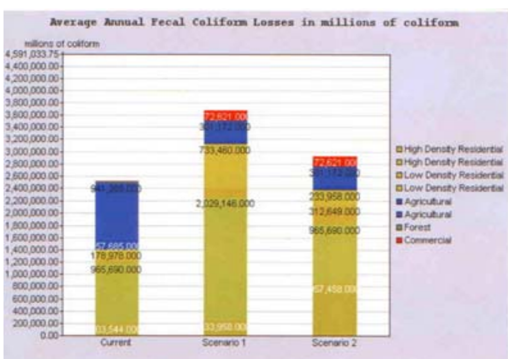
Avg. Runoff Depth by Landuse		View as: Select	
Land Use	Hydrologic Soil group	Curve Number	Runoff Depth (in)
High Density Residential	B	85	11.38
High Density Residential	D	92	19.41
Low Density Residential	B	70	4.37
Low Density Residential	D	85	11.38
Agricultural	A	64	2.95
Agricultural	B	75	6.01
Forest	D	77	6.79
Commercial	C	94	22.96
Average Annual Rainfall Depth (in)			45.98



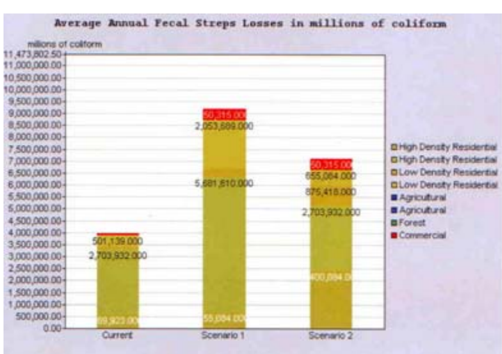
Suspended Solids (lbs)		View as: Select	
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	91798	105515	386713
High Density Residential	435526	915145	435526
Low Density Residential	20259	54497	141004
Low Density Residential	80719	330790	105515
Agricultural	142766	71383	71383
Agricultural	852207	272677	272677
Forest	6142	3071	3071
Commercial	24494	305464	305464
Total	1653911	2058542	1721353



Zinc (lbs)		View as: Select	
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	179	205	754
High Density Residential	849	1785	849
Low Density Residential	39	106	275
Low Density Residential	157	645	205
Agricultural	21	10	10
Agricultural	127	40	40
Forest	36	18	18
Commercial	79	990	990
Total	1487	3799	3141



Fecal Coliform (millions of coliform)		View as: Select	
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	203544	233958	857458
High Density Residential	965690	2029146	965690
Low Density Residential	44920	120837	312649
Low Density Residential	178978	733460	233958
Agricultural	157685	78842	78842
Agricultural	941265	301172	301172
Forest	5583	2791	2791
Commercial	13842	172621	172621
Total	2511507	3672827	2925181



Fecal Strep (millions of coliform)		View as: Select	
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	569923	655084	2400884
High Density Residential	2703932	5681610	2703932
Low Density Residential	125778	338344	875418
Low Density Residential	501139	2053689	655084
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	36110	450315	450315
Total	3936882	9179042	7085633

The Belews Creek Watershed Partnership along with the staff of the Stormwater Management Division of Jefferson County completed an examination of the natural resources and critical areas within the watershed. The group wrote a mission statement with two primary goals for the Watershed Management Plan. The primary goals are:

> ***Prevent further degradation to Belews Creek***
> *The lack of and destruction of riparian corridors, increased development causing an increase in stormwater runoff, the floodplain, and failing septics are threats to Belews Creek.*
>
> ***Maintain the long-term quality of its water resources***
> *It is essential to protect Belews Creek by actively implementing and maintaining management objectives that address the causes and impacts of pollutant sources.*

Several issues should be addressed to accomplish these goals. The Watershed Partnership Committee developed the following list.

1. Evaluate stormwater runoff and its affect on the watershed.
2. Determine existing riparian corridors and educate landowners on the benefit of maintaining and/or establishing riparian corridors.
3. Encourage appropriate maintenance and repair of septic systems.
4. Encourage use of natural fertilizers, pesticides, herbicides, detergents, and eliminate yard waste dumping.
5. Minimize the runoff impact in areas of sinkholes and losing streams.
6. Prepare a Belews Creek Floodplain Study.
7. Evaluate the impact of existing and future dam designs.
8. Encourage building requirements for stream crossings (bridges).

5.1 Goal: Evaluate stormwater runoff and its affect on the watershed

5.1.1 Indicators: Evidence of erosion along the creek, suspended solids in water, the build-up of gravel, and plants and sediment in the creek channel. Evidence of sand and siltation filling in Lake Tishomingo. Loss of ground cover as new development increases. Soil with high erosion potential.

5.1.2 Source: Lack of riparian corridors, lack of erosion control, soil conditions, changes in land use – increase in impervious surfaces, lack of retention/detention areas.

Figure 61: Evidence of erosion

5.1.3 Objective: Utilize Jefferson County's Erosion & Sediment Control Stormwater Manual for erosion control techniques. Use the Long-Term Hydrologic Impact Assessment Model (L-THIA) to project affects of runoff. Establish a public education program delineating the benefits of Low Impact Development (LID) and rain gardens. Educate developers on soil types in planning future developments in highly erodible soils. Associate information on stream movements and the role channel gravel plays in the process.

Fig. 62: Construction

5.2 Goal: Determine existing riparian corridors and educate landowners on the benefit of maintaining and/or establishing riparian corridors.

5.2.1 Indicators: Creek bank erosion and disturbance, surface runoff running directly into the creek, lack of groundwater to replenish creek, and warm creek water.

5.2.2 Source: Evidence of ATVs running through the creek and destroying vegetation along the banks, cattle in the creek destroying stream bank vegetation, lack of bank stabilization, buffer strips removed for farming

Fig. 63: ATV path through the creek

5.2.3 Objective: Develop a program to educate landowners about the benefits of maintaining and/or establishing riparian corridors along the creek. Inform farmers of alternate ways of watering livestock to keep them out of creek channel.

5.3 Goal: Encourage appropriate maintenance and repair of septic systems.

5.3.1 Indicators: In areas affected by illicit discharges, water contain algae bloom, plant decay odor, leaking drain lines, and septic odor.

5.3.2 Source: Lack of septic system maintenance, failure of private onsite septic systems and overflow from sewage plant at Raintree.

Fig. 64: Septic discharge

5.3.3 Objective: Develop a public education program on proper care and repair of septic systems. Develop pump-out programs. Monitor evidence of leaking septics and involve county inspectors where appropriate. Economic Development occasionally has funding available to replace failing septics.

5.4 Goal: Encourage intelligent use of chemical fertilizers, pesticides, herbicides, proper use of detergents and proper ways to handle yard waste

5.4.1 Indicators: Algae growth, cloudy water, odor of decay caused by excessive phosphorus and nitrogen in the water. Yard waste washes into creek causes damage to creek banks and adds nitrogen to the water.

Fig. 65: Algae growth

5.4.2 Source: Chemicals used on croplands and lawns. Property owners dumping yard waste and trash onto the stream bank causing destruction of bank stabilizing plant growth.

5.4.3 Objective: Public Education is needed to encourage soil testing to determine if chemicals are necessary and explain the benefits of composting yard waste.

5.5 Goal: Minimize runoff impact in the area of sinkholes and losing streams.

5.5.1 Indicators: Sink holes (Figure 21) and losing streams (Appendix – Section 11.2) located by field observation and on the USGS Topography Map.

5.5.2 Source: Natural soil and rock conditions allow pollutants in surface water to penetrate soil to underground crevices and directly enter the aquifer.

5.5.3 Objective: Locate sink hole and losing stream area and direct development sites/drainage/dumping away from from area of sinkholes.

5.6 Goal: Prepare a Belews Creek Floodplain Study

5.6.1 Indicators: FEMA maps reflects the floodway from the Big River to Sand Creek, but has not been determined for the remainder of Belews Creek.

Fig 66: Flood conditions

5.6.2 Source: Floodway carried debris and high velocity water during flood conditions causing property damage and injury.

5.6.3 Objective: Obtain funds for an engineered study of Belews Creek to determine the floodway so building regulations can be properly enforced.

5.7 Goal: Evaluate the impact of existing and future dam design.

5.7.1 Indicators: Leaking dams, erosion and sediment runoff, location of dams near streams.

Fig. 67: Dam

5.7.2 Source: Instability in dam structure, disrepair of dams

5.7.3 Objective: Evaluate existing dams for impact on watershed. Educate and assist in new dam design.

5.8 Goal: Encourage building requirements for stream crossings (bridges).

5.8.1 Indicators: Stream crossings are deteriorating and are unsafe to handle emergency vehicles and trash trucks. Cuts in creek bank indicate bridge angled improperly. Bridges cause blockage of flood waters.

Fig. 68: Bridge crossing

5.8.2 Source: Older bridges are improperly installed or are in disrepair. Bridges are angled toward the stream bank instead of creek channel. Supports of bridges cause debris to hang up in flood condition. Bridge decks are too low on some crossings.

5.8.3 Objective: Work with property owners and County officials to establish guidelines for effective bridge construction and repair in the future.

Section 5 reflects the goals, indicators and objectives based upon the findings from the field survey and the Watershed Partnership's knowledge of the Belews Creek Watershed. The eight goals delineated in Section 5 are prioritized by Management Unit and appropriate actions identified in this section.

6.1 – Evaluate Stormwater runoff and its affect on the watershed

The L-THIA analysis in Section 4.2 reflects the non-point source of pollutants for the entire Belews Creek Watershed. Each Management Unit was analyzed individually with the results documented in the Section 11.7 to this plan. The results for fourteen non-point source pollutants are reflected in each scenario. These pollutants are nitrogen, phosphorus, suspended solids, lead, copper, zinc, cadmium, chromium, nickel, BOD, COD, oil and grease, fecal coliform and fecal strep. Based upon potential land use change and soil types, the pollutants with the greatest percentage of change in each management unit are addressed in the following analysis and actions. If future testing reveals any pollutant to be at or above acceptable standards, efforts should be made to identify the source and corrective actions taken.

6.1.1 Management Unit 3 has the highest potential impact from oil and grease, suspended solids and fecal coliform. The 1,650 acres in MU3 are in close proximity to new Highway 21, Highway A and the City of Hillsboro. This location is attractive for commercial development and high density residential development. Six tributaries to Belews Creek are located in MU3. Management Unit 3 has identified sink holes and a high probability that some of the tributaries should be classified as losing streams.

Fig. 70: MU3

Fig. 69: Aerial view of MU3

Actions

Identify sink hole locations and determine if and where tributaries should be classified as losing streams. Oil and grease from roads, auto fluids, etc., can be transported in stormwater runoff to these locations. As development occurs, replace on-site septic systems, a source of fecal coliform, with a central sewer system. Comply with Jefferson County Stormwater Management Ordinance and encourage Low Impact Development to reduce suspended solids in runoff.

6.1.2 Management Unit 4 has the highest potential impact from BOD, COD and Fecal Strep. This MU with its large acre parcels and access to new Highway 21 is a candidate for increased residential growth. There are 5 tributaries to Belews Creek in this MU.

Fig. 71: MU4

Fig. 72: Aerial view of MU4

Actions

Enforce Jefferson County Stormwater Management Ordinance with emphasis of detention requirements and maintaining riparian corridor buffer zones to minimize BOD and COD pollutants. As development occurs, replace on-site septics (a source of fecal strep) with central sewer system.

6.1.3 Management Unit 6 is ranked third in potential for non-point pollution concerns as land use changes occur. Oil and Grease and BOD will be of specific concern in MU6.

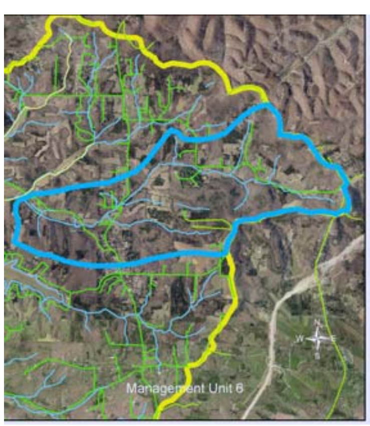


Fig. 73: MU6

Fig. 74: Aerial view of MU6

Actions

Special concerns for the erodible soils found in MU6 should be addressed during new development. Erodible soils can transport suspended solids and oil and grease. The tributaries to Sand Creek in this MU contain heavy deposits of sedimentation that will have an impact on the flood carrying capability. During construction, erosion and sediment control BMP's should be monitored closely. Riparian buffer zones will filter stormwater runoff which will help reduce the organisms that use the oxygen (BOD) in the water.

6.1.4 Management Unit 5 results indicate suspended solids and fecal coliform are and will be issues as land use changes. The tributaries to Lake Tishomingo transport sedimentation from the erodible soils to the lake. Existing on-site septic systems in this Management Unit are a concern. Lake Tishomingo itself acts as a filter for the non-point pollutants and the discharge from the lake is not currently an issue.

Fig. 75: MU5

Fig. 76: Aerial view of MU5

Actions

Install central sewer system in developed areas which will reduce the fecal coliform pollutant. Encourage central sewer system versus on-site for new development. Require sedimentation basin during new development and strictly enforced erosion and sedimentation control BMP's to reduce suspended solids.

6.1.5 The four remaining Management Units in the watershed are susceptible to land use change and associated non-point pollution. The items of significance for each and actions are summarized below:

MU7 – Suspended Solids, COD, Fecal Strep and BOD.

Action – Management Unit 7 has two stream order 3 tributaries to Sand Creek that should have the 100' riparian buffer requirement enforced. The buffer will minimize the impact of the four pollutants in this MU.

Fig. 77: Aerial view of MU7

MU8 – Fecal Strep, COD and BOD.

Fig. 78: Aerial view of MU8

Action – Management Unit 8 includes the major corridor and main channel of Belews Creek, agriculture and livestock (fecal strep) are prevalent. Land owners should be educated on the impacts of these activities and alternative methods implemented. Maintaining or re-establishing the riparian corridor of this stream Order 4 and 5 in MU8 will improve the water quality (COD & BOD) in Belews Creek. The FEMA floodplain will need to be administered and an associated floodway determined.

MU1 – Oil and Grease, COD, BOD and Fecal Strep.

Fig. 79: Aerial view of MU1

Action – Management Unit 1 includes the City of Hillsboro and is the headwaters of Belews Creek. Continued growth, including additional commercial development, will have an impact on the watershed (oil and grease).The City of Hillsboro is not under the jurisdiction of Jefferson County for Stormwater management issues. Equivalent standards, i.e., erosion and sediment control, riparian buffers, detention, etc., should be required by Hillsboro (COD and BOD). The Hillsboro central sewer system should be extended as new development occurs to include the development (fecal strep).

MU2 – Oil and Grease, COD and BOD.

Fig. 80: Aerial view of a Raintree Lake

Action – Management Unit 2 consists of Raintree Plantation and the tributaries to its four lakes. Issues with their sewage treatment plant and wells for drinking water have been addressed and corrective action is under way. When these facilities are completed, new home construction will resume and the population should double within 20 years. (oil and grease). Pet waste and fertilizers (COD and BOD) on yards are issues. Residents should be educated on BMP’s that can reduce these pollutants. The resulting pollutants will enter their lakes where they will settle out and become diluted before entering Gallagher Creek or Belews Creek itself. Winter Lake receives extensive sedimentation from its tributary. Efforts should include bank stabilization (suspended solids) to minimize the erosion and investigating the possibility of dredging the lake to remove the existing build-up.

6.2 Determine existing riparian corridors and educate landowners on benefit of maintaining and/or establishing riparian corridors.

Ten maps are contained in the Section 11.6 to this watershed plan titled Belews Creek Riparian Corridors and FEMA Flood Hazard Boundaries. The Jefferson County Land Disturbance and Stormwater Management ordinance requires a 100 foot buffer, from top of bank, for all stream orders 3 and above and a 50' buffer for stream orders 1 and 2. This buffer zone will filter pollutants before entering the stream and recharge the ground water by minimizing stormwater runoff entering the stream.

Fig. 81: Buffer Zone for Belews Creek

Fig 82: Buffer Zone for Sand Creek

Action – Using Jefferson County's GIS and/or Pictometry system, areas that do not meet the buffer requirements can be identified and parcel ownership identified. An on-going project should be initiated to identify and re-establish the buffer zones where they do not exist.

6.3 Encourage appropriate maintenance and repair of Septic Systems

Except for the City of Hillsboro and Raintree Plantation, the entire Belews Creek watershed has on-site septic systems. The soil types in the Belews Watershed provide a challenge to the effective installation of on-site septic systems. Defective on-site septic systems are recognized as a problem in Jefferson County.

Figure 83

Figure 84

Jefferson County Photos. Views of result of septic discharge in Belews Creek

Action – Educate landowners on the impact of failing septic systems. Initiate a program to assist in testing existing systems and replace/repair as needed. Develop a strategy and plan for providing central sewer systems for the entire watershed. Educational resources are identified at the end of this section and in Section 8.

6.4 Encourage intelligent use of chemical fertilizers, pesticides, herbicides, proper use of detergents and proper ways to handle yard waste.

Detergents, fertilizers, pet waste and yard waste contain the nutrients phosphorous and nitrogen that cause the excessive growth of algae in water. As the algae dies, a chemical process takes place in the decaying process that uses the dissolved oxygen in the water. This is the same dissolved oxygen needed by aquatic life for survival. Not only does the decaying algae rob oxygen from the water, it also causes water to taste and smell bad. Soil testing can identify overuse of chemicals that eventually wash into the creek.

Yard waste (carbon) and trash along creek banks can destroy the vegetative cover that helps prevent erosion and sedimentation. It also encourages rodent and mosquito breeding.

Figures 85 and 86: Jefferson County Photo: Clean Stream volunteers pull trash from Belews Creek

Fig. 87: Jefferson County Photo: Dumpster located in the floodplain along Belews Creek.

Action – Create literature that can be mailed to selected areas within the watershed. Create educational program with recommendations that can be presented at home owner associations. Work with Missouri Extension Office to educate agriculture and livestock owners on methods of reducing impact of chemicals on land.

6.5 Minimize runoff impact in the area of sinkholes and losing streams.

Sinkholes and losing streams can be a direct path to ground water and the aquifer. Stormwater runoff entering these locations can transfer pollutants into the subsurface environment. The impact on drinking water is not known.

The Belews Creek watershed has sinkholes and losing streams identified in the NCRS-EPA database.

Fig. 88: Source: Jefferson County. Sink Hole area of MU3.

Fig 89: Source: Jefferson County. Losing Stream Map of Belews Creek.

Actions

Study the impact stormwater runoff entering losing streams and sinkholes have on the ground water and aquifer. The results of this study will determine the severity of the action needed to protect the watershed and all of Jefferson County. When new development is proposed in an area that will discharge stormwater into sinkholes or an area designated as a losing stream, extra considerations will be needed.

6.6 Prepare a Belews Creek Floodplain Study

Jefferson County has the map modernization digital maps from FEMA. Belews Creek has been studied and a floodway determined from its mouth to the convergence of Sand Creek. The remaining portion of the watershed has not been studied and, therefore, does not have a recorded floodway. The Jefferson County Flood Damage Prevention Ordinance does not allow any activity in the floodway.

Action

Study the Belews Creek floodplain and have the results recorded with FEMA.

6.7 Evaluate the impact of existing and future dam design

Dams are not regulated by Jefferson County. Assistance is provided to landowners by the Jefferson County Soil and Water Conservation District when requested. The Jefferson County Land Disturbance and Stormwater Management Ordinance regulates land disturbance of one acre or more. Most new dams would fall under this regulation. In addition, the riparian buffer requirements requires 50' from top of bank for Stream Orders 1 and 2 and 100' for Stream Orders 3 and above be undisturbed. These requirements should alleviate some of the concerns for new dams.

Existing dams, (see Section 11.4 for location of three dams) should be individually inspected to assure there are no defects that could cause harm to the watershed.

Action

Inspect existing dams for defects and potential impact on watershed. Review proposed dams for compliance with Jefferson County requirements.

6.8 Encourage building requirements for stream crossings (bridges)

Many of the existing bridges and culverts in the watershed were visited during the field inventory. Existing state road bridges (Highway BB) and county road bridges, i.e., Regina Road, Hillsboro-House Springs Road, have been repaired/replaced in recent years. The conditions of these bridges are monitored by those organizations and repairs scheduled as needed.

Many of the private bridges throughout the watershed are in need of repair or replacement. The majority of these bridges/culverts were installed with limited funding and have not been maintained. The cost to replace a bridge is the responsibility of the owners that use the crossing to access their property. See Section 11.4 for some of the private bridge crossings in the watershed.

The condition of some bridges produces a hazard for emergency vehicles (fire trucks) to cross when needed. Trash hauling trucks will not cross some of the bridges thereby requiring trash containers be located before the crossing – usually in the floodplain.

Action

The owners of private stream crossings, bridges or culverts, should have an engineering study conducted to determine the proper size and design needed to provide a safe crossing. The monies required to construct the crossing is the responsibility of the owners. Financial assistance may be available through grants or low-cost loans.

Resources available to assist or advise in the completion of the Actions for the above named items are listed below.	
On-Site Septic Systems	University of Missouri Extension Center 636-797-5391 Eastern Missouri Small Flows Organization (EMSO)
Bank Stabilization Soil Types/Sink Holes	Jefferson County Soil & Water Conservation District 636-789-2441
Erosion Control Sedimentation Prevention	Jefferson County Stormwater Division 636-797-6228 Missouri Department of Natural Resources 800-361-4827
Buffer Zones	Jefferson County Stormwater Division 636-797-6228 Missouri Department of Natural Resources 800-361-4827 Missouri Department of Conservation 636-441-4554
Floodway Study	Local Engineers
Dams and Bridges – sizing	Jefferson County Public Works Department 636-797-5341 Local structural engineers
Stream Clean Up	Open Space Council – Ron Coleman 636-451-6090
Livestock in the creek Bacteria in the creek	Jefferson County Stormwater Division 636-797-6228
Pesticides/Herbicides	Jefferson County Stormwater Division 636-797-6228
Yard Waste in creek	Jefferson County Stormwater Division 636-797-6228

Table 14 – Educational Resources

Section 6.9 – Summary of Load Reductions and Monitoring

The actions identified in this section should have a positive impact on the non-point source pollutants identified in the Long Term Hydrologic Impact Assessment in Section 4.9.2.

The following table reflects the percentage reduction for all of the non-point source pollutants for the entire watershed. See Section 11.7 for the results for each management unit.

Through continued field observations and chemical testing, by both Stream Team and Jefferson County Stormwater Management Division, the water quality will be monitored. Any abnormality will require further investigation.

Total Belews Creek Watershed				
Pollutant	Pre-BMP Current	No BMPs Scenario 1	Post BMP Scenario 2	% Reduction Estimate over No BMPs
BOD (lbs./acre)	26.7	61.5	48.8	21%
COD (lbs./acre)	49.1	141.5	116.9	17%
Cadmium (lbs./acre	1.4	2.1	1.7	19%
Chromium (lbs./acre)	0.01	0.01	0.01	0
Copper (lbs./acre)	0.01	0.03	0.02	50%
Lead (lbs./acre)	0.01	0.02	0.02	0
Nickel (lbs./acre)	0.01	0.02	0.02	0
Nitrogen (lbs./acre)	4.5	5.2	4.3	17%
Oil & Grease (lbs./acre)	1.8	6.5	5.7	12%
Suspended Solids (lbs./acre)	100.2	124.8	104.3	16%
Zinc (lbs./acre)	0.09	0.23	0.19	17%
Fecal Coliform (millions of coliform/acre	152.2	222.9	177.3	20%
Fecal Strep (millions of coliform/acre	238.6	556.3	429.4	23%
Note: NPDES and EPA standards will be used to relate the conditions within the watershed to acceptable levels.				

