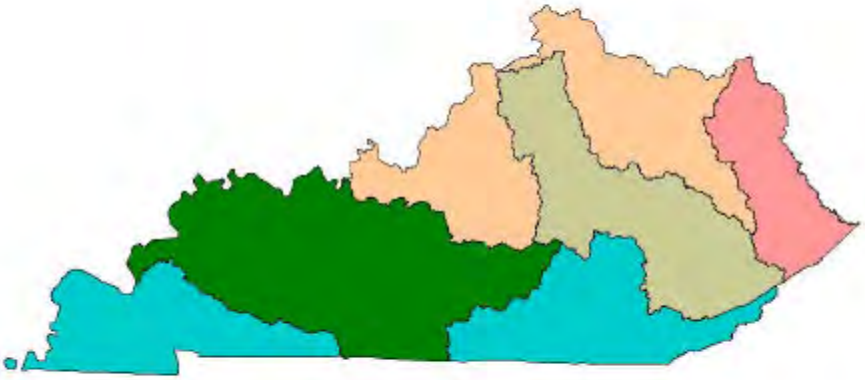
2004 Kentucky Report to Congress on Water Quality

with emphasis on the Green/Tradewater and Big Sandy/Little Sandy/Tygarts Basin Management Units



Kentucky Environmental and
Public Protection Cabinet
Division of Water
April 1, 2004

This report was printed with state funds on recycled paper.

ACKNOWLEDGMENTS

This report covers the fourth and fifth years of the intensive inter-agency watershed monitoring effort including work from state, federal and local agencies. The Kentucky Department of Fish and Wildlife Resources and their district fisheries biologists have played a key role in providing monitoring data for this report. The U.S. Army Corps of Engineers, Louisville District, contributed to planning, monitoring and data submittal on the reservoirs they manage in the Green/Tradewater Basin Management Unit. The Kentucky Division of Environmental Services provided analyses of all water quality samples submitted by Division of Water. Appreciation to staff in the following field offices: Bowling Green, Columbia, Hazard, Madisonville and Morehead, for collecting many of the surface water quality samples and analyzing bacteria samples. The Nonpoint Source Program of Kentucky Division of Water provided a 319 grant for biological and bacterial monitoring by Western Kentucky University in the Green/Tradewater Basin Management Unit. U.S. EPA National Health and Environmental effects Research Laboratory in Corvallis, Oregon provided the random monitoring design and analysis. Thanks to Kentucky Nature Preserves Commission for providing monitoring data. Thank you to those who have promoted the watershed effort through Kentucky Division of Water. I would like to thank all the staff in Water Quality and Groundwater branches of Kentucky Division of Water for their dedication to the efforts of monitoring and assessing the waters of the commonwealth. I am grateful to colleagues who made valuable comments on this report. Finally, a special thank you to secretaries Rita Hockensmith and Monica Kope for their work that was invaluable down the stretch in finalizing this report.

Randall G. Payne
Kentucky 305(b) Coordinator
April 2004

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Chapter 1. Introduction

This report was prepared by the Kentucky Division of Water (DOW) for submittal to the U.S. Environmental Protection Agency (EPA) to fulfill requirements of Section 305(b) of the Federal Water Pollution Control (or Clean Water) Act of 1972 (P.L. 92-500), as subsequently amended. Section 305(b) of the Act requires states to assess and report current water quality conditions to EPA every two years.

The DOW initiated a five-year rotating watershed management approach in 1997. Results from the first basin management unit (BMU), the Kentucky River, were reported in the 2000 305(b) report. The current (2004) report consists primarily of results from monitoring in the fourth and fifth BMUs, the Green/Tradewater BMU in 2001 and the Big Sandy/Little Sandy/ Tygarts BMU in 2002. The report also presents a summary of data from the entire state. Data collected by the Ohio River Valley Water Sanitation Commission (ORSANCO) were used to make assessments for the main stem of the Ohio River.

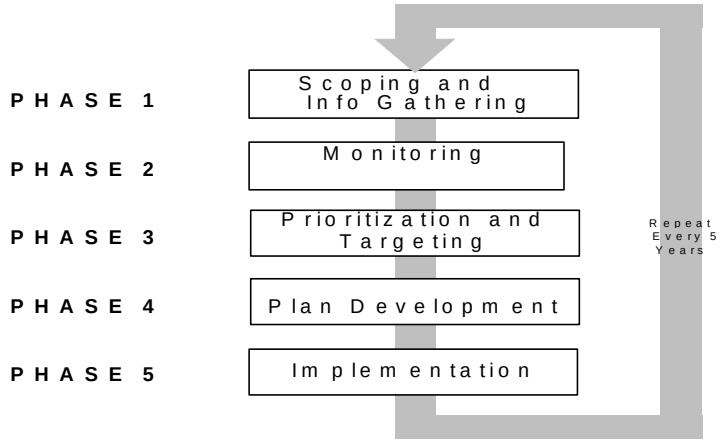
Impaired waters in the Green/Tradewater BMU identified by this report also are listed in the 2004 303(d) report (Kentucky Division of Water, 2004). However, there are reasons that some impaired waters are not 303(d)-listed. For example, compliance problems at facilities with adequate permits are not on the 303(d) report because the total maximum daily load (TMDL) has already been calculated and accounted for in the permit. These issues are discussed in more detail in the 303(d) report.

Chapter 2. Watershed Management Framework

In order to better characterize the waters of the state, and better coordinate resources toward addressing problems, Kentucky adopted a Watershed Management Framework in 1997. The purpose of this management framework is to use programs, people, information, and funds as efficiently as possible to protect, maintain, and restore water and land resources. This approach provides a framework in place and time within which participating individuals and institutions can link and support one another's efforts in watershed management.

According to the adopted framework, the state is divided into five basin management units (see Figure 2-1 and Schedule below) for the purposes of focusing management activities spatially. Activities within each unit follow a five-year schedule, staggered by one year, so that efforts can be better focused temporally within a basin. Phases in the cycle include: (1) collecting information about water resources in the basin; (2) identifying priority watersheds; (3) listing the watersheds in the basin in order of priority and deciding which problems can be solved with existing funds; (4) determining how best to solve the problems in the watershed; (5) developing an action plan; (6) and carrying out the strategies in the plan. Public participation is also encouraged throughout the process, allowing citizens and organizations to stay informed and have an active role in management of the resource.

Monitoring and assessment take place in the second and third years, respectively, of the watershed cycle.



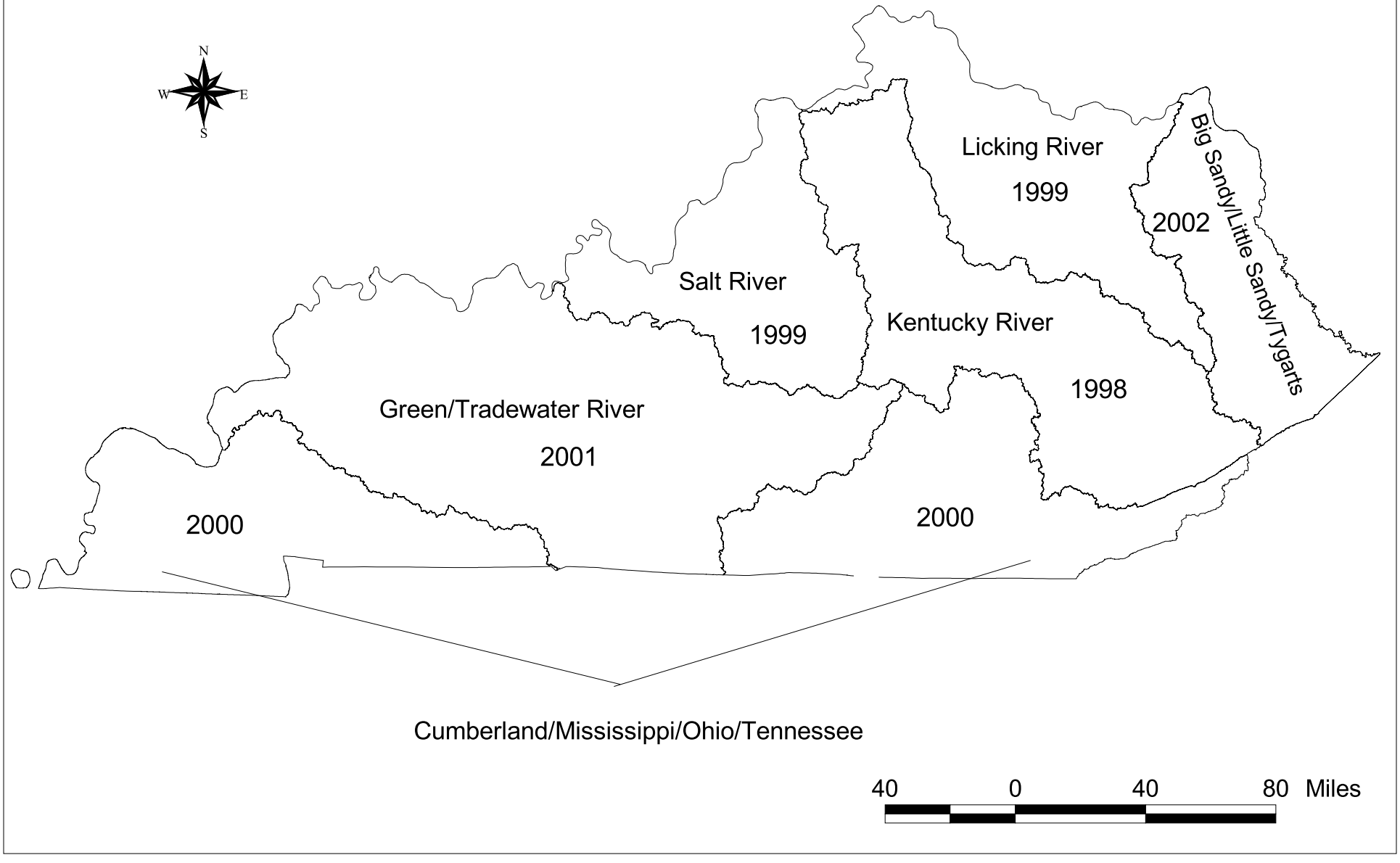
Each basin was phased into the Watershed Framework schedule as listed below. Monitoring activities begin in the second year of the cycle.

- July 1997 – Kentucky River basin
- July 1998 – Salt and Licking river basins
- July 1999 – Cumberland, Tennessee, and Mississippi river basins
- July 2000 – Green and Tradewater river basins
- July 2001 – Big Sandy River, Little Sandy River , and Tygarts Creek Basins

Benefits of this approach include:

- Better coordination of resource management activities around common basin management units and schedules.
- Better ability to stretch limited dollars for implementation activities through partnering.
- Better information about water resources without higher monitoring costs.
- More data as monitoring efforts are coordinated – approximately a four-fold increase in assessment data has been realized since the inception of the watershed approach in 1998.
- Better data as agencies standardize methods and procedures.
- Greater opportunities for citizen involvement.

Figure 2-1. Kentucky Basin Management Units and monitoring years of initial five-year cycle.



Chapter 3. Rivers and Streams

3.1 Data Collection

The water quality assessments of rivers and streams were based on the support of designated uses in waters depicted on U.S. Geological Survey (USGS) 1:100,000 scale topographic maps. According to EPA's National Hydrologic Dataset (NHD), these maps contain 49,171 stream miles for the entire state – 11,743 miles in the Green/Tradewater BMU and 4,586 miles in Big Sandy/Little Sandy/Tygarts BMU, distributed as follows in the major river basins:

Green River Basin (incl. Ohio River Basin)……10,933
Tradewater River Basin (incl. Ohio River Basin) ...……. 2,224
Big Sandy River Basin ……. 2,907
Little Sandy River Basin …….. 1,102
Tygarts Creek Basin ……... 677

For this report, monitoring occurred in 16 of the state's 42 8-digit HUCs (hydrologic unit codes) established by the U.S. Geological Survey (Figure 3-1). In the Green/Tradewater BMU, 337 stream segments are assessed on 237 streams (Figure 3-2), and 181 stream segments are assessed on 152 streams in the Big/Little Sandy and Tygarts BMU (Figure 3-3). Totals for both these basins include the adjacent Ohio River minor tributaries. Most of these assessments stemmed from intensive multi-agency watershed monitoring in 2001 and 2002. However, some data more than five years old were considered valid, and some data collected after 2002 were used for this reporting period.

Biological assessments for aquatic life use only were also determined using a random (probabilistic) survey approach. Seventy-six stream sites were monitored in the Green/Tradewater BMU (Table 3-1 and Figure 3-4). This random approach was also implemented in the Big Sandy/Little Sandy/Tygarts BMU (Table 3-2 and Figure 3-5), where 51 stream sites were monitored for aquatic life use.

Volunteer monitoring bacteria data were used as a screening tool but were not used directly in assessments of use support. Additional bacteria data were collected by DOW and contractors funded through a Section 319(h) grant on many of the streams identified as problematic by volunteer data. In the future, DOW will use volunteer data more directly, applying them to waterbody assessments.

Figure 3-1. Eight-digit HUCs comprising the Green/Tradewater and Big Sandy/Little Sandy/ Tygarts Basin Management Units.

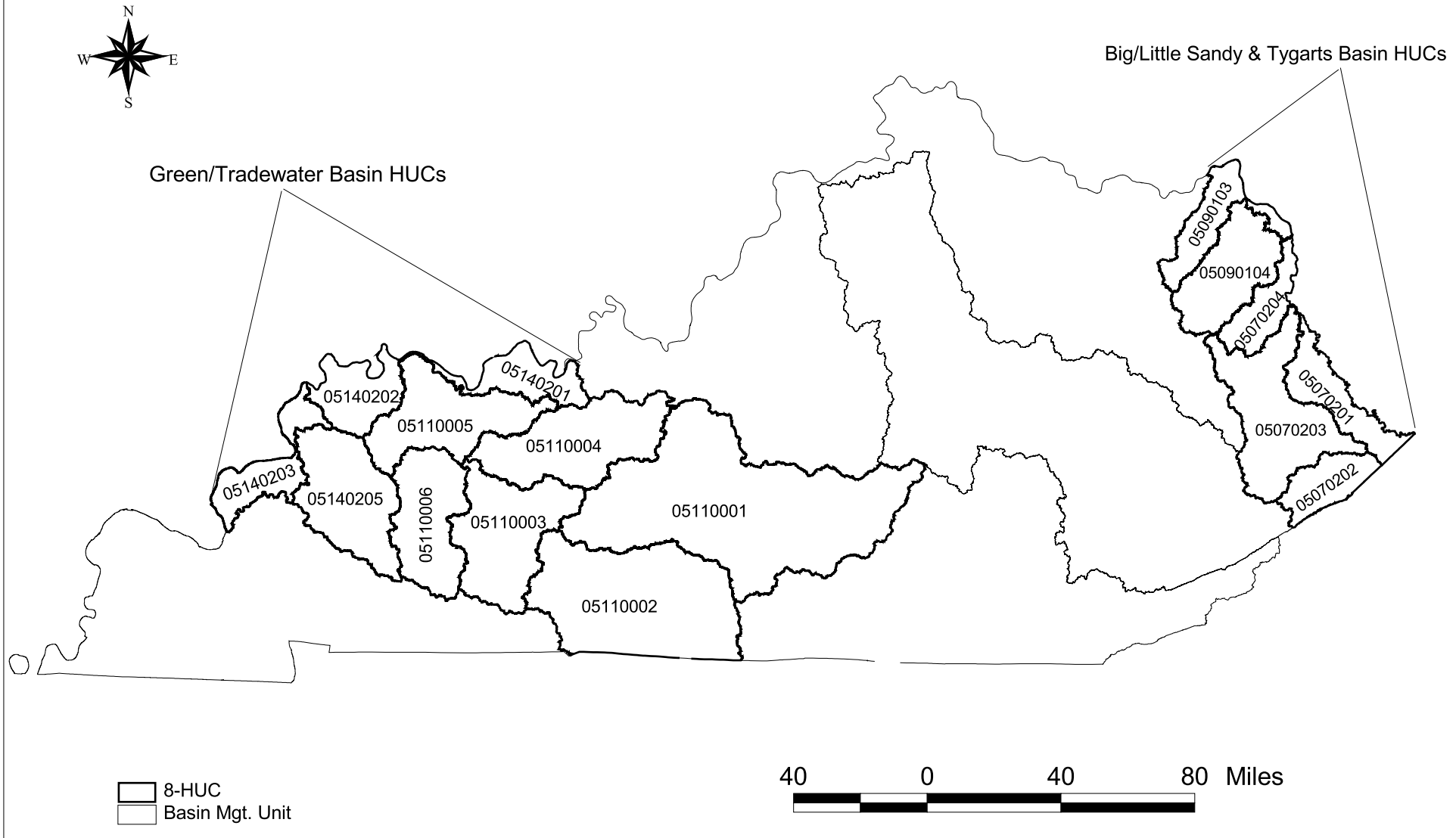


Fig. 3-2. Targeted Monitoring in Green/Tradewater River Basin Management Unit.

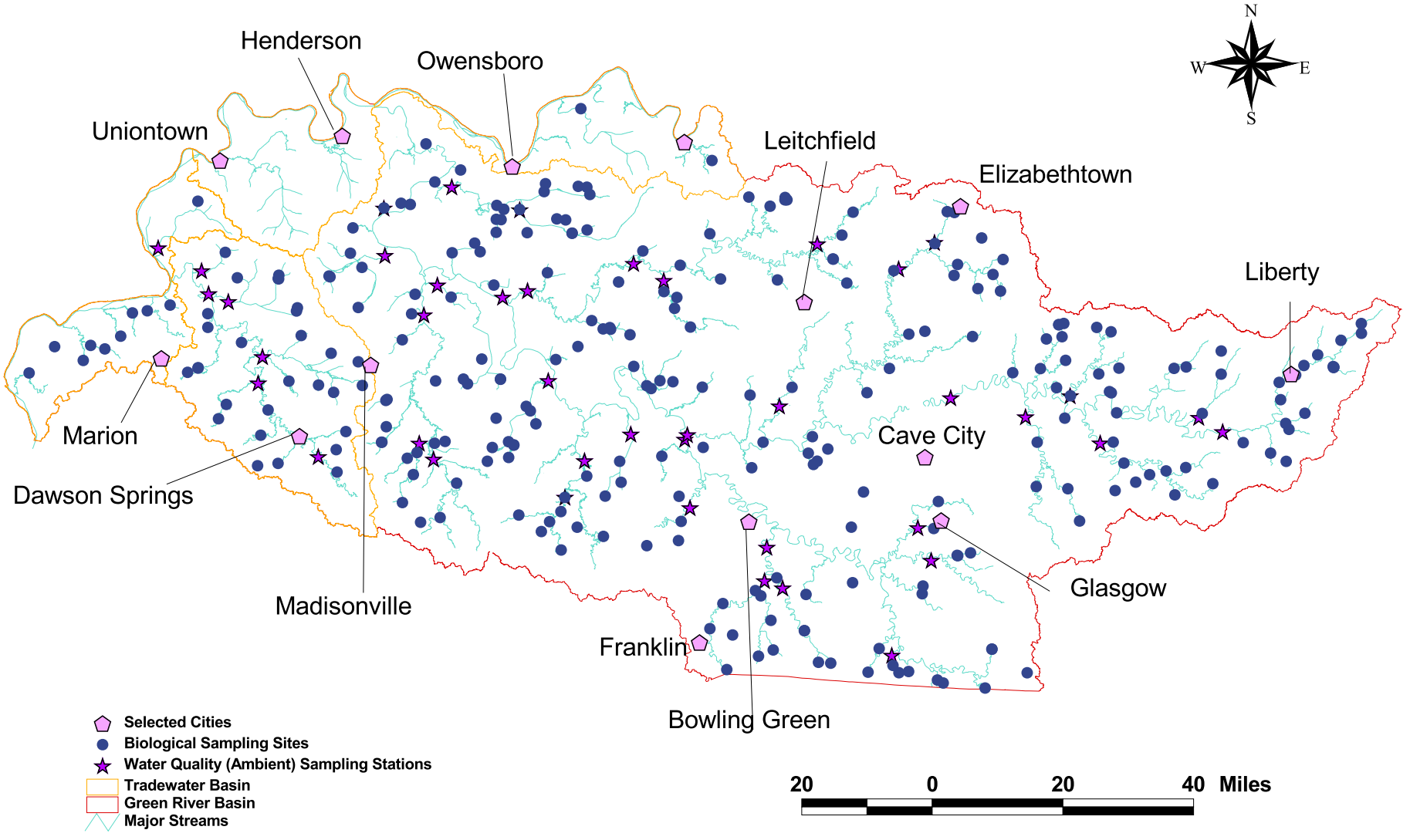


Figure 3-3. Targeted monitoring in the Big Sandy/Little Sandy/Tygarts Basin Management Unit.

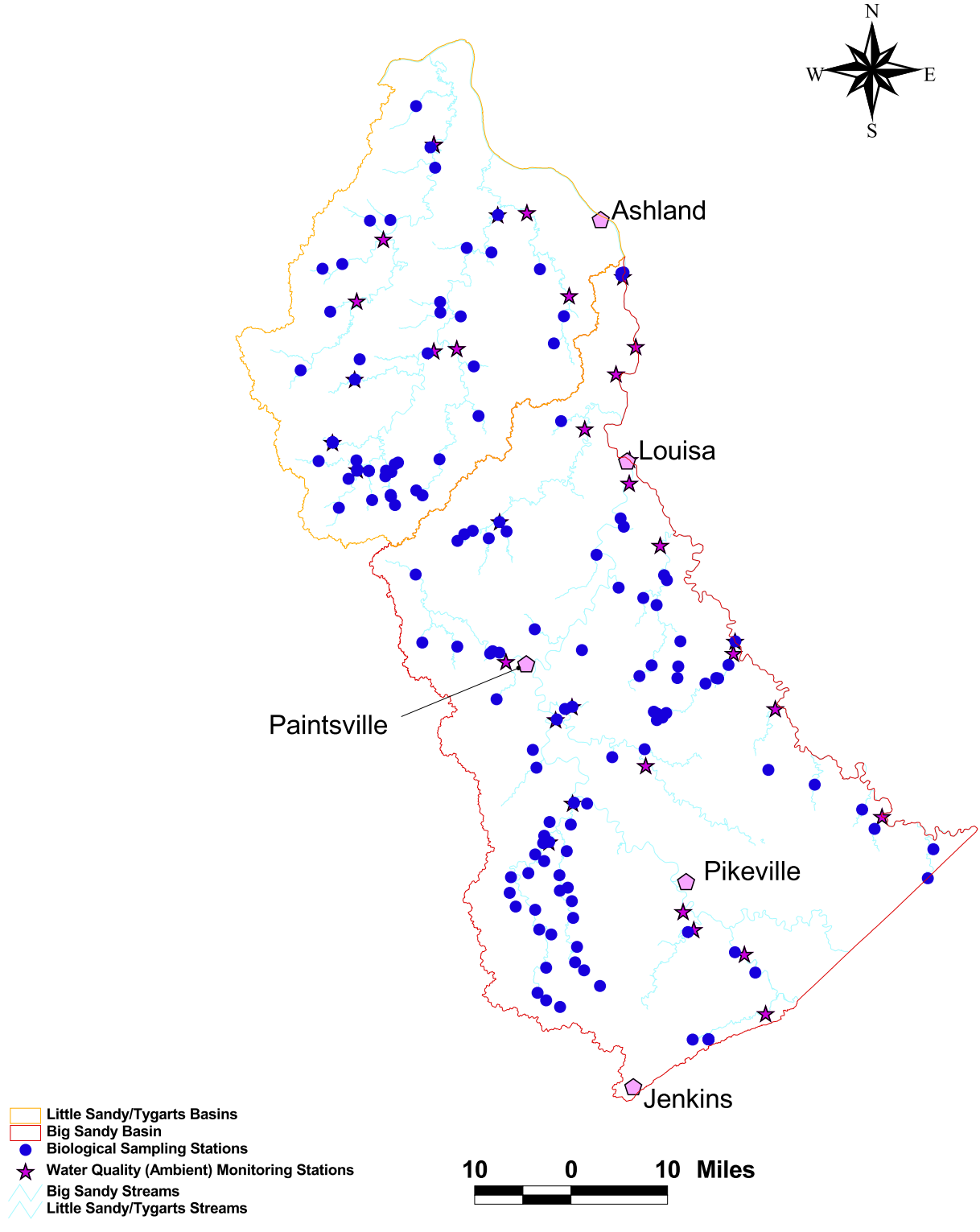


Table 3-1. Key to stream names sampled and assessed in the Green/Tradewater BMU using probabilistic methodology.

1. Old Panther Cr.
2. Clay Lick Cr.
3. West Fork Pond R.
4. Skaggs Cr.
5. Bacon Cr.
6. Indian Camp Cr.
7. Deer Cr.
8. Green R.
9. Long Fork Salt Lick Cr.
10. Long Lick Cr.
11. West Fork Drakes Cr.
12. Russell Cr.
13. Little Muddy Cr.
14. Big Brush Cr.
15. *UT Hatter Cr.
16. Nolin R.
17. *UT Wiggington Cr.
18. Sulphur Cr.
19. Bull Run
20. Deer Cr.
21. Taylor Fork
22. Pond R.
23. Little Barren R.
24. Grassy Cr.
25. Deer Cr.
26. Little Beaverdam Cr.
27. Casey Cr.
28. *UT West Fork Lewis Cr.
29. Trammel Cr.
30. Sunfish Cr.
31. *UT Cool Springs Cr.
32. Old Panther Cr.
33. Middle Pitman Cr.
34. Sulphur Fork Cr.
35. Bear Run Fork
36. Thompson Br.
37. *UT Butler Cr.
38. Tyson Br.
39. Drakes Cr.
40. Clifty Cr.
41. Piney Cr.
42. Ward Cr.
43. Adams Fork Rough R.
44. South Fork Little Barren R.
45. Crooked Cr.
46. East Fork Pond R.
47. Highland Cr.
48. Lindy Cr.
49. Jenny Hollow Br.
50. Narge Cr.
51. *UT Bull Run Cr.
52. Puncheon Cr.
53. Gilles Ditch
54. Pigeonroost Cr.
55. Forbes Cr.
56. *UT Slover Cr.
57. Salt Lick Cr.
58. Dorsey Run
59. Jarrett Fork
60. Casey Cr.
61. *UT Middle Pittman Cr.
62. *UT Flat Cr.
63. *UT Mays Run
64. West Fork Drakes Cr.
65. Beaverdam Cr.
66. Deer Cr.
67. Bear Cr.
68. Sycamore Br.
69. South Fork Panther Cr.
70. Wolf Lick Cr.
71. Sount Fork Little Barren R.
72. East Fork Little Barren R.
73. Bayou Cr.
74. West Fork Pond R.
75. Goose Pond Ditch
76. *UT Pond Cr.

*UT= unnamed tributary

Figure 3-4. Probabilistic monitoring sites in the Green/Tradewater Basin Management Unit.

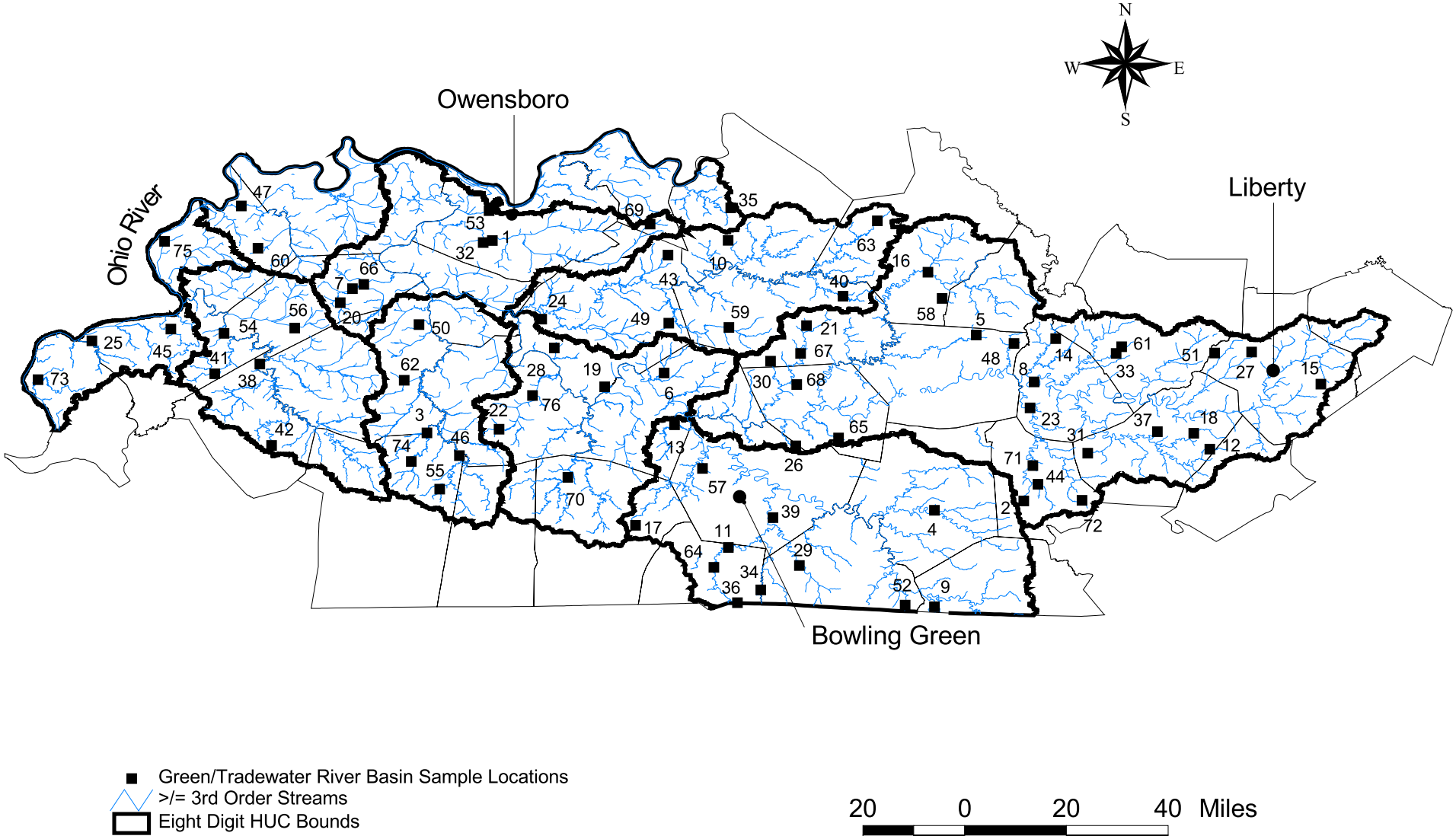
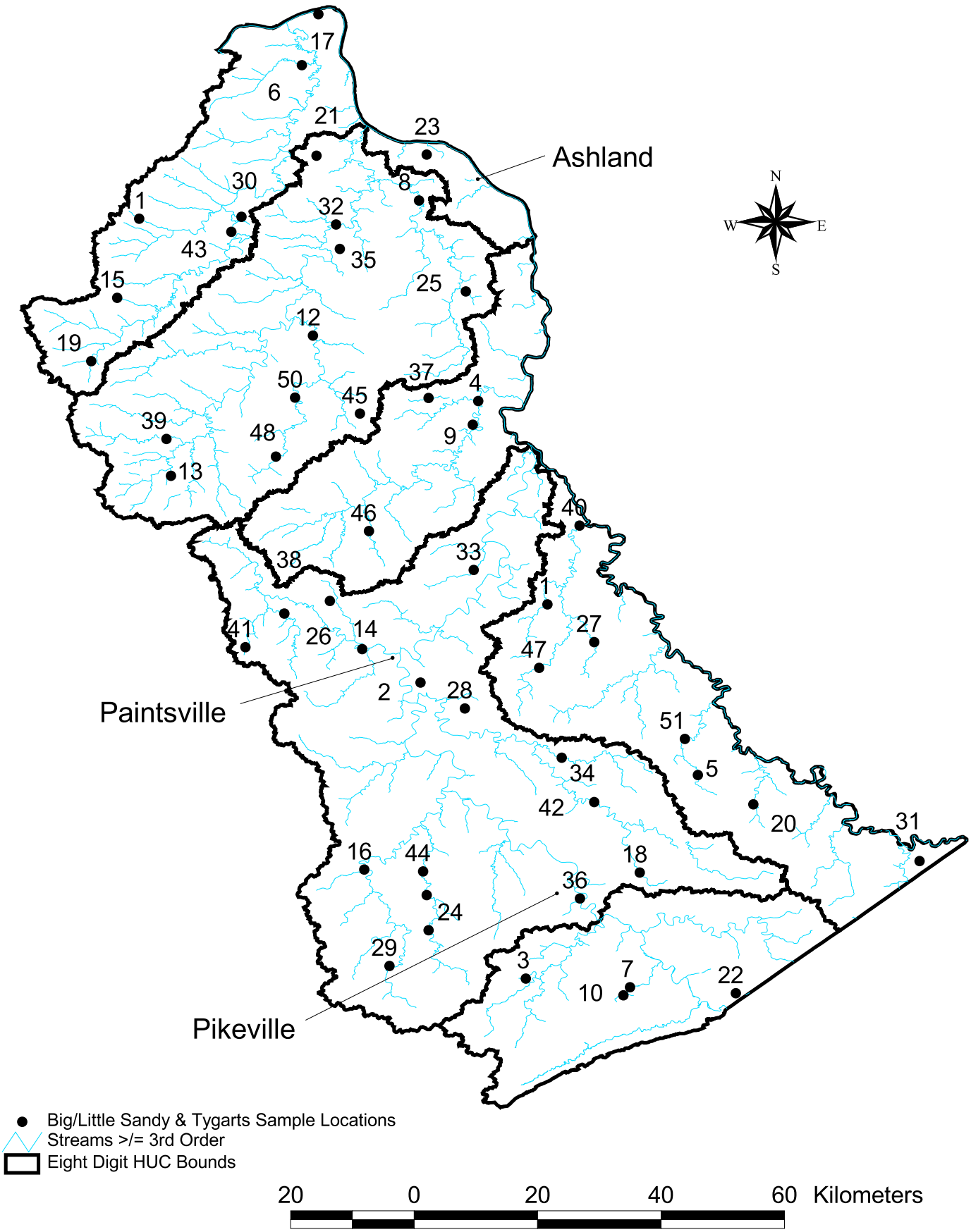


Table 3-2. Key to stream names sampled and assessed in the Big Sandy/Little Sandy/Tygarts BMU using probabilistic methodology.

1. Rockhouse Fk.
2. Miller Cr.
3. Indian Cr.
4. Blaine Cr.
5. Big Cr.
6. Schultz Cr.
7. Marrowbone Cr.
8. Lost Cr.
9. Blaine Cr.
10. Marrowbone Cr.
11. Smith Cr.
12. Little Fk. Little Sandy R.
13. Left Fk. Redwine Cr.
14. Paint Cr.
15. Trough Camp Cr.
16. Right Fk. Beaver Cr.
17. Newberry Cr.
18. Raccoon Cr.
19. Tygarts Cr.
20. Pond Cr.
21. Allcorn Cr.
22. Wolfpen Br.
23. UT Chinns Br.
24. Left Fk. Beaver Cr.
25. Ellingtons Cr.
26. Sturgeon Cr.
27. Coldwater Fk.
28. Long Br.
29. Right Fk. Beaver Cr.
30. Backs Br.
31. Lower Elk Cr.
32. Laurel Cr.
33. Georges Cr.
34. Left Fk. Johns Cr.
35. Tunnel Br.
36. Island Cr.
37. Little Cat Fk.
38. Little Paint Cr.
39. Laurel Cr.
40. Rockcastle Cr.
41. Big Mine Fk.
42. Johns Cr.
43. Tygarts Cr.
44. Left Fk. Beaver Cr.
45. Caney Fk.
46. Hood Cr.
47. Middle Fk. Rockcastle Cr.
48. Little Fk. Little Sandy R.
49. Left Fk. Beaver Cr.
50. Little Fk. Little Sandy R.
51. Big Cr.

Figure 3-5. Probabilistic monitoring sites in the Big Sandy/Little Sandy/Tygarts Basin Management Unit.



3.1.1 Ambient (Long-Term) Monitoring Network

Water Quality. DOW's statewide ambient water quality monitoring network was increased from 44 to 70 fixed stations with the initiation of intensive monitoring under the watershed approach in May 1998. Ambient stations are located in the downstream and mid-unit reaches of USGS 8-digit hydrologic (cataloging) units, upstream of major reservoirs and in the downstream reaches of major tributaries. The Big Sandy/Little Sandy/Tygarts BMU contains nine ambient stations and the Green/Tradewater BMU has 18 ambient water quality stations (Table 3-3). The ambient stations of a watershed management unit are sampled monthly during the year the unit is in the monitoring phase of the watershed cycle. During the other four years of the watershed cycle, sampling frequency is reduced to bimonthly to devote more monitoring and laboratory resources to the rotating watershed water quality network (described later). Field measurements are taken for pH, dissolved oxygen, specific conductance and temperature, and samples are analyzed for nutrients, metals and also pesticides and herbicides if the streams are in predominantly agricultural areas. The purpose of the ambient water quality sampling is to assess long-term conditions and trends on rivers and the larger streams of the state. In addition to DOW's network, long-term stations are maintained by ORSANCO on the lower Licking, lower Big Sandy, lower Green, lower Tennessee and lower Cumberland rivers and by the USGS on the lower Tennessee River.

Sediment Quality. Sediment quality is determined at the ambient stations during the year in which monitoring occurs in a watershed management unit. At this time, sediment data supplement other data types; the data are not used directly in assessments of use support.

