WATER QUALITY AND USE

Beneficial Use Attainment

The MDNR maintains a list of beneficial uses for classified streams of Missouri. Beneficial uses and classifications of streams within the Niangua Watershed are shown in Table 14. Aquatic life protection, fishing, and livestock and wildlife watering are designated beneficial uses of all classified streams within the watershed. LOZ, Lake Niangua, and most of the NR and LNR are also classified for whole body contact recreation and boating. Three segments within the watershed are designated cold-water fisheries. These include 6.0 miles of the NR, 2.0 miles of Bennett Spring Branch, and 1.5 miles of Mill Creek. Many streams are designated for cool-water fishing. A portion of LNR is classified as an "Outstanding State Resource" which is conferred upon "high quality waters that may require exceptionally stringent water quality management requirements to assure conformance with the antidegradation policy" (MoCSR, 1991). According to the Missouri Water Quality Watershed Plan all stream uses were being maintained in 1984 with the possible exception of aquatic life protection in a two mile section of the NR below the Marshfield Sewage Treatment Plant (MDNR, 1984).

A study of the Grand Glaize Arm of LOZ in the early 1980s revealed high levels of fecal coliform bacteria in residentially developed coves (Mitzelfelt, 1985). The high levels were attributed to septic systems and other individual onsite systems; point sources including small treatment systems and municipal treatment plants; and occasional pleasure boat discharges of untreated sewage. Many of the samples exceeded the state standards for whole body contact recreation of 200 colonies per 100 ml. Samples from highly developed coves exceeded the standards on two-thirds of the sampling dates in both years of the study. Samples in moderately developed coves occasionally exceeded the standards and those in undeveloped and slightly developed coves did not exceed the standards. Bacteria levels correlated with tourist traffic on major roads and peaked during, or on the day after, holidays. This study was followed by one in 1984 by the Lake of the Ozarks Council of Governments and one in 1990 by the MDH and MDNR (MDNR, 1996). Although higher levels of bacteria were detected in developed coves than in less-developed coves, the state bacteria standards for whole body contact were not exceeded in any coves. The MDC and MDH are currently conducting a similar, multi-year study. Jones and Kaiser (1988) reported that nutrients, algae, and turbidity were all greater in the Niangua Arm than in the Grand Glaize or Gravois arms, which they attributed to higher numbers of domestic wastewater discharges.

Recently enacted legislation that allows for creation of special zones for planning and zoning ordinances may help reduce these problems. A temporary committee was appointed by the Camden County Commission in July 1996 to study this option and recommend boundaries for a "lake zone", an area around the lake with special zoning regulations, which will eventually need to be approved by public vote.

Water quality in Lake Niangua, and in the NR immediately upstream and downstream from the lake, was well within the requirements for protection of aquatic life in all eight of the ESE samples obtained during 1989 and 1990, and was comparable to the water quality in other Ozark streams (ESE, 1990). Fecal coliform concentrations exceeded 200 colonies/100 ml, the Missouri Water Quality Standard for

Table 14. Water quality classification and beneficial uses of classified streams and lakes within the Niangua Watershed.

Stream	Class	Start	End	Length	County	Beneficial Use
AB Creek	C	Mouth	32,37N,18W	3.0	Dallas_Camden	W,L
Bank Branch	C	Mouth	35,37N,17W	5.0	Camden	W,L,F
Bannister Hollow	C	Mouth	36,38N,19W	4.0	Camden	W,L,C
Bennett Spring Branch	P	Mouth	Bennett Spring	2.0	Laclede	W,L,F,C
Benton Branch	P	Mouth	11,34N,19W	0.5	Dallas	W,L
Benton Branch	C	11,34N,19W	11,34N,19W	1.0	Dallas	W,L
Broadus Branch	C	Mouth	15,37N,18W	1.5	Camden	W,L
Cahoochie Creek	C	Mouth	9,36N,20W	4.0	Dallas	W,L
Cat Hollow	C	Mouth	33,35N,18W	2.0	Dallas	W,L
Cave Creek	C	Mouth	14,34N,18W	3.0	Dallas	W,L
Coatney Creek	P	Mouth	15,36N,19W	2.0	Dallas	W,L
Dousinbury Creek	P	Mouth	17,33N,18W	3.5	Dallas	W,L
Dousinbury Creek	C	17,33N,18W	15,33N,18W	2.0	Dallas	W,L
Durington Creek	C	Mouth	06,34N,19W	4.0	Dallas	W,L
E. Fork Niangua River	C	33,32N,18W	25,31N,18W	6.0	Webster	W,L,R

Fiery Fork	C	Mouth	36,39N,19W	2.0	Camden	W,L
Fourmile Creek	C	Mouth	29,34N,18W	5.0	Dallas	W,L
Goose Creek	C	Mouth	15,32N,18W	3.0	Dallas	W,L
Gower Branch	C	Mouth	09,32N,19W	2.0	Dallas	W,L
Greasy Creek	P	Mouth	31,34N,19W	4.0	Dallas	W,L,F
Greasy Creek	C	31,34N,19W	11,32N,20W	10.5	Dallas	W,L,F
Greer Creek	C	Mouth	25,32N,19W	3.0	Webster	W,L
Halsey Hollow	C	Mouth	2,35N,18W	2.0	Dallas	W,L
Jakes Creek	C	Mouth	24,35N,19W	10.0	Dallas	W,L
Jarvis Hollow	C	Mouth	23,38N,17W	1.5	Camden	W,L
Jerktail Branch	C	Mouth	11,34N,19W	0.5	Dallas	W,L
Jones Branch	C	Mouth	32,33N,19W	3.0	Dallas	W,L
Judge Creek	C	Mouth	19,36N,19W	3.0	Dallas	W,L
Kolb Branch	C	Mouth	2,38N,19W	2.0	Camden	W,L
Little Niangua River	P	Mouth	26,36N,19W	43.0	Camden_Dallas	W,L,R,B,O
Little Niangua River	C	26,36N,19W	20,35N,19W	7.0	Dallas	W,L,R,B,O
Long Branch	C	Mouth	33,37N,19W	3.0	Camden	W,L
Macks Creek	P	Mouth	Hwy. 54	8.0	Camden	W,L
Macks Creek	C	Hwy. 54	23,37N,19W	2.5	Camden	W,L

Mill Creek	P	Mouth	9,36N,18W	1.5	Dallas	W,L,C,R
Mill Creek	P	9,36N,18W	8,36N,18W	1.5	Dallas	W,L
Mountain Creek	P	Mouth	23,35N,17W	6.0	Laclede	W,L
Niangua River	P	Mouth	Power Plant	5.0	Camden	W,L,R,B
Niangua River	C	Power Plant	Tunnel Dam	6.0	Camden	W,L,R,B
Niangua River	P	Dallas County Line	11,35N,18W	24.0	Dallas	W,L,R,B,F
Niangua River	P	11,35N,18W	Bennett Spring Branch	6.0	Dallas	W,L,R,B,F,C
Niangua River	P	Bennett Spring Branch	33,32N,18W	51.0	Dallas-Webster	W,L,R,B,F
Lake Niangua	L3	35,37N,18W		360 Ac	Camden	W,L,R,B
Lake Of The Ozarks	L2	SE 19,40N,15W		59520 Ac	Camden	W,L,R,B
Prairie Hollow	P	Mouth	04,37N,18W	7.0	Camden	W,L
Sarah Branch	C	Mouth	01,32N,18W	3.0	Webster	W,L
Spencer Creek	C	Mouth	14,37N,17W	2.0	Camden	W,L
Spring Hollow	C	Bennett Sprg	27,34N,17W	10.0	Laclede	W,L
Starvey Creek	C	Mouth	15,32N,18W	3.0	Dallas	W,L
Sweet Hollow	C	Mouth	27,36N,17W	3.0	Laclede	W,L
Thomas Creek	C	Mouth	3,35N,20W	7.0	Hickory_Dallas	W,L

Trib W. Fork. Niangua R.	P	Mouth	19,31N,18W	1.5	Webster	W,L
Trib Mill Creek	C	Mouth	14,37N,15W	1.5	Camden	W,L
Trib Greasy Creek	C	Mouth	33,33N,20W	1.0	Dallas	W,L
Trib Lake Niangua	C	Mouth	19,37N,17W	1.0	Camden	W,L
Trib Macks Creek	C	Mouth	6,37N,18W	1.0	Camden	W,L
Trib Niangua River	C	Mouth	17,37N,17W	1.0	Camden	W,L
Trib Thomas Creek	C	Mouth	26,36N,20W	0.5	Dallas	W,L
Tunas Branch	C	Mouth	33,36N,19W	3.0	Dallas	W,L
W. Fork Niangua River	P	33,32N,18W	33,31N,18W	7.0	Webster	W,L
Woolsey Creek	C	Mouth	5,36N,17W	4.0	Camden_Laclede	W,L,R,B

Class:

C - Streams which may cease flow in dry periods but maintain permanent pools which support aquatic life.
P - Streams that maintain permanent flow even in drought periods.
L2 - Major reservoirs.
L3 - Other lakes.

Beneficial Use:

I - irrigation of cropland.
W - watering for livestock and wildlife.
L - protection of aquatic life.
C - cold-water fishery.
R - whole-body-contact recreation.
B - boating and canoeing with limited body contact.
D - drinking water supply.
P - industrial processing or cooling water.
O - Outstanding state resource.
F - cool-water fishing.

recreational use, in four samples (ESE, 1990). One of these instances occurred in Lake Niangua, one in the bypass reach, and two in the NR downstream from the powerhouse discharge. These violations all occurred in samples taken after heavy rainfall in August 1989 and June 1990. Similar violations were recorded occasionally in the UNAWP sampling (1994-1995) after rainfall events (Smale et al., 1995).

