

WATER QUALITY AND USE

Little surface water quality data exists for the Spring River Tributaries Watershed. Much of the existing data is over 20 years old and thus is insufficient for drawing a present day conclusion. However, once contemporary data is obtained it may be possible to perform a limited comparison between present and past surface water quality.

The United States Geological Survey (USGS) periodically measured chemical and physical water quality conditions at two locations on the Warm Fork of the Spring River within the Spring River Tributaries Watershed in Missouri in the 1960s and early 1970s. Water quality data was collected at Station 07069150 at Thayer, Missouri in December of 1964. Several water quality measurements were also collected at Station 07069170 near Thayer, Missouri from 1969 to 1975 (Tables Wq01 and Wq02)(USGS 1999a). Station 07069170 experienced fecal coliform levels exceeding state standards for whole body contact recreation (200 col. per 100 ml) in 6 of 21 samples (MDNR 1996a and USGS 1999a).

Duchrow (1977) collected a total of 74 taxa of aquatic invertebrates from two sites on the Warm Fork of the Spring River during a water quality/aquatic invertebrate study. Site Swf-4 was located above Thayer and site Swf-0 was located below Thayer (Figure Bc03). Water quality was evaluated by comparing calculated species diversity index values to established standards for Missouri streams (Tables Wq03 and Wq04). Both sites exhibited similar invertebrate communities. Many pollution sensitive invertebrates were collected. Water quality parameter values at these did not meet established criteria for unpolluted Missouri streams annually; however, they did meet this criteria seasonally. According to Duchrow, the Warm Fork of the Spring River exhibited "characteristics of an unpolluted Missouri stream" despite the sources of pollution existing within the watershed. He adds that productivity within the stream appeared to be higher than that of the Jack's Fork and Current Rivers. This was probably due to the increased nutrient input from the large amount of pasture in the watershed as well as treated sewage effluent (Duchrow 1977).

Ground water quality has been documented to be less than desirable periodically in the watershed. Turbidity has been a problem for both municipal and private wells within the watershed (Vaughn 1998). Water quality tests performed by the Missouri State Public Health Laboratory in Springfield on 171 private wells in Howell County from July 1998 to August 1999 indicate that 70 well samples tested were unsafe. A well is considered unsafe if any Coliform exists in the sample (Farmer, personal communication).

Water Use

Water use within the Spring River Tributaries Watershed is relatively high. Data obtained from the United States Geological Survey National Water Use Database (1999b) indicate that total water withdrawn within the watershed in 1995 was 4.29 million gallons per day (mgd) (Table Wq05). This is more than the total amount of water withdrawn within the Eleven Point Watershed at 4.08 mgd. Reasons for this difference are undoubtedly due to the higher population density within the Spring River Tributaries Watershed.

Nearly all of the water withdrawn in the Spring River Tributaries Watershed comes from groundwater. Ground water withdrawn within the watershed is 3.85 million gallons per day (mgd) while surface water

withdrawn is 0.44 mgd (USGS 1999B). All surface water withdrawn is for livestock use.

Domestic water use is the most prevalent use within the Spring River Tributaries Watershed. Domestic deliveries from public water supplies in 1995 equaled 1.02 million gallons per day. Self-supplied water withdrawn in 1995 equaled 0.82 million gallons per day (Table Wq07)(USGS 1999b).

The Missouri Department of Natural Resources maintains records of "major" users (those facilities capable of withdrawing 100,000 gallons/day) of surface and ground water throughout the state. Recent records (1993) indicate that although there are no major surface water users, three major ground water users exist within the Spring River Tributaries Watershed. The major ground water users include the cities of West Plains and Thayer as well as Richards R-V School District. Annual water withdrawals (million gallons/year) for West Plains, Thayer, and Richards R-V School District are 716, 522, and 165 respectively (MDNR 1993).

