Estimating Users of Water Resources: Springfield–Greene County Data Collection Plan

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1 INTRODUCTION

The quality of life in the Springfield–Greene County, Missouri, region depends on the health of its water resources. Whether using water for everyday life, to support a business, or for recreation and other enjoyment, the region's many water users depend on a reliable and clean source of water.

Springfield is on a plateau and many streams start within its boundaries and flow through the city, providing greenway corridors for recreational trails and wildlife while conveying stormwater from urban development. These streams have access points for paddlers and other boaters. Streams and rivers also receive sanitary wastewater effluent from Springfield and surrounding communities. At several locations, the streams are impounded for municipal water supply and recreational uses, including fishing, boating, and swimming. Several industries intake source water for processing food and other products, and a number of industries discharge permitted stormwater and wastewater to the streams. In agricultural areas surrounding Springfield, cattle and other livestock use streams for drinking water.

How water is managed within the city and county also affects water users downstream. Much of the streamflow from the Springfield–Greene County area drains to either Stockton Reservoir or Table Rock Lake. Recreation at these lakes draws local and out-of-town visitors, generating economic activity within the Springfield–Greene County region. Stockton Reservoir also functions as a municipal water supply for the area.

Improvements to water resources could potentially increase the ecological, economic, and social values of water use in the region, and coordinating management of air and land quality can help increase these values. Through a comprehensive integrated plan, the city of Springfield, Greene County, and City Utilities of Springfield (project partners) are addressing the region's various Clean Water Act regulatory obligations and air quality and land resource quality obligations. With the integrated plan, the project partners seek to prioritize investments in water, land, and air resource improvements that address the most pressing problems first and provide the greatest value to the area's citizens. The partners are using economic, social, and environmental benefits information for decision analysis and public outreach about the integrated plan.

A quantitative assessment of water users can help communicate the importance of water resource protection and improvement as well as provide data for prioritizing projects. As part of the Springfield–Greene County effort, EPA investigated data on water resource users within and downstream of the city and county. After compiling existing data, the EPA project team identified data gaps and developed recommended methods for collecting additional data to address these gaps. This data collection plan provides next steps for the project partners as well as ideas for other communities on how to collect water resource user data to help support an integrated planning process.

2 MAJOR WATER USERS

Government agencies, industries, and the public all depend on the quality and quantity of water supply available for consumptive use. The Missouri Department of Natural Resources (MDNR) defines a major water user as a public or private entity that can withdraw 100,000 gallons/day from a source of either surface or groundwater. MDNR maintains a database of water withdrawal types and totals from 1987 to 2013. Data for 2014 are also available, but some water users have not yet reported their 2014 records to MDNR (B. Fredrick, MDNR, personal communication to H. Fisher, May 2015). Other data sets are available for industrial water users/dischargers and agricultural operations that may use water resources.

Some data were only available on a watershed or county basis. The following study area definitions were used to guide compilation of available data:

- If data were available on a **watershed unit basis**, the study area was defined as the Upper James River within Greene County (see Appendix A for relevant HUC-12s); the Middle James River (HUC 10160006); the Lower James River (HUC 10160011); and the Upper Little Sac River, Lower Little Sac River, and Upper Sac River watersheds (see Appendix A for watersheds defined by HUC-12s within HUC 10290106). The Upper James River watershed was limited to the area within Greene County because the remaining watershed area upstream would be minimally affected by management decisions within the city and county.
- If data were available on a **county basis**, then the study area was defined as Polk, Greene, Christian, and Stone Counties.

These area definitions reflect the majority of land within the city and county. In addition, these areas include the majority of land downstream of city and county urban areas where water quality from stormwater and wastewater would be affected. The area definitions are illustrated in Figure 1 along with the locations of the major surface and groundwater users within the study area watersheds.

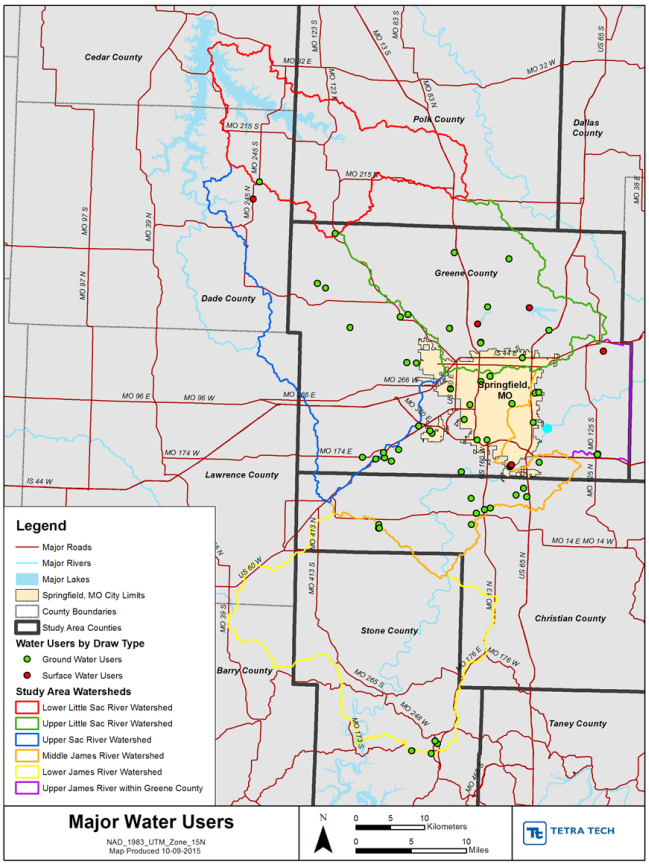

Figure 1. MDNR major water users within the study area watersheds.

2.1 Data Sources

Data sources for groundwater and surface water are discussed in Sections 2.1.1 and 2.1.2 below. These categories are not mutually exclusive, and commonalities are noted for each data set.

2.1.1 Surface Water Usage

Table 1 summarizes the most recent water usage by the four major surface water users in the study area, who withdrew nearly 42 billion gallons in 2013. Four of these intakes are used for municipal water supply, and five are used to support power generation at the City Utilities James River Power Plant at Lake Springfield. None of the surface intakes were used for commercial, livestock, industrial, dewatering, irrigation, or recreational purposes.

Table 1. MDNR major surface water users in study area watersheds

Major Water User ID	Water Draw Identifier	2013 Total Withdrawal (million gallons)	Watershed	Type
59360400	6999670	1,396	Upper Little Sac River Watershed	Municipal
59360400	5852675	2,595	Upper Little Sac River Watershed	Municipal
59360400	5023206	1,565	Upper Little Sac River Watershed	Municipal
59360400	6060386	4,043	Upper James River within Greene County	Municipal
67261846	6322355	6,453	Upper James River within Greene County	Electric
67261846	6350724	5,936	Upper James River within Greene County	Electric
67261846	5849991	10,426	Upper James River within Greene County	Electric
67261846	5738646	6,782	Upper James River within Greene County	Electric
67261846	4470297	2,506	Upper James River within Greene County	Electric

2.1.2 Groundwater Usage

Table 2 summarizes the most recent groundwater usage by the 29 major groundwater users in the watershed study area, representing 51 individual water draws. These users withdrew nearly 3.3 billion gallons of groundwater in 2013. All potential water use categories (municipal, commercial, wildlife, livestock, electric, industrial, irrigation, recreation, and dewatering) were represented by at least one user except for the dewatering category.

Separate from the major water users database, MDNR also maintains counts of domestic wells built since 1987. Within the entire Sac River and James River Basins collectively, about 18,000 wells have been built since 1987. Some of these wells may no longer be operating, and other wells may exist that were built before 1987.

Table 2. MDNR major groundwater users in study area watersheds

Major Water User ID	Water Draw Identifier	2013 Total Withdrawal (million gallons)	Percent in Use Category							
			Municipal	Commercial	Wildlife	Livestock	Electric	Industrial	Irrigation	Recreation
Lower James River Watershed										
66495158	3937626	9.2	70%	30%	0%	0%	0%	0%	0%	0%
66495158	2024627	10.1	70%	30%	0%	0%	0%	0%	0%	0%
66495158	1800847	9.3	70%	30%	0%	0%	0%	0%	0%	0%
63673585	1775463	42.0	100%	0%	0%	0%	0%	0%	0%	0%
63673585	1210572	17.4	100%	0%	0%	0%	0%	0%	0%	0%
65964179	2081729	0.1	100%	0%	0%	0%	0%	0%	0%	0%
65964179	1731212	0.1	100%	0%	0%	0%	0%	0%	0%	0%
Middle James River Watershed										
46256175	1084101	48.0	0%	0%	0%	0%	0%	0%	100%	0%
48110165	3138470	51.0	100%	0%	0%	0%	0%	0%	0%	0%
48110165	2803972	215.7	100%	0%	0%	0%	0%	0%	0%	0%
48110165	2366605	70.4	100%	0%	0%	0%	0%	0%	0%	0%
46256175	2940849	58.0	0%	0%	0%	0%	0%	0%	100%	0%
48110165	1982312	63.4	100%	0%	0%	0%	0%	0%	0%	0%
43926398	1589467	6.3	100%	0%	0%	0%	0%	0%	0%	0%
48110165	2151087	51.8	100%	0%	0%	0%	0%	0%	0%	0%
42730537	2216911	62.5	0%	0%	0%	0%	0%	100%	0%	0%
64422154	70001099	26.1	0%	40%	0%	0%	0%	58%	2%	0%
61001240	7000687	15.6	0%	0%	0%	0%	0%	100%	0%	0%
58789980	1069981	76.5	80%	18%	0%	0%	0%	1%	0%	1%
58789980	3938697	204.4	80%	18%	0%	0%	0%	1%	0%	1%
58789980	1533067	102.6	80%	18%	0%	0%	0%	1%	0%	1%
69997329	7000149	212.4	0%	0%	0%	0%	100%	0%	0%	0%
69997329	7000148	101.4	0%	0%	0%	0%	100%	0%	0%	0%
69997329	7000147	338.9	0%	0%	0%	0%	100%	0%	0%	0%
48293764	2955154	8.2	0%	0%	0%	0%	0%	0%	100%	0%
69504824	1661009	122.6	0%	0%	0%	0%	0%	100%	0%	0%
67261846	3907537	30.1	0%	0%	0%	0%	100%	0%	0%	0%
67261846	3104471	39.2	0%	0%	0%	0%	100%	0%	0%	0%
58053612	3658314	145.4	100%	0%	0%	0%	0%	0%	0%	0%

