LITTLE SAC RIVER WATERSHED MANAGEMENT PLAN

COVERING THE FELLOWS – MCDANIEL AND FULBRIGHT WATERSHEDS

GREENE COUNTY SOIL AND WATER CONSERVATION DISTRICT
IN PARTNERSHIP WITH THE
WATERSHED COMMITTEE OF THE OZARKS
AND THE MISSOURI DEPARTMENT OF NATURAL RESOURCES

This plan has been made possible with funding from the U.S. Environmental Protection Agency Region VII, through the Missouri Department of Natural Resources, under Section 319 of the Clean Water Act.

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Introducing the project

The Fellows /McDaniel-Fulbright Watershed Management Plan is a non-regulatory document. It was written as a subset to the Little Sac River Watershed Management plan that covers all of the Little Sac River Watershed including Fellows and McDaniel Lakes and the Fulbright Spring Watershed as well as the Asher Creek, North Dry Sac River and the Little Sac River proper. It portrays the watershed and its water quality, what actions are presently being done to maintain water quality, and what actions are needed to improve water quality. All best management practices suggested to stakeholders are purely voluntary in their implementation. This includes city, county, public and private properties within the watershed.

This plan is intended to be ever-changing and dynamic, just as the river and its watershed. One set of plans made at this time may not meet the challenges that arise in the future. If major changes are seen in the watershed or seen in the water quality of the Little Sac River then the plan should be addressed as deemed necessary to compensate for the water quality in the watershed. Otherwise, it should be re-visited every 5-8 years to evaluate the effectiveness of the management measures, and the perception of the public on the water quality.

Also included in the plan are 9 critical elements. These 9 critical elements are identified by the EPA and the Missouri Department of Natural Resources (the Department), to be essential to a successful watershed management plan. Comments and concerns were recorded from initial stakeholder meeting within the watershed and then adapted to the 9 critical elements that are required. This approach then satisfies both regulatory purposes and public concerns about the watershed. The 9 elements also act as a framework for the plan. Outlining who, what, where, when, why and how much management measures intended to improve water quality will cost.

Mission Statement and Purpose

To help stakeholders identify water quality concerns and to develop a collective vision of protection and restoration of the watershed using a long range management plan.

A Watershed Management Plan for the Fellows/ McDaniel (HUC 10290106-050001) and Fulbright (HUC 102901060-050002) sub-watersheds is necessary to guide stakeholders within the watershed as they seek to improve the Little Sac River water quality. The Watershed Committee of the Ozarks and the Greene County Soil and Water Conservation District believe that creating a watershed management plan for the Little Sac River watershed will help to protect and improve water quality in Fellows, McDaniel, and Stockton lakes (important drinking water resources) by identifying pollutant sources, identifying better management practices to be implemented, setting reachable goals and developing a timeline for implementation. A management plan would also help our current monitoring program to determine success of implemented projects/programs.

Development of a watershed management plan will increase the success of future projects, address issues related to the current TMDLs for the Little Sac River and McDaniel Lake, help to better determine where efforts should be focused, and fulfill specific grant application requirements for securing future funding.

Fellows Lake

History of Watershed Committee

The Watershed Committee of the Ozarks began 24 years ago, the Chair of the Board of Public Utilities, N. L. "Mac" McCartney, sent a memo to Springfield Mayor Harry Strawn. The memo began: "With your concurrence, I have appointed an ad hoc task force to develop a program for the protection of surface and subsurface watersheds which supply Springfield and the surrounding area with drinking water." It was a prophetic statement and a visionary approach. Development was encroaching into the drinking watersheds and officials worried about whether public policies and programs would effectively protect our precious drinking water supplies.

In November 1983, the Task Force issued its report and recommendations, many of which are pertinent and instructive even today. One recommendation centered on the need for a permanent body whose primary purpose would be oversight and protection of public drinking water sources. From this recommendation, the Watershed Management Coordinating Committee was established. In 1989, the organization became a non-profit corporation and changed its name to Watershed Committee of the Ozarks. The Committee adopted a six-member board, comprised of three citizen appointees representing the respective sponsors and three at-large positions.

"The mission of the Watershed Committee of the Ozarks is to preserve and improve the water supplies of Springfield and Greene County through education and effective management of the region's watersheds"

History of Greene County SWCD

In the 1930s, Americans realized how devastating soil erosion could be, as the Dust Bowl swept across the nation relocating an estimated 300 million tons of soil. Legislation began to take shape to better manage and conserve our nation's soil. In 1935 Congress set up the Soil Conservation Service as an agency under the Department of Agriculture. In 1937, the Standard State Soil Conservation law was developed. This act provided for the organization of soil conservation districts, as governmental subdivisions of the state, in order to carry on projects for erosion control. Then in 1943, Missouri's General Assembly passed Senate Bill 80, the Soil Districts Law, which ultimately became Chapter 278 of the Missouri Revised Statutes. Gradually over the next 49 years counties across Missouri have been forming local soil & water conservation districts. The Greene County Soil & Water Conservation District was formed in 1969. The district is locally led by farmers who live within the county and are elected by other farmers in the county to serve four year terms.

A one-tenth-of-one-percent sales tax for parks and soils was passed by Missouri voters in 1984 to fund state parks and soil and water conservation efforts. It is estimated that more than 148 million tons of soil have been saved since the start of the sales tax. However, millions of tons of soil still wash away every year on cultivated cropland in Missouri. The majority of this tax has been used to assist agricultural landowners through voluntary programs that are developed by the Soil and Water Districts Commission. The agricultural nonpoint source special area land treatment program (AgNPS SALT) is one example of how this money has been used to help landowners. The AgNPS SALT program provides funding for five to seven year projects that focus on decreasing sediments, pesticides and nutrients from entering waterways. By promoting good farming techniques that help keep soil on the fields and our waters clean, each soil and water conservation district is working with landowners to conserve and protect farmland in the State of Missouri.

Introduction of the Fellows -McDaniel- Fulbright Watersheds

The Little Sac River begins at the north edge of Springfield and Strafford to flow west to form Fellows and McDaniel Lakes. On its journey north to Stockton Lake, the Little Sac's upper reaches count more than 127 miles of springs, creeks and major tributaries including the; South Dry Sac, Pea Ridge Creek, Grandview Branch and Mill Creek. This 44,256 acre watershed also drains the north quarter of the city of Springfield. This watershed has a diverse land use that changes from very urbanized/high density population in the southern part of the watershed that includes part of Springfield, to the rural agricultural lands in the northern half.

Two important lakes, Fellows and McDaniel Lakes, dominate this watershed. Both lakes, classified L1 lakes in the state Water Quality Standards, are owned and operated by City Utilities of Springfield. The primary purpose for both lakes is drinking water for the city of Springfield and can amount to more than 50% of Springfield's daily supply.

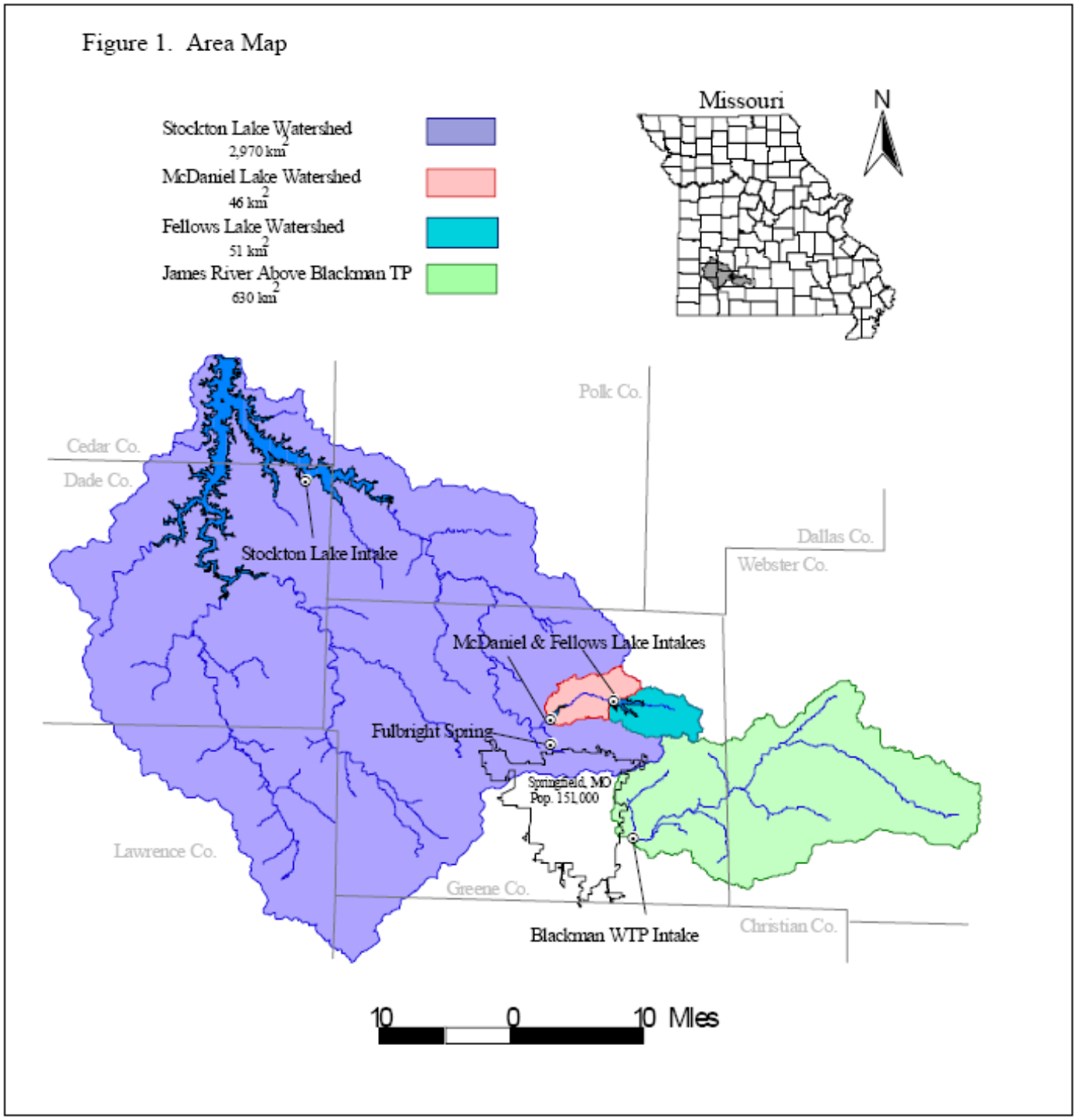
McDaniel Lake was constructed by impounding the Little Sac River in 1929. McDaniel covers over 300 acres and stores 1 billion gallons of water in North Central Greene County. The McDaniel Lake hypolimnetic withdrawal system operated by City Utilities of Springfield is the only industrial coded facility in the basin, which has a design flow of 3.2 MGD and is permitted for ammonia and total suspended solids.

Fellows Lake, further to the east and upstream from McDaniel Lake was constructed in 1957; it covers over 820 acres and stores 11 billion gallons of water. Light to moderate recreational use from Springfield residents (fishing, boating and picnicking) takes place on Fellows Lake. Very little recreational activity occurs on McDaniel Lake, because of access restrictions by City Utilities of Springfield.

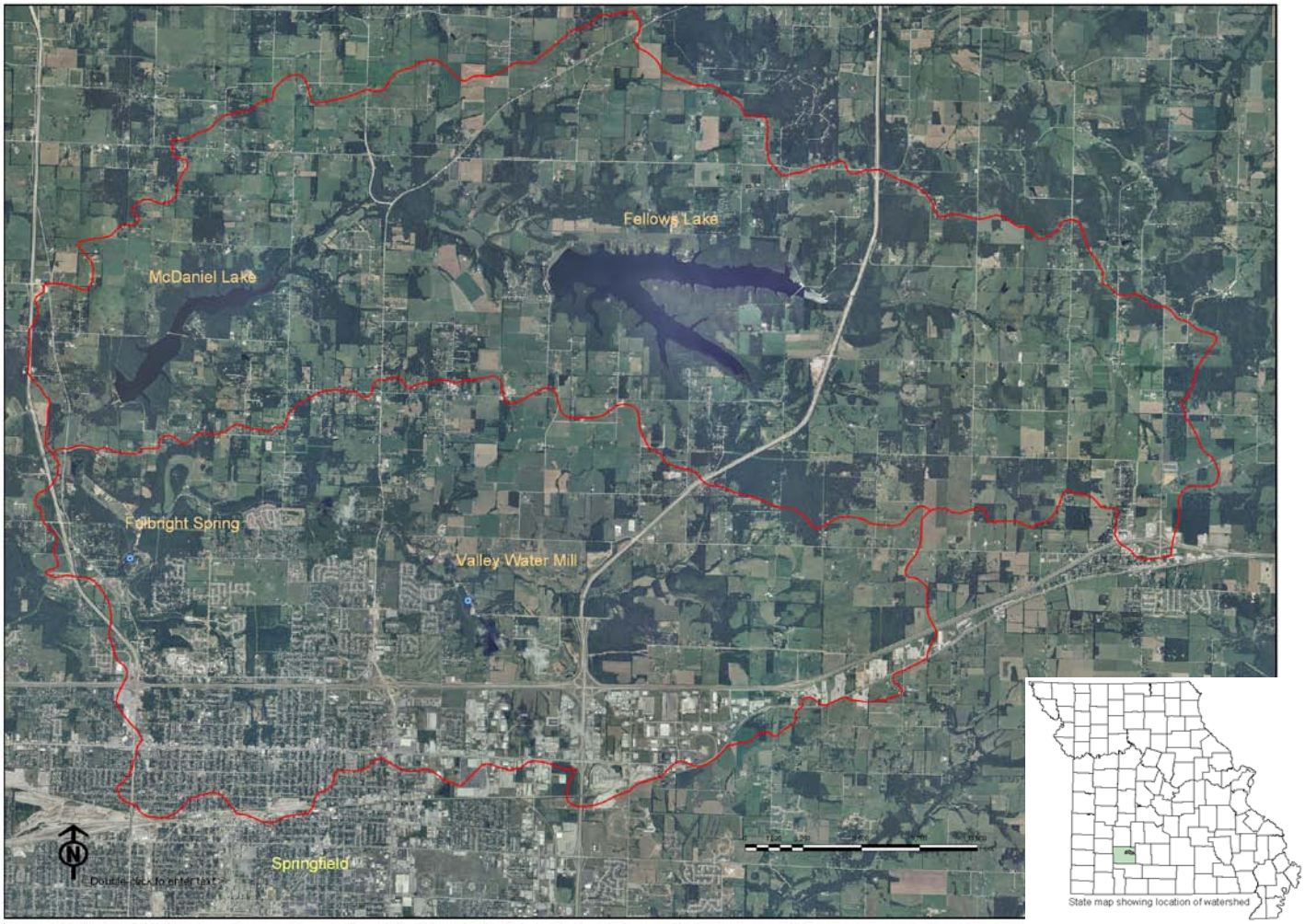
Other drinking water sources associated with this watershed include Fulbright Spring and Valley Water Mill. Fulbright Spring, Springfield's original public drinking water facility, was first built in 1883 and produces from 2 to 40 million gallons a day. Valley Water Mill Spring farther to the east has been used as a public drinking source for the community since as early as 1899.

More recently, and in anticipation of ever growing future needs, the Nuccitelli Pipeline from Stockton Lake to Fellows Lake was completed in 1996. This pipeline completes the loop for waters emerging north of Strafford, flowing through Fellows and McDaniel Lakes and down the Little Sac River, past the North West Waste Water Treatment Plant to Stockton Lake where it is pumped back to Fellows Lake so it can serve the communities needs again. Though the pipeline helps to alleviate water shortages for the City of Springfield it increases the complexity of the pollution problem by transferring water from one watershed to another.

Below is a map of the Stockton Lake Watershed with a portion of the James River for reference.