Chemical Quality of Stream Flow

The most thorough water quality monitoring in the watershed was completed in the Upper Niangua Subwatershed for the UNAWP between 1991 and 1995. A summary of the data for select parameters is shown in Appendix E. Based on the accumulated data, water quality in the upper Niangua was described as average (Smale et al., 1995). The data did not indicate consistently high levels of nutrients or pathogens at any of the 20 sites monitored. There were, however, high levels of nitrates, phosphates, and fecal bacteria and fecal viruses detected during high flow events. This pattern is typical of Ozark streams where the main source of contaminants are non-point sources such as agricultural and storm water runoff. It is likely that aquatic plants utilize abundant nutrients during these events to increase growth and the excess nutrients are flushed downstream rapidly. This could result in excessive algae growth even though high levels of nutrients are not detected during normal flows. The average nitrate levels were relatively high at the Bennett Spring station (G002) and at Jake George Springs (G019). However, higher levels are typically measured at springs (Smale et al., 1995).

Select water quality criteria from the Missouri Code of State Regulations (MoCSR, 1995) are exhibited in Table 15. Only common pollutants are listed and the criteria for metals are those for chronic levels that apply to general warm-water fisheries (GWWF). For some metals more stringent criteria apply to cool- or cold-water fisheries and less stringent values may apply for acute levels.

Stream Teams and Water Quality Monitors

Trained volunteers have assisted in the protection of streams throughout the state. The Stream Team program was initiated in 1989 by three sponsors, the MDC, the MDNR, and the CFM. Over 1700 volunteers in Missouri have completed water quality monitoring classes offered by the program. Twenty-seven Stream Teams and Volunteer Water Quality Monitors have been active in the Niangua Watershed (Table 15). Projects have included litter clean-up, water chemistry and macroinvertebrate sampling, tree planting for bank stabilization, stream inventories, and educational exhibits. Figure 12.5 shows locations where Stream Teams have reported activities. A total of 141 activities have been reported. Six additional Stream Teams (#s 161, 231, 267, 377, 423, 670) have formed within the watershed, but not reported activities. Fifteen monitors have submitted water quality monitoring data, many from multiple sites on many occasions. Thirteen teams have conducted litter pickups, the second most popular activity statewide. The Stream Team Program also supplies thousands of litter bags to canoe and boat liveries in the watershed which they provide to renters for their trash.

Volunteer data are reviewed by MDC and MDNR staff and entered in a statewide database. Recently data have been made available to the public on the Stream Team website (~). Agencies have used these data to determine baseline conditions of Missouri streams, identify impaired watersheds, and educate and inform the public. Volunteers have used their data to raise community awareness and help their communities solve problems and plan wisely. These volunteer efforts are likely to become more important in the future as awareness about stream issues and monitoring capabilities increase.

Chronic Fish Kill Areas

Table 15. Stream Teams and Volunteer Water Quality Monitors with adopted reaches within the Niangua River Basin and known activities.

Location Number		Team Number		Stream	Reported Activities	Years Reported
51		313		Little Niangua River	INV, WQM	1996-1997
104		478		West Fork Ninagua River	LPU, MTG, PLT, PRE, WQM	1996-1998
230		770		Niangua River	WQM	1996
231		770		Little Niangua River	ART, EDU, LPU, MED, MTG, OTH, PRE, WKS, WQM	1996-1997
234		772		Little Niangua River	MTG, PLT, WQM	1996-1999
247		807		Niangua River	INV, LPU, MTG, WKS	1996-1997
273		869		Dousinbury Creek	ART, LPU, PLT, WQM	1996-1997
344[1]		945		Niangua River	LPU	1997
426		994		Little Niangua River	ART, LPU, MED, OTH, WKS, WQM	1996-1998
428		331		Spencer Creek	INV, LPU, WQM	1997-1998
436		869		Niangua River	OTH, WQM	1997
719		313		Little Niangua River	INV, WQM	1997-1998
867		994		Little Niangua River	LPU	1998
897		1157		Mill Creek	FOR, LPU, MTG	1998
1027[2]		994		Little Niangua River	DIS, OTH	1998
1040		1171		Niangua River	INV, LPU	1998
1233		9997		Niangua River	WQM	1997
1300		1157		Mill Creek	INV, LPU	1999

1409		1293		Niangua River	WQM	1999
1445		266		Niangua River	EDU, LPU, OTH	1999
1466		135		Niangua River	INV, LPU, WQM	1990-1996
1467		678		Greer Creek	LPU, PLT	1996
1808		9997		Greasy Creek	WQM	1996

[1] **Precise location unknown**

[2] **Non-site specific activities**

Activity Codes:

ART = News article OTH = Other

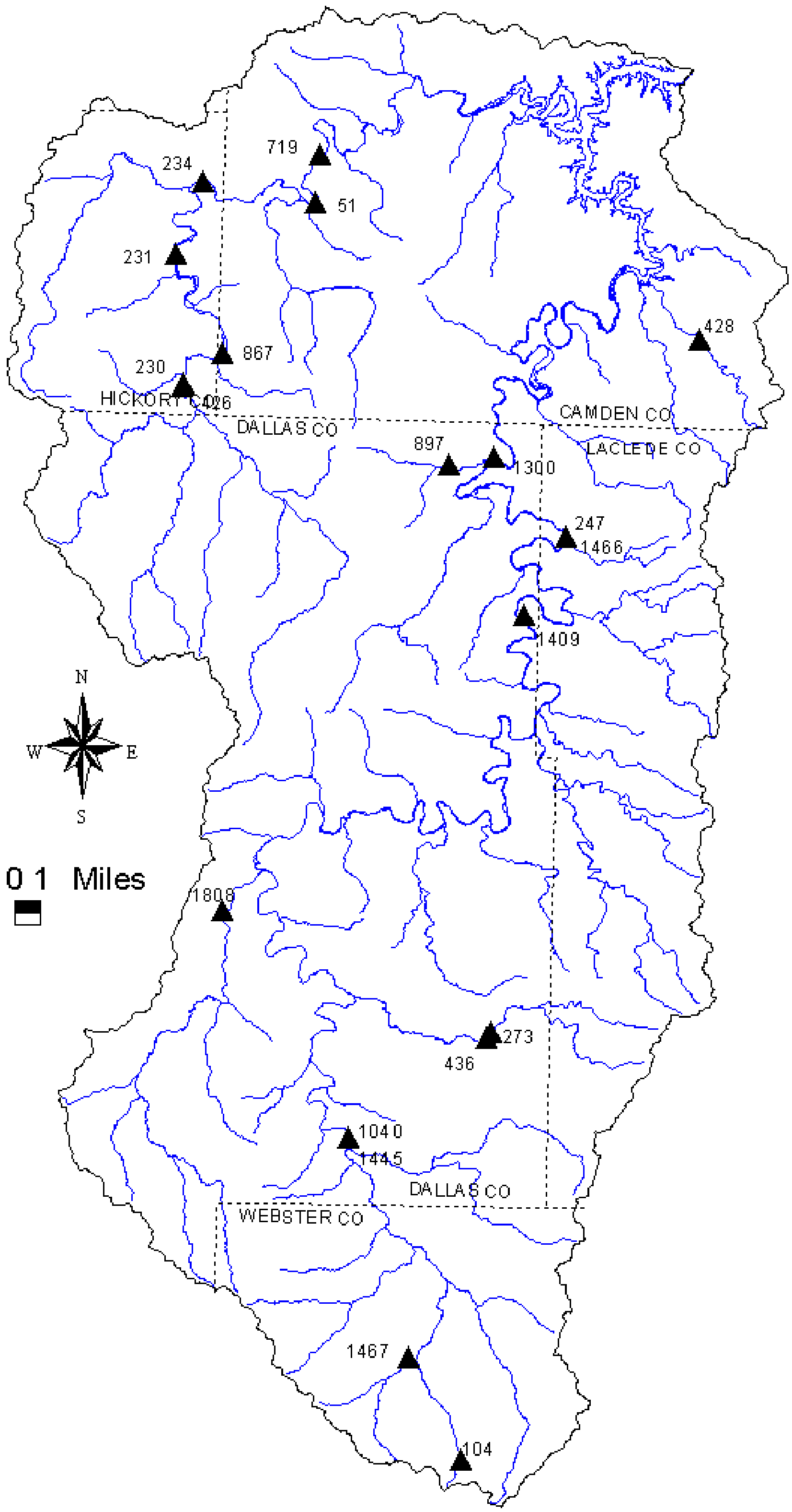
EDU = Educational project PRE = Presentation at public or governmental meeting

LPU = Litter pickup WKS = Attended training workshop

MED = Media interview WQM = Water quality monitoring

MTG = Stream Team meeting

Figure 12.5. Stream Team activity sites within the Niangua Watershed.



Documented fish kills and water pollution events are listed in Table 16 and mapped in Figure 13. MDC records indicate five fish kills have occurred in the watershed since 1979 (Table 16). One chronic fish-kill area is located downstream from the Marshfield sewage treatment facility. Fish mortalities in this area have been attributed to low dissolved oxygen, due to a combination of high nutrient inflow, low stream flows, and high water temperatures (MDNR, unpublished). Marshfield's recent efforts to upgrade their facility are discussed in the Point Source Pollution section. Petroleum product spills from ruptured pipelines have occurred at several sites and been responsible for at least one fish kill. One fish kill was documented at Lake Niangua in 1988. This event was attributed to rapid drawdown of surface water in August that stranded fish in shallow areas with high temperatures and low dissolved oxygen levels. To prevent similar events, the recently approved relicensing agreement limits fluctuations in lake levels to 0.5 feet and requires notification of MDC personnel.

Fish Contamination Levels/Health Advisories

Since 1987, annual tissue samples have been obtained from several fish species in LOZ to monitor select contaminants. None of the Niangua Arm samples (Table 18) exceeded action levels set by the Food and Drug Administration (FDA). During this period, the action level for chlordane (300 ppb) was exceeded in paddlefish from the Osage Arm in several years between 1988 and 1994. This resulted in health advisories issued by the Missouri Department of Health (MDH) to limit consumption of paddlefish from LOZ to one pound per week. Paddlefish caught anywhere in the Ozarks were removed from the health advisory in July 1995. The MDH also issued a health advisory in 1994 warning that sturgeon caught anywhere in Missouri should not be eaten due the high levels of chlordane and polychlorinated biphenyls (PCB's). However, sturgeon have not been observed in LOZ since the 1970s and may have been extirpated.