Table 15 – L-THIA Scenarios for Belews Creek Watershed

Community involvement is critical to successful watershed planning and implementation protection strategies. Input from citizens, community leaders, local government staff, and other stakeholders will be a key component of the Belews Creek Watershed Project. Building support for the protection of Belews Creek Watershed will require educating stakeholders, developers and government personnel on the benefits of natural resource conservation.

7.1 – Watershed Partnership Committee

As part of the Belews Creek Watershed Project, a Partnership Committee of stakeholders was formed to help with the visual survey and provide input for this Watershed Plan. The Partnership Committee includes watershed citizens, local government staff from Jefferson County and technical advisory support from the Missouri Department of Conservation, the Jefferson County Soil and Water Conservation District, and the USDA-NRCS. Additionally, members of the Partnership Committee served as reviewers for the final plan and provided comments and feedback for the recommendations.

7.2 – Volunteer Stream Team

Volunteers from the Partnership Committee participated in a Clean Stream event on Belews Creek after the visual survey was completed. The Committee plans to participate in a Clean Stream event annually along Belews Creek by working with the Missouri Stream Team.

7.3 – Newsletter and Residential Mailings

Citizens are encouraged to continue communication with other stakeholders by way of an information letter or newsletter. The letter will provide general information about continued watershed planning efforts. Citizens are encouraged to discuss stream concerns, attend watershed training events and volunteer for Stream Team efforts.

The Partnership Committee is encouraged to develop and maintain a website for the Belews Creek Watershed Project where photographs, news events, and copies of the newsletter can be accessed as well as share comments and questions.

7.4 – Workshops

Workshops are a great way of exchanging ideas, designing training programs, developing strategies, and scheduling future events and can involve interested residents from the watershed. Topics of discussion may include: (1) a review of the value and importance of streams and water resources in the community, (2) identification of problems due to land use changes, and (3) discussion of potential strategies for minimizing existing and future problems along Belews Creek. Representatives from the County, representatives from the Home Builders Association, and an attorney, as well as local developers may be asked to participate in these workshops.

7.5 – Media Coverage

The Partnership Committee is encouraged to establish a relationship with several local newspapers and routinely provide input and background on watershed related issues within and surrounding the Belews Creek Watershed. Reporters may also be invited to participate in events like public workshops, educational events, and other related projects.

7.6 – Reports and Information Availability

The Partnership Committee is encouraged to develop an interactive website that announces projects, various project maps, newsletter archives, monitoring results and downloadable files for reports and educational brochures. A copy of this Watershed Management Plan should also be available on the website.

The Partnership Committee is also encouraged to include links to other watershed websites.

7.7 – Future Efforts

Continued education and outreach are necessary to insure long-term success for the project. Recommendations to further education include activities such as:

- Collaboration with existing organizations to sponsor a variety of watershed awareness events such as water festivals, stream teams, clean ups, etc., with an educational component

- Develop slide presentations, exhibits, brochures, and other educational materials specifically targeted to address one of the objectives mentioned in Section 5. Distribute materials to schools, water festivals, and other public events that may have watershed resident attendees

- Send targeted mailings to homeowners within each management unit relating to a specific protection effort such as native landscaping and rain gardens, that may be most beneficial for that particular section of the watershed

- Provide cost share programs when possible to residents and developers within the watershed to encourage implementation of conservation practices.

- Water quality monitoring throughout the watershed should be conducted at least once a year. Missouri Stream Team members have offered to assist in this testing. Jefferson County Stormwater Management has water quality testing equipment that can be used whenever specific testing at any location is needed.

- Review yearly this watershed plan and schedule activities accordingly. Keep a “working copy” of the plan reflecting goals that have been started and/or completed.

- Update the plan every five years to reflect the status of the watershed at that time.

Section 8 – Financial & Technical Assistance Required & Implementation Schedule

Successful implementation of the goals and action items presented in Section 6 will require capital and technical support through both public and private organizations. Obtaining funding for these goals will require economic justification and effort by the citizens of the watershed with participation by Jefferson County Stormwater Management Division. The following information is an estimate of the financial and technical assistance required for each goal and action and an implementation schedule. The start of the implementation will be contingent on financial assistance being available. The estimate of the duration of the activity would apply whenever a start date is determined.

Resources are available to search for funding to accomplish the goals identified in this watershed plan. These resources include the Plan2Fund watershed planning tool by the Environmental Financial Center at Boise State University and U.S. Environmental Protection Agency websites "Catalog of Federal Funding Sources for Watershed Protection" and "Watershed Funding". See Section 11.8 for these resources.

Goals & Actions	*Lead Responsible Entity*	*Technical Assistance Required*	*Estimated Financial Requirements*	*Implementation*	
				Start	*Duration*
6.1 Evaluate Stormwater Runoff and its Impact on Watershed					
6.1.1 Management Unit #3					
Identify Sinkholes and Losing Streams	SWM	DNR, P&Z	See 6.5		
Correct On-Site Septic Problems	BLDG	EDC	See 6.3	1/2009	
Enforce Storm Water Management Ordinance	SWM	P&Z, BLDG	$1,000 – TRNG	2008	ON-GOING
Encourage Low Impact Development	SWM	P&Z	$1,000 - TRNG	2008	ON-GOING
6.1.2 Management Unit #4					
Enforce Stormwater Management Ordinance	SWM	P&Z, BLDG	See.1.1	2008	ON-GOING
Maintain Riparian Buffer Corridors	SWM	P&Z, BCWP, MDC	Currently Funded	2008	ON-GOING
Correct On-Site Septic Problems	BLDG	EDC	5,000/problem	1/2009	5 YR
6.1.3 Management Unit #6					
Determine Methods to Control Erodible Soils	SWM	DNR, NCRS	$5,000	6/2009	1 YR
Restoration of Stream Due to Heavy Sedimentation	SWM	DNR, NCRS, COE, ENG.	$20,000/project	9/2009	6 MO/ project
Enforce Stormwater Management Ordinance	SWM	P&Z, BLDG	See 6.1.1		
6.1.4 Management Unit #5					
Replace On-Site Septic With Central Sewer	BCWP	DNR, JCPSD		2008	
Restoration of Stream due to Heavy Sedimentation	SWM	DNR, NCRS, COE, ENG	$20,000/project	9/2009	6 MO/ project
Enforce Stormwater Management Ordinance	SWM	P&Z, BLDG	See 6.1.1		
6.1.5 Management Units					
MU #7 – Enforce and Restore 100' Riparian Buffer	SWM	MDC, BCWP	See 6.2		
MU #8 – Enforce and Restore 100' Riparian Buffer	SWM	MDC, BCWP	See 6.2		
MU #8 – Administer FEMA Floodplain &	BLDG	FEMA/SEMA	Current Funds	2008	ON-GOING
Determine Floodway	BLDG	See 6.6			
MU #1 – City of Hillsboro Stormwater Ordinance	HBORO	SWM, BLDG, DNR	Current Funds	2008	ON-GOING
Extend Central Sewer System	HBORO	DNR	TBD	TBD	TBD
MU #2 – Sewer System & Wells at Raintree	BCWP	JCPSD	Funded	2008	2009
Pet Waste & Fertilizers	BCWP	SWM	$1,000	9/2009	6 MO
Heavy Sedimentation	BCWP	SWM, DNR, NCRS, COE, ENG	$20,000/ Project	9/2009	6 MO/ project

Goals & Actions	*Lead Responsible Entity*	*Technical Assistance Required*	*Estimated Financial Requirements*	*Implementation*	
				Start	*Duration*
6.2 Determine existing riparian corridors and educate landowners on benefit of maintaining and/or establishing corridors					
Identify areas without sufficient buffer zones	BCWP	SWM, NCRS	Current Funds	6/2009	6 MO
Re-establish buffer zones	BCWP	DNR, NCRS	$1,000/project	2009	5 YEARS
6.3 Encourage Maintenance and Repair of Septic Systems					
Educate land owners	SWM	BLDG, EMSO	$1,000 – TRNG	1/2009	2 YEARS
Test existing on-site septic system	BLDG	EMSO, BCWP	$100/SITE	1/2009	5 YEARS
Repair or replace failing system	BLDG	EDC, EMSO, BCWP	$5,000/SITE	6/2009	5 YEARS
6.4 Encourage intelligent use of chemical fertilizers, pesticides, herbicides, proper use of detergents and proper ways to handle yard waste					
Create literature and mail to select areas	SWN	NCRS, UMEC	$1,000	6/2009	6 MO
Conduct presentations to homeowner association	SWM	BCWP, NCRS, UMEC	$500/presentation	2010	5 YEARS
Educate agriculture and livestock owners	UMEC	NCRS	$1,000	6/2009	6 MO
6.5 Minimize runoff impact in areas of sinkholes and losing streams					
Study impact of stormwater entering sinkholes and losing streams	SWM	DNR, P&Z	$10,000	6/2009	6 MO
Protect areas of sinkholes and losing streams from polluted runoff	SWM	P&Z	Current Funds	2008	ON-GOING
6.6 Prepare a Belews Creek Floodplain Study					
Engineering study of watershed to determine floodplain and floodway	BLDG	FEMA/SEMA ENG	$25,000	2010	6 MO
Record study data with FEMA	BLDG	FEMA/SEMA	$1,000	2010	3 MO
6.7 Evaluate the impact of existing and future dam design					
Inspect existing dams	BCWP	DNR, ENG	$1,000/SITE	2010	1 YEAR
Review proposed dams for compliance with Jefferson County requirements	PW	ENG	Current Funds	2009	ON-GOING
6.8 Encourage building requirements for stream crossings					
Private stream crossings need engineering study to determine proper size and design	BCWP	ENG, PW	$5,000/STUDY	2010	5 YEARS
Replace faulty bridges	BCWP	GRANTS	TBD	TBD	TBD

Acronyms

BCWP	Belews Creek Watershed Partnership	JCPSD	Jefferson County Public Sewer District
BLDG	Building Division	MDC	Missouri Department of Conservation
COE	Corps of Engineers	NRCS	Natural Resources Conservation Service
CONST	Construction	P&Z	Planning and Zoning
DNR	Department of Natural Resources	PW	Public Works of Jefferson County
EDC	Economic Development Corporation	SEMA	State Emergency Management Agency
EMSO	Eastern Missouri Small Flows Organization	SWD	Soil and Water Conservation District
ENG	Engineering Support	SWM	Jefferson County Stormwater Management
FEMA	Federal Emergency Management Agency	TBD	To Be Determined
HBORO	City of Hillsboro	UMEC	University of Missouri Extension Center

Table 16 – Technical and Financial Assistance Required and Implementation Schedule with Acronyms

Section 9 – Grant Fulfillment of Nine Elements

The nine elements required by the Missouri Department of Natural Resources for Minigrant, #G06-NPS-03 Section 319 of the Clean Water Act, are listed below with a brief summary addressing each item, as well as pointers to sections of this plan that address the elements in more detail.

1. Identify causes and sources of non-point source impacts to the watershed that need to be controlled.
A combination of field assessment Section 3 and modeling Section 4 were used to estimate the levels and relative importance of pollutants within the Belews Creek Watershed. Section 4.2 details these analyses and these results.

2. Estimate load reductions that can be achieved through the recommendations and best management practices provided in this plan.
Estimates were made using the Long-Term Hydrologic Impact Assessment (L-THIA), and are explained in Section 4.2 for the watershed and Section 6 for each Management Unit. The L-THIA results for each MU are in the Section 11.7.

3. Describe the measures that will be implemented to protect the watershed.
Sections 2, 3, and 4 provides policy guidelines for the entire Belews Creek Watershed while Section 6 details and prioritizes actions targeted for each of the eight management units.

4. Estimate the financial and technical assistance required to achieve the goals of the plan.
Estimates for required financial and technical assistance are provided in Section 8 of this plan with funding resources in the Section 11.8.

5. Describe an approach for creating a public understanding, acceptance, and participation in the plan.
Necessary educational components are described in the objectives for each goal in Section 5 of this plan, with Public Involvement and Education described in Section 7.

6. Provide a schedule for implementing the plan.
Recommended actions are prioritized by Management Unit in Sections 5 and 6, with a schedule for implementing these actions in Section 8.

7. Develop measurable milestones for implementation of this plan.
Milestones for plan implementation by Management Unit are described in Section 6 of this plan.

8. Develop criteria to determine if load reductions are being achieved.
Load reductions will be measured according to standards used in Section 4.9.2 of this plan. Compliance with Jefferson County Land Disturbance and Stormwater Management Ordinance will be the criteria used to determine if load reductions are achieved as summarized in Section 6.9 and Section 8.

9. Develop a monitoring plan to evaluate effectiveness of the plan over time.
Section 7.7 recommends a yearly review of the plan to reflect accomplishments and plan next activities. Every five years it is recommended the plan be re-evaluated and adjusted to reflect changes in land use and effectiveness of actions, education and landowner participation.

Section 10 – References

Applied Ecological Services and Patti Banks Associates. 2006. *Brush Creek Mid-Shed Comprehensive Watershed Management Plan* for the Plate Land Trust

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Department of Conservation Fishery Management – Kevin Meneau

USDA-NRCS

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George Ogle & Company. 1898. *Standard Atlas of Jefferson County Missouri*

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USGS Topography Maps

MEGA – Missouri Environmental Geology Atlas. Sesquicentennial Edition, 2003. Department of Natural Resources, Geological Survey and Resource Assessment Division.

MSDIS Data, msdisweb.missouri.edu/datasearch

Handbook for Developing Watershed Plans to Restore and Protect Our Waters

Section 11 – Appendix

11.1 Stream Order

11.2 Losing Stream

11.3 Survey Form

11.4 Field Survey Maps
- Bridges
- Dams
- Sedimentation
- Creek Bank Disturbance

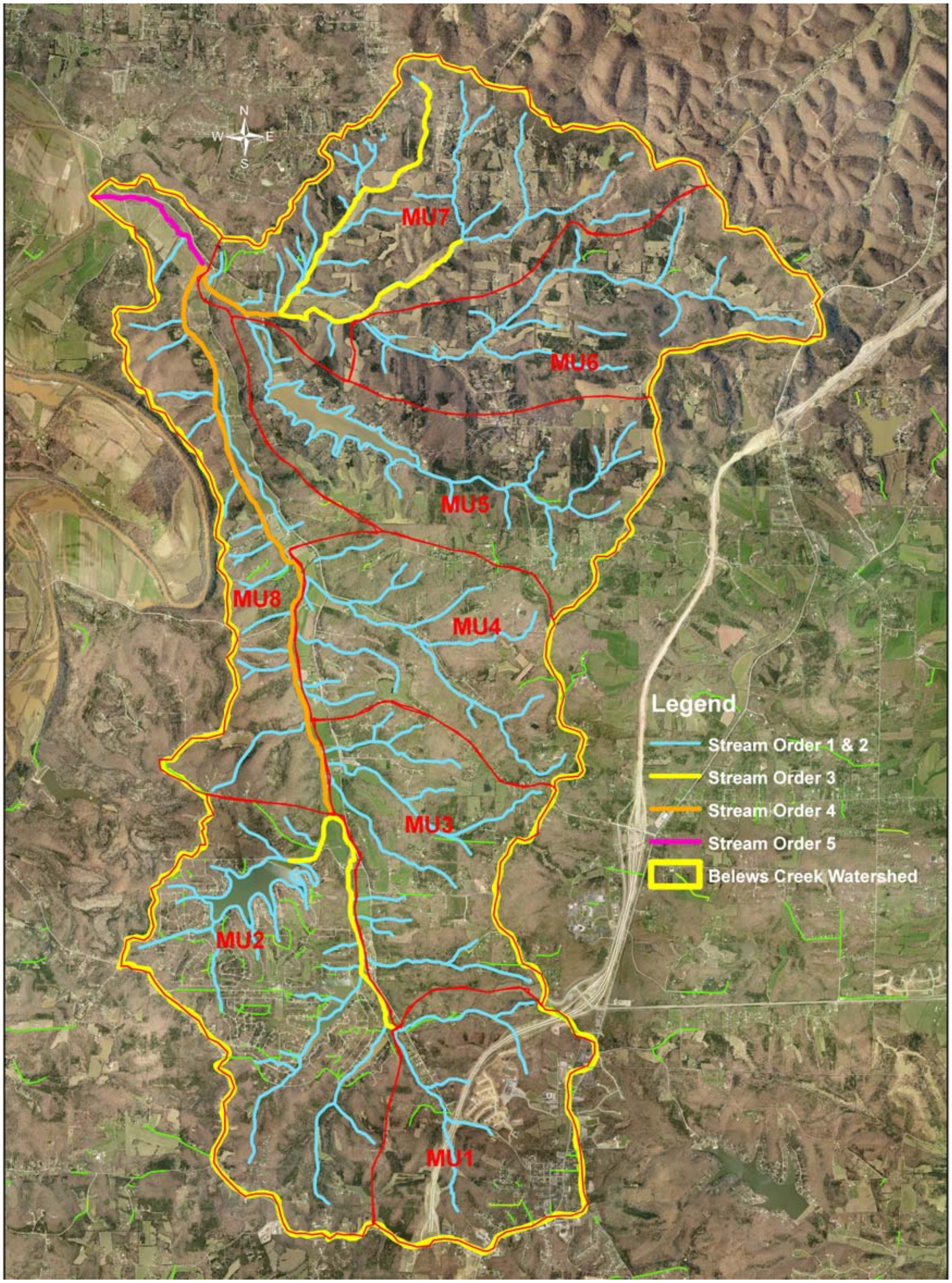
11.5 Chemical Testing

11.6 FEMA & Riparian Corridor

11.7 L-THIA By Management Unit

11.8 Funding Resources

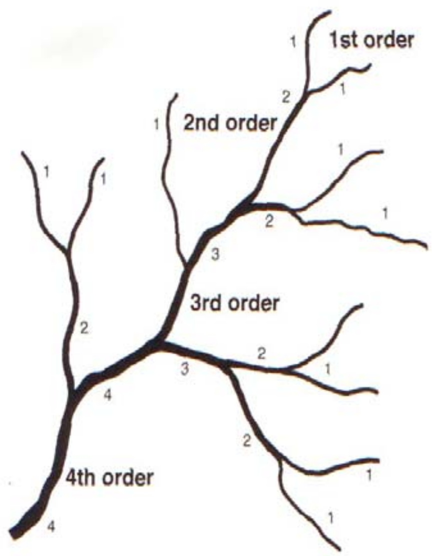
Section 11.1 – Stream Order



Stream Order Determination

Streams can be classified in a few different ways. One way to classify a stream is by size. In any particular watershed, the smallest streams that have year round water and no tributaries are **first order** streams.

Further along the course, a **second order** stream may join another second order stream to form a third order stream, and so on.



When a first order stream joins a second order stream, the resulting stream remains a second order stream. A **third order** stream is only formed if two second order streams come together. A **fourth order** stream is formed when two third order streams flow together. A **fifth order** stream is formed when two fourth order streams flow together, and on it goes.

The basis for determining stream order within Jefferson County is the blue line or intermittent blue line on the USGS Quad Maps.

Small headwater streams originate from a variety of sources—snowmelt, surface runoff, a lake outlet, or ground water which surfaces as springs. These headwater streams are classified as first order and second order streams. They are no more than a few feet wide. These headwater streams have a relatively straight V-shaped channel. The substrate or stream bottom is composed of boulders and cobblestones.

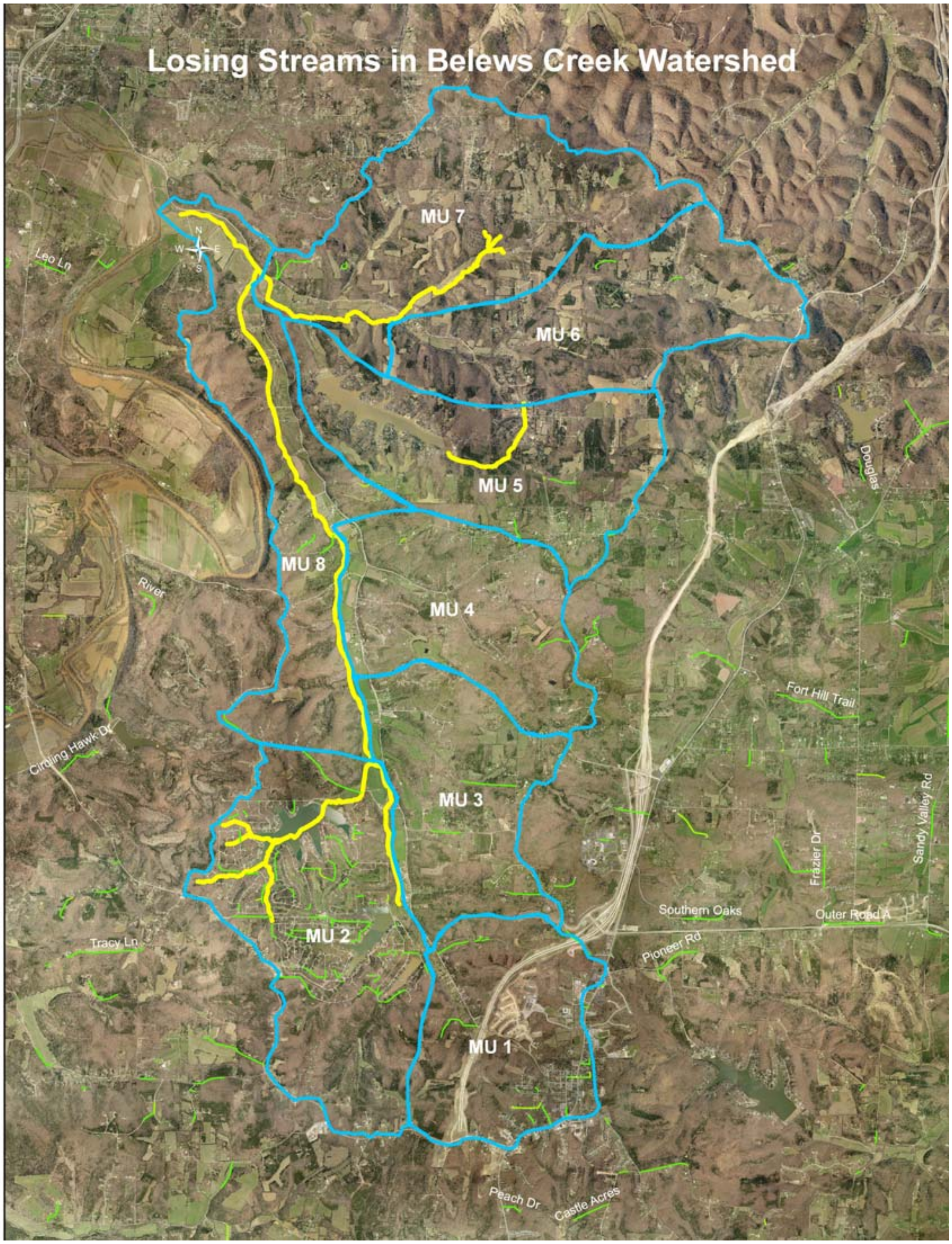
Downstream, in the middle reaches of the river system, some tributaries have entered the stream and added to the flow. The wider, bigger and deeper U-shaped channel is now a third or fourth order stream. The middle river reach has a meandering or braided channel with a substrate or bottom of boulders, cobble and gravel.