2009 photo of the Little Sac River Watershed including Fellows/McDaniel Lakes and Fulbright Spring



Soils, Climate and Geologic Characteristics

The Little Sac watershed originates in Eldon-Pembroke, Peridge-Wilderness-Goss-Pembroke, and Needleye-Viraton-Wilderness soil associations. It then flows through Peridge-Wilderness-Goss-Pembroke soils. Two impoundments near the headwaters of the Little Sac watershed (Fellows Lake and McDaniel Lake) cause a rapid descent to Hartville-Ashton-Cedargap-Nolin bottomland soils. In general, the soils are moderately deep to very deep, moderately well drained to well drained, and medium to fine textured.

The watershed is characterized by a temperate climate with warm, humid summers and cool, wet winters. The National Oceanic and Atmospheric Administration (NOAA) operate a climatological station at the Springfield-Branson Regional Airport, which is in the northwestern part of the city of Springfield. The average temperature range as measured at the airport is 67 to 90 °F (degrees Fahrenheit) during the summer and 20 to 42 °F during the winter. The average annual precipitation is between 40 and 42 in. (inches) of rainfall and 17 in. of snowfall in Springfield. The annual runoff from precipitation ranges from 8-10 inches.

Elevations in the watershed range from 1075 ft at the watershed outlet to 1400 ft at the eastern most boundary. The major part of the watershed consists of rolling plains. On the east side, broad upland areas divide the Little Sac watershed from the Pomme de Terre watershed.

Hydrologic Setting

The Ozarks, including the Fellows/McDaniel Watershed, are well known for their karst geology characterized by numerous sinkholes, caves, bedrock fractures and streams. The karst developments that are typical of the Springfield plateau aquifer are mostly located south and east of the Fellows/ McDaniel Watershed.

Two aquifers lie under the Fellows /McDaniel-Fulbright Watershed. The Ozark aquifer is a high-yielding, deep confined aquifer of generally very good quality. It provides for municipal, agricultural and industrial water. The Springfield plateau aquifer is an unconfined shallow aquifer located about 200 ft below the ground surface that is recharged by precipitation. The aquifer is generally of good quality and was a water supply resource until the mid-1950s. Since then, the contamination of the aquifer around Springfield and other places has prompted stricter regulations for wells. Most of the domestic water is now pumped from the deep Ozark aquifer but the Springfield plateau aquifer still provides agricultural and industrial water.

The majority of rural residents within the watershed derive drinking water from public and domestic wells. Approximately 10 public wells (multi-users connected to one system) are located in the watershed. The number of domestic wells is estimated at around 550. As the rural population continues to grow and expand, the demands for good quality water will increase. Consequently, more public and domestic wells will likely be installed. Considerable private well testing has been conducted in Greene County. Coliform bacteria and nitrates have been detected in some wells, but the number of "unsafe" results decreased over the past several years. The greatest potential threat to groundwater quality appears to be shallow wells located in areas with soils that have severe limitations for septic systems or those in close proximity to abandoned wells.

Land Use

The Fellows/McDaniel-Fulbright Watershed is located in the Ozark Border Area, Major Land Resource Area (MLRA) 116B. This area is part of the northeast and central farming forest region. The Ozark Border MLRA is comprised of approximately 35% forest, 25% pasture mainly of introduced grasses and legumes, and 40% cropland. Feed grains and hay are the main crops. Shallow wells, small creeks, small ponds or springs are often used for livestock needs. Deep wells supply drinking water and water for high volume uses. This area supports oak-hickory forests. The grassland supports a combination of introduced and native tall-prairie grasses consisting mainly of indian grass, little bluestem, big bluestem, and switch grass. Introduced grasses include fescue, annual crab grasses, and Kentucky bluegrass. The pastures are mostly in fescue grass over-seeded with clover.

The Fellows/McDaniel-Fulbright Watershed consists mostly of grassland (51%) and forests (25%). The grassland designation includes hay and pasture. Hayland, which is sometimes considered cropland, behaves more like grassland in terms of runoff, erosion, and nutrient loads and have been left in this class. Urban areas are found in 18% of the watershed. This is the north part of Springfield. A high contamination potential is due to the high urban population density and the amount of impervious surfaces. The CARES Mapping Service measures this watershed at about 7% impervious area draining into the basin. New developments have been required to use extended detention basins with approx 40 hours of retention time as well as grass buffer strips and grass channels since the County Water Quality Protection Policy passed in 1999.

McDaniel Lake

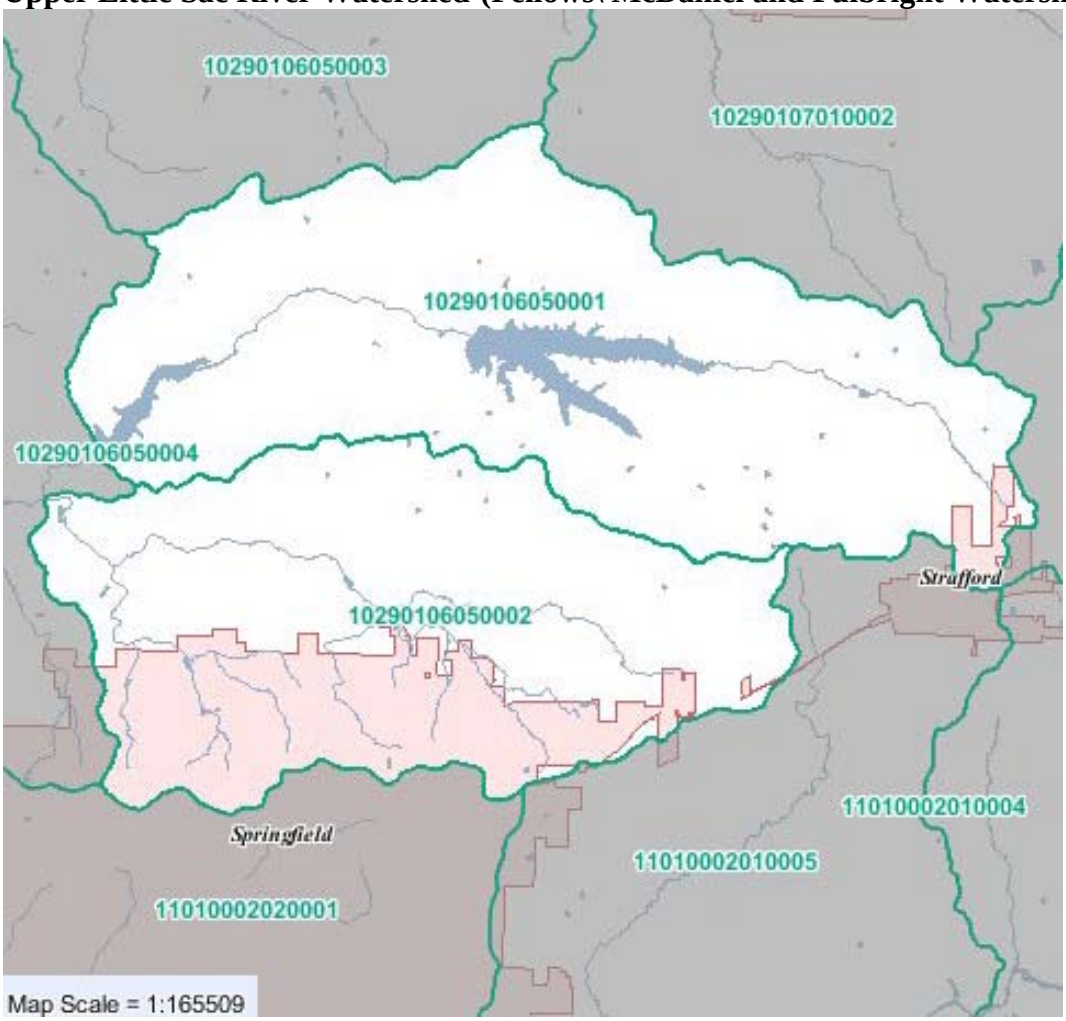
Mill Creek below Valley Water Mill Dam

The Little Sac River

South Dry Sac

Describing the Little Sac River Watershed (Maps)

The Upper Little Sac River Watershed-(Fellows\ McDaniel and Fulbright Watersheds)



General Watershed Information

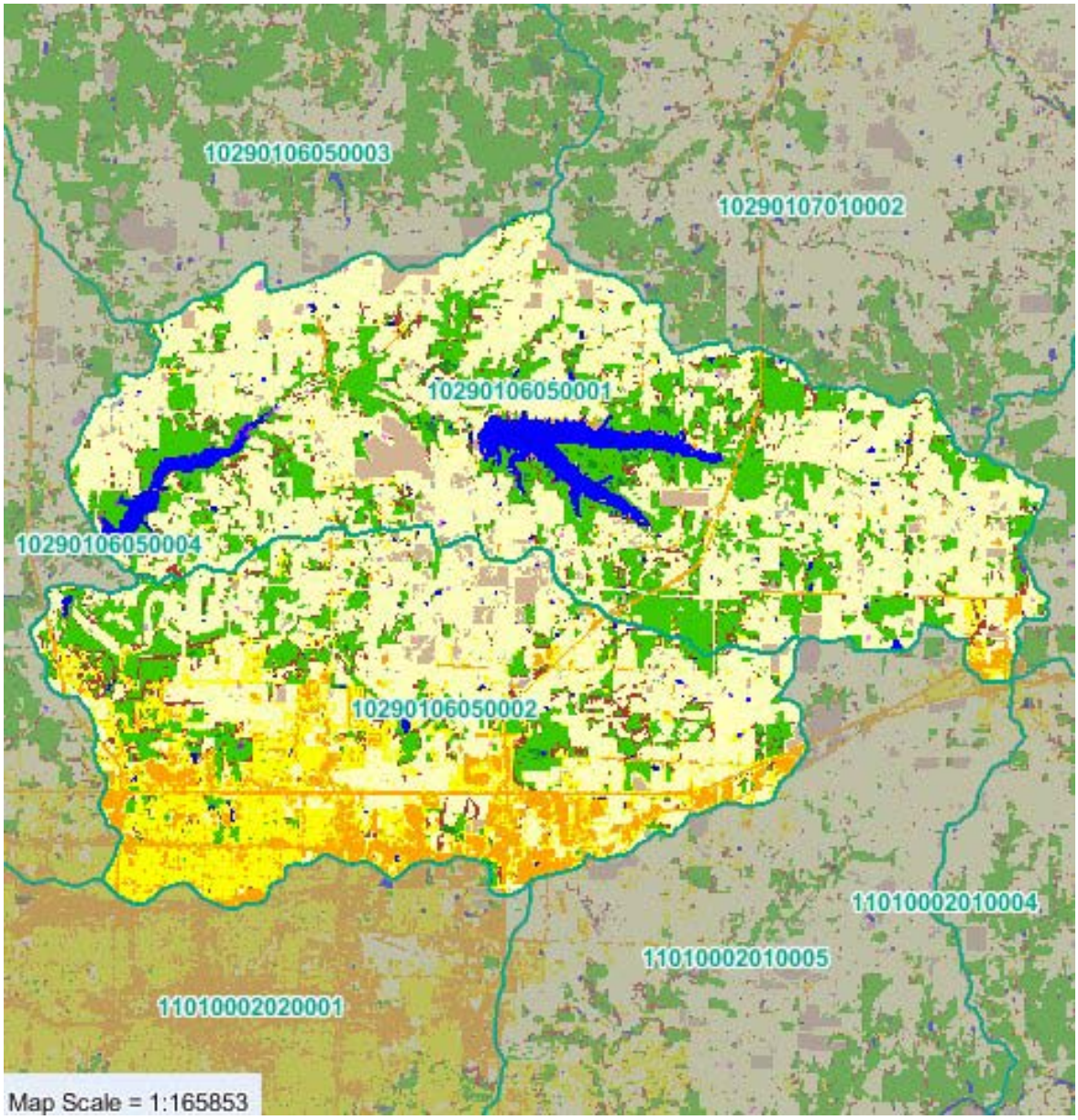
Fellows/ McDaniel Watershed HUC 10290106050001	
Counties:	Greene
Total Acres:	24,731.32
Population, 2000:	3,228 persons 83.53 persons/sq mile
Fulbright Watershed HUC 10290106050002	
Counties:	Greene
Total Acres:	19,524.3
Population, 2000:	21,068 persons 690.60 persons/sq mile

Stream Data

Fellows/ McDaniel Watershed HUC 10290106050001		
Stream Name (top 5)		Miles
Little Sac River		18.26
Stream Type	Miles	Percent
Perennial	7.52	10.77%
Intermittent	51.55	73.83%
Undesignated	0.00	0.00%
Other	10.76	15.41%
Total	69.83	

Fulbright Watershed HUC 10290106050002		
Stream Name (top 5)		Miles
Mill Creek		15.04
South Dry Sac River		10.14
Grandview Branch		2.98
Pea Ridge Creek		2.63
Stream Type	Miles	Percent
Perennial	9.85	17.20%
Intermittent	46.76	81.69%
Undesignated	0.00	0.00%
Other	0.64	1.11%
Total	57.24	

Land Use and Land Cover

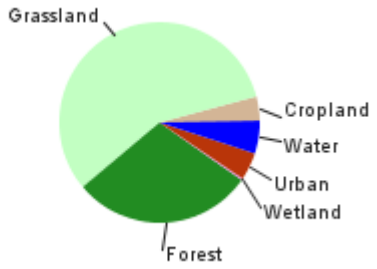


Cropland
High density Urban
Barren or Sparsely Vegetated
Grassland
Open Water
Impervious
Deciduous Forest
Low Density Urban
Deciduous Woody\ Herbaceous
Wetland

Land Use Data

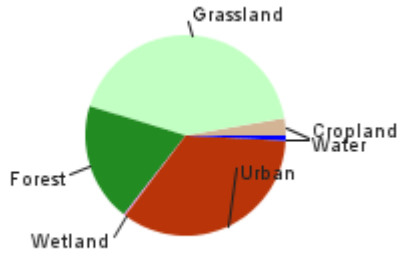
Fellows/ McDaniel Watershed HUC 10290106050001

Landcover	Acres	Percent
Cropland	1,023.46	4.14%
Grassland	14,060.25	56.86%
Forest	7,197.58	29.11%
Wetland	80.96	0.33%
Urban	1,091.51	4.42%
Water	1,272.99	5.15%



Fulbright Watershed HUC 10290106050002

Landcover	Acres	Percent
Cropland	549.98	2.82%
Grassland	8,311.34	42.57%
Forest	3,766.49	19.29%
Wetland	27.79	0.14%
Urban	6,750.79	34.58%
Water	117.87	0.60%