Biology. Fish, macroinvertebrate and algae data from the ambient stations provide long-term and trend information on mainstem rivers and many major tributaries. These stations will be revisited every five years. Most of the ambient biological stations are located on streams that also have water quality monitoring.

Fish Tissue. Fish tissue samples were obtained from 23 sites in the Green/Tradewater BMU and 14 sites in the Big Sandy/Little Sandy/Tygarts Creek BMU. Tissue is analyzed for metals, including mercury, PCBs, chlordane, pesticides and herbicides. Results are used to determine if there are potential problems with contaminants in fish tissue that required further sampling. If results are not elevated, no further fish tissue sampling is conducted.

Table 3-3. Statewide primary water quality stations with Green/Tradewater and BigSandy/Little Sandy/Tygarts Creek BMUs highlighted in bold type.

River Basin	Station	HUC	Mile-Point	Location	Latitude	Longitude	Drainage (mi^2)	Type
Big Sandy								
Tug Fork	**2**	**05070201**	**35.1**	**at Kermit, WV**	**37 50 16**	**-82 24 35**	**1,280**	**hydrologic unit index site**
Tug Fork	**3**	**05070201**	**77.7**	**at Freeburn**	**37 33 58**	**-82 08 38**	**271**	**mid-hydrologic unit index site**
Levisa Fork	**6**	**05070202**	**115.0**	**nr Pikeville**	**37 27 51**	**-82 08 38**	**1,232**	**hydrologic unit index site**
Levisa Fork	**64**	**05070203**	**29.6**	**nr Louisa**	**38 04 50**	**-82 36 01**	**2,326**	**hydrologic unit index site**
Levisa Fork	**94**	**05070203**	**75.0**	**at Auxier**	**37 43 44.2**	**-82 45 16.1**	**1,726**	**mid-hydrological unit index site**
Beaver Creek	**95**	**05070203**	**95.0**	**at Allen**	**37 36 09.6**	**-82 43 39.4**	**240**	**major tributary**
Johns Creek	**96**	**05070203**	**26.6**	**at McCombs**	**37 39 19.1**	**-82 31 33.2**	**168**	**infloto Dewey Res. Major trib.**
Little Sandy								
Little Sandy River	**49**	**05090104**	**13.2**	**at Argillite**	**38 29 26**	**-82 50 03**	**522**	**hydrologic unit index site**
Tygarts Creek								
Tygarts Creek	**48**	**05090103**	**23.5**	**nr Lynn**	**38 35 58.9**	**-82 57 10.1**	**242**	**hydrologic unit index site**
Ohio River Tributaries								
Kinniconick Creek	63	05090201	10.4	nr Tannery	38 32 37	-83 13 28	230	major tributary
Licking River								
Licking River	62	05100101	226	at West Liberty	37 54 53	-83 15 43	335	inflow to Cave Run Reservoir
Slate Creek	93	05100101	10.0	nr Owingsville	38 08 29.3	-83 15 43	230	major tributary
Licking River	61	05100101	78.2	at Claysville	38 31 14	-84 11 00	1993	mid-hydrologic unit index site
N. Fk. Licking R.	60	05100101	6.9	nr Milford	38 35 50	-84 09 20	290	major tributary
S. Fk. Licking R.	59	05100102	11.7	at Morgan	38 36 12	-84 24 03	839	hydrologic unit index site
Hinkston Creek	102	05100102	0.2	at Ruddles Mill	38 18 16.6	-84 14 16.5	260	major tributary
Stoner Creek	101	05100102	0.6	nr Ruddles Mill	38 18 10.3	-84 14 58.9	284	major tributary
Salt River								
Salt River	29	05140102	22.9	at Shepardsville	37 59 06	-85 43 03	1,197	hydrologic unit index site
Salt River	52	05140102	82.5	at Glensboro	38 00 08	-85 03 35	172	major reservoir inflow
Brashears Creek	105	05140102	1.2	at Taylorsville	38 02 14	-85 20 26	262	major tributary
Floyds Fork	100	05140102	7.4	nr Shepardsville	38 02 06	-85 39 34	259	major tributary
Rolling Fork	57	05140103	12.3	nr Lebanon Jct.	37 49 23	-85 44 53	1,375	hydrologic unit index site
Beech Fork	41	05140103	48.0	nr Maud	37 49 58	-85 17 46	436	major tributary
Kentucky River								
Eagle Creek	22	05100205	21.5	Glencoe	38 42 22	-84 49 32	437	hydrologic unit index site
Kentucky River	24	05100205	64.8	Frankfort	38 12 46.3	-84 52 21.5	5,412	hydrologic unit index site
Kentucky River	66	05100205	30.5	Lockport	38 26 42	-84 57 25	6,180	hydrologic unit index site
Kentucky River	67	05100205	119.0	High Bridge	37 49 08.9	-84 42 23.3	5,036	hydrologic unit index site
Elkhorn Creek	98	05100205	10.3	Peaks Mill	38 16 06.9	-84 48 52.3	473	major tributary
Dix River	45	05100205	34.7	nr Danville	37 38 30	-84 39 39	318	hydrologic unit index site
Silver Creek	99	05100205	5.9	Ruthion	37 43 58	-84 26 13.2	100	major tributary
Kentucky River	58	05100204	191.0	nr Trapp	37 50 48	-84 04 52	3,236	hydrologic unit index site
Red River	46	05100204	21.6	Clay City	37 51 55	-83 56 00	362	hydrologic unit index site
N. Fk. Kentucky R.	31	05100201	49.7	Jackson	37 33 04	-83 23 04	1,101	hydrologic unit index site
Troublesome Creek	90	05100201	7.2	nr Clayhole	37 28 30	-83 16 46.2	187	major tributary
Middle Fk. KY R.	32	05100202	8.4	Tallega	37 33 18	-83 35 38	537	hydrologic unit index site
S. Fk. Kentucky R.	33	05100203	12.1	Booneville	37 28 30	-83 40 14	722	hydrologic unit index site
Red Bird River	91	05100203	50.4	nr Onieda	37 14 12.6	-83 38 42.5	190	major tributary
Goose Creek	92	05100203	3.4	nr Oneida	37 14 13.3	-83 40 15.6	250	major tributary

Table 3-3 (cont.). Statewide primary water quality stations with Green/Tradewater and Big Sandy/Little Sandy/Tygarts BMUs highlighted in bold type.

River Basin	Station	HUC	Mile-Point	Location	Latitude	Longitude	Drainage (mi^2)	Type
Cumberland River								
Cumberland River	86	05130101	661	at Calvin	36 43 19.7	-83 37 31.9	770	mid-hydrologic unit index site
Cumberland River	9	05130101	563	at Cumberland Falls	36 50 08	-84 20 25	1,977	hydrologic unit index site
Clear Fork	87	05130101	0.9	nr Williansburg	36 43 33.2	-84 08 32.6	370	major tributary
Rockcastle River	10	05130102	24.7	at Billows	37 10 17	-84 17 48	604	hydrologic unit index site
Horse Lick Creek	51	05130102	0.1	nr Lamero	37 19 13.3	-84 08 19.2	62	special interest watershed
Cumberland River	7	05130103	423	nr Burkesville	36 44 46.5	-85 22 18.2	6,053	hydrologic unit index site
Buck Creek	88	05130103	12.3	nr Dykes	37 03 36.3	-84 25 34.9	294	major tributary
S. Fk. Cumberland R.	8	05130104	44.8	at Blue Heron	36 40 13	-84 32 56	954	hydrologic unit index site
Little River	43	05130205	24.4	nr Cadiz	36 50 26	-87 46 39	269	major tributary
Red River	69	05130205	49	nr Keysburg	36 38 26.9	-86 58 44.7	509	hydrologic unit index site
Green River								
Green River	**18**	**05110001**	**226**	**at Munfordville**	**37 16 07.2**	**-85 5307.0**	**1,673**	**hydrologic unit index site**
Green River	**76**	**05110001**	**334**	**at Neatsville**	**37 11 30.9**	**-85 07 49.1**	**339**	**major reservoir inflow**
Nolin River	**21**	**05110001**	**80.9**	**at White Mills**	**37 33 18**	**-86 01 52**	**357**	**major reservoir inflow / trib**
Russell Creek	**77**	**05110001**	**10.0**	**nr Bramlett**	**37 10 04.1**	**-85 28 12.6**	**289**	**major tributary**
Little Barren River	**78**	**05110001**	**6.3**	**nr Monroe**	**37 13 35.2**	**-85 40 39.2**	**256**	**major tributary**
Bear Creek	**75**	**05110001**	**11.8**	**nr Huff**	**37 14 55.8**	**-86 21 40.4**	**159**	**major tributary**
Barren River	**72**	**05110002**	**1.0**	**nr Woodbury**	**37 10 23.8**	**-86 37 23.5**	**1,968**	**hydrologic unit index site**
Barren River	**73**	**05110002**	**114**	**nr Holland**	**36 41 46.8**	**-86 02 48.2**	**398**	**major reservoir inflow**
Drakes Creek	**74**	**05110002**	**8.0**	**nr Bowling Green**	**36 56 05.7**	**-86 23 34.7**	**502**	**major tributary**
Green River	**55**	**05110003**	**72**	**at Livermore**	**37 29 03.1**	**-87 08 04.0**	**6,431**	**hydrologic unit index site**
Mud River	**56**	**05110003**	**17.4**	**nr Gus**	**37 07 24**	**-86 46 15**	**268**	**major tributary**
Green River	**103**	**05110003**	**150**	**nr Woodbury**	**37 11 00.4**	**-86 36 57.5**	**3,140**	**hydrologic unit index site**
Rough River	**14**	**05110004**	**62.5**	**nr Dundee**	**37 33 46**	**-86 46 15**	**757**	**mid-hydrologic unit index site**
Rough River	**54**	**05110004**	**1.0**	**nr Livermore**	**37 29 03.1**	**-87 07 07.6**	**1,068**	**hydrologic unit index site**
Panther Creek	**70**	**05110005**	**5.4**	**nr W. Louisville**	**37 43 38.3**	**-87 16 50.5**	**374**	**major tributary**
Pond River	**12**	**05110006**	**12.4**	**nr Sacramento**	**37 23 42**	**-83 41 36**	**523**	**hydrologic unit index site**
Ohio River Tributaries								
Highland Creek	**71**	**05140102**	**5.5**	**nr Uniontown**	**37 47 00.7**	**-87 52 08.5**	**237**	**major tributary**
Tradewater River								
Tradewater River	**53**	**05140205**	**15.1**	**nr Sullivan**	**37 28 46.0**	**-87 57 13**	**861**	**hydrologic unit index site**
Tennessee River								
Clarks River	106	06040006	14.3	nr Sharpe	36 58 18.5	-88 30 53.9	313	hydrologic unit index site
W. Fork Clarks R.	107	06040006	7.8	nr Symsonia	36 55 56.9	-88 32 37.6	187	major tributary
Mississippi River								
Bayou de Chien	37	08010201	11.2	nr Moscow	36 36 54.8	-89 01 48.4	69	major tributary
Mayfield Creek	42	08010201	10.8	nr Magee Springs	36 55 47.6	-88 56 34.7	300	major tributary

3.1.2 Rotating Watershed Network

Water Quality. An inter-agency monitoring team established several objectives for the one-year watershed water quality monitoring stations. The objectives were to: (1) obtain an overall representation of the quality of the basin's water resources; (2) determine water quality conditions associated with major land cover/land uses such as forest, urban, agriculture and mining; (3) characterize the basin's least impacted waters; and (4) collect data for establishing total maximum daily loads (TMDLs) as required by Section 303(d) of the Clean Water Act. Parameters analyzed were similar to those described earlier for the ambient network.

The Division of Environmental Services, the laboratory of the Kentucky Environmental and Public Protection Cabinet, analyzed water quality samples collected by the DOW. The rotating watershed water quality monitoring network consisted of 26 stations in the Green/Tradewater BMU and 25 stations in the Big/Little Sandy River and Tygarts Creek BMU (Table 3-4). These usually were located at the downstream reaches of USGS 11-digit watersheds, and many were coupled with biological sampling and with USGS gauging stations. Monthly sampling, sometimes complemented by rain event sampling, was conducted over the 12-month watershed monitoring period (April 2001 – March 2002 in the Green/Tradewater River BMU and April 2002 – March 2003 in the Big/Little Sandy River and Tygarts BMU) to characterize water quality of each watershed represented.

Section 319(h) nonpoint source grant monies were used to fund additional bacteriological monitoring by Western Kentucky University (WKU) at 36 sites in the Green/Tradewater BMU. Site selection was based largely on bacteria problems indicated from data collected by the basin volunteer Watershed Watch groups and to obtain data on streams with recreation potential. Also, DOW continued to sample areas with long-standing swimming advisories in three basins: 24 sites in the upper Cumberland River basin on nine streams, 20 sites in the Northern Kentucky area (lower Licking River Basin) and 29 sites in the North Fork Kentucky River Basin from Chavies to the headwater.

Table 3-4. Rotating watershed water quality stations, April 2001 through March 2003.

Site ID	Stream	Latitude	Longitude	Milepoint	Description
		Green/Tradewater River BMU			
GRN001	Dennis O'Nan Ditch	37.5791	-88.0978	2.1	nr DeKoven
GRN002	Cypress Creek	37.5305	-87.9751	2.2	at Sturgis
GRN003	Craborchard Creek	37.4634	-87.8983	2.3	nr Wheatcroft
GRN004	Clear Creek	37.3425	-87.8003	1.6	nr Providence
GRN005	Donaldson Creek	37.284	-87.8101	2.2	nr Fryer
GRN006	Tradewater River	37.123	-87.6392	102.2	at Hopkins Park Rd.
GRN007	Canoe Creek	37.802	-87.6248	3.3	at Henderson
GRN009	S. Fk. Panther Creek	37.6793	-87.0907	1.7	nr Sutherland
GRN010	Sputzman Creek	37.6778	-87.47	1.4	nr Niagra
GRN011	Blackford Creek	37.8989	-86.9866	3.3	nr Maceo
GRN012	Deer Creek	37.573	-87.4651	3.0	nr Sebree
GRN013	Cypress Creek	37.509	-87.3168	3.1	nr Rumsey
GRN014	W. Fk. Pond R.	37.1569	-87.3599	2.2	nr Mt. Carmel
GRN015	Caney Creek	37.5261	-86.6865	2.5	nr Olaton
GRN016	Rough River	37.6098	-86.2588	129.2	at Hardin Springs
GRN017	Pond Creek	37.3005	-87.0046	0.3	nr Paradise
GRN018	Wolf Lick Creek	37.0416	-86.9541	4.0	nr Dunmore
GRN019	Muddy Creek	37.1837	-86.7732	5.0	nr Dunbar
GRN020	Gasper River	37.0217	-86.6068	11.9	nr Hadley
GRN021	W. Fk. Drakes Creek	36.8609	-86.3992	21.6	nr Matlock
GRN022	Trammel Fork	36.845	-86.3494	5.1	nr Allen Springs
GRN023	Beaver Creek	36.9898	-85.9754	10.5	nr Glasgow
GRN024	Skaggs Creek	36.9074	-85.939	21.3	nr Roseville
GRN025	Big Pitman Creek	37.273	-85.554	3.0	nr Greensburg
GRN026	Casey Creek	37.2239	-85.1967	3.7	nr Knifley
GRN027	Valley Creek	37.6135	-85.9314	2.1	nr Glendale
		Big Sandy/Little Sandy/Tygarts BMU			
BSW002	Little Fk. of Little Sandy River	38.2918	-82.9208	2.9	nr Hitchens
BSW003	Little Sandy River	38.2895	-82.9649	44.8	at Leon
BSW004	Little Sandy River	38.114	-83.1174	72.8	nr Sandy Hook
BSW005	Buffalo Creek	38.4594	-83.0546	0.4	nr Kehoe
BSW006	E. Fk. Little Sandy R.	38.4928	-82.779	5.1	nr Danleyton
BSW007	E. Fk. Little Sandy R.	38.3659	-82.7032	25.3	nr Cannonsburg
BSW008	Tygarts Creek	38.3675	-83.109	65.3	at Carter Caves SRP
BSW009	Big Sinking Creek	38.2499	-83.1173	10.7	nr Olive Hill
BSW010	Big Caney Creek	38.1561	-83.1627	7.8	nr Ordinary
BSW011	Hood Creek	38.4953	-82.6708	0.8	nr Ashland
BSW012	Shelby Creek	37.4067	-82.5071	2.6	nr Shelbiana
BSW013	Russell Creek	37.3669	-82.4135	4.0	nr Marrowbone
BSW014	Wolf Creek	37.8199	-82.414	1.3	nr Lovely
BSW015	Right Fk. Beaver Cr.	37.5458	-82.7748	3.3	at Waco
BSW016	Big Creek	37.7342	-82.3386	0.8	nr Nolan
BSW017	Elkhorn Creek	37.2765	-82.3776	2.5	nr Elkhorn City

Table 3-4 (cont.). Rotating watershed water quality stations, April 2001 through March 2003.

Site ID	Stream	Latitude	Longitude	Milepoint	Description
		Big Sandy/Little Sandy/Tygarts BMU			
BSW018	Blaine Creek	38.029	-82.8495	42.0	at Blaine
BSW019	Blaine Creek	38.1763	-82.6726	9.5	at Fallsburg
BSW020	Bear Creek	38.2458	-82.6186	1.0	at Buchanan
BSW021	Tug Fork	38.1169	-82.5988	0.1	at Louisa/Ft. Gay
BSW022	Rockcastle Creek	37.9859	-82.5455	3.3	nr Clifford
BSW023	Big Sandy River	38.3899	-82.5994	1.9	boat
BSW024	Big Sandy River	38.2857	-82.579	10.0	boat
BSW025	Paint Creek	37.8187	-82.8456	4.3	nr Paintsville
BSW026	Johns Creek	37.7479	-82.7229	4.4	nr Nero

3.1.3 Bioassessment Monitoring Programs

Introduction. There are four biological monitoring programs within the Kentucky Division of Water . Those programs have the same primary purpose of assessing the aquatic life use support of streams in the commonwealth. Although, each program is driven by broad objectives, together they provide a comprehensive program that addresses aquatic life use attainment from several approaches: (1) random, overall snapshot of the ambient conditions; (2) the integration of conditions in relatively large watersheds monitored for long-term trend evaluation; (3) impact assessments related to nonpoint source pollution and; (4) a regional reference program that assesses least impacted streams for development of metric benchmarks used to assess lotic ecosystems.

Reference Reach Program. In 1991, DOW began a Reference Reach (RR) program to gather data from the state's least impacted streams. Biologists first identified potential least impacted waters representative of geographic regions of the state known as ecoregions. Then, data on physicochemical water quality, sediment quality, fish tissue residue, habitat condition, and biotic conditions were collected to define the potential environmental quality for the streams of a particular ecoregion and allow other streams in the same ecoregion to be compared to the reference condition. Data from the reference reach program provided the basis for the development of narrative and numerical biocriteria for the various ecoregions of the commonwealth. Fifty-five stream sites from seven level III ecoregions were initially sampled in the spring and fall of 1992-1993. Since that time, many more potential reference reach streams

were sampled. Some were adopted as reference reach streams; others were rejected because they did not possess adequate quality to represent least impacted condition. Currently, there are 52 RR streams totaling 490 miles throughout the commonwealth (Table 3-5). Another 80 streams totaling 399 miles will be considered for inclusion during the upcoming triennial review of water quality standards. There are 15 (95.95 miles) existing and 48 proposed RR streams (including new segments) equaling 333.36 miles in the two BMUs covered in this report. A list of candidate RR streams in the two BMUs of interest occurs in Table 3-6.

Watershed Biological Monitoring Program (WBMP). The WBMP monitors streams in a fixed-station network so long-term trends can be tracked in the targeted fourth and fifth order watersheds. Targeted stations were placed in the downstream reaches of fourth, fifth and occasionally sixth order (on 1:24,000 scale USGS topographic maps) watersheds. One reason for this choice was that the number of these watersheds closely matched the available monitoring resources. Another favorable attribute of this design was that these watersheds were more hydrologically accurate and uniform in size than 11-digit watersheds. Most of these streams were monitored for at least one component of the biological community (fish, macroinvertebrate or algae).

Often, ambient water quality data were also collected at these locations. These stations will be revisited every five years.

Nonpoint Source Program (NPSP). The NPSP conducted biological monitoring focused on a myriad of watershed concerns related to pollutant degradation ranging from soil erosion and nutrient runoff from agricultural practices to urban runoff. Typically, fish and macroinvertebrate communities were targeted for assessment determination. Sample location priorities were gleaned from Kentucky nonpoint source assessment report (KDOW and UK, 1999).

Probabilistic Monitoring Program (PMP). The DOW conducted a random survey of wadeable streams (potential stream population are all first – fifth order) using locations generated by the EPA Office of Research and Development in Corvallis, Oregon. This probabilistic monitoring design was employed to statistically assess aquatic life use support on the majority of Kentucky's waters. This effort was designed for a basin unit with criteria provided to make a random, statistically valid selection from candidate streams to monitor for bioassessments that

Table 3-5. Reference reach streams[a] in Kentucky.

Stream	County	Location	Basin	Start Segment	End Segment	Total Miles
Cane Creek	Whitley	0.1 mi below Daylight Branch	Upper Cumberland	11.5	7	4.5
Bark Camp Creek	Whitley	U.S. Forest Service Rd 193 bridge	Upper Cumberland	7.6	2.6	5
Eagle Creek	McCreary	KY 896 bridge	Upper Cumberland	6.3	3	3.3
South Fork Dog Slaughter Creek	Whitley	1000 ft above foot bridge (Dog Slaughter Falls Trail)	Upper Cumberland	4.6	0	4.6
Buck Creek	Pulaski	Off Bud Rainey Rd	Upper Cumberland	62.6	28.9	33.7
Marsh Creek	McCreary	KY 478 bridge	Upper Cumberland	26.2	12.6	13.6
Horse Lick Creek	Jackson	Horse Lick Creek Rd at first ford	Upper Cumberland	21.2	1.9	19.3
Bad Branch	Letcher	0.2 mi above KY 932 bridge	Upper Cumberland	3.0	0	3
Beaverdam Creek	**Edmonson**	**KY 101-259 bridge**	**Green**	**14.0**	**7.6**	**6.4**
Gasper River	**Logan**	**0.2 mi above Bucksville Rd bridge**	**Green**	**38.0**	**32.3**	**5.7**
Trammel Fork	**Allen**	**0.1 mi below Red Hill Rd bridge**	**Green**	**30.15**	**19.4**	**10.75**
Lick Creek	**Simpson**	**0.1 mi above HWY 585 (265) bridge**	**Green**	**9.9**	**5.3**	**4.6**
Peter Creek	**Barren**	**HWY 3179; Oil Well Rd**	**Green**	**18.05**	**13.05**	**5**
Caney Fork	**Barren**	**0.1 mi below Hwy 3179 (Oil Well Rd)**	**Green**	**6.6**	**0.8**	**5.8**
Falling Timber Creek	**Metcalfe**	**Hwy 640 bridge crossing**	**Green**	**16.0**	**11.5**	**4.5**
Russell Creek	**Adair**	**0.15 mi below KY Hwy 80 at Gentry's Mill**	**Green**	**68.0**	**23.8**	**44.2**
Goose Creek	**Casey**	**Off Brock Rd**	**Green**	**14.6**	**5.6**	**9**
Drennon Creek	Henry	Flat Bottom Rd crossing	Kentucky	11.9	10.5	1.4
Indian Creek	Carroll	Hwy 36 bridge	Kentucky	4.7	0.55	4.15
Musselman Creek	Grant	Lawrenceville – Keefer Rd bridge	Kentucky	8.4	2.6	5.8
Clear Creek	Woodford	Hifner Rd bridge, 2.1 mi S of Mortonsville	Kentucky	19.0	4.1	14.9
Station Camp Creek	Estill	Off KY Hwy 1209 at Estill-Jackson County boundary	Kentucky	22.3	19	3.3
South Fork Station Camp Creek	Jackson	KY 89 bridge	Kentucky	48.6	5.3	43.3
Sturgeon Creek	Lee	Off Sturgeon Creek Rd	Kentucky	31.1	4	27.3
Gladie Creek	Menifee	0.2 mi upstream of bridge	Kentucky	8.4	0	8.4
East Fork Indian Creek	Menifee	1 mi upstream of West Fork Indian Cr	Kentucky	8.5	0	8.5
Wolfpen Branch	Menifee	at KY 715 bridge	Kentucky	3.3	0	3.3
Right Fork Buffalo Creek	Owsley	Off Whoopflarea Rd	Kentucky	11.2	0	11.2
Buffalo Creek	Owsley	Side road along mainsteam	Kentucky	12.8	0.8	12
Coles Fork	Breathitt	in Robinson Forest	Kentucky	5.5	0	5.5
Elisha Creek	Leslie	Elisha Creek Rd	Kentucky	3.3	0.95	2.35

Table 3-5 (cont.). Reference reach streams[a] in Kentucky.

Line Fork Creek	Letcher	off KY 160	Kentucky	27.5	17.3	10.2
North Fork Licking River	Morgan	0.1 mi below Bucket Branch	Licking	21.3	13	8.3
Bucket Branch	Morgan	Leisure – Paragon Rd bridge	Licking	1.9	0	1.9
Devils Fork	Morgan	KY 711 bridge	Licking	7.8	0	7.8
Big Sinking Creek	**Carter**	**KY 986 bridge**	**Little Sandy**	**15.2**	**10.7**	**4.5**
Arabs Fork	**Elliott**	**KY 1620 bridge**	**Little Sandy**	**4.7**	**0**	**4.7**
Big Caney Creek	**Elliott**	**off KY 32, Binion Ford Rd**	**Little Sandy**	**15**	**2.2**	**12.8**
Laurel Creek	**Elliott**	**Carter School Rd bridge**	**Little Sandy**	**14.4**	**7.6**	**6.8**
Yellowbank Creek	Breckinridge	Cart-Manning Crossing Rd Wildlife Management Area	Ohio	11.9	4.4	7.5
Soldier Creek	Marshall	HWY 58 bridge	Tennessee	5.3	2.6	2.7
Blood River	Calloway	Grubbs Lane bridge; O.75 mi E of State Line Rd	Tennessee	15.65	15.1	0.55
Panther Creek	Calloway	KY 280 bridge	Tennessee	5.1	1.2	3.9
Tradewater River	**Christian**	**J. T. Sparkman Rd; 0.7 mi from Mt. Zoar Rd**	**Tradewater**	**132.3**	**126**	**6.3**
Sandlick Creek	**Christian**	**Mt. Carmel-Camp Cr. Rd; 0.75 mi W of KY Hwy 109**	**Tradewater**	**9.0**	**3.5**	**5.5**
Wilson Creek	Bullitt	Mt. Carmel Church Rd, first crossing	Salt	17	12.2	4.8
Salt Lick Creek	Marion	Off Salt Lick Rd	Salt	8.4	5.3	3.1
Otter Creek	Larue	0.1 mi below West Fork, Herbert-Howell Rd	Salt	2.7	1.75	0.95
West Fork Red River	Christian	Carter Rd bridge	Lower Cumberland	26.5	16.3	10.2
Whippoorwill Creek	Logan	KY Hwy 2375 bridge	Lower Cumberland	44.6	0	44.6

[a]Streams in bold are in Green/Tradewater and Big/Little Sandy and Tygarts BMUs

Table 3-6. Candidate list of reference reach streams in Green/Tradewater and Big Sandy/Little Sandy/Tygarts BMUs.

Basin	Stream[a]	Segment	River Mile	Total Miles	County
Green River	Beaverdam Cr.	Mouth to Headwaters	0.0-14.1	14.1	Edmonson
	Cane Run	Nolin R. Backwaters to Headwaters	1-6.5	5.5	Hart
	Caney Fork	Mouth to Headwaters	0.0-6.6	6.6	Barren
	Clifty Cr.	Barton Run to W. Ky. Parkway	7.3-17.2	9.9	Grayson
	Clifty Cr.	Little Clifty Cr. to Sulphur Lick	7.7-13.2	5.5	Todd
	East Fk. Little Barren R.	Red Lick Cr. to Flat Cr.	19.0-20.2	1.2	Metcalfe
	Ellis Fk.	Mouth to Headwaters	0.0-3.2	3.2	Adair
	Falling Timber Cr.	Landuse Change to Headwaters	7.0-15.5	8.5	Metcalfe
	Fiddlers Cr.	Mouth to Headwaters	0.0-5.8	5.8	Breckinridge
	Forbes Cr.	Mouth to Unidentified Tributary	0.0-3.9	3.9	Christian
	Gasper R.	Clear Fork to Wiggington Cr.	17.0-35.2	18.2	Logan
	Goose Cr.	Mouth to Little Goose	0.0-8.1	8.1	Casey
	Green R. Unid. Tributary	Landuse Change to Headwaters	0.8-3.2	2.4	Adair
	Halls Cr.	Unidentified Tributary to Headwaters	9.6-12.1	2.5	Ohio
	Lick Cr.	Mouth to Headwaters	0.0-9.9	9.9	Simpson
	Linders Cr.	Mouth to Sutzer Cr.	0.0-7.7	7.7	Hardin
	Little Beaverdam Cr.	Mouth to SR 743	0.0-11.3	11.3	Warren
	Little Short Cr.	Mouth to Headwaters	0.0-3.0	3.0	Grayson
	Lynn Camp Cr.	Mouth to Lindy Cr.	0.0-8.3	8.3	Hart
	McFarland Cr.	Grays Br. to Unidentified Tributary	1.4-4.8	3.4	Christian
	Meeting Cr.	Little Meeting Cr. to Petty Br.	5.2-13.8	8.6	Hardin
	Muddy Cr.	Landuse Change to Headwaters	13.0-15.5	2.5	Ohio
	North Fork Rough R.	Buffalo Cr. to Reservoir Dam	23.44-28.1	4.66	Breckinridge
	Peter Cr.	Caney Fk. to Dry Fk.	11.6-18.5	6.9	Barren
	Pond Run	Landuse Change to Headwaters	1.4-6.8	5.4	Breckinridge/Ohio
	Rough R.	Linders Cr. To Vertress Cr.	136.9-147.8	10.9	Hardin
	Russell Cr.	Mouth to Columbia WWTP	0.0-40.0	40.0	Adair
	Russell Cr.	Reynolds Cr. to Headwaters	55.9-68.2	12.3	Adair
	Sixes Cr.	Wild Br. to Headwaters	2.0-7.5	5.5	Ohio
	Sulphur Br.	Mouth to Headwaters	0.0-2.0	2.0	Edmonson
	Trammel Fk.	Mouth to Tennessee Stateline	0.0-30.15	30.15	Allen
	West Fk. Pond R.	Unidentified Tributary to E. Br. Pond R.	12.7-22.5	9.8	Christian
	White Oak Cr. Unid. Tributary	Hovious Rd. Crossing to SR 76	0.4-3.0	2.6	Adair
Tradewater River	E. Fk. Flynn Fk.	Landuse Change to Headwaters	2.5-*4.6	2.1	Caldwell
	Piney Cr.	L. Beshear Backwaters to Headwaters	4.5-10.2	5.7	Caldwell
	Piney Cr. Unid. Tributary	Mouth to Headwaters	0.0-2.9	2.9	Caldwell
	Sandlick Cr.	Camp Cr. to Headwaters	4.9-9.0	4.1	Christian
	Tradewater R.	Dripping Spgs. Br. To Buntin Lake Dam	123.2-131.1	7.9	Christian
Big Sandy River	Hobbs Fk.	Mouth to Headwaters	0.0-3.8	3.8	Martin
	Hobbs Fk. to Unid. Tributary	Hobbs Fk. to Headwaters	0.0-0.55	0.55	Martin
	Lower Pigeon Br.	L. Fk. to Headwaters	0.5-1.7	1.2	Pike
	Russell Fk.	Clinch Field RR Yard off SR 80 to VA Stateline	14.4-16.0	1.6	Pike
	Toms Br.	Mouth to Headwaters	0.0-1.4	1.4	Pike

Table 3-6 (cont.). Candidate list of reference reach streams in Green/Tradewater and Big Sandy/Little Sandy/Tygarts BMUs.

Basin	Stream[a]	Segment	River Mile	Total Miles	County
Little Sandy R.	Meadow Br.	Mouth to Headwaters	0.0-1.4	1.4	Elliott
	Middle Fk. Little Sandy R.	Mouth to Sheepskin Br.	0.0-3.6	3.6	Elliott
	Nichols Fk.	Green Br. to Headwaters	0.0-1.9	1.9	Elliott
	Laurel Cr.	Carter School Rd. Bridge t Headwaters	7.6-14.4	6.8	Elliott
Ohio R.	Crooked Cr.	Rush Cr. To City Lake Dam	17.5-25.6	8.1	Crittenden

[a]Includes new candidate streams and current reference reach streams with proposed changes to segments.

reflect the basin as a whole.

Network design and sampling procedures developed by EPA's Environmental Monitoring and Assessment Program (EMAP) were used in Kentucky's random survey. Sampling locations were selected from EPA's River Reach File 3 (essentially blue lines on a 1:100,000 USGS scale map), which provide the framework. In the design process, the number of sample sites needed to satisfy a known confidence interval was determined so statistically valid extrapolation of the data can be made for the whole basin when assigning the miles of use attainment.

Once each segment was analyzed for level of aquatic life use support, calculations were made based on similar streams in the basin. For example, the results (full support, partial support and nonsupport) of first-order streams in the probabilistic assessment were extrapolated to total number of miles of first-order streams in the basin management unit, then second-order streams, etc. Nothing can be said about streams greater than fifth order in each basin, except for those stream reaches assessed by targeted sampling. As with targeted monitoring, reaches typically extended from one significant tributary to another; occasionally, land use or a point source discharge was the reach terminus.

Macroinvertebrates were collected once at each sample location from spring through early summer, habitat was assessed at each site, and physical data were measured by multiparameter probe. EPA provided sampling locations as latitude/longitude coordinates. According to EMAP protocols, sampling was conducted in a reach around the coordinates equal to 40 channel widths. Sampling methods followed those of the DOW biological programs (Kentucky Division of Water, 2002). Where habitat was not necessarily similar to that sampled by usual protocols (an uncommon occurrence) in high gradient streams (riffle, pool, run), best professional judgment was used to interpret results from such reaches.

Other Agencies. Kentucky State Nature Preserves Commission collected fish at three stations. In the Green/Tradewater BMU in 2001, the Kentucky Department of Fish and Wildlife Resources (KDFWR, 2002 and 2003) sampled fish at 70 locations.

Federally Threatened and Endangered Species. Waters were reviewed to determine if federally threatened or endangered species populations had been extirpated or significantly declined since November 1975. The latter date was important because a use was defined as an "existing use" in Kentucky water quality standards regulations if the use existed on that date, even if it had been lost or the current designated use was different.

3.1.4 Other Data Sources

Discharge Monitoring Reports. Discharge monitoring report (DMR) data, collected by Kentucky Pollutant Discharge Elimination System (KPDES) permit holders, were accessed through DOW's permit compliance system database. Depending on the relative sizes of the wastewater discharge, the receiving stream and the severity of the permit violations, it sometimes was possible to assess instream uses as threatened or impaired. Because instream data were usually not collected, stream assessments based only on DMR data are considered evaluated, not monitored.

Coal Mining Operations. Coal mining permits required instream monitoring when mining activity had the potential to affect Outstanding State Resource Waters containing a federally listed threatened or endangered species. Biological and water quality monitoring extended from the pre-mining phase through bond release. These data were used to assess aquatic life use.

Effects of Effluent Toxicity on Aquatic Communities. Several streams were sampled in 1995 to test the hypothesis that failure of point source discharges to meet whole effluent toxicity permit limits resulted in instream biological impacts. Biological assemblages were sampled both up- and downstream of the point source discharges to determine differences in community metrics and use support.

3.2 Assessment Methodology

Overall use support was determined by following U.S. EPA (1997) guidelines that define fully supporting as fully supporting all uses for which data are available. If a segment supported one use but did not support another, it was listed as not supporting. For instance, if a segment supported Warm Water Aquatic Habitat (WAH) but not Primary Contact Recreation (PCR), it was listed as not supporting. A segment was listed as partially supporting if any assessed use fell into that category, even if another use was fully supported. Many waterbodies were assessed for only one use because data were not available to assess other uses.

3.2.1 Aquatic Life and Primary Contact Recreation Use Support

The water quality and biological data provided by the programs described in the preceding pages were used to assess use support in rivers and streams. Data were categorized as "monitored" or "evaluated." Monitored data were derived from site-specific surveys and were

generally no more than five years old. In some instances where conditions were believed to have remained mostly unchanged, monitored data collected prior to 1995 were still considered valid and waters described by these data were categorized as monitored. Also, data from the random survey network were used. More than 9,800 stream miles had been monitored in the commonwealth by targeted efforts through March 2003. Like the targeted stations, each random survey station was used to assess a limited reach of stream around the sample point. Few evaluated waters remain in the assessment database. All efforts in the watershed initiative were to gather defensible, monitored data. However, there were some monitoring data more than five years old, strong anecdotal information, and extrapolation of discharge data that resulted in evaluated assessments.

The total number of assessed stream miles was determined by adding the miles represented by the random survey and the miles assessed by targeted monitoring. In other words, miles assessed by targeted monitoring in wadeable (first – fifth-order) streams were included in miles assessed by the random survey. However, results were also presented separately for targeted and random total miles.