Table 2. MDNR major groundwater users in study area watersheds										
			Municipal	Commercial	Wildlife	Livestock	Electric	Industrial	Irrigation	Recreation
58053612	3017200	123.7	100%	0%	0%	0%	0%	0%	0%	0%
60344079	1032114	28.3	0%	0%	0%	0%	0%	0%	100%	0%
Upper Little Sac River Watershed										
56815154	1427664	8.7	0%	0%	0%	0%	0%	0%	100%	0%
52269193	1454125	0.9	100%	0%	0%	0%	0%	0%	0%	0%
59360400	2513004	477.0	100%	0%	0%	0%	0%	0%	0%	0%
42634682	2241123	8.6	100%	0%	0%	0%	0%	0%	0%	0%
51611581	2381036	2.6	100%	0%	0%	0%	0%	0%	0%	0%
44825923	2493142	0.0	100%	0%	0%	0%	0%	0%	0%	0%
44825923	1926613	0.2	100%	0%	0%	0%	0%	0%	0%	0%
Upper Sac River Watershed										
55558196	2050861	0.2	100%	0%	0%	0%	0%	0%	0%	0%
61832195	1851879	0.2	100%	0%	0%	0%	0%	0%	0%	0%
58789980	2931883	100.3	80%	18%	0%	0%	0%	1%	0%	1%
69800219	7000955	130.0	50%	10%	5%	10%	10%	5%	5%	5%
69800219	1945810	46.4	50%	10%	5%	10%	10%	5%	5%	5%
69800219	7000954	103.0	50%	10%	5%	10%	10%	5%	5%	5%
69800219	2898306	62.7	50%	10%	5%	10%	10%	5%	5%	5%
Lower Little Sac River Watershed										
51370263	3907872	6.9	100%	0%	0%	0%	0%	0%	0%	0%
48998312	1003567	13.9	100%	0%	0%	0%	0%	0%	0%	0%
Upper James River within Greene County										
59386395	1869296	9.8	0%	0%	0%	0%	0%	0%	100%	0%
59386395	1371098	16.9	0%	0%	0%	0%	0%	0%	100%	0%
40273187	2218849	3.5	0%	100%	0%	0%	0%	0%	0%	0%
40273187	1616437	2.7	0%	100%	0%	0%	0%	0%	0%	0%
Total (million gallons)		**3,285.4**	**1,876.1**	**146.5**	**17.1**	**34.2**	**756.2**	**237.9**	**195.5**	**21.9**

2.1.3 Industrial Groundwater Users

Table 2 identifies several of the major groundwater users as industrial operations. Industrial water users may discharge to the city's publicly owned treatment works (POTW), the city's municipal separate storm sewer system (MS4), or directly to streams. Dischargers are tracked through either the city's own database (if discharging to the POTW) or the National Pollutant Discharge Elimination System (NPDES). These listings may include facilities that use raw water from their own withdrawals or that purchase treated water from a water utility.

Appendix B provides data on Springfield's major industrial water users who require permits and regular water quality monitoring to discharge wastewater to the city's POTW. This list includes users that depend on source water quality and quantity for their daily operations. Seven food-related producers represent a regulated discharge of about 1.2 million gallons per day. These users were Dairy Farmers of America, Hiland Dairy, IsoNova Technologies (animal feeds), Kemin Industries (animal feeds), Kraft Foods, Ozarks Coca-Cola Bottlers, and French's Food Co./Reckitt Benckiser. The other industrial users generally represented a range of industrial processes using and discharging water with a regulated discharge of 2.2 million gallons per day. Additionally, about 100 entities within the city limits of Springfield have NPDES industrial stormwater discharge permits for discharge to the city's MS4 or directly to streams.

2.1.4 Agricultural Groundwater Users

Beef cattle represent the largest agricultural industry in the Springfield–Greene County study area. Dairy operations and horse farms are also fairly prevalent. The EPA project team investigated available data to estimate the number of livestock and extent to which they use streams directly as a water source in the study area; the analysis did not consider farm ponds or wells. The Springfield–Greene County integrated plan will consider the water quality effects of unlimited livestock access to streams. This practice also represents an intensive use of a water resource, an important component to Springfield–Greene County's valuation of regional water uses.

Pastures represent the majority of agricultural land within the study area (Figure 2 and Table 3) according to the National Agricultural Statistics

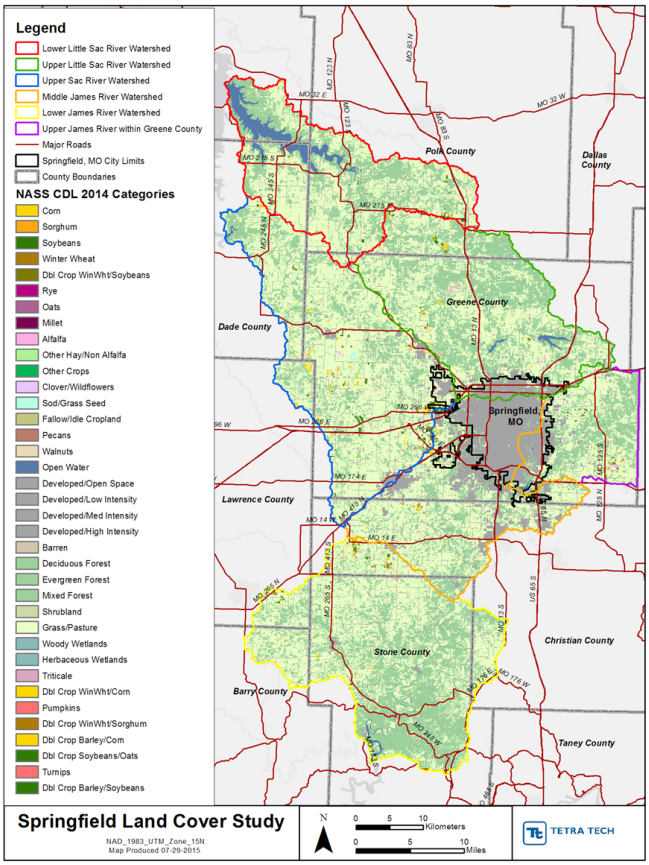

Figure 2. NASS 2014 land cover in study area watersheds

Service (NASS) Crop Data Layer (CDL), which is derived using satellite imagery[1] (NASS 2014). After pastures, the agricultural operations with the greatest aerial coverage were hay, corn, and soybeans. The MDNR major groundwater users data in Table 2 identifies several livestock operations that are considered major groundwater users in the study area. Considering the extent of pasture, many additional water users are likely to exist. Some pasture operations may use streams directly as a water source, while others may use wells. Data were not readily available on the amount of water used by pasture operations in the study area. NASS also publishes county-level data on counts of livestock (Appendix C).

[1] https://nassgeodata.gmu.edu/CropScape/

Table 3. Percent NASS 2014 land cover distribution within study area watersheds

NASS CDL 2014 Categories	Middle James River Watershed	Lower James River Watershed	Upper Sac River Watershed	Upper Little Sac River Watershed	Lower Little Sac River Watershed	Upper James River within Greene County	All
Corn	0.40%	0.41%	0.91%	0.30%	0.20%	0.15%	0.45%
Sorghum	0.01%	<0.01%	<0.01%	<0.01%	<0.01%	0.00%	<0.01%
Soybeans	0.32%	0.15%	0.60%	0.23%	0.36%	0.31%	0.33%
Winter wheat	0.19%	0.25%	0.16%	0.05%	0.11%	0.58%	0.19%
Winter wheat/ soybeans (double crop)	0.02%	0.11%	0.37%	0.08%	0.10%	0.01%	0.14%
Rye	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	0.00%	<0.01%
Oats	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	0.00%	<0.01%
Millet	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	0.00%	<0.01%
Alfalfa	0.19%	0.24%	0.39%	0.28%	0.27%	0.51%	0.29%
Other hay/non- alfalfa	0.43%	0.65%	1.24%	0.46%	1.01%	0.39%	0.74%
Other crops	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	0.01%	<0.01%
Clover/wildflowers	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%
Sod/grass seed	0.01%	0.01%	0.21%	0.01%	0.01%	<0.01%	0.05%
Fallow/idle cropland	<0.01%	0.01%	0.06%	<0.01%	<0.01%	<0.01%	0.02%
Pecans	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%
Walnuts	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%
Open water	0.10%	0.49%	0.13%	0.72%	8.48%	0.49%	1.55%
Developed/open space	9.11%	4.62%	4.56%	4.96%	3.53%	6.49%	5.35%
Developed/low intensity	15.63%	0.89%	2.58%	3.72%	0.94%	8.95%	4.67%
Developed/medium intensity	9.53%	0.17%	0.70%	1.68%	0.07%	3.34%	2.24%
Developed/high Intensity	3.64%	0.02%	0.22%	0.69%	0.01%	0.77%	0.80%
Barren	0.17%	0.03%	0.04%	0.16%	0.06%	0.24%	0.10%
Deciduous forest	18.98%	41.08%	23.11%	39.06%	33.36%	32.73%	31.68%
Evergreen forest	0.29%	0.86%	0.40%	2.02%	1.49%	0.44%	0.94%
Mixed forest	0.06%	0.08%	0.05%	0.15%	0.07%	0.07%	0.08%
Shrubland	0.01%	0.01%	0.01%	0.02%	0.02%	0.01%	0.01%
Grass/pasture	40.87%	49.87%	64.22%	45.37%	49.75%	44.47%	50.32%
Woody wetlands	0.04%	0.04%	0.03%	0.03%	0.15%	0.01%	0.05%
Herbaceous wetlands	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%
Triticale	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%
Winter wheat/corn (double crop)	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%
Pumpkins	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%
Winter wheat/ sorghum (double crop)	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%
Barley/corn (double crop)	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%
Soybeans/oats (double crop)	<0.01%	<0.01%	<0.01%	0.02%	<0.01%	<0.01%	<0.01%
Turnips	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%
Barley/soybeans (double crop)	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%

2.2 Estimating Cattle Access

Data were not available on cattle access to streams. A survey of farmers could provide an estimate, but with the large watershed area and many pasture operations, a direct survey may be cost-prohibitive for a local government.