Progressing downstream towards the stream's mouth, more tributaries have entered and added more flow to create a mainstream river. The channel widens and meanders in wide arching loops. The bottom is gravel, sand and mud.

At its mouth, the river empties into another body of water and carries its remaining load of sediment, debris and other substances with it. The water body can be an estuary, a lake or a larger river system.

A watershed is one interconnected land/water system. An action in one area of a watershed, even far up into its headwaters, can affect what happens in distant areas downstream. Any changes we make to the land surface or to the vegetation also changes some aspect of the hydrologic cycle.

Section 11.2 – Losing Streams



VISUAL STREAM SURVEY INVENTORY SHEET

Date ____________ Name ______________________________ Group ______________

Watershed Name __________________ Stream or Tributary ID ____________________________

Site # ________ Date ____________ Time __________ Weather Conditions ____________

Data Submitter ____

Participants ____

1a. Floodplain Land Use: (Left) Industrial ____ Commercial ____ Residential ____ Row Crops ____
Pasture/hayfields _____ Woods _____ Other (specify) __________________

Riparian Cover: (Left) Trees _____ Grasses or weeds _____ Bare ground _____ Buildings _____
Parking lots/streets _____ Other (specify) __________________________

Comments: ____

____

____

1b. Floodplain Land Use: (Right) Industrial ____ Commercial ____ Residential ____ Row Crops ____
Pasture/hayfields _____ Woods _____ Other (specify) __________________

Riparian Cover: (Right) Trees _____ Grasses or weeds _____ Bare ground _____ Buildings _____
Parking lots/streets _____ Other (specify) __________________________

Comments: ____

____

____

2a. Streambank Conditions: (Left) Trees _____ Grasses or Weeds _____ Bare Ground _____
Bedrock _____ Pavement/riprap _____ Height of Bank _____ (inches)

Comments: ____

____

____

2b. Streambank Conditions: (Right) Trees _____ Grasses or Weeds _____ Bare Ground _____
Bedrock _____ Pavement/riprap _____ Height of Bank _____ (inches)

Comments: ____

____

____

Missouri Department of Natural Resources

3a. Bed Composition of riffle: (flowing water) Silt or Mud ______ Sand ______ Gravel ______
Cobble (2-10") ______ Boulders>10" ______ Bedrock ______ Width of Bed ____________ ft.

3b. Bed Composition (no water) Silt ______ Sand ______ Gravel ______ Cobble (2-10") ______
Boulders> 10" ______ Bedrock ______ Width of Bed ____________ ft.

Comments: ____

____

____

4. Algae

What percent of stream bottom is covered by visible algae? __________%
Of the algae observed, what percentage is:
(a) close-growing ______% + (b) filamentous (strands over 2" long ______% = 100%

5. Water Color (describe) ____
(clear, brown, green, milky, oily sheen, etc.)

6. Water Odor (describe) ____
(sewage odor, chemical odor, petroleum odor, rotten egg odor, musky or organic odor)

7. **Signs of Human Use** (describe) ____

____

____

Examples: pull-offs, dirt roads , footpaths, food and drink containers, campfires, etc.

8. GPS Coordinates (if available)____

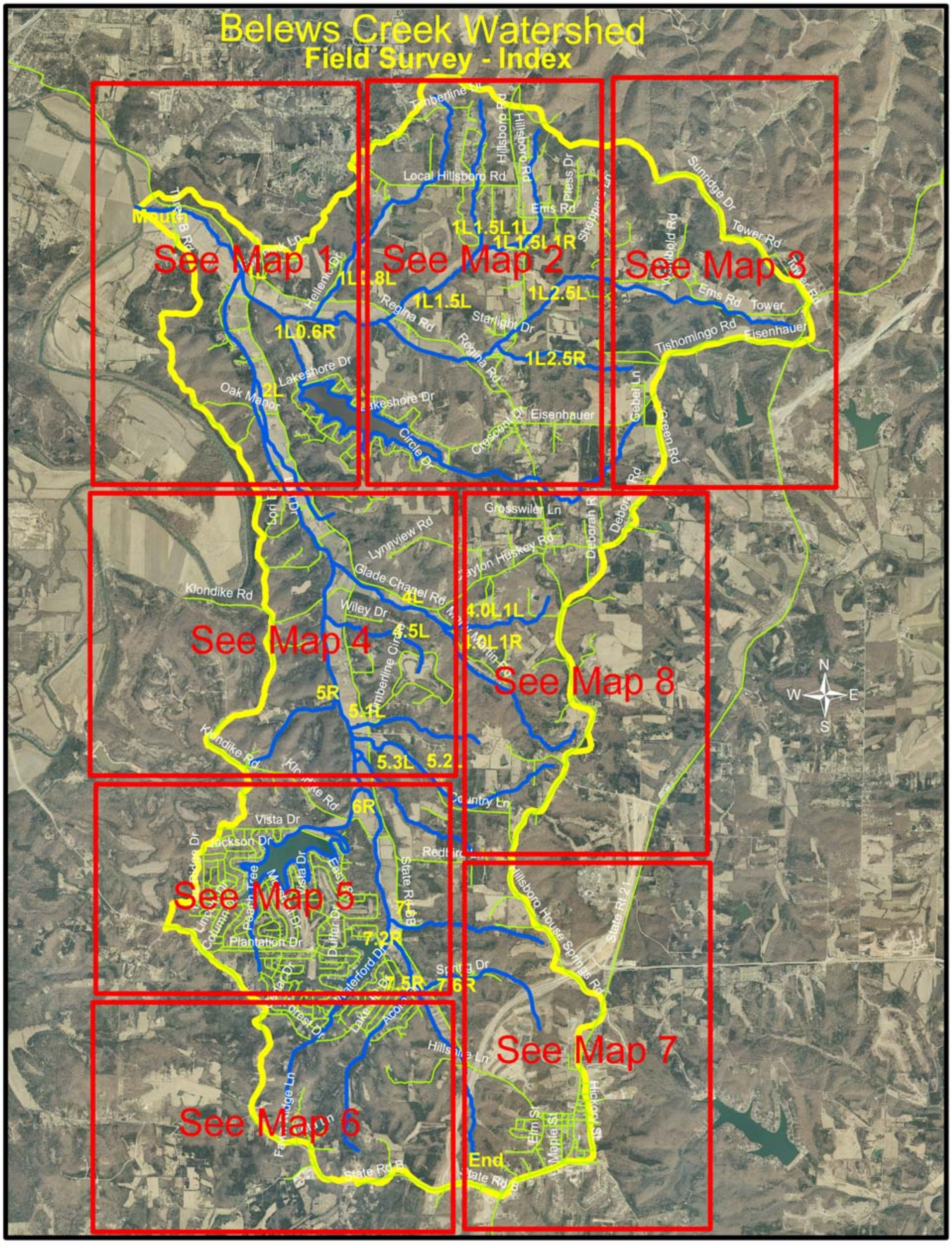
9. Comments ____

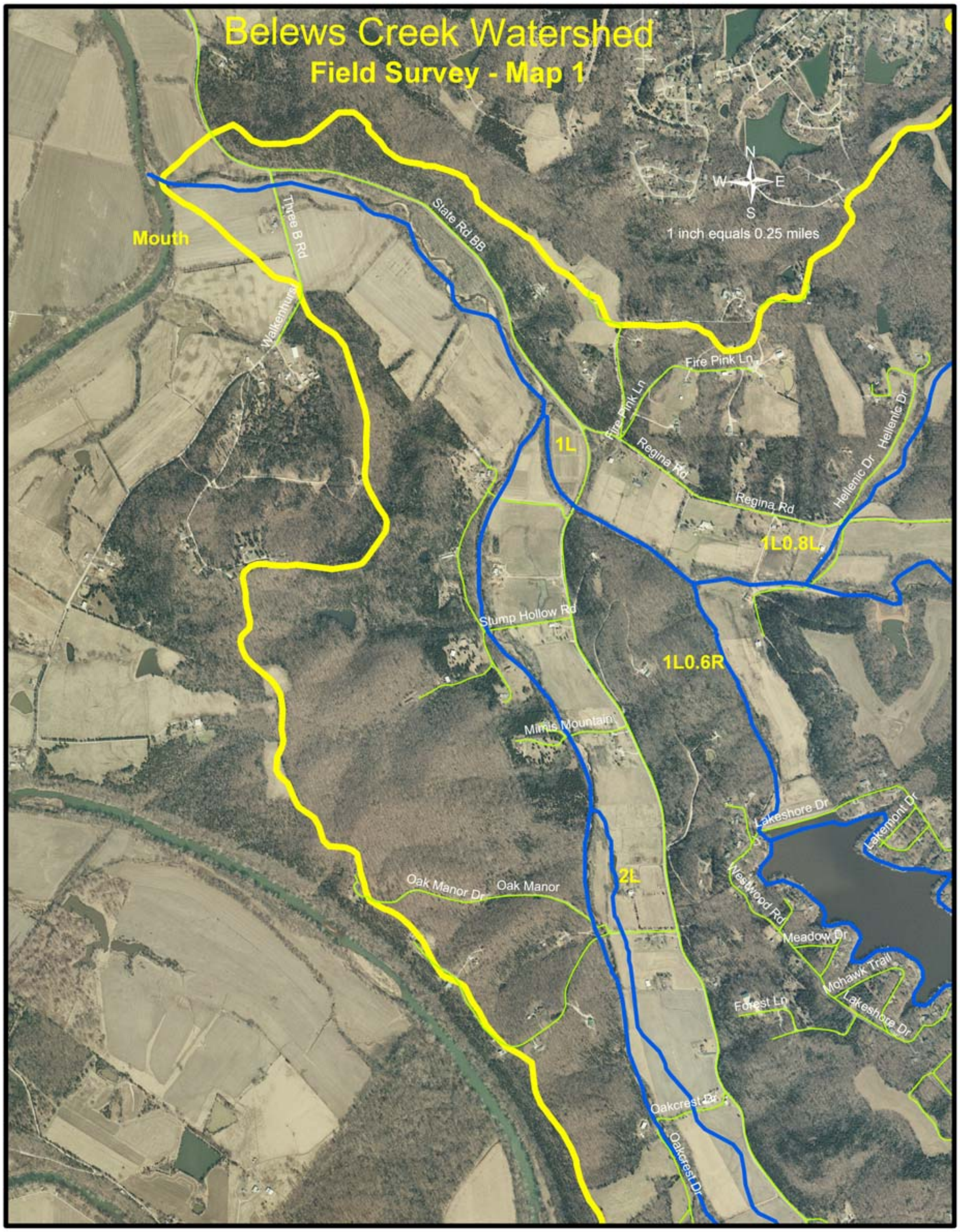
____

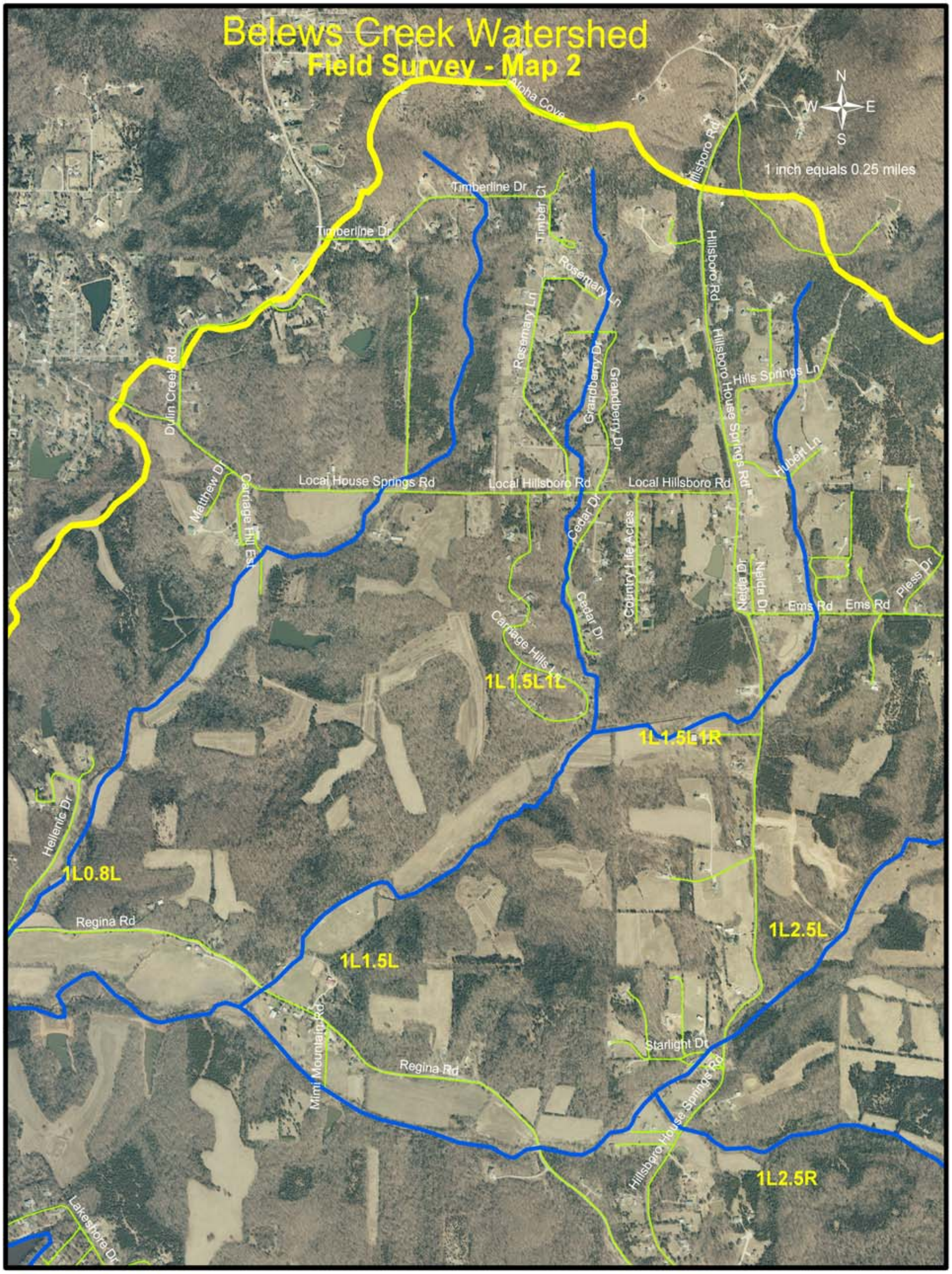
____

List anything not covered above.

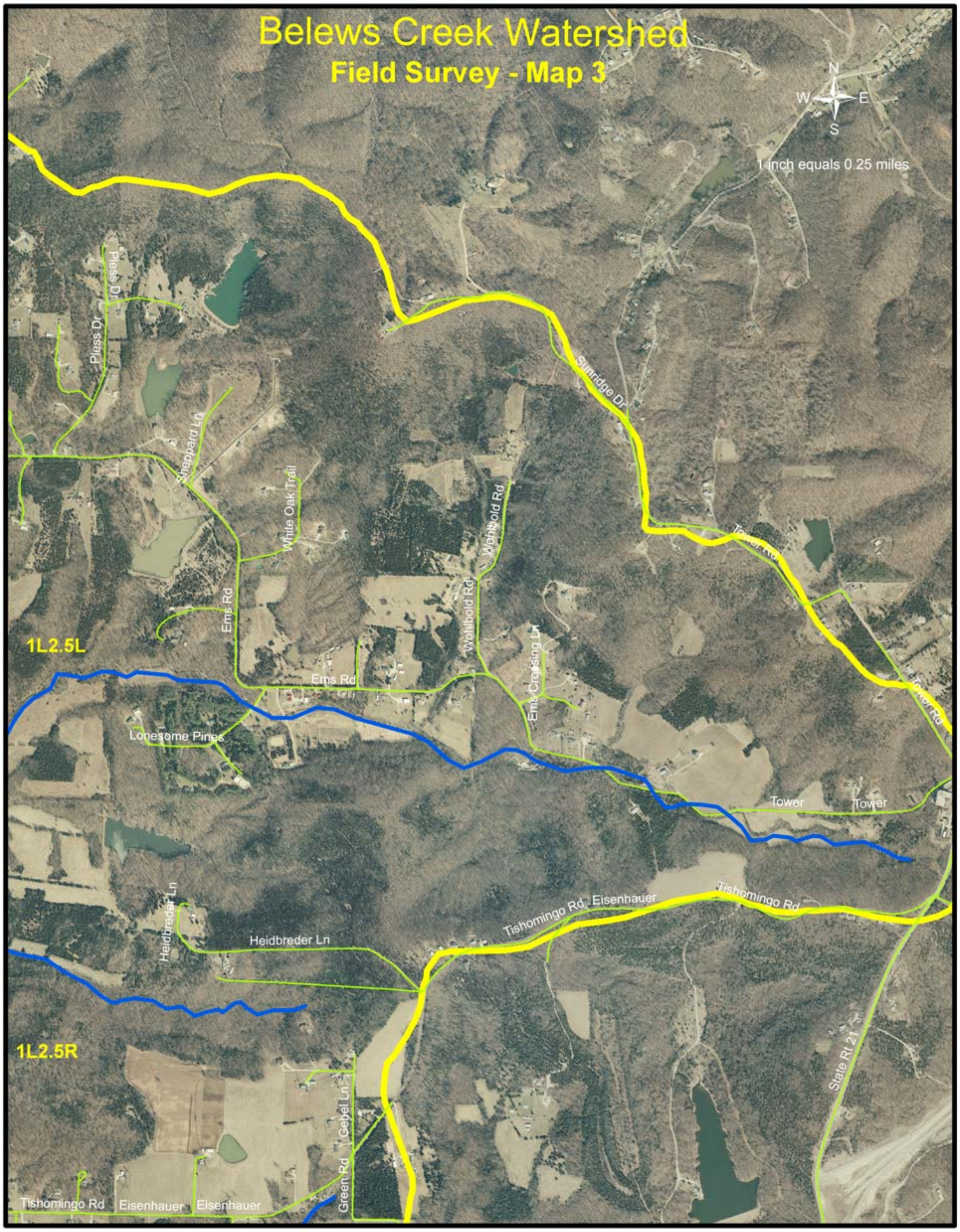
Section 11.4 – Field Survey Maps

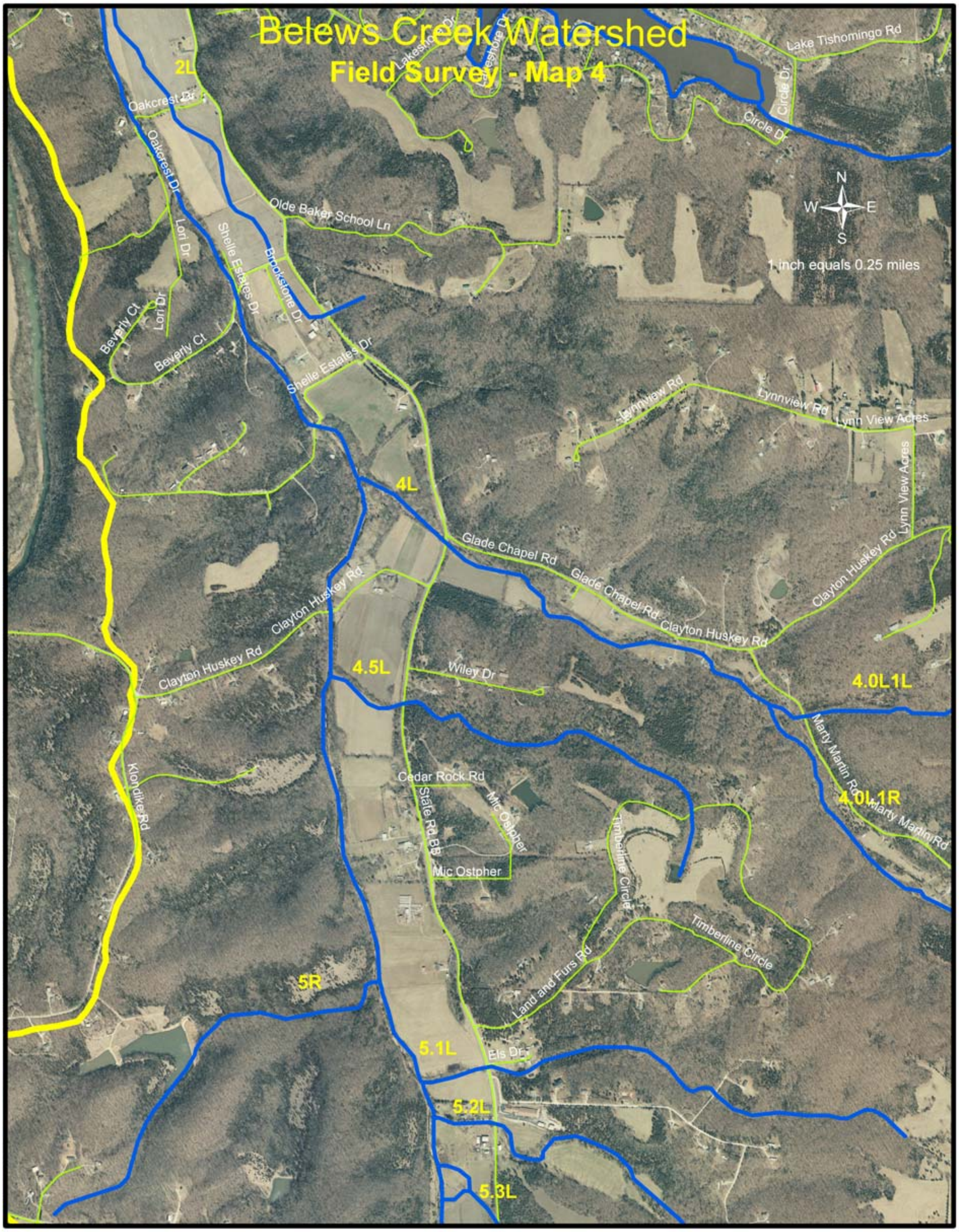


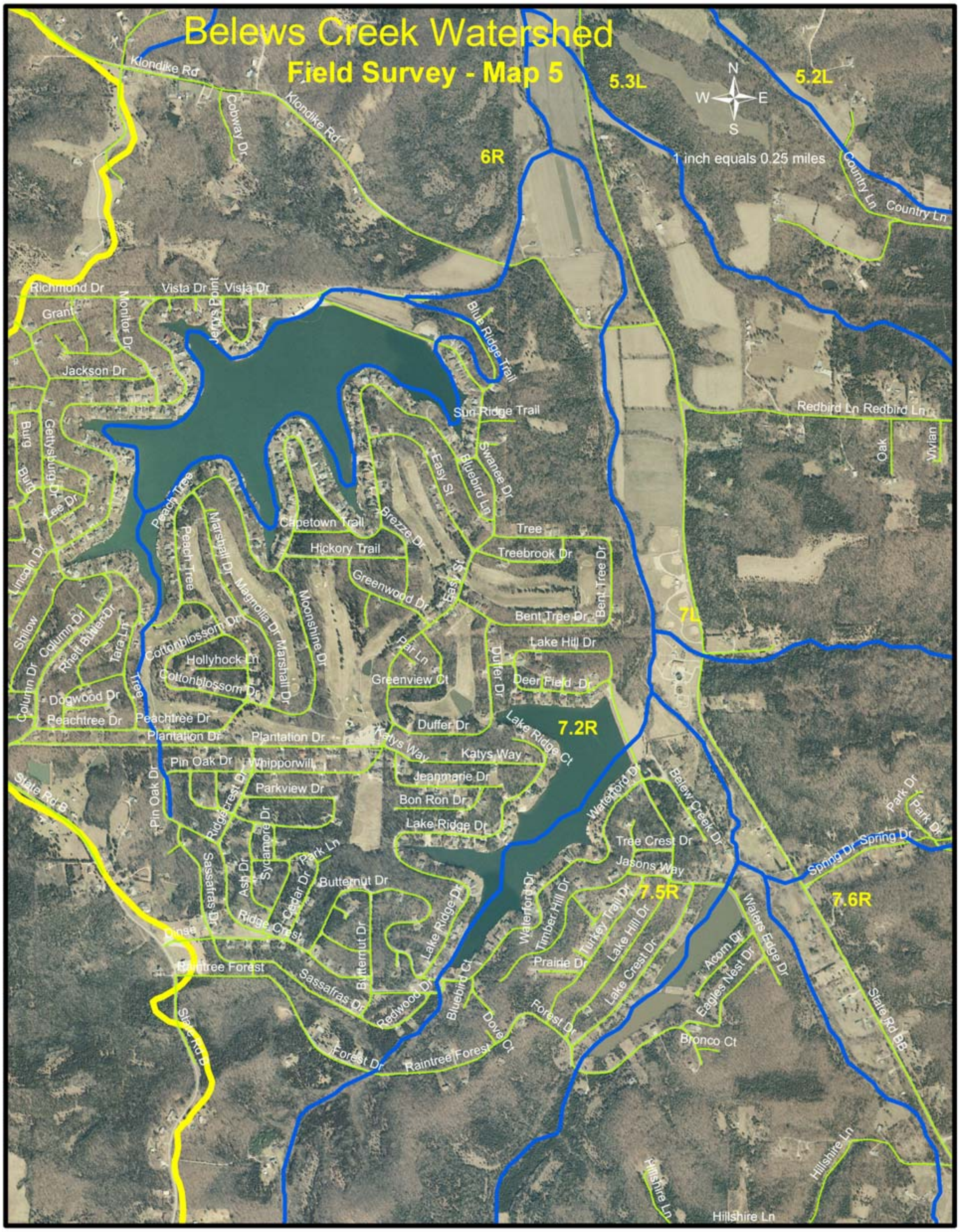

Belews Creek Watershed
Field Survey - Map 1
N
W
E
S
1 inch equals 0.25 miles
Mouth
Three B Rd
State Rd BB
Walkenhurst
Fire Pink Ln
1L
Regina Rd
Hellenic Dr
1L0.8L
1L0.6R
Stump Hollow Rd
Mimis Mountain
Lakeshore Dr
Lakemont Dr
Westwood Rd
2L
Oak Manor Dr
Oak Manor
Meadow Dr
Mohawk Trail
Forest Ln
Oakcrest Dr