Water Quality Data. Chemical data collected by the DOW and others were assessed according to EPA guidance (U.S. EPA 1997). Water quality data were compared to criteria contained in Kentucky Water Quality Standards Regulations (401 KAR 5:031). The segment fully supported WAH use when criteria for dissolved oxygen, un-ionized ammonia, temperature and pH were not met in 10 percent or less of the samples collected (October 1997 – March 2003 for the ambient stations and 12 months for the rotating watershed stations). Partial support was indicated if any one criterion for these parameters was not met in 11-25 percent of the samples. A segment was not supporting if any one of these criteria was not met more than 25 percent of the time.

Data for mercury, cadmium, copper, iron, lead and zinc were analyzed for violations of acute criteria listed in state water quality standards regulations using at least three years of data during the period October 1997 – March 2003. The segment fully supported WAH use if all criteria were met at stations with quarterly or less frequent sampling, or if only one violation occurred at stations with monthly sampling. Partial support was indicated if any one criterion was not met more than once but in less than 10 percent of the samples. The segment was not supporting if criteria were exceeded in greater than 10 percent of the samples. The assessment

criteria were closely linked to the way state and federal water quality criteria were developed. Aquatic life was considered protected if, on average, the acute criteria were not exceeded more than once every three years. Data were also compared to chronic criteria. Observations that equaled or were only slightly greater than chronic criteria were not considered to violate water quality standards.

Fecal coliform and pH data were used to indicate the degree of support for PCR (swimming) use. The use was fully supported if the fecal coliform bacteria criterion of 400 colonies per 100-milliliters, was not met in less than 20 percent of the samples, partially supported if the criterion was not met in 25-33 percent of the samples, and not supported if the criterion was not met in 33 percent or more of the samples. Streams with pH less than 6.0 or greater than 9.0 SU in more than 10 percent of the samples were considered to not support swimming use.

Biological Data. Several community structure function metrics were analyzed for each assemblage (algae, macroinvertebrates and fish) as described earlier in this chapter. As outlined in Table 3-7, the metric scores were used to determine biotic integrity and aquatic life use support for each stream reach monitored. Expectations for metric values were dependent on stream size, ecoregion and habitat quality. Bioassessments integrate data from the biological community, habitat, physical environment, water quality and professional judgment of aquatic biologists.

Biological data sometimes were judged to be indeterminate. This occurred in only a few occasions in these two BMUs when only one assemblage (usually fish, where sampling occurred in an area documented as poor natural habitat) was used for assessment. On other occasions the data were considered inadequate or the results borderline, and it was felt that re-sampling would be more appropriate than making a use-support decision with existing data. Stations with inconclusive data were labeled “Maybe” or “Re-sample” in Appendices 3-1 and 3-2. These streams will be sampled again in the next watershed cycle.

Table 3-7. Biological criteria for assessment of warm water aquatic habitat use support[a]

Assemblage	Fully Supporting	Partially Supporting	Not Supporting
Algae	Diatom Bioassessment Index (DBI) Classification of excellent or good, biomass similar to reference/control or STORET mean.	DBI classification of fair, increased biomass (if nutrient enriched) of filamentous green algae.	DBI classification of poor, biomass very low (toxicity), or high (organic enrichment).
Macroinvertebrate	Macroinvertebrate Bioassessment Index (MBI) excellent or good, high EPT, sensitive species present.	MBI classification of fair, EPT lower than expected in relation to available habitat, reduction in RA of sensitive taxa. Some alterations of functional groups evident.	MBI classification of poor, EPT low, TNI of tolerant taxa very high. Most functional groups missing from community.
Fish	Index of Biotic Integrity (IBI) excellent or good, presence of rare, endangered or species of special concern.	IBI fair.	IBI poor, very poor, or no fish.

[a]Acronyms used in this table are: EPT = Ephemeroptera, Plecoptera, Trichoptera; RA = Relative Abundance; TNI = Total Number of Individuals

Federally Threatened and Endangered Species. Waters with federally threatened or endangered species in November 1975 have an existing "use" of Outstanding State Resource Water, and the loss or significant decline of one of these populations constitutes a use impairment.

3.2.2 Fish Consumption Use Support

Fish consumption was a category that, in conjunction with aquatic life use, assesses attainment of the fishable goal of the Clean Water Act. Assessment of the fishable goal was separated into these two categories in 1992 because a fish consumption advisory does not preclude attainment of the aquatic life use and vice versa. Separating fish consumption and aquatic life use support gave a clearer picture of actual water quality conditions.

Kentucky revised its methodology for issuing fish consumption advisories in 1998 to a risk-based approach patterned after the Great Lakes Initiative. The risk-based approach generally was more conservative than the Food and Drug Administration (FDA) action levels that were used previously. For example, the FDA action level for mercury was 1.0 ppm, but the risk-based number for issuing an advisory was as low as 0.12 ppm.

As a result of this change in methodology, a statewide advisory was issued in April 2000 for children under six and women of childbearing age to not consume more than one meal a week of any fish from Kentucky waters because of mercury. However, USEPA (2001a) issued a draft mercury water quality criterion expressed as a methylmercury concentration in fish tissue of 0.3 ppm. Therefore, for purposes of 305(b) reporting, waters were not considered impaired unless fish exhibited mercury tissue concentrations of at least 0.3 ppm. In other words, the fish tissue concentration triggering the statewide advisory (0.12 ppm) was considered more stringent than water quality standards.

Other than the statewide advisory for mercury explained above, the following criteria were used to assess support for the fish consumption use:

- Fully supporting - no fish advisories or bans in effect
- Partially supporting - "restricted consumption" fish advisory or ban in effect for general population or a subpopulation that potentially could be at a greater cancer risk (e.g., pregnant women, children). Restricted consumption was defined as limits on the number of meals consumed per unit time for one or more fish species
- Not supporting – "no consumption" fish advisory or ban in effect for general population or a subpopulation that potentially could be at greater risk, for one or more fish species, or a commercial fishing ban in effect

3.2.3 Drinking Water Use Support

Drinking water use support was determined in several ways. First, compliance with maximum contaminant levels (MCLs) in finished water was determined by the annual average of quarterly samples. Drinking water use assessments in reservoirs were supplemented by surveys of drinking water operators on any taste and odor problems and use of biocides. The routine application of a biocide, or use of carbon filtration, were reasons for assessing a source of water as not fully supporting the domestic water supply use. Instream water quality data generally were not available to assess drinking water use.

3.2.4 Causes and Sources

Causes and sources were categorized by codes given in national guidance. Causes for primary contact recreation, fish consumption, and water supply usually were easily identified. The majority of aquatic habitats not supporting aquatic life use were determined by biological monitoring; causes were identified by observations and judgment of field biologists. All causes may not be evident in the field, and there may be other causes contributing to use impairment that are not listed. Sources of all types of use impairments were even more difficult to determine and should be considered as "probable" sources at the 305(b) stage. Once listed in the 303(d) report, subsequent intensive monitoring and watershed reconnaissance of land uses will more fully identify sources.

3.3 Use Support

3.3.1 Statewide

Targeted Monitoring: Aquatic Life Use. Statewide summary results from targeted monitoring (Table 3-8) now encompass five years of intensive watershed monitoring in the Kentucky, Salt/Licking, Cumberland/Mississippi/Ohio/Tennessee, Green/Tradewater and Big Sandy/Little Sandy/Tygarts BMUs. These data are supplemented with pre-1998 assessments at locations where those assessments are deemed still valid.

Probabilistic monitoring results are included in the targeted monitoring statistics since that method is also used for specific stream reach assessments as well as extrapolation of data for aquatic life use support in a given BMU. Total miles of waters meeting full use support are 4,942, and an additional 225 miles are fully supporting but threatened; partial support miles are 2,385, and waters not meeting designated uses are 2,270. Primary contact recreation continues to be the use with the highest percentage of miles not supporting (48.6 percent); however, fish consumption is now almost equal with 48.0 percent (Table 3-8). There are 5,979 miles (66.6 percent) of waters fully supporting aquatic life, use and 2,995 miles (33.4 percent) of this use has assessed waters partially or non-supporting. Compared to the 2002 305(b) report, aquatic life miles fully supporting increased by 255 miles, while waters partially or nonsupporting has increased by 475 miles. The fully supporting waters have decreased by 4.6 percent and partial or

Table 3-8. Use support summary of Kentucky rivers and streams (miles), targeted monitoring.

	Assessed	Fully Supporting	Fully Supporting But Threatened	Partially Supporting	Not Supporting
Overall	9,821.8	4,942.1	225.0	2,384.8	2,270.0
Aquatic Life	8,974.4	5,730.4	248.8	1,781.5	1,213.7
Fish Consumption	2,011.1	1,046.1	0.0	847.5	117.5
Primary Contact Recreation	3,039.5	1,491.6	71.4	330.3	1,146.3
Domestic Water Supply	1,453.2	1,344.4	108.8	0.0	0.0

nonsupporting waters have increased by 4.6 percent.

Fish Consumption Use. This use was fully supported in 52.0 percent of the miles assessed; that compares to 62.0 percent from the 2002 305(b) report. Besides the statewide fish consumption advisory for mercury, long-standing fish consumption advisories remain in effect in several rivers and streams throughout the state. The major source of mercury is generally thought to be air emissions from coal-fired boilers. Because of the interstate issues, EPA is conducting national studies and will likely be involved in eventual efforts to calculate TMDLs and reduce mercury inputs. PCBs in fish tissue affect 71.5 miles of Town Branch and Mud River in Logan, Butler and Muhlenberg counties, 46.9 miles of West Fork Drakes Creek in Simpson and Warren counties, and 6.5 miles of Little Bayou Creek in McCracken County. Fish consumption advisories on the Ohio River are discussed in Section 3.3.3. See Appendices 3-1 and 3-2 for level of impairment to streams due to mercury or PCBs in the Green/Tradewater and Big Sandy/Little Sandy/Tygarts BMUs,.

Swimming Use. Swimming advisories remain in effect on several streams in the upper Cumberland River Basin, lower Licking River Basin and North Fork Kentucky River.

Upper Cumberland River Basin

- Cumberland River from Hwy 2014 to Pineville Hwy 66 and from Hwy 219 to Harlan
- Martins Fork from Harlan to Cawood Water Plant
- Catrons Creek
- Clover Fork
- Straight Creek
- Poor Fork from Harlan to Looney Creek
- Looney Creek from mouth to Lynch Water Plant bridge

Lower Licking River Basin

- Licking River from Banklick Creek to Ohio River
- Banklick Creek
- Threemile Creek

North Fork Kentucky River

- North Fork Kentucky River upstream of Chavies to source

Probabilistic Monitoring: Aquatic Life Use. The PMP effort has been implemented through a complete five-year cycle in the state. Data results on a statewide basis are presented in Table 3-9. These assessment data are exclusive of targeted monitoring, unlike the targeted results presented in Table 3-8 that incorporate both methodologies. These data indicate 42 percent of stream miles (first – fifth order) are fully supporting aquatic life use while 58 percent of statewide stream miles are not fully supporting that use (Table 3-9). This is in contrast to targeted results indicating approximately 67 percent fully supporting and 33 percent partially and not supporting aquatic life use. There are some reasons for this apparent discrepancy. Targeted monitoring is that, an inherent bias in monitoring strategy. For example, one of the targets is the RR program. This is a deliberate and necessary effort to find the best stream reaches in the commonwealth. From this, these reaches can be afforded additional protection through Kentucky's water quality standards. Also, the WBMP monitors 4^{th} – 6^{th} order stream reaches on a cyclical schedule. These ambient locations typically support aquatic life use. The nature of random monitoring lends itself to integrating ambient conditions in a basin or bioregion since there is no bias of sample locations.

The five leading causes of impairment are siltation, pathogens, other habitat alterations, PCBs and organic enrichment/low DO (Table 3-10). The tope five probable sources are most

Table 3-9. Use support summary of Kentucky rivers and streams (miles), probabilistic monitoring.

	Total Assessed	Fully Supporting	Partially Supporting	Not Supporting
Aquatic Life	25,419 (42%)	10,619 (42%)	6,574 (26%)	8,226 (32%)

often identified as: (1) source unknown; (2) agriculture; (3) habitat modification (other than hydromodification); (4) resource extraction; and (5) urban runoff/storm sewers (Table 3-11).

Individual use support by major river basin is shown in Table 3-12. This overview of the commonwealth's major river basins show the greatest river miles not supporting aquatic life use are found in two (Green and Big Sandy basins) of the four basins monitored during this report cycle (Table 3-12). The Big Sandy and Tradewater river basins are both in areas of intensive land use. The former is one of the most intensive coal producing areas and the Tradewater River Basin is an area of large-scale crop production. Less than one-third of the assessed stream miles in the Big Sandy Basin and about 40 percent of assessed river miles in the Tradewater River Basin fully support aquatic life use (Figure 3-6). The most problematic basins for primary contact recreation are in the upper and lower Cumberland, Tennessee river basins and in minor Ohio River tributaries not associated with the two BMUs of primary discussion (Table 3-12). The upper Cumberland River Basin has both one of the highest percentages of aquatic life use support and lowest primary contact recreation support levels (Table 3-12). This table (3-12) may not reflect the extent of the pathogen problem in the Big Sandy River Basin because it has a high percent of monitored streams where frequent observations were made of straight pipes from houses that discharged both gray and black water directly into streams. There are 165 miles of assessed streams and rivers where this source was observed while monitoring (Table 3-13), but bacterial samples were not collected for analysis.

Table 3-10. Ranking of causes of impairment in Kentucky rivers and streams.

Cause/Stressor Category	Impacted Miles
Siltation	1,753.2
Pathogens	1,348.1
Other Habitat Alterations	1,023.1
PCBs	805.5
Organic Enrichment/Low DO	570.2
Nutrients	540.1
Salinity/TDS/Chlorides	499.9
Causes Unknown	463.9
Metals	362.5
Flow Alteration	337.8
Sulfates	240.7
pH	229.7
Dioxins	194.4
Turbidity	141.0
Algal Growth/Chlorophyll *a*	55.1
Suspended Solids	52.8
Unionized Ammonia	39.5
Thermal Modifications	33.1
Unknown Toxicity	19.3
Priority Organics	18.0
Noxious Aquatic Weeds	13.8
Radiation	13.0
Chlorine	12.2
Oil and Grease	11.5
Other Inorganics	11.5
Exotic Species	8.4
Pesticides	5.3
Nonpriority Organics	5.2
Taste and Odor	1.9

Table 3-11. Probable sources of impairment in Kentucky rivers and streams.

Source Category	Miles Impacted
Source Unknown	1,631
Agriculture	1,477.2
Crop-related Sources	634.1
Nonirrigated Crop Production	424.4
Irrigated Crop Production	84.4
Specialty Crop Production	3.6
Grazing related Sources	620.8
Pasture grazing - Riparian and/or Upland	222.9
Pasture grazing – Upland	19.6
Range grazing - Riparian and/or Upland	0.7
Intensive Animal Feeding Operations	105.6
Concentrated Animal Feeding Operations (permitted, point source)	22.3
Confined Animal Feeding Operations (NPS)	49.4
Habitat Modification (other than Hydromodification)	1059.2
Removal of Riparian Vegetation	717.7
Bank or Shoreline Modification/Destabilization	265.6
Drainage/Filling of Wetlands	10.7
Resource Extraction	924.7
Surface Mining	525.4
Subsurface Mining	222.8
Dredge Mining	25.6
Petroleum Activities	190.6
Mine Tailings	6.9
Acid Mine Drainage	114.5
Abandoned Mining	91
Inactive Mining	104.1
Urban Runoff/Storm Sewers	721.3
Erosion and Sedimentation	267.3
Non-industrial Permitted	4.3
Industrial Permitted	15.8
Other Urban Runoff	178.3
Illicit Connections/Illegal Hook-ups/Dry Weather Flows	10.6
Hydromodification	527.1
Channelization	403.2
Dredging	92.4
Dam Construction	3.2
Upstream Impoundment	35.1
Flow Regulation/Modification	32.1
Silviculture	254.4
Harvesting, Restoration, Residue Management	156.8
Logging Road Construction/Maintenance	10.5
Silvicultural Point Sources	3.5

Table 3-11 (cont.). Probable sources of impairment in Kentucky rivers and streams.

Source Category	Miles Impacted
Municipal Point Sources	347.3
Major Municipal Point Source	92.8
Minor Municipal Point Source	41.2
Package Plants (Small Flows)	63.0
Land Disposal	396.3
Inappropriate Waste Disposal/Wildcat Dumping	44.7
Onsite Wastewater Systems (Septic Tanks)	254.4
Septage Disposal	8.7
Industrial Point Sources	211.2
Major Industrial Point Source	6.5
Minor Industrial Point Source	1.7
Combined Sewer Overflow	17.3
Collection System Failure	35.2
Construction	197.0
Highway/Road/Bridge Construction	52.2
Land Development	100.1
Highway/Road/Bridge Runoff	133.9
Natural Sources	45.2
Sediment Resuspension	33.9
Recreation and Tourism Activities (other than Boating - see	19.1
Golf courses	12.9
Spills	10.3
Other	4.1
Sources outside State Jurisdiction or Borders	3.6
Highway Maintenance and Runoff	1.9

Table 3-12. Number of river miles assessed and the level of support by use in each major river basin. Those basins in bold type represent the Green/Tradewater and Big Sandy/-Little Sandy/Tygarts BMUs.

Basin	Total Assessed	Supporting	Full Support Threatened	Partial Supporting	Nonsupport
Green River					
Aquatic Life	1,635.0	1,111.2	30.1	257.8	235.9
Fish Consumption	371.8	195.7	0.0	68.4	107.7
Swimming	596.8	408.6	0.0	33.7	146.6
Drinking Water	291.6	291.6	0.0	0.0	0.0
Tradewater River					
Aquatic Life	156.3	63.6	0.0	35.8	56.9
Fish Consumption	0.0	0.0	0.0	0.0	0.0
Swimming	46.3	26.7	0.0	5.3	14.3
Drinking Water	0.0	0.0	0.0	0.0	0.0
Big Sandy River					
Aquatic Life	694.8	187.9	28.9	291.5	186.5
Fish Consumption	94.7	78.8	0.0	15.9	0.0
Swimming	222.5	41.6	66.3	0.0	114.6
Drinking Water	53.5	35.3	18.0	0.0	0.0
Little Sandy River					
Aquatic Life	180.9	89.8	0.9	80.7	9.5
Fish Consumption	8.0	8.0	0.0	0.0	0.0
Swimming	44.5	42.8	0.0	0.0	1.7
Drinking Water	14.3	14.3	0.0	0.0	0.0
Tygarts Creek					
Aquatic Life	79.8	59.4	0.0	16.0	1.1
Fish Consumption	12.9	10.6	0.0	0.0	2.3
Swimming	16.5	16.5	0.0	0.0	0.0
Drinking Water	10.6	10.6	0.0	0.0	0.0
Ohio River (minor tribs of these two BMUs)					
Aquatic Life	168.1	83.6	1.6	25.9	57.0
Fish Consumption	0.0	0.0	0.0	0.0	0.0
Swimming	31.0	14.1	1.6	0.0	15.3
Drinking Water	0.0	0.0	0.0	0.0	0.0
Kentucky River					
Aquatic Life	1,805.4	1,277.6	46.9	371.7	109.2
Fish Consumption	455.2	384.7	0.0	70.5	0.0
Swimming	609.2	317.5	1.0	81.6	209.1
Drinking Water	43.4	43.4	0.0	0.0	0.0

Table 3-12 (cont.). Number of river miles assessed and the level of support by use in each major river basin. Those basins in bold type represent the Green/Tradewater and Big Sandy/- Little Sandy/Tygarts BMUs.

Basin	Total Assessed	Supporting	Full Support Threatened	Partial Supporting	Nonsupport
Licking River					
Aquatic Life	562.1	288.7	26.8	139.8	106.8
Fish Consumption	130.7	130.7	0.0	0.0	0.0
Swimming	512.0	289.6	0.0	39.0	183.4
Drinking Water	197.4	197.4	0.0	0.0	0.0
Salt River					
Aquatic Life	576.6	401.8	39.6	74.9	60.3
Fish Consumption	90.2	78.7	0.0	10.5	1.0
Swimming	194.3	122.9	2.5	1.6	67.3
Drinking Water	21.1	21.1	0.0	0.0	0.0
Upper Cumberland River					
Aquatic Life	1,275.8	904.4	57.3	156.9	157.2
Fish Consumption	123.5	90.7	0.0	32.8	0.0
Swimming	239.2	86.8	0.0	14.2	138.2
Drinking Water	152.6	150.4	0.0	0.0	0.0
Lower Cumberland River					
Aquatic Life	308.5	159.8	0.0	83.6	65.1
Fish Consumption	18.2	8.7	0.0	9.5	0.0
Swimming	137.0	46.4	0.0	27.4	63.2
Drinking Water	38.1	38.1	0.0	0.0	0.0
Mississippi River					
Aquatic Life	249.8	79.4	0.0	100.6	69.8
Fish Consumption	17.2	17.2	0.0	0.0	0.0
Swimming	40.7	25.5	0.0	11.8	3.4
Drinking Water	0.0	0.0	0.0	0.0	0.0
Tennessee River					
Aquatic Life	336.9	165.6	3.6	126.6	41.1
Fish Consumption	17.5	11.5	0.0	6.0	0.0
Swimming	121.5	17.8	0.0	38.8	64.9
Drinking Water	5.1	5.1	0.0	0.0	0.0
Ohio River (minor tributaries)					
Aquatic Life	523.3	287.7	14.6	80.7	140.3
Fish Consumption	43.6	37.1	0.0	0.0	6.5
Swimming	167.7	42.1	1.6	34.1	89.5
Drinking Water	0.0	0.0	0.0	0.0	0.0

Figure 3-6. Aquatic life and primary contact recreation use support by major river basin in Kentucky.

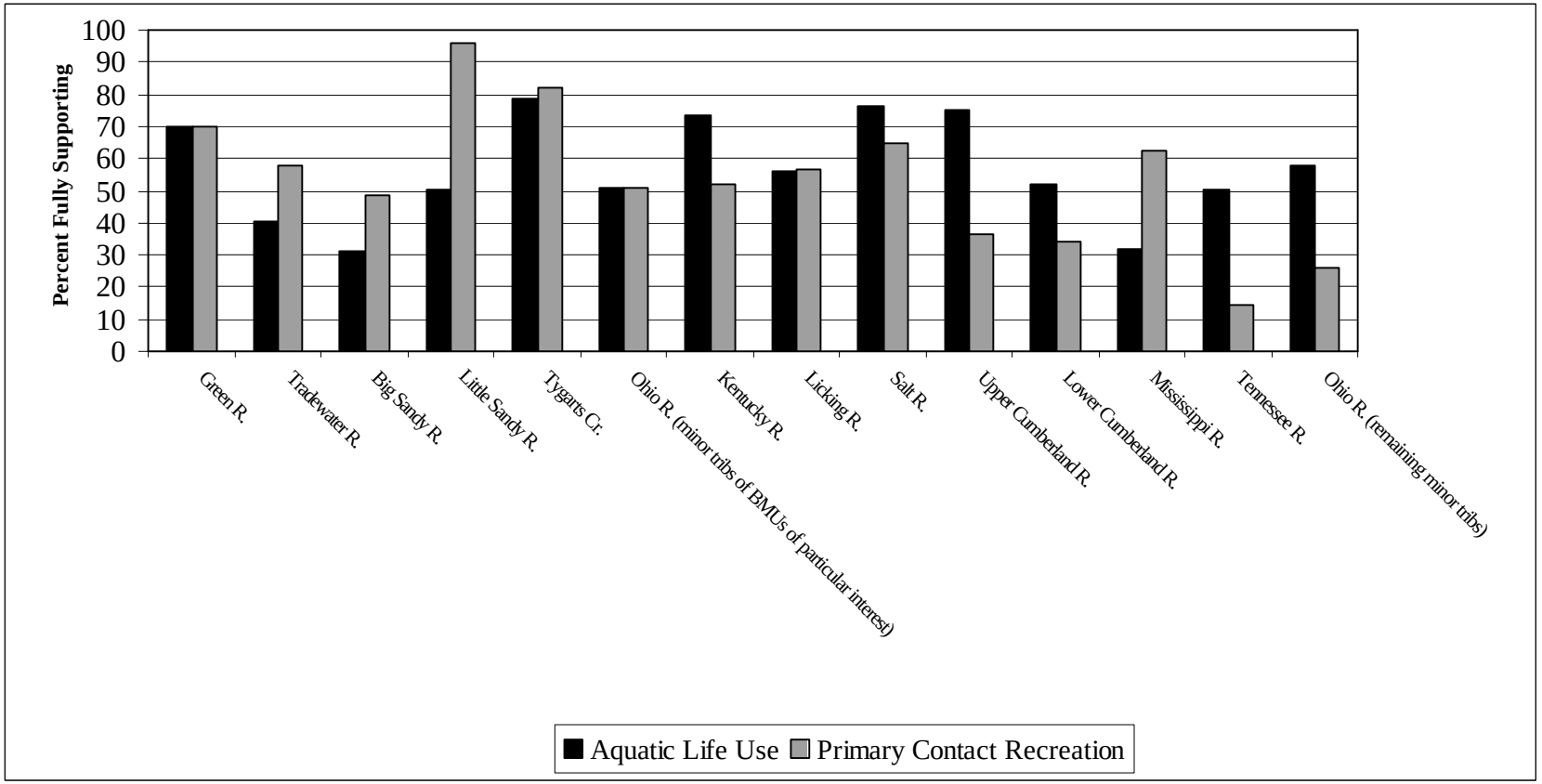


Table 3-13. Number of river miles of the top five causes and sources of impairment assessed in the major river basins within the two BMUs of interest.

River Basin	Miles		Miles
Green River			
Causes		*Sources*	
Siltation	370.5	Agriculture	421.4
Other Habitat Modifications	224.1	Habitat Modifications	329.5
Pathogens	158.9	Source Unknown	177.7
PCBs	146.9	Hydromodifications	159.5
Salinity/TDS/Chlorides	110.7	Resource Extraction	156.4
Tradewater River			
Causes		*Sources*	
Siltation	77.6	Habitat Modification	56.5
Other Habitat Modifications	48.8	Source Unknown	47.8
Flow Alterations	41.4	Resource Extraction	47.6
Organic Enrichment/Low DO	36.3	Hydromodification	46.4
pH	22.1	Agriculture	45.7
Big Sandy River			
Causes		*Sources*	
Siltation	482.7	Resource Extraction	459.8
Salinity/TDS/Chlorides	284.3	Urban runoff/Storm sewers	287.2
Other Habitat Modifications	265.8	Habitat Modification	56.6
Sulfates	182.5	Land Disposal (165.2 Onsite Wastewater Systems)	222.4
Pathogens	124.7	Petroleum Activities	107.2
Little Sandy River			
Causes		*Sources*	
Siltation	89.3	Agriculture	61.0
Other Habitat Modification	70.5	Habitat Modification	55.1
Salinity/TDS/Chlorides	23.7	Resource Extraction	40.0
Sulfates	182.5	Urban Runoff/Storm sewers	25.8
Flow Alterations	14.6	Silviculture	23.2

Table 3-13 (cont.). Number of river miles of the top five causes and sources of impairment assessed in the major river basins within the two BMUs of interest.

Tygarts Creek	Miles		Miles
Causes		*Sources*	
Other Habitat Alterations	20.4	Agriculture	15.5
Siltation	20.1	Hydromodification	13.9
Flow Alteration	10.1	Habitat Modification	11.1
Sulfates	5.7	Urban runoff/Storm Sewers	4.6
PCBs	2.3	Source Unknown	2.3
Ohio River Minor Tributaries (Sandy/Tygarts BMU)			
Siltation	3.9	Urban runoff/Storm Sewers	3.9
Salinity/TDS/Chlorides	2.8	Hydromodification	3.9
Nutrients	2.8	Highway/Road/Bridge Runoff	2.8
Thermal Modification	1.1	Agriculture	2.8
Other habitat Alterations	1.1	Habitat Modification(other than hydromodification)	1.1
Ohio River Minor Tributaries (Green/Tradewater BMU)			
Other Habitat Alterations	30.4	Habitat Modification (other than hydromodification)	44.4
Organic Enrichment/Low DO	24.7	Agriculture	30.7
Cause Unknown	21.9	Hydromodification	16.0
Siltation	18.7	Source Unknown	11.7
Nutrients	13.0	Resource Extraction	8.9

3.3.2 Monitoring Results for Green/Tradewater and Big Sandy/Little Sandy/Tygarts BMUs

Causes, sources and landuses. Complete monitoring information for these two BMUs is located in Appendices 3-1 and 3-2. These tables contain specific streams monitored, sample mile points and assessed segment reaches in miles. Causes and sources of impairment are listed in Table 3-13 by the five major river basins that comprise the Green/Tradewater and Big Sandy/Little Sandy/Tygarts Creek BMUs. The minor Ohio River tributaries in the Green/Tradewater BMU, HUC 05140201, 05140202 and 05140203 and those in the Tygarts Creek eight-digit HUC (05090103) are separated from the remaining minor Ohio River Tributaries with separate HUCs in Table 3-13.

The few Ohio River minor tributary streams in the Tygarts Creek Basin occur primarily in northern Boyd and Greenup counties. The landscape is urban in this small area while the remaining watershed (>90 percent) is forested with small-scale agriculture production. Those agricultural practices (source) (Table 3-13) are mostly associated with crop production and cattle grazing (Table 3-11). The category "Other Habitat Alterations (other than flow)" is primarily due to removal of riparian zone vegetation and related bank sloughing from cattle grazing or crop production that includes cultivation to the stream bank. These practices result in disturbances that increase sedimentation load that abrades and smothers habitat, resulting in loss of habitat availability for macroinvertebrate colonization. These disturbances may result in flow alterations from channel straightening and removal of contours that dissipate water velocity energy and aid in habitat stability and habitat loss. The Little Sandy River Basin reflects similar landuses, with siltation related to agriculture the primary contributor to impairment to aquatic life use (Table 3-13). However, "salinity/TDS/chlorides" replaced flow alteration as the third cause of stress to the aquatic environment in this basin as opposed to Tygarts Basin. Siltation is identified as the leading cause of impairment in the Big Sandy Basin; however, "resource extraction" is the leading source, replacing agriculture in the previous two basins (Table 3-13). "Salinity/TDS/chloride" is the second leading cause or stressor in this basin (Table 3-13). The elevated specific conductance in these waters is related to resource (coal) mining in this basin. Specific conductance is an indirect measure of pollution, and sources include ions such as sulfate, iron, magnesium, chloride and other minerals. Elevated quantities of iron are associated with coal mining activities and results in water chemistry changes that are deleterious to aquatic plants and animals. The precipitate tends to smother algal beds and reduce photosynthetic

processes of plants. This same physical stress reduces respiration processes of gills associated with most insects and fishes. This land use can also work to lower pH of water to harmful levels to many aquatic organisms, especially fish and plants. The lowering of pH can occur in the presence of high amounts of sulfates which can occur through the coal mining process and in presence of hydrogen ions will form sulphuric acid. This chemical process works to lower alkalinity, and in the presence of large concentrations, will strip the natural buffering capacity of the stream. The opposite is often measured in areas of coal extraction where pH is elevated to levels greater than 9.0 SU. This occurs when an abundance of cations from minerals such magnesium and calcium are liberated into the water column, often through disturbance of the geologic strata. Thirteen first through second order streams, with coal mining as the sole source of disturbance, failed to support aquatic life use. These streams are affected by the conditions previously described; namely, high specific conductivity and habitat modifications/smothering.

The Green/Tradewater BMU is primarily rural with associated agriculture. Stream assessment data (causes and sources) for the seven eight-digit HUCs associated with the Green/Tradewater River BMU are in Table 3-13. The single most significant cause of degradation of the two river basins in this BMU is siltation (Table 3-13). The land uses in the Green River Basin are primarily agriculture, with small-scale farms making up the bulk of operations in the upper Green and Barren River subbasins, and forest. The lower Green River Basin has a myriad of land uses encompassing farms (some large scale commercial operations) and resource (primarily coal) extraction. In this region, farms are typified by hundreds of acres in row crop production of soybeans and corn, in contrast to the small, more diversified farms in the upper basin. Loss of wetlands in the lower basin has also been a result of agribusiness; this loss further diminishes the natural filter and buffer capacity of this ecosystem.

Targeted Monitoring: Aquatic Life Use. The targeted monitoring effort resulted in 1,792 miles assessed for aquatic life in the Green/Tradewater BMU (Table3-14). From this, the RR program identified 38 candidate RR stream locations with 33 in the Green River Basin and five in the Tradewater Basin (Table 3-6); these RR streams total 280.31 miles and 22.7 miles, respectively. This is 16.9 percent of the targeted total stream miles assessed. Approximately 67 percent of targeted miles are in full support of aquatic life use, whereas nearly 33 percent of all

Table 3-14. Comparison of probabilistic and targeted monitoring results for aquatic life use in the Green/Tradewater and Big Sandy/Little Sandy/Tygarts BMUs, 2001-02.

	Full Support		Partial Support		Nonsupport	
River Basin	Prob	Target	Prob	Target	Prob	Target
Green/Tradewater (miles)	2,409	1,205	1,213	294	2,871	293
(percent)	(37.1)	(67.3)	(18.7)	(16.4)	(44.2)	(16.4)
Big Sandy/Little Sandy/ Tygarts (miles)	476	367	1,649	388	1,691	197
(percent)	(12.5)	(38.4)	(43.2)	(40.6)	(44.3)	(20.6)

targeted miles assessed did not fully support (Table 3-14). The NSP conducted biological monitoring in 31 stream locations. This program focused on a prioritized list of streams impacted from nonpoint source pollution within the BMU (KDOW and UK, 1999). The 44 primary and rotating watershed ambient water quality sites in this BMU were also assessed for aquatic life use support based on physicochemical results.

The Big Sandy/Little Sandy/Tygarts BMU monitoring effort resulted in 952 miles assessed for aquatic life (Table 3-14). The RR program identified 22.25 miles of candidate stream reaches in this BMU from nine streams (Table 3-6). This is 2.3 percent of the total number of targeted miles assessed. Five of these RR streams are in the Big Sandy Basin and four occur in the Little Sandy Basin. Overall, 38.4 percent of all targeted stream miles fully support aquatic life use and 61.2 percent of those 952 miles are not fully supporting that use (Table 3-14). The NSP conducted biological monitoring in 27 stream locations. This program focused on a prioritized list of streams impacted from nonpoint source pollution within the BMU (KDOW and UK, 1999). The 34 primary and rotating watershed ambient water quality sites in this BMU were also assessed for aquatic life use support based on physicochemical results.

While the majority of miles assessed at targeted monitoring locations for aquatic life are assessed based on biological monitoring, some of those miles are assessed using water chemistry at long-term and rotating watershed locations.

Targeted Monitoring: Fish Consumption Use. Fish tissue was analyzed for mercury and PCB burden in the Green River Basin. There are 372 miles river assessed for this use; of those, 196 miles are fully supporting this use while 176 miles are partially or not supporting

(Table 3-12). No fish tissue was analyzed for fish consumption in the Tradewater River Basin.

The Big Sandy River Basin had 95 river miles assessed for fish consumption use. Seventy-nine are fully supporting while 16 miles are partially or not supporting (Table 3-12). Eight river miles were assessed in the Little Sandy River Basin. All eight miles are fully supporting the use (Figure 3-12). Thirteen river miles were assessed for fish consumption in Tygarts Creek Basin. Eleven miles are fully supporting while two river miles are not supporting the use (Table 3-12).

Targeted Monitoring: Swimming Use. Water column samples were take and analyzed for the presence and quantity of fecal coliform colonies to assess this use support. Five hundred ninety-seven river miles are assessed in Green River Basin for this use (Table 3-12). Of those river miles, approximately 409 are fully supporting and 180 are partially or not fully supporting this use. Forty-six river miles were assessed for swimming use. Approximately 27 river miles are fully supporting the use while 20 river miles are partially or not supporting (Table 3-12).

In the Big Sandy River Basin, 223 miles were assessed for swimming use. Of those river miles, 108 are fully supporting while 115 river miles are partially or not supporting (Table 3-12). Forty-five river miles were assessed in the Little Sandy River Basin (Table 3-12). Approximately forty-three river miles are fully supporting this use while two river miles are not supporting. The Tygarts Creek Basin had 17 river miles assessed for swimming use support (Table 3-12). All 17 miles are fully supporting this use.

Targeted Monitoring: Drinking Water Supply. All miles assessed in the two BMUs are fully supporting this use (Table 3-12). However, the Big Sandy River Basin does have approximately 66 river miles as fully supporting but threatened.

Probabilistic Monitoring: Aquatic Life Use. The sample design for the Green/Tradewater BMU statistically represents 6,310 miles (based on EPA River Reach File 3) of streams (first through fifth order) assessed for aquatic life use support by the probabilistic monitoring program. Seventy-six stream locations are assessed in this BMU (Table 3-1 and Figure 3-4). Of those, 37.1 percent (2,409 miles) are fully supporting; 18.7 percent (1,213 miles) are partially supporting; and 44.2 percent (2,871 miles) are nonsupporting for aquatic life use. Therefore, 62.9 percent, or 4,084 river miles in the basin are not fully supporting aquatic life use (Table 3-14).

In the Big Sandy/Little Sandy/Tygarts BMU, probabilistic sampling occurred at 51 first through fifth order stream locations (Table 3-2 and Figure 3-5). This sample design statistically represents 3,815 river miles. Of these stream miles, only 12.5 percent are fully supporting aquatic life use (476 miles); 43.2 percent (1,649 miles) are partially supporting aquatic life use; and 44.3 percent (1,691 miles) are nonsupport for aquatic life use. Therefore, over 87 percent (>3,300 miles out of 3,815 miles) of this basin has a level of impairment severe enough not to meet aquatic life use (Table 3-14).