The amount of water withdrawn in the watershed is likely to continue to rise in the upper portion of the watershed with a projected increase in the population of Howell County. Projections of population increase of Missouri counties have been calculated by the Missouri Office of Administration (MOA), Division of Budget and Planning for three different projection scenarios in a report entitled "Projections of the Population of Missouri Counties By Age, Gender, and Race: 1990 to 2020" (<http://www.oa.state.mo.us/bp/popproj/index.htm>)(MOA 1994). The combined population for Howell and Oregon Counties is expected to increase 6% to 27% by the year 2020.

Rule 10 CSR 20-7.031 of the Rules of Department of Natural Resources Division 20-Clean Water Commission Chapter 7-Water Quality identifies beneficial uses of the waters of the state of Missouri in order that water quality standards are established for protection of those uses. Table Wq06 lists designated uses for streams of the Spring River Tributaries Watershed. Beneficial use designations have been determined for 13 reaches representing 10 streams within the Spring River Tributaries Watershed. All listed streams must meet criteria for "protection of warm water aquatic life and human health-fish consumption" as well as "livestock and wildlife watering". The Warm Fork of the Spring River, in addition to the previously mentioned uses, must also meet water quality standards for irrigation, whole body contact recreation, and boating/canoeing from the State Line to Section 25, Township 23 North, Range 6 West (MDNR 1996a).

Section 303d of the federal Clean Water Law requires that states identify those waters for which current pollution control measures are inadequate. This is accomplished by comparing data from those waters with water quality criteria established for designated beneficial uses of those waters (MDNR 1999b). Those waters are then included in the 303(d) list. The state must then conduct Total Maximum Daily Load (TMDL) studies on those waters in order to determine what pollution control measures are required and then insure those measures are implemented (MDNR 1999a). The Final 1998 303(d) list for Missouri includes 0.3 miles of Howell Creek (MDNR 1999c). The pollutant at this site is chlorine associated with the West Plains waste water treatment plant. The Clean Water Act requires that the list be updated every 2 years thus the next 303(d) list should be available in the year 2000 (MDNR 1999b).

Point Source Pollution/Nonpoint Source Pollution

Table Wq07 lists the eleven National Pollution Discharge Elimination System (NPDES) sites currently within the Spring River Tributaries Watershed (Figure Wq01). The cities of West Plains and Thayer, Missouri are the only permitted (by MDNR) municipal wastewater discharges within the watershed in

Missouri(MDNR 1998a). As of 1994, the Thayer waste water treatment facility (WWTF) was discharging 0.23 million gallons per day (mgd) into the Warm Fork. The West Plains WWTF, located on Howell Creek, was the largest NPDES discharge within the watershed. As of 1994 the West Plains WWTF was discharging 1.7 mgd; normally accounting for the entire flow of Howell Creek at this point of the stream. It was determined that water quality problems were caused by this discharge for 1 to 2 miles of stream (MDNR 1994). Howell Creek is a losing stream for its entire reach (MDNR 1984). For this reason, the potential for groundwater contamination is always present. This is perhaps best illustrated by an incident that occurred in 1978: The bottom of the West Plains sewage lagoon collapsed into a sinkhole releasing a large amount of sewage into the groundwater system. A dye trace indicated that this sewage was transported through the system to Mammoth Spring, Arkansas; a distance of 20 miles, in 12 days (MDNR 1984).

The Missouri Department of Natural Resources, Division of Geology and Land Survey has identified 10 active and 122 prospecting or historical mining operations within the Spring River Tributaries Watershed in Missouri. Of the 10 active mines, all are gravel pits or limestone quarries (MDNR 1998b). There are currently no permitted in-stream gravel operations within the watershed (Zeaman, personal communication). However, it is highly likely that unpermitted sites exist within the watershed. The majority of historical mining sites are past producers of iron. Nearly all of these are surface mines which dot the watershed (MDNR 1998). Due to the karst nature of the watershed, these surface mines have the potential to allow pollutants into the ground water system.