Public Lands

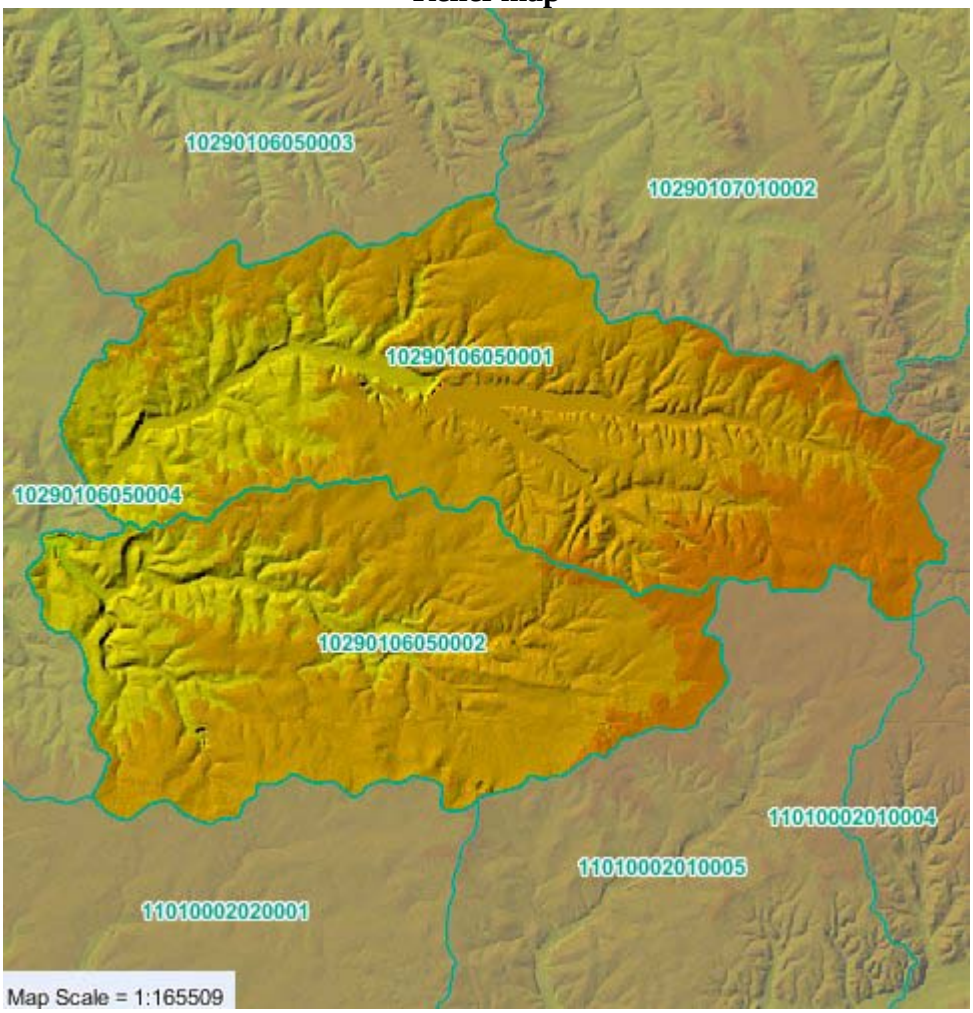
10290106050001		
	0 Acres	0 % of HU
10290106050002		
	Acres	% of HU
Total:	10	0.05%
OZARK EMPIRE FAIR FACILITY	0.3	0.00%
SOUTHWEST REGIONAL OFFICE	9.7	0.05%

Wetlands

10290106050001	
Wetland Acres:	1,222.93
% of Area Classified as Wetlands:	4.94%

10290106050002	
Wetland Acres:	124.53
% of Area Classified as Wetlands:	0.64%

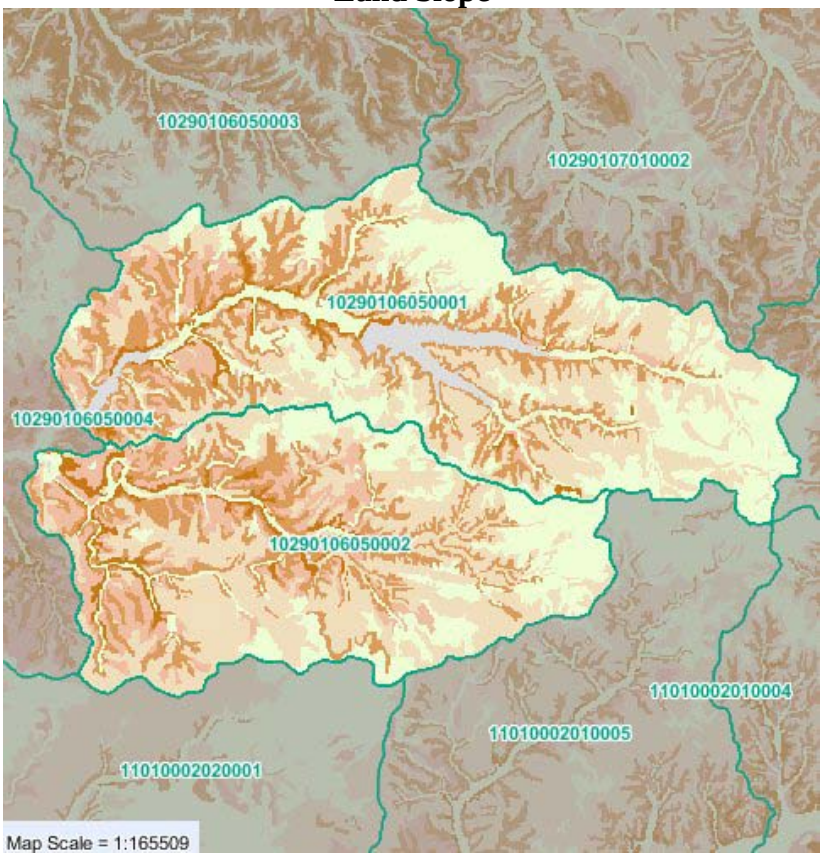
Relief map



Fellows/ McDaniel Watershed HUC 10290106050001	
Minimum Elevation:	1,090.4 ft
Maximum Elevation:	1,515.3 ft
Mean Elevation:	1,310.8 ft

Fulbright Watershed HUC 10290106050002	
Minimum Elevation:	1,075 ft
Maximum Elevation:	1,454.4 ft
Mean Elevation:	1,296 ft

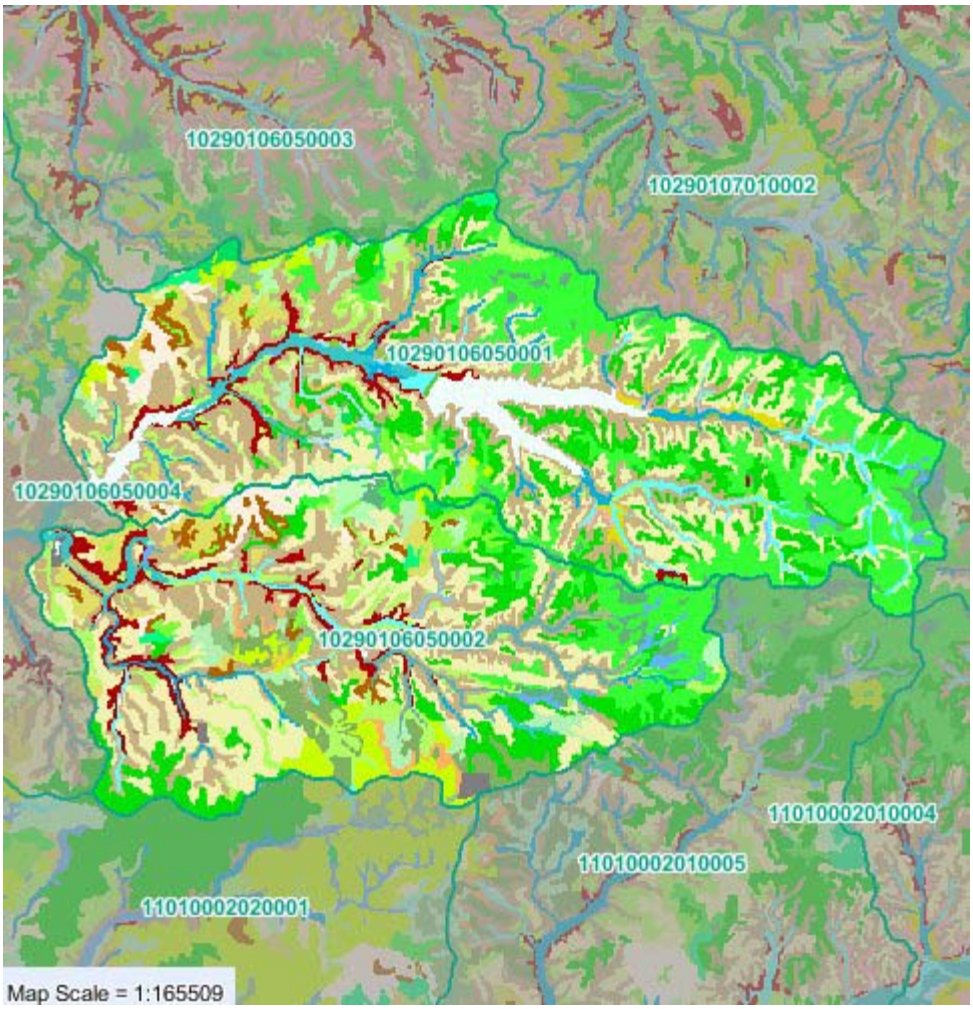
Land Slope



0 to 2.5 Percent	10 to 14 Percent	Not Rated
3 to 5 Percent	15 Percent or Greater	6 to 9 Percent

Fellows / McDaniel Watershed HUC 10290106050001 Slope Category	Acres	Percent
0-3%:	9,126	36.90%
3-6%:	7,118	28.78%
6-10%:	4,653	18.82%
10-15%:	2,472	10.00%
> 15%:	1,362	5.51%
Total:	24,731	100.00%
Fulbright Watershed HUC 10290106050002 Slope Category	Acres	Percent
0-3%:	8,257	42.29%
3-6%:	6,033	30.90%
6-10%:	2,966	15.19%
10-15%:	1,490	7.63%
> 15%:	778	3.98%
Total:	19,524	100.00%

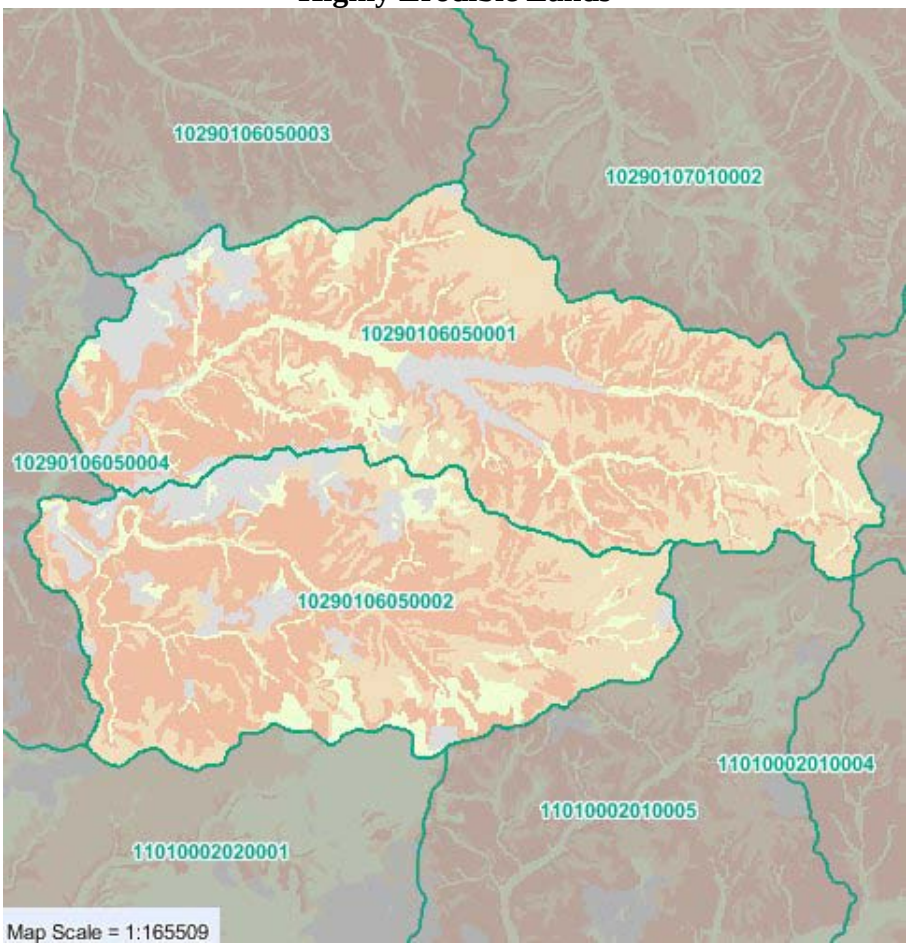
Soils



Soils

10290106050001 Map Unit Name (top 5)	Percent
Needleye silt loam, 1 to 3 percent slopes	20.22%
Goss gravelly silt loam, 8 to 15 percent slopes	19.91%
Wilderness gravelly silt loam, 3 to 8 percent slopes	16.87%
Viraton silt loam, 2 to 5 percent slopes	10.53%
Peridge silt loam, 2 to 5 percent slopes	5.15%
10290106050002 Map Unit Name (top 5)	Percent
Goss gravelly silt loam, 8 to 15 percent slopes	16.42%
Wilderness gravelly silt loam, 3 to 8 percent slopes	13.17%
Goss-Wilderness complex, 3 to 8 percent slopes	12.91%
Viraton silt loam, 2 to 5 percent slopes	9.9%
Needleye silt loam, 1 to 3 percent slopes	9.45%

Highly Erodible Lands



Highly Erodible Land

Not Highly Erodible Land

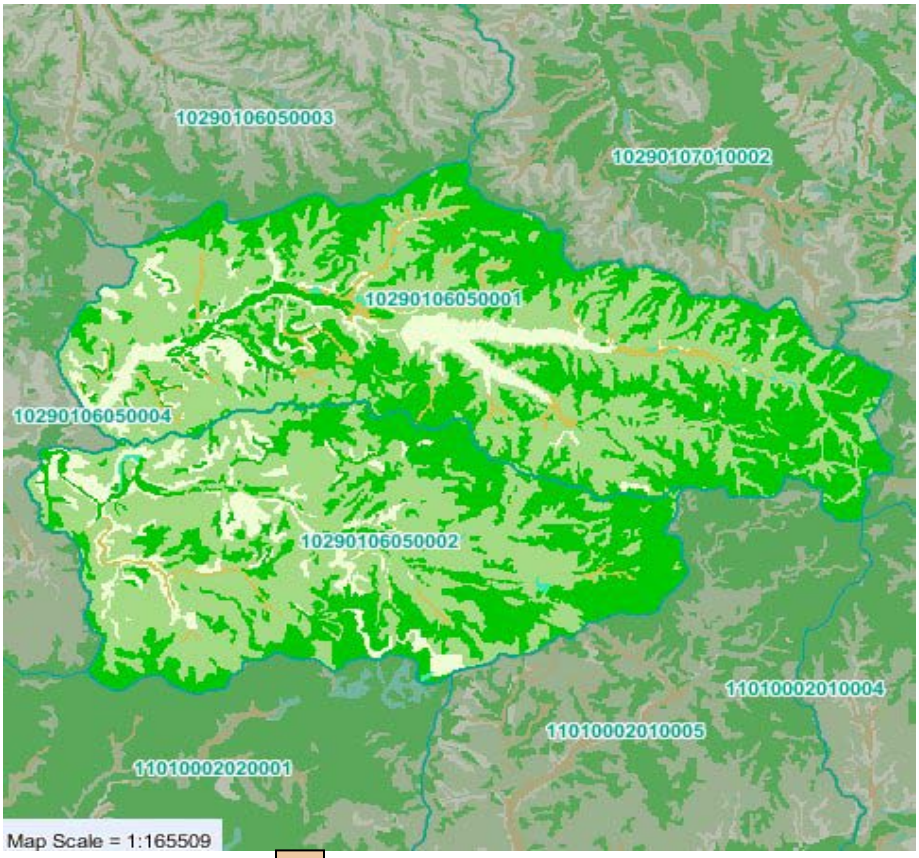
Potentially Highly Erodible Land

Not Rated

10290106050001		
Type	Acres	Percent
Highly Erodible	11,260.99	45.53%
Potentially Highly Erodible	9,871.67	39.92%
Not Highly Erodible	2,548.3	10.30%
Not Rated	1,050.37	4.25%

10290106050002		
Type	Acres	Percent
Highly Erodible	10,499.28	53.78%
Potentially Highly Erodible	6,858.67	35.13%
Not Highly Erodible	1,939.02	9.93%
Not Rated	227.34	1.16%