Probabilistic and Targeted Monitoring Compared. Probabilistic and targeted monitoring results differed greatly in the Green/Tradewater BMU (Table 3-14). In this BMU, the RR and other programs identified nearly one-fifth of targeted streams as candidates for exceptional water designation (Table 3-6). In a geographic area as large as this BMU, land uses may vary greatly between different ecoregions. This can create widely disparate stream conditions, providing high quality streams that are clustered in a fairly small area. Looking at the distribution of reference reach streams and candidates, 15 counties in this BMU have no representative RR streams (Tables 3-5 and 3-6) and 11 of those 15 counties are found in the western portion of this BMU. This area is comprised by the Interior River Valleys and Hills ecoregion and has a greater percentage of disturbed land, primarily from surface mining for coal and large-scale crop production.

The Big Sandy/Little Sandy/Tygarts BMU use support results are more similar between the targeted and probabilistic methods. Probabilistic results indicate 87.5 percent of stream miles are partial or nonsupport for aquatic life use and targeted results show 61.2 percent of monitored streams in those two categories are impaired (Table 3-14). This high degree of stream impairment in this BMU is further highlighted by the fact that only four reference reach streams occur in this BMU (Table 3-5) and only nine additional RR streams are identified as candidates (Table 3-6) from the intensive monitoring effort in 2002. Land uses vary between the three basins in this BMU, but approximately two-thirds of the area is within a major coal producing area and gas and petroleum extraction is widely prevalent, although most petroleum drilling has declined. Also, due to topography, population centers occur in the narrow valleys along stream corridors. These high-density populations result in riparian vegetation removal, subsequent bank erosion and failure.

3.3.3 Ohio River

ORSANCO assessed uses in the 664 miles of the Ohio River main stem that forms Kentucky's northern boundary (ORSANCO 2004). No reaches of the Ohio River fully supports all uses. Drinking water use fully supports, except for 15 miles in the Louisville are, aquatic life use was fully supporting except in 14 miles in lower river. However,. All of the miles partially supported the fish consumption use because of limited fish consumption advisories for PCBs and dioxin. Of the approximately 636 river miles assessed for swimming use, 84 miles (13%) partially supported and 274 (43%) miles did not support, often because of combined sewer overflows during and immediately following rainfall events in and downstream of urban areas.

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Appendix 3-1. Monitoring Information from the Green/Tradewater Basin Management Unit

Monitoring Results
Green/Tradewater BMU

Waterbody	HUC	County	Segments (milepoints)	Fish	Macro-invertebrate	Algae	Water Quality	FC Bacteria	Fish Tissue	Program	Start Date	End Date	Aquatic Life	PCR	FC	DWS
Big Cr.	05110001	Adair Co.	3.0 to 8.2					x		WKU	06/01/2001	10/01/2001		NS		
Butler Fk.	05110001	Adair Co.	2.3 to 4.0					x		WKU	06/01/2001	10/31/2001		NS		
Glens Fk.	05110001	Adair Co.	0.0 to 8.0					x		WKU	06/01/2001	10/31/2001		NS		
Green R.	05110001	Adair Co.	334.2 to 342.2				x	x		KDOW AWQ	10/01/1997	10/31/2002	FS	FS		
Pettys Fk.	05110001	Adair Co.	0.0 to 6.0					x		WKU	06/01/2001	10/31/2001		NS		
Russell Cr.	05110001	Adair Co.	40.0 to 41.5					x		WKU	06/01/2001	10/31/2001		NS		
Russell Cr.	05110001	Adair Co.	41.5 to 68.2	x	x	x	x			KDOW RR	06/13/2001	08/08/2001	T			FS
Russell Cr.	05110001	Adair Co.	23.8 to 40.0	x	x	x				KDOW RR	07/01/1992	08/28/2001	FS			
Sulphur Cr.	05110001	Adair Co.	0.0 to 10.5					x		WKU	06/01/2001	10/31/2001		FS		
Sulphur Cr.	05110001	Adair Co.	11.4 to 15.1		x					KDOW PROB	06/13/2001	06/03/2001	FS			
UT to Butler Br.	05110001	Adair Co.	0.0 to 1.7		x					KDOW PROB	06/13/2001	06/13/2001	PS			
UT to Cool Springs Cr.	05110001	Adair Co.	0.0 to 1.6		x					KDOW PROB	06/14/2001	06/14/2001	NS			
Big Reedy Cr.	05110001	Butler Co.	7.5 to 13.6					x		WKU	06/01/2001	10/31/2001		NS		
Green R.	05110001	Butler Co.	149.5 to 168.4				x	x		KDOW AWQ	10/01/1997	10/31/2002		FS		
Brush Cr.	05110001	Casey Co.	0.0 to 6.2	x						KDFWR	08/23/2001	08/23/2001	PS			
Calhoun Cr.	05110001	Casey Co.	0.0 to 2.8	x						KDFWR	08/23/2001	08/23/2001	PS			
Casey Cr.	05110001	Casey Co.	18.0 to 21.4		x					KDOW PROB	06/11/2001	06/11/2001	FS			
Casey Cr.	05110001	Casey Co.	3.7 to 4.7	x	x	x	x	x		KDOW AWQ	04/01/2001	03/31/2002	FS	PS		
Dry Cr.	05110001	Casey Co.	0.0 to 3.7	x						KDFWR	09/05/2001	09/05/2001	PS			
Goose Cr.	05110001	Casey Co.	0 to 8.1	x	x	x				KDOW RR	05/01/1992	06/12/2001	FS			
Green R.	05110001	Casey Co.	359.0 to 366.1	x	x	x				KDOW RR	07/03/2001	07/03/2001	FS			
Liberty Lk.	05110001	Casey Co.	Liberty Lk.				x			KDOW LAKES	04/15/2001	10/15/2001	FS			FS
South Fork	05110001	Casey Co.	0.0 to 2.3	x	x	x				KDOW WBM	06/26/2001	06/26/2001	FS			
South Fork	05110001	Casey Co.	2.3 to 7.5	x						KDFWR	08/23/2001	08/23/2001	FS			
UT to Bull Run Cr.	05110001	Casey Co.	0.1 to 1.0		x					KDOW PROB	06/12/2001	06/12/2001	FS			
UT to Hatter Cr.	05110001	Casey Co.	1.1 to 1.6		x					KDOW PROB	06/11/2001	06/11/2001	FS			
Alexander Cr.	05110001	Edmonson Co.	0.0 to 3.6	x	x	x				KDOW RR	07/25/2001	07/25/2001	FS			
Alexander Cr.	05110001	Edmonson Co.	3.6 to 8.0	x	x	x				KDOW RR	06/27/2001	06/27/2001	FS			
Bear Cr.	05110001	Edmonson Co.	14.5 to 22.2	x	x	x				KDOW WBM	08/22/2001	08/22/2001	NS			
Bear Cr.	05110001	Edmonson Co.	8.0 to 12.6				x	x		KDOW AWQ	05/01/1998	09/01/2002	FS	FS		
Beaverdam Cr.	05110001	Edmonson Co.	0.0 to 14.1	x	x	x				KDOW RR	06/28/2001	07/25/2001	FS			
Dismal Cr.	05110001	Edmonson Co.	0 to 2.3								07/01/1997		NS			
Sulphur Br.	05110001	Edmonson Co.	0.0 to 3.2	x	x	x				KDOW RR	06/27/2001	06/27/2001	FS			
Sycamore Cr.	05110001	Edmonson Co.	0.0 to 1.5		x					WKU	07/18/2001	07/18/2001	NS			
Bear Cr.	05110001	Grayson Co.	22.6 to 31.7		x					WKU	07/18/2001	07/18/2001	PS			
Rock Cr.	05110001	Grayson Co.	0 to 7.1								07/01/1997		FS			
Sunfish Cr.	05110001	Grayson Co.	6.6 to 9.7		x					KDOW PROB	06/26/2001	06/26/2001	PS			
Taylor Fk.	05110001	Grayson Co.	0 to 4.0		x					KDOW PROB	06/29/2001	06/29/2001	NS			
Big Brush Cr.	05110001	Green Co.	0.0 to 4.8	x	x	x				KDOW WBM	06/28/2001	06/28/2001	FS			
Big Brush Cr.	05110001	Green Co.	12.5 to 16.7	x	x					KDFWR	06/18/2001	07/23/2001	FS			
Big Pitman Cr.	05110001	Green Co.	0.0 to 13.6	x	x	x	x	x		KDOW AWQ	04/01/2001	03/31/2002	FS	PS		
Big Pitman Cr.	05110001	Green Co.	26.9 to 32.0	x						KDFWR	07/11/2001	07/11/2001	PS			
Green R.	05110001	Green Co.	250.2 to 265.8	x	x					KDOW PROB	07/02/2001	10/02/2002	FS			
Green R.	05110001	Green Co.	265.8 to 276.8	x						KSNPC	10/02/2002	10/02/2002	FS			
Green R.	05110001	Green Co.	276.8 to 279.8						x	KDOW AB	11/15/2001	11/15/2001			FS	
Little Barren R.	05110001	Green Co.	0.0 to 8.8				x	x		KDOW AWQ	05/01/1998	09/30/2002	FS	PS		
Little Barren R.	05110001	Green Co.	8.8 to 14.1		x					KDOW PROB	07/02/2001	07/02/2001	FS			

Monitoring Results
Green/Tradewater BMU

Waterbody	HUC	County	Segments (milepoints)	Fish	Macro-invertebrate	Algae	Water Quality	FC Bacteria	Fish Tissue	Program	Start Date	End Date	Aquatic Life	PCR	FC	DWS
Little Pitman Cr.	05110001	Green Co.	0.0 to 8.1	x	x	x				KDOW WBM	06/21/2001	06/21/2001	FS			
Little Russell Cr.	05110001	Green Co.	0 to 5.1	x	x	x				KDOW RR	05/01/1992	08/07/2001	FS			
Meadow Cr.	05110001	Green Co.	0.0 to 0.6	x						KDFWR	08/21/2001	08/01/2001	FS			
Meadow Cr.	05110001	Green Co.	0.6 to 7.5	x						KDFWR	07/01/2001	07/01/2001	FS			
Middle Pitman Cr.	05110001	Green Co.	0.0 to 7.6	x	x	x				KDOW WBM	07/03/2001	07/03/2001	FS			
Russell Cr.	05110001	Green Co.	0.0 to 7.2					x		WKU	06/01/2001	10/31/2001		FS		
Russell Cr.	05110001	Green Co.	12.8 to 23.8	x	x	x				KDOW WBM	07/02/2001	07/02/2001	FS			
Russell Cr.	05110001	Green Co.	7.2 to 12.8				x	x		KDOW AWQ	05/01/1998	10/31/2002	FS	FS		
S. Fk. Russell Cr.	05110001	Green Co.	0.0 to 6.4	x	x	x				KDOW IS	12/01/1993	12/01/1993	FS			
UT to S. Fk. Russell Cr.	05110001	Green Co.	0.0 to 0.6	x	x	x				KDOW IS	12/01/1993		NS			
Billy Cr.	05110001	Hardin Co.	0.0 to 5.9	x				x	x	KDFWR	06/01/2001	10/31/2001	PS	NS	FS	
Cox's Run	05110001	Hardin Co.	0.0 to 3.2	x						KDFWR	07/13/2001	07/13/2001	PS			
Dorsey Run	05110001	Hardin Co.	1.9 to 3.7		x					KDOW PROB	06/29/2001	06/29/2001	NS			
Freeman Lk.	05110001	Hardin Co.	Freeman Lk.				x			KDOW LAKES	04/15/2001	10/15/2001	FS			FS
Nolin R.	05110001	Hardin Co.	54.8 to 93.2	x	x	x	x	x		KDOW AWQ	10/01/1997	09/30/2002	FS	FS	FS	FS
Nolin R.	05110001	Hardin Co.	93.2 to 101.2	x	x	x				KDOW WBM	06/15/2001	08/23/2001	FS			
Valley Cr.	05110001	Hardin Co.	0.0 to 3.5	x	x	x	x	x		KDOW AWQ	04/01/2001	03/31/2002	PS	NS		
Valley Cr.	05110001	Hardin Co.	10.3 to 11.8					x		WKU	06/01/2001	10/31/2001		NS		
Valley Cr.	05110001	Hardin Co.	8.0 to 10.3	x						KDFWR	07/24/2001	07/24/2001	NS			
Bacon Cr.	05110001	Hart Co.	17.2 to 26.3	x	x	x				KDOW RR	08/06/2001	08/06/2001	PS			
Bacon Cr.	05110001	Hart Co.	2.0 to 17.2	x	x	x	x		x	KDOW AB	10/01/1994	09/01/1997	FS		FS	
Bacon Cr.	05110001	Hart Co.	26.3 to 28.0		x					KDOW PROB	10/01/1994	09/01/1997	FS			
Cane Run	05110001	Hart Co.	1.0 to 6.5	x	x	x				KDOW RR	06/28/2001	06/28/2001	FS			
Green R.	05110001	Hart Co.	246.4 to 250.2	x						KSNPC	10/01/2002	10/01/2002	FS			
Green R.	05110001	Hart Co.	207.8 to 246.4		x		x	x	x	KDOW AWQ	10/01/1997	09/30/2002	FS	FS	PS	FS
Lindy Cr.	05110001	Hart Co.	0.0 to 0.9		x					KDOW PROB	06/18/2001	06/18/2001	PS			
Lynn Camp Cr.	05110001	Hart Co.	0 to 8.3	x	x	x				KDOW RR	07/12/2001	07/12/2001	FS			
Nolin R. Res.	05110001	Hart Co.	Nolin River Res.				x		x	LCOE	05/01/2001	09/01/2001	FS		FS	FS
Roundstone Cr.	05110001	Hart Co.	0.0 to 10.1	x	x	x				KDOW WBM	08/22/2001	08/22/2001	FS			
Barren Run	05110001	Larue Co.	0.0 to 5.5	x						KDFWR	07/06/2001	07/06/2001	FS			
N. Fk. Nolin R.	05110001	Larue Co.	2.3 to 9.5				x				01/01/1994	12/01/1995				FS
Salem Lk.	05110001	Larue Co.	Salem Lk.				x			KDOW LAKES	04/15/2001	10/15/2001	FS			
S. Fk. Nolin R.	05110001	Larue Co.	0.0 to 6.4	x						KDFWR	08/21/2001	08/21/2001	FS			
Walters Cr.	05110001	Larue Co.	0.0 to 2.4	x						KDFWR	07/03/2001	07/03/2001	FS			
Green R.	05110001	Lincoln Co.	374.3 to 383.4	x	x	x				KDOW WBM	06/13/2001	06/13/2001	FS			
UT to Wiggington Cr.	05110001	Logan Co.	0.9 to 1.9		x					WKU	07/20/2001	07/20/2001	NS			
Green R.	05110001	Mc Lean Co.	28.4 to 55.1				x			KDES	01/01/1998	12/31/2002	FS			FS
Claylick Cr.	05110001	Metcalfe Co.	4.1 to 5.3		x					KDOW PROB	07/03/2001	07/03/2001	PS			
E. Fk. Little Barren R.	05110001	Metcalfe Co.	0.0 to 15.5	x	x	x				KDOW WBM	06/19/2001	06/19/2001	FS			
E. Fk. Little Barren R.	05110001	Metcalfe Co.	18.8 to 25.2	x	x	x				KDOW RR	08/07/2001	08/14/2001	FS			
Metcalfe County Lk.	05110001	Metcalfe Co.	Metcalfe County Lk.				x			KDOW LAKES	04/15/2001	10/15/2001	FS			
S. Fk. Little Barren R.	05110001	Metcalfe Co.	0.0 to 11.9	x	x	x				KDOW WBM	06/27/2001	06/27/2001	FS			
S. Fk. Little Barren R.	05110001	Metcalfe Co.	0.0 to 24.5		x					KDOW PROB	07/03/2001	07/03/2001	FS			
S. Fk. Little Barren R.	05110001	Metcalfe Co.	24.1 to 45.7		x					WKU	07/16/2001	07/16/2001	FS			
Campbellsville City Res.	05110001	Taylor Co.	Campbellsville City Res.				x			KDOW LAKES	04/15/2001	10/15/2001	FS			
Green R.	05110001	Taylor Co.	279.8 to 295.6		x		x			KDES	05/01/2000	10/01/2001	FS			FS
Green R. Res.	05110001	Taylor Co.	Green River Res.				x		x	LCOE	05/01/2001	09/01/2001	FS		PS	FS

Monitoring Results
Green/Tradewater BMU

Waterbody	HUC	County	Segments (milepoints)	Fish	Macro-invertebrate	Algae	Water Quality	FC Bacteria	Fish Tissue	Program	Start Date	End Date	Aquatic Life	PCR	FC	DWS
Little Pitman Cr.	05110001	Taylor Co.	10.1 to 11.2	x	x	x				KDOW IS	10/01/1995		T			
Middle Pitman Cr.	05110001	Taylor Co.	8.2 to 10.0		x					KDOW PROB	06/14/2001	06/14/2001	FS			
Mill Cr.	05110001	Taylor Co.	0.0 to 2.6	x						KDFWR	07/11/2001	07/11/2001	FS			
Poplar Grove Br.	05110001	Taylor Co.	0.0 to 3.0					x		WKU	06/01/2001	10/31/2001		NS		
Spurlington Lk.	05110001	Taylor Co.	Spurlington Lk.				x			KDOW LAKES	04/15/2001	10/15/2001	FS			
Upper Brush Cr.	05110001	Taylor Co.	0.0 to 2.8					x		WKU	06/01/2001	10/31/2001		FS		
UT to Middle Pitman Cr.	05110001	Taylor Co.	0.0 to 0.6		x					KDOW PROB	07/11/2001	07/11/2001	FS			
Claylick Cr.	05110001	Warren Co.	2.0 to 3.1					x		WKU	06/01/2001	10/31/2001		NS		
Little Beaverdam Cr.	05110001	Warren Co.	0 to 10.7	x	x	x				KDOW RR	04/01/1992		FS			
Shanty Hollow Lk.	05110001	Warren Co.	Shanty Hollow Lk.				x			KDOW LAKES	04/15/2001	10/15/2001	FS			
Barren R.	05110002	Allen Co.	110 to 124.3	x			x	x		KDOW AWQ			FS	NS		FS
Barren R. Res.	05110002	Allen Co.	Barren River Res.				x		x	LCOE	05/16/2001	09/11/2001	FS		PS	FS
Little Trammel Cr.	05110002	Allen Co.	0.0 to 2.4	x						KDFWR	07/03/2001	07/03/2001	FS			
Puncheon Cr.	05110002	Allen Co.	1.8 to 4.6	x	x					KDOW PROB	06/19/2001	07/13/2001	FS			
Sulphur Fk. Cr.	05110002	Allen Co.	0.0 to 5.3	x						KDFWR	07/02/2001	07/02/2001	FS			
Sulphur Fk. Cr.	05110002	Allen Co.	5.4 to 8.0		x					KDOW PROB	06/20/2001	06/20/2001	FS			
Trammel Cr.	05110002	Allen Co.	23.55 to 30.15	x	x	x				KDOW RR	07/20/2001	07/20/2001	FS			
Beaver Cr.	05110002	Barren Co.	16.6 to 29.0	x	x	x	x			KDES	01/01/1998	12/31/2002	FS			FS
Beaver Cr.	05110002	Barren Co.	9.4 to 16.6				x	x		KDOW AWQ	04/01/2001	03/31/2002	FS			
Boyds Cr.	05110002	Barren Co.	0 to 1.7										NS			
Caney Fk.	05110002	Barren Co.	0 to 6.6							KDOW RR	04/25/1995	07/24/2001	FS			
Peter Cr.	05110002	Barren Co.	11.6 to 18.5	x	x	x				KDOW RR	04/01/1995	07/24/2001	FS			
Skaggs Cr.	05110002	Barren Co.	16.6 to 24.5	x	x			x		KDOW AWQ	04/01/2001	03/31/2002	FS	Resample		
S. Fk. Beaver Cr.	05110002	Barren Co.	1.2 to 5.9	x						KDFWR	07/17/2001	07/17/2001	PS			
Little Muddy Cr.	05110002	Butler Co.	4.9 to 6.4		x					WKU	07/26/2001	07/26/2001	NS			
Little Muddy Cr.	05110002	Butler Co.	6.4 to 12.9	x						KDFWR	08/08/2001	08/08/2001	PS			
Black Lick Cr.	05110002	Logan Co.	11.2 to 12.2				x				01/01/1995	12/01/1997	NS			
Blacklick Cr.	05110002	Logan Co.	11.2 to 12.2				x			DMR	01/01/1995	01/01/1997	NS			
Gasper R.	05110002	Logan Co.	14.5 to 17.0	x	x	x				KDOW RR	08/14/2001	08/14/2001	FS			
Gasper R.	05110002	Logan Co.	17.0 to 35.2	x	x	x				KDOW RR	06/01/1992	06/26/2001	FS			
Cypress Cr.	05110002	Mc Lean Co.	0 to 5.8				x	x		KDOW AWQ	04/01/2001	03/31/2002	FS	FS		
Falling Timber Cr.	05110002	Metcalfe Co.	7.0 to 15.5	x	x	x				KDOW RR	04/01/1995	07/01/1997	FS			
Falling Timber Cr.	05110002	Metcalfe Co.	3.0 to 7.0	x	x	x			x	KDOW WBM	07/01/2001		FS		FS	
E. Fk. Barren R.	05110002	Monroe Co.	4.2 to 8.6	x	x	x				KDFWR	07/05/2001	07/10/2001	FS			
Indian Cr.	05110002	Monroe Co.	0.6 to 5.3	x						KSNPC	10/01/2001	10/01/2001	FS			
Line Cr.	05110002	Monroe Co.	0.0 to 7.0	x						KDFWR	07/05/2001	07/05/2001	FS			
Long Fk.	05110002	Monroe Co.	0.6 to 2.0	x	x					KDOW PROB	06/19/2001	08/07/2001	FS			
Mill Cr. Lk. (Monroe Co..)	05110002	Monroe Co.	Mill Creek				x			KDOW LAKES	04/15/2001	10/15/2001	FS			FS
Salt Lick Cr.	05110002	Monroe Co.	20. To 4.9	x						KDFWR	08/07/2001	08/07/2001	FS			
Cypress Cr.	05110002	Muhlenberg Co.	25.0 to to33.3	x						KDFWR	07/23/2001	07/23/2001	PS			
Lick Cr.	05110002	Simpson Co.	0.0 to 9.9	x	x	x				KDOW RR	04/01/1995	07/20/2001	FS			
Thompson Br.	05110002	Simpson Co.	0.4 to 1.6		x					KDOW PROB	06/20/2001	06/20/2001	FS			
W. Fk. Drakes Cr.	05110002	Simpson Co.	22.9 to 26.6				x			KDES	01/01/1998	12/31/2002				FS
W. Fk. Drakes Cr.	05110002	Simpson Co.	26.6 to 32.8	x	x	x				KDOW RR	07/19/2001	07/19/2001	FS			
W. Fk. Drakes Cr.	05110002	Simpson Co.	9.9 to 22.9	x	x	x			x	KDOW WBM	07/11/2001	07/18/2001	FS		PS	
Barren R.	05110002	Warren Co.	0 to 8.4				x	x		KDOW AWQ	05/01/1998	10/01/2001	FS	FS		
Barren R.	05110002	Warren Co.	29.4 to 35.0					x						PS		

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Barren R.	05110002	Warren Co.	35.0 to 43.6				x	x		Field Office	01/01/1997	10/31/2002		FS		FS
Barren R.	05110002	Warren Co.	8.4 to 15	x	x	x				KDOW AWQ	08/29/1990	08/30/1994	FS			
Drakes Cr.	05110002	Warren Co.	6.1 to 13.0				x	x	x	KDOW IS	06/21/2001	06/21/2001	FS	FS	PS	
Gasper R.	05110002	Warren Co.	7.7 to 14.5				x	x		KDOW AWQ	04/01/2001	03/31/2002	FS	FS		
Little Beaverdam Cr.	05110002	Warren Co.	10.7 to 11.4		x					KDOW PROB	06/22/2001	06/22/2001	PS			
Middle Fk. Drakes Cr.	05110002	Warren Co.	0 to 21.5	x	x	x					06/01/1993	06/01/1993	FS		FS	
Salt Lick Cr.	05110002	Warren Co.	0.0 to 1.3		x					KDOW PROB	07/03/2001	07/03/2001	NS			
Trammel Cr.	05110002	Warren Co.	0 to 23.55	x	x	x	x	x		KDOW RR	05/01/1997	03/01/2002	FS	FS		
W. Fk. Drakes Cr.	05110002	Warren Co.	0.0 to 9.9						x	KDOW IS	04/01/2001	03/31/2002			PS	
W. Fk. Drakes Cr.	05110002	Warren Co.	0 to 23.4						x		01/01/1986	12/01/1996			NS	
W. Fk. Drakes Cr.	5110002	Simpson Co.	9.9 to 22.9						x	DOWWMB	7/11/2001	7/18/2001	FS		NS	
W. Fk. Drakes Cr.	05110002	Warren Co.	23.4 to 32.8				x		x		01/01/1996		FS			FS
UT to Pond Run	05110003	Breckinridge Co.	0.0 to 0.7	x	x	x				KDOW RR	05/08/2002	05/08/2002	FS			
E. Prong Indian Camp Cr.	05110003	Butler Co.	0.0 to 6.3	x						KDFWR	07/11/2001	07/11/2001	FS			
Green R.	05110003	Butler Co.	108.6 to 149.5				x		x	KDOW WBM	01/01/1998	12/31/2002			FS	FS
Indian Camp Cr.	05110003	Butler Co.	0.0 to 3.0					x		WKU	06/01/2001	10/31/2001		FS		
Indian Camp Cr.	05110003	Butler Co.	3.9 to 10.2		x					WKU	07/11/2001	07/26/2001	PS			
Mud R.	05110003	Butler Co.	38.9 to 67.8						x	KDOW IS	09/18/2002				NS	
Mud R.	05110003	Butler Co.	9.0 to 30.5				x	x	x	KDOW AWQ	10/01/1997	10/31/2002	PS	FS	NS	
Muddy Cr.	05110003	Butler Co.	0.0 to 5.7				x	x		KDOW AWQ	04/01/2001	03/31/2002		FS		
Muddy Cr.	05110003	Butler Co.	12.1 to 14.9	x						KDFWR	07/24/2001	07/24/2001	PS			
Welch Cr.	05110003	Butler Co.	0.0 to 16.4	x						KDFWR	07/11/2001	07/11/2001	FS			
Austin Cr.	05110003	Logan Co.	2.6 to 3.6				x			KDOW WET	02/01/2000	09/01/2001	PS			
Briggs Lk.	05110003	Logan Co.	Briggs Lk.				x			KDOW LAKES	04/15/2001	10/15/2001	FS			
Elk Lick Cr.	05110003	Logan Co.	3.6 to 11.7	x	x	x				KDOW RR	06/26/2001	06/26/2001	FS			
Lk. Malone	05110003	Logan Co.	Lk. Malone				x			KDOW LAKES	04/15/2001	10/15/2001	FS			FS
Lewisburg Lk.	05110003	Logan Co.	Lewisburg Lk.				x			KDOW LAKES	04/15/1983	10/15/1983	FS			
Motts Lick Cr.	05110003	Logan Co.	0.0 to 3.2	x						KDFWR	07/12/2001	07/12/2001	FS			
Mud R.	05110003	Logan Co.	30.5 to38.9					x	x	WKU	06/01/2001	10/31/2001		FS	NS	
Spa Lk.	05110003	Logan Co.	Spa Lk.				x			KDOW LAKES	04/15/2001	10/15/2001	FS			
Town Br.	05110003	Logan Co.	0.0 to 6.7						x	KDOW IS	01/01/1996	09/18/2002			NS	
Wolf Lick Cr.	05110003	Logan Co.	3.3 to 13.7	x	x			x		WKU	06/01/2001	10/31/2001	PS	FS		
Green R.	05110003	Mc Lean Co.	71.3 to 108.6	x	x	x	x	x	x	KDOW AWQ	10/01/1997	10/31/2002	FS	FS	FS	FS
Bat E. Cr.	05110003	Muhlenberg Co.	0.0 to 3.3	x	x		x	x		WKU	06/26/2001	10/01/2001	PS	FS		
Bat E. Cr.	05110003	Muhlenberg Co.	3.3 to 7.1	x	x		x			KDOW NPS	06/26/2001	06/26/2001	PS			
Beech Cr.	05110003	Muhlenberg Co.	0 to 3.4				x			KDOW IS	07/02/1997		NS	NS		
Caney Cr.	05110003	Muhlenberg Co.	1.3 to 5.5					x			01/01/1997			NS		
Caney Cr.	05110003	Muhlenberg Co.	0 to 2.4					x			01/01/1997			NS		
Lk. Luzerne	05110003	Muhlenberg Co.	Lk. Luzerne							KDOW LAKES	04/15/1992	10/15/1992	FS			PS
Mud R.	05110003	Muhlenberg Co.	0 to 9.0						x	KDOW IS					NS	
Plum Cr.	05110003	Muhlenberg Co.	0 to 2.5							KDOW IS	07/01/1997		NS			
Pond Cr.	05110003	Muhlenberg Co.	0.0 to 4.7				x	x		KDOW AWQ	05/01/2001	10/31/2001	FS	PS		
Pond Cr.	05110003	Muhlenberg Co.	16.3 to 20.0	x	x		x			KDOW NPS	06/22/2001	06/22/2001	PS			
Pond Cr.	05110003	Muhlenberg Co.	20.0 to 23.3		x					WKU	07/23/2001	07/23/2001	NS			
Pond Cr.	05110003	Muhlenberg Co.	4.7 to 9.4	x	x		x	x		KDOW NPS	07/02/1997	10/31/2001	NS			
Pond Cr.	05110003	Muhlenberg Co.	9.4 to 13.6	x	x		x	x		KDOW NPS	07/02/1997	10/31/2001	NS	FS		
Salt Lick Cr.	05110003	Muhlenberg Co.	0.0 to 2.9	x	x		x			KDOW NPS	06/21/2001	06/21/2001	T			

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Sand Lick Cr.	05110003	Muhlenberg Co.	0.0 to 3.0	x	x		x			KDOW NPS	06/21/2001	06/21/2001	PS			
UT to Pond Cr.	05110003	Muhlenberg Co.	0.0 to 2.3		x					WKU	07/05/2001	07/05/2001	NS			
Whiskey Run	05110003	Muhlenberg Co.	1.5 to 1.8										PS			
Lewis Cr.	05110003	Ohio Co.	1.2 to 6.4		x			x		WKU	10/01/1997	10/31/2001	PS	FS		
Pond Run	05110003	Ohio Co.	0.0 to 6.3	x	x	x				KDOW RR	05/08/2002	05/08/2002	FS			
Renders Cr.	05110003	Ohio Co.	1.2 to 3.4	x	x		x			KDOW NPS	04/01/1998	06/27/2001	NS			
Sixes Cr.	05110003	Ohio Co.	0.0 to 7.5	x	x	x				KDOW RR	05/09/2002	05/09/2002	FS			
UT to W. Fk. Lewis Cr.	05110003	Ohio Co.	0.0 to 2.2		x					WKU	07/10/2001	07/10/2001	NS			
Clifty Cr.	05110003	Todd Co.	0.0 to 13.2	x	x	x				KDOW RR	06/27/2001	06/27/2001	FS			
Indian Cr.	05110003	Warren Co.	0.0 to 7.3	x						KDFWR	07/11/2001	07/11/2001	FS			
Daniels Cr.	05110004	Breckinridge Co.	0.0 to 5.7		x					KDOW IS	10/01/1997		PS			
Fiddlers Cr.	05110004	Breckinridge Co.	0.0 to 5.8	x	x	x				KDOW RR	05/09/2001	05/09/2001	FS			
Long Lick Cr.	05110004	Breckinridge Co.	4.5 to 6.9		x					KDOW PROB	06/28/2001	06/28/2001	NS			
N. Fk. Rough R.	05110004	Breckinridge Co.	26.8 to 28.1	x	x	x				KDOW RR	05/09/2001	05/09/2001	FS			
N. Fk. Rough R.	05110004	Breckinridge Co.	19.0 to 23.4	x	x					KDOW IS	01/01/1997	08/02/2001	FS			
Rock Lick Cr.	05110004	Breckinridge Co.	0.0 to 12.9										FS			
Tules Cr.	05110004	Breckinridge Co.	6.2 to 14.1	x						KDFWR	08/02/2001	08/02/2001	FS			
Muddy Cr.	05110004	Butler Co.	8.3 to 12.1	x	x	x				KDOW WBM	07/24/2001	07/24/2001	NS			
Beaver Dam Cr.	05110004	Grayson Co.	0 to 6.3										FS			
Caneyville City Res.	05110004	Grayson Co.	Caneyville City Res.				x			KDOW LAKES	04/15/1992	10/15/1992	FS			PS
Clifty Cr.	05110004	Grayson Co.	12.6 to 15.6		x					KDOW PROB	06/25/2001	06/25/2001	FS			
Clifty Cr.	05110004	Grayson Co.	7.3 to 22.2	x	x	x				KDOW RR	07/11/2001	07/11/2001	FS			
Clifty Cr.	05110004	Grayson Co.	0.0 to 4.9								06/01/1992	06/01/1992	FS			
Jarret Fk.	05110004	Grayson Co.	0.0 to 1.0		x					KDOW PROB	06/22/2001	06/22/2001	NS			
Little Short Cr.	05110004	Grayson Co.	0.0 to 3.0	x	x	x				KDOW PROB	05/08/2001	05/08/2001	FS			
Meeting Cr.	05110004	Grayson Co.	5.2 to 13.8	x	x	x				KDOW RR	07/11/2001	08/02/2001	FS			
N. Fk. Caney Cr.	05110004	Grayson Co.	0.0 to 7.8										FS			
S. Fk. Caney Cr.	05110004	Grayson Co.	0.0 to 10.6										FS			
Linders Cr.	05110004	Hardin Co.	0.0 to 7.7	x	x	x				KDOW RR	06/01/1995	07/10/2001	FS			
Rough R.	05110004	Hardin Co.	127.6 to 147.8	x	x	x	x	x		KDOW AWQ	10/01/1997	10/31/2002	FS	FS		
Rough R. Res.	05110004	Hardin Co.	Rough River Res.				x		x	LCOE	05/01/2001	09/01/2001	FS		PS	FS
UT to Mays Run	05110004	Hardin Co.	0.0 to 0.4		x					WKU	07/17/2001	07/17/2001	FS			
Rough R.	05110004	Mc Lean Co.	0.0 to 10.2				x	x		KDOW AWQ	10/01/1997	10/31/2002	FS	FS		
Caney Cr.	05110004	Muhlenberg Co.	0.0 to 3.6	x	x		x			KDOW NPS	06/26/2001	06/26/2001	PS			
Adams Fk.	05110004	Ohio Co.	0.0 to 4.6	x						KDFWR	08/07/2001	08/07/2001	PS			
Adams Fk.	05110004	Ohio Co.	8.9 to to 9.8		x					KDOW PROB	06/27/2001	06/27/2001	FS			
Barnett Cr.	05110004	Ohio Co.	0.0 to 6.1		x					KDOW IS	10/01/1997		FS			
Caney Cr.	05110004	Ohio Co.	0.0 to 4.3				x	x		KDOW AWQ	04/01/2001	03/31/2002		FS		
Caney Cr.	05110004	Ohio Co.	11.4 to 17.95					x		WKU	06/01/2001	10/01/2001		FS		
Caney Cr.	05110004	Ohio Co.	17.95 to 23.3					x		WKU	06/01/2001	10/01/2001		FS		
Grassy Cr.	05110004	Ohio Co.	0.8 to 2.9		x					KDOW PROB	06/27/2001	06/27/2001	NS			
Halls Cr.	05110004	Ohio Co.	8.6 to 12.1	x	x	x				KDOW RR	05/10/2002	05/10/2002	FS			
Jenny Hollow Br.	05110004	Ohio Co.	0.0 to 2.4		x					KDOW PROB	06/26/2001	06/26/2001	NS			
Lk. Washburn	05110004	Ohio Co.	Lk. Washburn				x			KDOW LAKES	04/15/2001	10/15/2001	FS			
McGrady Cr.	05110004	Ohio Co.	0.0 to 2.0					x		WKU	06/01/2001	10/31/2001		FS		
Muddy Cr.	05110004	Ohio Co.	1.9 to 3.9	x	x	x		x		KDOW WBM	06/01/2001	10/31/2001	NS	FS		
Muddy Cr.	05110004	Ohio Co.	5.9 to 9.1	x						KDFWR	07/13/2001	07/13/2001	PS			