There are currently no health advisories for LOZ or Niangua Watershed fishes. However, MDH fish advisories (MDH, 1994; MDH, 1996) have included the statewide warning, "Pregnant or nursing females and young children may be at higher risk from eating contaminated fish, and should eat less than one pound a week of the fatty species". The warning cautions that many contaminants become concentrated in fatty tissue and eggs of fatty species such as catfish, carp, buffalo, drum, suckers, and paddlefish. Current plans include sampling Niangua Arm fish every 3 years beginning in 1998.

Pipelines

Five buried pipelines cross the Niangua Watershed (Figure 14). Pipelines pose a threat to groundwater as well as streams in the watershed, because they pass through several karst areas with sinkholes and losing streams inside and outside the watershed (Figure 11). Three of the pipelines are used for transporting crude oil, diesel fuel, and fertilizer. The 10-inch Shell pipeline is currently not in use but may be reactivated in the future. The Williams pipeline was reportedly being considered for use as a fiber optics conduit (Vandike, 1992). At least four pipeline ruptures have resulted in water pollution problems and fish kills since 1979 (Table 17). In addition, pipelines have become exposed by streambed erosion at three sites in the past four years (Dousinbury Creek SM 5.5, Greasy Creek SM 11.5, NR SM 100.2). Recent gravel excavation had occurred near all three of these sites, and the resulting headcuts and destabilized channels may have created the erosion problems. Most of the pipelines in the watershed do not appear on 7.5 minute topographic maps, so it has been difficult to determine whether proposed 404 activities may impact pipelines in the vicinity. The recently enacted general permit (MRKGP-34M) includes conditions that should minimize headcutting and channel destabilization. However, COE

Table 16. Documented fish kills and water pollution events within the Niangua Watershed.

Site Number	Date	Stream	Problem	Length Affected	Number Fish Killed
K001	04/09/79	Hankens Branch	Crude oil pipeline rupture impacted private pond	- -	- -
K002	10/21/79	Niangua River	Chromic acid & hydrogen peroxide truck spill	- -	0
K003	05/30/80	?	Oil spill, pipeline leak resulted in avian mortal	0.0	0
K004	04/02/84	West Fork Niangua	Municipal sewage bypass-unknown area affected	- -	0
K005	10/24/84	Hankens Branch	Herbicide transportation spill	0.0	0
K006	05/11/86	West Fork Niangua	Industrial: petroleum	- -	0
K007	06/11/86	West Fork Niangua	Municipal: sewage	- -	0
K008	05/13/87	Starks Creek	Other: Petroleum products	- -	0
K010	08/12/88	Niangua River	Other: Drawdown of Lake Niangua	2.0	50
K011	04/29/90	East Fork Niangua	Industrial: petroleum	- -	0
K012	07/02/90	Niangua Arm (LOZ)	Municipal: sewage	- -	- -
K013	07/07/91	West Fork Niangua Trib	Raw sewage discharge due to blocked manhole	1.0	12,420
K014	07/26/91	Racetrack Hollow	Camdenton STP sludge released from lagoon	1.0	0
K015	10/05/93	Bennett Spring Branch	Other: excess trout feed and waste	0.0	0
K016	03/14/94	Trib Dousinbury Creek	52,000 tires burned - Bennett Spring recharge area	0.0	0
K017	10/05/95	Racetrack Hollow	Concrete dumped in stream	0.1	>4
K018	11/26/84	Dousinbury Creek	Diesel fuel pipeline break	- -	- -
K019*	10/18/84	Dousinbury Creek Trib	Diesel fuel pipeline rupture	0.1	Small number
K020*	10/24/85	West Fork Niangua River	Unknown problem	- -	2,588

K021*	**07/02/90**	**Niangua Arm (LOZ)**	**Periodic sewage discharge private facility**	**- -**	**0**
K022*	**12/04/92**	**Greasy Creek**	**Undetermined problem**	**- -**	**- -**

- - unknown length effected or number killed.

*** sites were not mapped because locations could not be determined (K019-K022).**

Figure 13. Documented fish kills and water pollution events within the Niangua River Watershed and spring recharge area.

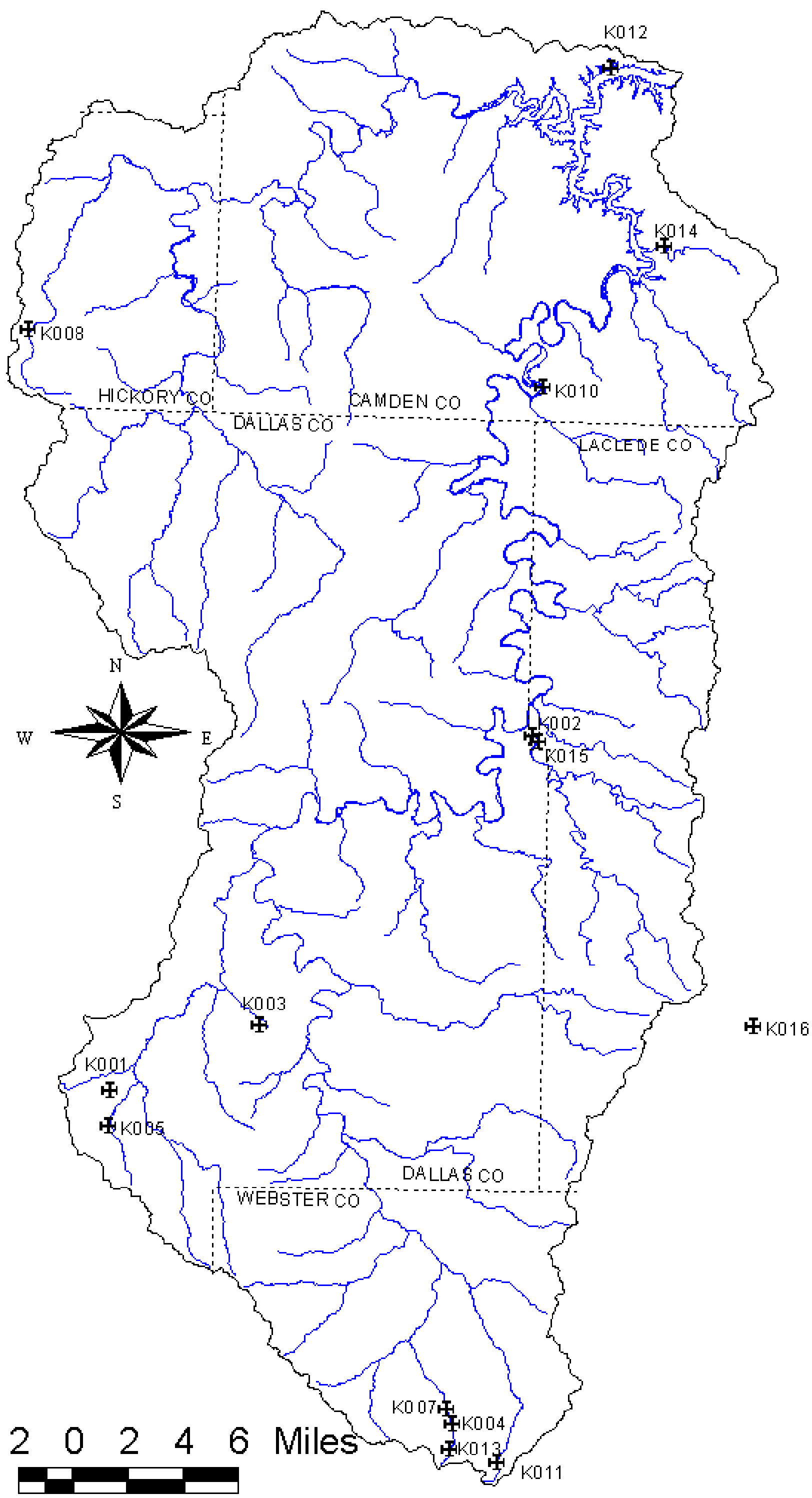


Table 18. Numbers and human population equivalents (PE) of NPDES permitted animal waste facilities within the Niangua Watershed.

Operation Type	Total Number	Number with PE data		PE
Dairy cows	51		38	80,955
Poultry layers or pullets	2		2	17,100
Swine finishing	3		0	--
Swine nursery	1		1	1,536
Sows, boars, and sow and litter	5		0	--
TOTALS	62		41	113,766

NPDES - National Pollution Discharge Elimination System.

-- no PE data available

Figure 14. Buried intrastate pipelines that cross the Niangua Watershed.