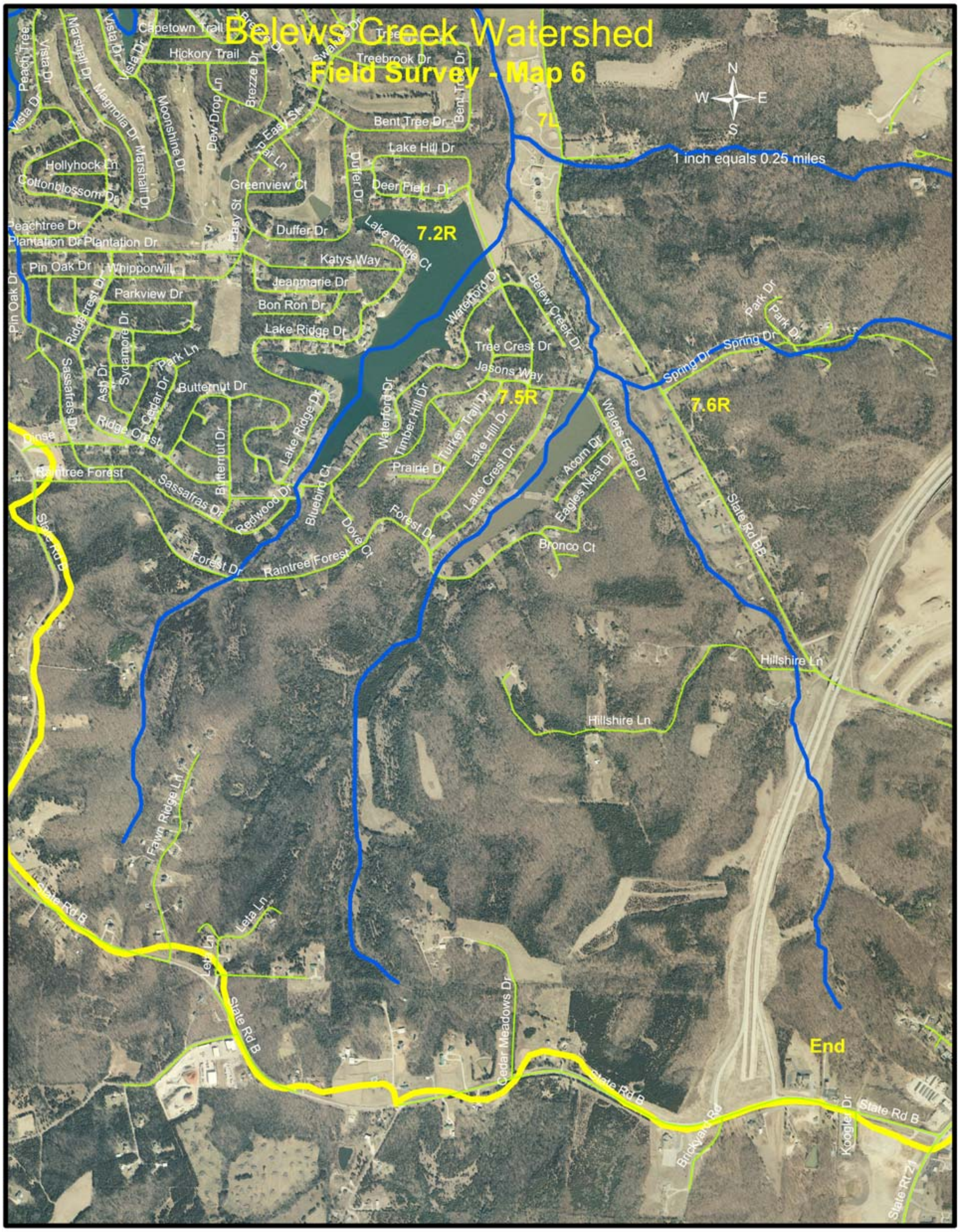


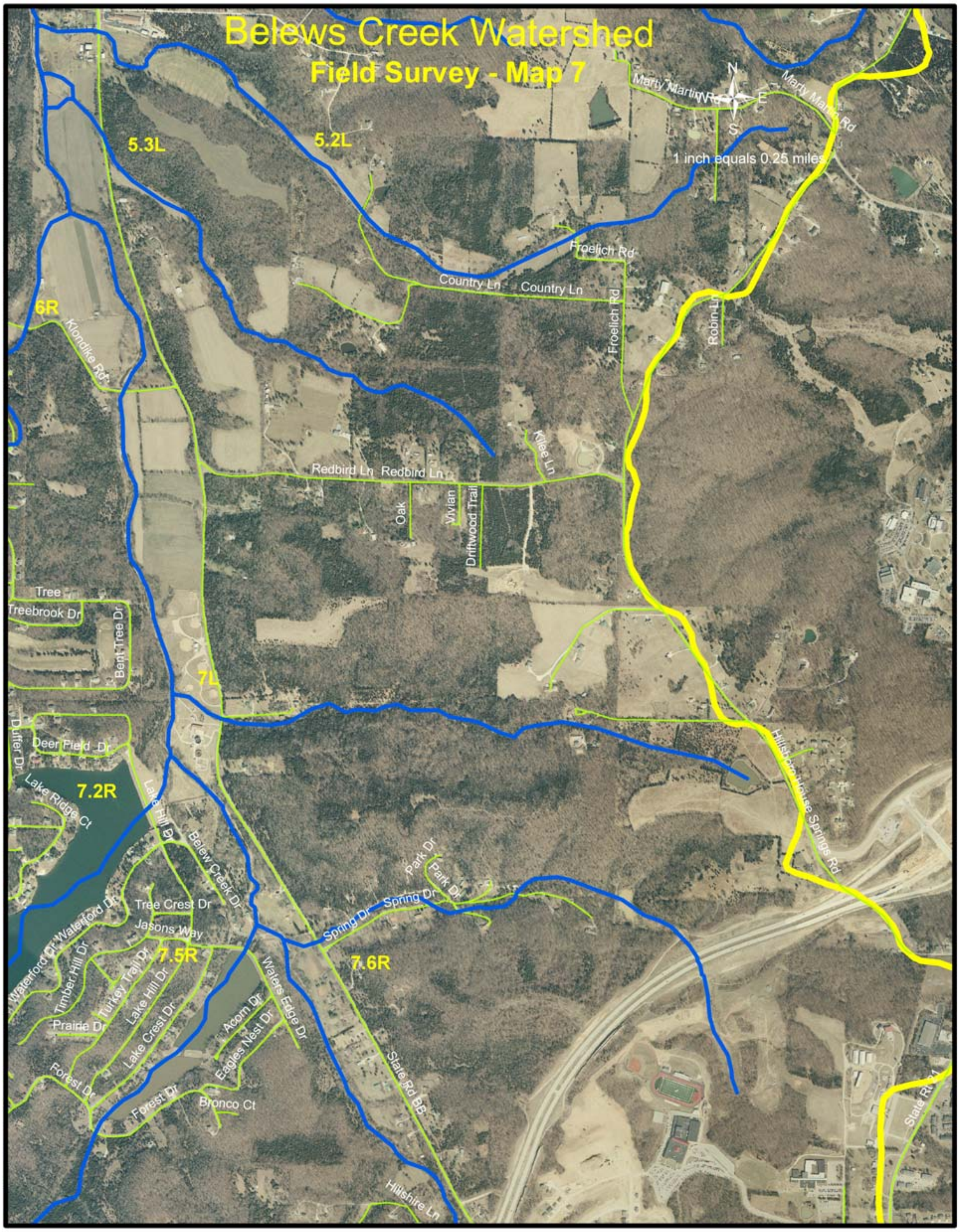
Belews Creek Watershed
Field Survey - Map 2
N
W
E
S
1 inch equals 0.25 miles
Aloha Cove
Timberline Dr
Timber Ct
Timberline Dr
Rosemary Ln
Rosemary Ln
Hillsboro Rd
Hillsboro Rd
Hillsboro Rd
Hillsboro House Springs Rd
Hills Springs Ln
Granberry Dr
Grandberry Dr
Dulin Creek Rd
Hubert Ln
Matthew Dr
Carriage Hill Est
Local House Springs Rd
Local Hillsboro Rd
Local Hillsboro Rd
Cedar Dr
Country Life Acres
Cedar Dr
Nelda Dr
Nelda Dr
Ems Rd
Ems Rd
Pless Dr
Carriage Hills Ln
1L1.5L1L
1L1.5L1R
Hellenic Dr
1L0.8L
Regina Rd
1L2.5L
1L1.5L
Mimi Mountain Rd
Starlight Dr
Regina Rd
Hillsboro House Springs Rd
1L2.5R
Lakeshore Dr

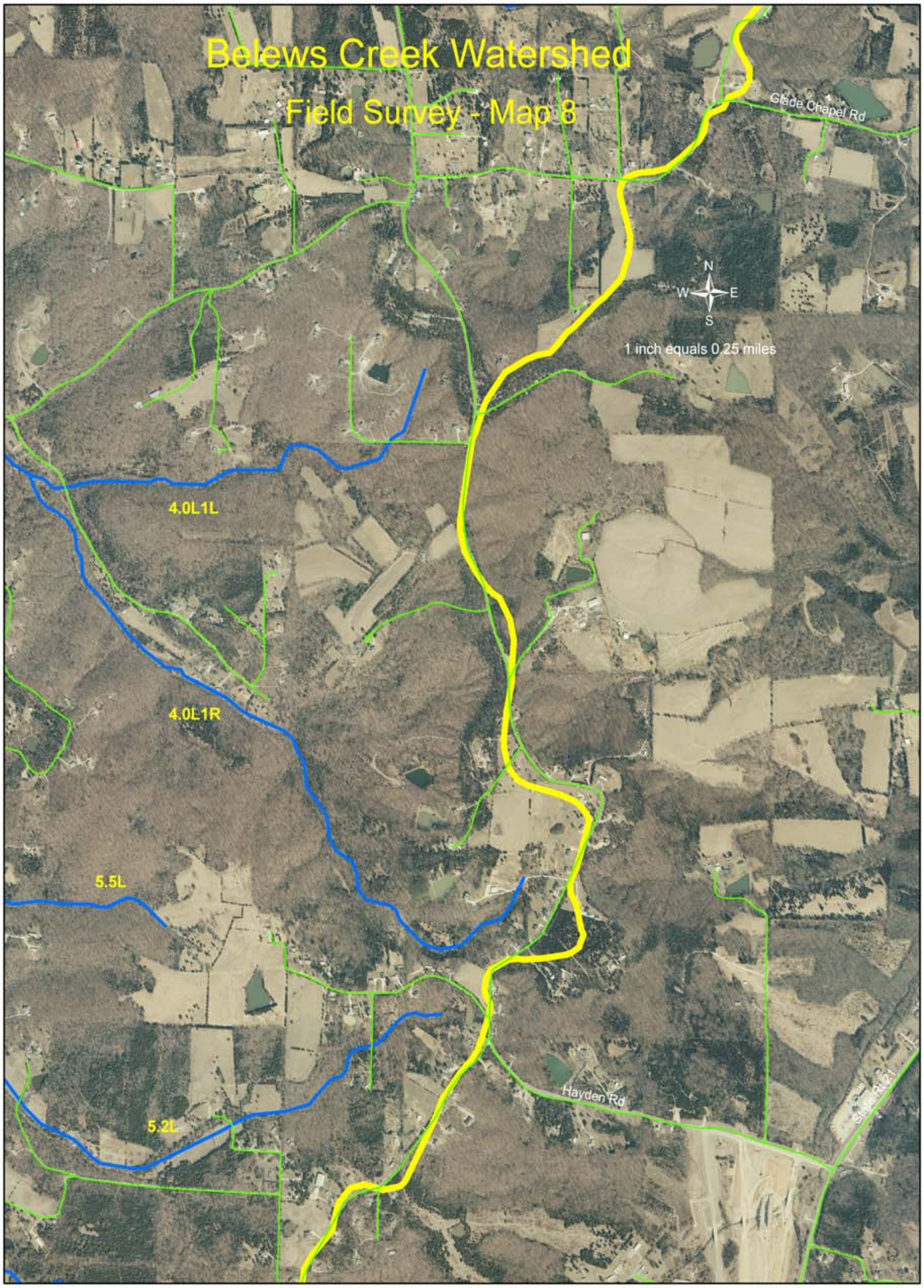

Belews Creek Watershed
Field Survey - Map 3
N
W
E
S
1 inch equals 0.25 miles
Pless Dr
Pless Dr
Sheppard Ln
White Oak Trail
Wohlbold Rd
Wohlbold Rd
Sunridge Dr
Tower Rd
Ems Rd
Ems Rd
Ems Crossing Ln
1L2.5L
Lonesome Pines
Tower
Tower
Tower Rd
Tishomingo Rd
Eisenhauer
Tishomingo Rd
Heidbreder Ln
Heidbreder Ln
1L2.5R
State Rt 21
Gebel Ln
Green Rd
Tishomingo Rd
Eisenhauer
Eisenhauer


Belews Creek Watershed
Field Survey - Map 4
1 inch equals 0.25 miles
N
W
E
S
2L
4L
4.5L
4.0L1L
4.0L1R
5R
5.1L
5.2L
5.3L
Lake Tishomingo Rd
Circle Dr
Oakcrest Dr
Lori Dr
Shelle Estates Dr
Brookstone Dr
Olde Baker School Ln
Beverly Ct
Lynnview Rd
Lynn View Acres
Glade Chapel Rd
Clayton Huskey Rd
Wiley Dr
Marty Martin Rd
Cedar Rock Rd
State Rd BB
Mic Ostpher
Timberline Circle
Land and Furs Rd
Klondike Rd
Els Dr


Belews Creek Watershed
Field Survey - Map 5
1 inch equals 0.25 miles
N
W
E
S
5.3L
5.2L
6R
7L
7.2R
7.5R
7.6R

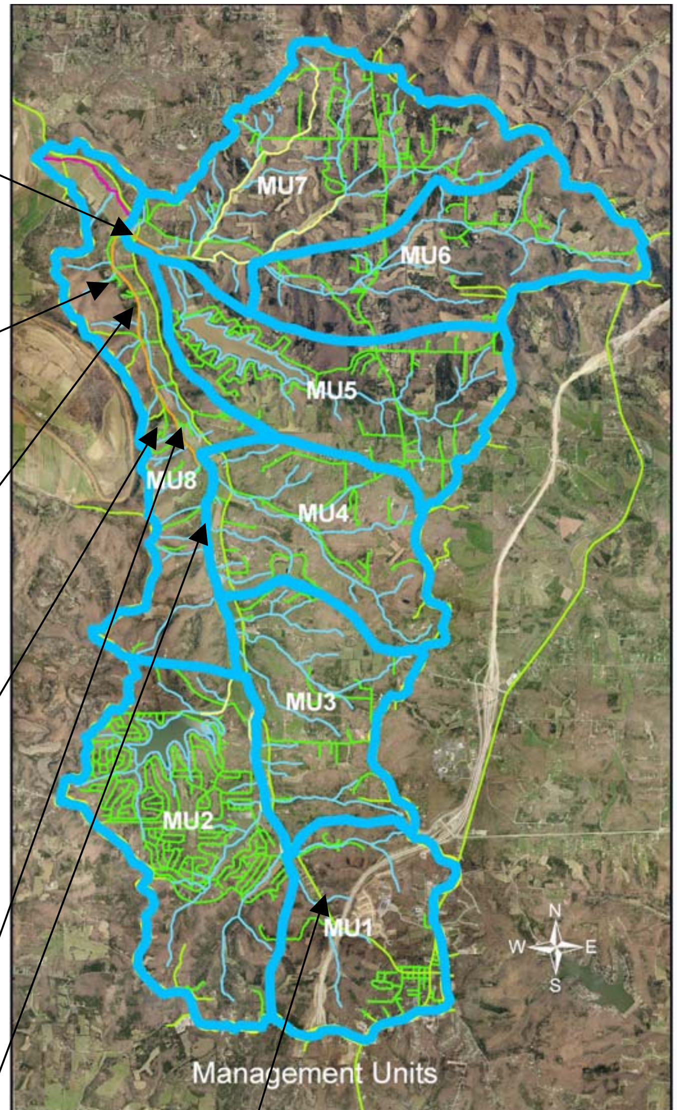

Belews Creek Watershed
Field Survey - Map 6
1 inch equals 0.25 miles
7L
7.2R
7.5R
7.6R
End
State Rd B
State Rd BB
Hillshire Ln
Cedar Meadows Dr
Raintree Forest
Forest Dr
Lake Ridge Dr
Plantation Dr
Belew Creek Dr
Waters Edge Dr
Spring Dr
Park Dr
Brickyard Rd
Koogler Dr
Fawn Ridge Ln
Leta Ln


Belews Creek Watershed
Field Survey - Map 7
N
E
S
1 inch equals 0.25 miles
5.3L
5.2L
6R
7L
7.2R
7.5R
7.6R
Marty Martin Rd
Froelich Rd
Country Ln
Robin Ln
Klondike Rd
Redbird Ln
Kilee Ln
Oak
Vivian
Driftwood Trail
Treebrook Dr
Bent Tree Dr
Deer Field Dr
Duffer Dr
Lake Ridge Ct
Lake Hill Dr
Belew Creek Dr
Park Dr
Spring Dr
Tree Crest Dr
Jasons Way
Waterford Dr
Timber Hill Dr
Turkey Trail Dr
Prairie Dr
Lake Crest Dr
Acorn Dr
Waters Edge Dr
Eagles Nest Dr
Forest Dr
Bronco Ct
State Rd BB
Hillshire Ln


Belews Creek Watershed
Field Survey - Map 8
Glade Chapel Rd
N
W
E
S
1 inch equals 0.25 miles
4.0L1L
4.0L1R
5.5L
5.2L
Hayden Rd
State Rt 21