Prime Farmlands

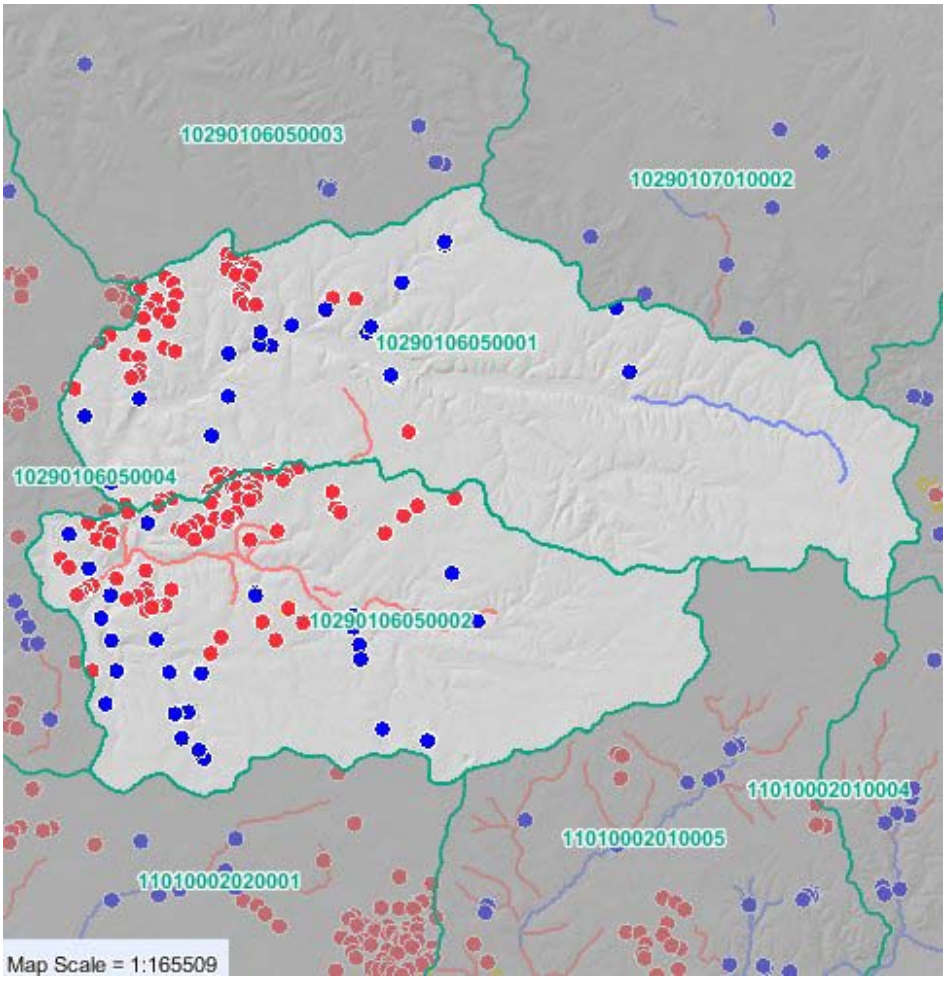


Prime Farmland
Prime Farmland with Limitations
Not Prime Farmland
Farmland of Statewide Importance
Prime Farmland if Drained

10290106050001		
Type	Acres	Percent
Prime Farmland	10,433.45	42.19%
Prime Farmland if Drained	60.78	0.25%
Prime Farmland with Limitation	729.16	2.95%
Farmland of Statewide Importance	11,416.2	46.16%
Not Prime Farmland	2,091.73	8.46%

10290106050002		
Type	Acres	Percent
Prime Farmland	7,409.28	37.95%
Prime Farmland if Drained	70.61	0.36%
Prime Farmland with Limitation	218.1	1.12%
Farmland of Statewide Importance	10,322.19	52.87%
Not Prime Farmland	1,504.11	7.70%

Karst Features



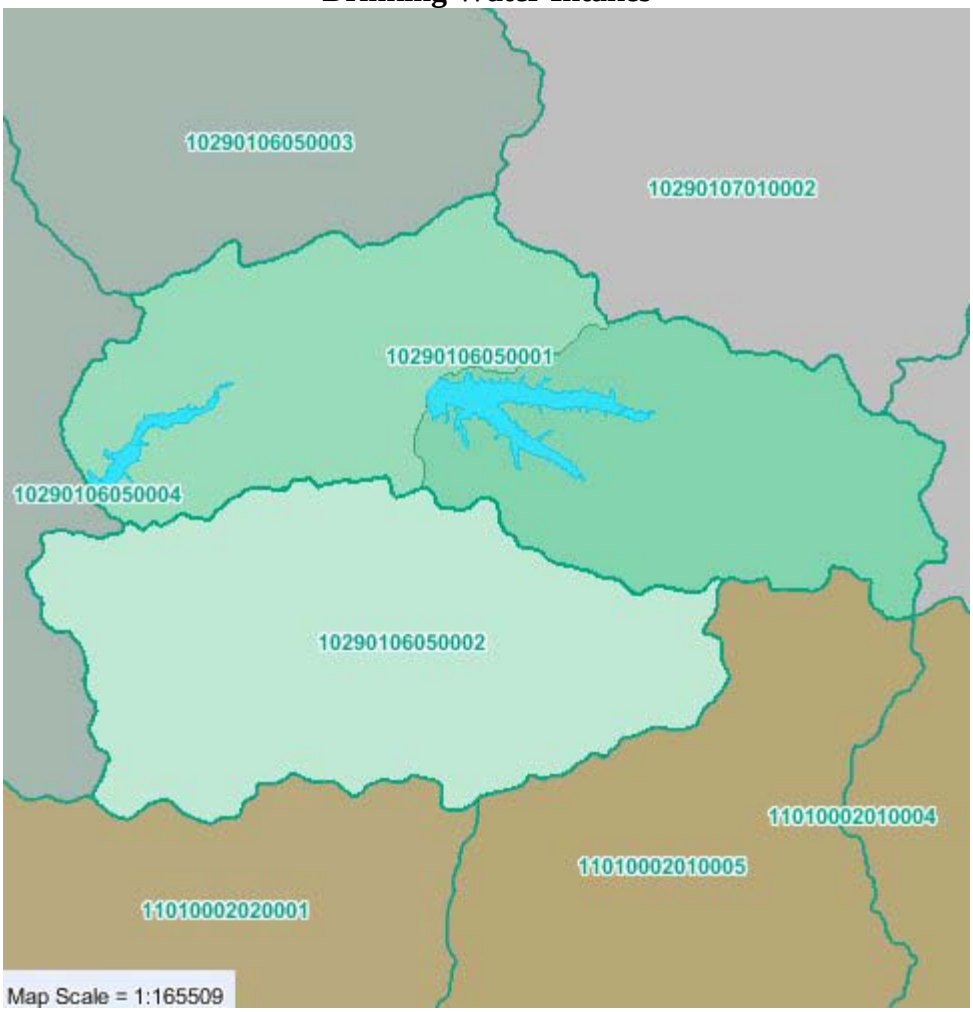
Springs — Gaining Streams

Sinkholes — Losing streams

10290106050001		
	Numbers	Miles
Gaining streams:	1	1.35
Losing streams:	1	3.86
Sinkholes:	276	
Springs:	21	

10290106050002		
	Numbers	Miles
Gaining streams:	6	9.86
Losing streams:	0	0.00
Sinkholes:	378	
Springs:	29	

Drinking Water Intakes



Fellows Lake Basin

Fulbright Spring Basin

McDaniel Lake Basin

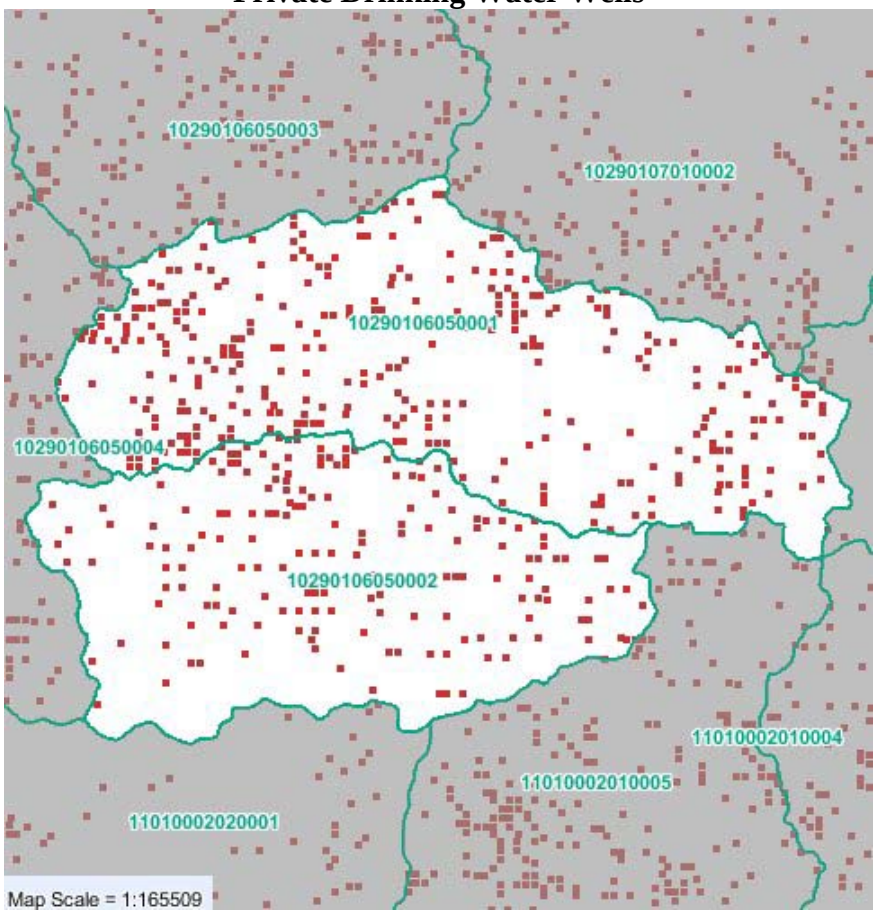
Public Water Supply Lakes

Drinking Water Intakes

10290106050001		
Intakes	Number	Persons Served
Total:	2	134,313
Community:		134,313

10290106050002		
Intakes	Number	Persons Served
Total:	1	134,313
Community:		134,313

Private Drinking Water Wells

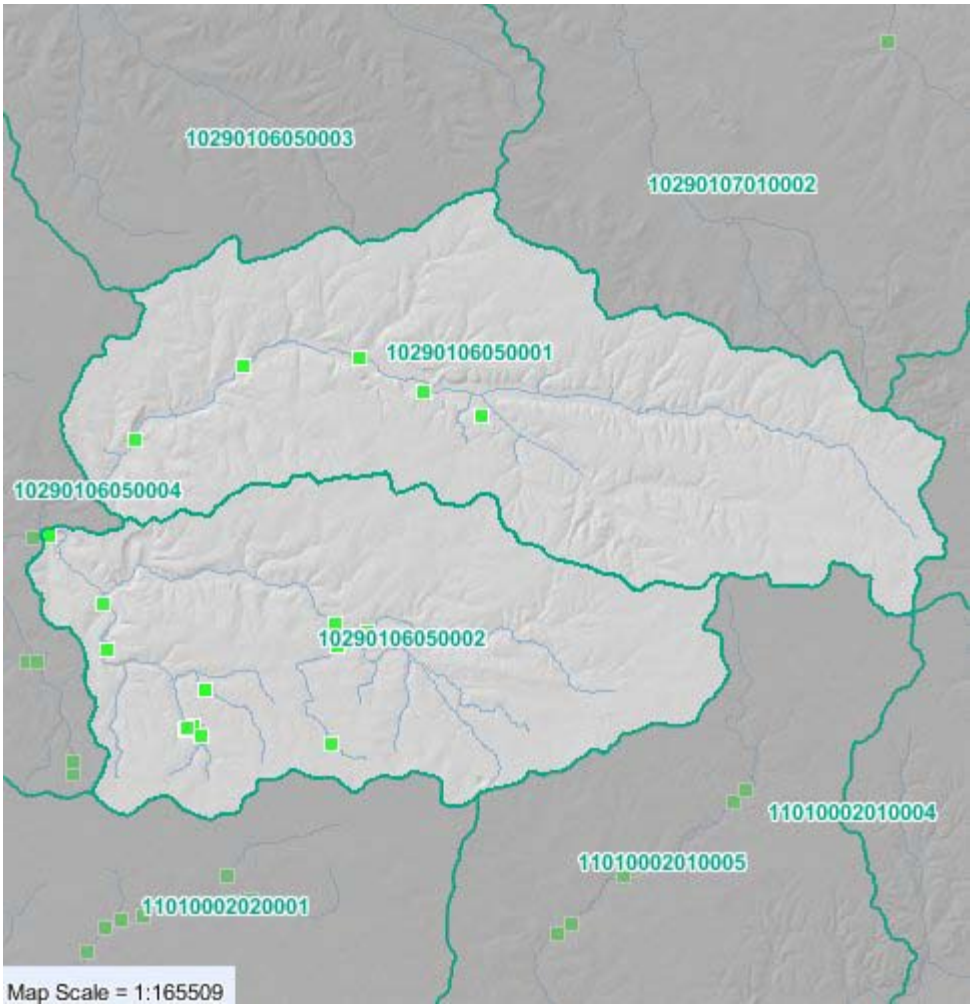


Drinking Water Wells

10290106050001		
Wells	Number	Persons Served
Total:	366	
Private:	359	*no data*
Public (Active):	7	16,850
Community:	5	16,225
Transient Noncommunity:	2	625
Non-transient Noncommunity:	0	0

10290106050002		
Wells	Number	Persons Served
Total:	199	
Private:	190	*no data*
Public (Active):	9	16,239
Community:	4	15,069
Transient Noncommunity:	1	150
Non-transient Noncommunity:	3	1,020

Local Stream Teams

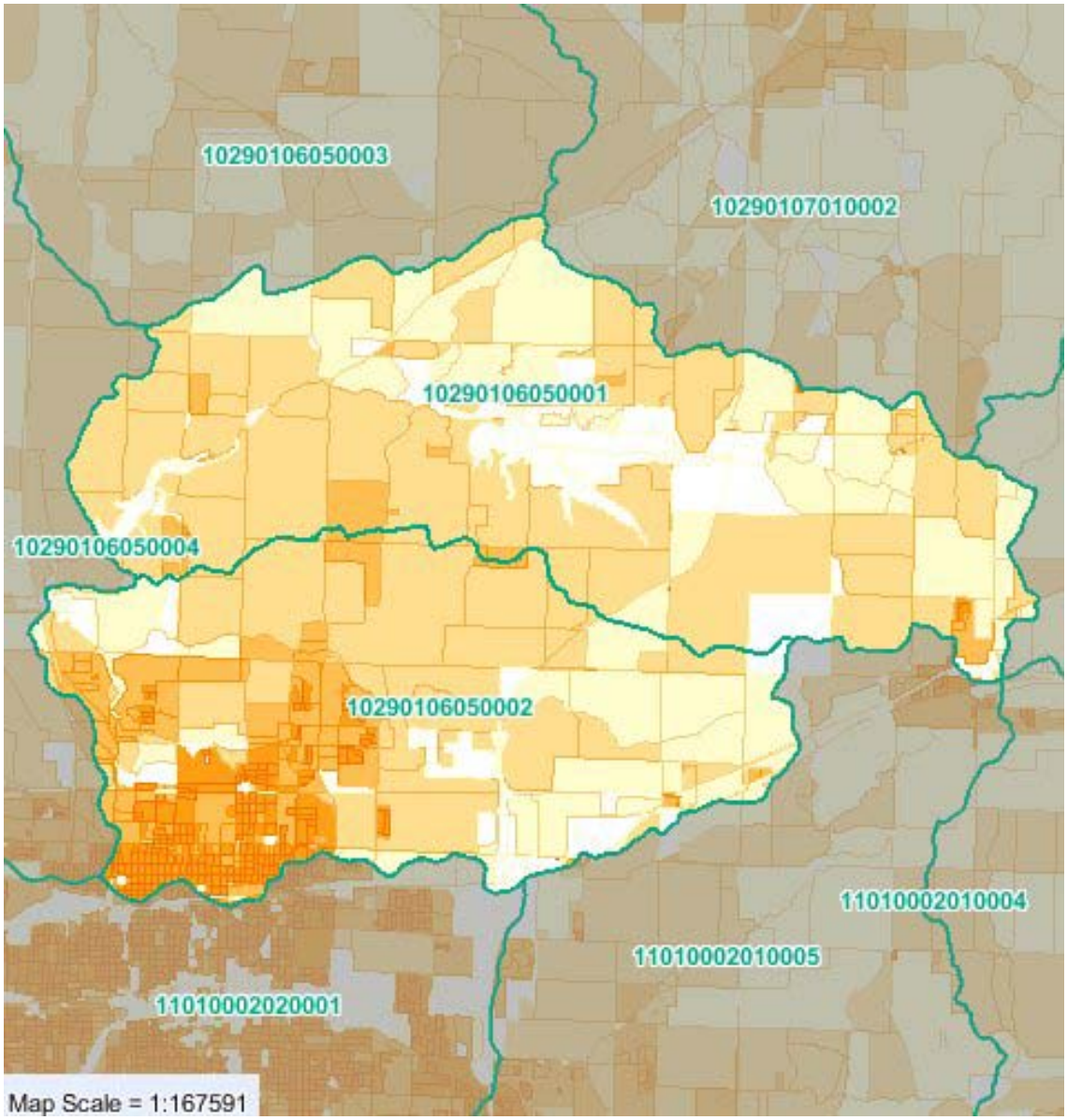


Local Initiatives

10290106050001	
Stream Teams:	5

10290106050002	
Stream Teams:	14

Census Data



- 2,500 or More Persons Per Sq Mile
- 250 - 2,499.99 Persons Per Sq Mile
- 50 - 249.99 Persons Per Sq Mile
- Less than 50 Persons Per Sq Mile
- No population