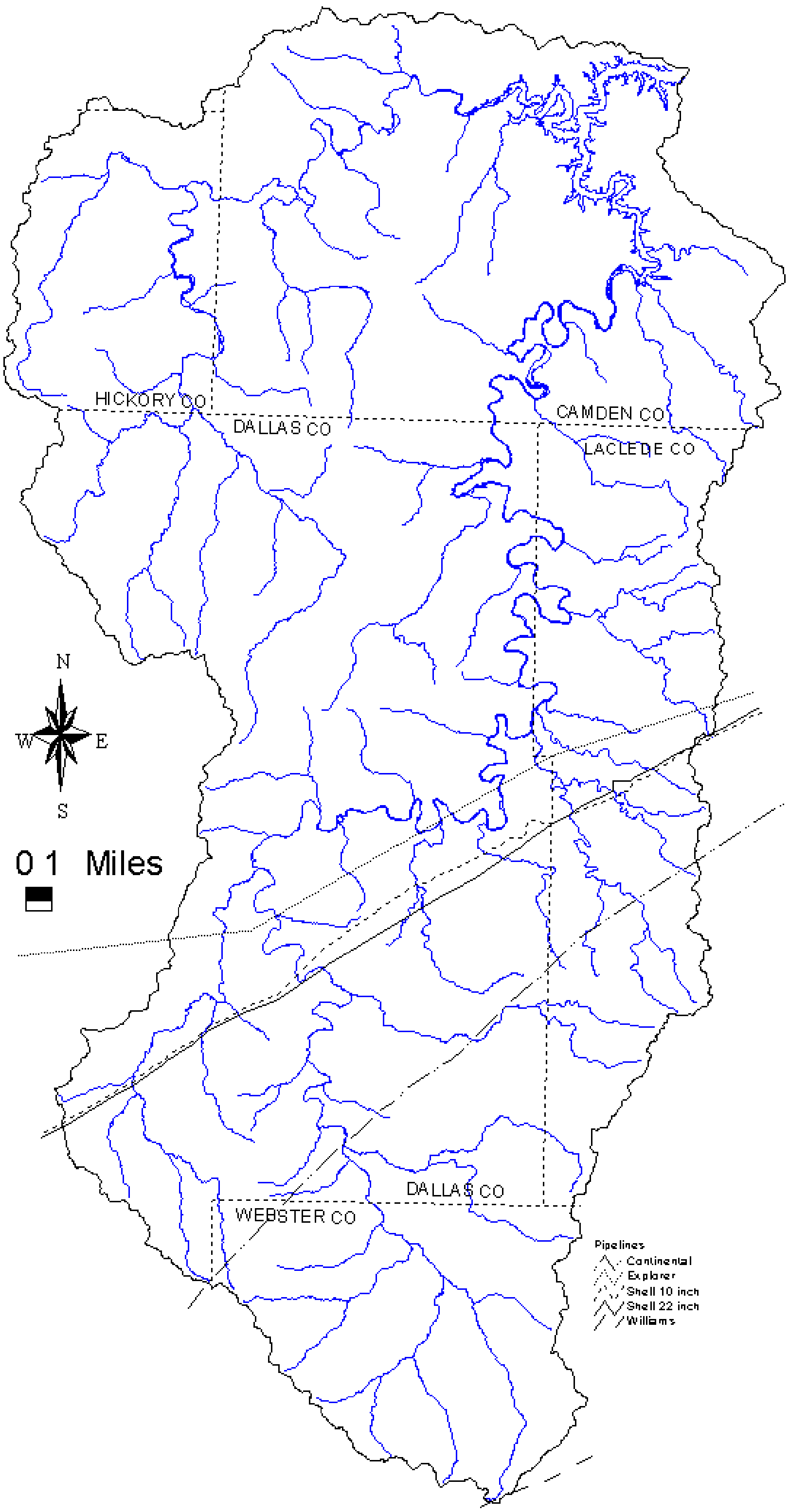


Table 17. Potential toxic or hazardous waste sites within the Niangua Watershed.

Site Number	Owner	Location	Type	Problem
T001	Case Real Estate	Marshfield, MO	UST	unknown toxins, unknown impacts
T002	Wal-Mart Store #78	Marshfield, MO	LUST	unknown toxins, unknown impacts
T003	Gier Oil Company	Marshfield, MO	LUST	unknown toxins, unknown impacts
T004	Tyler Coupling Company	Marshfield, MO	TRI in onsite landfill	several metals, unknown impacts
T005	York Quality Caskets	Marshfield, MO	TRI in onsite landfill	several metals, unknown impacts
T006	Fast Trip #28	Marshfield, MO	LUST	unknown toxins, unknown impacts
T007	Mt. Zion Baptist Church	Charity, MO	LUST	petroleum products Groundwater contamination
T008	Burlington Northern RR	Phillipsburg, MO	buried tanker spill	red and yellow phosphorus soil contamination, potential groundwater contamination
T009	Shell Pipeline Company	Dallas County	Superfund site (cleaned)	petroleum sludge, unknown impacts, sludge removed from site 1/95 to Buffalo STP.
T010	Bird Moving and Storage	Lebanon, MO	LUST	unknown toxins, unknown impacts
T011	Lebanon Site	Lebanon, MO	UST, LUST	unknown toxins fumes in sewers and buildings Bennett Spring recharge area

T012	R H Mini Serve	Lebanon, MO	LUST	unknown toxins, unknown impacts
T013	Lebanon Special Road District	Lebanon, MO	LUST	unknown toxins, unknown impacts
T014	Wal-Mart Store	Lebanon, MO	LUST	unknown toxins, unknown impacts
T015	Detroit Tool	Lebanon, MO	LUST	unknown toxins, unknown impacts
T016	Phillips 66 / Thompson Station	Roach, MO	LUST	unknown toxins, unknown impacts
T017	Magic Chrome	Camdenton, MO	UST, Superfund site	various metals and chrome, soil and unknown groundwater contamination, metal plating
T018	Modine Heat Transfer, Inc.	Camdenton, MO	TRI, Superfund site (proposed)	TCE, 1,11,-TCA, PCE, vinyl chloride, soil and groundwater contamination

UST = Underground storage tank with leaking status undetermined.

LUST = Leaking underground storage tank.

TRI = Toxic Release Inventory maintained by MDNR.

(All data obtained from MDNR)

authority to regulate in stream gravel excavation has been severely limited by a recent court ruling (see 404 Activities section). Nationwide permits, however, are not as restrictive, and frequently the MDC is not consulted or informed of their issuance. The COE apparently does not check on the location of pipelines when considering applications.

Point Source Pollution

All wastewater discharges which are considered point sources are required to obtain National Pollution Discharge Elimination System (NPDES) permits. The MDNR issues and monitors these permits throughout the state, and the Springfield Regional Office is responsible for the Niangua Watershed. All NPDES permitted discharges as of December 13, 1995 are shown in Figure 15.

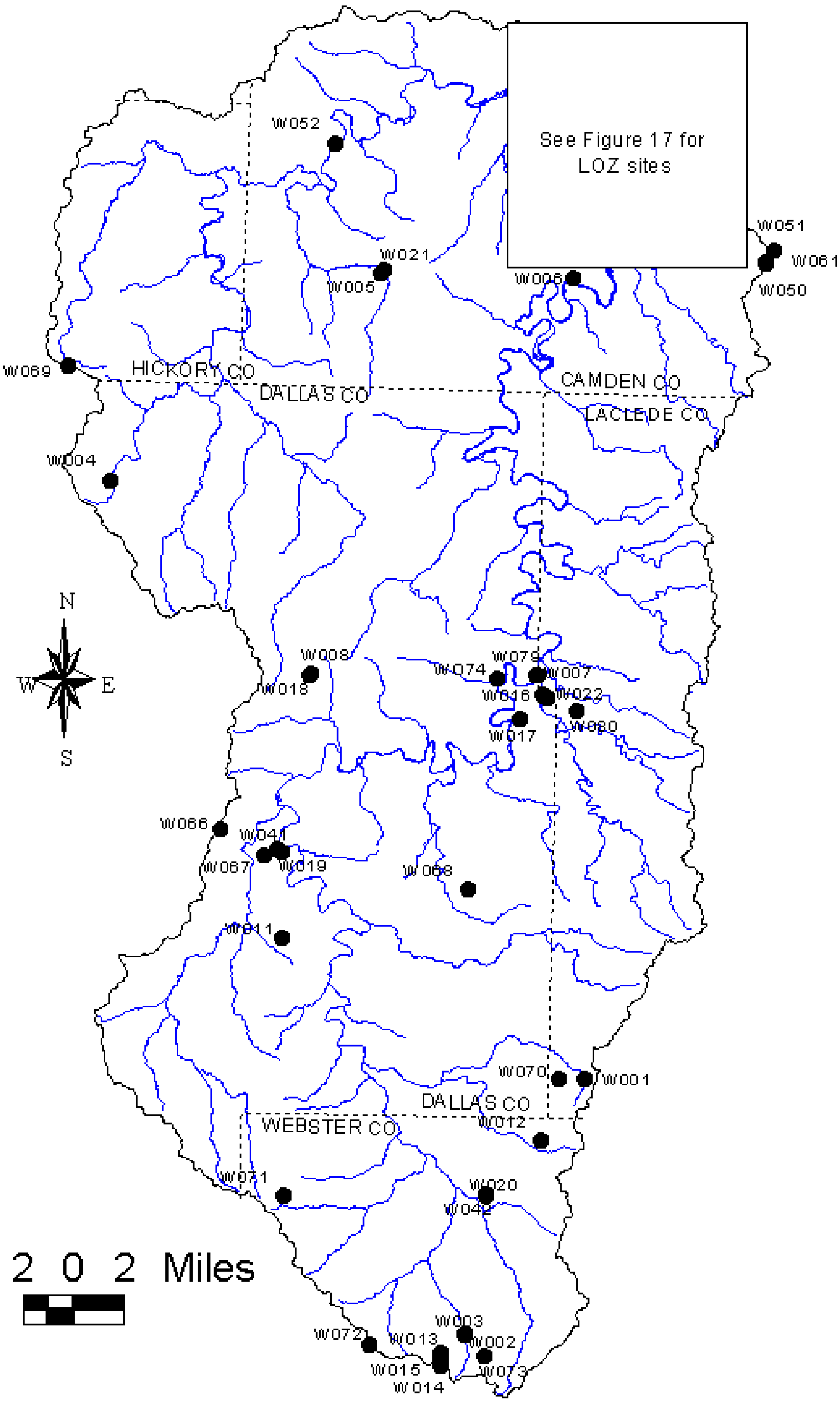
Municipal Sewage Treatment Plants

Four municipal sewage treatment plants (STPs) have been issued NPDES permits to discharge wastewater into surface waters of the Niangua Watershed. The City of Camdenton STP has had problems on several occasions which have resulted in discharge of pollutants to tributaries of the Niangua Arm (LOZ). These included mechanical failures of lift stations and the intentional release of sludge from an abandoned sewage lagoon. No fish kills or long lasting pollution problems have been documented from these incidents. The lagoon has been filled in and the lift station problems corrected (Ed Sears (MDNR), pers. comm.). Camdenton constructed a new treatment facility in 1989 featuring an oxidation ditch and ultraviolet disinfection which releases 0.35 million gallons per day (MGD) into Racetrack Hollow. This tributary flows approximately 0.6 miles to the Niangua Arm (LOZ). Recent volunteer monitoring has revealed a degraded invertebrate community near the mouth (Bob Schulz (MDC), pers. Comm.).