Instead, the EPA project team developed an approach using a combination of geographic information system (GIS) data and information from local Natural Resources Conservation Service (NRCS) agents. The approach involves creating a layer of grazed land with stream access using the following steps (additional GIS processing methods, assumptions, and caveats are provided in Appendix D):

1. Select the highest resolution land cover data set available that classifies land based on detailed agricultural land uses. The project partners indicated that NASS CDL was the best available data set for the Springfield–Greene County area. Other communities may have access to other data.
2. Select the best available perennial streams and roads data set. If local, higher resolution data sets are not available, then the U.S. Geological Survey National Hydrography Dataset (NHD) and U.S. Census Bureau roads coverage data can be used (NHDPlus 2015, U.S. Census Bureau 2014). The most appropriate NHD version currently available is NHDPlus v2.1 Flow Lines (select perennial streams, connectors, and artificial paths; remove intermittent streams).
3. Using the land cover data, identify the land that is managed as pasture (in NASS, the Grass/Pasture class can be used). This will result in a map with individual pasture fields.
4. Select fields that are greater than a particular acreage threshold to avoid the inclusion of residential parcels. Based on an initial analysis of NASS, a 5-acre threshold appears to avoid most residential parcels, while the majority of pasture remains. Other communities could start with this threshold and adjust based on a visual assessment of the data.
5. Split fields using the roads data set to create individual fields where cattle are more likely to move freely. This step is not necessary if the land cover data set accurately reflects roads.
6. Create a buffer around the perennial streams that is 1,320 feet wide on either side. This width corresponds to the average distance that cattle are likely to travel to a stream based on the best professional judgment of NRCS agents local to the Springfield–Greene County region (Appendix D). Other communities should review this assumption with their own local NRCS agents and revise according to local livestock management practices.
7. Clip pasture fields to the 1,320-foot buffer. The result provides an estimate of the location and pasture area that likely provides stream access for livestock.

Once the pasture with stream access layer is created, that area can be tabulated by county and applied to available statistics on livestock densities. NASS publishes county-level survey data on acres of pasture and livestock counts, collected through the U.S. Department of Agriculture's Census of Agriculture. For each county and livestock type, the proportion of livestock per pasture acre can be applied to the pasture with stream access layer to estimate the number of livestock accessing streams. For instance, Greene County has about 217,000 acres of pasture and 55,000 cattle, which translates into roughly 0.25 cattle per acre of pasture. About 43,000 acres of pasture have stream access within the downstream watersheds in Greene County. Applying the 0.25 proportion, this translated into an estimated 11,000 cattle with access to streams downstream of the city.[2] The same methods can be used to estimate any pasture animal surveyed by the Census of Agriculture, including beef cows and dairy cows. NASS does not estimate horse numbers, but if another source estimates the county horse population, then the proportional population with stream access could be estimated.

[2] The same methods result in an estimate of 8,000 cattle with access to streams in the Upper James River watershed in Greene County upstream from the city.

3 RECREATIONAL USERS

A wide range of water-related recreational opportunities are available within the city of Springfield and Greene County. The Springfield–Greene County Park Board maintains most of the parks that offer water recreation. Other park management entities include the following:

- City Utilities of Springfield: Fellows Lake, McDaniel Lake, and Lake Springfield (in partnership with the Park Board).
- Missouri Department of Conservation (MDC): state conservation areas, fisheries management at Fellows Lake and Lake Springfield.
- National Park Service (NPS): Wilson Creek National Battlefield.

The EPA project team compiled available data on recreational users, identified data gaps, and developed recommended methods to address the remaining data needs.

3.1 Available Data

The EPA project team investigated available recreational user data for parks managed within the city of Springfield and Greene County. The project team then investigated information from canoe and kayak vendors to gain insight into how many recreational users are affected downstream of the city and county along the Sac and James Rivers.

3.1.1 Fellows Lake

Fellows Lake is an 820-acre water supply reservoir owned by City Utilities of Springfield. The reservoir was created in 1955 by impounding a portion of the Little Sac River, approximately 10 miles northeast of the city of Springfield. Recreational opportunities at the lake include fishing (muskie, bass, catfish, crappie, and sunfish), boating, canoeing, kayaking, picnicking, and waterfowl hunting.

Fellows Lake data were collected from MDC's Fellows Lake 2014 Annual Report. The report provides the number of boat permits sold from 1997 to 2014. Operators must obtain boat permits from the lake marina before launching any watercraft (Woods 2014).

Beginning in March 2013, boaters could purchase a $10 daily permit, a $20 non-motorized annual permit, or a $35 annual motorized permit (Woods 2014). Before 2013, all boaters were required to buy the same annual permit. The number of boat permits sold from 1997 to 2008 ranged from 1,426 to 1,725. Following a price increase from $5 to $25 per permit in 2009, the number of permits sold dropped to 1,186 in 2009 and 1,137 in 2010. In 2011, the price of an annual permit rose again to $35 and sales dropped to 966 permits. In 2012, permit sales rose to 1,047. In 2013, the availability of multiple permit options boosted total permit sales to 1,259, with 732 motorized permits, 377 non-motorized permits, and 150 day passes. In 2014, annual total permit sales increased again to 1,271, with 696 motorized permits, 423 non-motorized permits, and 152 day passes.

Through a survey conducted in 2013 and 2014, MDC estimated that 9,261 and 19,822 fishing trips occurred in those years, respectively. MDC also estimated 28,484 hours of fishing in 2013 and 54,910 hours in 2014. In 2013, 565 anglers were surveyed, while 1,562 were surveyed in 2014. Anglers were surveyed at a greater frequency in 2014, which may explain the substantial increase in counts between the two years (K. Vedt, MDC, personal communication to H. Fisher, May–June 2015).

View of Valley Water Mill Lake from pedestrian bridge.
City of Springfield, Department of Environmental Services

3.1.2 Springfield–Greene County Parks

The EPA project team reviewed park locations managed by the Springfield–Greene County Park Board and developed the following list of parks that included water-related primary or secondary recreational opportunities:

- Lake Springfield Park
- Ritter Springs Park
- Sequiota Park
- Valley Water Mill Park
- Rivercut Golf Course
- Cruse Dog Park
- Horton-Smith Golf Course
- Bill & Payne Stewart Golf Course
- Nathanael Greene/Close Memorial Park
- Dickerson Park Zoo
- Fassnight Park
- Phelps Grove Park
- Rutledge-Wilson Farm Park
- Doling Park
- Smith Park
- Silver Springs Park
- McDaniel Park
- Jordan Valley Park

The EPA project team focused information gathering on the parks with the largest water features and the most diverse recreational opportunities. Both Lake Springfield and Valley Water Mill Park are popular for water-related recreation. Recreational opportunities at Lake Springfield include fishing, boating, canoeing, kayaking, and picnicking. Picnic shelters with lake views are also available for rental, and the boat house community room, kitchen, and deck are rented for weddings and other events with a scenic view of the lake. Lake Springfield staff estimated that approximately 53,327 people visit the lake annually, and 3,000 of those visitors rent watercraft on the lake. These are conservative estimates. The total watercraft use might fall within 6,000 to 10,000 people per year if visitors with their own watercraft were included (J. Chamberlin, Lake Springfield Boathouse, personal communication to H. Fisher, May 2015).

Recreational opportunities at Valley Water Mill Park include fishing, picnicking, hiking, and environmental education. Boating and swimming are not allowed. The Watershed Center for the Ozarks is also located at this park and holds educational events throughout the year. As shown in Table 4, the center had 4,639 visitors in 2014, up from 1,605 in 2013 (Watershed Committee of the Ozarks 2014).

Table 4. Watershed Committee of the Ozarks education and outreach participation 2013–2014		
	2013	**2014**
Participants visiting watershed center	1,605	4,639
Event bookings (excluding field trips)	53	49
Watershed center field trips	53	71
Volunteer hours logged	1,626	2,705
Booths at community events	6	11
Jordan Creek tours	11	19
Onsite wastewater training center uses	3	8
Blog Posts	92	75 (including 33 Water Wednesday Posts)

Visitor counts are not available for every park. However, the Dickerson Park Zoo maintains annual visitor counts. During calendar year 2014, 208,992 people visited the zoo (M. Arnold, Dickerson Park Zoo, personal communication to H. Fisher, May 2015).