Census Data

10290106050001		
Total Population:	3,228	
Persons/Sq Mile:	83.53	
Age 0-4:	156	5.58%
Age 5-17:	510	18.23%
Age 18-64:	1,766	63.14%
Age 65 and up:	365	13.05%
College Degree:	437	22.40%
Some College:	481	24.65%
High School Only:	735	37.67%
No High School:	298	15.27%
Households:	1,054	
Average Household Income:	$59,095.18	
% of Income from Public Assistance:	1.23%	

10290106050002		
Total Population:	21,068	
Persons/Sq Mile:	690.60	
Age 0-4:	1,271	6.00%
Age 5-17:	3,494	16.49%
Age 18-64:	13,353	63.03%
Age 65 and up:	3,068	14.48%
College Degree:	2,584	19.41%
Some College:	3,201	24.04%
High School Only:	4,612	34.64%
No High School:	2,918	21.92%
Households:	8,332	
Average Household Income:	$37,492.8	
% of Income from Public Assistance:	4.19%	

DATA SOURCES

8-Digit Hydrologic Unit Boundaries: USDA Natural Resources Conservation Service (NRCS), Version 14, 2006.

10-Digit Hydrologic Unit Boundaries: USDA Natural Resources Conservation Service (NRCS), Version 14, 2006.

12-Digit Hydrologic Unit Boundaries: USDA Natural Resources Conservation Service (NRCS), Version 14, 2006.

14-Digit Hydrologic Unit Boundaries: USDA Natural Resources Conservation Service (NRCS), 2000.

303(d) Listed Lakes and Streams: Missouri Department of Natural Resources, 2004 (2002 303(d) list).

Average Annual Precipitation: PRISM (Parameter-elevation Regressions on Independent Slopes Model) dataset for 1961-1990, Oregon State University.

Census Data: 2000 U.S. Census Data.

Cities and Towns: 2000 U.S. Census Tiger Boundary File.

Common Resource Areas: USDA Natural Resources Conservation Service (NRCS), 2006.

Confined Animal Feeding Operations (CAFOs): Missouri Department of Natural Resources, 2006.

County Boundaries: 1:24,000, Lincoln University Geographic Information System and Remote Sensing (GIS/RS) Laboratory, July 1997.

Crop Acres by Crop Type: NASS County crop estimates, average acres 2000-2004.

Highly Erodible Lands: USDA Natural Resources Conservation Service, SSURGO data (NASIS attributes), 2007.

Highways and Roads: Missouri Department of Transportation (MoDOT), 2005. U.S. Census Tiger Boundary Files, 2000.

Hydrologic Soil Groups: USDA Natural Resources Conservation Service, SSURGO data (NASIS attributes), 2007.

Land Ownership: MoDNR, 2006, MDC, 2006, USFS, 2005, MoRAP, 2000.

Land Slope: 10-Meter Digital Elevation Model, CARES, 2004.

Land Use/Land Cover: Missouri Resource Assessment Partnership (MoRAP), 2005.

Losing/Gaining Streams: Missouri Department of Natural Resources, DGLS, 2006.

Major Land Resource Areas: USDA Natural Resources Conservation Service (NRCS), 2006.

National Wetland Inventory: U.S. Fish and Wildlife Service, 10/1981 to present.

Outstanding National Resource Waters: CARES mapping of 10 CSR 20-7 Table D watershed, 2003.

Outstanding State Resource Waters: CARES mapping of 10 CSR 20-7 Table D watershed, 2004.

Prime Farmland: USDA Natural Resources Conservation Service, SSURGO data (NASIS attributes), 2007

Private Wells: Missouri Department of Natural Resources, 2006.

Public Drinking Water Watersheds: Missouri Department of Natural Resources, 2003 (CARES update 2007).

Public Drinking Water Wells: Missouri Department of Natural Resources, 2007. MoDNR 2007 Census of Missouri Public Water Systems.

Relief Map: 10-Meter shaded relief, CARES, 2004.

Sinkholes: Missouri Department of Natural Resources, 2006.

Sink Areas: Missouri Department of Natural Resources, 2006.

Source Water Areas: Missouri Department of Natural Resources, 2007.

Springs: Missouri Department of Natural Resources, 2006.

Streams and Lakes: U.S. Geological Survey (USGS) National Hydrologic Dataset, 2005.

Stream Teams: Missouri Department of Conservation, 2007.

USGS NWIS Sites: USGS National Water Information System (NWIS), 2007.

ESTABLISHING BENCHMARKS

List of Existing Water Quality Information and Data

The Little Sac River Watershed is one of the sources for the public drinking water of the City of Springfield. This watershed is a high priority to maintain and this has led to copious amounts of data and research. To date (7/21/2009) this is the current list of water quality research in the watershed. It will be updated as needed when new or undiscovered data or research is revealed.

Little Sac Water Quality Data

1. WCO – WQM Field Data, 2003-2008
2. Stream Team - Biological/Visual/Chemical, 1995-2006
3. Waste Water Treatment Plant- Online Graphs of Effluent, 2004-06
   http://www.springfieldmo.gov/sanitary/northwest.html
4. City of Springfield – 2002-2007 Storm water data (Pea Ridge and S. Dry Sac)
5. MODNR – L. Sac (CU, USGS, MDNR, SPFDPW, FAPRI) 1984-2006
6. Data Gap (Sac River) – (MDNR, CU, WCO, SPW, USGS, FAPRI)
   http://www.mecwater.com/projects.asp?proj_ID=276

Little Sac Watershed Related Reports

1. Fellows/McDaniel /Fulbright Watershed Plan – January 2010
2. Little Sac Watershed Management Plan – October 2009
   http://www.watershedcommittee.org/wordpress/wp-content/uploads/2009/07/the_little_sac_river_watershed_management_plan_2009.pdf
3. Little Sac River TMDL - FAPRI June 2006, http://dnr.mo.gov/env/wpp/tmdl/1381-l-sac-r-tmdl.pdf
4. Little Sac Watershed Restoration Project Final Report – WCO, Nov 2005
5. Little Sac River Watershed Bact. Source Tracking – FAPRI-UMC, May 2005
   http://dnr.mo.gov/env/wpp/tmdl/1381-l-sac-r-tmdl.pdf
6. Water Quality in the Little Sac River near Springfield – USGS 1999-2001
7. Watershed Restoration Action Strategy (WRAS) – 2000
8. Identification of sources of nutrients and fecal coliform bacterial contamination in the Little Sac River, Greene and Polk Counties, Missouri – USGS, MDNR, WCO, 1999
9. Fellows-McDaniel Lakes Watershed Protection Project – WCO, 1998
10. Water Quality in the Ozark Plateau – 1992-95, USGS
11. Sac River Watershed Inventory and Assessment – MDC ,
    http://mdc.mo.gov/fish/watershed/sac/hardcopy/

Nine Critical Elements

1. Identify Causes and Sources of Impairment (upper watershed)

This Fellows/ McDaniel-Fulbright Watershed Management plan is being written as a subset to the larger Little Sac River Watershed plan. This plan will not only address the issues involving the Fellows/McDaniel Watershed but it must deal with the contamination issues regarding the Little Sac River as well. Due to the fact that the impaired section of the Little Sac River is directly below the outlet for the Fellows/McDaniel-Fulbright Watershed, any improvements to one should benefit the other.
It is recommended that this plan be revisited on a regular basis in order to determine if the recommendations are being followed, what effect they are having and whether or not they need to be updated.

Sources of Impairment in the Watershed

Fellows and McDaniel Lakes were first put on the 303d list in 1998 for algae and ag/urban NPS issues and again in 2002 for nutrients and mercury. The Little Sac River was listed for high bacteria levels associated with the Northwest Wastewater Treatment Plant (NW WWTP), and other non-point sources. However there has been a long and well documented history of pollution issues in the watershed. City Utilities of Springfield had been receiving customer complaints regarding the taste and odor of drinking water from McDaniel Lake prior to 1982. However, in 1982, an event occurred that was severe enough to cause City Utilities management to take steps to address the problem long-term. After samples were taken the problems in McDaniel Lake were linked to cyanobacteria (or blue-green algae) metabolites[4], primarily geosmin and 2-methylisoborneal (MIB). According to the Missouri Department of Natural Resources TMDL for McDaniel Lake,

> "…increased production of cyanobacteria is related primarily to phosphorus (P) and nitrogen (N) in the water, abundant sunlight, and warm water temperatures… The withdrawal of water from Fellows and McDaniel Lakes for drinking water and transfer of water from other watersheds (Stockton Lake and the James River) into the lakes adds another layer of complexity. These activities can alter the water-to-sediment ratio and affect stratification, the natural thermal layering of lakes due to temperature differences in the water. These activities can also affect nutrient storage-and-release from bottom sediments, as well as cause fluctuations in mean lake elevation… "
>
> "…City Utilities of Springfield has managed to impede the inevitable eutrophication of McDaniel Lake by focusing on the water that enters into that drinking water reservoir. Periodic heavy rains erode soil, nutrients, trash and debris from the watershed tributaries into Fellows Lake (FLL) and McDaniel Lake (MDL). The major causes of eutrophication have been: 1) increased nutrient loading from agricultural sources, 2) urban stormwater runoff of nutrients and pollutants from lawns and septic tanks, 3) improper treatment of wastewater, 4) increased concentration of nutrients in a decreased water volume. All are the result of inadequate watershed management, drought, and continued increased demand for water."

Further taste and odor events have occurred since 1982, specifically in 1991, 1997-2000, and 2002 in McDaniel Lake. Fellows Lake was also listed for algae on the 1998 303(d) list but was delisted in 2007 at the Departments request because only one taste and odor event has occurred and there is no additional data to indicate the lake is impaired.

Twenty seven miles of the Little Sac River were first listed on the 303(d) list for E. coli in 1998 and 2002 due to E. coli concentrations that exceed the water quality standard for whole body contact set by the Department. According to the TMDL developed by the Department the sources of the impairment are both point and non-point pollution. Initially the Department attributed the majority of contamination to Springfield's NW WWTP. In response to a 2004 FAPRI report and the development of the TMDL the treatment plant has under gone major renovation and by the time the Little Sac River Watershed TMDL was approved in 2006, the NW WWTP had begun disinfecting the effluent water year-round. Consequently, according to the TMDL, 21% of the E. coli load was removed from the watershed.

According to the Little Sac River TMDL, the main contribution of impairment is from non-point sources with in the watershed. A list of potential sources of impairment was derived by the TMDL stakeholder committee. The TMDL stakeholder committee listed livestock, horses, septic tanks, wildlife, permitted facilities, and storm runoff from urban areas as potential sources of bacteria. DNA source tracking was conducted by the Food an Agricultural Policy Research Institute (FAPRI), at the University of Missouri, to examine these sources. Researchers at FAPRI then used modeling to estimate the loading percentages of the Little Sac River. This was conducted at 2 monitoring locations according to the FAPRI study.

According to this study:

> "DNA analyses of these samples showed that the hosts of these bacteria colonies include the following sources present in the watershed: cattle, sewage, geese, and horses. At Farm Road 129, 15% of the bacteria were attributed to geese, 16% to sewage, 9% to cattle, 7% to horses, and 2% to septic. At Farm Road 215, 27% of the bacteria were attributed to geese, 13% to sewage, 14% to cattle, 10% to horses, and 2% to septic. However, more than half (51%) of the fecal coliform at Farm Road 129 and 34% at Road 215 could not be identified with our database. Only 3% of the bacteria identified as coming from sewage can be attributed to the Northwest WWTP treated effluent, implying that there are other sources of sewage."

> "At base flow, the loadings potentially come from contamination of the springs or from direct input to streams (illegal discharges, cattle in streams, wildlife). While there are some data about these springs, the information is not as thorough as would be needed to build an accurate model of the watershed hydrology

Springs and septic systems have long been suspect in the Watershed. A 1983 study found that septic systems with lateral filter fields are potential pollution sources, especially when inadequately designed or installed in poorly to moderately suited soils like those found within the Upper Little Sac Watershed. The Ney and Thornson study concluded that about 60% of the septic systems in Greene County add detectable contamination to the groundwater system. The table on the next page details some of the data collected in the FAPRI DNA Source Tracking study and the Little Sac River TMDL.

The table below details FAPRI DNA Source Tracking data taken from the Little Sac River TMDL.