The treatment system in Marshfield is an extended aeration facility with a sludge storage pond and discharges approximately 0.6 MGD. A second outfall at the facility releases storm water and effluent when flows exceed the capacity of the main treatment system. The excess flow receives primary filtration and chlorination. Both discharges flow into a tributary within 0.5 miles of its confluence with the West Fork of the NR. In stream surveys of the tributary and the West Fork have indicated low dissolved oxygen, sludge deposits, and pollution tolerant benthic organisms for approximately 1.5 miles downstream from the discharges (unpublished data, MDNR). Four water pollution or fish-kill events have been documented below this facility. The presence of toxic metals in the wastewater discharges from area industries has been a concern in Marshfield, and more stringent limits for metals have been included in a recently revised permit (Ed Sears (MDNR), pers. comm. 10/96). The West Fork is classified as a losing stream for 0.4 miles beginning within 1.0 mile of the Marshfield discharge, so more stringent discharge limits are included in its NPDES permit. The MDNR is currently reviewing an engineering report that proposes to upgrade the collection system and treatment facility to extend their usefulness another 20 years, however, plans do not include increased capacity (Dave Ehlig (MDNR), pers. comm. 10/96).

Conway's treatment system consists of two lagoons which discharge approximately 0.05 MGD into Jones Creek approximately 10.5 miles from its confluence with the NR. The treatment system is not meeting discharge limits, and the MDNR has advised them to make improvements (Ed Sears (MDNR), pers. comm. 10/96). About 0.4 miles of Jones Creek is impacted by this discharge, exhibiting pollution tolerant animals and heavy algae growth (MDNR, 1995). Jones Creek is unclassified in this area. The City of Urbana discharges 0.045 MGD from two lagoons into the East Branch of Cahoochie Creek, an unclassified stream, about 7.0 miles from the LNR. The system is currently in compliance with permit

Figure 15. NPDES wastewater discharges on streams, excluding animal waste discharges within the Niangua River Watershed.



limits (Ed Sears (MDNR), pers. comm. 10/96).

The City of Lebanon is outside the surface watershed of the Niangua, but the STP discharges to Dry Auglaize Creek, a losing stream within the recharge area for Bennett Spring. The facility is not capable of treating storm water runoff, and the city has been in litigation with the MDNR for several years (Ed Sears (MDNR), pers. Comm. 10/96). During storm water events untreated sewage is released in Goodwin Hollow and Dry Auglaize Creek, both losing streams within the Bennett Spring and Sweet Blue Spring recharge areas.

Buffalo, the third largest town within the watershed, discharges wastewater into the Lindley Creek watershed outside the Niangua Watershed. Some sludge from the Buffalo STP is applied on agricultural land within the watershed. The City of Niangua STP, a small oxidation ditch, discharges to a tributary of the Osage Fork of the Gasconade River. This stream is outside the Niangua Watershed and is not known to be hydrologically connected to the watershed.

Sludge Application Sites
There are nine sites within the Niangua Watershed where sludge from municipal sewage treatment plants has been applied to agricultural land (Table 19; Figure 16). These sites are all within twenty miles of the treatment plants and are permitted through the NPDES permits for each municipality. These sites are self-monitored by the municipalities who must furnish annual reports to the MDNR on the location, landowner, application dates, and amounts. Various parameters, including metal concentrations, nitrates, phosphates, and percent solids must be monitored; and individual and cumulative levels must be within limits. The MDNR has not documented any environmental problems at any of the sludge application sites in the watershed (Robert Magai (MDNR), pers. comm.).

There are probably sites within the Niangua Watershed where private haulers dispose of sludge from private septic systems and other wastewater treatment systems. These may include land application sites or anaerobic lagoons. Private haulers have only recently been required by sludge regulations to obtain licenses and report their activities, and no information is currently available from the MDNR.

Non-POTWs
There are 48 permitted non-POTWs (non-public owned treatment works) within the watershed. Thirty-one discharge into either the Niangua Arm or the Little Niangua Arm (Figure 17). These facilities are mostly extended aeration treatment systems with chlorinated effluent and flows in the range of 1,000 to 55,000 gallons per day (GPD). They are self-monitored quarterly, semiannually, or annually depending on the flow and site conditions. The number of permits for non-POTWs releasing effluent to LOZ has increased dramatically in recent years. Occasional violations of water quality standards have been reported in highly developed coves (Mitzelfelt, 1985). Due to the neglect of proper maintenance and the infrequent monitoring of these facilities, their contribution to nutrient loading and pathogen contamination of the lake is probably considerable.

The Bennett Spring Fish Hatchery uses about 20 percent of the average flow from Bennett Spring for trout production prior to discharging the water into the Niangua River. There have been no known problems with this discharge, except occasional complaints by anglers of excess turbidity when raceways are flushed to remove accumulated sediment. Most of the sediment laden effluent is now applied to MDC land at Bennett Spring CA.

Other wastewater from Bennett Spring State Park is treated in three lagoons and then land applied on the

Table 19. Estimated numbers and human population equivalent (PE) of all cattle within the Niangua Watershed by county.

County	Number in Watershed			Population Equivalent in Watershed			
	Milk Cows	Other Cattle[1]	Total Cattle	Milk Cows	Other Cattle[1]	Total Cattle	Total Cattle in Pasture[2]
Camden	417	8,945	9,362	8,346	125,227	133,574	
Dallas	5,796	40,817	46,613	115,929	571,435	687,365	
Hickory	355	6,693	7,049	7,105	93,707	100,812	
Laclede	1,810	12,337	14,146	36,198	172,712	208,910	
Webster	2,296	12,007	14,303	45,922	168,097	214,020	
Total	10,675	80,799	91,474	213,500	1,131,180	1,344,680	1,230,914

[1] **Other Cattle includes all cattle except milk cows.**

[2] **Total Cattle less those reported in NPDES facility permits in confined facilities (calculated for total watershed only).**

Figure 16. Landfills, quarries, sludge disposal application sites, and toxic waste sites within the Niangua River Watershed and spring recharge area.