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Muddy Cr.	05110004	Ohio Co.	9.1 to 15.5	x	x	x				KDOW RR	05/09/2002	05/09/2002	FS			
No Cr.	05110004	Ohio Co.	0.0 to 9.6		x					KDOW IS	10/01/1997		FS			
N. Fk. Barnett Cr.	05110004	Ohio Co.	0.0 to 2.8	x						KDFWR	07/13/2001	07/13/2001	PS			
Pigeon Cr.	05110004	Ohio Co.	0.0 to 2.9	x						KDFWR	07/13/2001	07/13/2001	PS			
Rough R.	05110004	Ohio Co.	26.7 to 28.0					x		WKU	06/01/2001	10/31/2001		FS		
Rough R.	05110004	Ohio Co.	59.4 to 64.0				x	x		KDOW AWQ	10/01/1997	10/31/2002	FS	FS		
Smith Cr.	05110004	Ohio Co.	0.0 to 4.5	x						KDFWR	08/07/2001	08/07/2001	FS			
Three Lick Fk.	05110004	Ohio Co.	0.0 to 3.3	x						KDFWR	07/13/2001	07/13/2001	NS			
Barnett Cr.	05110004	Trigg Co.	0 to 13.4										FS			
Burnett Fk.	05110005	Daviess Co.	0.0 to 1.3	x	x		x			KDOW NPS	07/24/2001	07/24/2001	PS			
Cane Run	05110005	Daviess Co.	0.0 to 3.6	x	x		x			KDOW NPS	07/25/2001	07/25/2001	PS			
Carpenter Lk.	05110005	Daviess Co.	Carpenter Lk.				x			KDOW LAKES	04/15/2001	10/15/2001	FS			
Crooked Cr.	05110005	Daviess Co.	0.0 to 2.9					x		WKU	06/01/2001	10/31/2001		NS		
Deserter Cr.	05110005	Daviess Co.	0.0 to 3.1					x		WKU	06/01/2001	10/31/2001		NS		
E. Fk. Knoblick Cr.	05110005	Daviess Co.	0.0 to 5.3										FS			
Gilles Ditch	05110005	Daviess Co.	0.0 to 4.9		x					WKU	07/10/2001	07/10/2001	NS			
Horse Fk.	05110005	Daviess Co.	0.0 to 5.5								07/01/1997		NS			
Joes Br.	05110005	Daviess Co.	0.0 to 3.5	x	x		x			KDOW NPS	08/07/2001	08/07/2001	PS			
Joes Run	05110005	Daviess Co.	0.0 to 2.4	x	x		x			KDOW NPS	08/07/2001	08/07/2001	PS			
Kingfisher Lk.	05110005	Daviess Co.	Kingfisher Lk.				x			KDOW LAKES	04/15/2001	10/15/2001	FS			
Knoblick Cr.	05110005	Daviess Co.	0.0 to 2.1					x		WKU	06/01/2001	10/31/2001		NS		
N. Fk. Panther Cr.	05110005	Daviess Co.	4.2 to 6.0					x		WKU	06/01/2001	10/31/2001		NS		
N. Fk. Panther Cr.	05110005	Daviess Co.	0.0 to 4.2	x	x		x			KDOW NPS	08/06/2001	08/06/2001	PS			
N. Fk. Panther Cr.	05110005	Daviess Co.	9.5 to 12.7	x	x		x			KDOW NPS	07/25/2001	07/25/2001	PS			
Old Panther Cr.	05110005	Daviess Co.	0.4 to 5.7		x					WKU	08/31/2001	08/31/2001	NS			
Old Panther Cr.	05110005	Daviess Co.	5.7 to 8.8		x					WKU	08/30/2001	08/30/2001	NS			
Panther Cr.	05110005	Daviess Co.	0.0 to 2.7	x						KDFWR	07/25/2001	07/25/2001	NS			
Panther Cr.	05110005	Daviess Co.	17.1 to 19.5	x	x		x			KDOW NPS	08/06/2001	08/06/2001	NS			
Panther Cr.	05110005	Daviess Co.	2.7 to 5.6				x	x		KDOW AWQ	05/01/1998	10/31/2002		NS		
Rhodes Cr.	05110005	Daviess Co.	0.0 to 1.9	x						KDFWR	07/25/2001	07/25/2001	PS			
Rhodes Cr.	05110005	Daviess Co.	2.2 to 6.4	x	x		x			KDOW NPS	07/12/2001	07/12/2001	NS			
Rhodes Cr.	05110005	Daviess Co.	0.0 to 1.2								01/01/1990		FS			
Rhodes Cr.	05110005	Daviess Co.	0.0 to 2.2	x	x		x			KDOW NPS	10/01/1997	07/11/2001	NS			
Rhodes Cr.	05110005	Daviess Co.	1.2 to 7.3								01/01/1990		NS			
S. Fk. Panther Cr.	05110005	Daviess Co.	0.0 to 2.3	x	x		x	x		KDOW AWQ	06/01/2001	10/31/2001	PS	NS		
S. Fk. Panther Cr.	05110005	Daviess Co.	13.5 to 17.7					x		WKU	06/01/2001	10/31/2001		NS		
S. Fk. Panther Cr.	05110005	Daviess Co.	9.5 to 13.5	x	x		x	x		KDOW NPS	06/01/2001	10/31/2001	PS	NS		
Sweepstakes Br.	05110005	Daviess Co.	1.0 to 3.8	x	x		x			KDOW NPS	07/24/2001	07/24/2001	PS			
Two Mile Cr.	05110005	Daviess Co.	0.0 to 4.85	x	x		x			KDOW NPS	07/12/2001	07/12/2001	T			
W. Fk. Knoblick Cr.	05110005	Daviess Co.	0.0 to 8.3										FS			
Wolf Br. Ditch	05110005	Daviess Co.	0.0 to 4.1	x	x		x			KDOW NPS	07/11/2001	07/11/2001	PS			
N. Br.	05110005	Hancock Co.	0.0 to 12.4		x					WKU	07/17/2001	07/17/2001	NS			
Cash Cr.	05110005	Henderson Co.	0.0 to 5.8	x						KDFWR	07/24/2001	07/24/2001	PS			
Lick Cr.	05110005	Henderson Co.	0.0 to 3.7	x	x					KDOW IS	07/15/1997	07/24/2001	NS			
Richland Sl.	05110005	Henderson Co.	0.0 to 4.7	x						KDFWR	07/15/1997	07/25/2001	NS			
Sputzman Cr.	05110005	Henderson Co.	1.0 to 4.1	x	x	x	x	x		KDOW AWQ	04/01/2001	03/31/2002	PS			
Sputzman Cr.	05110005	Henderson Co.	0.0 to 4								05/01/1995	05/01/1995	FS			

Monitoring Results
Green/Tradewater BMU

Waterbody	HUC	County	Segments (milepoints)	Fish	Macro-invertebrate	Algae	Water Quality	FC Bacteria	Fish Tissue	Program	Start Date	End Date	Aquatic Life	PCR	FC	DWS
Brush Fk.	05110005	Mc Lean Co.	0.0 to 3.8	x	x		x			KDOW NPS	06/28/2001	06/28/2001	NS	NS		
Buck Cr.	05110005	Mc Lean Co.	0.0 to 8.0	x				x		KDFWR	07/12/2001	07/12/2001	PS	NS		
Green R.	05110005	Mc Lean Co.	63.1to 71.3				x			KDES	01/01/1998	12/31/2002				FS
Long Falls Cr.	05110005	Mc Lean Co.	0.0 to7.5	x	x		x	x		KDOW NPS	10/01/1997	07/13/2001	PS	NS		
Long Falls Cr.	05110005	Mc Lean Co.	7.5 to 11.8	x				x		KDFWR	07/10/2001	07/10/2001	PS	NS		
Mill Cr.	05110005	Ohio Co.	0.0 to 3.8					x		WKU	06/01/2001	10/31/2001		NS		
Deer Cr.	05110005	Webster Co.	0.0 to 8.2		x		x	x		KDOW AWQ	04/01/2001	03/01/2002	NS	FS		
Deer Cr.	05110005	Webster Co.	8.2 to 17.5	x	x					WKU	07/30/2001	07/30/2001	NS			
E. Fk. Deer Cr.	05110005	Webster Co.	0.0 to 6.8	x						KDFWR	07/01/2001	07/01/2001	NS			
Groves Cr.	05110005	Webster Co.	0.0 to 6.2	x						KDFWR	07/24/2001	07/24/2001	NS			
Knoblick Cr.	05110005	Webster Co.	0.0 to 5.3	x						KDFWR	07/17/2001	07/17/2001	NS			
Buck Cr.	05110006	Christian Co.	1.3 to 7.4					x		WKU	06/01/2001	10/31/2001		FS		
Buck Fk.	05110006	Christian Co.	14.0 to 20.0					x		WKU	06/01/2001	10/31/2001		NS		
E. Br.	05110006	Christian Co.	0.0 to 2.0					x		WKU	06/01/2001	10/31/2001		FS		
Forbes Cr.	05110006	Christian Co.	0.0 to 1.5		x					KDOW PROB	07/05/2001	07/05/2001	FS			
Pennyrile Lk.	05110006	Christian Co.	Pennyrile Lk.				x			KDOW LAKES	04/15/2001	10/15/2001	FS			
Craborchard Cr.	05110006	Hopkins Co.	0.0 to 4.6	x	x		x	x		KDOW NPS	06/01/2001	10/31/2001	NS	FS		
Drakes Cr.	05110006	Hopkins Co.	8.5 to 21.3	x					x		01/01/1993		FS		NS	
Elk Cr.	05110006	Hopkins Co.	0.0 to 5.4	x						KDFWR	07/16/2001	07/16/2001	NS			
Flat Cr.	05110006	Hopkins Co.	0.0 to 10.6	x	x		x	x		KDOW NPS	07/01/1997	10/31/2001	NS	FS		
Grapevine Lk.	05110006	Hopkins Co.	Grapevine Lk.				x			KDOW LAKES	04/15/2001	10/15/2001	FS			PS
McFarland Cr.	05110006	Hopkins Co.	1.4 to 4.8	x	x	x				KDOW RR	06/20/2001	06/20/2001	FS			
Narge Cr.	05110006	Hopkins Co.	2.2 to 3.9		x					WKU	07/10/2001	07/10/2001	NS			
Otter Cr.	05110006	Hopkins Co.	0.0 to 6.2	x						KDFWR	07/15/2001	07/15/2001	NS			
Pleasant Run	05110006	Hopkins Co.	0.0 to 2.1				x	x		KDOW IS	07/01/1997	10/31/2001	NS	NS		
Pond R.	05110006	Hopkins Co.	0.0 to1.0					x		WKU	06/01/2001	10/31/2001		FS		
Pond R.	05110006	Hopkins Co.	2.1 to 20.8	x	x	x	x	x		KDOW AWQ	08/01/1994	09/30/2002	PS		FS	
UT to Flat Cr.	05110006	Hopkins Co.	0.0 to 3.4		x					WKU	07/30/2001	07/30/2001	NS			
W. Fk. Pond R.	05110006	Hopkins Co.	0.0 to 27										FS			
Pond Drain	05110006	Mc Lean Co.	0.0 to 2.0	x						KDFWR	07/11/2001	07/11/2001	PS			
Brier Cr.	05110006	Muhlenberg Co.	0 to 4.7				x			KDOW AWQ	07/01/1997		NS	NS		
Elk Pond Cr.	05110006	Muhlenberg Co.	0.0 to 4.5					x		WKU	06/01/2001	10/31/2001		NS		
Isaacs Cr.	05110006	Muhlenberg Co.	0.0 to 7.4	x						KDFWR	07/23/2001	07/23/2001	NS	NS		
Jarnells Cr.	05110006	Muhlenberg Co.	0.0 to 7.7								07/01/1997		NS			
Jarrels Cr.	05110006	Muhlenberg Co.	0.0 to 1.6					x		WKU	06/01/2001	10/31/2001		NS		
Little Cypress Cr.	05110006	Muhlenberg Co.	0.0 to 9.2	x	x		x			KDOW NPS	06/20/2001	07/11/2001	PS			
Muddy Fk.	05110006	Muhlenberg Co.	0.0 to 3.4	x	x		x			KDOW NPS	06/20/2001	06/20/2001	T			
Plum Cr.	05110006	Muhlenberg Co.	2.5 to 4.3					x		WKU	06/01/2001	10/31/2001		NS		
Pond R.	05110006	Muhlenberg Co.	69.1 to 79.7		x			x		WKU	06/01/2001	10/31/2001	FS	FS		
Thompson Cr.	05110006	Muhlenberg Co.	0.0 to 6								07/01/1997		NS			
UT to Cypress Cr.	05110006	Muhlenberg Co.	0.0 to 1.6	x	x		x			KDOW NPS	06/20/2001	06/20/2001	PS			
Havana Cr.	05110006	Webster Co.	0.0 to 1.9	x						KDFWR	07/17/2001	07/17/2001	PS			
Bear Run	05140201	Breckinridge Co.	1.5 to 1.9		x					KDOW PROB	06/28/2001	06/28/2001	NS			
Clover Cr.	05140201	Breckinridge Co.	7.8 to 9.2	x	x	x				KDOW RR	06/21/2001	06/21/2001	PS			
Blackford Cr.	05140201	Daviess Co.	3.6 to 8.0	x	x	x				KDOW WBM	07/25/2001	07/25/2001	PS			
Pup Cr.	05140201	Daviess Co.	0.0 to 17.6										FS			
Blackford Cr.	05140201	Hancock Co.	0.0 to 3.6				x	x		KDOW AWQ	04/01/2001	03/01/2002		FS		

Monitoring Results
Green/Tradewater BMU

Waterbody	HUC	County	Segments (milepoints)	Fish	Macro-invertebrate	Algae	Water Quality	FC Bacteria	Fish Tissue	Program	Start Date	End Date	Aquatic Life	PCR	FC	DWS
Butchers Br.	05140201	Hancock Co.	0.0 to 2.3								01/01/1978		NS	NS		
Lead Cr.	05140201	Hancock Co.	0.0 to 0.6				x						T	T		
Lead Cr.	05140201	Hancock Co.	10.6 to 11.6				x						T	T		
Lead Cr.	05140201	Hancock Co.	3.5 to 4.5				x						NS	NS		
Canoe Cr.	05140202	Henderson Co.	0.0 to 3.9				x	x		KDOW AWQ	04/01/2001	03/31/2002	Resample	NS		
Scenic Lk.	05140202	Henderson Co.	Scenic Lk.							KDOW LAKES	04/15/1992	10/15/1992	PS			
Casey Cr.	05140202	Union Co.	0.6 to 9.5		x					KDOW PROB	07/09/2001	07/09/2001	NS			
Highland Cr.	05140202	Union Co.	0.0 to 7.1		x		x	x		KDOW AWQ	05/01/1998	10/31/2002	PS	NS		
Mauzy Lk.	05140202	Union Co.	Mauzy Lk.				x			KDOW LAKES	04/15/2001	10/25/2001	FS			
UT of Casey Cr.	05140202	Union Co.	0.0 to 1				x						NS	NS		
Camp Cr.	05140203	Crittenden Co.	0.0 to 4.3	x						KDFWR	07/03/2001	07/03/2001	FS			
Camp Cr.	05140203	Crittenden Co.	0.0 to 7								06/01/1993	06/01/1993	FS			
Coefield Cr.	05140203	Crittenden Co.	0.0 to 7.2	x	x	x				KDOW RR	06/19/2001	06/19/2001	FS			
Crooked Cr.	05140203	Crittenden Co.	0.0 to 11.7	x	x	x				KDOW AB	07/11/2001	08/07/2001	PS			
Crooked Cr.	05140203	Crittenden Co.	17.5 to 22.4	x	x	x				KDOW RR	05/28/2002	05/28/2002	FS			
Lk. George	05140203	Crittenden Co.	Lk. George				x			KDOW LAKES	04/15/2001	10/15/2001	FS			FS
Rush Cr.	05140203	Crittenden Co.	0.0 to 1.3	x	x	x				KDOW RR	05/28/2001	05/28/2001	PS			
Bayou Cr.	05140203	Livingston Co.	0.0 to 17.3	x	x					KDFWR	07/05/2001	07/30/2001	NS			
Buck Cr.	05140203	Livingston Co.	0.0 to 7.4	x						KDFWR	07/05/2001	07/05/2001	FS			
Dyer Hill Cr.	05140203	Livingston Co.	0.0 to 7										FS			
Hurricane Cr.	05140203	Trigg Co.	0.0 to 17.7								06/01/1994	06/01/1994	FS			
Dennis Onans Ditch	05140203	Union Co.	0.0 to 5.1				x	x		KDOW AWQ	04/01/2001	03/31/2002	FS	FS		
Goose Pond Ditch/Wardens Sl.	05140203	Union Co.	0.0 to 14.0		x					WKU	09/28/2001	09/28/2001	NS			
Sugg Cr.	05140203	Union Co.	0.0 to 1.4	x						KDFWR	06/05/2001	06/05/2001	NS			
Caney Cr.	05140205	Caldwell Co.	0.0 to 3.3	x						KDFWR	06/18/2001	06/18/2001	NS			
Donaldson Cr.	05140205	Caldwell Co.	0.0 to 5.3	x	x	x	x	x		KDOW AWQ	04/01/2001	03/31/2002	FS	FS		
E. Fk. Flynn Fk.	05140205	Caldwell Co.	2.0 to 5.4	x	x	x				KDOW RR	04/15/2002	04/15/2002	FS			
Lk. Beshear	05140205	Caldwell Co.	Lk. Beshear				x			KDOW LAKES	04/15/2001	10/15/2001	FS			FS
Montgomery Cr.	05140205	Caldwell Co.	0.0 to 7.5	x						KDFWR	06/21/2001	06/21/2001	FS			
Tradewater R.	05140205	Caldwell Co.	87.7 to 92.2					x		WKU	06/01/2001	10/31/2001		FS		
Tyson Br.	05140205	Caldwell Co.	0.0 to 2.5		x					WKU	07/11/2001	07/11/2001	NS			
UT to Piney Cr.	05140205	Caldwell Co.	0.0 to 2.4	x	x	x				KDOW RR	04/16/2002	04/16/2002	FS			
Ward Cr.	05140205	Caldwell Co.	4.9 to 10.1		x					WKU	07/24/3200	07/24/2001	NS			
Castleberry Cr.	05140205	Christian Co.	0.0 to 2.2	x						KDFWR	06/21/2001	06/21/2001	PS			
Sandlick Cr.	05140205	Christian Co.	4.9 to 9	x	x	x				KDOW RR	05/01/1993	04/16/2002	FS			
Tradewater R.	05140205	Christian Co.	95.0 to 109.2				x	x		KDOW AWQ	04/01/2001	03/31/2002	FS	FS		
Tradewater R.	05140205	Christian Co.	120.3 to 131.1	x	x	x				KDOW RR	05/01/1993	05/01/1994	FS			
UT to Sandlick Cr.	05140205	Christian Co.	0.0 to 1.5		x					KDOW RR	04/16/2002	04/16/2002	FS			
Hoods Cr.	05140205	Crittenden Co.	0.0 to 6.9	x	x	x				KDOW RR	06/18/2001	06/18/2001	FS			
Pigeonroost Cr.	05140205	Crittenden Co.	0.9 to 3.9		x					KDOW PROB	07/02/2001	07/02/2001	PS			
Piney Cr.	05140205	Crittenden Co.	17.1 to 25.1	x	x	x				KDOW RR	06/18/2001	07/02/2001	FS			
Piney Cr.	05140205	Crittenden Co.	4.6 to 1.0	x	x	x				KDOW RR	04/16/2002	04/16/2002	FS			
Wolf Cr.	05140205	Crittenden Co.	0.0 to 1.2							KDFWR	07/02/2001	07/02/2001	NS			
Brooks Cr.	05140205	Hopkins Co.	0.0 to 4.3		x					KDOW IS	07/01/1997		FS			
Buffalo Cr.	05140205	Hopkins Co.	0.0 to 6.7	x						KDFWR	06/21/2001	06/21/2001	PS			
Cane Run	05140205	Hopkins Co.	0.0 to 3.4				x			KDOW IS	07/01/1997		NS	NS		
Caney Cr.	05140205	Hopkins Co.	0.0 to 8.0	x						KDFWR	06/21/2001	06/21/2001	NS			

Monitoring Results
Green/Tradewater BMU

Waterbody	HUC	County	Segments (milepoints)	Fish	Macro-invertebrate	Algae	Water Quality	FC Bacteria	Fish Tissue	Program	Start Date	End Date	Aquatic Life	PCR	FC	DWS
Clear Cr.	05140205	Hopkins Co.	0.0 to 2.7				x	x		KDOW AB	04/01/2001	03/31/2002	NS	FS		
Clear Cr.	05140205	Hopkins Co.	19.1 to 25.5	x						KDFWR	06/01/2001	06/01/2001	PS			
Copper Cr.	05140205	Hopkins Co.	0.0 to 1.1				x			Field Office			NS			
Copperas Cr.	05140205	Hopkins Co.	0.0 to 3.1				x			Field Office			NS			
Greasy Cr.	05140205	Hopkins Co.	2.1 to 5.2	x							08/01/1997		NS	NS		
Greasy Cr.	05140205	Hopkins Co.	5.2 to 6.5	x	x						08/01/1997		FS			
Hurricane Cr.	05140205	Hopkins Co.	0.7 to 2.2				x			Field Office			NS	NS		
Lk. Peewee	05140205	Hopkins Co.	Lk. Peewee				x			KDOW LAKES	04/15/2001	10/15/2001	FS			PS
Lambs Cr.	05140205	Hopkins Co.	0.0 to 3.5	x						KDFWR	06/18/2001	06/18/2001	PS			
Lick Cr.	05140205	Hopkins Co.	0.0 to 12.1	x						KDFWR	06/18/2001	06/18/2001	NS			
Loch Mary	05140205	Hopkins Co.	Loch Mary				x			KDOW LAKES	04/15/2001	10/15/2001	FS			FS
Pogue Cr.	05140205	Hopkins Co.	0.0 to 4.6		x					KDOW IS	10/01/1997		FS			
Pond Cr.	05140205	Hopkins Co.	0.0 to 5.5	x						KDFWR	06/06/2001	06/06/2001	PS			
Richland Cr.	05140205	Hopkins Co.	0.0 to 4.4	x						KDFWR	06/18/2001	06/18/2001	NS			
Sugar Cr.	05140205	Hopkins Co.	0.0 to 5.3		x		x			KDOW IS	07/01/1997		PS	PS		
Tradewater R.	05140205	Hopkins Co.	62.1 to 78.1	x	x	x				KDOW WBM	08/08/2001	08/08/2001	FS			
Weirs Cr.	05140205	Hopkins Co.	0.0 to 5.0	x					x	KDFWR	07/13/2001	07/13/2001	NS			
Cypress Cr.	05140205	Union Co.	0.0 to 2.25				x	x		KDOW AWQ	04/01/2001	03/31/2002	FS	NS		
Moffit Lk.	05140205	Union Co.	Moffit Lk.				x			KDOW LAKES	04/15/2001	10/15/2001	FS			
Tradewater R.	05140205	Union Co.	40.8 to 45.9				x			KDES	01/01/1998	12/31/2002				FS
Tradewater R.	05140205	Union Co.	7.2 to 16.7	x	x	x				KDOW WBM	08/08/2001	08/08/2001	FS			
Caney Cr.	05140205	Webster Co.	3.5 to 7.9	x						KDFWR	06/05/2001	06/05/2001	PS			
Craborchard Cr.	05140205	Webster Co.	1.4 to 8.8				x	x		KDOW AWQ	04/01/2001	03/31/2002		NS		
Craborchard Cr.	05140205	Webster Co.	13.2 to 15.3	x						KDFWR	06/05/2001	06/05/2001	PS			
Lynn Fk.	05140205	Webster Co.	0.0 to 2.4	x						KDFWR	06/05/2001	06/05/2001	PS			
Providence City Res.	05140205	Webster Co.	Providence City Res.				x			KDOW LAKES	04/15/2001	10/15/2001	FS			FS
Smith Ditch	05140205	Webster Co.	3.0 to 5.7	x						KDFWR	06/05/2001	06/05/2001	NS			
UT to Slover Cr.	05140205	Webster Co.	0.2 to 1.2		x					KDOW PROB	07/10/2001	07/10/2001	NS			

Appendix 3-2. Monitoring Information from the
Big/Little Sandy & Tygarts Basin Management Unit

Monitoring Results
Big/Little Sandy
Tygarts BMU

Waterbody	HUC	County	Segments (milepoints)	Fish	Macro-invertebrate	Algae	WQ	FC Bacteria	Fish Tissue	Program	Start Date	End Date	Aquatic Life	PCR	FC	DWS
Rockcastle Cr.	05070201	Lawrence Co.	0.0 to 3.7		x		x	x		KDOW PROB	04/01/2002	03/31/2003	PS	FS		
Coldwater Fk.	05070201	Martin Co.	2.1 to 8.8	x	x					KDOW PROB	06/11/2002	06/11/2002	PS			
Hobbs Fk.	05070201	Martin Co.	0.0 to 2.0	x	x	x				KDOW RR	05/19/1997	05/19/1997	FS			
Hobbs Fk.	05070201	Martin Co.	2.0 to 3.9		x					KDOW RR	04/11/2001	4/11/2001	FS			
Martin County Lake	05070201	Martin Co.	Martin County Lk.				x			KDOW LAKES	04/15/1997	10/30/1997	FS			FS
Middle Fk. Rockcastle Cr.	05070201	Martin Co.	0.0 to 16.8	x	x					KDOW IS	10/16/2000	10/09/2003	PS			
Panther Fk.	05070201	Martin Co.	0.0 to 3.72	x	x					KDOW IS	10/11/2002	10/16/2002	PS			
Rockcastle Cr.	05070201	Martin Co.	3.7 to 13.25	x	x				x	KDOW IS	10/16/2000	07/31/2002	PS		FS	
Rockhouse Fk.	05070201	Martin Co.	0.0 to 6.3		x					KDOW PROB	06/11/2002	06/11/2002	PS			
Tug Fk.	05070201	Martin Co.	0.0 to 7.5				x	x		KDOW AWQ	04/01/2002	03/31/2003	FS	FS		
Tug Fk.	05070201	Martin Co.	33.9 to 36.6	x	x	x	x	x		KDOW WBM	04/01/2002	03/31/2003	FS	NS		
Tug Fk.	05070201	Martin Co.	71.9 to 77.7	x	x	x			x	KDOW WBM	08/07/2002	08/07/2002	FS		PS	
Wolf Cr.	05070201	Martin Co.	0.0 to 6.5	x	x		x	x		KDOW AWQ	04/01/2002	03/31/2003	PS	NS		
Wolf Cr.	05070201	Martin Co.	13.3 to 17.6	x	x					KDOW IS	10/11/2002	10/09/2003	NS			
Wolf Cr.	05070201	Martin Co.	17.6 to 20.5	x	x					KDOW IS	10/12/2000	10/15/2003	PS			
Wolf Cr.	05070201	Martin Co.	6.5 to 13.3	x	x					KDOW IS	10/11/2001	10/15/2003	PS			
Big Cr.	05070201	Pike Co.	0.0 to 1.9				x	x		KDOW AWQ	04/01/2002	03/31/2003	FS	NS		
Big Cr.	05070201	Pike Co.	10.7 to 15.1	x	x	x				KDOW WBM	06/12/2002	07/09/2002	PS			
Big Cr.	05070201	Pike Co.	7.3 to 10.7		x					KDOW PROB	06/19/2002	06/19/2002	PS			
Knox Cr.	05070201	Pike Co.	7.0 to 7.6	x	x	x				KDOW RR	07/31/2002	07/31/2002	PS			
Long Fk.	05070201	Pike Co.	0.0 to 5.1										NS	NS		
Lower Elk Fk.	05070201	Pike Co.	0.4 to 2.4		x					KDOW PROB	04/24/2002	04/24/2002	FS			
Peter Cr.	05070201	Pike Co.	0.0 to 20.1										T	T		
Pond Cr.	05070201	Pike Co.	3.4 To 9.7		x					KDOW PROB	06/19/2002	06/19/2002	PS			
Tug Fk.	05070201	Pike Co.	78.25 to 84.4				x	x		KDOW AWQ	04/01/2002	03/31/2003	FS	NS		
Levisa Fk.	05070202	Floyd Co.	81.0 to 99.9		x	x	x	x		KDOW AWQ	01/01/2002	03/31/2003	FS	NS		FS
Elkhorn Cr.	05070202	Pike Co.	0.0 to 10.6	x	x	x	x	x		KDOW AWQ	04/01/2002	03/31/2003	PS	NS		
Fishtrap Res.	05070202	Pike Co.	Fishtrap Res.				x		x	KDOW LAKES	05/29/2002	10/09/2002	FS		FS	
Grape Vine Cr.	05070202	Pike Co.	0.0 to 6.5										FS			
Hurricane Cr.	05070202	Pike Co.	0.5 to 2.9										NS	NS		
Indian Cr.	05070202	Pike Co.	0.0 to 3.5		x					KDOW PROB	07/02/2002	07/02/2002	PS			
Johnson Br.	05070202	Pike Co.	0.0 to 0.9	x	x	x				KDOW RR	05/15/2003	05/15/2003	FS			
Lower Pigeon Br.	05070202	Pike Co.	0.6 to 1.9	x	x	x				KDOW RR	04/12/2002	04/12/2002	FS			
Marrowbone Cr.	05070202	Pike Co.	1.4 to 11.3		x					KDOW PROB	07/02/2002	07/02/2002	PS			
Robinson Cr.	05070202	Pike Co.	0.0 to 2.1	x						KDFWR	08/14/2002	08/14/2002	T			
Russell Fk	05070202	Pike Co.	0.0 to 4.2				x	x		KDOW AWQ	04/01/2002	03/31/2003	FS	NS		
Russell Fk	05070202	Pike Co.	12.9 to 16.0				x			KDOW DWB	01/01/2002	12/31/2002				FS
Russell Fk	05070202	Pike Co.	6.2 to 9.2	x	x	x				KDOW WBM	07/10/2002	07/10/2002	FS			
Shelby Cr.	05070202	Pike Co.	0.0 to 6.1	x	x	x	x	x		KDOW WBM	04/01/2002	03/31/2003	PS	FS		
Shelby Cr.	05070202	Pike Co.	6.1 to 13.3	x						KDFWR	08/14/2002	08/14/2002	PS			
Toms Br.	05070202	Pike Co.	0.0 to 1.6		x					KDOW RR	04/12/2001	04/12/2001	FS			
Upper Pidgeon Br.	05070202	Pike Co.	0.0 to 2.1	x	x	x				KDOW RR	05/16/2002	05/16/2002	NS			
Wolfpen Br.	05070202	Pike Co.	0.0 to 1.7		x					KDOW PROB	04/25/2002	04/25/2002	NS			
Abbot Cr.	05070203	Floyd Co.	1.2 to 2.0				x			DMR	01/01/1998	12/31/2003	NS	NS		
Arkansas Cr.	05070203	Floyd Co.	0.0 to 3.6	x	x					KDOW NPS	04/15/2002	04/15/2002	NS			
Beaver Cr.	05070203	Floyd Co.	0.0 to 3.9	x	x	x	x	x		KDOW WBM	04/01/2002	03/31/2003	PS	NS		

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Buck Br.	05070203	Floyd Co.	0.0 to 2.8	x	x					KDOW NPS	04/15/2002	04/15/2002	NS			
Bull Cr.	05070203	Floyd Co.	0.0 to 7.2										PS	T		
Caleb Fk.	05070203	Floyd Co.	0.0 to 1.2	x	x					KDOW NPS	05/01/2002	05/01/2002	NS			
Clear Cr.	05070203	Floyd Co.	0.0 to 4.9	x	x					KDOW NPS	05/22/2002	05/22/2002	NS			
Dewey Lake	05070203	Floyd Co.	Dewey Lk.				x			KDOW LAKES	05/02/2002	10/09/2002	FS			
Frasure Br.	05070203	Floyd Co.	0.0 to 5.2	x	x					KDOW NPS	07/10/2002	07/10/2002	PS			
Goose Cr.	05070203	Floyd Co.	0.0 to 2.2	x	x					KDOW NPS	04/17/2002	04/17/2002	NS			
Jacks Br.	05070203	Floyd Co.	0.0 to 4.4	x	x					KDOW NPS	05/23/2002	05/23/2002	NS			
Johns Br.	05070203	Floyd Co.	0.0 to 1.6	x	x					KDOW NPS	04/16/2002	04/16/2002	NS			
Johns Cr.	05070203	Floyd Co.	0.0 to 4.4		x	x				KDOW WBM	07/17/2002	07/17/2002	FS			
Left Fk. Middle Cr.	05070203	Floyd Co.	0.0 to 8.4				x			OUTSIDE LAB	03/15/2002	11/11/2003	NS			
Lick Fk.	05070203	Floyd Co.	0.0 to 2.0										NS	NS		
Long Br.	05070203	Floyd Co.	0.0 to 2.0		x					KDOW PROB	04/23/2002	04/23/2002	NS			
Middle Cr.	05070203	Floyd Co.	0.0 to 18.0				x						PS			T
Mud Cr.	05070203	Floyd Co.	0.0 to 2.7	x						KDFWR	08/15/2002	08/15/2002	NS			
Mudlick Cr.	05070203	Floyd Co.	0.0 to 11.0										PS			
Otter Cr.	05070203	Floyd Co.	0.0 to 0.5	x	x					KDOW NPS	05/22/2002	05/22/2002	NS			
Prater Cr.	05070203	Floyd Co.	0.0 to 4.8	x						KDFWR	08/15/2002	08/15/2002	FS			
Right Fk. Beaver Cr.	05070203	Floyd Co.	0.0 to 17.4	x	x		x	x		KDOW AWQ	04/01/2002	03/31/2003	PS	NS		
Rock Fk.	05070203	Floyd Co.	0.0 to 7.0	x	x					KDOW NPS	07/11/2002	07/11/2002	PS			
Salt Lick Cr.	05070203	Floyd Co.	0.0 to 6.8	x	x					KDOW NPS	04/18/2002	04/18/2002	PS			
Simpson Br.	05070203	Floyd Co.	0.0 to 1.8	x	x					KDOW NPS	05/16/2002	05/16/2002	PS			
Sizemore Br.	05070203	Floyd Co.	0.0 to 2.0	x	x					KDOW NPS	05/02/2002	05/02/2002	NS			
Spewing Camp Br.	05070203	Floyd Co.	0.0 to 3.1				x			OUTSIDE LAB	03/20/2003	12/16/2003	NS			
Steele Cr.	05070203	Floyd Co.	0.0 to 2.4	x	x					KDOW NPS	04/30/2002	04/30/2002	NS			
Stephens Br.	05070203	Floyd Co.	0.0 to 2.6	x	x					KDOW NPS	04/16/2002	04/16/2002	NS			
Turkey Cr.	05070203	Floyd Co.	0.0 to 5.9	x	x					KDOW NPS	04/17/2002	04/17/0200	NS			
Wilson Cr.	05070203	Floyd Co.	0.0 to 2.9	x	x					KDOW NPS	04/17/2002	04/17/2002	NS			
Georges Cr.	05070203	Johnson Co.	0.9 to 6.5		x					KDOW PROB	07/10/2002	07/10/2002	FS			
Jennys Cr.	05070203	Johnson Co.	0.0 to 18.8										NS			
Levisa Fk.	05070203	Johnson Co.	72.8 to 79.6		x	x	x			KDOW WBM	01/01/2002	12/31/2002	FS	NS		FS
Little Paint Cr.	05070203	Johnson Co.	3.2 to 6.4		x					KDOW PROB	06/25/2002	06/25/2002	PS			
Little Paint Cr.	05070203	Johnson Co.	6.4 to 11.6	x						KDFWR	08/06/2002	08/06/2002	PS			
Miller Cr.	05070203	Johnson Co.	0.0 to 6.4		x					KDOW PROB	04/17/2002	04/17/2002	NS			
Paint Cr.	05070203	Johnson Co.	0.0 to 7.9	x	x	x	x	x		KDOW AWQ	04/01/2002	03/31/2003	NS	NS		
Paintsville Res.	05070203	Johnson Co.	Paintsville Res.				x		x	KDOW LAKES	05/30/2002	10/14/2002	FS		PS	
Sturgeon Br.	05070203	Johnson Co.	0.0 to above 1.1		x					KDOW PROB	04/24/2002	04/24/2002	Resample			
Toms Cr.	05070203	Johnson Co.	0.0 to 11.3										FS			
Arnold Fk.	05070203	Knott Co.	0.0 to 2.6	x	x					KDOW NPS	05/16/2002	05/16/2002	NS			
Bill D Br.	05070203	Knott Co.	0.0 to 1.1	x	x					KDOW NPS	05/21/2002	05/21/2002	NS			
Buck Br. and Right Fk. Beaver Cr.	05070203	Knott Co.	0 to 39.0										NS	T		
Caney Fk.	05070203	Knott Co.	0.0 to 7.5	x	x					KDOW NPS	07/11/2002	07/11/2002	FS			
Dry Cr.	05070203	Knott Co.	0.0 to 4.0	x	x					KDOW NPS	05/21/2002	05/21/2002	PS			
Jones Fk.	05070203	Knott Co.	0.0 to 9.4	x	x					KDOW NPS	07/10/2002	07/10/2002	PS			
Left Fk. Beaver Cr.	05070203	Knott Co.	0.0 to 11.4	x	x					KDOW NPS	06/26/2002	08/15/2002	PS			
Left Fk. Beaver Cr.	05070203	Knott Co.	13.6 to 18.7		x					KDOW PROB	07/01/2002	07/01/2002	PS			