Table 18. Average predicted daily loadings at FR129, by source

	Actual Northwest WTTP	Urban runoff	Cattle	other Unknown	Goose	Springs	Total
Base load (%)	9.86E+09 (3%)	0.00	0.00	0.00	0.00	2.97E+11 (97%)	3.07E+11 (100%)
Surface load (%)	0.00	1.34E+11 (6%)	3.01E+11 (14%)	1.28 E+12 (61%)	3.71E+11 (18%)	0.00	2.09E+12 (100%)
Total load (%)	9.86E+09 (0%)	1.34E+11 (6%)	3.01E+11 (13%)	1.28E+12 (54%)	3.71E+11 (15%)	2.97E+11 (12%)	2.39E+12 (100%)

Table 19. Average predicted daily loadings at RD215, by source

	Actual Northwest WTTP	Urban runoff	Cattle	other Unknown	Goose	Springs	Total
Base load (%)	3.45E+09 (2%)	0.00	0.00	0.00	0.00	1.54E+11 (98%)	1.57E+11 (100%)
Surface load (%)	0.00	8.46E+10 (2%)	5.43E+11 (14%)	2.53E+12 (66%)	6.59E+11 (17%)	0.00	3.82E+12 (100%)
Total load (%)	3.45E+09 (0%)	8.46E+10 (2%)	5.43E+11 (14%)	2.53E+12 (64%)	6.59E+11 (17%)	1.54E+11 (4%)	3.98E+12 (100%)

Table 20. Average measured load fraction in each host class during the 2004 recreation season

	Sewage	Septic	Cattle	Horses	Goose	Unknown	Total
FR 129	12%	2%	9%	10%	16%	52%	100%
RD 215	9%	2%	18%	12%	31%	27%	100%

The Fulbright landfill has historically been a significant nonpoint source of contamination in the Sac River Basin. The Fulbright landfill borders the South Dry Sac River and was used for municipal and industrial waste disposal in the 1960s and early 1970s. High concentrations of contaminants were first discovered leaching from the Fulbright landfill in 1978 by a Southwest Missouri State University geology student. The industrial solvent trichloroethene (TCE) was subsequently discovered in nearby Ritter Springs and Fantastic Caverns in 1981. The Fulbright Landfill was consequently placed on the EPA's National Priorities List in 1983. A study by Mantei and Foster (1991) suggested the Fulbright Landfill leaches copper, lead, zinc, cadmium, and silver. Contaminates of concern at the Fulbright Landfill identified by the EPA include arsenic, beryllium, cadmium, chromium, lead, mercury, nickel, zinc, and selected organic compounds (EPA, 2005). Remedial actions were first initiated at the Fulbright Landfill in 1990, which included the removal of drums and contaminated soil. Land use restrictions and groundwater and surface water monitoring were also implemented at that time. A review conducted by EPA in 2000 identified issues with the maintenance of the landfill cap (e.g., low spots and solid waste protrusions). The City of Springfield responded with grading plans to address the settlement in 2003 and initiated stream bank stabilization efforts in 2004. Landfill materials along approximately 3,200 feet of the stream bank were excavated and replaced with clean clay fill. Reinforcing mats, fiber coir logs, articulated concrete block

mats, and reseeding efforts were used to protect the replaced slope. In 2004 EPA selected the Fulbright Landfill site as a demonstration project for the “Return to Use” initiative, which is designed to remove barriers to reusing a site that are not necessary for the protection of human health, the environment, or the implemented remedy. The City of Springfield recently completed the development of a greenway trail through the site. Based on an inspection of the site in 2004, EPA concluded that plans for the greenway trail were appropriate and that no additional grading of the landfill caps appears necessary (EPA, 2005). A fourth five-year is scheduled to begin in 2010 with a goal of having the review completed and the report written by June of 2010. This review will examine the existing monitoring data, review the site information and will inspect the site to visually confirm and document the site condition.

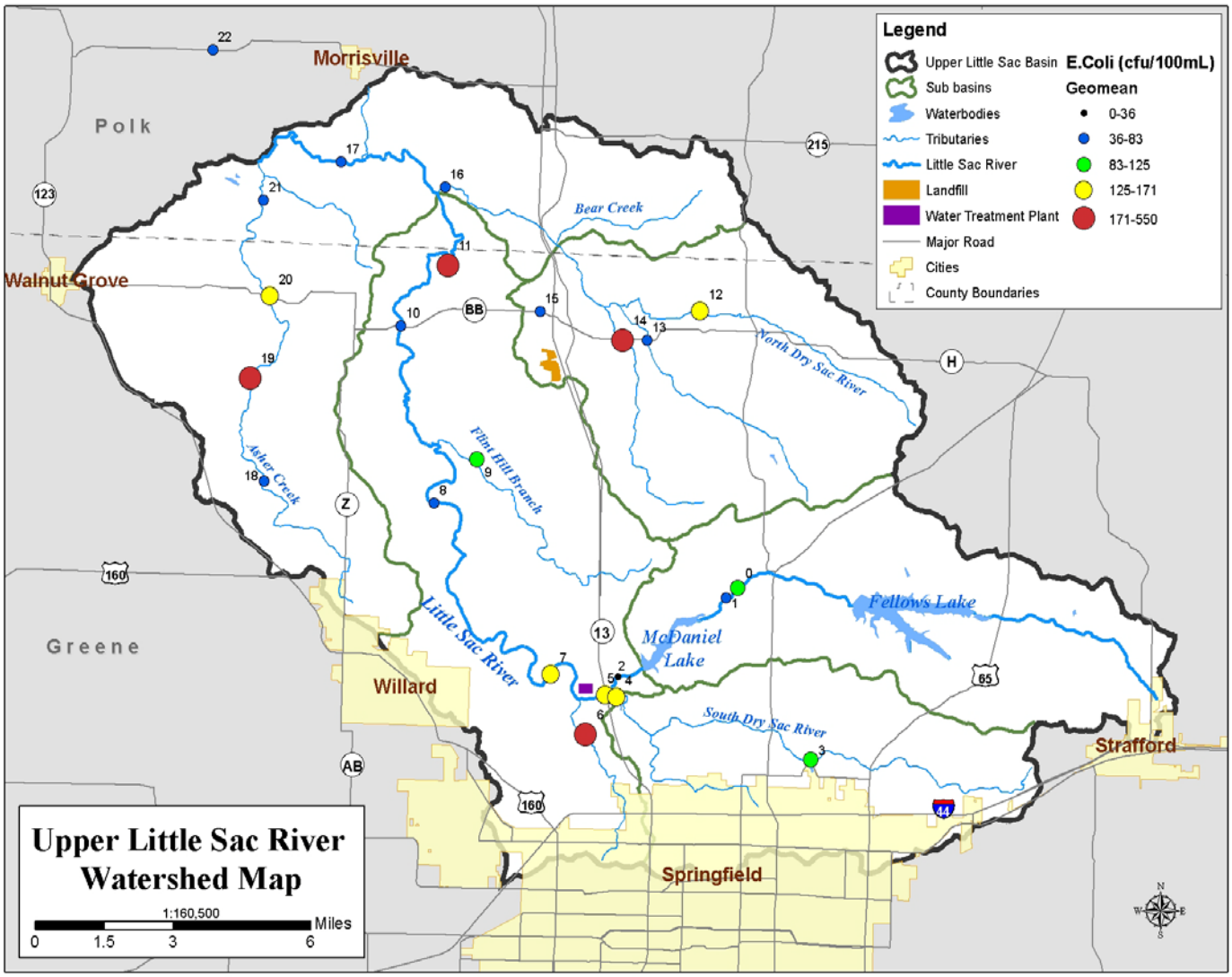
Urban influences, particularly in the southern portion of the Watershed have created the potential for nonpoint source pollution problems related to storm water runoff. Urban runoff has been shown to contain heavy metals, pesticides, low dissolved oxygen levels, pathogens, and nutrients. Aquatic macro-invertebrate species diversity (indicators of water quality) suffers when the quality of stream waters declines. One study (Humphrey, 1994) demonstrated a loss of diversity in macro-invertebrates at locations along the Little Sac River. Another study in the nearby Pearson Creek Watershed, found similar results and attributed macro-invertebrate declines to urban growth (Youngsteadt, 1995). Studies to date indicate that Springfield's storm water does contain pollutants of concern but at relatively low levels. However, expanding urbanization as well as increased use of lawn fertilizers and pesticides, can pose a future threat to water quality when considering that the South Dry Sac is a losing stream and that much of the watershed area is underlain by karst geology features such as sinkholes. Examples of such impacts have been exhibited at Fulbright Spring which receives a portion of its recharge from the South Dry Sac. Turbidity levels and fecal coliform at this water supply spring show significant increases during higher discharges.

The potential for water quality problems is not limited to urban sources. Nutrients from both agricultural and urban runoff have been identified as problems in both reservoirs -- McDaniel Lake and Fellows Lake. Crop production occurs on only a very small percent of the watershed. Consequently, agricultural pesticides have not been found to pose a water quality problem. The source of agricultural pollutants is primarily livestock on pasture. Greene County was ranked eleventh in the state in 2006 for numbers of beef cattle. Runoff from livestock operations can contain significant amounts of sediment and nutrients. Concentrations of livestock along streams can result in excessive stream bank erosion and delivery of sediment downstream.

Rural residences specifically small acreages and lots also have the potential to negatively impact water quality. Animal confinements, such as horse stalls and pens, can contribute nutrients and sediment to the water resource system.

In March of 2008, the Southwest Missouri Water Quality Improvement Project funded the completion of the Sac River Basin Water Quality Data Gap Analysis. This project was aimed to compile and analyze all existing water quality data for the Sac River Basin. One analysis completed was mapping of the highest geomeans of E. coli (cfu/100mL) throughout the Little Sac River watershed. Though this covers an area larger than the area designated in this management plan, it does provide data pertinent to the discussion. The following map on page 36 shows the geomean of the E. coli levels in the Little Sac Watershed.

Source of Impairment Map "Areas of Concern"



The current E. coli data shows where the "hot-spots" of contamination are within the upper watershed. These hot spots and their watershed are potential "areas of concern" and could be good locations where new management efforts and further research might focus.

Sample Site Locations for the Sac R. Data Gap Analysis with in the Little Sac River Watershed

ID	Site Description	latitude	longitude	Geomean
0	L. Sac R. at FR 68	37.318900	-93.276800	98
1	L.Sac R. at FR 159	37.315900	-93.281200	70
2	L. Sac R. nr. Springfield	37.291710	-93.324080	36
3	South Dry Sac at Valley Water Mill	37.266440	-93.247690	83
4	South Dry Sac River bl. Springfield	37.285600	-93.324630	134
5	Little Sac River-State Hwy 13	37.286217	-93.329083	141
6	Spring Branch	37.274210	-93.336860	171
7	L. Sac R. 1 mi.bl. Spfd NW WWTP at FR 125 ***	37.292500	-93.350700	133

*** The only sample site used in 2006 TMDL for the upper Little Sac River Watershed.

Data Sources

- Missouri Department of Natural Resources, Little Sac River Watershed Fecal Coliform TMDL, June 2006.

- Environmental Resources Coalition, Southwest Missouri Water Quality Improvement Project Sac River Basin Water Quality Gap Analysis, March 2008.

- Missouri Department of Natural Resources, Water Pollution Control Program, McDaniel Lake, Algae TMDL, February 2004

Load Reduction Goal

The Little Sac Watershed TMDL concluded through their research and monitoring of two sample sites that the load reduction goals would be as following:

> "A TMDL for each site was determined based on the simulated flows and the water quality standard of 200 colonies/100 ml. Model results show that the average daily load at FR129 needs to be reduced by 70% to 90% in order to meet the whole body contact fecal coliform criteria throughout all flow conditions."

These percentages are based on two sampling sites in the watershed. Fifty two percent of the loading at farm road 129 is unknown. Does this suggest that more research is needed to isolate the influences of bacteria into the stream? The TMDL suggested that springs are the main contributor to bacterial loading during base flow. If this correct, the springs' recharge areas near the bacteria "hot-spots" should be investigated for potential pollution sources. DNA studies and dye traces should be performed in the recharge areas of springs near these "hot-spots" to determine the loading sources. Then these sources can be addressed according to the management practices proposed within this watershed plan.

The McDaniel Lake TMDL reached the following conclusion for load reductions specific to the Fellows McDaniel watersheds:

"…nutrient availability, namely phosphorus, will ultimately control the algal carrying capacity of McDaniel Lake. Therefore, in an effort to control biomass at levels that reduce the risk of cyanobacteria proliferation, total phosphorus loading shall be allocated so that chlorophyll-a near the dam does not exceed 10 µg/L… Therefore, to achieve a chlorophyll-a target concentration of 10 µg/L at McDaniel Lakes dam, total phosphorus loading to the lake should be reduced by 40 percent."

2. Expected Load Reductions

Load Reductions Needed to Achieve Environmental Goals

According to the goals set out by the McDaniel Lake TMDL,

> **"…to achieve a chlorophyll-a target concentration of 10 μg/L at McDaniel Lake dam, total phosphorus loading to the lake should be reduced by 40 percent."**

Given an approximate existing total phosphorus load to McDaniel Lake of 3.36 lbs/day or 43.6 μg/L, a 40 percent reduction in total phosphorus is necessary to achieve the target load of 2.01 lbs/day. The steps and values used to determine loading and percent reduction of total phosphorus can be found in Appendix E of the McDaniel Lake TMDL.

In order to achieve the Little Sac Watershed Bacterial TMDL goal of whole body contact criteria the Little Sac River TMDL recommended a nearly 70% to 90% reduction in E. coli levels.

Bacterial Load Allocations for the Little Sac River

	Base flows (more than 83% of total flow is base flow)		Medium flows (base flow is less than 83% but more than 53% of total flow)		Extreme flows (base flow is less than 53% of total flow)	
Location	FR 129	RD 215	FR 129	RD 215	FR 129	RD 215
Load capacity (colonies/day)	1.90E+11	4.38E+11	2.54E+11	5.09E+11	1.34E+12	3.17E+12
MOS (colonies/day)	1.14E+10	2.73E+10	2.02E+10	4.79E+10	1.06E+11	5.62E+11
Waste load allocation (colonies/day)	9.47E+10	9.47E+10	9.47E+10	9.47E+10	9.47E+10	9.47E+10
Load allocation (colonies/day)	8.36E+10	3.16E+11	1.40E+11	3.66E+11	1.14E+12	2.51E+12
Current load from data (colonies/day)	NA	2.48E+11	NA	5.78E+11	NA	2.94E+12
Current load from model (colonies/day)	5.09E+11	6.76E+11	2.03E+12	2.20E+12	9.42E+12	1.16E+13
Reduction (colonies/day)	3.31E+11	[0; 2.65E+11][a]	1.80E+12	[1.17E+11; 1.73E+12][a]	8.19E+12	[3.30E+11; 9.04E+12][a]
Reduction (%)	65%	[0; 39%][a]	88%	[20%;79%][a]	87%	[11%;78%][a]

Desired Load Reduction Quantified for Each Source of Impairment

The non-point sources listed as potential contributors to the impairment of the Little Sac River are described in the TMDL and a load reduction is given for each to meet water quality standards.

> "The reduction of the springs' bacterial contamination is considered here because it has been determined that they are responsible for more than 97% of the load at FR129 at base flow. This determination is based on the data that is currently available. As additional springs monitoring data better characterize their water quality, this will be updated.
> A 30% reduction of the goose population is a starting point for the purpose of estimating what it would do on the general bacteria levels in the watershed. A publication by the Missouri Conservation Commission gives details about giant Canada geese and the methods used to control their numbers (MDC, 2002). Canada goose control activities include habitat modification, exclusion, harassment, chemical repellents, and lethal control.
> Reductions of urban runoff fecal coliform loadings to the stream can be attained with detention basins or with edge-of-impervious-area vegetation buffer strips. The 50% reduction is also a starting point for the purpose of estimating what it would do on the stream bacteria concentrations. As mentioned earlier, several efforts are already directed at encouraging enhanced urban designs that minimize urban runoff." -Little Sac River TMDL

If the main source of contamination is springs, then further research is needed to isolate those springs and correct the problem. DNA source tracking, dye traces, and further water quality monitoring could be possible avenues to isolate the issues.