The Springfield–Greene County Park Board also maintains over 100 miles of trails, including about 65 miles of greenways. Many of these greenways follow streams and include stream crossings. The nonprofit organization Ozark Greenways partners with the Springfield–Greene County Park Department to develop a network of greenway trails. Ozark Greenways staff and volunteers collected user data from 2009 to 2010 (Table 5) by using mechanical trail counters placed along trails on a rotating schedule (T. Whaley, Ozark Greenways, personal communication to A. Orndorff, July 2015). Since only three trail counters were used to cover 68 miles of the greenway trail system, Ozark used some averaging and manual counts. In recent years, to estimate the number of people using the greenways, the nonprofit obtains the visitor counts at the Springfield Conservation Nature Center from MDC and adjusts them proportionally based on the ratio of trail miles at the nature center versus the greenway trail miles. Since the nature center does not allow bicycles or dogs, they double the counts to approximately reflect the dog owners and cyclists that use the greenways. Ozark Greenways estimates that thousands of people use their trails per week (L. Tack, Ozark Greenways, personal communication to H. Fisher, May 2015).

Table 5. Ozark Greenways 2009–2010 trail counts						
Trails	**2009–2010 Trail Counts**					
	Hour	**Day (8hrs)**	**Week**	**Month**	**Year**	**Total**
Galloway Creek	25	200	1,400	5,600	67,200	67,200
South Creek	20	160	1,120	4,480	53,760	53,760
Sac River MT	1	8	56	224	2,688	2,688
Sac River Ridder	1	8	56	224	2,688	2,688
Sac River Lost Hill	1	8	56	224	2,688	2,688
Sac River Truman	2	16	112	448	5,376	5,376
Volunteer Nature Trail	2	16	112	448	5,376	5,376

Table 5. Ozark Greenways 2009–2010 trail counts						
Trails	**2009–2010 Trail Counts**					
Trail of Tears	1	8	56	224	2,688	2,688
Ward Branch North/ Shadowood	2	16	112	448	5,376	5,376
Ward Branch South/ Wanda Gray	3	24	168	672	8,064	8,064
Jordan Creek between the parks	3	24	168	672	8,064	8,064
Jordan Valley Park	3	24	168	672	8,064	8,064
Jordan Creek Ewing-Cruse	1	8	56	224	2,688	2,688
Frisco Highline Spf-Willard	3	24	168	672	8,064	8,064
Frisco Willard-Walnut Grove	3	24	168	672	8,064	8,064
Frisco Highline Polk County	2	16	112	448	5,376	5,376
Frisco Highline Events	0	0	0	0	700	700
Wilson Creek/Rutledge/ Hattisburg	3	24	168	672	8,064	8,064
Valley Water Mill Nature Trail	2	16	112	448	5,376	5,376
Lake Springfield	2	16	112	448	5,376	5,376
Fassnight Creek	1	8	56	224	2,688	2,688
					Total	**218,428**

3.1.3 State Conservation Areas

MDC manages several conservation areas and stream access points within the Springfield–Greene County region. The stream access points in Greene County are Phenix (Clear Creek), Crighton (James River), and Tailwaters (James River; managed by City Utilities of Springfield). Downstream of Springfield–Greene County urban areas, there are five MDC boat ramps along the James River and one MDC boat ramp near the confluence of the Sac River and Stockton Reservoir. Other than the recent Fellows Lake angler survey discussed above, MDC has not collected user data at state conservation areas or stream access points.

In addition to the state conservation areas, MDC operates the Springfield Conservation Nature Center. MDC counts the number of visitors entering the nature center and those using its trails. Table 6 summarizes the annual counts from the most recent three fiscal years (FYs). MDC has been collecting building entrance data since 1989 and trail use data since 1992.

Boardwalk at Springfield Conservation Nature Center.
City of Springfield, Department of Environmental Services

Table 6. Springfield Conservation Nature Center user data, FY 2012–2014

Year	Building Entrance	Trails
FY 2012	84,379	181,048
FY 2013	84,447	194,520
FY 2014	84,619	210,236

3.1.4 National Battlefield

Wilson's Creek National Battlefield is located southwest of the city of Springfield and is owned by the NPS. Wilson's Creek flows through the center of the park, from north to south, and smaller segments of Shuyler Creek and Terrell Creek also run through portions of the park. The park's main recreational activities are historical tours (including a 4.9-mile, self-guided auto tour), five walking trails that vary in length from a quarter to three quarters of a mile, and a 7-mile trail system for horseback riding.

The NPS provided visitor counts for Wilson's Creek National Battlefield. Table 7 presents a summary of visitation totals by month for federal FY 2014. The numbers were recorded at the location or event listed in the first column. No active fishing or watercraft activity takes place within the park. However, visitors benefit indirectly by walking along and enjoying the creek's aesthetics.

Table 7. FY 2014 summary of monthly visitation totals													
Location or Event	**OCT**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**Annual**
Visitor center (visitation)	334	2,358	3,927	105	211	204	4,787	6,081	4,892	4,892	4,330	3,564	35,685
Junior ranger booklets (completed)	13	20	14	0	22	65	59	8	169	63	130	36	599
Education program (number of school groups)	4	6	0	0	0	0	35	66	11	0	2	0	124
Education program (number of students)	110	225	0	0	0	0	1,260	3,000	295	0	20	0	4,910
Education program (attendance)							6,300	13,500	885		20	0	20,705
Ray House tour (number of visitors)	254	599	43	0	111	815	2,896	4,250	2,347	698	1,016	692	13,721
Civil War medical talk (number of visitors	0	190	0	0	0	0	1,260	3,035	295	0	0	0	4,780
Civil War soldier talk (number of visitors)	0	150	0	0	0	0	1,260	3,183	387	0	140	50	5,170
Education in the 1860s (number of visitors)	0	0	0	0	0	0	1,260	3,037	0	0	28	0	4,325
Artillery and living history weekends (number of visitors)	150							446	905	925		420	2,846
Artillery and living history weekends (number of programs)	40							10	13	10			73
ARTS in PARKS (number of visitors	0							1,110	350	0			1,460
ARTS in PARKS (number of events)	0							5	1	0			6

3.1.5 Canoe and Kayak Vendors

The number of watercraft used annually can be associated with the public's interest in streams around the Springfield–Greene County area and with how much value the public places in such recreation. The EPA project team contacted vendors who lease watercraft along the James and Sac Rivers to obtain the number (estimates) of watercraft rented during a year. Rented watercraft included boats, pontoons, canoes, and kayaks. The team identified and contacted 11 vendors, most of whom were willing to provide information; all information collected represents estimates or rough descriptions of annual activity. Most vendors were open from March/April until the end of September each year, and the majority of their business was conducted on weekends during that timeframe. Table 8 presents the vendor data, and Figure 3 displays the vendor locations. As noted in Table 8,

Kayaks on the James River. *City of Springfield, Department of Environmental Services*

five vendors were located outside of the study area watersheds, either on or downstream of Stockton Lake. The data collected suggest that over 21,000 watercraft rentals occur annually in the study area.

Table 8. Watercraft rental information in the study area watersheds

Vendor	In Study Area?	Waterbody	Number of Watercraft in Stock	Comments
James River Outfitters, LLC	Yes	James River	88 canoes, 39 kayaks, and 6 John boats	Sold out most weekends from April 15 to October 1
Y-Bridge Canoe Rental	Yes	James River	--	Not willing to provide information
Camp Harlow, LLC	Yes	James River	25 canoes and 4 kayaks	Only a few are rented out each weekend, depending on time of year and weather
Mutton Creek Marina and Campgrounds	No	Stockton Lake	4 pontoon boats, 2 canoes, 2 paddle boats, and 2 jet skis	Varies with weather; rent out approximately 25 to 35% of watercraft each weekend
Caplinger Mills River Front Resort	No	Sac River	--	Approximately 2,200 canoes rented annually from May 1 to October 31
Orleans Trail Resort and Marina	No	Stockton Lake	6 pontoon and fishing boats	On average, 3 boats are rented out each weekend
Stockton State Park Marina	Yes	Stockton Lake	--	Unable to provide information
Riverside Bait and Canoe Rental	No	Sac River	40 canoes and 5 kayaks	Varies weekend by weekend and by whether the Stockton Dam is open; rented out 10 canoes and 1 kayak during Memorial Day weekend
Hootentown Canoe Rental and Campground	Yes	James River	--	Approximately 3,000 canoes and 500 kayaks rented annually
Caplinger Woods	No	Sac River	100 canoes and 7 kayaks	Normally all canoes are in the water every Saturday from Memorial Day weekend to Labor Day weekend
Lake Springfield Park, Boathouse and Marina	Yes	Lake Springfield	--	Approximately 3,000 watercrafts rented annually; total watercraft count could potentially range between 6,000 and 10,000 if personal watercraft is included

3.2 Recommended Methods

As noted above, existing recreational user data has been collected using a variety of methods, including automatic trail counters, visitor center door counters, boat rental sales, and direct surveys. The city and county can use the available data to estimate a lower bound for recreational use in the area. However, user data are not available for many of the Springfield–Greene County parks, state conservation areas, and stream access points. While rental information is available, data on the use of privately owned watercraft are not available. Additional data collection could provide a more accurate estimate of the overall water-related recreational use in the area.

Recreational use surveys can provide valuable information to local organizations, municipalities, and state agencies, especially for planning and future capital development projects. Methods for surveying recreational users include mechanical counting devices, direct observation, self-registration, and counting access permits. These

methods can be expanded to collect additional information beyond user counts, including useful data about where users are from, why they use the recreational area, and what they would like to have in a recreational area (e.g., playground, benches, and additional trails). The following sections review the available data collection methods.

3.2.1 Mechanical Trail Counters

Traffic counters are portable, battery-operated instruments that tally passing objects. They may be positioned to count use of roads, streams, or trails. Some trail counters can record specific time intervals (e.g., every hour) for over a year. Mechanical counters are most effective when combined with other tools to access an area's recreational use.