11.4.1 – Bridges, Dams, Sedimentation, Creek Bank Disturbance Locations

Bridges



Private Bridge over Sand Creek

Bridge at Stump Hollow

Bridge at Mini Mountain

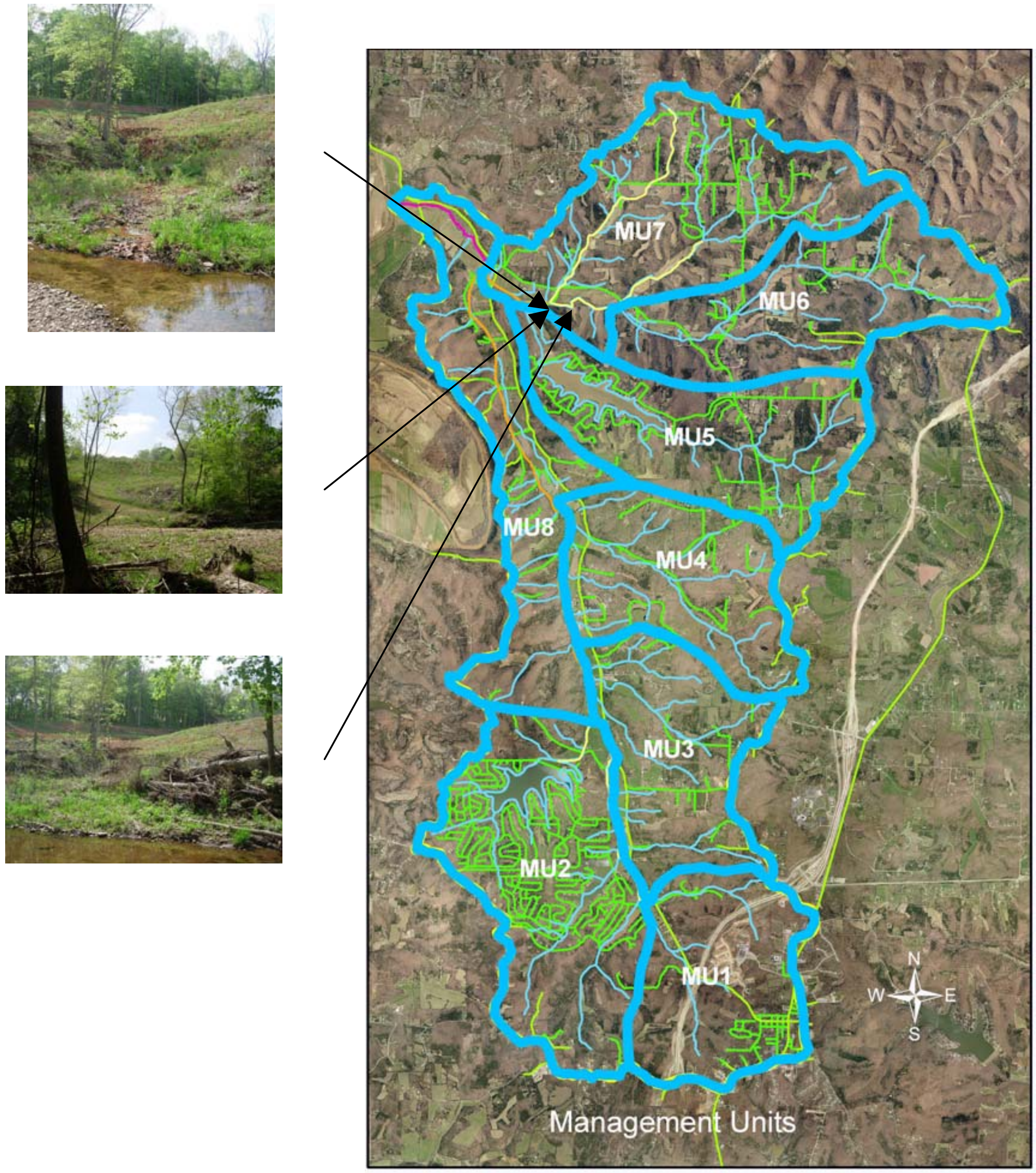
Bridge at Oak Crest

Another Bridge at Oak Crest

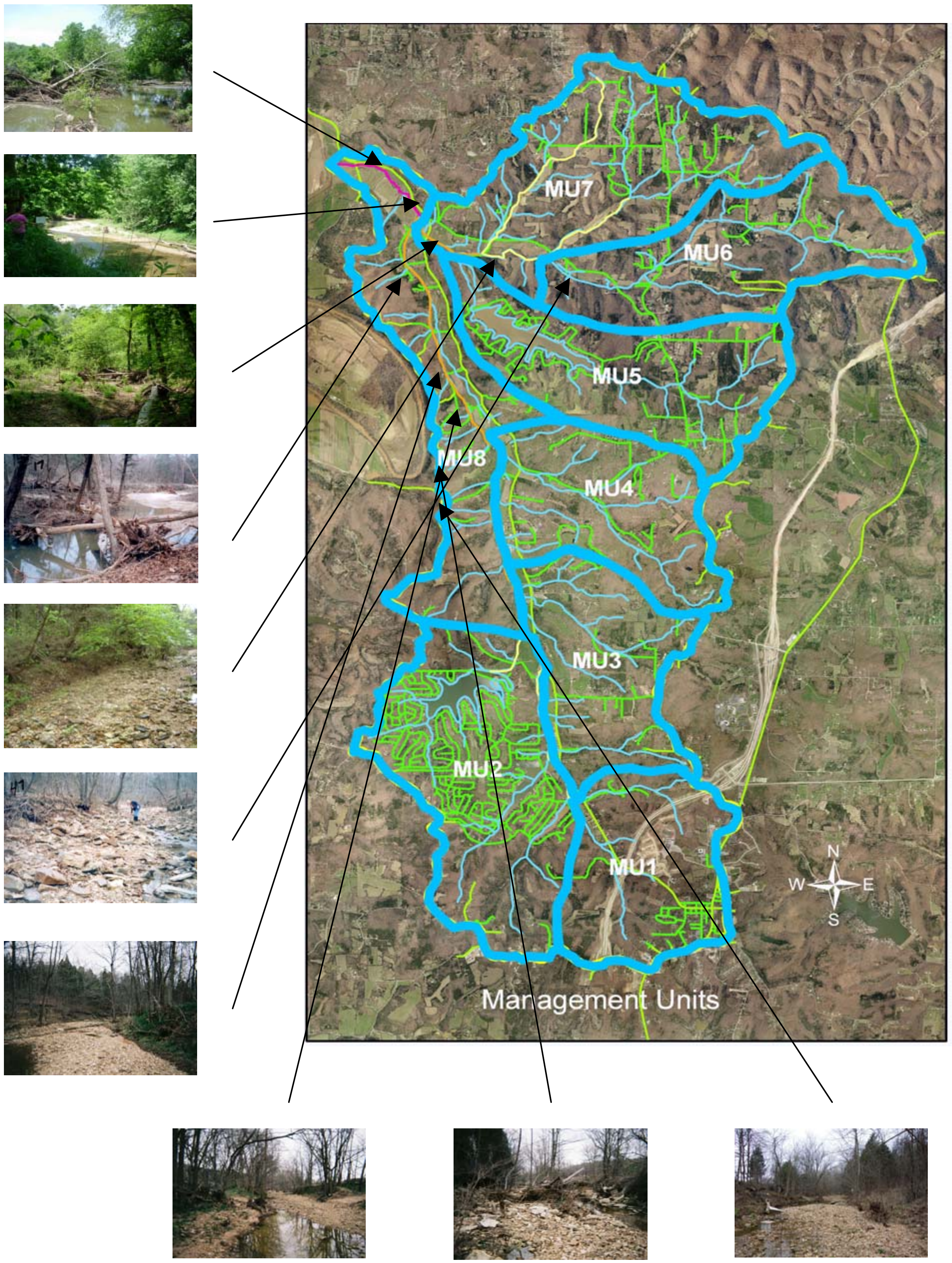
Bridge at Shelle Estates

Hillshire Bridge

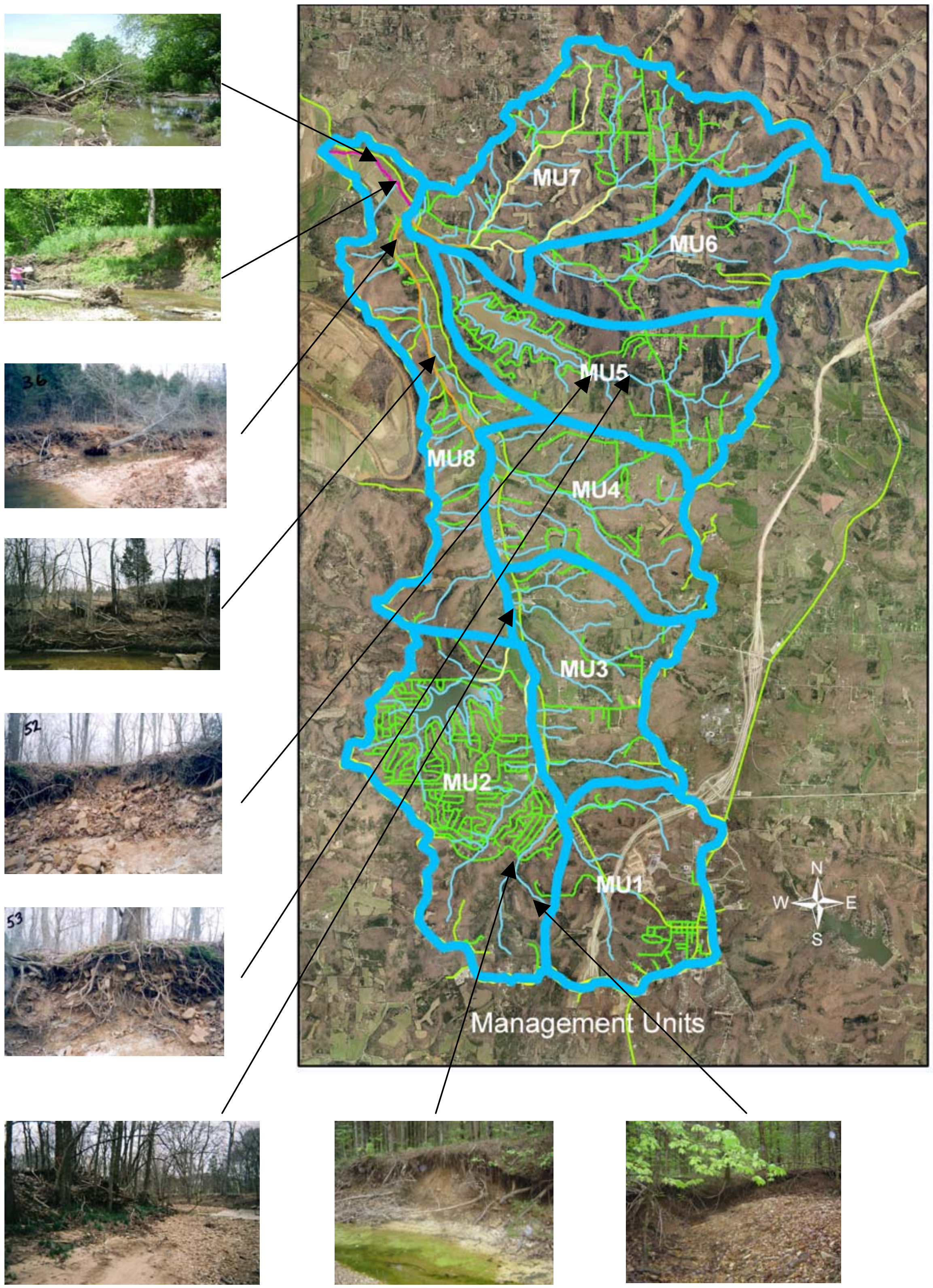
11.4.2 - Dams



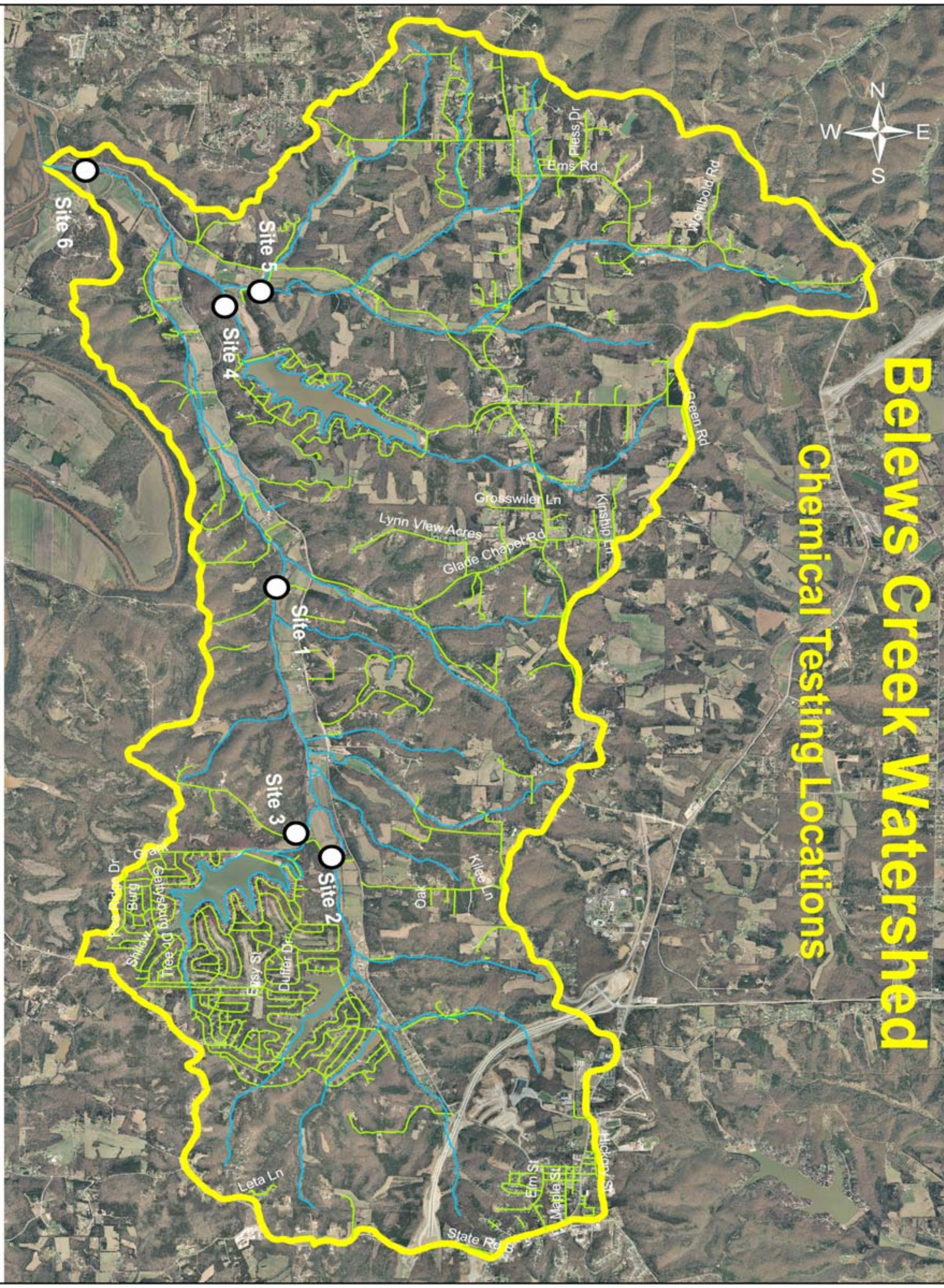
11.4.3 - Sedimentation



11.4.4 - Creek Bank Disturbance



Section 11.5 – Chemical Testing Locations

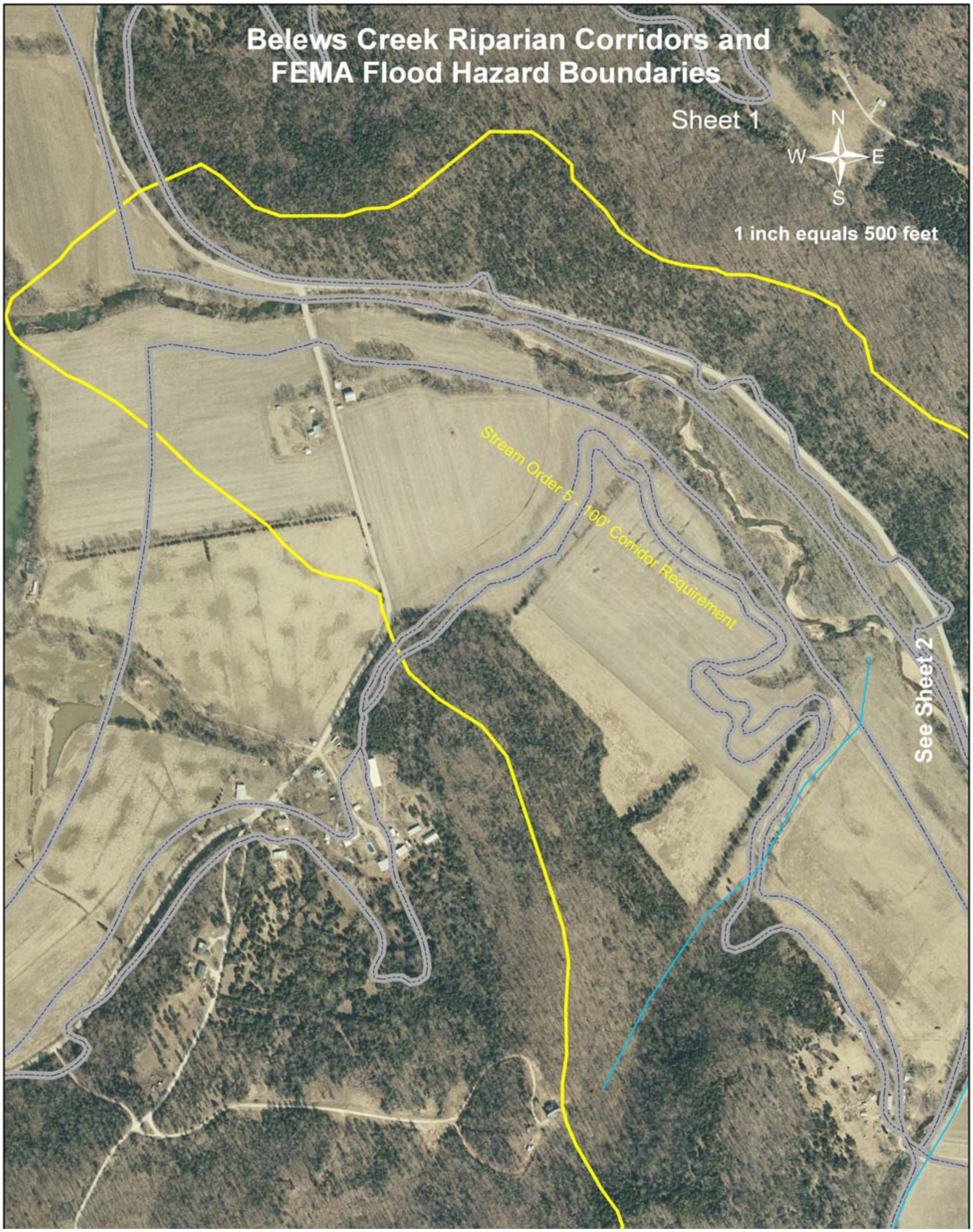


Belews Creek Water Quality Testing

	Site 1	Site 1	Site 1	Site 2	Site 2	Site 2
Date	8/24/05	10/18/05	10/08/07	9/09/05	10/18/05	10/08/07
Rainfall (inches in last 7 days)	2.6	0		0	0	
Weather Conditions	Cloudy	Sunny		Pt. Cldy	Clear	
Air Temperature (^oC)	24	18		24	19	
Water Temperature (^oC)	20	17		22	16	
Dissolved O_2 (mg/L)	14	6		8	11	
Dissolved O_2 % Saturation	154	62		92	112	
PH	7.8	7.8		8.6	8.8	
NO_3 -N (mg/L) -Nitrate	1.5	8.0		4.0	10.0	
Conductivity (μS/cm)	660	910		860	1130	
NH_3 - N (mg/L) - Ammonia	0.06	0.18		0.0	0.12	
PO_4 (mg/L)	1.78	2.90		>3.30	>3.30	
Turbidity	<10	<10		<10	<10	

	Site 3	Site 3	Site 3	Site 4	Site 5	Site 6	Site 6
Date	9/09/05	10/18/05	10/08/07	9/09/05	9/09/05	9/29/05	10/18/05
Rainfall (inches in last 7 days)	0	0		0	0	3.0	0
Weather Conditions	Pt. Cldy	Clear		Sunny	Sunny	Sunny	Clear
Air Temperature (^oC)	24	19		30	29	14	21
Water Temperature (^oC)	20	15		17	31	16	17
Dissolved O_2 (mg/L)	5	6		11	7	8	10
Dissolved O_2 % Saturation	55	60		114	94	81	104
PH	8.0	7.6		8.1	7.9	8.0	8.0
NO_3 -N (mg/L) -Nitrate	6.0	10		0.5	0.25	0.5	0.5
Conductivity (μS/cm)	990	1210		330	470	400	550
NH_3 - N (mg/L) - Ammonia	0.0			0.07	0.01	0.77	0.12
PO_4 (mg/L)	>3.30			0.24	0.22	0.27	0.20
Turbidity	<10			<10	<10	200	<10

Section 11.6 – FEMA and Riparian Corridor

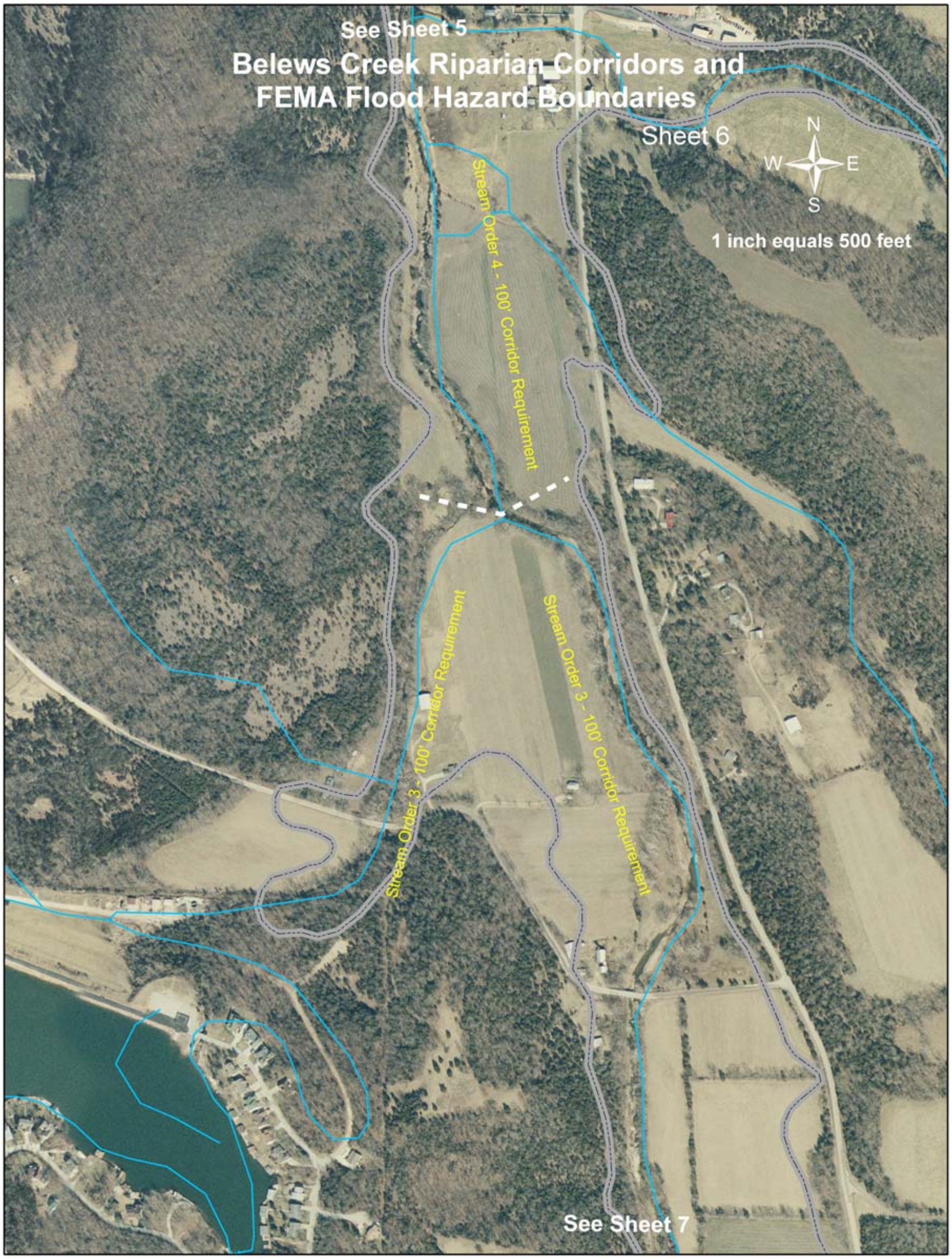


Belews Creek Riparian Corridors and FEMA Flood Hazard Boundaries
Sheet 2
N
W
E
S
1 inch equals 500 feet
See Sheet 1
See Sheet
See Sheet 3
Stream Order 4 - 100' Corridor Requirement
Stream Order 4 - 100' Corridor Requirement