Estimated Load Reduction for Each Management Measure (Element 3)

Urban Watershed Area

Management Measure	Pollutants Addressed	Estimated Load Reduction @ Each BMP Location
Zoo Storm water BMPs	Sediment, bacteria, nutrients	Sed-50%/Bact-75%/Nutr-25%
Doling Park Lake Improvements	Sediment, bacteria, nutrients	Sed-50%/Bact-75%/Nutr-25%
Storm water inspections of industrial/high risk operations	Heavy metals, sediment	HeavMtl-Site Dependant Sediment-50%
Regional Detention Basins	Sediment	Sed-50%
City of Springfield & Greene County Water quality requirements for new developments & significant redevelopments	Dependent on BMP type	Variable
City of Springfield & Greene County Land Disturbance/ Site Grading Permit Programs	Sediment	50%-70%
Public education and outreach programs	Nutrients, pesticides, household chemicals, sediment, runoff volume	Variable on BMP and Funding
Flood Plain Development Planning Program	Nutrients, Bacteria, Sediment	Sed-50%/Bact-75%/Nutr-25%
Water Quality Protection of Wells, Springs, Sinkholes, Caves	Nutrients, Bacteria, Sediment	Sed-50%/Bact-75%/Nutr-25%

Rural Watershed Area

Management Measure	Pollutants Addressed	Estimated Load Reduction @ Each BMP Location
Education & Outreach (Onsite Waste Water Training Facility & Watershed Center)	sediment, bacteria, nutrients	Sed-50%/Bact-75%/Nutr-25%
Springs Source Tracking Research	Sediment, bacteria, nutrients	Sed-50%/Bact-75%/Nutr-25%
Septic Remediation/Install/Repair/Maintenance	Heavy metals, oil, sediment, phosphorus, others	
Riparian Habitat Improvement	Sediment, Bacteria, Nutrients, Run-off volume, Temp.	Sed-50%/Bact-75%/Nutr-25%
Nutrient Management	Dependent on BMP type	
Sheet/Rill Erosion Prevention	Sediment, nutrients, bacteria	Sed-50%/Bact-75%/Nutr-25%
Forage Management	Nutrients, sediment, bacteria	Sed-50%/Bact-75%/Nutr-25%
Flood Plain Development Planning Program	Bacteria, Sediment, Nutrients	Sed-50%/Bact-75%/Nutr-25%
Water Quality Protection for Wells, Sinkholes, caves,	Bacteria, Sediment, Nutrients	Sed-50%/Bact-75%/Nutr-25%
Low-Impact Development Test Site @ Legacy Trails	Bacteria, Sediment, Nutrients	Sed-50%/Bact-75%/Nutr-25%

Data Sources used

- Missouri Department of Natural Resources, Little Sac River Watershed Fecal Coliform TMDL, June 2006.
- Center for Watershed Protection, National Pollutant Removal Performance Database, Version 3 September 2007
- International Stormwater Best Management Practices (BMP) Database [1999-2008], Overview of performance by BMP Category and Common Pollutant Type, June 2008
- Missouri Department of Natural Resources, McDaniel Lake Watershed Algae TMDL, February 2004

3. Proposed Management Measures

Springfield uses ground and surface water for its drinking water sources. This comes from different sub-watersheds and each watershed has different characteristics. Each watershed should also have different management strategies to address and maintain the quality/quantity of drinking water in the area. There is also a highly urban to rural transition within the watershed that should be considered when planning management measures. Due to these issues this plan will be divided into the Urban and Rural areas within the Fellows/McDaniel Lake - Fulbright Spring watershed. Each of these areas will be addressed with specific sets of management measures that will address issues common to the urban and rural settings.

Urban Watershed Area Management Measures

Management Measure	Responsible Party	Size/Quantity	Date: Start/End	Pollutants Addressed
Zoo Storm water BMPs	City of Springfield Storm Water Services	Approx. 500 feet of lakeshore stabilization and BMPs for approx. 1.5 acres of animal exhibits	Summer 2009 – Summer 2010	Runoff volume, sediment, bacteria, nutrients
Doling Park Lake Improvements	City of Springfield Storm Water Services	Approx. 500 feet of lakeshore stabilization; waterfowl deterrent measures; 400 feet of channel improvements	2010	Sediment, bacteria, nutrients
Storm water inspections of industrial/high risk operations	City of Springfield Storm Water Services	Avg. 5 inspections annually	Ongoing	Heavy metals, oil, sediment, others
Regional Detention Basins	Private developers	10 basins	Ongoing property acquisition as available	Sediment
Water quality requirements for new developments & significant redevelopments	City of Springfield Storm Water Services & Greene County Resource Management	Per development/ redevelopment	Ongoing	Dependent on BMP type
Land Disturbance/ Site Grading Permit Program	City of Springfield Storm Water Services/ Greene County Resource Management	Per land disturbance site	Ongoing	Sediment
Public education and outreach programs	City of Springfield Storm Water Services, Watershed Committee of the Ozarks	-20 presentations, 15 community events, 5,000 handouts, various other projects annually - SSWS -40,000 people reached by - WCO	Ongoing	Nutrients, pesticides, household chemicals, sediment, runoff volume
Flood Plain Development Planning Program	Greene County Resource Management	Per Proposed Development	Ongoing	Nutrient, Sediment, Bacteria
Water Protection for Well, Sinkholes, Caves & Springs	Greene County Resource Management	Site Dependant	Ongoing	Nutrients, Bacteria, Sediment, Pesticides

Rural Watershed Area Management Measures

Management Measure	Responsible Party	Size/Quantity	Date: Start/End	Pollutants Addressed
Education & Outreach	WCO, SWCD	-40,000 people reached by – WCO, SWCD	Ongoing	Nutrients, pesticides, household chemicals, sediment, runoff volume
Springs Source Tracking Research	Interested Party	1 graduate research project at the 4 areas of critical priority	When Funded	Bacteria
Little Sac Watershed Septic Remediation Project	WCO/Greene County SWCD/Grant Recipients	Funding Dependant	When Funded	Bacteria, phosphorus
Riparian Habitat Improvement	WCO/Greene County SWCD/Grant Recipients	5 acres/year	Start 2010	Sediment, bacteria, nutrients
Nutrient Management	Greene County SWCD	50 acres/year	Start 2010	Nutrients
Sheet/Rill Erosion Prevention	Greene County SWCD	40 acres/year	Start 2010	Nutrients, bacteria, sediment
On-Site Waste Water System Install/Repair/Maintenance	Greene County Resource Management / Other	Per Qualified Applicant	Ongoing	Nutrients, Bacteria
Forage Management	Greene County SWCD	200 acres/year	Start 2010	Nutrients, bacteria, sediment, runoff volume
Flood Plain Development Planning Program	Greene County Resource Management	Per Planned Development	Ongoing	Nutrients, Sediment, Bacteria
Water Quality Protection for Wells, Sinkholes, Caves, Springs	Greene County Resource Management	Per Instance	Ongoing	Nutrients, Sediment, Bacteria

Other Possible Landowner/Homeowner/Business Owner Management Measures

Management Measure	Responsible Party	Pollutants Addressed
Water Conservation/ Pollution Prevention -Rain Barrel -Low Flow -Less Irrigation -Native Landscaping -Rain Gardens -Recycle House Hold Chemicals -Pick up your pet's waste (urban areas) -Don't dump in storm drains -Do Not Litter (we all live down stream) -Green Roof -Pervious Pavement	Home Owners/Landowners/Business Owners (Urban and Rural)	Run-off Volume, water usage demand, bacteria, nutrients, chemical

These measures are effective practices that can be utilized by the land, home or small business owners in the watershed. With widespread implementation they can help and maintain the water quality and quantity in the Little Sac River. The numbers of these measures in the watershed is undetermined and it is unknown what amount of a load reduction they would have in the Little Sac River.

Process to Evaluate Effectiveness of Management Measures

Continued routine water sampling for E. coli and phosphorus will be used to monitor the effectiveness of the management measures that effect water quality directly. (See element 9 monitoring component) There is also the possibility for further surveys within the watershed, either mailed or online, to monitor the public opinion of the water quality in the Little Sac Watershed.

4. Technical and Financial Assistance Needs

Urban Watershed Area

Management Measure	Responsible Party	Cost Estimate of Planning & Implementation per measure	Funding Sources /Cost Share
Zoo Storm water BMPs	City of Springfield Storm Water Services	$750,000	Greene County Parks/Waterways Sales Tax
Doling Park Lake Improvements	City of Springfield Storm Water Services	$1 Million	Greene County Parks/Waterways Sales Tax
Storm water inspections of industrial/high risk operations	City of Springfield Storm Water Services	$1,000 annually	General Fund
Regional Detention Basins	Private developers	$100,000 annually $1 Million Total	Payment n lieu of detention funds and future storm water bond issues
Water quality requirements for new developments & significant redevelopments	City of Springfield Storm Water Services & Greene County Resource Management	Dependant of BMP	Private Developers
Land Disturbance/ Site Grading Permit Program	City of Springfield Storm Water Services/ Greene County Resource Management	Dependant of Site	Private Developers
Public education and outreach programs	City of Springfield Storm Water Services, Watershed Committee of the Ozarks	$60,000 Annually	Various City Funds
Flood Plain Development Planning Program	Greene County Resource Management	$50,000 Annually	Various

Rural Watershed Area

Management Measure	Responsible Party	Cost Estimate of Planning & Implementation per measure	Funding Sources (Fed, State, County, City, Private)
Education & Outreach	WCO	$50,000/year	WCO
Springs Source Tracking Research	Interested Party	$100,000/year	Unknown
Little Sac Watershed Septic Remediation Project	WCO/Greene County SWCD/Grant Recipients	$5,000-15,000/site	Greene County SWCD/Grants
Riparian Habitat Improvement	WCO/Greene County SWCD/Grant Recipients	$15,000 per 5 acres/year	Greene County SWCD/Grants
Nutrient Management	Greene County SWCD	$1,500 per 50 acres/year	Greene County SWCD/Grants
Sheet/Rill Erosion Prevention	Greene County SWCD	$70 per 40 acres/year	Greene County SWCD/Grants
On-Site Waste Water System Install/Repair/Maintenance	Greene County Resource Management	Up to $15,000/site	Greene County
Forage Management	Greene County SWCD	$250 per 200 acres/year	Greene County SWCD/Grants
Water Quality Protection for Wells, Sinkholes, Caves, Springs	Greene County Resource Management and SWCD	$4,000/site	Greene County

5. Information, Education, and Public Participation

Information and education are critical components to any management plan that serve to enhance public understanding and participation in selecting, designing, and implementing the NPS management measures.

The Watershed Committee and Greene County SWCD have worked with watershed stakeholders through mailings, phone calls, personal visits, newspaper articles, Newsletters, Monthly Meetings, as well as a web page specifically designed for the WMP.

Assisting in the development of this management plan, the following people served on the stakeholder and technical committees.

Stakeholder Committee: Paul and Katheryn Sloan, Wayne Fortner, Jim Farrell, Amy Strickland, Chad Wolsey, Jordan Feemster, and Larry Jones

Technical Committee: Jon Williams, Vanessa Brandon, Scott Foley, Mike Crocker, Kevin Barnes, Dave Ballou, Rey Gumucio, Barbara Lucks, Janet Hicks, Carrie Lamb, Todd Wagoner, Mark Green, Eric Morris, Charles Parrot, Michael Bowers, Kyle Kosovich, and Stacey Armstong

Public Meetings Held

Stakeholder Meetings Dates	Technical Meetings Dates
June 24 2008	July 22 2008
September 22 2008	April 14 2009
July 21 2009	July 21 2009
August 11 2009	August 11 2009

Educational Outreach Materials for WMP & Future Management Measures

Brochure – L. Sac WMP; BMP's for your Home
Web Site-, www.swcd.mo.gov/greene www.watershedcenter.com
L. Sac WMP Stakeholder Folders
Field Days
Spring Forage Conference
Horse Fest
Watershed Center
Farm Fest
Low-Impact Development Site @ Legacy Trails
Onsite Waste Water Training Facility

6/7. Implementation Time Line

Urban Watershed Area

Management Measure	Responsible Party	Dates and Expected Accomplishments	Interim Milestones	Milestones
Zoo Storm water BMPs	City of Springfield Storm Water Services	START Summer 2009 – END Summer 2010	Summer 2008	N/A
Doling Park Lake Improvements	City of Springfield Storm Water Services	START/END 2010	N/A	N/A
Storm water inspections of industrial/high risk operations	City of Springfield Storm Water Services	Re-evaluate in 4-6 years if needed	Ongoing	Ongoing
Regional Detention Basins	Private developers	Ongoing property acquisition when available	Ongoing	Ongoing
Water quality requirements for new developments & significant redevelopments	City of Springfield Storm Water Services & Greene County Resource Management	Re-evaluate in 4-6 years if needed	Ongoing	Ongoing
Land Disturbance/Site Grading Permit Program	City of Springfield Storm Water Services/ Greene County Resource Management	START December 2008 - ongoing	Ongoing	Ongoing
Public education and outreach programs	City of Springfield Storm Water Services, Watershed Committee of the Ozarks	Re-evaluate in 1-3 years if needed	Ongoing	Ongoing
Flood Plain Development Planning Program	Greene County Resource Management	Re-evaluate in 4-6 years if needed	Ongoing	Ongoing
Water Protection for Well, Sinkholes, Caves & Springs	Greene County Resource Management	Re-evaluate in 4-6 years if needed	Ongoing	Ongoing

Rural Watershed Area

Management Measure	Responsible Party	Dates and Expected Accomplishments	Interim Milestones	Milestones
Education & Outreach	WCO	Re-evaluate in 1-3 years if needed	Ongoing	Ongoing
Springs Source Tracking Research	Interested Party	Awaiting Funding Opportunity	NA	NA
Little Sac Watershed Septic Remediation Project	WCO/Greene County SWCD/Grant Recipients	Awaiting Funding Opportunity	NA	NA
Riparian Habitat Improvement	WCO/Greene County SWCD/Grant Recipients	Start 2010, pending funding	Ongoing	Ongoing
Nutrient Management	Greene County SWCD	Start 2010, pending funding	Ongoing	Ongoing
Sheet/Rill Erosion Prevention	Greene County SWCD	Start 2010, pending funding	Ongoing	Ongoing
On-Site Waste Water System Install/Repair/Maintenance	Greene County Resource Management	Awaiting Funding	Ongoing	Ongoing
Forage Management	Greene County SWCD	Start 2010, pending funding	Ongoing	Ongoing
Flood Plain Development Planning Program	Greene County Resource Management	Re-evaluate in 4-6 years if needed	Ongoing	Ongoing
Water Quality Protection for Wells, Sinkholes, Caves, Springs	Greene County Resource Management	Re-evaluate in 4-6 years if needed	Ongoing	Ongoing

8. Load Reduction Evaluation Criteria

Urban Watershed Area

Management Measure	Responsible Party	Progress Indicators	Evaluation Criteria	Threshold Criteria to Change Plan When Goals Not Met
Zoo Storm water BMPs	City of Springfield Storm Water Services	BMP Completion	WQM Data	5yrs Re-evaluation of water quality in Little Sac River
Doling Park Lake Improvements	City of Springfield Storm Water Services	Completion	WQM Data	5yrs Re-evaluation of water quality in Little Sac River
Storm water inspections of industrial/high risk operations	City of Springfield Storm Water Services	# Inspections	WQM Data	5yrs Re-evaluation of water quality in Little Sac River
Regional Detention Basins	Private developers	# Basins	WQM Data	5yrs Re-evaluation of water quality in Little Sac River
Water quality requirements for new developments & significant redevelopments	City of Springfield Storm Water Services & Greene County Resource Management	# Developments	WQM Data	5yrs Re-evaluation of water quality in Little Sac River
Land Disturbance/ Site Grading Permit Program	City of Springfield Storm Water Services/ Greene County Resource Management	# permits	WQM Data	5yrs Re-evaluation of water quality in Little Sac River
Public education and outreach programs	City of Springfield Storm Water Services, Watershed Committee of the Ozarks	# Of people reached	Surveys	5yr survey for stakeholders w/in Watershed
Flood Plain Development Planning Program	Greene County Resource Management	# flood plain plans	WQM Data	5yrs Re-evaluation of water quality in Little Sac River
Water Protection for Well, Sinkholes, Caves & Springs	Greene County Resource Management	#'s of sites	WQM Data	5yrs Re-evaluation of water quality in Little Sac River