From 2009 to 2010, Ozark Greenways installed three mechanical trail counters on a rotating schedule. The counters were installed at three different locations along the same trail for a certain period of time and then moved to another trail segment. The three counters covered 68 miles of the greenway trail system. Volunteers also manually recorded counts at various trailheads throughout the year (T. Whaley, Ozark Greenways, personal communication to A. Orndorff, July 2015). Updated counts have not been conducted since 2010 for several reasons, including a lack of staff time and volunteers to place, relocate, and record the counter numbers. The counters' age, maintenance, and accuracy are also in decline. Finally, the cost for replacing the counters is not affordable.

Recreational areas that have a parking lot might use pneumatic road tube sensors to count the number of vehicles entering the park. Pneumatic road tube sensors send a burst of air pressure along a rubber tube when a vehicle's tires pass over the tube (USDOT 2014). The pressure pulse closes an air switch, producing an electrical signal that is transmitted to a counter or analysis software. Road tube sensors can be quickly installed and are usually low-cost and easy

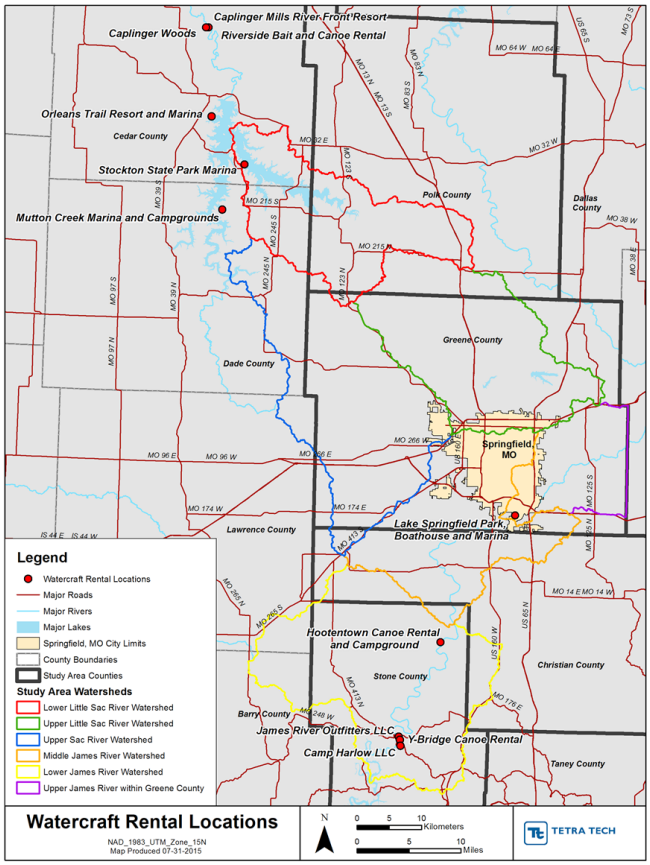

Figure 3. Watercraft rental locations.

to maintain. Since road tube sensors count the number of vehicles and not users, certain assumptions and averages must be made. If visitors mostly drive their personal vehicles, then assuming two people per car is reasonable. If visitors are frequently dropped off by bus, then assumptions should be increased accordingly.

3.2.2 Manual Trail Counts

Park staff or volunteers conduct manual trail counts through direct observation and record them on paper or an electronic device. The most accurate counts are obtained when enough staff are available to record counts throughout an entire day during the busy season. The labor hours required for this approach can be cost-prohibitive. Manual trail counts can be combined with other methods, as Ozark Greenways demonstrated, to obtain more accurate data while lowering costs.

3.2.3 Self-Registration

Self-registration consists of providing survey forms for the recreational user to voluntarily complete. Survey forms can be made available at information centers, ranger stations, trailheads, or designated entry points to a recreational area. These forms can either be filled out on site and deposited into a drop box or taken home and mailed back to the park or recreational organization. Maintaining a "sign-in" book on site would be a comparable alternative to the drop-box method. The mail-back method can be via a self-addressed stamped envelope or business reply mail.

Self-registration is a low-cost method because users voluntarily record their information. The labor needs consist of having someone monitor and refill the supply of survey forms and periodically empty the drop boxes. At least one staff or volunteer would need to collect the forms that were either sent in or collected in the drop box and record the information provided.

3.2.4 Counting Access Permits

Recreational activities such as boating, hunting, and fishing require a permit. Some parks may also require permits for hosting events at the park. Tracking and recording the number of permits sold each year can provide a rough estimate for the number of users in a park, and even a strong estimate for parks where the permitted activity is the main attraction. For example, MDC collects and reports the number of boat permits sold in its annual reports (Woods 2014). It has collected 17 years of data for Fellows Lake, which shows how annual permit sales have fluctuated as day passes have been introduced and permits have been categorized for motorized and non-motorized boats.

3.2.5 Summary and Recommendations

The selection of user data collection methods depends on the availability of funding and labor hours as well as the feasibility of installing automatic counters at a given location. Collaboration between the state, Ozark Greenways, Springfield–Greene County, and other entities may provide the best opportunity to collect additional data. A partnership could be formed and funding leveraged. Labor-intensive surveys could be conducted at several new locations to determine which sites have similar visitation. If funding can be identified, automatic counters could be installed at a few representative locations. Counts at these locations could be used to extrapolate visitor counts at similar locations. The extrapolated results could be validated periodically by direct surveys or through self-registration methods (e.g., drop box). For example, many stream access points could be surveyed on the same day, and these surveys would be repeated several times during a season. Representative low-, medium-, and high-volume sites could then be selected for automatic counters (either vehicle or trail counters depending on feasibility). Direct surveys could be conducted periodically at the stream access points to validate the automatic counter results.

4 VEHICLE COUNTS AT STREAM CROSSINGS


Scenic views from roadways.
City of Springfield, Department of Environmental Services

Scenic views of streams and lakes offer an aesthetic value to drivers, and traffic counts at these road crossings can help estimate how many people enjoy these views. The photographs above provide two examples of scenic stream crossings in the Springfield–Greene County area. Traffic count data, or vehicle volume, can often be obtained from a state's department of transportation, and some local governments may also collect additional traffic data.

4.1 Available Data

The EPA project team obtained vehicle volume data from the Missouri Department of Transportation's (MDOT's) website. MDOT determines the annual average daily traffic (AADT) by deploying pneumatic road tube sensors perpendicular to the roadway. These tubes count vehicles as they drive over particular roadway segments. Every three years, MDOT produces maps detailing the amount of traffic on Missouri's state highways.

MDOT's 2013 vehicle count map (MDOT 2013) was compared with a standard Google map of Greene County with roads and waterbodies. For each intersection where a road intersected a waterbody, it was reasonably determined through street view images if the average driver could view the waterbody and possibly obtain some aesthetic value from this view. These intersections were recorded and matched with the locations where the vehicle count data were obtained. Any intersection within 1 mile of where the vehicle count data were taken was considered a match.

Table 9 lists the available vehicle counts at stream crossings with a significant driver view in Greene County. The highest vehicle counts occurred at the U.S. Highway 60/James River (27,471 AADT) and U.S. Highway 65/Little Pomme de Terre River (12,062 AADT). Traffic volume was not available for 77 stream crossings (listed in Appendix E).

Table 9. MDOT traffic data at road-stream intersections with significant driver views	
Road/Stream Intersection	**2013 Annual Average Daily Traffic**
U.S. Hwy 60/James River	27,471
Farm Rd 164/Nolichucky River	988
State Hwy BB/Asher Creek	430
State Hwy H/Little Sac River	5,391
State Hwy E/Pomme de Terre River	1,194
U.S. Hwy 65/Little Pomme de Terre River	12,062
State Rd U/Sac River	508
U.S. Hwy 160/Sac River	1,892
State Hwy F/Sac River	690
U.S. Hwy 160/Clear Creek	2,933

4.2 Recommended Methods

Transportation departments often use statistical methods to extrapolate known vehicular data to road segments and intersections where data have not been collected. Recent methods include statistical analyses that incorporate spatial relationships (Eom et al. 2006), and such methods would likely provide a robust traffic volume estimate for Springfield road crossings without observed data. Springfield–Greene County and other communities could use more simplified approaches if a less robust order-of-magnitude estimate is desired.

The simplest approach would be to sort the road crossings with and without data into categories and calculate the average traffic volume for each road crossing category. Within each category, communities would then use these averages to estimate the traffic volume at each road crossing where observed data are not available. Categories for road crossings could be based on how the state or local government classifies roads. For example, MDOT uses the following major classes when reporting traffic volume data: interstate, U.S. routes, state routes, lettered routes, business routes and loops, and spur routes and alternate routes.

Estimates based on averages may need to be adjusted manually based on location and other knowledge of particular road crossings. For example, a spur road between two state roads where both state roads have less than 500 vehicles per day should also have less than 500 vehicles per day.

5 SUMMARY

The EPA project team explored available data on water users to illustrate the value of water resources in the Springfield–Greene County area. The data illustrate the magnitude of users across the region. Within the study area watersheds (Greene County and downstream of Springfield–Greene County), about 45 billion gallons of water are withdrawn from surface and groundwater sources each year (based on 2013 data). Among livestock populations downstream of urban areas, over 10,000 cattle depend on streams as a direct water supply. Trails, including many that follow or cross streams, draw thousands of visitors each week, resulting in over 200,000 individual visits each year. While limited data are available on boat use, watercraft rental in the region reflects at least 20,000 individual uses annually.