Land disruption from road and bridge construction, as well as urban expansion, often results in increased sediment loads to receiving water systems. Bridge construction also results in stream channel modification, which affects stream flow both up and down stream from the bridge. Since 1995 there have been fourteen 404 permitted operations within the Spring River Tributaries Watershed in Missouri (Table Hc01 and Figure Wq02)(USCOE 1999). Seven of these involved bridge work. According to the Missouri Department of Transportation Highway and Bridge Construction Schedule http://www.modot.state.mo.us/accountability/stip/South_Central_Area.htm , there currently (11/6/98) are 2 state highway projects involving bridge work scheduled within the watershed from 1999-2003 (Table Hc02).

Currently (1999) significant land disruption corresponding to highway construction and urban expansion is occurring in the upper portion of the Spring River Tributaries Watershed. Much of this land has been left devoid of vegetation for extended periods of time thus increasing it's susceptibility to erosion. While little permanent surface water exists in this portion of the watershed, the increased sediment load may eventually alter the ability of intermittent streams to carry off excess water during periods of flooding. In addition, due to the number of losing stream miles in this portion of the watershed, some sediments as well as incidental pollutants from construction sites could potentially reach groundwater. As stated previously, ground water quality problems have been experienced within the watershed.

According to MDNR (1984), livestock waste constitutes a major percentage of the Spring River Tributaries Watershed's total organic waste. This contributes to the Biological Oxygen Demand (BOD), suspended solids, fecal coliform, and fecal streptococci loads (MDNR 1984). The number of cattle and hogs within the watershed has been estimated to be 52,599 in 1993. This has been calculated based on numbers by county, as indicated by 1994 Missouri Farm Facts (MDA and USDA 1994), multiplied by percent of total county area occupied by the watershed . As in other parts of the state, a large number of cattle in the watershed are on pasture and many spend a large portion of their time in or near stream

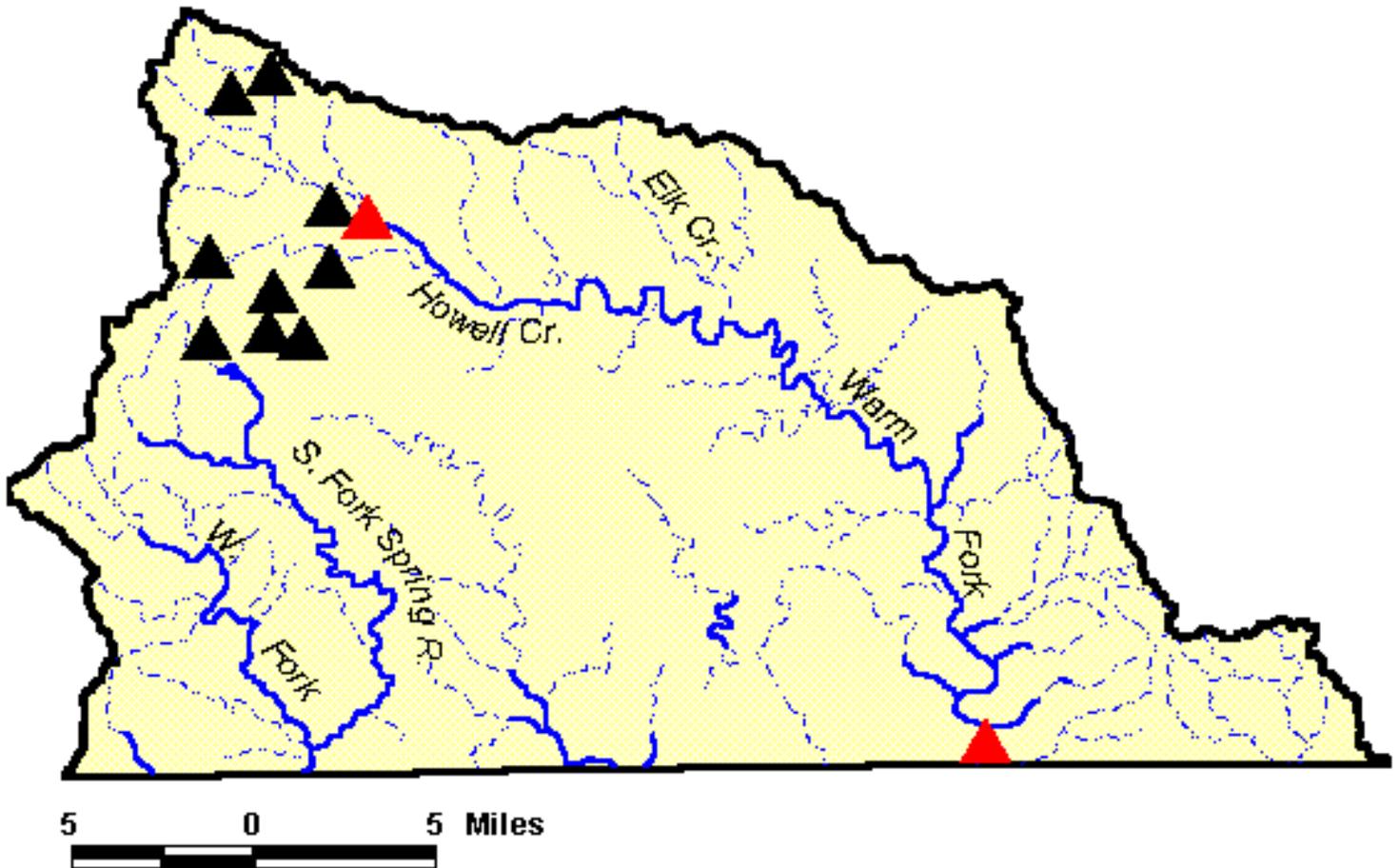
channels. Results of this include increased organics and bacterial loading, turbidity, and high concentrations of algae (MDNR 1984). Another possible impact occurs when "no discharge" lagoons or pits serving confined lots discharge to streams. In 1984, there were 15 of these facilities which generated 27,024 PE of waste in the Spring River Tributaries Watershed (MDNR 1984).