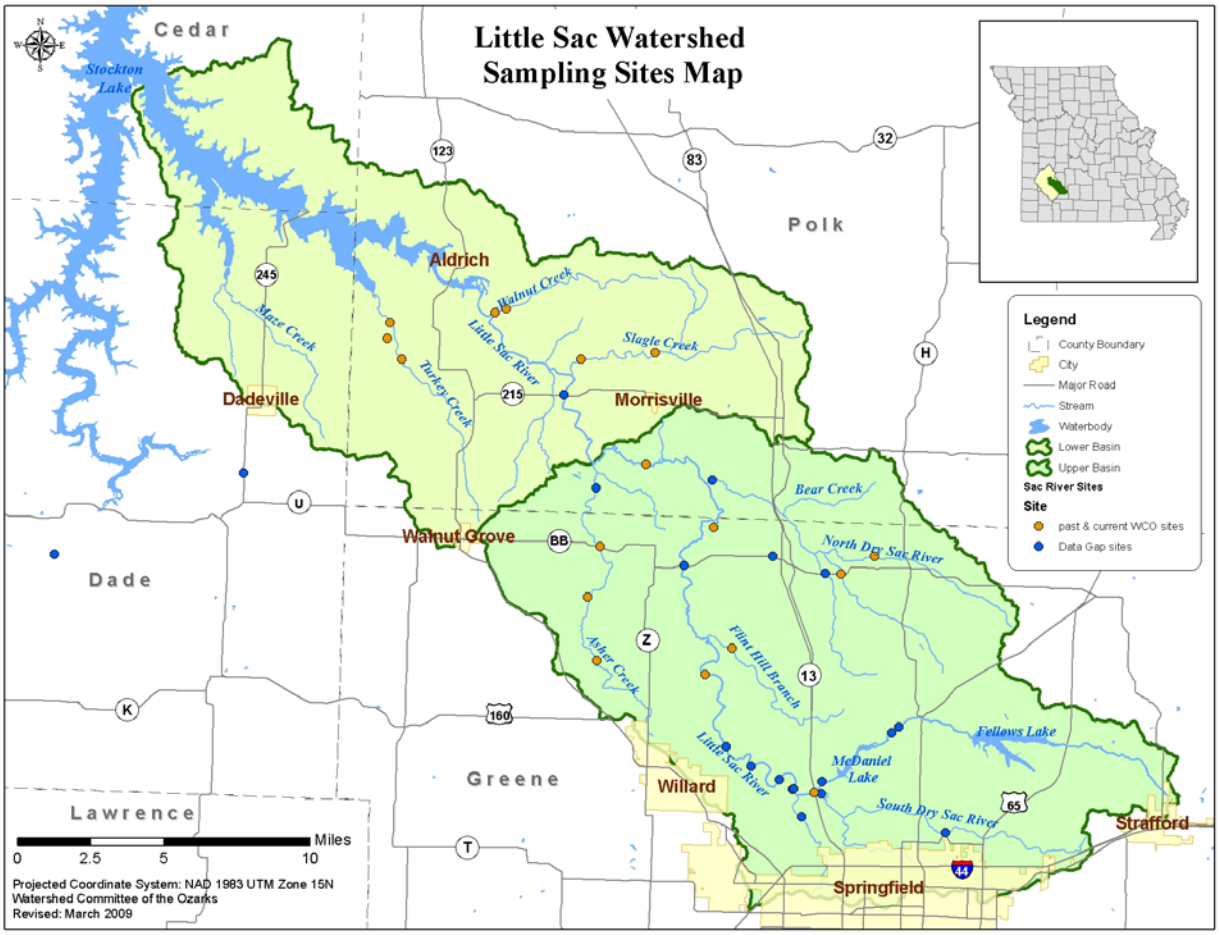
Rural Watershed Area

Management Measure	Responsible Party	Progress Indicators	Evaluation Criteria	Threshold Criteria to Change Plan When Goals Not Met
Education & Outreach	WCO	# People Reached	Surveys	…E&O results show >60% involvement in watershed efforts by landowners
Springs Source Tracking Research	Interested Party	# Springs	WQM Data	N/A
Little Sac Watershed Septic Remediation Project	WCO/Greene County SWCD/Grant Recipients	# Sites	WQM Data	…80% compromised systems are replaced along riparian or karst areas
Riparian Habitat Improvement	WCO/Greene County SWCD/Grant Recipients	# Miles/Acres	WQM Data	All Critical Riparian areas are remediated
Nutrient Management	Greene County SWCD	# Farms/Acres	WQM Data	5yrs Re-evaluation of water quality in Little Sac River
Sheet/Rill Erosion Prevention	Greene County SWCD	# Farms/Acres	WQM Data	5yrs Re-evaluation of water quality in Little Sac River
On-Site Waste Water System Install/Repair/Maintenance	Greene County Resource Management	#Systems	WQM Data	5yrs Re-evaluation of water quality in Little Sac River
Forage Management	Greene County SWCD	#Farms/Acres	WQM Data	5yrs Re-evaluation of water quality in Little Sac River
Flood Plain Development Planning Program	Greene County Resource Management	# Plans	WQM Data	5yrs Re-evaluation of water quality in Little Sac River
Water Quality Protection for Wells, Sinkholes, Caves, Springs	Greene County Resource Management	# Sites	WQM Data	5yrs Re-evaluation of water quality in Little Sac River

9. Monitoring Component

Number of Monitoring Sites

The Watershed Committee of the Ozarks currently monitors 18 sites within the Little Sac Watershed. Each site is sampled for: Temp, Cond., pH, DO, Nutrients N & P, and E. Coli/Total Coliform.



Sampling Frequency

Each Site is sampled monthly unless high water conditions are prevailing at the time. Only base flow water levels are sampled by WCO.

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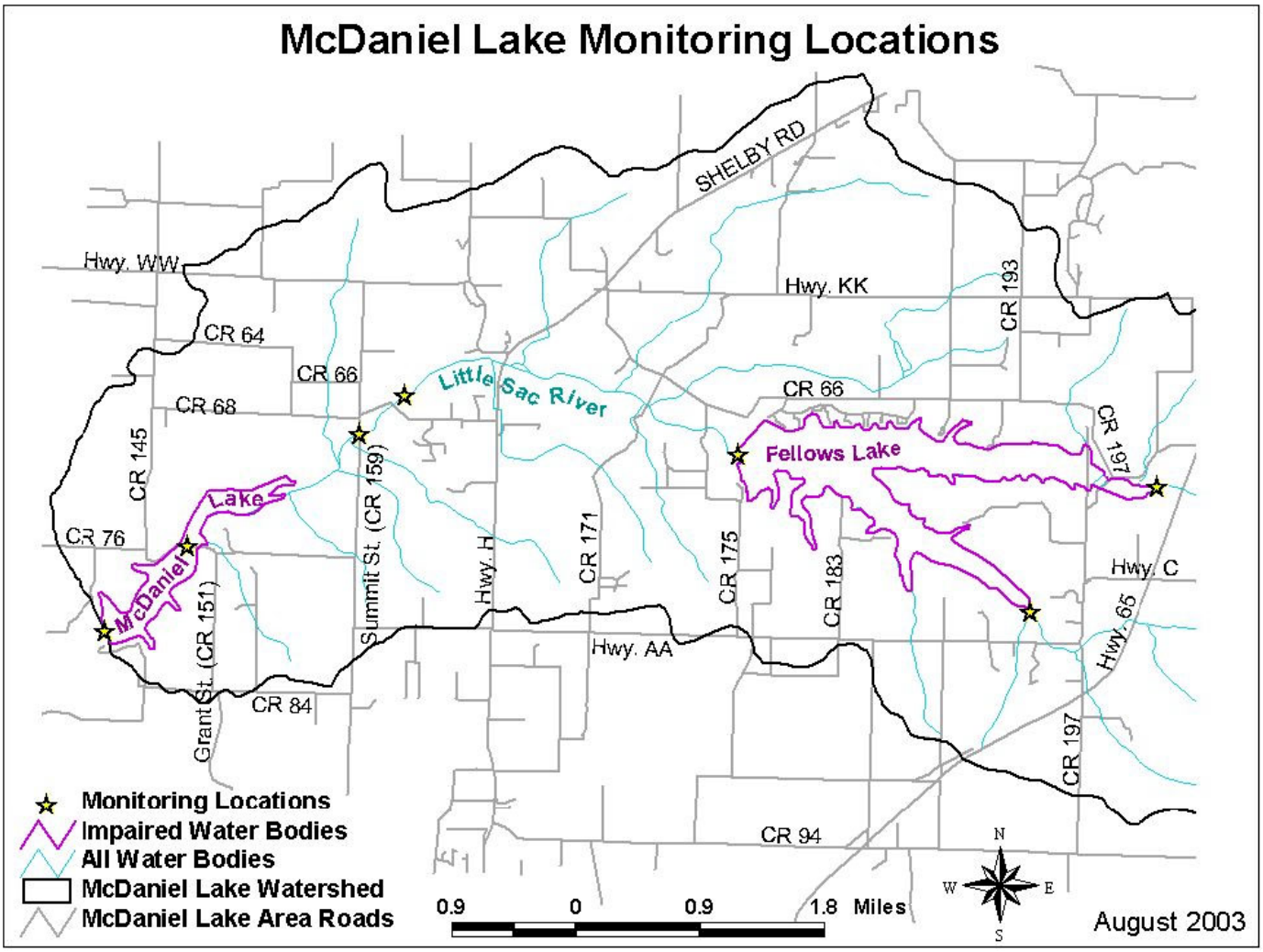
This map details the ongoing City Utility sampling program in the Fellows/McDaniel Lake Watershed.



City Utilities describes its sampling program as a proactive, scheduled, fixed-station sampling by trained technicians or experienced environmental professionals. The Blackman Laboratories, operated by City Utilities of Springfield, utilize weekly, monthly or quarterly physical sampling of multiple sites in the Fellows/McDaniel-Fulbright watershed. Blackman Laboratories has volunteered to provide the Greene County SWCD with any pertinent water quality data necessary to document progress in the watershed.

The present sample plan specifies the sampling and analyses of the following:

Bacteriology: Fecal Coliform and Total Coliform.
Chemical: Relevant Herbicides, Pesticides, Total Organic Carbon, Common Metals, Common Ions, Dissolved Oxygen, Total Dissolved Solids, Total Suspended Solids, pH, Conductivity, Turbidity, Alkalinity, Calcium Hardness, Magnesium, Temperature, Total Phosphate, Ortho Phosphate, Nitrates/Nitrites.
Toxicity: Delta Tox testing providing indication of the presence of over 250 known chemicals and organisms known for potential for accidental or intentional contamination of water supplies. Mycrocystine testing for cyanotoxins is performed in season.

All samples are taken in accordance with the Clean Water Act (CWA) and in keeping with the guidelines relevant to a DNR certified lab performing Drinking Water analyses.

Improving trends in water quality will provide evidence needed to attribute water quality improvements to implementation of BMP systems. The following two tables give further detail on the CU sampling program.

Current City Utility McDaniel Lake Intake Sampling at the Dam (MDL001)

McDaniel Lake Intake Parameters	Number of Samples		
	Weekly	Monthly	Quarterly
Alkalinity	1		
Calcium	1		
Calcium Hardness	1		
Coliform	1		
Common Ions*		1	
Common Metals*		1	
Conductivity	1		
Fecal Coliform	1		
Geosmin/MIB	Sampled as needed		
H/P EPA 504 "DBCP"			1
H/P EPA 505 "Aldrin"			1
H/P EPA 507 "Alachlor"			1
pH	1		
Quarterly Metals***			1
Solids, Total Dissolved			1
Solids, Total Suspended			1
Target pH	1		
Temperature	1		
Threshold Odor	1		
Total Hardness	1		
TOC	1		
Turbidity	1		
Total Phosphate as P	1		
Number of sampling events per year	52	12	4

Additional FMFW Watershed Sampling Data

Lakes Watershed Parameters	Number of Samples		
	Weekly	Monthly	Quarterly
Common Ions*		3	
Common Metals**		3	
Chlorophyll-a		3	
Dissolved Oxygen		8	
Phytoplankton		9	
Total Phosphate as P		39	
Temperature		104	
Zooplankton		9	
Number of sampling events per year		9	

*Bromide, chloride, fluoride, nitrate, nitrite, orthophosphate, & sulfate

**Copper, iron, lead, manganese, sodium, & zinc

Summary

The preceding plan was developed with extensive input by stakeholders in the watershed as well as technical experts from the community. It has been compiled from the many existing plans such as the Bacterial TMDL for the Little Sac River, the Algae TMDL for McDaniel Lake, the Little Sac River WRAS, and the Upper Little Sac River Watershed AgNPS SALT Management plan as well as the Data Gap Analysis for the Sac River Basin. It reflects an effort to bring all of the documents together with current public input in order to provide one document that can guide future resource management decisions in the watershed as well as provide a basis for grant funding projects. At the same time it reflects an in depth look at only two of the many fourteen digit hydrologic units in the entire Sac River Watershed.

Of all the fourteen digit watersheds in the Sac River Basin, the Fellows/ McDaniel – Fulbright area is the most important due to its use as a public drinking source by the third largest city in the State. It also presents the most complex pollution problem as well as possible the most difficult to correct. The complex issues in this watershed include urban and sub-urban storm-water runoff, lawn nutrient runoff and contamination from onsite waste-water effluent. Rural and agricultural issues involving livestock access to streams, over application of fertilizer and runoff from pastures and hayfields also play an important and well documented role in the pollution history of the area.

Over the last fifteen years there have been multiple grant projects targeting this watershed as well as tens of thousands of dollars spent by landowners and local, State and Federal agencies to correct these pollution issues. The programs and local efforts have been successful in that Fellows Lake is no longer listed on the 303d list and the Northwest Waste Water Treatment Plant is no longer considered the bacterial pollution source it once was. They have also pointed out that non-point source pollution is an ongoing problem associated directly with man's activities. There are no silver bullet fixes to these issues. Periodically plans like this one must be developed in order to gage what the current pollution causes and effects are and where the communities concerns lie. This plan is not meant to be the end all last answer to the issues in this watershed but a snapshot at what is going on at this time. It should be reviewed and revised in another ten years or less, in order make sure the best decisions are made based on the best most up to date information available.

Finally, the success of this plan and the restoration efforts that come out of it will be directly related to the extent the community is engaged and involved. Any successful restoration effort must begin with the most important common denominator, the Landowner.

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Appendix

Load Allocation Calculations
From McDaniel Lake TMDL

The steps and values used in calculating the Total Phosphorus load reduction are as follows:

1. Average total phosphorus concentration for McDaniel Lake is 43.6 µg/L.

2. Estimate stream flow by drainage-area size
   USGS #06918740 Little Sac River near Morrisville, MO Drainage area = 151,680 acres
   Mean daily flow = 91.20 ft^3/sec

   (The flow data can be downloaded from the following website:
   http://nwis.waterdata.usgs.gov/mo/nwis/discharge?search_site_no=06918740&search_site_no_match_type=exact&format=station_list&sort_key=site_no&group_key=NONE&sitefile_output_format=html_table&column_name=agency_cd&column_name=site_no&column_name=station_nm&column_name=lat_va&column_name=long_va&column_name=state_cd&column_name=county_cd&column_name=alt_va&column_name=huc_cd&list_of_search_criteria=search_site_no)

   McDaniel Lake watershed - Drainage area = 23,776 acres

   (23,776 ac)/(151,680 ac) = 15.675%

   July-September 1983-2002 Flow Data
   (15.675%)*(91.20 ft^3/sec) = **14.30 ft^3/sec**
   McDaniel Lake watershed - **Est. mean flow = 14.30 ft^3/sec**

3. Use equation below with target TP concentration of 26.68 µg/L (from Table 1, Section 4) and the flow calculated in #2 above:
   TP Loading in pounds/day = (TP concentration in µg/L)*(0.005395)*(flow in ft^3/sec)
   0.005395 = the constant used when converting µg/L and ft^3/sec to pounds per day
   Target Loading in lb/day = 26.68 µg/L *0 .005395 * 14.30 ft^3/sec
   Target Loading or LC = 2.06 lb/day

4. Use equation below with current TP concentration of 43.6 µg/L (from # 1, above) and the flow calculated in #2:
   TP Loading in pounds/day = (TP concentration in µg/L)*(0.005395)*(flow in ft^3/sec)
   Current Loading in lb/day = 43.6 µg/L * 0.005395 * 14.30 ft^3/sec
   Current Loading = 3.36 lb/day

5. Determine the required load reduction.
   Use the next equation to calculate the percent reduction:
   [(Existing Load-LA)/Existing Load] = % TP reduction
   Note: The LA (2.01 lb/day) is the only variable of the LC that will be affected by the reduction.
   [(3.36-2.01)/3.36] = **40 % TP reduction**