Methods outlined in this plan can provide additional estimates of recreational users, water use for livestock, and scenic views from road crossings. A combination of direct surveys, automatic counters, and extrapolation can be used to develop cost-effective, order-of-magnitude estimates of recreational visitors. When local data are not available, national-scale data can be combined with local knowledge of agricultural practices to estimate water use in rural areas, as demonstrated by methods outlined for cattle access to streams. Finally, average vehicle volumes at road crossings can be applied to similar road categories to provide an approximate estimate of scenic views experienced annually.

The breadth of water uses considered in this plan reflects the unique value of water to the Springfield–Greene County region. While other communities may find commonalities with Springfield–Greene County, identifying major water uses is an important part of the valuation process, and each community should assess their unique uses and why they are important. Through this evaluation, a community can find a useful tool for prioritizing projects and for illustrating the importance of protecting and improving water quality through the integrated planning process.

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APPENDIX A: HUC AGGREGATION FOR STUDY AREA WATERSHED

Table A-1. HUC-12 aggregation for study area subwatersheds

HUC-12	HUC-12 Name
Middle James River	
110100020301	Headwaters Wilson's Creek
110100020303	Wilson's Creek
110100020302	Terrell Creek
110100020305	Green Valley Creek-James River
110100020304	Ward Branch-James River
Lower James River	
110100020505	Lower Crane Creek
110100020503	Spring Creek
110100020506	Tory Creek-James River
110100020504	Middle Crane Creek
110100020501	Goff Creek
110100020502	Upper Crane Creek
110100020508	Pine Run-James River
110100020509	Wilson Run-James River
110100020507	Railey Creek
Upper Little Sac River	
102901060406	Asher Creek-Little Sac River
102901060403	North Dry Sac River
102901060404	Flint Hill Branch-Little Sac River
102901060402	Headwaters Little Sac River
102901060401	South Dry Sac River
Lower Little Sac River	
102901060503	Little Sac River
102901060502	Walnut Creek-Little Sac River
102901060501	Turkey Creek
102901060405	Slagle Creek

HUC-12	HUC-12 Name
Upper Sac River	
102901060503	Little Sac River
102901060502	Walnut Creek-Little Sac River
102901060501	Turkey Creek
102901060405	Slagle Creek
Upper Sac River	
102901060207	Cave Spring Branch-Sac River
102901060205	Clear Creek
102901060206	Dry Branch-Sac River
102901060204	Headwaters Clear Creek
102901060203	Sycamore Creek-Sac River
102901060202	Headwaters Sac River
102901060201	Pickerel Creek
Upper James River within Greene County	
110100020108	Lake Springfield-James River
110100020107	Turner Creek-James River
110100020106	Pearson Creek
110100020105	Sawyer Creek-James River (partial)

APPENDIX B: PERMITTED INDUSTRIAL DISCHARGERS

Table B-1. City of Springfield permitted industrial dischargers

Industry Name	Categorical Standard	Regulated Process	Treatment Y or N	Treatment Type	Regulated Flow (1000 gal/day)	Total Flow (1000 gal/day)	Last Inspection
ACRO Trailer Co.	433	Passivate/pickle	Y	Precipitation/ pH adjust	No discharge	1.1	12/12/14
American Products	433	Phosphatize/clean	Y	Precipitation	7.2	10.3	12/09/14
Ameripride Linen	N/A	Industrial laundry	Y	Precipitation/ filter	82.3	84.1	12/08/14
Aramark	N/A	Laundry	Y	Precipitation/ filter	87.1	88	12/30/14
BCP Ingredients, Inc.	414	Organic chemical	Y	Aeration/ settling	0.5	0.9	12/30/14
Black Oak Landfill	N/A	Leachate	N	Aeration	22.9	—	10/27/14
Central States Industrial	433	Passivation	Y	Evaporation/oil separation	0.3	1.3	12/15/14
Cintas Corporation	N/A	Industrial laundry	N	Screen/settle	50.5	52.8	11/14/14
City Utilities James R. Power	423	Electric generation	N		No Discharge	2	11/12/14
Culligan of Springfield	N/A	Water softener maintenance	Y	pH adjust	3.7	3.8	12/21/14
Custom Metalcraft, Inc.	433	Passivation	Y	pH adjust	0.4	0.7	11/14/14
Custom Powder Systems	433	Passivation	Y	pH adjust	0.15	0.95	12/18/14
Dairy Farmers of America	N/A	Dairy products	Y	pH adjust	474	474.1	12/23/14
Enterprise Laundry	N/A	Industrial laundry	Y	Lint trap/settle	57.8	58.7	12/03/14
Erickson Transport	442	Transportation	Y	Grease interceptor	1.1	1.4	12/03/14
Euticals	439	Pharmaceutical	Y	Air strip/pH adjust	23.1	24	12/29/14
Glanbia Nutritionals	439	Mixing	Y	Settle	0.721	.8	12/22/14
Hiland Dairy	N/A	Dairy products	Y	pH adjust	229	229	12/17/14
Holloway America	433	Electropolish	Y	Precipitation/ pH adjust	4.9	6.0	12/16/14
IsoNova Technologies	N/A	Animal feeds	Y	Aeration	5.6	5.8	12/11/14
John Twitty Energy Center	423	Electric generation	N		518.2	518.5	12/31/14
Kemin Industries	N/A	Animal feeds	Y	Aeration	0.2	0.2	12/11/14
Kraft Foods	N/A	Cheese/pasta	N	Grease interceptor/pH/ BOD red.	333.7	350.6	09/10/14
L & W Industries	433	Phosphatize	Y	Evaporation	No Discharge	0.8	12/18/14

Table B-1. City of Springfield permitted industrial dischargers

Industry Name	Categorical Standard	Regulated Process	Treatment Y or N	Treatment Type	Regulated Flow (1000 gal/day)	Total Flow (1000 gal/day)	Last Inspection
Loren Cook, Barnes Street	433	Phosphatize/clean	Y	pH adjust	6.7	11.6	11/18/14
Loren Cook, Dale Street	433	Phosphatize/clean	N	Sedimentation	21.3	23.7	11/18/14
Milky-Way Transport	442	Transportation	N	Grease interceptor	No discharge	9.9	12/23/14
3M Springfield	433	Coating	N		0.6	42.9	12/05/14
Multi-Craft Contractors	433	Passivation	Y	pH adjust	0.05	1.1	11/18/14
Nabors Landfill (closed)	N/A	Leachate	N		2.3	2.3	CLOSED
Northstar Battery Co., LLC	461	Pb battery manufacturing	Y	Precipitation/ filter	2.8	23.2	10/28/14
Northstar Battery Co., LLC—Plant #2	461	Pb battery manufacturing	Y	Precipitation/ filter	1.4	30.7	10/28/14
Ozarks Coca-Cola Bottlers	N/A	Soft drink	N	pH adjust	59.3	60.4	11/24/14
Paul Mueller Company	433	Passivation	Y	Precipitation	4.6	4.8	12/18/14
Positronic Industries	433	Metal plating	Y	Precipitation/ filter	11.4	12	12/23/14
PCI Acquisition, LLC/ Precision Coatings	466	Paint formulation	N		No discharge	1.6	12/11/14
French's Food Co./Reckitt Benckiser	N/A	Sauces	Y	pH adjust	148.6	153.6	12/04/14
Regal Corp./ RBC Mfg. Corp.	433	Phosphatize	Y	Precipitation/ filter	20.4	76.6	08/29/14
Springfield Branson National Airport	449	Aircraft de-icing	N		0.027	5.75	N/A
Springfield Remanufacturing Corp	433	Coating	N		No discharge	12.7	12/30/14
Springfield Sanitary Landfill	N/A	Leachate	N		22.7	22.8	12/16/14
Stainless Fabrication	433	Passivation	Y	Precipitation	1.4	3.9	12/18/14
ABEC/Stainless Technology	433	Passivation	Y	Precipitation/ filter	1.4	8.2	11/19/14
T-Haul Tank Lines	442	Transportation	Y	Grease interceptor	3.5	3.8	12/18/14
Unifirst	N/A	Industrial laundry	Y	Filter	33.5	34.7	12/17/14

APPENDIX C: NASS CROP AND LIVESTOCK STATISTICS

Table C-1. NASS agricultural census summary statistics for study area counties

	Polk County	Christian County	Greene County	Stone County
Farm Results				
Farms (number)	1,505	1,177	1,752	601
Land in farms (acres)	336,228	179,468	210,600	118,015
Average size of farm (acres)	223	152	120	196
Median size of farm (acres)	100	78	50	111
Total cropland (acres)	102,638	53,328	68,216	32,121
Harvested cropland (acres)	83,527	44,286	60,254	25,793
Irrigated land (acres)	1,347	64	316	134
Livestock and Poultry Results				
Cattle and calves inventory (number)	90,519	33,967	55,424	24,651
Beef cows (number)	39,962	15,440	27,041	11,125
Milk cows (number)	3,484	881	1,998	1,169
Cattle and calves sold (number)	52,800	19,311	30,953	12,796
Hogs and pigs inventory (number)	4,622	190	291	48
Hogs and pigs sold (number)	17,156	185	1,030	34
Sheep and lambs inventory (number)	1,203	1,429	356	315
Layers inventory (number)	6,926	1,964	3,204	1,092
Broilers and other meat-type chickens sold (number)	984	878	6,154	5,338,124
Pastured Land and Operations Results				
Ag land, cropland, pastured only (acres)	12,116	5,168	4,305	2,670
Ag land, cropland, pastured only (Number of Operations)	116	70	88	28
Ag land, pastureland (acres)	208,340	109,333	126,356	69,869
Ag land, pastureland (number of operations)	1,329	993	1,417	516