Fish Kills

Since 1980 no fish kills have occurred as a result of pollution incidents within the Spring River Tributaries Watershed (MDC 1999). In December of 1997 a lack of stream flow as well as the icing of the stagnant pools is believed to have contributed to low dissolved oxygen levels resulting in a fish kill on the Warm Fork near Warm Fork Spring (Mayers, Personal Communication).

Figure Wq01.

Spring River Tributaries Watershed National Pollution Discharge Elimination System (NPDES) Sites 1998



Legend

NPDES Sites 1998

- ▲ Municipal Waste Water Facility
- ▲ Other

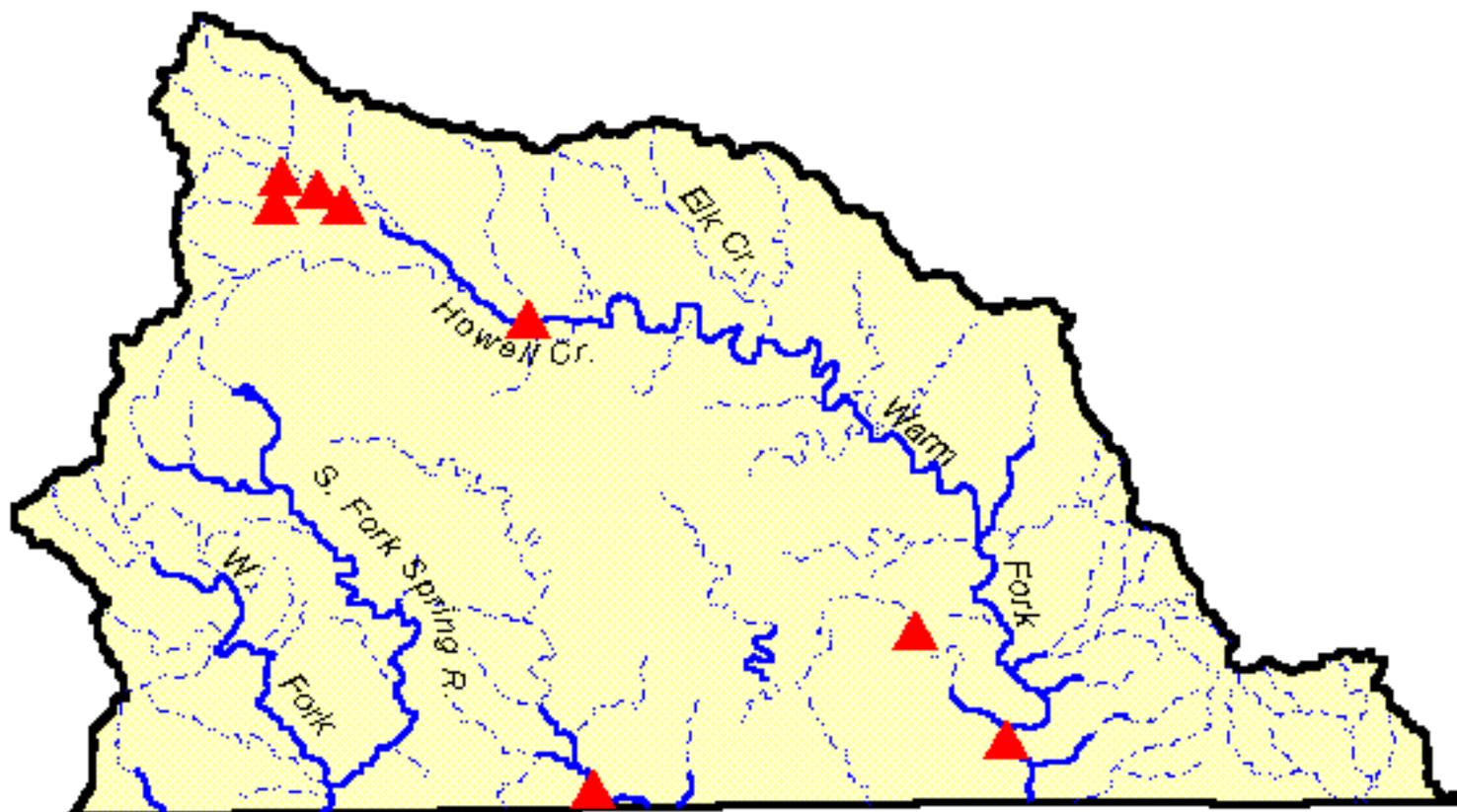


MDC 3/1999

Figure Wq02.

Spring River Tributaries Watershed

404 Sites



5 0 5 Miles



Legend

▲ 404 Site (USCOE 1999)

Note: One marker may represent more than one permit record.

MDC 3/1999

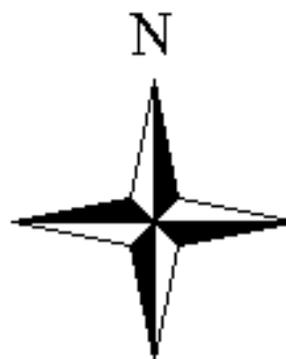


Table Wq01. Water quality measurements for the Warm Fork of the Spring River at Thayer for January and December 1964 (USGS 1999a).

Discharge (cfs)	9.3
Color (Platinum -Cobalt units)	2