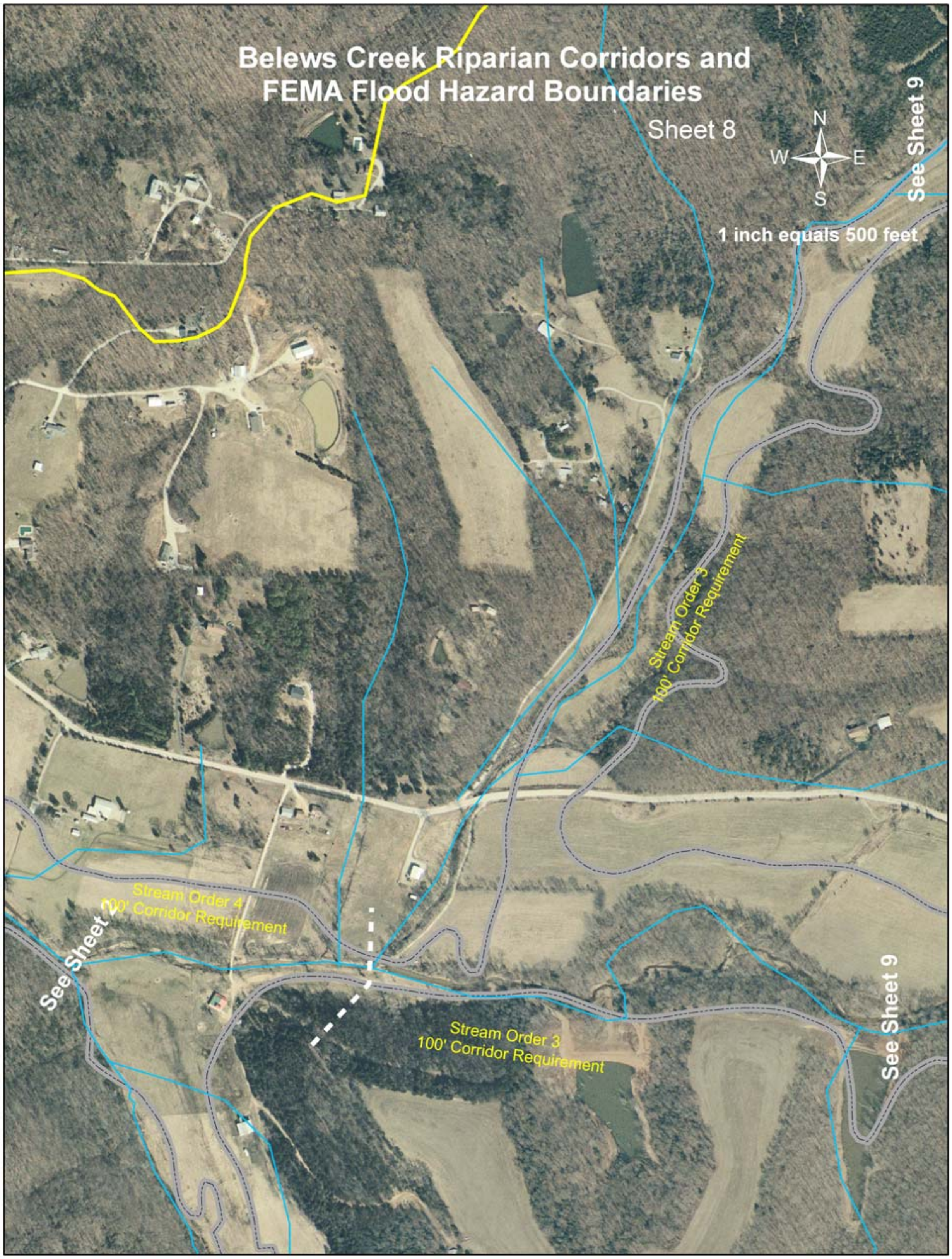

See Sheet 2
Belews Creek Riparian Corridors and
FEMA Flood Hazard Boundaries
Sheet 3
N
W
E
S
1 inch equals 500 feet
Stream Order 4 - 100' Corridor Requirement
See Sheet 3


See Sheet 3
Belews Creek Riparian Corridors and
FEMA Flood Hazard Boundaries
Sheet 4
N
W
E
S
1 inch equals 500 feet
Stream Order 4 - 100' Corridor Requirement
Stream Order 4 - 100' Corridor Requirement
See Sheet 5

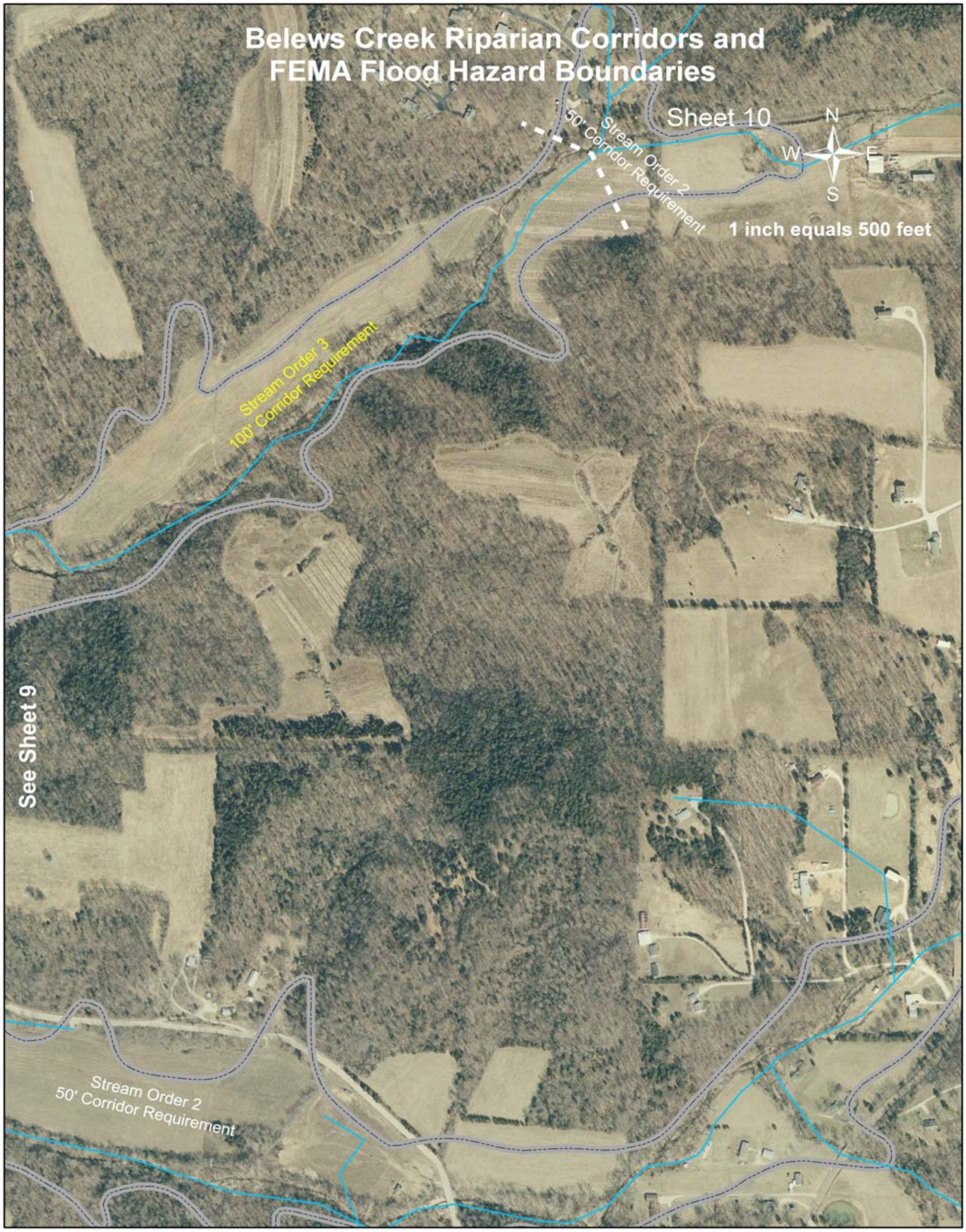

See Sheet 4
Belews Creek Riparian Corridors and FEMA Flood Hazard Boundaries
Sheet 5
N
W
E
S
1 inch equals 500 feet
Stream Order 4 - 100' Corridor Requirement
See Sheet 6


See Sheet 5
Belews Creek Riparian Corridors and
FEMA Flood Hazard Boundaries
Sheet 6
N
W
E
S
1 inch equals 500 feet
Stream Order 4 - 100' Corridor Requirement
Stream Order 3 - 100' Corridor Requirement
Stream Order 3 - 100' Corridor Requirement
See Sheet 7


See Sheet 6
Belews Creek Riparian Corridors and
FEMA Flood Hazard Boundaries
Sheet 7
N
W
E
S
1 inch equals 500 feet
Stream Order 3 - 100' Corridor Requirement
Stream Order 2
50' Corridor Requirement


Belews Creek Riparian Corridors and
FEMA Flood Hazard Boundaries
Sheet 8
N
W
E
S
1 inch equals 500 feet
See Sheet 9
Stream Order 3
100' Corridor Requirement
Stream Order 4
100' Corridor Requirement
See Sheet 2
Stream Order 3
100' Corridor Requirement
See Sheet 9


Belews Creek Riparian Corridors and
FEMA Flood Hazard Boundaries
Sheet 9
N
W
E
S
1 inch equals 500 feet
Stream Order 2
50' Corridor Requirement
Stream Order 3
100' Corridor Requirement
Stream Order 2
50' Corridor Requirement
Stream Order 3
100' Corridor Requirement
Stream Order 2
50' Corridor Requirement
See Sheet 8
See Sheet 10


Belews Creek Riparian Corridors and
FEMA Flood Hazard Boundaries
Sheet 10
N
W
E
S
1 inch equals 500 feet
Stream Order 2
50' Corridor Requirement
Stream Order 3
100' Corridor Requirement
See Sheet 9
Stream Order 2
50' Corridor Requirement

11.7 – L-THIA by Management Unit

The L-THIA analysis provides results for six non-point pollution sources. See the following reports by Management Unit for the complete results. For the Belews Creek Watershed Plan, six of the following pollutants were used and prioritized. If any of the other pollutants are identified in subsequent reviews as issues of concern, their associated results should be further investigated.

Biological Oxygen Demand (BOD) – This is a chemical procedure for determining how fast biological organisms use up oxygen in a body of water. It is used in water quality management and assessment, ecology and environmental science. BOD is not an accurate quantitative test, although it could be considered as an indication of the quality of a water source. BOD can be used as a gauge of the effectiveness of wastewater treatment plants.

Chemical Oxygen Demand (COD) – This is a test 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 (lakes, and rivers), making COD a useful measure of water quality. It is expressed in milligrams per liter (mg/L), which indicates the mass of oxygen consumed per liter of solution. Older references may express the units as parts per million (ppm).

Fecal Coliform & Fecal Strep – Coliforms and fecal streptococci are used as indicators of possible sewage contamination because they are commonly found in human and animal feces. Although they are generally not harmful themselves, they indicate the possible presence of pathologic (disease-causing) bacteria, viruses, and protozoans that also live in human and animal digestive systems. Therefore, their presence in streams suggests that pathogenic microorganisms might also be present and that swimming and eating shellfish might be a health risk. Since it is difficult, time-consuming, and expensive to test directly for the presence of a large variety of pathogens, water is usually tested for coliforms and fecal streptococci instead. Sources of fecal contamination to surface waters include wastewater treatment plants, on-site septic systems, domestic and wild animal manure, and storm runoff. Fecal bacteria can also cause cloudy water, unpleasant odors, excessive algae growth, and an increased oxygen demand.

Oil & Grease – These pollutants enter streams from stormwater runoff (roads and auto fluids, for example).

Suspended Solids – This refers to small solid particles that remain in suspension in water as a colloid or due to the motion of the water. It is used as one indicator of water quality.

The following chart includes other common pollutants and their sources.

Table 2-2. Summary of Common Pollutants and Sources

Pollutant	Potential Sources		Impacts on Waterbody Uses
	Point Sources	Nonpoint Sources	
Pathogens	• WWTPs • CSOs/SSOs • Permitted CAFOs • Discharges from meat processing facilities • Landfills	• Animals (domestic, wildlife, livestock) • Malfunctioning septic systems • Pastures • Boat pumpout facilities • Land application of manure • Land application of wastewater	• Primarily human health risks • Risk of illness from ingestion or from contact with contaminated water through recreation • Increased cost of treatment of drinking water supplies • Shellfish bed closures
Metals	• Urban runoff • WWTPs • CSO/SSOs • Landfills • Industrial facilities • Mine discharges	• Abandoned mine drainage • Hazardous waste sites (unknown or partially treated sources) • Marinas	• Aquatic life impairments (e.g., reduced fish populations due to acute/chronic concentrations or contaminated sediment) • Drinking water supplies (elevated concentrations in source water) • Fish contamination (e.g., mercury)
Nutrients	• WWTPs • CSOs/SSOs • CAFOs • Discharge from food- processing facilities • Landfills	• Cropland (fertilizer application) • Landscaped spaces in developed areas (e.g., lawns, golf courses) • Animals (domestic, wildlife, livestock) • Malfunctioning septic systems • Pastures • Boat pumpout • Land application of manure or wastewater	• Aquatic life impairments (e.g., effects from excess plant growth, low DO) • Direct drinking water supply impacts (e.g., dangers to human health from high levels of nitrates) • Indirect drinking water supply impacts (e.g., effects from excess plant growth clogging drinking water facility filters) • Recreational impacts (indirect impacts from excess plant growth on fisheries, boat/swimming access, appearance, and odors) • Human health impacts
Sediment	• WWTPs • Urban stormwater systems	• Agriculture (cropland and pastureland erosion) • Silviculture and timber harvesting • Rangeland erosion • Excessive streambank erosion • Construction • Roads • Urban runoff • Landslides • Abandoned mine drainage • Stream channel modification	• Fills pools used for refuge and rearing • Fills interstitial spaces between gravel (reduces spawning habitat by trapping emerging fish and reducing oxygen exchange) • When suspended, prevents fish from seeing food and can clog gills; high levels of suspended sediment can cause fish to avoid the stream • Taste/odor problems in drinking water • Impairs swimming/boating because of physical alteration of the channel • Indirect impacts on recreational fishing

Table 2-2. (continued)

Pollutant	Potential Sources		Impacts on Waterbody Uses
	Point Sources	Nonpoint Sources	
Temperature	• WWTPs • Cooling water discharges (power plants and other industrial sources) • Urban stormwater systems	• Lack of riparian shading • Shallow or wide channels (due to hydrologic modification) • Hydroelectric dams • Urban runoff (warmer runoff from impervious surfaces) • Sediment (cloudy water absorbs more heat than clear water) • Abandoned mine drainage	• Causes lethal effects when temperature exceeds tolerance limit • Increases metabolism (results in higher oxygen demand for aquatic organisms) • Increases food requirements • Decreases growth rates and DO • Influences timing of migration • Increases sensitivity to disease • Increases rates of photosynthesis (increases algal growth, depletes oxygen through plant decomposition) • Causes excess plant growth

Note: WWTP = wastewater treatment plant; CSO = combined sewer overflow; SSO = sanitary sewer overflow; CAFO = concentrated animal feeding operation; DO = dissolved oxygen.

L-THIA Projection Tables

SUMMARY OF SCENARIOS State: Missouri County: Jefferson		Management Unit One		
Land Use	Hydrologic Soil Group	Current	acres Scenario 1	Scenario 2
High Density Residential	B	750	750	1155
High Density Residential	D	0	405	0
Low Density Residential	B	165	0	0
Low Density Residential	D	0	85	85
Agricultural	A	200	85	85
Agricultural	B	350	0	0
Forest	D	100	0	0
Commercial	C	85	325	325

RUNOFF RESULTS

Avg. Annual Runoff Volume (acre-ft)

Land Use	Current	Scenario 1	Scenario 2
High Density Residential	708.40	708.40	1090.94
High Density Residential	0	652.46	0
Low Density Residential	59.84	0	0
Low Density Residential	0	80.28	80.28
Agricultural	48.97	20.81	20.81
Agricultural	174.59	0	0
Forest	56.35	0	0
Commercial	161.98	619.34	619.34
Total Annual Volume (acre-ft)	1210.15	2081.31	1811.38

Avg. Annual Runoff Depth (in)

Current	Scenario 2	Scenario 3
8.80	15.13	13.17

Avg. Runoff Depth by Landuse

Land Use	Hydrologic Soil group	Curve Number	Runoff Depth (in)
High Density Residential	B	85	11.38
High Density Residential	D	92	19.41
Low Density Residential	B	70	4.37
Low Density Residential	D	85	11.38
Agricultural	A	64	2.95
Agricultural	B	75	6.01
Forest	D	77	6.79
Commercial	C	94	22.96
Average Annual Rainfall Depth (in)			45.98

NONPOINT SOURCE POLLUTANT RESULTS			
Nitrogen (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	3512	3512	5409
High Density Residential	0	3235	0
Low Density Residential	296	0	0
Low Density Residential	0	398	398
Agricultural	587	249	249
Agricultural	2093	0	0
Forest	107	0	0
Commercial	591	2261	2261
Total	7186	9655	8317
Phosphorous (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	1100	1100	1694
High Density Residential	0	1013	0
Low Density Residential	92	0	0
Low Density Residential	0	124	124
Agricultural	173	73	73
Agricultural	618	0	0
Forest	1	0	0
Commercial	141	540	540
Total	2125	2850	2431
Suspended Solids (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	79136	79136	121870
High Density Residential	0	72887	0
Low Density Residential	6685	0	0
Low Density Residential	0	8968	8968
Agricultural	14276	6067	6067
Agricultural	50899	0	0
Forest	153	0	0
Commercial	24494	93656	93656
Total	175643	260714	230561
Lead (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	17	17	26

High Density Residential	0	15	0
Low Density Residential	1	0	0
Low Density Residential	0	1	1
Agricultural	0.200	0.085	0.085
Agricultural	0.713	0	0
Forest	0.767	0	0
Commercial	5	21	21
Total	24.68	54.085	48.085

Copper (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	17	17	26
High Density Residential	0	15	0
Low Density Residential	1	0	0
Low Density Residential	0	1	1
Agricultural	0.200	0.085	0.085
Agricultural	0.713	0	0
Forest	1	0	0
Commercial	6	24	24
Total	25.913	57.085	51.085

Zinc (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	154	154	237
High Density Residential	0	142	0
Low Density Residential	13	0	0
Low Density Residential	0	17	17
Agricultural	2	0.907	0.907
Agricultural	7	0	0
Forest	0.921	0	0
Commercial	79	303	303
Total	255.921	616.907	557.907

Cadmium (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	1	1	2
High Density Residential	0	1	0
Low Density Residential	0.122	0	0
Low Density Residential	0	0.164	0.164
Agricultural	0.133	0.056	0.056
Agricultural	0.475	0	0
Forest	0.152	0	0
Commercial	0.423	1	1

Total	2.305	3.22	3.22

Chromium (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	4	4	6
High Density Residential	0	3	0
Low Density Residential	0.342	0	0
Low Density Residential	0	0.459	0.459
Agricultural	1	0.567	0.567
Agricultural	4	0	0
Forest	1	0	0
Commercial	4	16	16
Total	14.342	24.026	23.026

Nickel (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	19	19	29
High Density Residential	0	17	0
Low Density Residential	1	0	0
Low Density Residential	0	2	2
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	5	19	19
Total	25	57	50

BOD (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	49219	49219	75797
High Density Residential	0	45332	0
Low Density Residential	4158	0	0
Low Density Residential	0	5578	5578
Agricultural	533	226	226
Agricultural	1902	0	0
Forest	76	0	0
Commercial	10150	38812	38812
Total	66038	139167	120413

COD (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	95542	95542	147136

High Density Residential	0	87998	0
Low Density Residential	8071	0	0
Low Density Residential	0	10828	10828
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	51196	195750	195750
Total	154809	390118	353714

Oil & Grease (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	3281	3281	5053
High Density Residential	0	3022	0
Low Density Residential	277	0	0
Low Density Residential	0	371	371
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	3972	15187	15187
Total	7530	21861	20611

Fecal Coliform (millions of coliform)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	175469	175469	270222
High Density Residential	0	161613	0
Low Density Residential	14823	0	0
Low Density Residential	0	19886	19886
Agricultural	15768	6701	6701
Agricultural	56218	0	0
Forest	139	0	0
Commercial	13842	52926	52926
Total	276259	416595	349735

Fecal Strep (millions of coliform)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	491313	491313	756622
High Density Residential	0	452517	0
Low Density Residential	41506	0	0
Low Density Residential	0	55682	55682
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	36110	138068	138068

Total	568929	1137580	950372

These results were generated by the L-THIA (Long-Term Hydrologic Impact Assessment) model at "http://www.ecn.purdue.edu/runoff/lthianew"

SUMMARY OF SCENARIOS State: Missouri County: Jefferson		Management Unit Two		
Land Use	Hydrologic Soil Group	Current	acres Scenario 1	Scenario 2
High Density Residential	B	0	0	130
High Density Residential	D	2120	2250	2120
Low Density Residential	B	0	0	0
Low Density Residential	D	130	135	135
Agricultural	A	200	65	65
Agricultural	B	100	65	65
Forest	D	100	0	0
Commercial	C	0	135	135

RUNOFF RESULTS

Avg. Annual Runoff Volume (acre-ft)

Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	122.79
High Density Residential	3415.38	3624.81	3415.38
Low Density Residential	0	0	0
Low Density Residential	122.79	127.51	127.51
Agricultural	48.97	15.91	15.91
Agricultural	49.88	32.42	32.42
Forest	56.35	0	0
Commercial	0	257.26	257.26
Total Annual Volume (acre-ft)	3693.38	4057.93	3971.29

Avg. Annual Runoff Depth (in)

Current	Scenario 2	Scenario 3
16.72	18.37	17.98

Avg. Runoff Depth by Landuse

Land Use	Hydrologic Soil group	Curve Number	Runoff Depth (in)
High Density Residential	B	85	11.38
High Density Residential	D	92	19.41
Low Density Residential	B	70	4.37
Low Density Residential	D	85	11.38
Agricultural	A	64	2.95
Agricultural	B	75	6.01
Forest	D	77	6.79
Commercial	C	94	22.96
Average Annual Rainfall Depth (in)			45.98

NONPOINT SOURCE POLLUTANT RESULTS

Nitrogen (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	608
High Density Residential	16936	17975	16936
Low Density Residential	0	0	0
Low Density Residential	608	632	632
Agricultural	587	190	190
Agricultural	598	388	388
Forest	107	0	0
Commercial	0	939	939
Total	18836	20124	19693

Phosphorous (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	190
High Density Residential	5304	5629	5304
Low Density Residential	0	0	0
Low Density Residential	190	198	198
Agricultural	173	56	56
Agricultural	176	114	114
Forest	1	0	0
Commercial	0	224	224
Total	5844	6221	6086

Suspended Solids (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	13716
High Density Residential	381535	404931	381535
Low Density Residential	0	0	0
Low Density Residential	13716	14244	14244
Agricultural	14276	4639	4639
Agricultural	14542	9452	9452
Forest	153	0	0
Commercial	0	38903	38903
Total	424222	472169	462489

Lead (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	3

High Density Residential	83	88	83
Low Density Residential	0	0	0
Low Density Residential	3	3	3
Agricultural	0.200	0.065	0.065
Agricultural	0.203	0.132	0.132
Forest	0.767	0	0
Commercial	0	9	9
Total	87.17	100.197	98.197

Copper (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	3
High Density Residential	83	88	83
Low Density Residential	0	0	0
Low Density Residential	3	3	3
Agricultural	0.200	0.065	0.065
Agricultural	0.203	0.132	0.132
Forest	1	0	0
Commercial	0	10	10
Total	87.403	101.197	99.197

Zinc (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	26
High Density Residential	744	790	744
Low Density Residential	0	0	0
Low Density Residential	26	27	27
Agricultural	2	0.693	0.693
Agricultural	2	1	1
Forest	0.921	0	0
Commercial	0	126	126
Total	774.921	944.693	924.693

Cadmium (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	0.250
High Density Residential	6	7	6
Low Density Residential	0	0	0
Low Density Residential	0.250	0.260	0.260
Agricultural	0.133	0.043	0.043
Agricultural	0.135	0.088	0.088
Forest	0.152	0	0
Commercial	0	0.672	0.672

Total	6.67	8.063	7.313

Chromium (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	0.702
High Density Residential	19	20	19
Low Density Residential	0	0	0
Low Density Residential	0.702	0.729	0.729
Agricultural	1	0.433	0.433
Agricultural	1	0.883	0.883
Forest	1	0	0
Commercial	0	7	7
Total	22.702	29.045	28.747