Table C-2. NASS pastureland statistics for study area counties

County	Data Item	Value
POLK	AG LAND, CROPLAND, PASTURED ONLY—ACRES	12,116
CHRISTIAN	AG LAND, CROPLAND, PASTURED ONLY—ACRES	5,168
GREENE	AG LAND, CROPLAND, PASTURED ONLY—ACRES	4,305
STONE	AG LAND, CROPLAND, PASTURED ONLY—ACRES	2,670
POLK	AG LAND, CROPLAND, PASTURED ONLY—NUMBER OF OPERATIONS	116
CHRISTIAN	AG LAND, CROPLAND, PASTURED ONLY—NUMBER OF OPERATIONS	70
GREENE	AG LAND, CROPLAND, PASTURED ONLY—NUMBER OF OPERATIONS	88
STONE	AG LAND, CROPLAND, PASTURED ONLY—NUMBER OF OPERATIONS	28
POLK	AG LAND, PASTURELAND—ACRES	208,340
CHRISTIAN	AG LAND, PASTURELAND—ACRES	109,333
GREENE	AG LAND, PASTURELAND—ACRES	126,356
STONE	AG LAND, PASTURELAND—ACRES	69,869
POLK	AG LAND, PASTURELAND—NUMBER OF OPERATIONS	1,329
CHRISTIAN	AG LAND, PASTURELAND—NUMBER OF OPERATIONS	993
GREENE	AG LAND, PASTURELAND—NUMBER OF OPERATIONS	1,417
STONE	AG LAND, PASTURELAND—NUMBER OF OPERATIONS	516

APPENDIX D: LIVESTOCK STREAM ACCESS METHODS

This appendix provides methods to estimate the area of grazed land with stream access. The project team used the study area watersheds downstream of the city of Springfield to test the application of these methods. Figure D-1 outlines the national data sets available for this analysis and suggests additional local data sets to use when applicable. Figure D-2 describes the GIS processing methods related to this analysis.

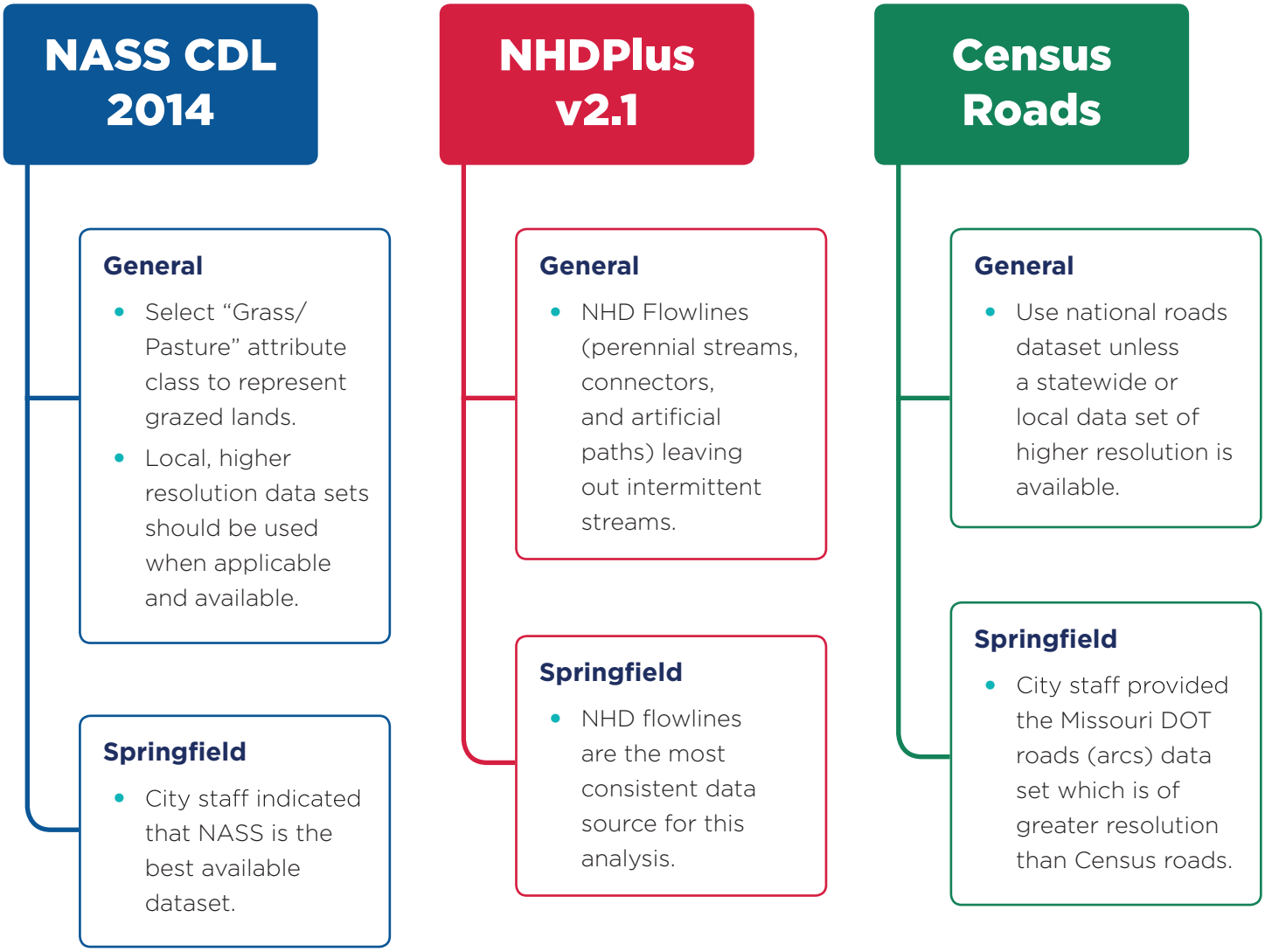
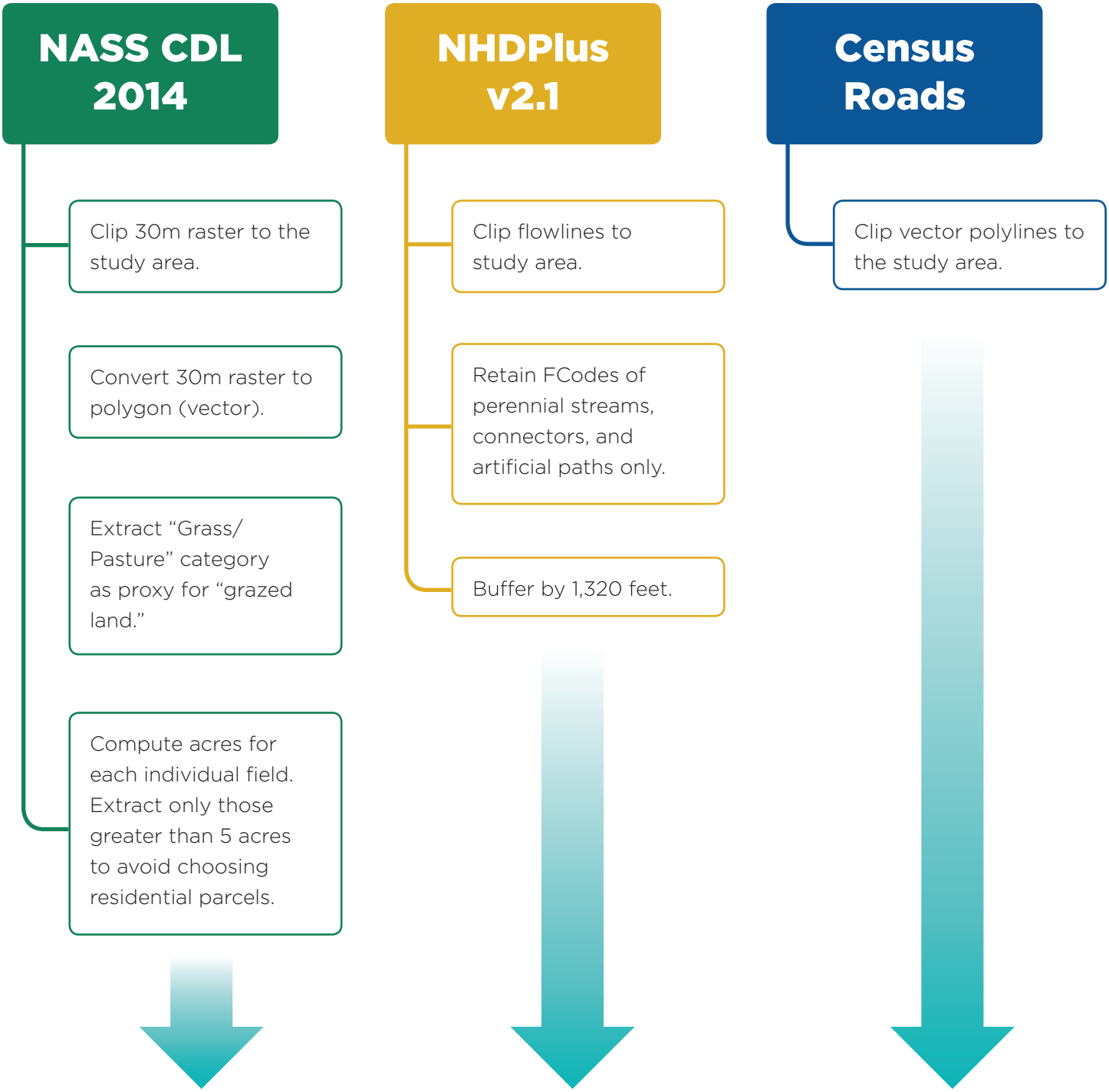


Figure D-1. Data sets of interest from national sources.