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Puncheon Br.	05070203	Knott Co.	0.0 to 3.6	x	x					KDOW NPS	05/17/2002	05/17/2002	PS			
Right Fk. Beaver Cr.	05070203	Knott Co.	30.3 to 33.4		x					KDOW PROB	07/01/2002	07/01/2002	PS			
Salisbury Br.	05070203	Knott Co.	0.0 to 1.8	x	x					KDOW NPS	05/01/2002	05/01/2002	PS			
Levisa Fk.	05070203	Lawrence Co.	0.0 to 2.9				x	x		KDOW AWQ	01/01/2002	03/31/2003	FS	FS		FS
Levisa Fk.	05070203	Lawrence Co.	5.0 to 15.1		x	x			x	KDOW WBM	08/06/2002	08/27/2002	PS		PS	
Big Mine Cr.	05070203	Magoffin Co.	1.4 to 3.9	x						KDFWR	08/06/2002	08/06/2002	PS			
Big Mine Cr.	05070203	Magoffin Co.	5.8 to 8.4		x					KDOW PROB	06/06/2002	06/06/2002	PS			
Open Fk.	05070203	Morgan Co.	6.4 to 11.3	x						KDFWR	08/06/2002	08/06/2002	PS			
Brushy Fk.	05070203	Pike Co.	2.2 to 10.0		x					KDOW PROB	06/10/2002	06/10/2002	NS			
Island Cr.	05070203	Pike Co.	0.0 to 1.7		x					KDOW PROB	06/20/2002	06/20/2002	PS			
Johns Cr.	05070203	Pike Co.	24.0 to 30.7		x	x	x	x	x	KDOW WBM	04/01/2002	03/31/2003	PS	NS	FS	
Johns Cr.	05070203	Pike Co.	34.4 to 42.5		x					KDOW PROB	06/10/2002	06/10/2002	NS			
Levisa Fk.	05070203	Pike Co.	116.2 to 120.6				x			KDOW DWB						FS
Raccoon Cr.	05070203	Pike Co.	5.6 to 7.4		x					KDOW PROB	06/19/2002	06/19/2002	PS			
Stinking Br.	05070203	Pike Co.	0.0 to 2.3								06/01/1980		NS	NS		
Big Sandy R.	05070204	Boyd Co.	0.0 to 2.6						x	KDOW WBM	08/23/2002	08/23/2002			FS	
Big Sandy R.	05070204	Boyd Co.	2.6 to 14.7				x	x		KDOW AWQ	04/01/2002	03/31/2003	FS	FS		
Ice Dam Cr.	05070204	Boyd Co.	0.0 to 0.4	x	x					KDOW NPS	03/13/2002	03/13/2003	NS			
Ice Dam Cr.	05070204	Boyd Co.	0.4 to 2.4	x	x					KDOW NPS	03/13/2002	03/13/2002	NS			
Paddle Cr.	05070204	Boyd Co.	0.0 to 1.4	x	x					KDOW NPS	04/05/2002	04/05/2002	NS			
Whites Cr.	05070204	Boyd Co.	0.6 to 3.5	x	x	x				KDOW RR	07/15/2002	07/15/2002	FS			
Whites Cr.	05070204	Boyd Co.	0.5 to 5.9								05/01/1997				FS	
Bear Cr.	05070204	Lawrence Co.	0.0 to 1.9	x	x	x	x	x		KDOW AWQ	04/01/2002	03/31/2003	PS	NS		
Blaine Cr.	05070204	Lawrence Co.	35.0 to 40.8				x	x		KDOW AWQ	04/01/2002	03/31/2003	FS	NS		
Blaine Cr.	05070204	Lawrence Co.	44.0 to 48.4	x						KDFWR	08/05/2002	08/05/2002	NS			
Blaine Cr.	05070204	Lawrence Co.	8.1 to 17.4		x		x	x		KDOW PROB	04/01/2002	03/31/2003	NS	FS		
Blaine Cr.	05070204	Lawrence Co.	41.6 to 43.0	x	x	x				KDOW WBM	07/31/2002	07/31/2002	PS			
Brushy Cr.	05070204	Lawrence Co.	0 to 11.1								06/01/1990	06/01/1990	FS		FS	
Caney Fk.	05070204	Lawrence Co.	0.9 to 3.5		x					KDOW PROB	04/11/2002	04/11/2002	FS			
Cat Fk.	05070204	Lawrence Co.	0.0 to 6.7	x						KDFWR	08/05/2002	08/05/2002	T			
Franks Cr.	05070204	Lawrence Co.	0.0 to 5.3										FS		FS	
Hood Cr.	05070204	Lawrence Co.	0.0 to 3.6	x						KDFWR	08/05/2002	08/05/2002	PS			
Hood Cr.	05070204	Lawrence Co.	3.6 to 5.4		x					KDOW PROB	06/18/2002	06/18/2002	FS			
Left Fk. Blaine Cr.	05070204	Lawrence Co.	0.0 to 2.1	x						KDFWR	08/06/2002	08/06/2002	NS			
Left Fk. Little Blaine Cr.	05070204	Lawrence Co.	0.0 to 8.5						x		06/01/1990	06/01/1990	FS		FS	
Little Blaine Cr.	05070204	Lawrence Co.	0.0 to 4.3								06/01/1990		FS			
Little Cat Fk.	05070204	Lawrence Co.	1.1 to 3.7		x					KDOW PROB	04/10/2002	04/10/2002	FS			
Lower Laurel Cr.	05070204	Lawrence Co.	0.0 to 10.0								06/01/1990	06/01/1990	FS		FS	
Lower Laurel Fk.	05070204	Lawrence Co.	0.0 to 7.9	x						KDFWR	08/05/2002	08/05/2002	PS			
Right Fk. Blaine Cr.	05070204	Lawrence Co.	0 to 6.2								06/01/1990	06/01/1990	PS		FS	
Right Fk. Cains Cr.	05070204	Lawrence Co.	0.0 to 5.4						x		06/01/1990	06/01/1990	FS		FS	
Right Fk. Little Blaine Cr.	05070204	Lawrence Co.	0.0 to 8.0						x		06/01/1990	06/01/1990	FS		FS	
Yatesville Res.	05070204	Lawrence Co.	Yatesville Res.				x			KDOW LAKES	05/02/2002	10/14/2002	FS			
Hood Cr.	05090103	Boyd Co.	0.0 to 5.4				x	x		KDOW AWQ	04/01/2002	03/31/2003	FS	FS		
Buffalo Cr.	05090103	Carter Co.	0.0 to 6.3				x	x		KDOW AWQ	04/01/2002	03/31/2003	FS	FS		
Buffalo Cr.	05090103	Carter Co.	6.3 to 9.6	x	x	x				KDOW WBM	06/11/2002	06/11/2002	FS			

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Jacobs Fk.	05090103	Carter Co.	3.6 to 5.7		x					KDOW PROB	07/03/2002	07/03/2002	PS			
McGlone Fk.	05090103	Carter Co.	0.0 to 2.5	x						KDFWR	06/26/2002	06/26/2002	FS			
Smith Cr.	05090103	Carter Co.	2.0 to 4.3		x					KDOW PROB	04/03/2002	04/03/2002	PS			
Smokey Valley Lake	05090103	Carter Co.	Smokey Valley Lk.				x			KDOW LAKES	05/22/2002	10/02/2002	FS			
Smoky Cr.	05090103	Carter Co.	1.4 to 3.8	x						KDFWR	06/27/2002	06/27/2002	Resample			
Soldier Fk.	05090103	Carter Co.	0.0 to 2.0	x						KDFWR	06/27/2002	06/27/2002	Resample			
Three Prong Br.	05090103	Carter Co.	0.0 to 5.8	x						KDFWR	06/26/2002	06/26/2002	FS			
Trough Camp	05090103	Carter Co.	1.5 to 6.1		x					KDOW PROB	04/11/2002	04/11/2002	PS			
Tygarts Cr.	05090103	Carter Co.	51.0 to 57.8	x	x	x				KDOW PROB	07/10/2002	07/10/2002	FS			
Tygarts Cr.	05090103	Carter Co.	78.0 to 88.6				x		x	KDOW IS	04/01/1994	12/01/1995	FS		FS	FS
Backs Br.	05090103	Greenup Co.	0.0 to 0.9		x					KDOW PROB	04/15/2002	04/15/2002	PS			
Brushy Cr.	05090103	Greenup Co.	0.0 to 3.9	x						KDFWR	06/25/2002	06/25/2002	FS			
Leatherwood Br.	05090103	Greenup Co.	0.0 to 4.3	x						KDFWR	06/25/2002	06/25/2002	FS			
Newberry Br.	05090103	Greenup Co.	0.0 to 2.8		x					KDOW PROB	04/16/2002	04/16/2002	NS			
Schultz Cr.	05090103	Greenup Co.	1.3 to 4.7		x					KDOW PROB	06/05/2002	06/05/2002	FS			
Schultz Cr.	05090103	Greenup Co.	4.7 to 10.8	x						KDFWR	06/24/2002	06/24/2002	PS			
Tygarts Cr.	05090103	Greenup Co.	22.9 to 29.5				x	x		KDOW AWQ	04/01/2002	03/31/2003	FS	FS		
Tygarts Cr.	05090103	Greenup Co.	29.5 to 31.8	x	x	x			x	KDOW WBM	06/26/2002	06/26/2002	FS		NS	
Tygarts Cr.	05090103	Greenup Co.	65.0 to 68.6				x	x		KDOW AWQ	04/01/2002	03/31/2003	FS	FS		
UT to Chinns Br.	05090103	Greenup Co.	0.0 to 1.1		x					KDOW PROB	04/11/2002	04/11/2002	NS			
White Oak Cr.	05090103	Greenup Co.	0.0 to 1.1	x									NS			
East Fk. Little Sandy River	05090104	Boyd Co.	24.9 to 26.4				x	x		KDOW AWQ	04/01/2002	03/31/2003	FS	NS		
East Fk. Little Sandy River	05090104	Boyd Co.	27.1 to 30.0		x	x				KDOW WBM	06/12/2002	06/12/2002	PS			
East Fk. Little Sandy River	05090104	Boyd Co.	4.7 to 9.0				x	x		KDOW AWQ	04/01/2002	03/31/2003	FS	FS		
Ellingtons Bear Cr	05090104	Boyd Co.	0.0 to 1.5		x					KDOW PROB	04/10/2002	04/10/2002	PS			
Garner Cr	05090104	Boyd Co.	0.0 to 1.8	x						KDFWR	07/09/2002	07/09/2002	PS			
Williams Cr.	05090104	Boyd Co.	0.0 to 2.9	x						KDFWR	07/03/2002	07/03/2002	PS			
Barrett Cr.	05090104	Carter Co.	0.0 to 7.2	x						KDFWR	07/02/2002	07/02/2002	PS			
Big Sinking Cr.	05090104	Carter Co.	6.1 to 15.2	x	x	x	x	x		KDOW RR	06/27/2002	06/27/2002	FS	FS		
Everman Cr	05090104	Carter Co.	0.0 to 5.7	x						KDFWR	07/10/2002	07/10/2002	PS			
Grayson Lake	05090104	Carter Co.	Grayson Lk.				x		x	KDOW LAKES	05/22/2002	10/03/2002	FS		PS	
Little Fk. Little Sandy R.	05090104	Carter Co.	12.0 to 23.8		x					KDOW PROB	07/08/2002	07/08/2002	PS			
Little Fk. Little Sandy R.	05090104	Carter Co.	2.3 to 4.8				x	x		KDOW AWQ	04/01/2002	03/31/2003	FS	FS		
Little Fk. Little Sandy R.	05090104	Carter Co.	4.8 to 6.0		x					KDOW PROB	07/08/2002	07/08/2002	PS			
Little Fk. Little Sandy R.	05090104	Carter Co.	6.0 to 12.0		x	x				KDOW WBM	06/25/2002	06/25/2002	FS			
Little Sandy R.	05090104	Carter Co.	40.1 to 42.5				x			KDOW DWB	01/01/2002	12/31/2002				FS
Little Sandy R.	05090104	Carter Co.	42.5 to 47.1		x	x	x	x		KDOW WBM	04/01/2002	03/31/2003	FS	FS		
Little Sinking Cr.	05090104	Carter Co.	0.0 to 6.2	x						KDFWR	07/15/2002	07/15/2002	FS			
Lower Stinson Cr.	05090104	Carter Co.	0.0 to 1.1	x						KDFWR	07/11/2002	07/11/2002	PS			
Straight Cr.	05090104	Carter Co.	0.0 to 3.8	x						KDFWR	07/11/2002	07/11/2002	PS			
Arabs Fk.	05090104	Elliott Co.	0.0 to 5.1							KDOW RR	04/01/1992	11/01/1994	FS			
Big Caney Cr.	05090104	Elliott Co.	1.8 to 13.4	x	x	x	x	x		KDOW AWQ	04/01/2002	03/31/2003	FS	FS		
Clay Fk	05090104	Elliott Co.	0.0 to 4.0	x	x	x				KDOW RR	04/01/1992	04/01/1992	FS			
Green Br	05090104	Elliott Co.	0.0 to 1.4		x	x				KDOW RR	04/29/2002	04/29/2002	FS			
Laurel Br	05090104	Elliott Co.	1.0 to 2.6	x	x					KDOW NPS	03/15/2002	03/15/2002	FS			
Laurel Cr.	05090104	Elliott Co.	0.0 to 7.6	x	x	x				KDOW RR	06/26/2002	06/26/2002	FS			

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Laurel Cr.	05090104	Elliott Co.	7.6 to 11.2	x	x	x				KDOW RR	07/02/2002	07/02/2002	FS			
Left Fk. Redwine Cr.	05090104	Elliott Co.	0.0 to 1.2		x					KDOW PROB	04/04/2002	04/04/2002	PS			
Lick Fk.	05090104	Elliott Co.	0.0 to 5.2	x	x					KDOW NPS	07/09/2002	07/09/2002	PS			
Little Fk. Little Sandy R.	05090104	Elliott Co.	23.8 to 27.7	x						KDFWR	07/12/2002	07/12/2002	NS			
Little Fk. Little Sandy R.	05090104	Elliott Co.	27.7 to 30.5		x					KDOW PROB	07/09/2002	07/09/2002	PS			
Little Sandy R.	05090104	Elliott Co.	71.8 to 74.7	x	x	x	x	x		KDOW AWQ	04/01/2002	03/31/2003	PS	FS		
Meadow Br.	05090104	Elliott Co.	0.0 to 1.4	x	x	x				KDOW RR	04/30/2002	04/30/2002	FS			
Middle Fk. Little Sandy R.	05090104	Elliott Co.	0.0 to 5.7	x	x	x				KDOW RR	07/16/2002	07/16/2002	FS			
Middle Fk. Little Sandy R.	05090104	Elliott Co.	5.7 to 7.5	x						KDFWR	07/17/2002	07/17/2002	PS			
Newcombe Cr.	05090104	Elliott Co.	0.0 to 6.9	x	x					KDOW NPS	07/09/2002	07/30/2002	PS			
Nichols Fk.	05090104	Elliott Co.	0.0 to 1.6	x	x	x				KDOW RR	04/29/2002	04/29/2002	FS			
Right Fk. Newcombe Cr.	05090104	Elliott Co.	0.0 to 4.2		x					KDOW NPS	04/16/2002	04/16/2002	PS			
Rocky Br.	05090104	Elliott Co.	0.0 to 3.2	x	x					KDOW NPS	04/04/2002	04/04/2002	PS			
S. Fk. Ruin Cr.	05090104	Elliott Co.	0.0 to 0.7	x						KDFWR	07/16/2002	07/16/2002	Resample			
UT to Newcombe Cr.	05090104	Elliott Co.	0.0 to 0.95	x	x					KDOW NPS	03/14/2002	03/14/2002	T			
UT to Newcombe Cr.	05090104	Elliott Co.	0.0 to 1.35	x	x					KDOW NPS	03/14/2002	03/14/2002	FS			
Wells Cr.	05090104	Elliott Co.	0.0 to 3.5	x						KDFWR	07/16/2002	07/16/2002	PS			
Allcorn Cr.	05090104	Greenup Co.	1.4 to 3.9		x					KDOW PROB	04/16/2002	04/16/2002	NS			
Cane Cr.	05090104	Greenup Co.	0.0 to 4.1	x						KDFWR	07/03/2002	07/03/2002	PS			
Greenbo Lake	05090104	Greenup Co.	Greenbo Lk.				x			KDOW LAKES	04/15/1998	10/30/1998	FS			FS
Little Sandy R.	05090104	Greenup Co.	0.0 to 0.2				x	x		DMR	01/01/1998	05/01/2002		NS		
Little Sandy R.	05090104	Greenup Co.	0.2 to 12.1				x			KDOW DWB	01/01/2002	12/31/2002				FS
Little Sandy R.	05090104	Greenup Co.	12.1 to 20.1	x	x	x	x	x	x	KDOW RR	04/01/2002	03/31/2003	FS	FS	FS	
Oldtown Cr.	05090104	Greenup Co.	0.0 to 1.9	x	x					KDOW PROB	06/05/2002	07/10/2002	PS			
Tunnel Br.	05090104	Greenup Co.	0.0 to 1.7		x					KDOW PROB	04/16/2002	04/16/2002	NS			
UT to E. Fk. Little Sandy R.	05090104	Greenup Co.	0.0 to 0.3		x					KDOW PROB	06/05/2002	06/05/2002	NS			
Dry Fk	05090104	Lawrence Co.	1.2 to 4.5	x						KDFWR	07/12/2002	07/12/2002	PS			

Chapter 4. Lakes and Reservoirs

4.1 Introduction

Since the initiation of the rotating basin approach in 1998, the state's significant publicly-owned reservoirs are monitored over a five-year cycle instead of the previous seven- to eight-year cycle. During this two-year reporting period, 31 reservoirs in the Green, Tradewater and Ohio River (minor tributaries) basins and eight reservoirs in the Tygarts Creek, Big Sandy, and Little Sandy river basins were monitored for trophic state and use support (Figures 4-1 – 16 in the back of this chapter).

Designated uses in lakes consist of Warm Water Aquatic Habitat (WAH) (sometimes in conjunction with Cold Water Aquatic Habitat (CAH) in lakes with a two-story fishery) and Primary and Secondary Contact Recreation (PCR and SCR). Many of the reservoirs also have a domestic water supply (DWS) use.

4.2 Methods

Sampling was conducted three times during the growing season, typically in late April to early May, July, and late September to early October. Composite nutrient and chlorophyll *a* samples were collected from the photic zone (one percent of light penetration), and dissolved oxygen, temperature, pH and specific conductivity measurements were obtained from profiles of the water column in the deepest part of the lake. Samples were taken in the area immediately upstream of the dam and at other locations on the main lake and major tributary embayments, depending on the size and configuration of each reservoir. Also, trophic data were provided by the U.S. Army Corps of Engineers (2001-2002) on lakes in the Green/Tradewater BMU.

Table 4-1. Criteria for lake use support classification.

Category	Warm Water Aquatic Habitat (At least two of the following criteria)	Secondary Contact Water Recreation (At least one of the following criteria)	Domestic Water Supply (At least one of the following criteria)
Not Supporting:	Fish kills caused by poor water quality	Widespread excess macrophyte/macro-scopic algal growth	Chronic taste and odor complaints caused by algae
	Severe hypolimnetic oxygen depletion	Chronic nuisance algal blooms	Chronic treatment problems caused by poor water quality
	Dissolved oxygen average less than 4 mg/l in the epilimnion		Exceeds drinking water MCL
Partially Supporting: (At least one of the following criteria)	Dissolved oxygen average less than 5 mg/l in the epilimnion	Localized or seasonally excessive macrophyte/macroscopic algal growth	Occasional taste and odor complaints caused by algae
	Severe hypolimnetic oxygen depletion	Occasional nuisance algal blooms	Occasional treatment problems caused by poor water quality
	Other specific cause (i.e. low pH)	High suspended sediment concentrations during the recreation season	
Fully Supporting:	None of the above	None of the above	None of the above

4.3 Assessment of Trophic State and Use Support

Trophic status was assessed in lakes by using the Carlson Trophic State Index (TSI) for chlorophyll *a*. This method is convenient because it allows lakes to be ranked numerically according to increasing eutrophy, and it also provides for a distinction between oligotrophic, mesotrophic, eutrophic, and hyper-eutrophic lakes. The growing season (April – October) average TSI value was used to rank each lake. Areas of lakes that exhibited trophic gradients or embayment differences often were analyzed separately. Use support in lakes was determined by criteria listed in Table 4-1.

4.4 Results

4.4.1 Statewide

Tables 4-2, 4-3 and 4-4 present statewide summaries of use support, causes and sources of impairments of reservoirs and lakes in the state. The water quality assessment of lakes includes more than 90 percent of the publicly-owned lake acreage of Kentucky. Sixty-seven of 107 lakes (62.6 percent) fully support their uses, 33 (30.8 percent) partially support uses, and 7 (6.5 percent) do not support one or more uses. On an acreage basis, more than 55 percent (120,372 acres) of the 217,597 assessed acres fully support uses, 43 percent (93,311 acres) partially support uses, and less than two percent (3,914 acres) do not support one or more uses (Table 4-2).

Mercury in fish tissue is the most frequent cause of uses in lakes not being fully supported (Table 4-3). Nutrients and organic enrichment/low dissolved oxygen are the second most frequent causes of use impairment, with agricultural runoff, land disposal and septic tanks the principal sources of the nutrients (Table 4-4). A fish consumption advisory for PCBs is in place on one reservoir of considerable size (Green River Lake), resulting in a high percentage of lake acres impacted by priority organics (Table 4-3). Naturally shallow lake basins (habitat alterations and siltation when combined), which allow the proliferation of nuisance aquatic weeds that impair secondary contact recreation, account for the fifth highest cause of use nonsupport. Other

Table 4-2. Lake use support summary, acres.

Use	Assessed	Fully Supporting	Partially Supporting	Not Supporting
Overall Support	217,597 (107)	120,372 (67)	93,311 (33)	3,914 (7)
Aquatic Life Support	217,597	207,647	6,176	3,775
Fish Consumption	203,513	115,688	87,825	0
Primary Contact Recreation	4,389	4,170	219	0
Secondary Contact Recreation	6,919	2,940	3,979	0
Drinking Water Supply	201,810	200,099	1,572	139

Table 4-3. Causes of use impairment in lakes.

Name	Acres Affected	Percent
Priority Organics	8,210	7
Metals	87,825	76
Nutrients	7,676	7
pH	219	<1
Siltation	2,417	2
Organic enrichment/Low DO	6,035	5
Other habitat alterations	413	<1
Taste and odor	854	<1
Suspended solids	1,810	<2
Algal Growth/Chlorophyll *a*	379	<1

Table 4-4. Sources of impairment in lakes.

Name	Acres Affected	Percent
Industrial Point Sources	8,210	24
Municipal Point Sources	4,309	12
Agriculture	9,074	26
Resource Extraction	3,259	9
Land Disposal	4,196	12
Contaminated Sediments	18	<1
Internal Nutrient Cycling (primarily lakes)	3,366	10
Natural Sources	2,401	7

natural conditions such as manganese releases from anoxic hypolimnetic water and nutrients in runoff from relatively undisturbed watersheds affect domestic water supply and secondary contact uses, respectively. Suspended solids from surface mining activities, which have decreased in severity as a source from previous years, impaired the secondary contact recreation use in only one eastern Kentucky reservoir.

4.4.2 Green/Tradewater and Sandy/Tygarts Basin Management Units

In the Green/Tradewater BMU, 22 reservoirs are eutrophic, seven mesotrophic and two oligotrophic. (Tables 4-5 and 4-6). Twenty of these reservoirs fully support uses and 11 partially support uses (Figures 4-1 – 16 at the end of this chapter).

Of the eight lakes and reservoirs monitored in the Big Sandy/Little Sandy/Tygarts BMU, five fully supported uses and three partially supported uses (Tables 4-5 and 4-6). The most common causes were mercury in fish tissue and nutrients (phosphorus, nitrogen) that eventually result in depleted or lowered dissolved oxygen in the water column.

Table 4-5. Lakes/reservoirs in Green/Tradewater and Big Sandy/Little Sandy/Tygarts BMUs fully supporting all uses.

Lake	Acres	County	Trophic State	Uses
Green River Basin				
Briggs Lake	19	Logan	Eutrophic	WAH,PCR,SCR
Carpenter Lake	64	Daviess	Eutrophic	WAH,PCR,SCR
Freeman Lake	160	Hardin	Mesotrophic	WAH,PCR,SCR,DWS
Kingfisher Lake	30	Daviess	Eutrophic	WAH,PCR,SCR
Lake Malone	826	Logan	Eutrophic	WAH,PCR,SCR,DWS
Lake Washburn	26	Ohio	Mesotrophic	WAH,PCR,SCR
Lewisburg Lake	51	Logan	Mesotrophic	WAH,PCR,SCR
Liberty Lake	79	Casey	Oligotrophic	WAH,PCR,SCR,DWS
Metcalfe County Lake	22	Metcalfe	Eutrophic	WAH,PCR,SCR
Mill Creek Lake (Monroe Co.)	109	Monroe	Eutrophic	WAH,PCR,SCR,DWS
Nolin River Reservoir	5790	Hart	Eutrophic	WAH,PCR,SCR,DWS
Pennyrile Lake	47	Christian	Mesotrophic	WAH,PCR,SCR
Shanty Hollow Lake	135	Warren	Eutrophic	WAH,PCR,SCR
Spurlington Lake	36	Taylor	Eutrophic	WAH,PCR,SCR
Ohio River (Minor Tribs) River Basin				
Lake George	53	Crittenden	Eutrophic	WAH,PCR,SCR,DWS
Mauzy Lake	84	Union	Eutrophic	WAH,PCR,SCR
Tradewater River Basin				
Lake Beshear	760	Caldwell	Eutrophic	WAH,PCR,SCR,DWS
Loch Mary	135	Hopkins	Mesotrophic	WAH,PCR,SCR,DWS
Moffit Lake	49	Union	Eutrophic	WAH,PCR,SCR
Providence City Reservoir	35	Webster	Oligotrophic	WAH,PCR,SCR,DWS
Big Sandy River				
Fishtrap Reservoir	1143	Pike	Mesotrophic	WAH,PCR,SCR
Martin County Lake	23	Martin	Oligotrophic	
Yatesville Reservoir	2242	Lawrence	Mesotrophic	WAH,PCR,SCR
Little Sandy River				
Greenbo Lake	181	Greenup	Oligotrophic	WAH,PCR,SCR,DWS
Tygarts Creek				
Smoky Valley Lake	36	Carter	Mesotrophic	WAH,PCR,SCR

Table 4-6. Lakes/reservoirs in Green/Tradewater and Big Sandy/Little Sandy/Tygarts BMUs partially supporting one or more uses.

Lake	Acres	County	Trophic State	Uses Impaired	Causes	Sources
Green River Basin						
Barren River Res.	10000	Allen	Eutrophic	FC	Mercury	Source Unknown
Campbellsville City Res.	63	Taylor	Eutrophic	SCR	Siltation	Agriculture, Natural Sources
Caneyville City Res.	75	Grayson	Eutrophic	SCR,DWS	Nutrients, Siltation	Natural Sources
Grapevine Lake	50	Hopkins	Mesotrophic	DWS	Nutrients	Source Unknown
Green River Res.	8210	Taylor	Eutrophic	FC	Mercury,PCBs	Source Unknown, Industrial Point Sources
Lake Luzerne	55	Muhlen-berg	Mesotrophic	DWS	Nutrients	Source Unknown
Lake Peewee	360	Hopkins	Eutrophic	DWS	Nutrients	Agriculture
Rough River Res.	5100	Hardin	Eutrophic	FC	Mercury	Source Unknown
Salem Lake	99	Larue	Eutrophic	SCR	Other Habitat Alterations	Agriculture
Spa Lake	240	Logan	Eutrophic	SCR	Siltation,Algal Growth/Chloro-phyll-a,Other habitat alterations	Agriculture, Natural Sources
Ohio River Basin						
Scenic Lake	18	Henderson	Eutrophic	WAH	Nutrients	Internal nutrient recycling, contaminated sediments
Big Sandy River						
Dewey Lake	1100	Floyd	Mesotrophic	SCR	Suspended Solids	Resource Extraction (Surface Mining)
Paintsville Res.	1139	Johnson	Oligotrophic	FC	Mercury	Source Unknown
Little Sandy River						
Grayson Lake	1512	Carter	Mesotrophic	FC	Mercury	Source Unknown

[a] WAH = Warm Water Aquatic Life; FC = Fish Consumption; DWS = Domestic Water Supply

Figure 4-1. Reservoirs monitored in the Green-Tradewater Basin.

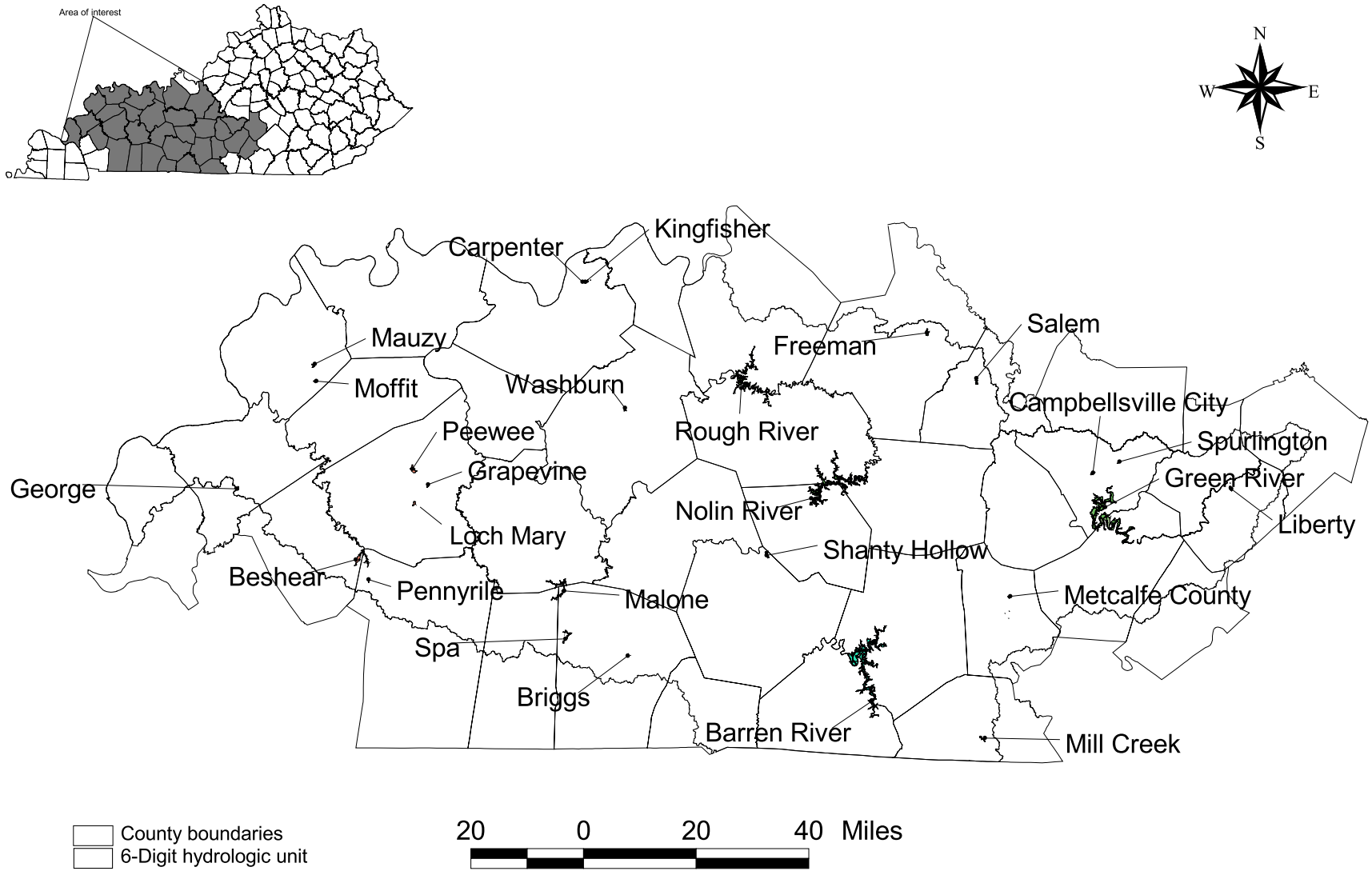
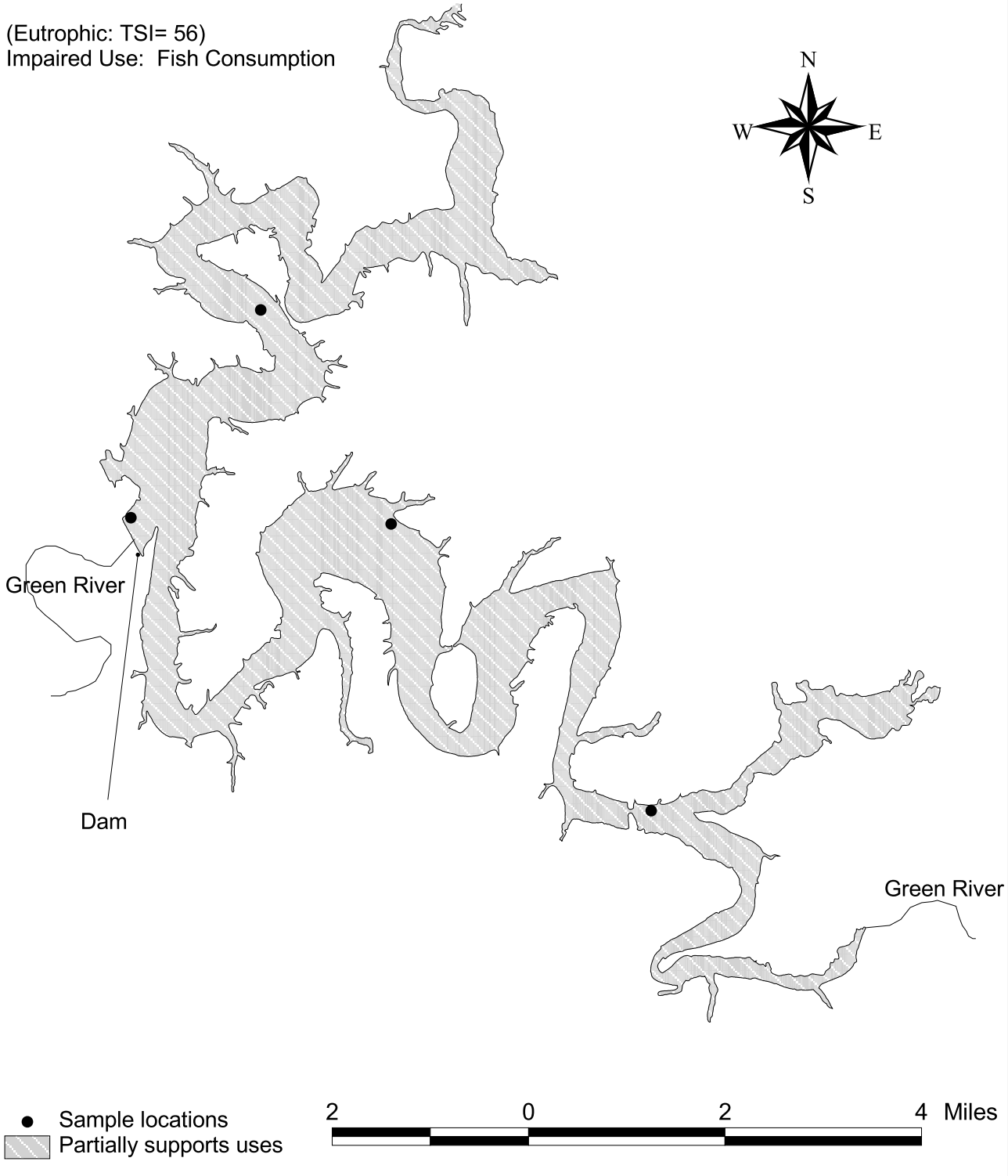


Figure 4-2. Monitoring sites on Green River Reservoir in the Green/Tradewater Basin Management Unit.

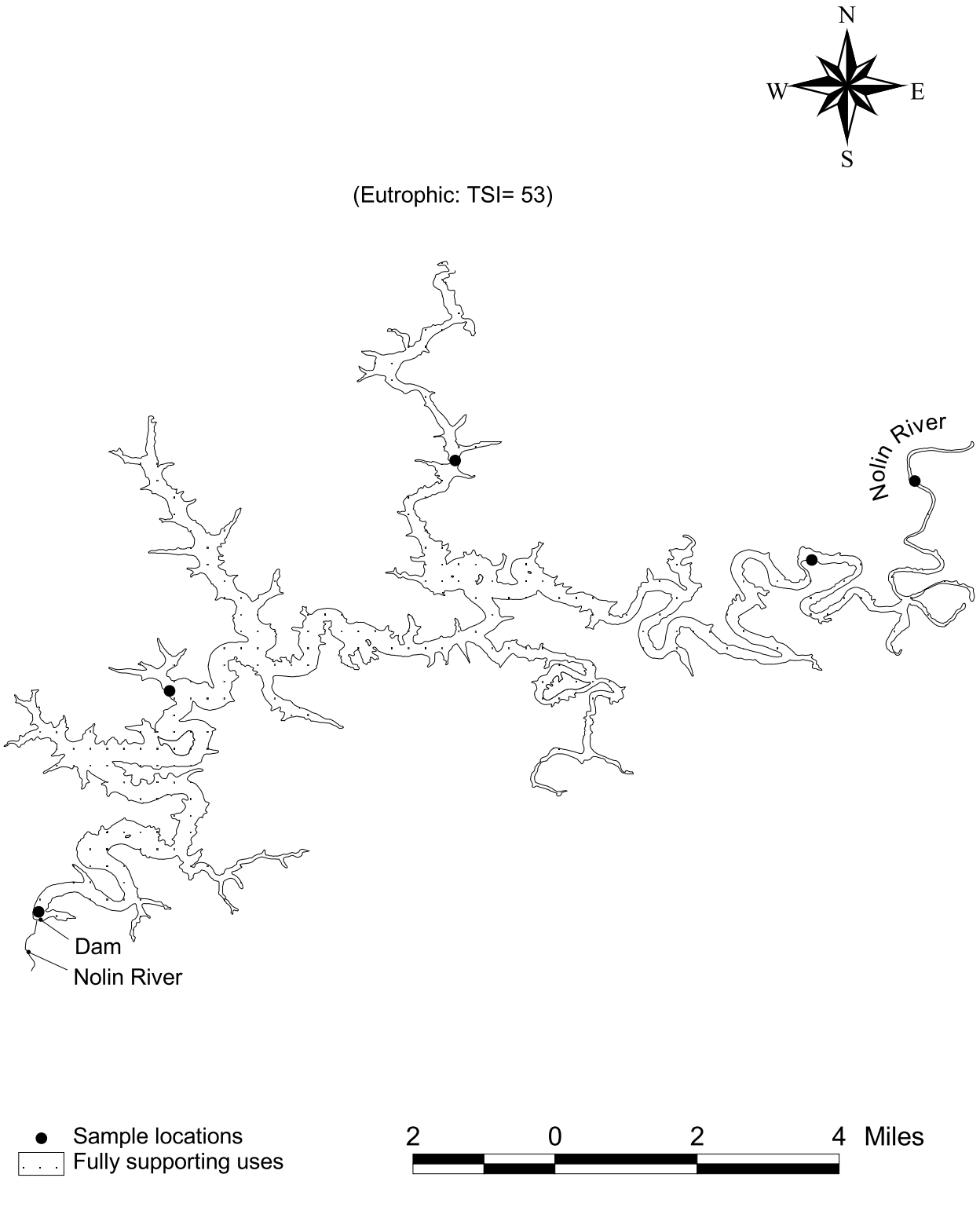


Source 2004 305(b) Report

Figure 4-3. Monitoring sites on Barren River Reservoir in the Green/Tradewater Basin Management Unit.