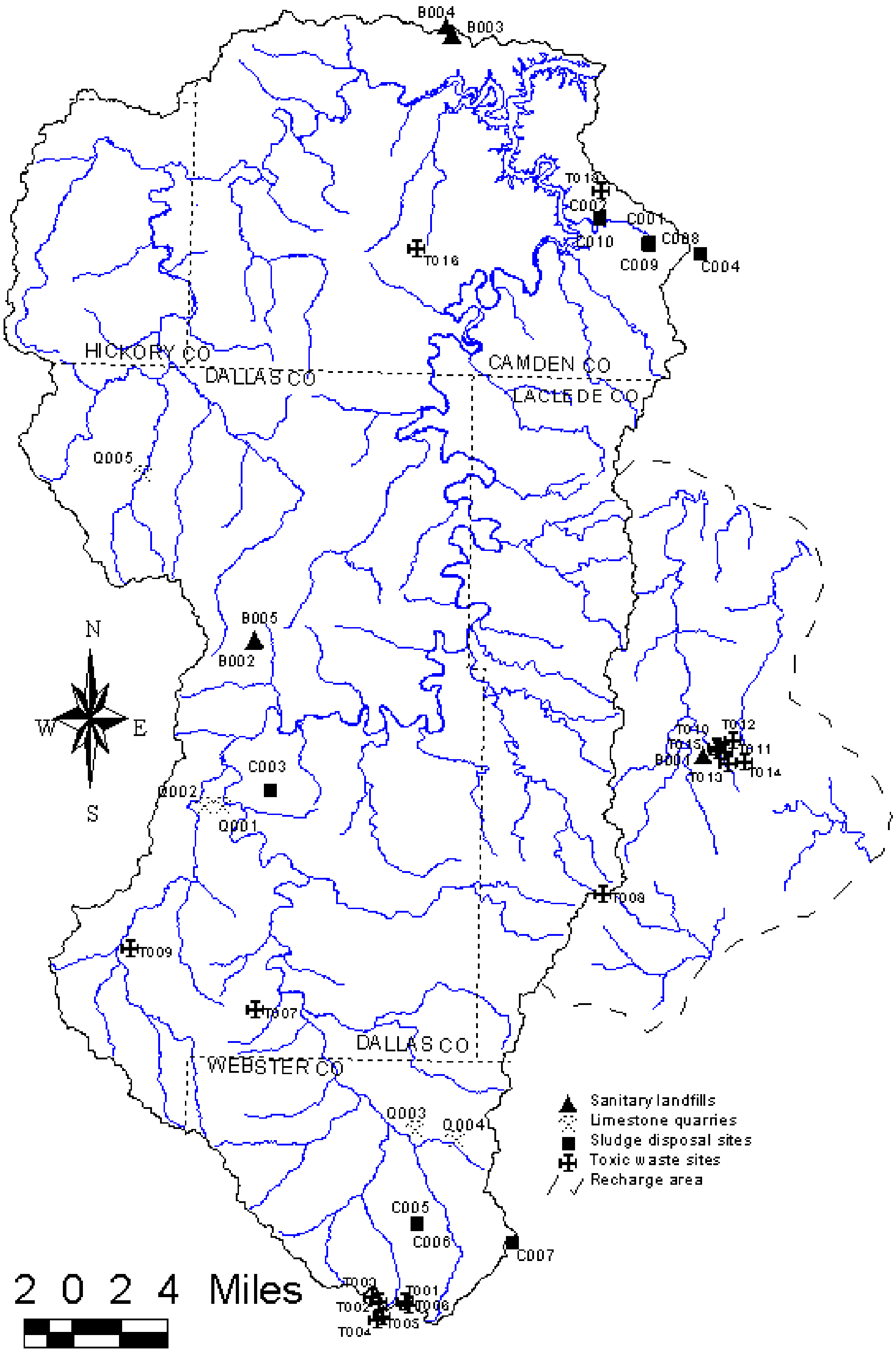
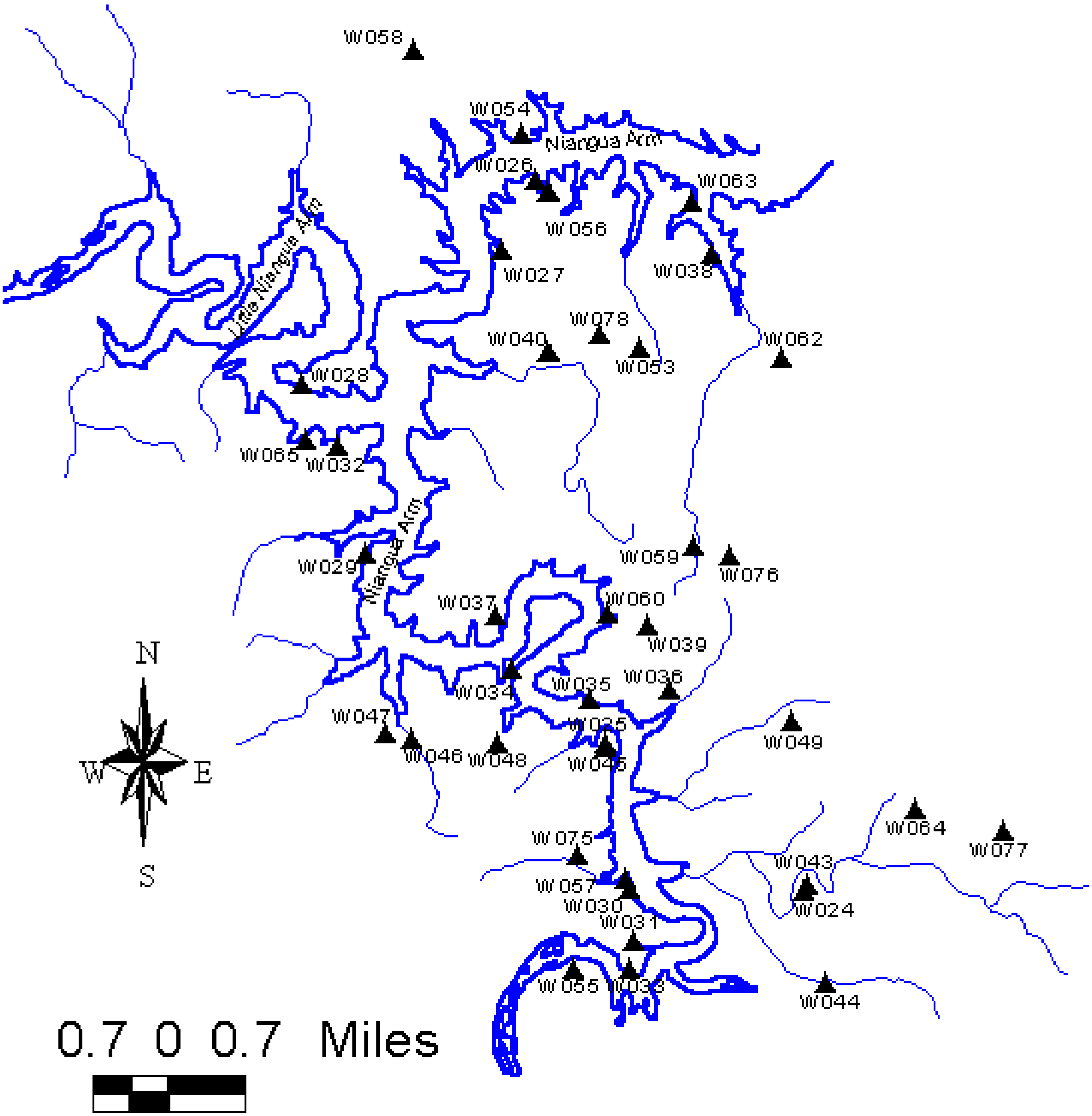


Figure 17. NPDES permitted waste water discharges on Lake of the Ozarks.



Bennett Spring CA. Historic ponding effluent and excess runoff problems have been reduced by increasing the land area for application. Lagoon effluent is occasionally drained directly into the Niangua River during high flows to increase storage capacity. These incidents have reportedly been reduced by eliminating some of the storm water that had been draining to the lagoons.

Storm Water Discharges

NPDES permits for storm water runoff have been issued for 15 discharges within the watershed. These include a closed landfill that discharges into a tributary to Durington Creek about 1.5 miles from the NR and a quarry that discharges to a tributary within 0.2 miles of the NR. Most of the permitted storm water discharges receive no treatment, although some may incorporate settling basins.

Landfills

All five municipal sanitary landfills located within the Niangua watershed have been closed (Table 20; Figure 16). The Lebanon Sanitary Landfill (B001) was active between 1977 and 1980, when all available space was exhausted. The underlying soils are poor and the site is in a karst area with a sinkhole nearby, so groundwater contamination is a concern (Jim Gross (MDNR), pers. comm.). A leachate collection system that discharges to the Lebanon STP has been installed, but on at least one occasion, leachate overflowed from a manhole to a nearby stream, a tributary to Goodwin Hollow (Jim Gross (MDNR), pers. comm.). Although this site lies outside the surface watershed of the Niangua Watershed, it and Goodwin Hollow are within a karst area that is hydrologically connected to Bennett Spring and Sweet Blue Spring. The Dallas County Landfill near Buffalo includes two sites. One (B002) was active between 1976 and 1986, and the other (B005) was active between 1980 and 1986. The landfill did not meet its closure conditions until December 1995 due to problems with surfacing leachate and inadequate vegetative cover. These problems have been corrected, but there is still concern that leachate may pass through the porous soil and

fractured bedrock underlying the site into groundwater aquifers (Jim Gross (MDNR), pers. comm.). The Ed Mehl Landfill near Camdenton includes two different sites (B003 and B004) active from 1979 through 1991. It was officially closed in 1995. No water contamination problems have been reported at the site (Kevin Johnson (MDNR), pers. comm.). A private landfill located in a karst area near Lebanon contains sawdust and other wood waste, and poses a potential threat to groundwater resources. This facility is outside the watershed, but within the Bennett Spring recharge area. No permit or monitoring is required for this facility because a 1990 revision of the Solid Waste Law exempts wood waste (Jim Gross (MDNR), pers. comm.).

There are numerous small dump sites, including municipal, county, and private sites, which were never permitted and cannot be utilized legally. There are no known water pollution problems associated with these sites.

Toxic Waste Sites

Eighteen sites with potential toxic or hazardous waste problems have been identified (Table 17; Figure 16). They are all sites regulated and monitored by the MDNR under several programs. The Leaking Underground Storage Tank Program maintains a list of known leaking, buried tanks containing substances which have known or potential water pollution problems. The Underground Storage Tank Program maintains a list of registered buried tanks that are not known to leak. Owners of these sites were required to register these tanks by August 28, 1996 to become eligible for insurance which limits their liability to $10,000 for future pollution problems. The Toxic Release Inventory (TRI) contains detailed

Table 20. Documented number of acres disturbed by fire between 1993 and 1995 within Camden, Dallas, and Laclede Counties.

Year	Forest Acres		Other Acres		Total Acres		Percent of Watershed Burned		Percent of Unidentified Sites[1]	
1993	2,893		753		3,646		0.5		40.4	
1994	6,802		2,309		9,111		1.4		55.4	
1995	9,109		1,821		10,930		1.6		34.6	

[1] Percent of sites for which the watershed could not be determined due to missing legal descriptions.

information about parties that release, store, or process toxic materials such as heavy metals and pesticides. Many listed facilities in the watershed are not included in Table 21 because they discharge to municipal sewage treatment plants. In these cases the toxins are usually retained in the sludge, and are regulated by the NPDES permit for the treatment plant. In addition, the MDNR maintains a list of Superfund sites, those which are candidates under investigation, or eligible for federal Superfund assistance to remove or otherwise control toxic wastes.

Quarries

Five limestone quarries have been permitted by the Land Reclamation Program (MDNR) (Table 22; Figure 16). One facility (Q001) is currently being investigated by the MDNR. The owner has a NPDES permit that limits suspended solids in its discharges and is responsible for self-monitoring them twice per year. A MDNR inspection in September 1996 revealed that sediment buildup in two detention basins could result in highly turbid discharges during storm runoff (Kevin Hess (MDNR), pers. comm.). The owner has been advised to clean out the basins.

404 Activities

Seventy-seven known permits were issued for 404 activities within the watershed between July 1992 and June 1996 (Appendix F; Figure 18). Only COE permits are listed for most of the sites. MDNR land reclamation permits were also issued for many of these sites, but are only included if no COE permit was recorded. The vast majority of permits (51) were issued for gravel removal. Eleven permits were issued for bridge construction or repairs, and six for bank stabilization. One permit was issued for pipeline armoring. MDC Fisheries Management personnel formally reported twenty violations to the COE during the same time period. Seventeen of these were associated with sand and gravel removal, including eight unpermitted sites and eleven occasions with one or more permit violations.

In January 1996, a general permit (MRKGP-34M) was enacted for gravel excavation in Missouri. Conditions formulated by the MDC, MDNR, and COE are included to minimize stream degradation. Excavation is prohibited in select streams identified by Fisheries Division personnel to protect spawning habitat of some species (Table 7). One hundred sixty-seven miles of Niangua Watershed streams are recommended for protection during the spring spawning season, March 15 through June 15, and fifteen miles are recommended for protection during the fall season (November 15 through February 15). The General Permit and recent changes in COE authority to regulate in stream excavation are discussed in greater detail in the Corps of Engineers Jurisdiction section. These changes could result in serious degradation to Missouri streams if alternate means to reduce environmental problems associated with sand and gravel removal are not adopted.