1. Use roads to split grass/pasture from NASS as necessary to create individual "fields" polygons (for Springfield area, NASS CDL already divided polygons by impervious land cover corresponding to roads).
2. Clip the resulting grazed land polygons by the streams buffer coverage. The result corresponds to the area of grazed land that has potential access to steams.

Figure D-2. Flow diagram of GIS methods and processes.

Based on a visual analysis of NASS, a 5-acre threshold avoided selection of most residential parcels, while the majority of pasture remained. Other communities could start with this threshold and adjust it based on a visual assessment of the data. Fields, for the purposes of this analysis, are defined as islands of grass/pasture from NASS that are made discontinuous by intersecting roads and streams.

The buffer width assumption was derived from local information provided by NRCS agents. The streams (NHD flowlines) were buffered by 1,320 feet, or a quarter of a mile, corresponding to how far cattle are likely to travel to a stream for water. This distance derived from knowledge of local conditions and cattle behavior and management (M. Green and S. Hefner, NRCS, personal communication to Alex Porteous, July 16, 2015). Other communities should consult with their local NRCS agents before using this assumption.

The EPA project team considered wells to further refine the analysis and inform which fields would have more residential plots and likely not have cattle visiting the stream. Most of the wells are coded as "domestic," which are just as likely to be out in a field somewhere as they are in a new, "rural" home backyard. They are also quite ubiquitous, and almost every field would have a well on it. Some wells may no longer be used, and others may be functional but only used when needed. Using the knowledge that livestock, particularly cattle, commonly have access to streams for watering purposes in the region, it was determined that it was unnecessary to use well locations to filter the results. Aerial imagery can be used to ground-truth and provide a sensitivity analysis to verify the results.

The methods require several assumptions that affect the certainty of the estimates. The buffer distance is assumed as an average distance, and livestock may travel farther to streams depending on individual management practices or field characteristics. In this instance, the grazed land would be underestimated.

The effect of exclusion fencing was assumed to be negligible for the purposes of the Springfield–Greene County analysis. Each community would need to review this assumption and determine whether the results need to be adjusted to account for exclusion fencing. Livestock stream access could be overestimated if significant exclusion fencing has been implemented.

Each local application of the above methods should evaluate the uncertainty of the estimates and document all major assumptions. Uncertainty in the land cover data is an additional consideration. Individual parcels may be classified by NASS as grazed land but could be used for another purpose. The use of broad animal-to-acre ratios from the agricultural census carries additional uncertainty. Animal densities on individual fields may vary, and animal densities within the buffer area may differ from densities countywide.

Figure D-3 depicts the analysis results, zoomed into the area west of Springfield. The map shows how the threshold of 5 acres of grazed land precludes most residential plots within the city limits. The map also includes satellite imagery because it is a useful way to ground-truth spatial results.

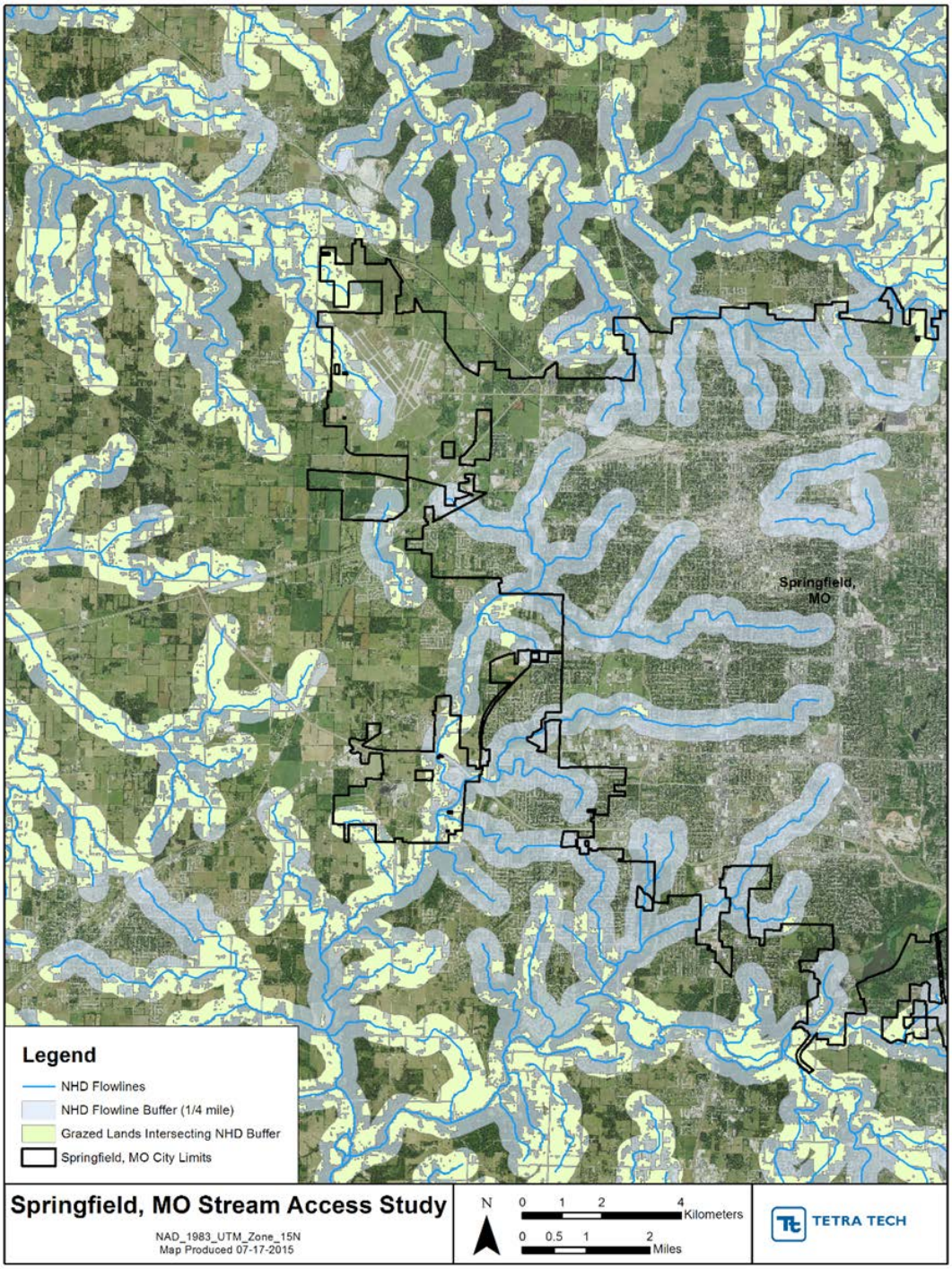


Figure D-3. Example map depicting the processed results.

APPENDIX E: ROAD-STREAM CROSSING DATA GAPS

MDOT traffic volume data were not available for the following road-stream crossings:

MO-413/James River

McCall Bridge Rd/James River

The Loop Rd (V-20)/James River (Hootentown Bridge)

State Highway M/James River

Big Bend Rd/Ficus Rd (N-18B)/James River

MO-14/James River

Nelson Mill Rd/James River

Blue Springs Rd/James River

Farm Rd 141/James River

MO-13/US Hwy 160/James River

Farm Rd 169/James River (Lake Springfield Dam)

US Hwy 65/Lake Springfield

E Farm Rd 148/James River

E State Hwy D/James River

MO-125/James River

E State Hwy Ad/Sayers Creek

S Farm Rd 241/Sayers Creek

E Farm Rd 150/Turner Creek

E Farm Rd 134/Broad Creek

E Buena Vista ln/Broad Creek

S Skyline Dr/Galloway Creek

E Avalon Dr/Galloway Creek

Farm Rd 193/Pierson Creek

Farm Rd 148/Pierson Creek

Farm Rd 199/Pierson Creek

Wilson Rd/Old Limey Rd/Wilson's Creek

Farm Rd 128/Pickerel Creek

Farm Rd 116/Sycamore Creek

Farm Rd 17/Sycamore Creek

Tour Rd/Wilson's Creek

Farm Rd 182/Wilson's Creek

Farm Rd 115/Wilson's Creek

Farm Rd 174/Wilson's Creek

State Hwy M/Wilson's Creek

Farm Rd 168/ Wilson's Creek

Farm Rd 146/ Wilson's Creek

W By-Pass/Wilson's Creek

Farm Rd 137/Wilson's Creek

Grant Ave/Wilson's Creek

Campbell Ave/Wilson's Creek

Farm Rd 115/Little Sac River

State Hwy BB/Little Sac River

Farm Rd 44/Little Sac River

Farm Rd 54/Little Sac River

State Hwy O/Little Sac River

Farm Rd 117/Little Sac River

County Rd 125/Little Sac River

Farm Rd 129/Little Sac River

Farm Rd 94/Spring Branch

Route 13/Little Sac River

Farm Rd 141/South Dry Sac River

County Rd 76/McDaniel Lake

Summit Street Rd/Little Sac River

Farm Rd 68/Little Sac River

Farm Rd 171/Little Sac River

Farm Rd 197/Fellows Lake
US Hwy 65/Little Sac River
Farm Rd 44/Pomme de Terre River
Farm Rd 225/Pomme de Terre River
Farm Rd 221/Pomme de Terre River
US Hwy 65/Pomme de Terre River
State Hwy CC/King Branch
State Hwy CC/Sims Branch
Farm Rd 20/Little Pomme de Terre River
State Hwy CC/Little Pomme de Terre River
MO-245/Sac River
Dade 122/Sac River
Farm Rd 34/Sac River
Farm Rd 44/Sac River
Farm Rd 68/Sac River
Farm Rd 74/Sac River
Farm Rd 84/Sac River
Lawrence 2007/Sac River
Lawrence 1247/Sac River
Farm Rd 17/Sac River
Farm Rd 35/Sac River
Farm Rd 128/Sac River