Nickel (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	3
High Density Residential	93	98	93
Low Density Residential	0	0	0
Low Density Residential	3	3	3
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	0	8	8
Total	96	109	107

BOD (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	8531
High Density Residential	237296	251847	237296
Low Density Residential	0	0	0
Low Density Residential	8531	8859	8859
Agricultural	533	173	173
Agricultural	543	353	353
Forest	76	0	0
Commercial	0	16122	16122
Total	246979	277354	271334

COD (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	16560

High Density Residential	460634	488880	460634
Low Density Residential	0	0	0
Low Density Residential	16560	17197	17197
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	0	81311	81311
Total	477194	587388	575702

Oil & Grease (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	568
High Density Residential	15819	16789	15819
Low Density Residential	0	0	0
Low Density Residential	568	590	590
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	0	6308	6308
Total	16387	23687	23285

Fecal Coliform (millions of coliform)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	30414
High Density Residential	845976	897852	845976
Low Density Residential	0	0	0
Low Density Residential	30414	31584	31584
Agricultural	15768	5124	5124
Agricultural	16062	10440	10440
Forest	139	0	0
Commercial	0	21984	21984
Total	908359	966984	945522

Fecal Strep (millions of coliform)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	85160
High Density Residential	2368734	2513986	2368734
Low Density Residential	0	0	0
Low Density Residential	85160	88436	88436
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	0	57351	57351

Total	2453894	2659773	2599681

These results were generated by the L-THIA (Long-Term Hydrologic Impact Assessment) model at "http://www.ecn.purdue.edu/runoff/lthianew"

SUMMARY OF SCENARIOS State: Missouri County: Jefferson		Management Unit Three		
Land Use	Hydrologic Soil Group	Current	acres Scenario 1	Scenario 2
High Density Residential	B	0	0	745
High Density Residential	D	0	745	0
Low Density Residential	B	0	0	0
Low Density Residential	D	165	165	165
Agricultural	A	200	100	100
Agricultural	B	485	175	175
Forest	D	800	300	300
Commercial	C	0	165	165

RUNOFF RESULTS
Avg. Annual Runoff Volume (acre-ft)

Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	703.68
High Density Residential	0	1200.21	0
Low Density Residential	0	0	0
Low Density Residential	155.84	155.84	155.84
Agricultural	48.97	24.48	24.48
Agricultural	241.93	87.29	87.29
Forest	450.85	169.07	169.07
Commercial	0	314.43	314.43
Total Annual Volume (acre-ft)	897.60	1951.35	1454.81

Avg. Annual Runoff Depth (in)

Current	Scenario 2	Scenario 3
6.52	14.19	10.58

Avg. Runoff Depth by Landuse

Land Use	Hydrologic Soil group	Curve Number	Runoff Depth (in)
High Density Residential	B	85	11.38
High Density Residential	D	92	19.41
Low Density Residential	B	70	4.37
Low Density Residential	D	85	11.38
Agricultural	A	64	2.95
Agricultural	B	75	6.01
Forest	D	77	6.79
Commercial	C	94	22.96
Average Annual Rainfall Depth (in)			45.98

NONPOINT SOURCE POLLUTANT RESULTS

Nitrogen (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	3489
High Density Residential	0	5951	0
Low Density Residential	0	0	0
Low Density Residential	772	772	772
Agricultural	587	293	293
Agricultural	2900	1046	1046
Forest	859	322	322
Commercial	0	1148	1148
Total	5118	9532	7070

Phosphorous (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	1092
High Density Residential	0	1864	0
Low Density Residential	0	0	0
Low Density Residential	242	242	242
Agricultural	173	86	86
Agricultural	856	309	309
Forest	12	4	4
Commercial	0	274	274
Total	1283	2779	2007

Suspended Solids (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	78608
High Density Residential	0	134077	0
Low Density Residential	0	0	0
Low Density Residential	17410	17410	17410
Agricultural	14276	7138	7138
Agricultural	70532	25449	25449
Forest	1228	460	460
Commercial	0	47548	47548
Total	103446	232082	176613

Lead (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	17

High Density Residential	0	29	0
Low Density Residential	0	0	0
Low Density Residential	3	3	3
Agricultural	0.200	0.100	0.100
Agricultural	0.988	0.356	0.356
Forest	6	2	2
Commercial	0	11	11
Total	10.188	45.456	33.456

Copper (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	17
High Density Residential	0	29	0
Low Density Residential	0	0	0
Low Density Residential	3	3	3
Agricultural	0.200	0.100	0.100
Agricultural	0.988	0.356	0.356
Forest	12	4	4
Commercial	0	12	12
Total	16.188	48.456	36.456

Zinc (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	153
High Density Residential	0	261	0
Low Density Residential	0	0	0
Low Density Residential	33	33	33
Agricultural	2	1	1
Agricultural	10	3	3
Forest	7	2	2
Commercial	0	154	154
Total	52	454	346

Cadmium (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	1
High Density Residential	0	2	0
Low Density Residential	0	0	0
Low Density Residential	0.318	0.318	0.318
Agricultural	0.133	0.066	0.066
Agricultural	0.659	0.237	0.237
Forest	1	0.456	0.456
Commercial	0	0.822	0.822

Total	2.11	3.899	2.899

Chromium (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	4
High Density Residential	0	6	0
Low Density Residential	0	0	0
Low Density Residential	0.891	0.891	0.891
Agricultural	1	0.667	0.667
Agricultural	6	2	2
Forest	9	3	3
Commercial	0	8	8
Total	16.891	20.558	18.558

Nickel (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	19
High Density Residential	0	32	0
Low Density Residential	0	0	0
Low Density Residential	4	4	4
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	0	10	10
Total	4	46	33

BOD (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	48890
High Density Residential	0	83389	0
Low Density Residential	0	0	0
Low Density Residential	10828	10828	10828
Agricultural	533	266	266
Agricultural	2636	951	951
Forest	614	230	230
Commercial	0	19704	19704
Total	14611	115368	80869

COD (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	94905

High Density Residential	0	161873	0
Low Density Residential	0	0	0
Low Density Residential	21019	21019	21019
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	0	99381	99381
Total	21019	282273	215305

Oil & Grease (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	3259
High Density Residential	0	5559	0
Low Density Residential	0	0	0
Low Density Residential	721	721	721
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	0	7710	7710
Total	721	13990	11690

Fecal Coliform (millions of coliform)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	174299
High Density Residential	0	297288	0
Low Density Residential	0	0	0
Low Density Residential	38603	38603	38603
Agricultural	15768	7884	7884
Agricultural	77903	28109	28109
Forest	1116	418	418
Commercial	0	26870	26870
Total	133390	399172	276183

Fecal Strep (millions of coliform)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	488037
High Density Residential	0	832408	0
Low Density Residential	0	0	0
Low Density Residential	108088	108088	108088
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	0	70096	70096

Total	108088	1010592	666221

These results were generated by the L-THIA (Long-Term Hydrologic Impact Assessment) model at "http://www.ecn.purdue.edu/runoff/lthianew"

SUMMARY OF SCENARIOS State: Missouri County: Jefferson		Management Unit Four		
Land Use	Hydrologic Soil Group	Current	acres Scenario 1	Scenario 2
High Density Residential	B	0	0	525
High Density Residential	D	0	525	0
Low Density Residential	B	0	100	480
Low Density Residential	D	0	525	145
Agricultural	A	200	100	100
Agricultural	B	750	250	250
Forest	D	800	250	250
Commercial	C	0	0	0

RUNOFF RESULTS

Avg. Annual Runoff Volume (acre-ft)

Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	495.88
High Density Residential	0	845.79	0
Low Density Residential	0	36.27	174.10
Low Density Residential	0	495.88	136.95
Agricultural	48.97	24.48	24.48
Agricultural	374.12	124.70	124.70
Forest	450.85	140.89	140.89
Commercial	0	0	0
Total Annual Volume (acre-ft)	873.94	1668.03	1097.02

Avg. Annual Runoff Depth (in)

Current	Scenario 2	Scenario 3
5.99	11.43	7.52

Avg. Runoff Depth by Landuse

Land Use	Hydrologic Soil group	Curve Number	Runoff Depth (in)
High Density Residential	B	85	11.38
High Density Residential	D	92	19.41
Low Density Residential	B	70	4.37
Low Density Residential	D	85	11.38
Agricultural	A	64	2.95
Agricultural	B	75	6.01
Forest	D	77	6.79
Commercial	C	94	22.96
Average Annual Rainfall Depth (in)			45.98

NONPOINT SOURCE POLLUTANT RESULTS

Nitrogen (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	2459
High Density Residential	0	4194	0
Low Density Residential	0	179	863
Low Density Residential	0	2459	679
Agricultural	587	293	293
Agricultural	4485	1495	1495
Forest	859	268	268
Commercial	0	0	0
Total	5931	8888	6057

Phosphorous (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	770
High Density Residential	0	1313	0
Low Density Residential	0	56	270
Low Density Residential	0	770	212
Agricultural	173	86	86
Agricultural	1325	441	441
Forest	12	3	3
Commercial	0	0	0
Total	1510	2669	1782

Suspended Solids (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	55395
High Density Residential	0	94484	0
Low Density Residential	0	4051	19448
Low Density Residential	0	55395	15299
Agricultural	14276	7138	7138
Agricultural	109070	36356	36356
Forest	1228	383	383
Commercial	0	0	0
Total	124574	197807	134019

Lead (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	12

High Density Residential	0	20	0
Low Density Residential	0	0.889	4
Low Density Residential	0	12	3
Agricultural	0.200	0.100	0.100
Agricultural	1	0.509	0.509
Forest	6	1	1
Commercial	0	0	0
Total	7.2	34.498	20.609

Copper (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	12
High Density Residential	0	20	0
Low Density Residential	0	0.889	4
Low Density Residential	0	12	3
Agricultural	0.200	0.100	0.100
Agricultural	1	0.509	0.509
Forest	12	3	3
Commercial	0	0	0
Total	13.2	36.498	22.609

Zinc (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	108
High Density Residential	0	184	0
Low Density Residential	0	7	37
Low Density Residential	0	108	29
Agricultural	2	1	1
Agricultural	16	5	5
Forest	7	2	2
Commercial	0	0	0
Total	25	307	182

Cadmium (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	1
High Density Residential	0	1	0
Low Density Residential	0	0.074	0.355
Low Density Residential	0	1	0.279
Agricultural	0.133	0.066	0.066
Agricultural	1	0.339	0.339
Forest	1	0.380	0.380
Commercial	0	0	0

Total	2.133	2.859	2.419

Chromium (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	2
High Density Residential	0	4	0
Low Density Residential	0	0.207	0.996
Low Density Residential	0	2	0.783
Agricultural	1	0.667	0.667
Agricultural	10	3	3
Forest	9	2	2
Commercial	0	0	0
Total	20	11.874	9.446

Nickel (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	13
High Density Residential	0	23	0
Low Density Residential	0	0.988	4
Low Density Residential	0	13	3
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	0	0	0
Total	0	36.988	20

BOD (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	34453
High Density Residential	0	58764	0
Low Density Residential	0	2520	12096
Low Density Residential	0	34453	9515
Agricultural	533	266	266
Agricultural	4077	1359	1359
Forest	614	191	191
Commercial	0	0	0
Total	5224	97553	57880

COD (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	66880

High Density Residential	0	114072	0
Low Density Residential	0	4891	23481
Low Density Residential	0	66880	18471
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	0	0	0
Total	0	185843	108832

Oil & Grease (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	2296
High Density Residential	0	3917	0
Low Density Residential	0	168	806
Low Density Residential	0	2296	634
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	0	0	0
Total	0	6381	3736

Fecal Coliform (millions of coliform)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	122828
High Density Residential	0	209498	0
Low Density Residential	0	8984	43124
Low Density Residential	0	122828	33924
Agricultural	15768	7884	7884
Agricultural	120469	40156	40156
Forest	1116	348	348
Commercial	0	0	0
Total	137353	389698	248264

Fecal Strep (millions of coliform)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	343919
High Density Residential	0	586596	0
Low Density Residential	0	25155	120747
Low Density Residential	0	343919	94987
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	0	0	0

Total	0	955670	559653

These results were generated by the L-THIA (Long-Term Hydrologic Impact Assessment) model at "http://www.ecn.purdue.edu/runoff/lthianew"

SUMMARY OF SCENARIOS State: Missouri County: Jefferson		Management Unit Five		
Land Use	Hydrologic Soil Group	Current	acres Scenario 1	Scenario 2
High Density Residential	B	120	250	645
High Density Residential	D	300	695	300
Low Density Residential	B	105	30	525
Low Density Residential	D	105	600	105
Agricultural	A	100	50	50
Agricultural	B	570	110	110
Forest	D	800	260	260
Commercial	C	0	105	105

RUNOFF RESULTS
Avg. Annual Runoff Volume (acre-ft)

Land Use	Current	Scenario 1	Scenario 2
High Density Residential	113.34	236.13	609.22
High Density Residential	483.30	1119.66	483.30
Low Density Residential	38.08	10.88	190.42
Low Density Residential	99.17	566.72	99.17
Agricultural	24.48	12.24	12.24
Agricultural	284.33	54.87	54.87
Forest	450.85	146.52	146.52
Commercial	0	200.09	200.09
Total Annual Volume (acre-ft)	1493.58	2347.14	1795.87

Avg. Annual Runoff Depth (in)

Current	Scenario 2	Scenario 3
8.53	13.41	10.26

Avg. Runoff Depth by Landuse

Land Use	Hydrologic Soil group	Curve Number	Runoff Depth (in)
High Density Residential	B	85	11.38
High Density Residential	D	92	19.41
Low Density Residential	B	70	4.37
Low Density Residential	D	85	11.38
Agricultural	A	64	2.95
Agricultural	B	75	6.01
Forest	D	77	6.79
Commercial	C	94	22.96
Average Annual Rainfall Depth (in)			45.98

NONPOINT SOURCE POLLUTANT RESULTS

Nitrogen (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	562	1170	3021
High Density Residential	2396	5552	2396
Low Density Residential	188	53	944
Low Density Residential	491	2810	491
Agricultural	293	146	146
Agricultural	3408	657	657
Forest	859	279	279
Commercial	0	730	730
Total	8197	11397	8664

Phosphorous (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	176	366	946
High Density Residential	750	1738	750
Low Density Residential	59	16	295
Low Density Residential	154	880	154
Agricultural	86	43	43
Agricultural	1007	194	194
Forest	12	3	3
Commercial	0	174	174
Total	2244	3414	2559

Suspended Solids (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	12661	26378	68057
High Density Residential	53990	125078	53990
Low Density Residential	4254	1215	21272
Low Density Residential	11079	63309	11079
Agricultural	7138	3569	3569
Agricultural	82893	15997	15997
Forest	1228	399	399
Commercial	0	30258	30258
Total	173243	266203	204621

Lead (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	2	5	14

High Density Residential	11	27	11
Low Density Residential	0.933	0.266	4
Low Density Residential	2	13	2
Agricultural	0.100	0.050	0.050
Agricultural	1	0.224	0.224
Forest	6	1	1
Commercial	0	7	7
Total	23.033	53.54	39.274

Copper (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	2	5	14
High Density Residential	11	27	11
Low Density Residential	0.933	0.266	4
Low Density Residential	2	13	2
Agricultural	0.100	0.050	0.050
Agricultural	1	0.224	0.224
Forest	12	3	3
Commercial	0	7	7
Total	29.033	55.54	41.274

Zinc (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	24	51	132
High Density Residential	105	244	105
Low Density Residential	8	2	41
Low Density Residential	21	123	21
Agricultural	1	0.533	0.533
Agricultural	12	2	2
Forest	7	2	2
Commercial	0	98	98
Total	178	522.533	401.533

Cadmium (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0.231	0.482	1
High Density Residential	0.987	2	0.987
Low Density Residential	0.077	0.022	0.389
Low Density Residential	0.202	1	0.202
Agricultural	0.066	0.033	0.033
Agricultural	0.774	0.149	0.149
Forest	1	0.395	0.395
Commercial	0	0.523	0.523

Total	3.337	4.604	3.678

Chromium (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0.648	1	3
High Density Residential	2	6	2
Low Density Residential	0.217	0.062	1
Low Density Residential	0.567	3	0.567
Agricultural	0.667	0.333	0.333
Agricultural	7	1	1
Forest	9	2	2
Commercial	0	5	5
Total	20.099	18.395	14.9

Nickel (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	3	6	16
High Density Residential	13	30	13
Low Density Residential	1	0.296	5
Low Density Residential	2	15	2
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	0	6	6
Total	19	57.296	42

BOD (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	7875	16406	42328
High Density Residential	33579	77792	33579
Low Density Residential	2646	756	13230
Low Density Residential	6890	39375	6890
Agricultural	266	133	133
Agricultural	3098	598	598
Forest	614	199	199
Commercial	0	12539	12539
Total	54968	147798	109496

COD (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	15286	31847	82166

High Density Residential	65184	151009	65184
Low Density Residential	5136	1467	25682
Low Density Residential	13376	76434	13376
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	0	63242	63242
Total	98982	323999	249650

Oil & Grease (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	525	1093	2821
High Density Residential	2238	5186	2238
Low Density Residential	176	50	882
Low Density Residential	459	2625	459
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	0	4906	4906
Total	3398	13860	11306

Fecal Coliform (millions of coliform)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	28075	58489	150903
High Density Residential	119713	277336	119713
Low Density Residential	9433	2695	47166
Low Density Residential	24565	140375	24565
Agricultural	7884	3942	3942
Agricultural	91556	17668	17668
Forest	1116	362	362
Commercial	0	17099	17099
Total	282342	517966	381418

Fecal Strep (millions of coliform)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	78610	163771	422529
High Density Residential	335198	776542	335198
Low Density Residential	26413	7546	132067
Low Density Residential	68783	393050	68783
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	0	44606	44606

Total	509004	1385515	1003183

These results were generated by the L-THIA (Long-Term Hydrologic Impact Assessment) model at "http://www.ecn.purdue.edu/runoff/lthianew"

SUMMARY OF SCENARIOS
State: Missouri
County: Jefferson

Management Unit Six

Land Use	Hydrologic Soil Group	Current	acres Scenario 1	Scenario 2
High Density Residential	B	0	0	205
High Density Residential	D	0	205	0
Low Density Residential	B	100	400	920
Low Density Residential	D	105	625	105
Agricultural	A	200	100	100
Agricultural	B	1045	170	170
Forest	D	600	450	450
Commercial	C	0	100	100

RUNOFF RESULTS
Avg. Annual Runoff Volume (acre-ft)

Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	193.63
High Density Residential	0	330.26	0
Low Density Residential	36.27	145.08	333.69
Low Density Residential	99.17	590.33	99.17
Agricultural	48.97	24.48	24.48
Agricultural	521.27	84.80	84.80
Forest	338.14	253.60	253.60
Commercial	0	190.56	190.56
Total Annual Volume (acre-ft)	1043.83	1619.14	1179.96

Avg. Annual Runoff Depth (in)

Current	Scenario 2	Scenario 3
6.11	9.47	6.90

Avg. Runoff Depth by Landuse

Land Use	Hydrologic Soil group	Curve Number	Runoff Depth (in)
High Density Residential	B	85	11.38
High Density Residential	D	92	19.41
Low Density Residential	B	70	4.37
Low Density Residential	D	85	11.38
Agricultural	A	64	2.95
Agricultural	B	75	6.01
Forest	D	77	6.79
Commercial	C	94	22.96
Average Annual Rainfall Depth (in)			45.98

NONPOINT SOURCE POLLUTANT RESULTS

Nitrogen (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	960
High Density Residential	0	1637	0
Low Density Residential	179	719	1654
Low Density Residential	491	2927	491
Agricultural	587	293	293
Agricultural	6249	1016	1016
Forest	644	483	483
Commercial	0	695	695
Total	8150	7770	5592

Phosphorous (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	300
High Density Residential	0	512	0
Low Density Residential	56	225	518
Low Density Residential	154	916	154
Agricultural	173	86	86
Agricultural	1846	300	300
Forest	9	6	6
Commercial	0	166	166
Total	2238	2211	1530

Suspended Solids (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	21630
High Density Residential	0	36893	0
Low Density Residential	4051	16207	37277
Low Density Residential	11079	65947	11079
Agricultural	14276	7138	7138
Agricultural	151972	24722	24722
Forest	921	690	690
Commercial	0	28817	28817
Total	182299	180414	131353

Lead (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	4

High Density Residential	0	8	0
Low Density Residential	0.889	3	8
Low Density Residential	2	14	2
Agricultural	0.200	0.100	0.100
Agricultural	2	0.346	0.346
Forest	4	3	3
Commercial	0	6	6
Total	9.089	34.446	23.446

Copper (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	4
High Density Residential	0	8	0
Low Density Residential	0.889	3	8
Low Density Residential	2	14	2
Agricultural	0.200	0.100	0.100
Agricultural	2	0.346	0.346
Forest	9	6	6
Commercial	0	7	7
Total	14.089	38.446	27.446

Zinc (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	42
High Density Residential	0	71	0
Low Density Residential	7	31	72
Low Density Residential	21	128	21
Agricultural	2	1	1
Agricultural	22	3	3
Forest	5	4	4
Commercial	0	93	93
Total	57	331	236

Cadmium (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	0.395
High Density Residential	0	0.674	0
Low Density Residential	0.074	0.296	0.681
Low Density Residential	0.202	1	0.202
Agricultural	0.133	0.066	0.066
Agricultural	1	0.231	0.231
Forest	0.912	0.684	0.684
Commercial	0	0.498	0.498

Total	2.321	3.449	2.757

Chromium (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	1
High Density Residential	0	1	0
Low Density Residential	0.207	0.830	1
Low Density Residential	0.567	3	0.567
Agricultural	1	0.667	0.667
Agricultural	14	2	2
Forest	6	5	5
Commercial	0	5	5
Total	21.774	17.497	15.234

Nickel (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	5
High Density Residential	0	8	0
Low Density Residential	0.988	3	9
Low Density Residential	2	16	2
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	0	6	6
Total	2.988	33	22

BOD (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	13453
High Density Residential	0	22946	0
Low Density Residential	2520	10080	23184
Low Density Residential	6890	41015	6890
Agricultural	533	266	266
Agricultural	5681	924	924
Forest	460	345	345
Commercial	0	11942	11942
Total	16084	87518	57004

COD (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	26115

High Density Residential	0	44542	0
Low Density Residential	4891	19567	45005
Low Density Residential	13376	79619	13376
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	0	60230	60230
Total	18267	203958	144726

Oil & Grease (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	896
High Density Residential	0	1529	0
Low Density Residential	168	672	1545
Low Density Residential	459	2734	459
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	0	4673	4673
Total	627	9608	7573

Fecal Coliform (millions of coliform)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	47961
High Density Residential	0	81804	0
Low Density Residential	8984	35936	82654
Low Density Residential	24565	146224	24565
Agricultural	15768	7884	7884
Agricultural	167853	27306	27306
Forest	837	628	628
Commercial	0	16285	16285
Total	218007	316067	207283

Fecal Strep (millions of coliform)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	134292
High Density Residential	0	229052	0
Low Density Residential	25155	100622	231432
Low Density Residential	68783	409427	68783
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	0	42482	42482

Total	93938	781583	476989

These results were generated by the L-THIA (Long-Term Hydrologic Impact Assessment) model at "http://www.ecn.purdue.edu/runoff/lthianew"