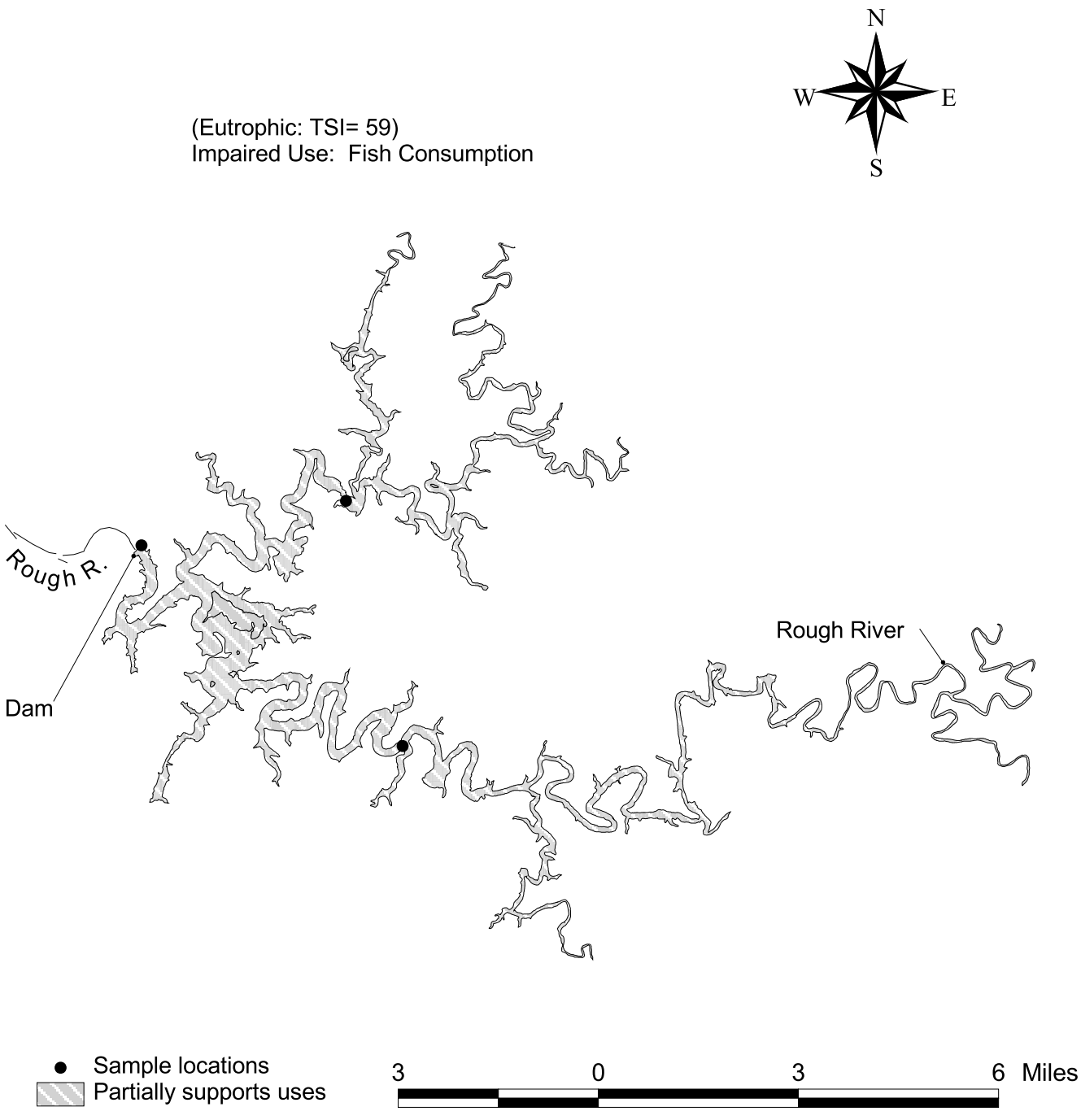
Source 2004 305(b) Report

Figure 4-4. Monitoring sites on Nolin River Reservoir in the Geen/Tradewater Basin Management Unit.



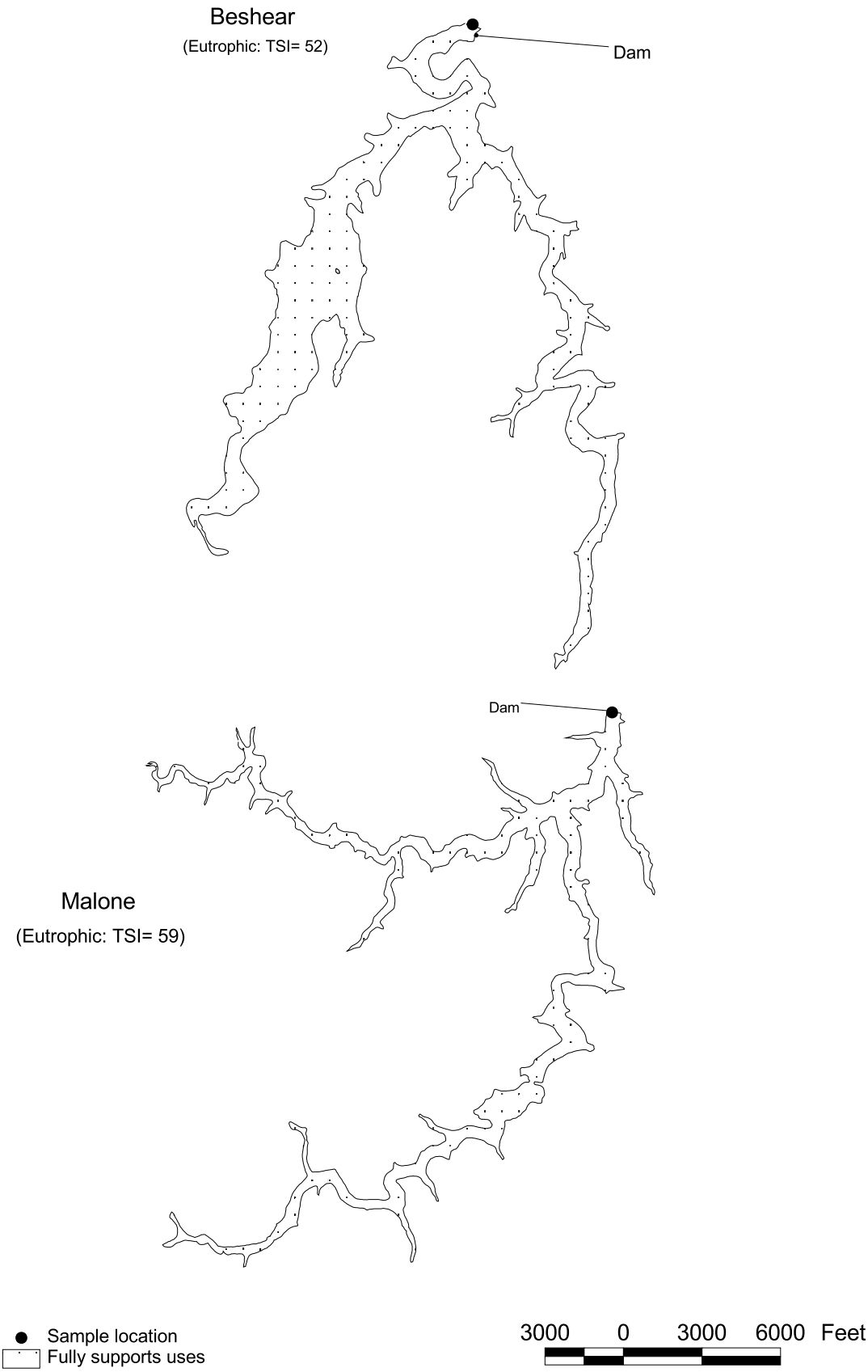
Source 2004 305(b) Report

Figure 4-5. Monitoring sites on Rough River Reservoir in the Green/Tradewater Basin Management Unit.



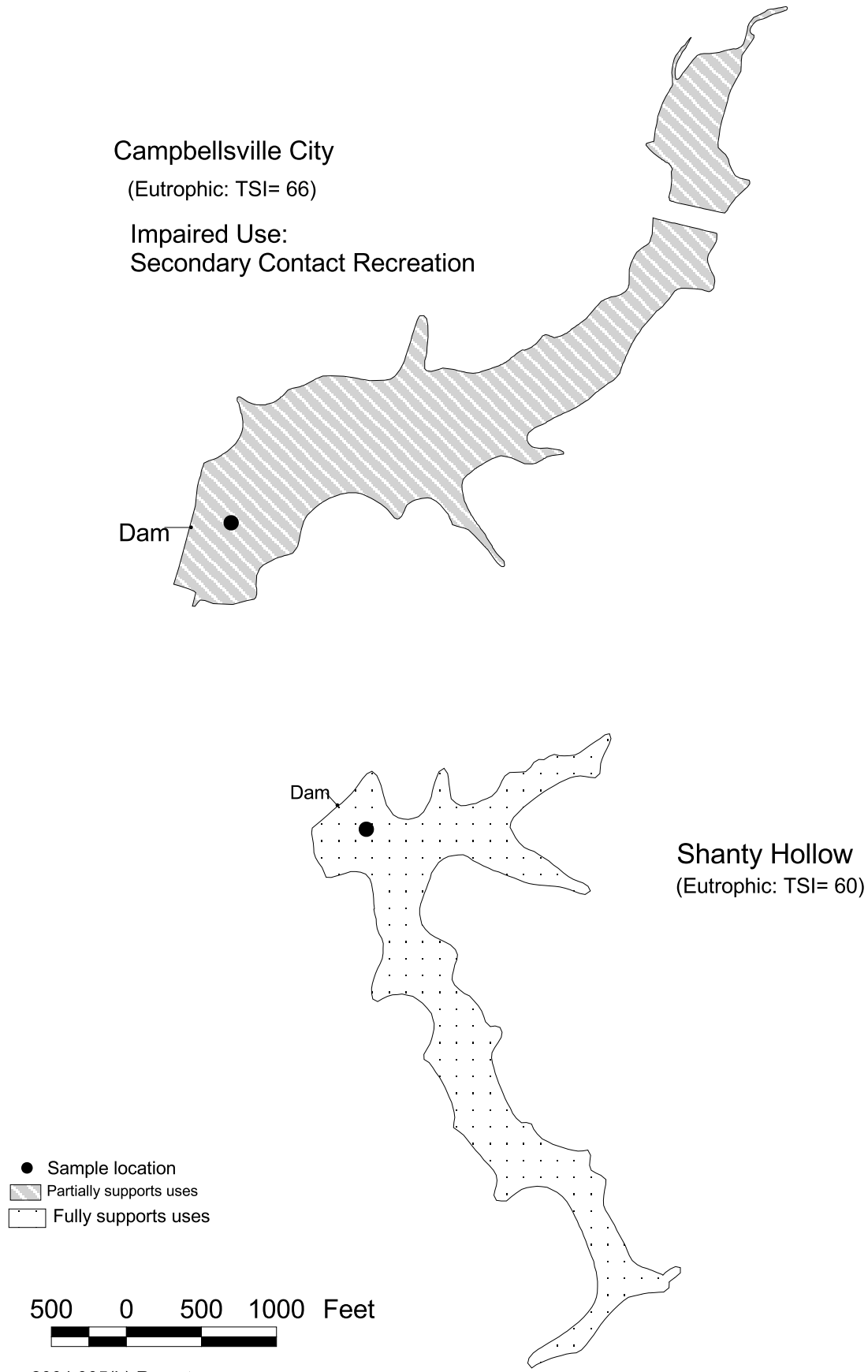
Source 2004 305(b) Report

Figure 4-6. Monitoring sites on Beshear and Malone reservoirs in the Green/Tradewater Basin Management Unit.



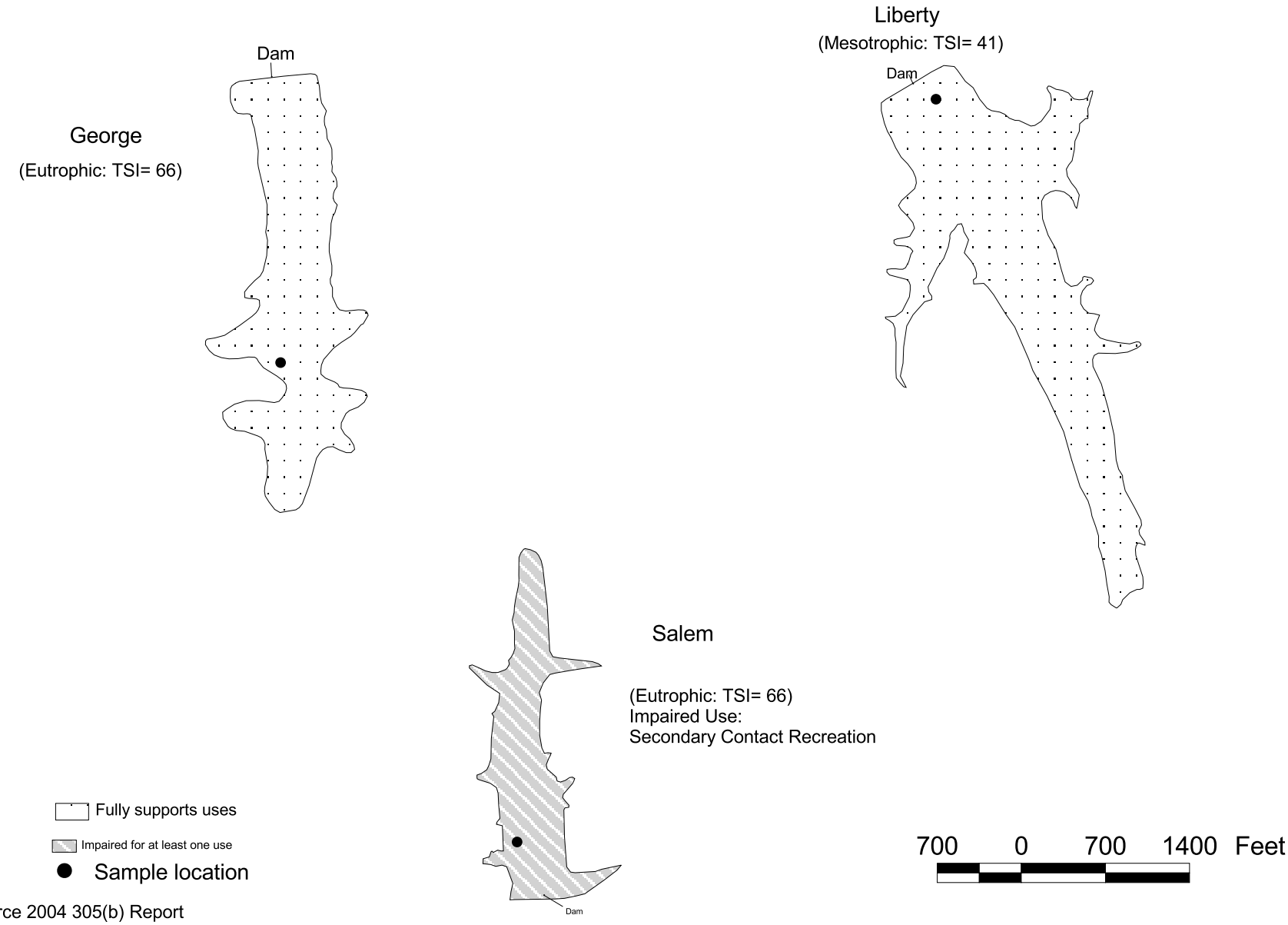
Source 2004 305(b) Report

Figure 4-7. Monitoring sites on Campbellsville City and Shanty Hollow reservoirs in the Green/Tradewater Basin Management Unit.



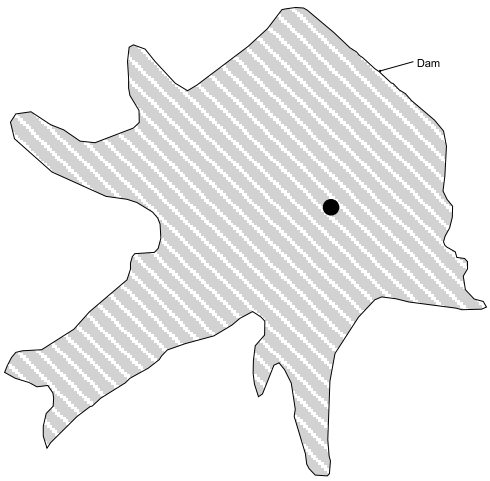
Source 2004 305(b) Report

Figure 4-8. Monitoring sites on George, Liberty and Salem reservoirs in the Green/Tradewater Basin Management Unit.



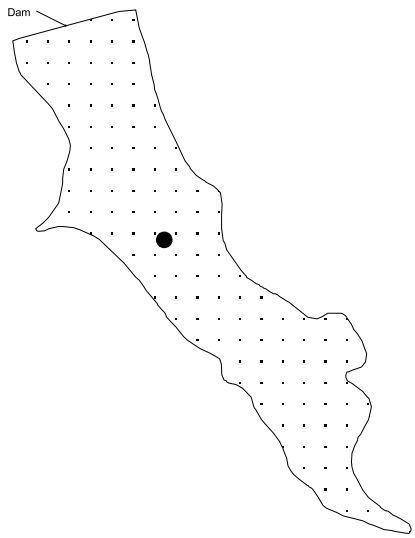
Source 2004 305(b) Report

Figure 4-9. Monitoring sites on Grapevine, Metcalfe County, Mill and Washburn reservoirs in the Green/Tradewater Basin Management Unit.



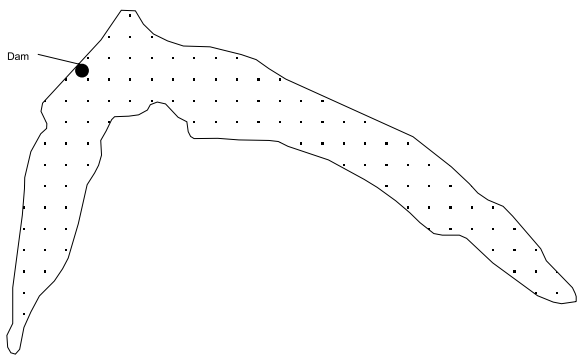
Grapevine

(Mesotrophic: TSI= 45)
Impaired Use: Domestic Water Supply



Metcalfe County
(Eutrophic: TSI= 67)

Mill Creek
(Eutrophic: TSI= 56)



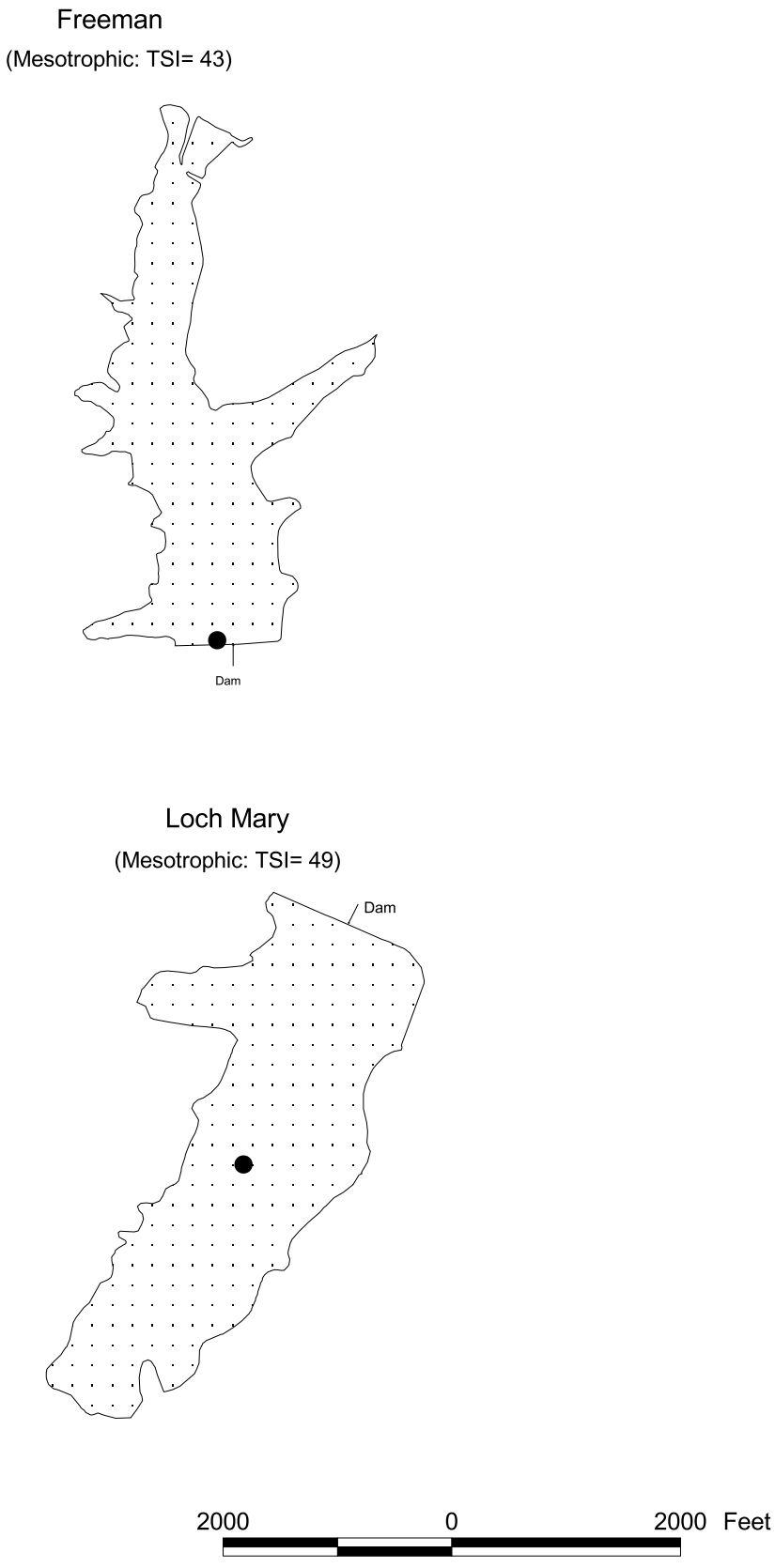
Washburn
(Mesotrophic: TSI= 50)

● Sample location
Impaired for at least one use
Fully supports uses

600 0 600 1200 Feet

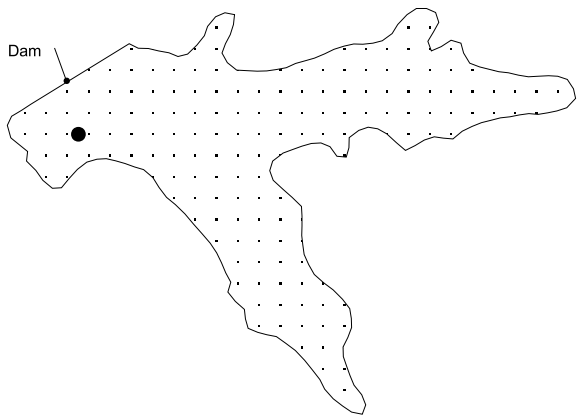
Source 2004 305(b) Report

Figure 4-10. Monitoring sites on Freeman and Loch Mary reservoirs in the Green/Tradewater Basin Management Unit.

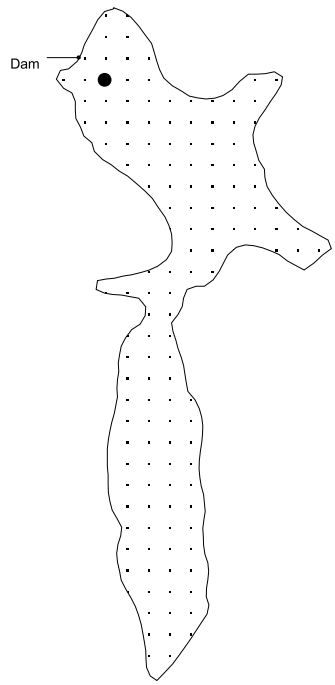


Source 2004 305(b) Report

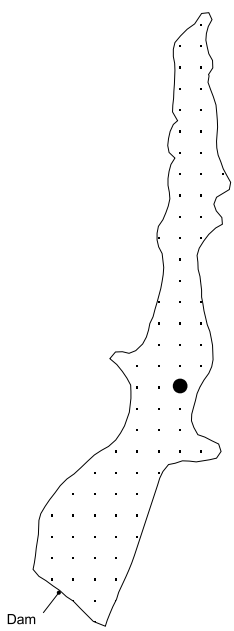
Figure 4-11. Monitoring sites on Moffit, Pennyrile and Spurlington reservoirs in the Green/Tradewater Basin Management Unit.



Moffit
(Eutrophic: TSI= 56)



Pennyrile
(Mesotrophic: TSI= 43)



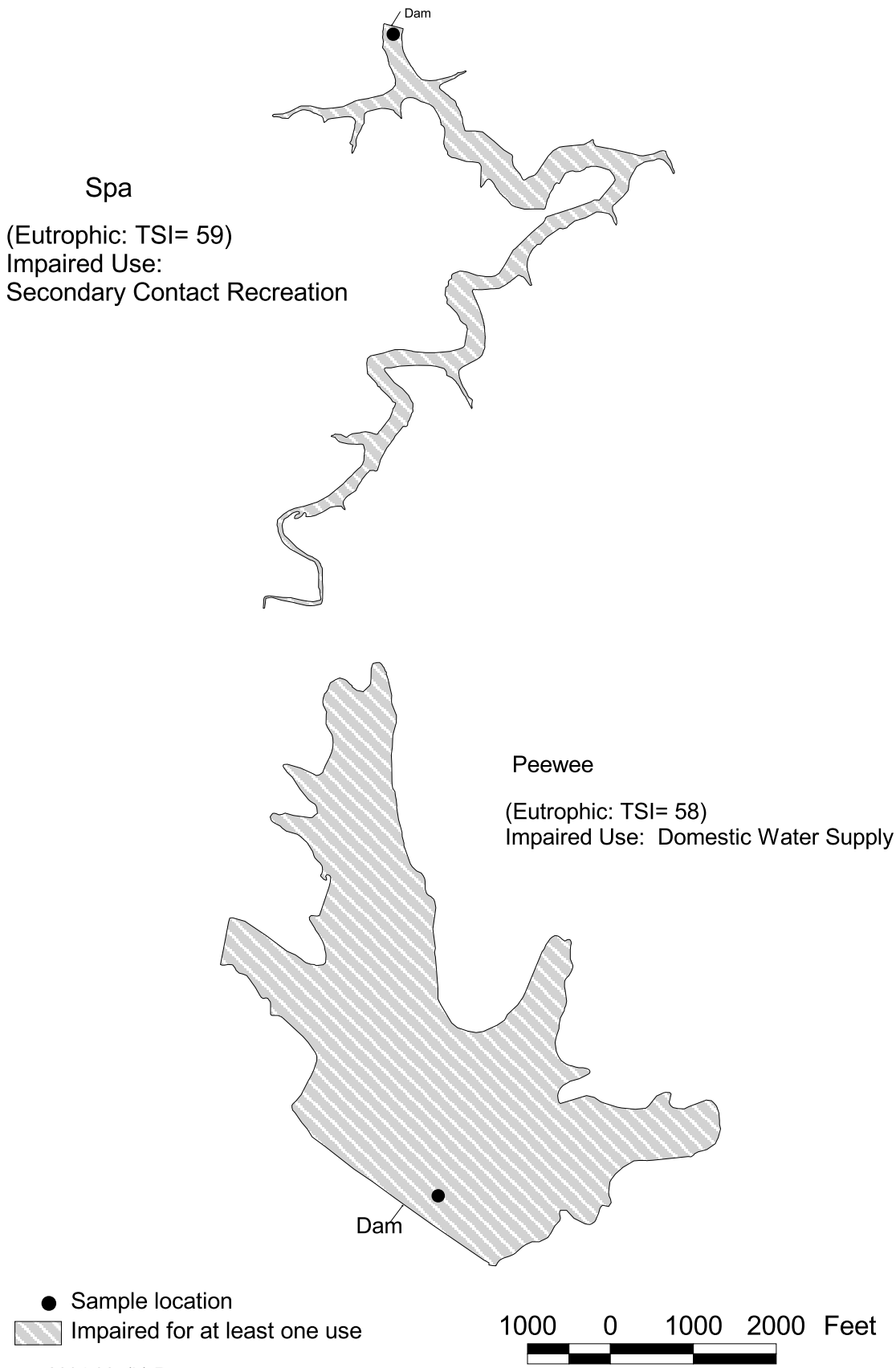
Spurlington
(Eutrophic: TSI= 55)

● Sample location
Fully supports uses

800 0 800 1600 Feet

Source 2004 305(b) Report

Figure 4-12. Monitoring sites on Spa and Peewee reservoirs in the Green/Tradewater Basin Management Unit.



Source 2004 305(b) Report

Figure 4-13. Reservoirs monitored in Big Sandy/Little Sandy/Tygarts Basin Management Unit.

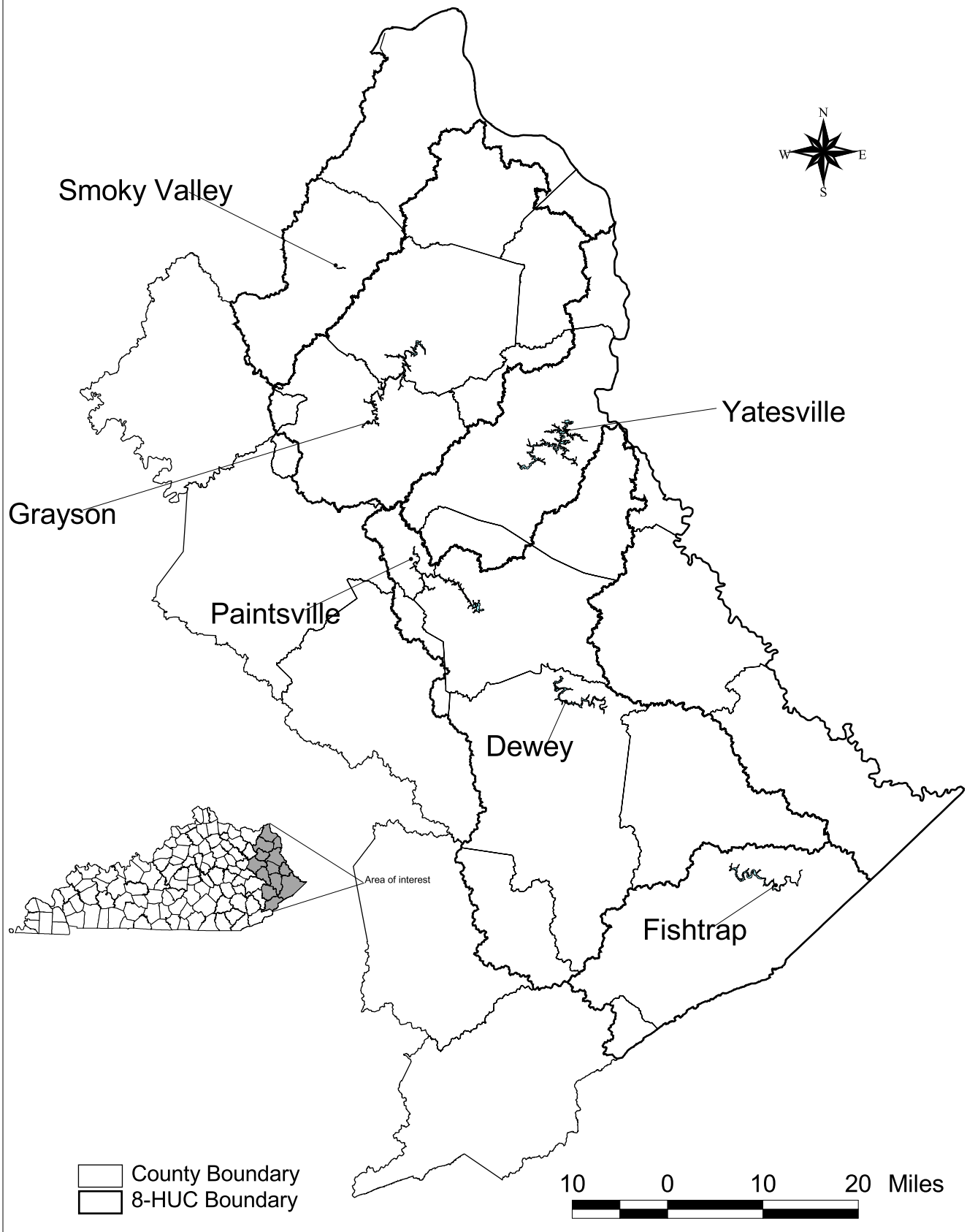
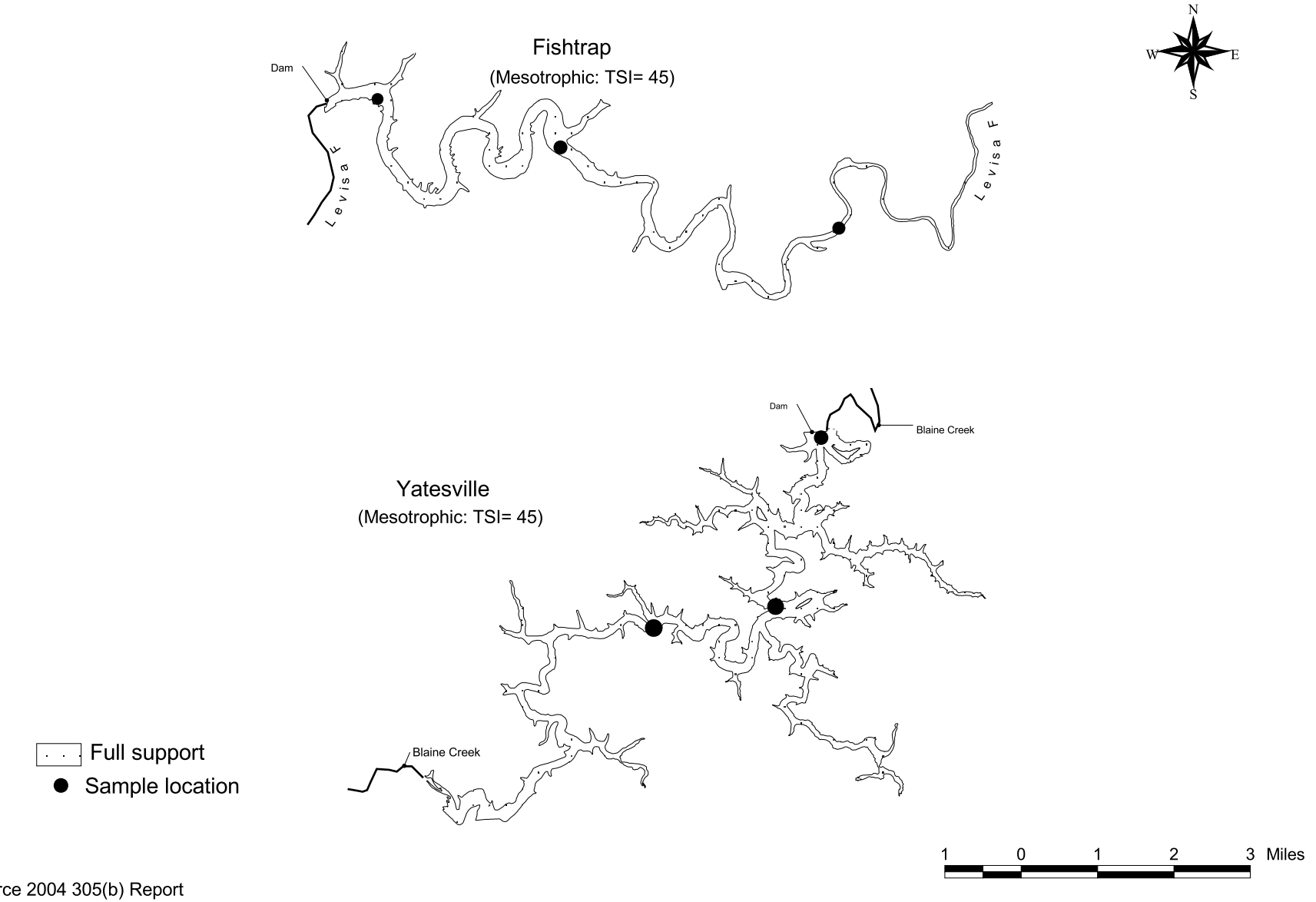
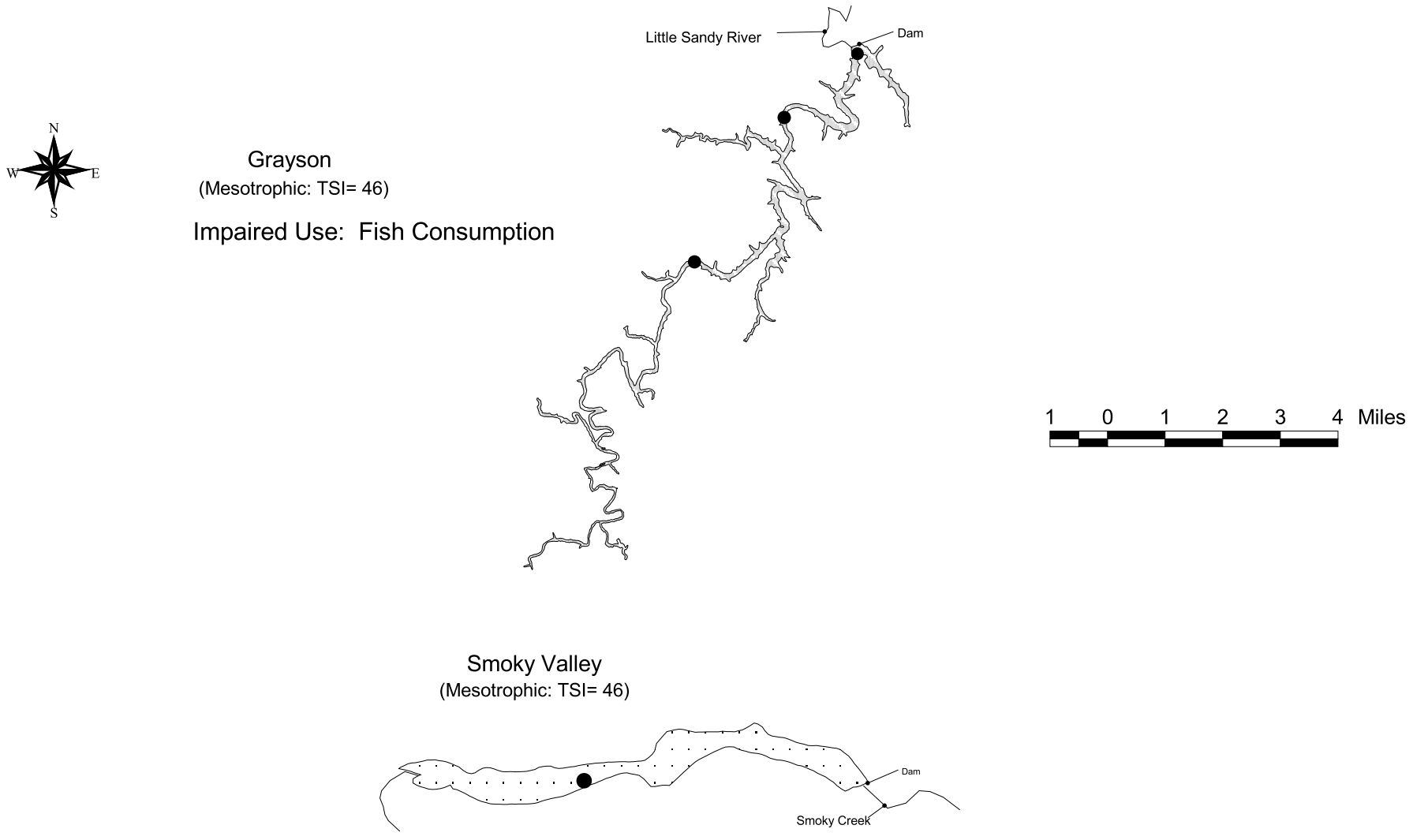


Figure 4-14. Monitoring sites on Fishtrap and Yatesville reservoirs in Big Sandy/Little Sandy/Tygarts Basin Management Unit.