Specific conductance (US/CM)	424
pH water whole field (standard units)	8
Carbon Dioxide dissolved (mg/l as CO₂)	4.5
ANC water unfiltered fet field (mg/l as HCO₃)	280
ANC unfiltered carbon fet field (mg/l as CO₃)	0
Hardness total (mg/l as CaCO₃)	240
Hardness non Ca WH WA total fl (mg/la CaCO₃)	4
Calcium dissolved (mg/l as Ca)	50
Magnesium dissolved (mg/l as Mg)	27
Sodium dissolved (mg/l as Na)	1
Sodium adsorbtion ratio	0
Sodium percent	1
Potassium dissolved (mg/l as K)	1.3
Chloride dissoloved (mg/l as Cl)	1.1
Sulfate dissolved (mg/l as SO₄)	4.2
Flouride dissolved (mg/l as F)	0
Silica dissloved (mg/l as SiO₂)	7.5
Solids, Manganese dissolved (ug/l as Mn)	0
Solids, residue at 180 deg. C dissolved (mg/l)	213

Sum of constituents dissolved (mg/l)	232
Solids, dissolved (tons per day)	5.35
Nitro-Solids, dissolved (tons per acre feet)	0.29
General nitrate dissolved (mg/l as NO₃)	0.8
Iron (ug/l as Fe)	20

Table Wq02. Water quality measurements for the Warm Fork of the Spring River below Thayer for January and July of 1970 and 1972 (USGS 1999a).