Animal Waste Point Sources

Seventy-one animal waste point sources are currently permitted within the watershed (Figure 19). As shown in Table 23, 51 of the 71 animal waste point sources are dairies, 11 are swine operations, and four are poultry operations. The total human population equivalent (PE) of the permitted facilities, for which PE data is available, is 113,766 (Table 18). This is far greater than the estimated 1994 human population of the watershed (34,679) and only includes animals in confinement facilities which have point discharges. Facilities which do not have permits or for which PE data is not available are not included, so this is a conservative estimate. Livestock in pastures, which occur in much greater numbers in the watershed, are considered in the following section. Most of the point sources are dairy farms with less than 300 animal units, and many have received UNAWP assistance for installing waste treatment systems. The University Extension Office in Dallas County estimates that 28 percent of the total manure

Figure 18. USCOE and MDNR permitted instream activities and violations within the Niangua River Watershed.

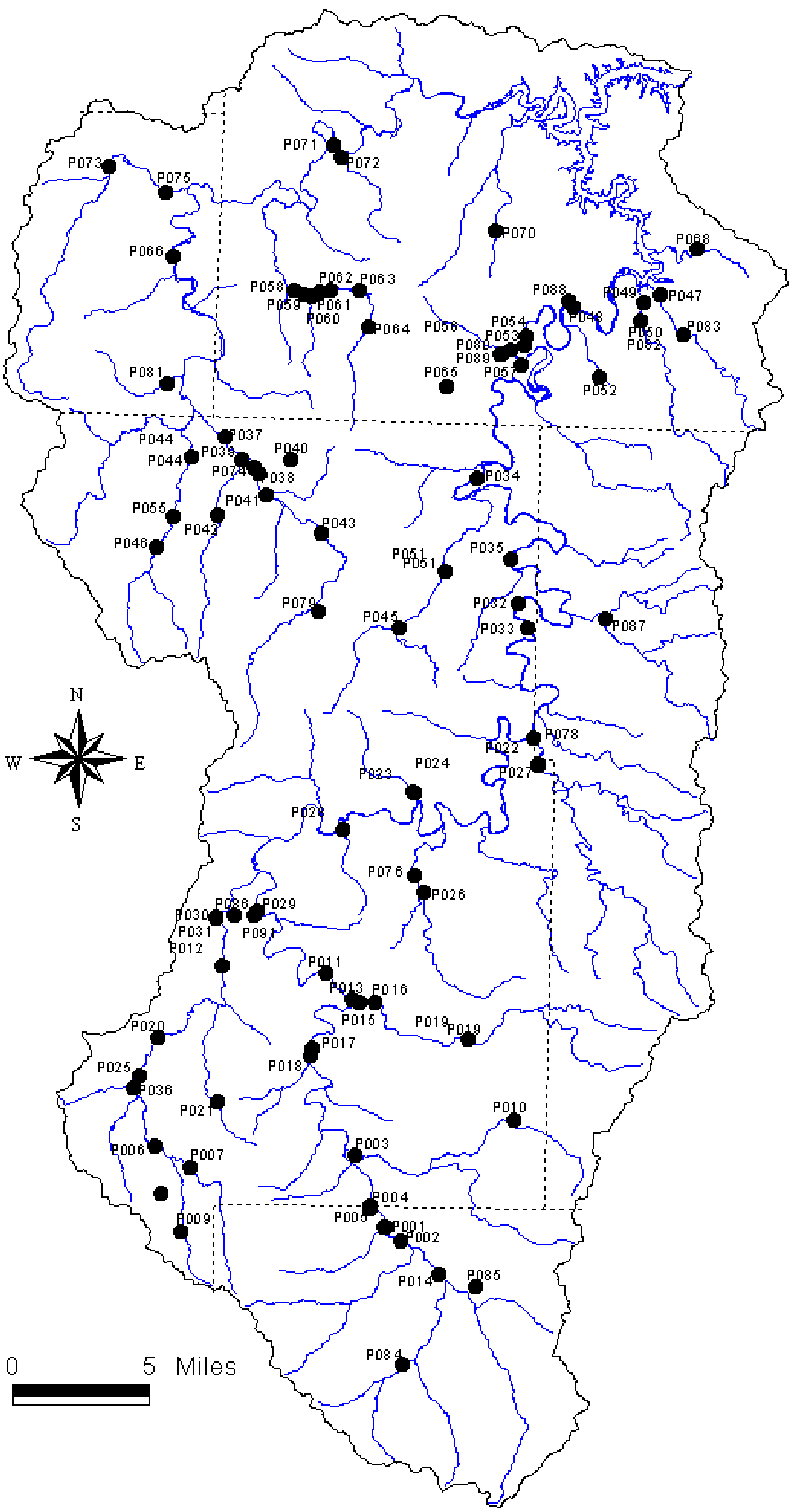
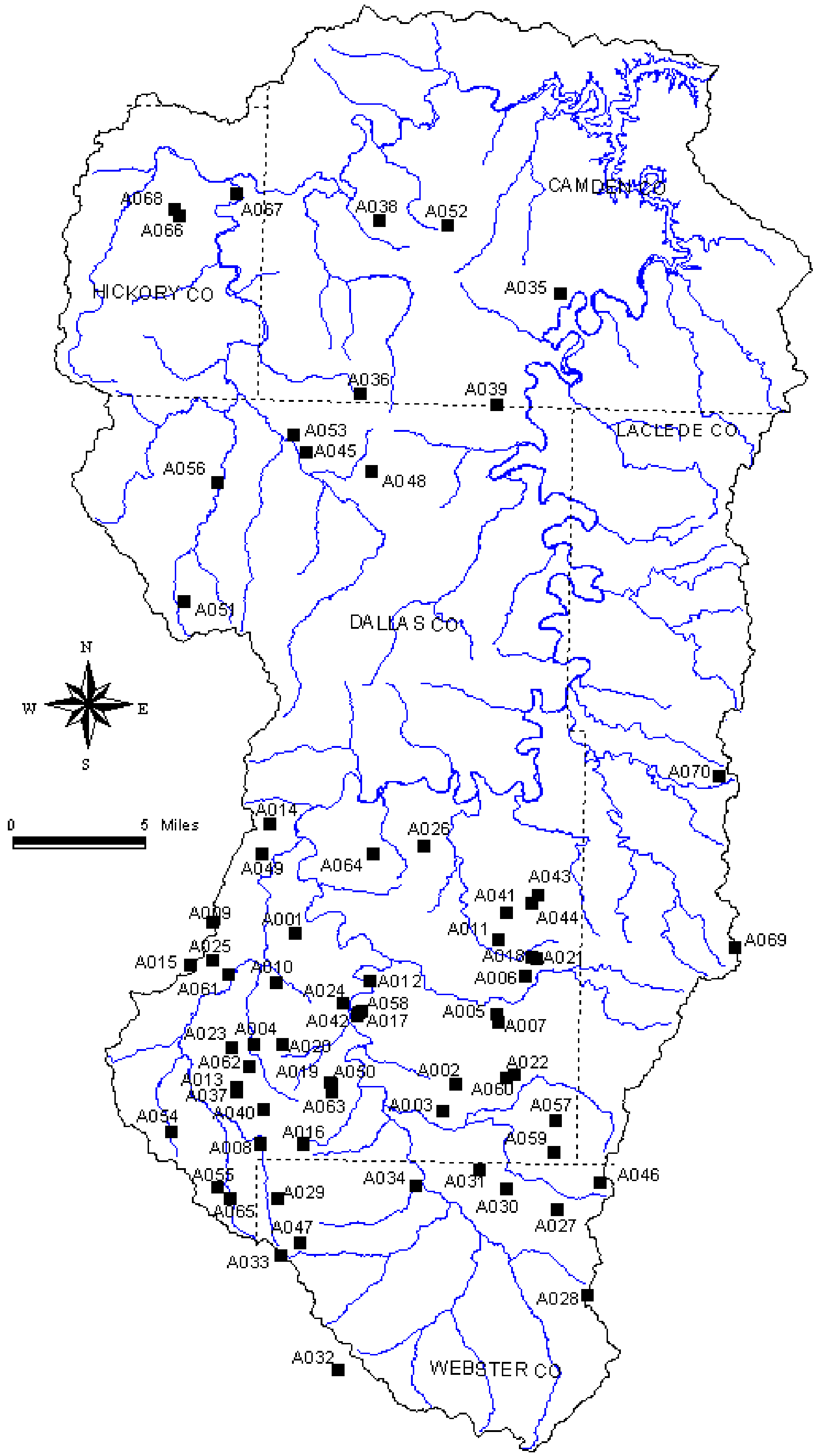


Figure 19. NPDES animal waste sites within the Niangua River Watershed.



production within the upper Niangua watershed is now being treated by facilities installed through UNAWP (Charles Shay (UMC Extension), pers. comm.). The USDA estimates that approximately 55,000 pounds of nitrogen and 10,000 pounds of phosphorus in 1994; and 113,000 pounds of nitrogen and 32,000 pounds of phosphorus in 1995, were intercepted and treated rather than flushed into streams (Smale et al., 1995). Nitrogen and phosphorus, fecal bacteria, and other contaminants, were monitored at 23 stations on the NR and its tributaries from summer 1991 to winter 1995. Preliminary results indicate that there were no detectable reductions in nutrient or pathogen levels that could be attributed to these installations (Smale et al, 1995). The inability to detect improvements may be due to the difficulty of monitoring water chemistry in streams because they are so dynamic, or the presence of other contaminant sources, such as cattle in pasture (see the following section).

In addition, ten sites within the study area were designated as intensive study sites, where sampling included: fish collections once per year; invertebrate collections twice per year using rapid bioassessment techniques; and a limited collection of associated physical and habitat data. Limited preliminary results indicate that invertebrate communities may be more sensitive than fish communities and both may be more sensitive to riparian conditions than to nutrient loading (Smale et al, 1995).