SUMMARY OF SCENARIOS State: Missouri County: Jefferson			Management Unit Seven	
Land Use	Hydrologic Soil Group	Current	acres Scenario 1	Scenario 2
High Density Residential	B	0	0	260
High Density Residential	D	0	260	0
Low Density Residential	B	130	200	765
Low Density Residential	D	260	825	260
Agricultural	A	100	50	50
Agricultural	B	1510	595	595
Forest	D	600	540	540
Commercial	C	0	130	130

RUNOFF RESULTS

Avg. Annual Runoff Volume (acre-ft)

Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	245.58
High Density Residential	0	418.86	0
Low Density Residential	47.15	72.54	277.47
Low Density Residential	245.58	779.24	245.58
Agricultural	24.48	12.24	12.24
Agricultural	753.23	296.80	296.80
Forest	338.14	304.32	304.32
Commercial	0	247.73	247.73
Total Annual Volume (acre-ft)	1408.59	2131.76	1629.74

Avg. Annual Runoff Depth (in)

Current	Scenario 2	Scenario 3
6.50	9.83	7.52

Avg. Runoff Depth by Landuse

Land Use	Hydrologic Soil group	Curve Number	Runoff Depth (in)
High Density Residential	B	85	11.38
High Density Residential	D	92	19.41
Low Density Residential	B	70	4.37
Low Density Residential	D	85	11.38
Agricultural	A	64	2.95
Agricultural	B	75	6.01
Forest	D	77	6.79
Commercial	C	94	22.96
Average Annual Rainfall Depth (in)			45.98

NONPOINT SOURCE POLLUTANT RESULTS

Nitrogen (lbs)

Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	1217
High Density Residential	0	2077	0
Low Density Residential	233	359	1375
Low Density Residential	1217	3864	1217
Agricultural	293	146	146
Agricultural	9030	3558	3558
Forest	644	580	580
Commercial	0	904	904
Total	11417	11488	8997

Phosphorous (lbs)

Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	381
High Density Residential	0	650	0
Low Density Residential	73	112	430
Low Density Residential	381	1210	381
Agricultural	86	43	43
Agricultural	2667	1051	1051
Forest	9	8	8
Commercial	0	216	216
Total	3216	3290	2510

Suspended Solids (lbs)

Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	27433
High Density Residential	0	46792	0
Low Density Residential	5267	8103	30996
Low Density Residential	27433	87050	27433
Agricultural	7138	3569	3569
Agricultural	219596	86529	86529
Forest	921	829	829
Commercial	0	37462	37462
Total	260355	270334	214251

Lead (lbs)

Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	6

High Density Residential	0	10	0
Low Density Residential	1	1	6
Low Density Residential	6	19	6
Agricultural	0.100	0.050	0.050
Agricultural	3	1	1
Forest	4	4	4
Commercial	0	8	8
Total	14.1	43.05	31.05

Copper (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	6
High Density Residential	0	10	0
Low Density Residential	1	1	6
Low Density Residential	6	19	6
Agricultural	0.100	0.050	0.050
Agricultural	3	1	1
Forest	9	8	8
Commercial	0	9	9
Total	19.1	48.05	36.05

Zinc (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	53
High Density Residential	0	91	0
Low Density Residential	10	15	60
Low Density Residential	53	169	53
Agricultural	1	0.533	0.533
Agricultural	32	12	12
Forest	5	4	4
Commercial	0	121	121
Total	101	412.533	303.533

Cadmium (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	0.501
High Density Residential	0	0.855	0
Low Density Residential	0.096	0.148	0.567
Low Density Residential	0.501	1	0.501
Agricultural	0.066	0.033	0.033
Agricultural	2	0.808	0.808
Forest	0.912	0.820	0.820
Commercial	0	0.648	0.648

Total	3.575	4.312	3.878

Chromium (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	1
High Density Residential	0	2	0
Low Density Residential	0.269	0.415	1
Low Density Residential	1	4	1
Agricultural	0.667	0.333	0.333
Agricultural	20	8	8
Forest	6	6	6
Commercial	0	6	6
Total	27.936	26.748	23.333

Nickel (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	6
High Density Residential	0	11	0
Low Density Residential	1	1	7
Low Density Residential	6	21	6
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	0	7	7
Total	7	40	26

BOD (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	17062
High Density Residential	0	29102	0
Low Density Residential	3276	5040	19278
Low Density Residential	17062	54140	17062
Agricultural	266	133	133
Agricultural	8209	3234	3234
Forest	460	414	414
Commercial	0	15525	15525
Total	29273	107588	72708

COD (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	33121

High Density Residential	0	56492	0
Low Density Residential	6359	9783	37422
Low Density Residential	33121	105097	33121
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	0	78300	78300
Total	39480	249672	181964

Oil & Grease (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	1137
High Density Residential	0	1940	0
Low Density Residential	218	336	1285
Low Density Residential	1137	3609	1137
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	0	6075	6075
Total	1355	11960	9634

Fecal Coliform (millions of coliform)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	60829
High Density Residential	0	103751	0
Low Density Residential	11679	17968	68728
Low Density Residential	60829	193015	60829
Agricultural	7884	3942	3942
Agricultural	242544	95572	95572
Forest	837	753	753
Commercial	0	21170	21170
Total	323773	436171	311823

Fecal Strep (millions of coliform)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	170321
High Density Residential	0	290505	0
Low Density Residential	32702	50311	192441
Low Density Residential	170321	540444	170321
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	0	55227	55227

Total	203023	936487	588310

These results were generated by the L-THIA (Long-Term Hydrologic Impact Assessment) model at "http://www.ecn.purdue.edu/runoff/lthianew"

LGEAN International City/County ICMA Management Association icma.org EPA

SUMMARY OF SCENARIOS State: Missouri County: Jefferson		Management Unit Eight		
Land Use	Hydrologic Soil Group	Current	acres Scenario 1	Scenario 2
High Density Residential	B	0	0	0
High Density Residential	D	0	0	0
Low Density Residential	B	0	615	790
Low Density Residential	D	0	175	0
Agricultural	A	800	450	450
Agricultural	B	1050	510	510
Forest	D	200	200	200
Commercial	C	0	100	100

RUNOFF RESULTS

Avg. Annual Runoff Volume (acre-ft)

Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	0
High Density Residential	0	0	0
Low Density Residential	0	223.06	286.54
Low Density Residential	0	165.29	0
Agricultural	195.88	110.18	110.18
Agricultural	523.77	254.40	254.40
Forest	112.71	112.71	112.71
Commercial	0	190.56	190.56
Total Annual Volume (acre-ft)	832.36	1056.22	954.40

Avg. Annual Runoff Depth (in)

Current	Scenario 2	Scenario 3
4.87	6.18	5.58

Avg. Runoff Depth by Landuse

Land Use	Hydrologic Soil group	Curve Number	Runoff Depth (in)
High Density Residential	B	85	11.38
High Density Residential	D	92	19.41
Low Density Residential	B	70	4.37
Low Density Residential	D	85	11.38
Agricultural	A	64	2.95
Agricultural	B	75	6.01
Forest	D	77	6.79
Commercial	C	94	22.96
Average Annual Rainfall Depth (in)			45.98

NONPOINT SOURCE POLLUTANT RESULTS

Nitrogen (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	0
High Density Residential	0	0	0
Low Density Residential	0	1106	1420
Low Density Residential	0	819	0
Agricultural	2348	1320	1320
Agricultural	6279	3049	3049
Forest	214	214	214
Commercial	0	695	695
Total	8841	7203	6698

Phosphorous (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	0
High Density Residential	0	0	0
Low Density Residential	0	346	445
Low Density Residential	0	256	0
Agricultural	693	390	390
Agricultural	1855	901	901
Forest	3	3	3
Commercial	0	166	166
Total	2551	2062	1905

Suspended Solids (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	0
High Density Residential	0	0	0
Low Density Residential	0	24918	32009
Low Density Residential	0	18465	0
Agricultural	57106	32122	32122
Agricultural	152699	74168	74168
Forest	307	307	307
Commercial	0	28817	28817
Total	210112	178797	167423

Lead (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	0

High Density Residential	0	0	0
Low Density Residential	0	5	7
Low Density Residential	0	4	0
Agricultural	0.800	0.450	0.450
Agricultural	2	1	1
Forest	1	1	1
Commercial	0	6	6
Total	3.8	17.45	15.45

Copper (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	0
High Density Residential	0	0	0
Low Density Residential	0	5	7
Low Density Residential	0	4	0
Agricultural	0.800	0.450	0.450
Agricultural	2	1	1
Forest	3	3	3
Commercial	0	7	7
Total	5.8	20.45	18.45

Zinc (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	0
High Density Residential	0	0	0
Low Density Residential	0	48	62
Low Density Residential	0	36	0
Agricultural	8	4	4
Agricultural	22	11	11
Forest	1	1	1
Commercial	0	93	93
Total	31	193	171

Cadmium (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	0
High Density Residential	0	0	0
Low Density Residential	0	0.455	0.585
Low Density Residential	0	0.337	0
Agricultural	0.533	0.300	0.300
Agricultural	1	0.693	0.693
Forest	0.304	0.304	0.304
Commercial	0	0.498	0.498

Total	1.837	2.587	2.38

Chromium (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	0
High Density Residential	0	0	0
Low Density Residential	0	1	1
Low Density Residential	0	0.945	0
Agricultural	5	3	3
Agricultural	14	6	6
Forest	2	2	2
Commercial	0	5	5
Total	21	17.945	17

Nickel (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	0
High Density Residential	0	0	0
Low Density Residential	0	6	7
Low Density Residential	0	4	0
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	0	6	6
Total	0	16	13

BOD (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	0
High Density Residential	0	0	0
Low Density Residential	0	15498	19908
Low Density Residential	0	11484	0
Agricultural	2134	1200	1200
Agricultural	5708	2772	2772
Forest	153	153	153
Commercial	0	11942	11942
Total	7995	43049	35975

COD (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	0

High Density Residential	0	0	0
Low Density Residential	0	30085	38645
Low Density Residential	0	22293	0
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	0	60230	60230
Total	0	112608	98875

Oil & Grease (lbs)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	0
High Density Residential	0	0	0
Low Density Residential	0	1033	1327
Low Density Residential	0	765	0
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	0	4673	4673
Total	0	6471	6000

Fecal Coliform (millions of coliform)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	0
High Density Residential	0	0	0
Low Density Residential	0	55252	70975
Low Density Residential	0	40942	0
Agricultural	63074	35479	35479
Agricultural	168656	81919	81919
Forest	279	279	279
Commercial	0	16285	16285
Total	232009	230156	204937

Fecal Strep (millions of coliform)			
Land Use	Current	Scenario 1	Scenario 2
High Density Residential	0	0	0
High Density Residential	0	0	0
Low Density Residential	0	154707	198730
Low Density Residential	0	114639	0
Agricultural	0	0	0
Agricultural	0	0	0
Forest	0	0	0
Commercial	0	42482	42482

Total	0	311828	241212

These results were generated by the L-THIA (Long-Term Hydrologic Impact Assessment) model at "http://www.ecn.purdue.edu/runoff/lthianew"

Resources are available to search for funding to accomplish the goals identified in this watershed plan. One of these resources is the Plan2Fund watershed planning tool by the Environmental Financial Center at Boise State University. The following represents entries into the Plan2Fund tool for Belews Creek.

Mode: View Edit

Environmental Finance Center
Boise State University

Bill Aho Logout

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You are here: Tools > Plan2Fund > Plan2Fund 3.0

Monday, August 25, 2008

Plan2Fund

Plan2Fund™

Plan2Fund Help

Belews Creek Watershed Management Plan

Main Page » Plan: Belews Creek Watershed Management Plan

Overview

Plan Focus:	Non-Point Pollution and Water Quality
Organization Type:	Local Government
Organization's Location:	Jefferson County Missouri

Mission Statement
To create and implement a comprehensive and strategic plan to prevent further degradation to the Belews Creek Watershed and to maintain the long-term quality of the water resources.

Goals

Evaluate Stormwater runoff and its affect on the watershed

Completed: 0.00%

Description: Analyze indicators including evidence of erosion along the creek, suspended solids in water, the build-up of gravel and plants and sediment in the creek channel.

Determine Existing Riparian Corridors and Educate Landowners

Completed: 0.00%

Description: The Jefferson County Land Disturbance and Stormwater Management oridinance requires a 100 foot buffer, from top of bank, for all stream orders 3 and above and a 50' buffer for stream orders 1 & 2. This buffer zone will filter pollutants before entering the stream and recharge the ground water by minimizing stormwater runoff entering the stream.

Encourage Appropriate Maintenance and Repair of

Completed: 0.00%

Financial Summary

Manage Resources

Total Expenses	$0.00
Total Allocated Funds	$0.00
Grant Funds	$0.00
Financial Contributions	$0.00
Non-Financial Contributions	$0.00
Current Remaining Balance	$0.00
Pledged (Pending) Funds	
Grants	$0.00
Contributions	$0.00

Reports

Select one of the reports below:

- Comprehensive Planning Summary
- Current Year's Planning Summary
- Grants By Status
- Grants By Deadline Date
- Comprehensive Budget Summary (Expense Budget)

Septic Systems

Description: Except for the City of Hillsboro and Raintree Plantation, the entire Belews Creek Watershed has on-site septic systems. The soil types in the Belews watershed provide a challenge to the effective installation of on-site septic systems. Defective on-site septic systems are recognized as a problem in Jefferson County.

Use of Chemical Fertilizers, Pesticides, etc. and Yard Waste

Completed:
0.00%

Description: Detergents, fertilizers, pet waste and yard waste contain the nutrients phosphorous and nitrogen that cause the excessive growth of algae in water. As the algae dies, a chemical process takes place in the decaying process that uses the dissolve oxygen in the water.

Minimize Runoff Impact in the area of Sinkholes and Losing Streams

Completed:
0.00%

Description: Sinkholes and losing streams can be a direct path to ground water and the aquifer. Stormwater entering these locations can transfer the pollutants into the subsurface environment. The impact on drinking water is not known.

Prepare a Belews Creek Floodplain Study

Completed:
0.00%

Description: Jefferson County has the map modernization digital maps from FEMA. Belews Creek has been studied and a floodway determined from its mouth to the convergence of Sand Creek. The remaining portion of the watershed has not been studied and, therefore, does not have a recorded floodway. The Jefferson County Flood Damage Prevention Ordinance does not allow any activity in the floodway.

Evaluate the Impact of Existing and Future Dam Design

Completed:
0.00%

Description: Dams are not regulated by Jefferson County. Assistance is provided to landowners by the Jefferson County Soil and Water Conservation District when requested.

Encourage Building Requirements for Stream Crossings (Bridges)

Completed:
0.00%

Description: Many of the private bridges throughout the watershed are in need of repair or replacement. The majority of these bridges/culverts were installed with limited funding and have not been maintained.

+ Add New Goal

Objectives not assigned to a goal

Directory of Watershed Resources

A Searchable Database of Funding Sources

- Search Our Database
- Contact Us
- About Us
- About the Directory
- Watershed Tools and Links
- Add or Update Program Information

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Search our Database

EFCN

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Search our Database

The Directory of Watershed Resources is a searchable database of resources available to assist with a variety of environmental projects. The database includes information on federal, state, private, and other funding sources and assistance. Users can search for programs through a targeted search, keyword search or through an index of federal, state and private sources.

The Directory currently includes funding information for the following states: Alaska, Arkansas, Connecticut, Idaho, Maine, Massachusetts, Missouri, New Hampshire, Oregon, Rhode Island, Vermont and Washington. To view funding information for states not included in this database, visit http://sspa.boisestate.edu/efc/Tools_Services/Directory/funding.htm or contact an EFC in your region.

Select the Type of Search:

- Targeted Search
- Keyword Search

Index of Federal / Interstate Agency Sources

- Index of State Agency Sources
- Index of Private / Foundation Sources

Search our Database EFCN

Back to Keyword Search

Results 1 through 10 of 12

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Program Name	Overview
Bullitt Foundation - Aquatic Ecosystems Program	The mission of The Bullitt Foundation is to protect, restore, and maintain the natural physical environment of the Pacific Northwest for present and future generations. The Foundation invites proposals from nonprofit organizations that serve Washington, O...
Coastal Planning Assistance Grants, Oregon	Cities and counties in Oregon's coastal zone are eligible for planning assistance grants from the Oregon Coastal Management Program in the Department of Land Conservation and Development (DLCD). These grants are supported by federal funds awarded to Orego...
Connecticut Clean Water Fund (CWF), Connecticut Department of Environmental Protection	The Clean Water Fund (CWF) provides a combination of grants and loans to municipalities which undertake water pollution control projects at the direction of the DEP. The fund consists of five accounts: the Water Pollution Control State account; the Feder...
Nonpoint Source Pollution (319) Projects, Vermont Department of Environmental Conservation	This program provides financial assistance to organizations tackling non-point source (NPS) pollution problems. The current focus of the program is on funding projects that restore or improve water quality in lakes, streams, and rivers that are impaired b...
Nonpoint Source Pollution Grants, Maine Department of Environmental Protection	This program provides financial assistance to organizations tackling non-point source (NPS) pollution problems. The current focus of the program is on funding projects that restore or protect lakes, streams, or coastal waters that are impaired or consid...
Non-Point Water Quality Grants, Washington Conservation Commission	Non-point Water Quality Grants provide financial assistance for implementation of projects and practices to improve water quality. Examples: Work with farmers to reduce water use; control run-off to reduce sedimentation; improve fish habitat; improve wat...
Priority Planning Project Grants	Cities and counties in Oregon's coastal zone are eligible for planning assistance grants from the Oregon Coastal Management Program in the Department of Land Conservation and Development (DLCD). These grants are supported by federal funds awarded to Orego...
Small-Scale Construction or Acquisition (Section 306A), Oregon	Cities and counties in Oregon's coastal zone are eligible for planning assistance grants from the Oregon Coastal Management Program in the Department of Land Conservation and Development (DLCD). These grants are supported by federal funds awarded to Orego...
State Revolving Fund for Wastewater and Drinking Water, Iowa	The Iowa SRF is operated through a unique partnership between the Department of Natural Resources (DNR) and the Iowa Finance Authority (IFA). The DNR administers the environmental and permitting aspects of the programs, while the IFA provides financial a...

Search our Database

EFCN

Back to Keyword Search

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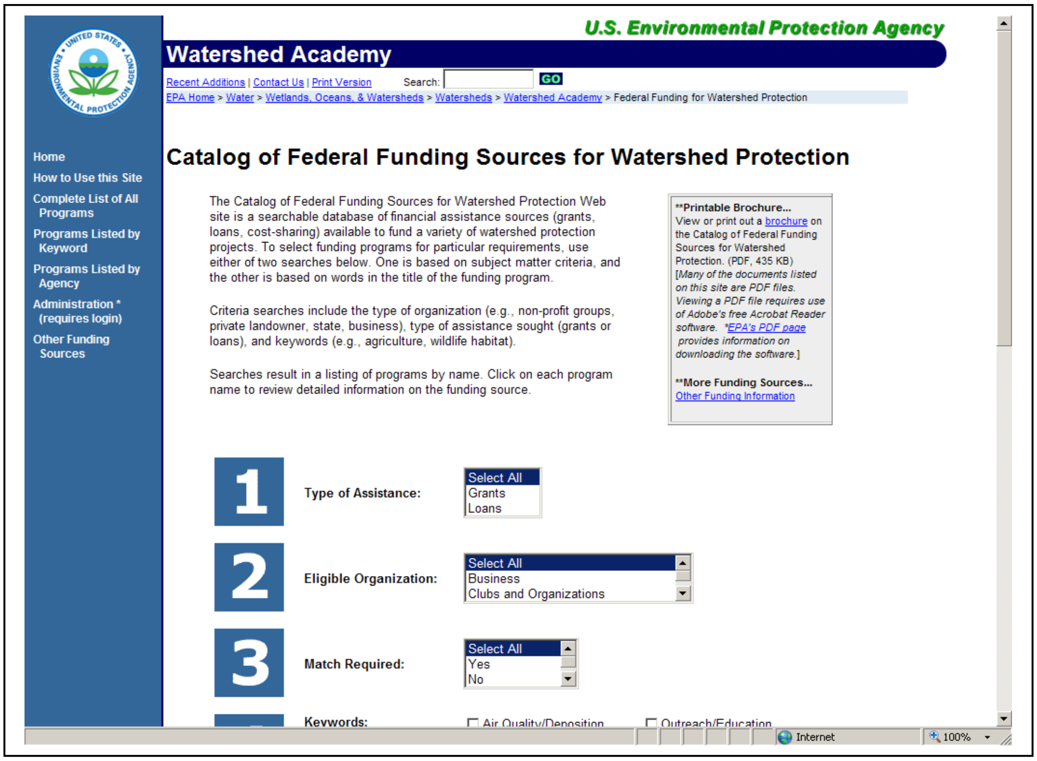
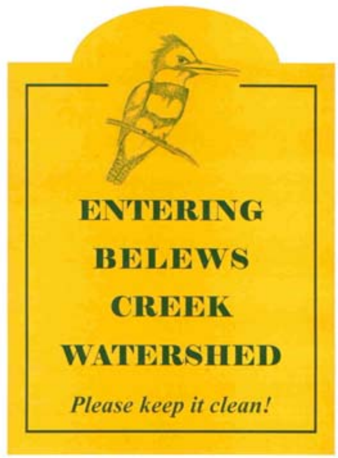
Program Name	Overview
Abandoned Mine Land Program, U.S. Dept. of Interior	Grants support the operation of an approved State or Tribal Abandoned Mine Land (AML) reclamation program. Approved programs use grant funds for mine site reclamation projects on eligible lands, which are lands and water mined or affected by coal mining ...
Abandoned Well Plugging Program	It is estimated that Missouri has more than 150,000 abandoned wells. These wells can be potential access points for pollutants to enter into ground water....
Abelard Foundation West / Common Counsel Foundation	Grants typically range from $5,000 to $12,000. Most grants are made for one year and provide general support funding. The majority of grants are made to organizations with annual budgets under $400,000 and whose staff, leadership and membership reflec...
Access & Habitat Program, Oregon Department of Fish & Wildlife	To qualify for A&H funding, a project must improve wildlife habitat and/or increase public hunting access to private land. A&H activities are designed to be grassroots in nature and encourage cooperative working relationships....
Acorn Foundation/Common Counsel Foundation	Grants typically range from $5,000 to $10,000 and are for general support funding. Most grants are made for one year and provide general support funding. The majority of grants are made to organizations with annual budgets under $400,000 and whose sta...
Action for Nature, Eco-Hero Awards	Action For Nature, Inc. is a nonprofit organization in San Francisco, California, that encourages young people to take personal action to better their environments, and to foster love and respect for nature. Founded by Shimon Schwarzschild whose own perso...
Action Plan Grants Program, Gulf of Maine Council on the Marine Environment	The Gulf of Maine Council offers grants for citizen groups and community organizations to pursue projects that support its priority goals, which are described in the 2001-2006 Action Plan (see website). Through a competitive grant process, the council aw...
Adopt-A-Highway Program, Missouri	The Missouri Department of Transportation is responsible for maintaining about 385,000 acres of right of way. Much of this consists of the roadsides along the highway. Because of this large task, MoDOT started the Adopt-A-Highway program in the fall of 19...
Agricultural Systems for Environmental Quality	Research focuses on the claypan soil region (MLRA 113) in the north central and northeastern part of the state, representative of more than seven million acres of cropland in the Midwest. Research may also be applicable to other areas of the Midwest with...

Other funding sources can be found at the U.S. Environmental Protection Agency websites "Catalog of Federal Funding Sources for Watershed Protection" and "Watershed Funding".



Belews Creek Watershed Management Plan

November 2008



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