	1/70	1/72	7/70	7/72
Temperature water (deg. C)	5.5	8.5	24.5	26
pH Water Whole Field (standard units)	8.1	8.1	8.3	7.9
Specific conductance (US/CM)	438	370	424	440
Oxygen dissolved (mg/l)	13.2	8.2	6.8	6
Oxygen dissolved (percent saturation)	105	70	81	73
Coliform, total immed. (cols. per 100 ml)	18			
Coliform, fecal, 0.45 um-mf (cols./100 ml)		24	75	990
ANC water unfiltered fet field (mg/l as CaCO3)	261	223	242	249
ANC water unfiltered fet field (mg/l as HCO3)	320	270	300	300
ANC unfiltered carbon fet field (mg/l as CO3)	0	0	0	0
Carbon Dioxide dissolved (mg/l as CO2)	4	3.4	2.4	6..1
Nitrogen, Ammonia dissolved (mg/l as N)	0.05		0	
Nitrogen, organic total (mg/l as N)	0.09	0.01	0.21	0.04
Nitrogen, Nitrate total (mg/l as N)		0.9		0.36
Nitrogen, Ammonia total (mg/l as N)		0		0.04
Phosphate, ortho, dissolved (mg/l as PO4)			0.04	
Phosphorus total (mg/l as P)	0.24	0.02		0.15
Phosphorus dissolved (mg/l as P)	0.04	0.01		0.14
Hardness total (mg/l as CaCO3)	260	230	240	250
Calcium dissolved (mg/l as Ca)	52	46	50	57
Magnesium dissolved (mg/l as Mg)	32	27	28	26

Sodium dissolved (mg/l as Na)	2.7	1.8	1.6	2.7
Sodium adsorption ratio	0.1	0.1	0	0.1
Sodium percent	2	2	1	2
Potassium dissolved (mg/l as K)	1.4	1.5	1.4	1.8
Chloride dissolved (mg/l as Cl)	1.9	2.1	1.4	3.2
Sulfate dissolved (mg/l as SO4)	4.8	7	3.8	3.2
Fluoride dissolved (mg/l as F)	0.1	0	0.1	0.6
Silica dissolved (mg/l as SiO2)	3.8	6.4	8.2	10
Iron, dissolved (ug/l as Fe)	4	0	90	0
Manganese, dissolved (ug/l as Mn)	15	50	10	10
Methylene Blue active substance mg/l	0.02		0.03	0.03
Solids, residu at 180 deg. Dissolved (mg/l)	245		231	263
Solids, sum of constituents dissolved (mg/l)	257		244	256
Nitrogen, Ammonia dissolved (mg/l as NH4)	0.06		0	
Nitrogen, Ammonia total (mg/l as NH4)				0.05
Nitrogen, Nitrate dissolved (mg/l as NO3)	0.08		2.6	
Hardness noncarb WH WA tot Fl mg/l as CaCO3	0		0	0
Streptococci Fecal, (cols. per 100 ml)	16	120	320	1600

Table Wq03. Summary of Duchrow's 1977 annual water quality parameter values for stations within the Spring River Tributaries Watershed, Missouri.

Location	¹ Species Diversity Index Value	Number of Mayfly and Stonefly Taxa
Swf-0 (Warm Fork below Thayer, Missouri)	6.4	23
Swf-4 (Warm Fork above Thayer, Missouri)	6.0	22

¹Species Diversity Index Value = $D = (s-1)/(\log_e N)$; where "s" equals the number of taxa and "N" is the total number of organisms in the sample.

Table Wq04. Water quality designations based on invertebrate insect population data for Missouri streams as used by Duchrow (1977).