Non-point Source Pollution

Agricultural Runoff

The main non-point pollution source in the watershed is probably runoff from dairy and beef cattle pastures. Cattle on pasture in the watershed produce waste equivalent to an estimated human population of over 1.2 million (Table 19). This estimate was derived from data from several sources. The number of cattle in counties within the watershed was obtained from statistics available from the Missouri Agricultural Statistics Service (MDA, 1995). The total numbers of beef cattle and dairy cattle in the watershed were calculated based on the assumption that both were equally distributed throughout the watershed. The estimated numbers within the watershed were multiplied by the population equivalents - PE=14 per 1,000 lbs for beef cattle, PE=20 per 1,000 lbs for milk cows (MDNR, 1989), and by 0.8, assuming the average weight of cattle in the watershed is 800 pounds (MDA, 1995). Finally, the estimated PE of cattle on pasture (1,230,914) was determined by subtracting the PE of NPDES permitted dairies in the watershed (Table 18) from the PE for total cattle in the watershed (Table 19).

Since some animal waste in pastures decomposes in place, and some nutrients are filtered out and absorbed by vegetation before they enter the surface or groundwater, the effects of this amount of waste on water quality and aquatic life, and the possible risks to human health, are difficult to predict. This diffuse reservoir of nutrients and pathogens may account for the high levels of fecal bacteria, nitrates, and phosphates reported by Smale et al, (1995) during the UNAWP after rainfall events. These non-point sources may contribute nitrates to groundwater reservoirs and springs, and explain why significant improvements were not detected under normal flow conditions during the UNAWP after point sources had been intercepted and treated.

Septic Systems

Septic systems and most other individual onsite wastewater treatment systems are intangible non-point sources that are difficult to pinpoint or quantify. This is especially true in most of rural Missouri because, until recently, permits were not necessary to install these systems. This lack of regulation is compounded by the fact that the thin, porous soils and shallow, fractured bedrock, that are common throughout the watershed, do not provide adequate soil treatment for conventional septic systems. Impervious soil types, such as clay hardpan and fragipan, are also common in the watershed. When installed improperly or in porous soils, the leachate can percolate rapidly through the soil to contaminate aquifers that supply springs and wells. In impervious soils, poorly treated leachate can surface and enter the nearest stream. Contamination from septic systems and other onsite systems has almost certainly been the major cause of elevated nutrient and pathogen levels in developed coves of LOZ (Mitzelfelt, 1985). In less highly developed areas away from the lake malfunctioning systems can contaminate small springs and streams in local areas, but the cumulative impacts of widely dispersed small systems are difficult to ascertain. A new statewide septic system regulation that went into effect in September 1995 should reduce these problems. It requires that permits be obtained for installation or major repair of septic systems on parcels less than three acres. In addition, minimum standards, based on expected use and site conditions, must be met. A soil percolation test or soil morphology examination must be completed by a licensed technician, and the system must be approved by a licensed engineer if less than minimal site conditions are detected. The regulation is administered by the Missouri Department of Health (MDH), but counties are encouraged to adopt ordinances as strict or more so, and to administer the permitting program themselves. Most counties within the Niangua Watershed have done so.

Camden County has enacted an ordinance that adopts the state standards and has opened the Camden County Wastewater Department in Camdenton. The ordinance includes restrictions that require permits for all lake front lots and that systems be set back at least 50 feet from the shoreline. Thousands of aerobic onsite treatment systems at private homes around the lake reportedly pose a continuing pollution problem (Craig Reichert (Camden County Sanitarian), pers. comm.). The new regulation does not affect existing systems unless contamination problems are documented or the system needs major repairs or replacement. Aerobic systems do not function properly without a fairly continuous flow of waste to maintain high numbers of aerobic decomposers. Therefore, they often fail to provide adequate treatment at homes around the lake that are only used seasonally or infrequently (Craig Reichert (Camden County Sanitarian), pers. comm.). This problem is often compounded by poorly designed or constructed soil absorption fields, which are especially important for infrequently used aerobic systems.

Dallas, Hickory, and Webster counties have also enacted ordinances equally or more strict than the statewide regulation. Dallas and Hickory Counties have local sanitarians, while Webster County is currently served by the Springfield Office (MDH). Laclede County has not enacted a local ordinance, so permits are issued by the Central Division Office (MDH).

Soil Erosion and Sedimentation

Although soil erosion in the watershed is considered to be fairly low at 2.5-5.0 tons per acre (MDNR, 1984), streambank erosion is a serious problem. Bank erosion is probably the main cause of excessive sediment bedload that is common throughout the watershed, and probably contributes to excessive turbidity and nutrification. Bank erosion frequently occurs because riparian woodlands have been cleared for pasture or are otherwise degraded. These problems are compounded by the fact that a high percentage of the watershed has been converted from woodland to pasture, and the runoff from pasture is much greater than the runoff from woodland.

Fire Disturbance

Manmade and natural fires are a common occurrence in the watershed during dry seasons and may increase runoff and erosion. MDC and rural fire department records were analyzed to determine the number of acres disturbed by fires between 1993 and 1995 (Table 20). The number of acres impacted is underestimated because high percentages of the reported fires did not include site descriptions (35-55%), so the watershed in which they occurred could not be determined. In addition, fire reports for Hickory and Webster counties were not included in the analysis. Most of the fires during this period occurred on forested land. Fires destroy the leaf litter and understory trees and brush that help reduce runoff and erosion in forests. Since most forest land occurs on sites with slopes too great to be cleared for pasture and most fires occur during

January and February when trees are bare, severe erosion is likely to occur after fires. MDC foresters have reported that some areas within the watershed, including the Tunnel Dam and Lead Mine areas, experience relatively large numbers of fires each year (Dennis Rhoades (MDC), pers. comm.). Spatial analysis of fire data was not performed for this inventory and assessment.

Water Use

The known major groundwater and surface water users in the watershed and within spring recharge areas are shown in Table 21 and Figure 20. There are no public water supply withdrawals from surface waters in the watershed. There are only four surface water users on record. The first, Sho-Me Power Corporation (R005) operates the Tunnel Dam Project for hydroelectric power generation. All of the water used for power generation is returned to the river 6.5 miles downstream from the dam. Since most of the flow of the NR during normal flows is used, this user can have a dramatic effect on water quality and aquatic life especially in the bypass loop. The utility must allow minimum flows in the bypass loop to maintain aquatic life (see Hydrology Section).

The MDC (R015) diverts water from Bennett Spring Branch for the Bennett Spring Trout Hatchery, and all the water is returned to the spring branch. Although there have been occasional complaints of turbid discharges due to periodic flushing of the raceways at the hatchery, no water quality problems have been documented. The two other surface water users, private landowners, are relatively minor users and there have been no documented problems associated with the identified use, farm irrigation.

The known groundwater users listed in Table 21 are mostly municipal water supply wells. They are included because of their potential impact on springs within the watershed. Some of these wells are located outside the surface watershed of the Niangua Watershed, but within recharge areas of watershed springs. (see Figure 11).

Tunnel Dam/Lake Niangua is the only hydropower facility operating within the watershed, however operation of Bagnell Dam (LOZ) can also impact this watershed. Sudden changes in water level when fish are spawning may reduce reproductive success. Changes in pool level are usually not of sufficient magnitude to seriously impact fish populations or recreational users during the remainder of the year.

Air Quality

There are no known air quality problems in the Niangua Watershed. The closest sources of industrial air contaminants are Springfield (40 miles to the southwest) and Kansas City (80 miles to the northwest). Prevailing winds could carry contaminants from either of these sources. The high alkalinity of watershed streams and lakes protects them from acidification due to acid rain. The MDNR Toxic Release Inventory (TRI) does not include any significant sources of airborne contaminants within the watershed.

Table 21. Major groundwater and surface water users within the Niangua Watershed and spring recharge area.

Site Number	User	Use	Twp	Rng	Sec	Topographic Map
R001	City/Camdenton (Rodeo)	Municipal Water Supply[2]	38	17	26	Green Bay Terrace
R002	City/Camdenton (Blair)	Municipal Water Supply[2]	38	17	26	Green Bay Terrace
R003	City/Camdenton (Mulberry)	Municipal Water Supply[2]	38	17	25	Green Bay Terrace
R004	Lake View Care Inc.	Domestic Water Supply[2]	38	17	14	Green Bay Terrace
R005	Show-Me Power Electric Cooperative	Electric Power Generation[1]	37	17	19	Hahatonka
R006	Robert P. Brown	Domestic Water Supply[2]	35	19	19	Tunas
R007	Laclede Co. PWSD #1	Municipal Water Supply[2]	34	16	06	Lebanon
R008	Laclede Co. PWSD #1	Municipal Water Supply[2]	34	16	02	Lebanon
R009	Laclede Co. PWSD #1	Municipal Water Supply[2]	33	17	01	Brush Creek
R010	Laclede Co. PWSD #1	Municipal Water Supply[2]	34	16	03	Lebanon
R011	Laclede Co. PWSD #1	Municipal Water Supply[2]	34	17	02	Bennett Spring
R012	Laclede Co. PWSD #1	Municipal Water Supply[2]	36	16	30	Eldridge East
R013	Laclede Co. PWSD #1	Municipal Water Supply[2]	35	16	23	Eldridge East
R014	Laclede Co. PWSD #1	Municipal Water Supply[2]	33	16	07	Brush Creek
R015	State of Missouri	Fish culture[1]	35	17	31	Bennett Spring

R016	**City of Marshfield**	**Municipal Water Supply[2]**	**30**	**18**	**03**	**Marshfield**
R017	**City of Marshfield**	**Municipal Water Supply[2]**	**30**	**18**	**09**	**Marshfield**
R018	**City of Marshfield**	**Municipal Water Supply[2]**	**30**	**18**	**10**	**Marshfield**
R019	**Ralph Vineyard**	**Farm irrigation[1]**	**31**	**18**	**28**	**Beach**
R020	**Ralph Vineyard**	**Farm irrigation[2]**	**31**	**18**	**33**	**Marshfield**
R021	**Gilbert Lee**	**Farm irrigation[1]**	**36**	**18**	**10**	**Leadmine**

[1] surface water use

[2] groundwater use

All data except R021 were obtained from the MDNR Water User Database.

Figure 20. Major water users listed by the MDNR within the Niangua River Watershed and spring recharge area.