	Seasonal		Annual		
Water Quality Designation	Species Diversity Index Value ¹	# of Mayfly & Stonefly Taxa	Species Diversity Index Value ¹	# of Mayfly & Stonefly Taxa	Total Taxa
Unpolluted	>3.9	>9	>6.9	>21	>56
Moderately Polluted	2.2-3.9	5-9	3.8-6.9	10-21	31-56
Polluted	<2.2	<5	<3.8	<10	<31

¹Species Diversity Index Value= $D = (s-1)/(\log_e N)$; where "s" equals the number of taxa and "N" is the total number of organisms in the sample.

Table Wq05. Water use within the Spring River Tributaries Watershed in Missouri (1995) based on withdrawals in millions of gallons per day (USGS 1999b).

Use	Ground Water	Surface Water	Total
Public Supply (Total)	2.78	0	2.78
Domestic (delivered)			1.02
Commercial (delivered)			0.21
Industrial (delivered)			0.17
Self Supplied (Total)	1.07	0.44	1.51
Domestic	0.82	0	0.82
Commercial	0.06	0	0.06
Livestock	0.15	0.44	0.59
Irrigation	0.04	0	0.04
Total	3.85	0.44	4.29

Table Wq06. Missouri Department of Natural Resources use designations for selected streams within the Spring River Tributaries Watershed, Missouri (MDNR 1996a). Locations are given in section, township, range format.

Stream Name	Miles	From	To	Designated Use*
Anthony Br.	0.5	Mouth	06,22n,05w	lww,aql
Elkhorn Br.	1.5	Mouth	05,21n,08w	lww,aql
English Cr.	2.5	State Line	33,22n,06w	lww,aql
Howell Cr.	14.0	08,23n,06w	22,24n,08w	lww,aql
Trib. to Howell Cr.	1.0	Mouth	12,23n,07w	lww,aql
Myatt Cr.	11.5	State Line	05,22n,07w	lww,aql
S.F. Spring R.	4.0	State Line	35,22n,08w	lww,aql
S.F. Spring R.	11.0	35,22n,08w	32,23n,08w	lww,aql
Trib. to S.F. Spring R.	1.0	Mouth	34,22n,08w	lww,aql
W.F. Spring R.	2.5	Mouth	31,22n,08w	lww,aql
W.F. Spring R.	9.5	31,22n,08w	10,22n,09w	lww,aql
Warm Fork Spring R.	12.0	State Line	25,23n,06w	irr,lww,aql,wbc,btg
Warm Fork Spring R.	10.0	25,23n,06w	08,23n,06w	lww,aql

Note: This table is not presented as a final authority.

***irr-irrigation**

clf-cool water fishery

lww-livestock & wildlife watering

cdf-cold water fishery

aql-protection of warm water aquatic life

wbc-whole body contact recreation and human health-fish consumption.

btg-boating & canoeing

dws-drinking water supply ind-industrial

Table Wq07. National Pollution Discharge Elimination System (NPDES) permit sites within the Spring River Tributaries Watershed in Missouri (MDNR 1998a).

Facility Name	Receiving Stream	Facility Type	County
Doss & Harper	Trib. Howell Creek	Lime Quarry	Howell
Glenwood R-VIII School	Trib. Mustion Creek	School	Howell
Henry's Mhp	Trib. Spring Creek	Mobile Home Park	Howell
MFA Oil	Trib. Howell Creek	Petroleum Storage	Howell
Moark Quarries	Trib. Mustion Creek	Sand Washing	Howell
Moark Quarries	Trib. Mustion Creek	Lime Quarry	Howell
S&S Quarry	Trib. Mustion Creek	Quarry	Howell
Thayer WWTF	Warm Fork	City Waste Water Plant	Oregon
Von Allmen Mobile Estates	Mustion Creek	Mobile Home Park	Howell
West Plains Landfill	Trib. Howell Creek	Landfill	Howell
West Plains WWTF	Howell Creek	City Waste Water Plant	Howell

Note: This table is not a final authority. Data subject to change.