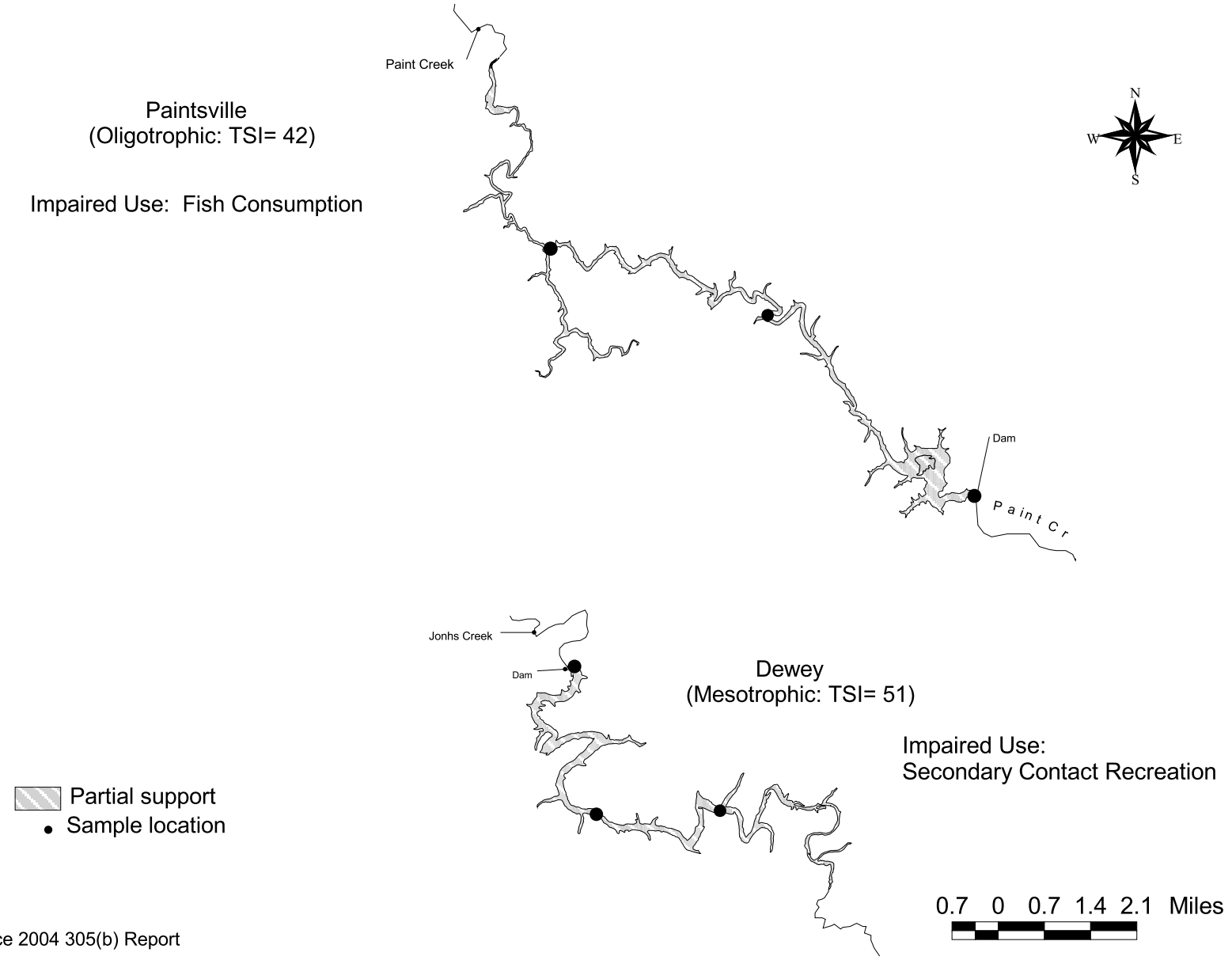
Source 2004 305(b) Report

Figure 4-15. Monitoring sites on Grayson and Smoky Valley reservoirs, Big Sandy/Little Sandy/Tygarts Basin Management Unit.



Source 2004 305(b) Report

Figure 4-16. Monitoring sites on Dewey and Paintsville reservoirs in Big Sandy/Little Sandy/Tygarts Basin Management Unit.



Source 2004 305(b) Report

REFERENCE

U.S. Army Corps of Engineers. 2001-2002. Personal communication, Louisville District with the Kentucky Division of Water.

Chapter 5. Groundwater

5.1 Introduction

Kentucky's groundwater is an important source of drinking water for more than one million Kentuckians, as well as a source of water for industry and irrigation. An estimated 1,292,744 Kentuckians are served by 211 public water systems (PWSs) that rely on groundwater, in whole or part, as their source. An additional 447,154 rural Kentuckians not connected to public water systems rely on private wells, springs and other sources (e.g. cisterns) for their drinking water (Figure 5-1). Groundwater also contributes significant recharge to streams. Protection of this resource is crucial to Kentucky's economy, public health and the environment.

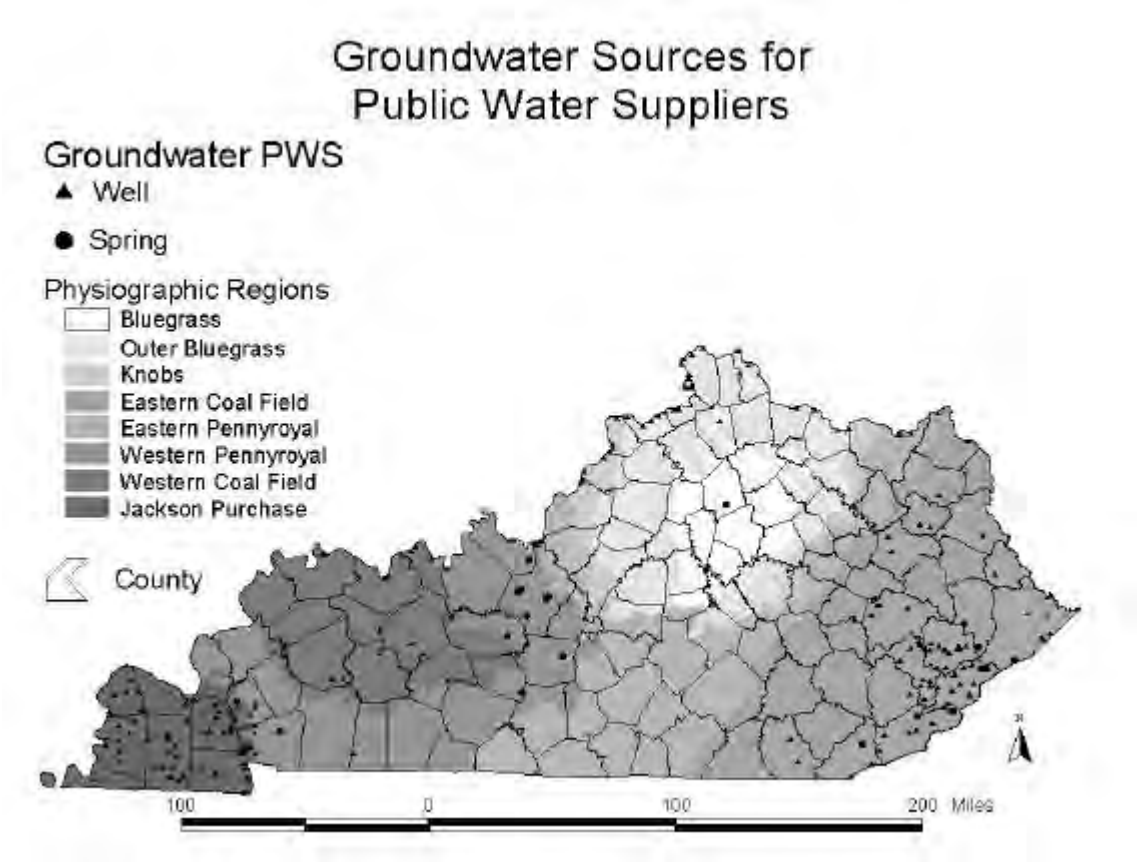
5.2 Availability and Use

Naturally occurring potable groundwater is found throughout Kentucky, although quantities available for use vary considerably, as controlled by regional geologic characteristics. Kentucky's groundwater resources occur in four aquifer types: (1) alluvial deposits in the Ohio and Mississippi river valleys; (2) karst aquifer systems of the Pennyroyal and Bluegrass regions; (3) unconsolidated sediments of the Jackson Purchase area; and (4) fractured bedrock aquifers of the Eastern and Western Coal Fields.

High-yielding wells constructed in alluvial deposits are typical of the Ohio and Mississippi river valleys that comprise Kentucky's northern and western borders. Wells in these valley aquifers are the most productive of any wells in the Commonwealth, producing adequate, high-quality water for domestic, public, industrial and agricultural use. Much of Kentucky's future drinking water needs will be met by these aquifers, as evidenced by recent moves to use them rather than surface-water sources.

Karst aquifers, developed in soluble rocks (e.g. limestone), are characterized by numerous shallow conduit-flow systems of generally limited extent. Approximately 50 percent of Kentucky is underlain by karst aquifers. The most extensive karst aquifers are in the Pennyroyal region of western Kentucky. Karst aquifers are present, but less well developed, in the Inner Bluegrass region. The availability of groundwater in karst areas is highly variable and generally supports public and domestic supplies. Locally, karst groundwater may support agriculture and industry.

Figure 5.1. Groundwater sources for public water suppliers in Kentucky.

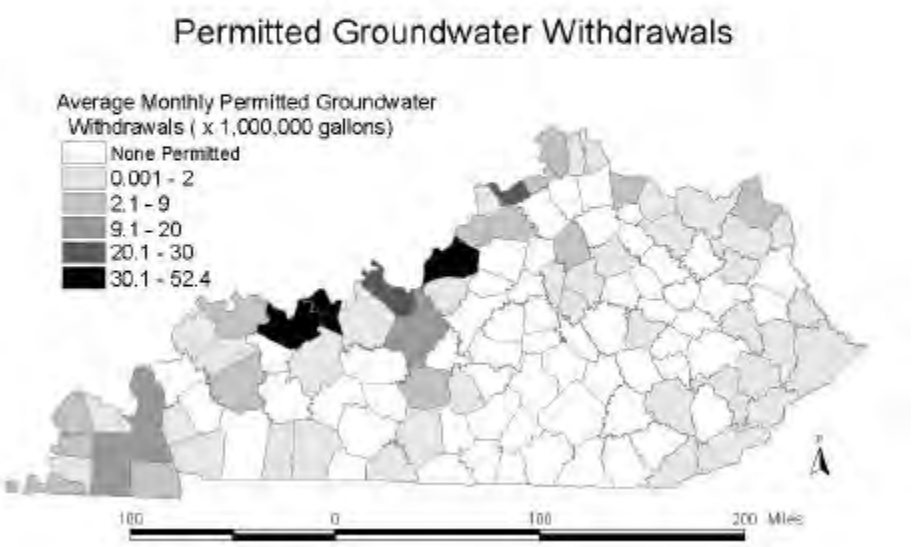


In the Western and Eastern Coal Field regions, wells in fractured sedimentary rocks generally provide sufficient water for domestic use and locally provide sufficient water for smaller public water systems. The unconsolidated sediments of the Jackson Purchase region are prolific aquifers, supporting widespread domestic, industrial and agricultural use, as well as public water systems.

In 2003, 35 percent of public water systems (PWSs) in Kentucky depended upon groundwater, in whole or part, as a source, withdrawing more than 70 million gallons per day total (Figure 5.2). The majority of groundwater use for PWSs is groundwater withdrawn from the alluvial deposits along the Ohio River and unconsolidated sediments in the Jackson Purchase. PWSs in eastern Kentucky are supplied by water wells and a number of PWSs in the Pennyroyal

and Bluegrass utilize natural springs. Households that depend upon private water wells for their drinking water are most numerous in eastern Kentucky and in the Jackson Purchase; these two regions account for about 75 percent of all new well construction in the state. Approximately 440,000 persons depend on groundwater from wells and springs to supply individual households (Table 5-1). This number of people on private sources (e.g. wells, springs) is decreasing as public

Figure 5.2. Permitted groundwater withdrawals in Kentucky.



water systems expand to serve areas previously unserved. Households that depend upon private water wells for their drinking water are most numerous in eastern Kentucky and in the Jackson Purchase; these two regions account for more than 65 percent of all new well construction in the state (Figure 5.3).

Table 5-1. Estimates of state population served by public water and private sources

	2003	% State Population	2000	% State Population	1990	% State Population
# Service Connections	980,676	N/A	958,150	N/A	900,217 [a]	N/A
Population Served	3,594,615[d]	88.9%	3,512,049 [b]	86.89%	2,970,717 [c]	80.61%
Population not served by a Community PWS[e]	447,154	11.1%	529,720 [d]	13.11%	714,578	19.30%
Population on private wells	316,167 [g]	7.82%	374,547	9.27%	505,254	13.71%
Population on private springs and other sources	130,987 [g]	3.24%	155,173	3.84%	209,324	5.68%
Total	4,041,769[f]	100.00	4,041,769[f]	100.00	3,685,296	100.00

[a] This is an estimated number of connections based on the population served in 1990.

[b] The population served by Community Public Water Systems was estimated in 2000.

[c] Number available from U.S. Census Bureau 1990.

[d] Population served was calculated assuming an increase in population served proportional to an increase of 2.35% in the number of connections, as reported by PWSs.

[e] Population Not Served by a Community PWS includes those who depend on private wells, springs, cisterns and hauled or bottled water. Subtracting the population served by PWSs from the total population of the state arrived at this number. Definitions: 1) "Community Public Water Systems" are public water systems serving an average of ≥ 25 people/day year-round or systems with ≥ 15 service connections; 2) "Service connections" are individual homes and businesses connected to Community Public Water Systems; 3) "Other sources" are springs, cisterns, and hauled water.

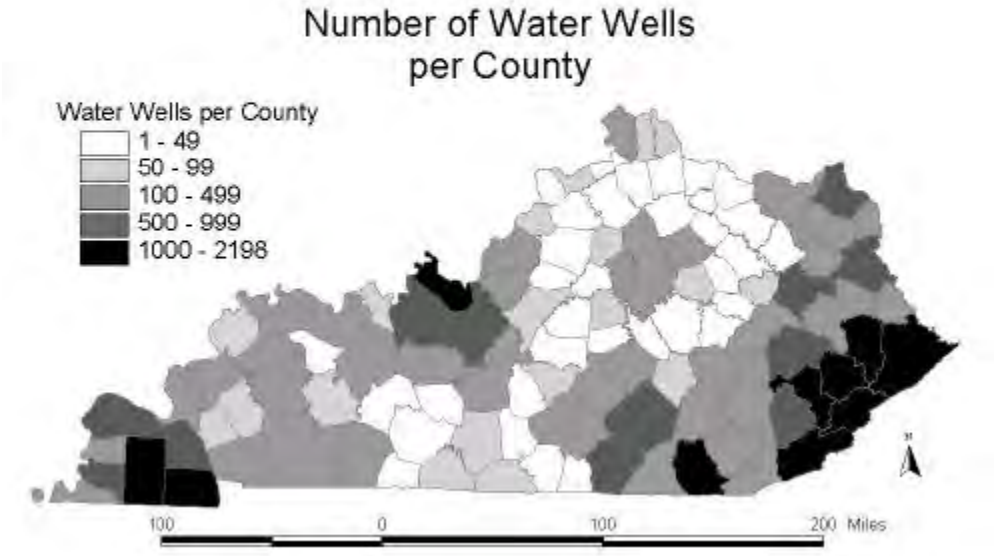
[f] Number available from U.S. Census Bureau 2000. This number is assumed to have not changed significantly since 2000.

[g] Numbers were calculated based on an assumed approximate constant ratio of the unserved population on private wells to the population on private springs and other sources.

5.3 Groundwater Quality

In Kentucky, the quality of groundwater used by households for private domestic supplies appears to be generally good, although there are regions of the state where specific problems exist. The principal, naturally occurring groundwater problems include pathogen infestation, elevated nitrates, high levels of iron and sulfur, and high levels of total dissolved solids (TDS) ("salty" or "hard" water). Of these contaminants, the presence of nitrates and pathogens in drinking water represent potentially serious health risks if regularly consumed above maximum contaminant levels (MCLs), especially by persons vulnerable to infection or other health impacts

Figure 5.3. Number of water wells per county in Kentucky.



(e.g. young children, the elderly, immune-compromised people). Pathogens, indicated by the presence of coliform bacteria, generally occur in wells from a lack of regular maintenance. Well disinfection is a simple process, but most well owners do not regularly conduct well disinfection. Pathogens are introduced to the well by other maintenance on the well or distribution system within the household. Pathogens may also be introduced to improperly constructed wells from local soils and may be impacted by septic systems or other on-site disposal. Improperly constructed wells

(e.g. insufficient casing, hand-dug wells) and shallow tile wells are more susceptible to pathogen infection than properly constructed wells. Normal pathogen response includes gastro-intestinal problems and flu-like symptoms.

Elevated nitrates (greater than 10 parts per million) do occur locally, principally in shallow wells in areas where sources of nitrate (e.g. fertilizer applications, manure storage and application, animal feedlots) are prevalent. Elevated nitrates are known to cause methemoglobinemia, or blue baby syndrome, in infants. Blue baby syndrome is a condition caused by the conversion of nitrate to nitrite in the blood, which affects the blood's ability to carry oxygen. Infants suffering from methemoglobinemia have skin that turns a blue-gray color, a condition known as cyanosis.

Elevated levels of iron and sulfur do not represent health risks, but do affect the aesthetic quality of water; water with relatively high levels of iron and sulfur have taste and odor issues, as well as staining of appliances, but are not particular health risks. Iron and sulfur are the most prevalent problems with well-water quality in Kentucky, as well as many other regions of the country.

Elevated TDS in wells occurs naturally in some areas and in other areas may be impacted by historic oil and gas drilling and injection activities. Elevated TDS is largely an aesthetic concern, making water "hard" and causing scaling in pipes and appliances. At higher levels, water may taste "salty" which at various levels is objectionable to some people.

5.3.1. Contamination Issues

Groundwater quality in Kentucky is generally good; water quality is directly related to land use, geology, groundwater sensitivity and well construction. Non-point source impacts on groundwater quality occur from nutrients and pesticides and result primarily from agricultural activities. Major sources of groundwater contamination in Kentucky are listed in Table 5-2.

Nitrates are a widespread concern, especially in shallow wells constructed in alluvial and coastal plain aquifers. Nitrates impact these aquifers largely because recharge in these areas is significantly rapid that attenuation of nitrates is not complete in the upper soil horizons. Agricultural activities, including fertilizer application, manure storage and application, and animal feeding operations are the principal sources of nitrates for these aquifers. Elevated nitrates have impacted a small number of PWSs relying on groundwater. In addition, preliminary data

Table 5-2. Major sources of groundwater contamination.

Contamination Source	Ten Highest Priority Sources (**X**)	Factors Considered in Selecting a Contaminant Source (See Below) (Use all that apply)	Contaminants (See Below) (Use all that apply)
Agricultural Activities			
Agriculture Chemical Facilities			
Animal Feedlots	**X**	I, III, V, VI, VII	B, E, J, K, L
Drainage Wells			
Fertilizer Applications	**X**	I, III, IV, V, VI, VII	E
Irrigation Practices			
Pesticides Applications	**X**	I, III, IV, VI, VII	A, B
On-farm Agricultural Mixing and Loading Procedures			
Land Application of Manure (unregulated)			
Storage and Treatment Activities			
Land Application			
Material Stockpiles			
Storage Tanks (above ground)			
Storage Tanks (underground)	**X**	I, III, IV, V, VI, VII	C, D, H
Surface Impoundment			
Waste Piles			
Waste Tailings			
Disposal Activities			
Shallow Injection Wells (Class V) – includes stormwater runoff from urban and agricultural land uses.	**X**	I, II, III, IV, V, VI, VII	A, B, C, D, E, F, G, H, J, L, M (Sediment)
Deep Injection Wells			
Landfills, including pre-law landfills	**X**	I, III, IV, V, VI, VII	A, B, C, D, E, F, G, H, I, J, K, L, M (Leachate Compounds)
Septic Systems	**X**	I, II, III, IV, V, VI, VII	A, B, C, D, E, F, G, H, J, K, L
Other			
Dry Cleaners	**X**	I, III, IV	C (TCE)
Hazardous Waste Generators			
Hazardous Waste Sites			
Industrial Facilities	**X**	I, III, IV, V, VII	A, B, C, D, E, F, G, H, I, J, K, L, M (TCE)
Material Transfer Operations			
Mining and Mine Drainage	**X**	I, III, IV, V, VI, VII	G, H, M (Sediment runoff, dewatering wells)
Oil and Gas wells/operations		III, IV, VI, VII	G, H
Pipelines and Sewer Lines			
Salt Storage and Road Salting			
Salt Water Intrusion			
Spills	**X**	I, II, III, IV, V, VII	A, B, C, D, E, F, G, H, I, J, K, L, M (TCE)
Transportation of Materials			
Various (e.g. drums wire-burners, battery crackers)			B, C, D, H,
Small-Scale Manufacturing and Repair Shops			

Factors

I- Human Health and/or environmental risk (toxicity)
II- Size of the population at risk
III- Location of the Sources relative to drinking water sources
IV- Number and Size of contaminant source
V- Hydrogeologic Sensitivity
VI- State Findings, other Findings
VII- Best Professional Judgment

Contaminants

A- Inorganic Pesticides
B- Organic Pesticides
C- Halogenated compounds
D- Petroleum compounds
E- Nitrate
F- Fluoride
G- Salinity / Brine
H- Metals
I- Radionuclides
J- Bacteria
K- Protozoa
L- Viruses
M- Other (see narrative)

indicate that shallow, private wells are more likely to have elevated levels of nitrates.

Pesticides are also a concern, principally in karst regions, the only areas of the state where pesticides are routinely detected in groundwater samples. Pesticides bypass soil attenuation processes in karst areas and contribute to elevated levels in karst groundwater systems. These aquifers, in turn, redistribute this pesticide-laden water to surface water systems in an efficient fashion, as groundwater and surface water in karst systems are in direct communication. Pesticides in groundwater have largely been a seasonal issue, but detections and significant concentrations are not limited to application season. Elevated levels of atrazine are most common. Elevated levels of atrazine in groundwater and surface water recently resulted in compliance problems for two PWSs in western Kentucky.

Urban sprawl and urban storm-water runoff also impact karst aquifers. Sprawl threatens some karst aquifers, particularly where new growth does not coincide, as is common, with extension of sewers. The additional hydrological loading resulting from concentrated use of septic systems exasperates collapse potentials, and the increased hydrologic, pathogen and nutrient loading commonly has dramatic effects on groundwater quality in karst basins. Improper storm-water injection in karst areas also impacts local karst groundwater quality.

High levels of naturally occurring iron and sulfur continue to impact private wells, producing aesthetic problems for well owners in many parts of the state, especially eastern Kentucky. The high levels of iron and sulfur commonly result from a lack of proper well maintenance, and in most circumstances, are preventable and treatable.

Bacteria occurrence remains common in wells, usually indicating potential sanitary problems. The occurrence of bacteria in well systems commonly results from a lack of proper well maintenance, and in most circumstances, is preventable and easily treatable.

Local contamination from landfills, USTs, Superfund and hazardous waste sites remains a concern as much for Kentucky as for other states. However, no widespread impacts or negative trends on water quality resulting from waste sites have occurred in Kentucky. The occurrence of MTBE and BTEX is largely limited to contaminated sites; occasional minor detections of BTEX and MTBE in urban karst springs result from storm-water runoff. Disruption of groundwater use of both private and public water supply wells because of contamination has occurred locally, but has been uncommon. There are currently 1489 sites with known or suspected groundwater contamination, including 1220 UST sites, 30 solid waste sites, 192 state and federal Superfund

sites and 47 hazardous waste sites with groundwater contamination (Table 5-3). The department is tracking contaminated groundwater sites and the condition of groundwater at these sites. Kentucky has recently developed a broad-based remediation program that applies to contaminated sites, including brownfields. This program should significantly reduce the number of contaminated sites over the next several years.

5.3.2. Ambient Groundwater Quality Monitoring

The Division of Water has collected and analyzed more than 2900 groundwater samples from more than 400 sites to characterize ambient groundwater conditions and nonpoint source impacts to groundwater (Figure 5.4). Sites are sampled from one to six times per year, based on aquifer type and monitoring goals. Water quality parameters evaluated include nutrients, major inorganic ions, metals, pesticides and volatile organic compounds, including MTBE. Analysis of groundwater for pathogens is a major logistical challenge. The division is beginning to address this gap in data.

A summary of the results of ambient groundwater monitoring for major parameters of concern in Kentucky is presented in Table 5-4. Water quality trends can be related to regional geology, land use, groundwater sensitivity (Figure 5.5) and well construction. Impacts on groundwater quality from human activities occur predominantly in the most sensitive (karst) areas and result primarily from agricultural activities. Persistent localized groundwater contamination from human activities occurs around older landfills, leaking underground storage tanks, poorly maintained septic systems and straight pipes, mining operations and drainage, and urban runoff. Less persistent, but still of concern locally, are spills and contamination from industrial facilities. Urban storm-water runoff is an increasing concern, particularly in karst areas where storm water is commonly managed via Class V Underground Injection Control wells.

Results. Specific groundwater quality standards have not been adopted in Kentucky; however, other applicable and appropriate standards are used to determine whether there have been impacts to groundwater. Generally, we assume the highest use of groundwater: that the groundwater is being consumed without any treatment, as hundreds of thousands of Kentuckians do consume groundwater in this fashion. Therefore, drinking water standards are generally used as a comparative standard for groundwater quality. Drinking water standards include maximum

Table 5-3. Groundwater contaminated sites summary, 2002 – 2003. Dates : 1-1-2002 to 12-31-2003 (Cumulative; subtracts sites that have been closed and includes new sites.)

Source Type	Number of Sites		Number of Sites with Confirmed Releases	Number of Sites with Groundwater Contamination	Contaminants	Source
NPL	19		19	19	PCBs, SVOCs, VOCs, Metals, Inorganics, Pesticides and Radionuclides	Division of Waste Management (DWM) Superfund Branch State Superfund Section
State Sites **CERCLIS**	1897		1217*	128**		
Non-UST Petroleum	949		908*	40-45**	Petroleum	
Old Landfills	22		22	22		DWM – Solid Waste Branch
UST	4,534		2,598	1,220	BTEX, PAH, Lead	DWM - UST Branch
RCRA Corrective Action	89	**RCRA-D 32**	30	30	Organic Compounds	DWM - Solid Waste Branch
		RCRA-C 59	53**	41	Pesticides, Cyanide, PCBs, VOCs, ABNs, PAHs, Metals, and Radionuclides	DWM – Hazardous Waste Branch
DOD/DOE	6		6	6		
UIC	Total 4365	**Class I** **Class II 3066** **Class V 6771**	N/A	N/A	Varied	EPA

Source Type

NPL - **N**ational **P**riority **L**ist
DOD - **D**epartment **O**f **D**efense
DOE - **D**epartment **O**f **E**nergy
CERCLIS - **C**omprehensive **E**nvironmental **R**esponse, **C**ompensation, and **L**iability **I**nformation **S**ystem
RCRA - **R**esource **C**onservation and **R**ecovery **A**ct
UIC - **U**nderground **I**njection **C**ontrol
UST - **U**nderground **S**torage **T**ank

* - This number is a best estimate; a new tracking system is being implemented and compliance with tracking protocols is not 100%.
** - This number is an approximation; not all sites have been verified.
*** - This number is estimated. Determining what constitutes a confirmed release for soils can vary based on the standard applied (e.g., U.S. EPA Region IX screening values, ambient background conditions, etc.).

Contaminants

PCB - Polychlorinated Biphenyl
SVOC - Semi Volatile Organic Compound
BTEX - Benzene, Toluene, Ethylene, and Xylene
PAH - Poly Aromatic Hydrocarbons
VOC - Volatile Organic Compound
ABN - Acid Base Neutral

contaminant levels (MCLs), secondary (aesthetic) standards (SMCLs), both promulgated for the drinking water program that regulates public water systems (PWSs). In addition, for elements or compounds that do not have an MCL or SMCL, a health advisory level (HAL) is used as a standard. Some impacts, such as nonpoint source impacts, to groundwater may be significant but well below any health or aesthetic concerns. It is appropriate to use reference groundwater conditions as a comparative standard for assessing these types of impacts.

Results: Inorganics. Fluoride is common in much of Kentucky as the mineral fluorite, and its presence in groundwater is also common; 95 percent of 571 samples collected over the reporting period had detections on fluoride. Only four samples exceeded the MCL for fluoride. The MCL is based on getting too much of a good thing. Fluoride is important is the development of health teeth and bones, but too much of this important mineral can cause fluoridosis of teeth and bones.

Results: Nutrients. As noted before, nitrate is naturally occurring in groundwater, but normally at low levels. Nitrate in elevated concentrations (>10 mg/L) in drinking water can cause health problems, specifically methemoglobinemia. Eighty-nine percent of samples collected detected nitrate; only four samples exceeded the MCL. However, we believe that planned research focused on shallow wells in agricultural areas will indicate a more widespread problem with nitrate in shallow groundwater.

Results: Metals. Arsenic was detected in approximately 18 percent of ambient samples collected and was detected at levels above the MCL (0.010 mg/L) in six (6) wells in the eastern Kentucky Coal Field and one well in the Ohio River alluvium. Arsenic is naturally occurring, and its occurrence may be related to iron-reducing bacteria in these wells.

Lead, a metal found in natural deposits, is commonly used in household plumbing materials and water service lines. Lead is not commonly detected in most groundwater, but is sometimes detected in samples as a result of leaching of lead from plumbing materials and service lines. Lead was detected in 18 percent of 579 samples collected, but exceeded the action level for lead in only seven (7) samples. Nevertheless, lead presents a significant health risk at even mildly elevated levels and needs to be addressed in each of the sources where it was detected.

Figure 5.4. Kentucky ambient groundwater monitoring network.

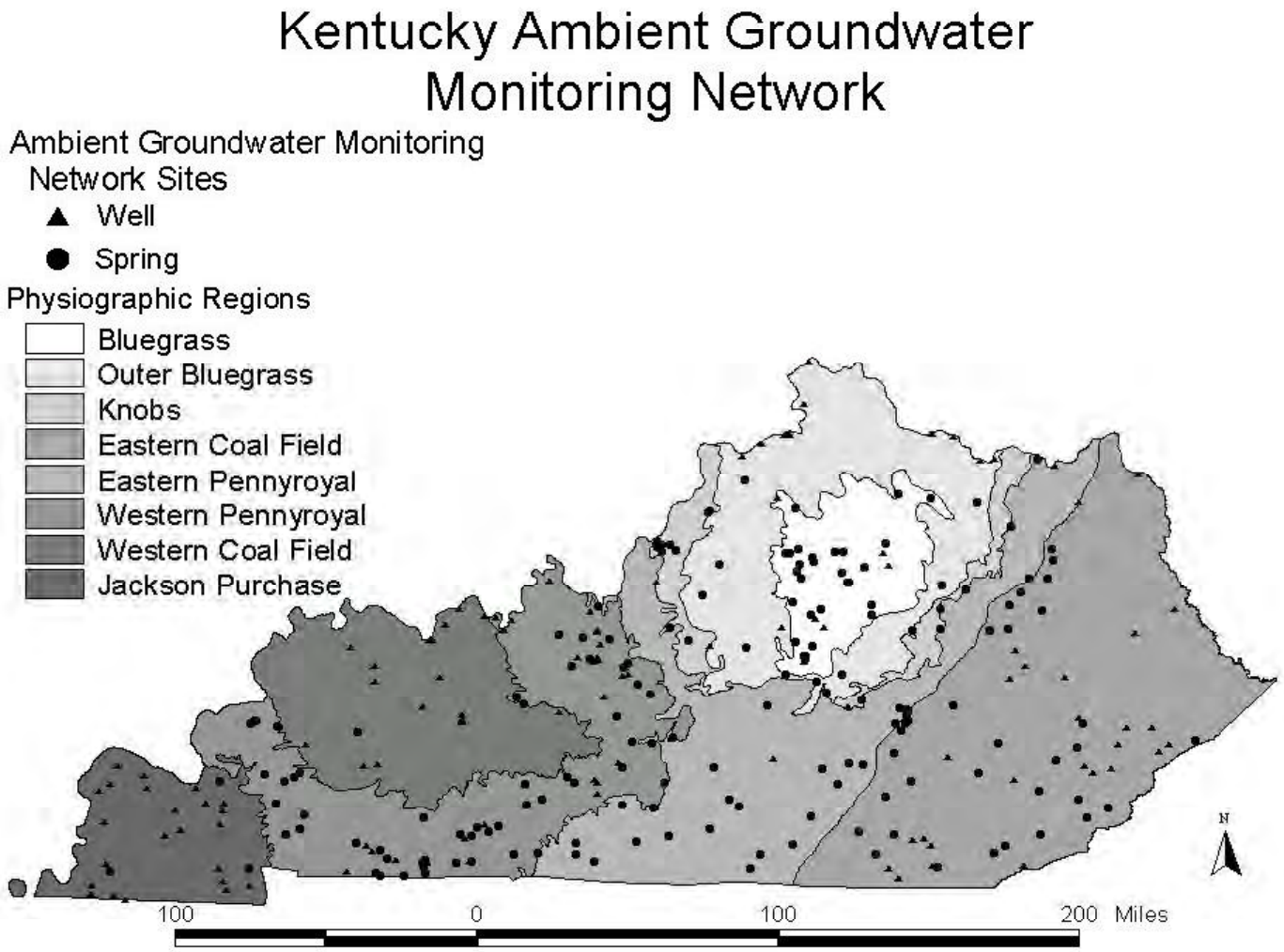
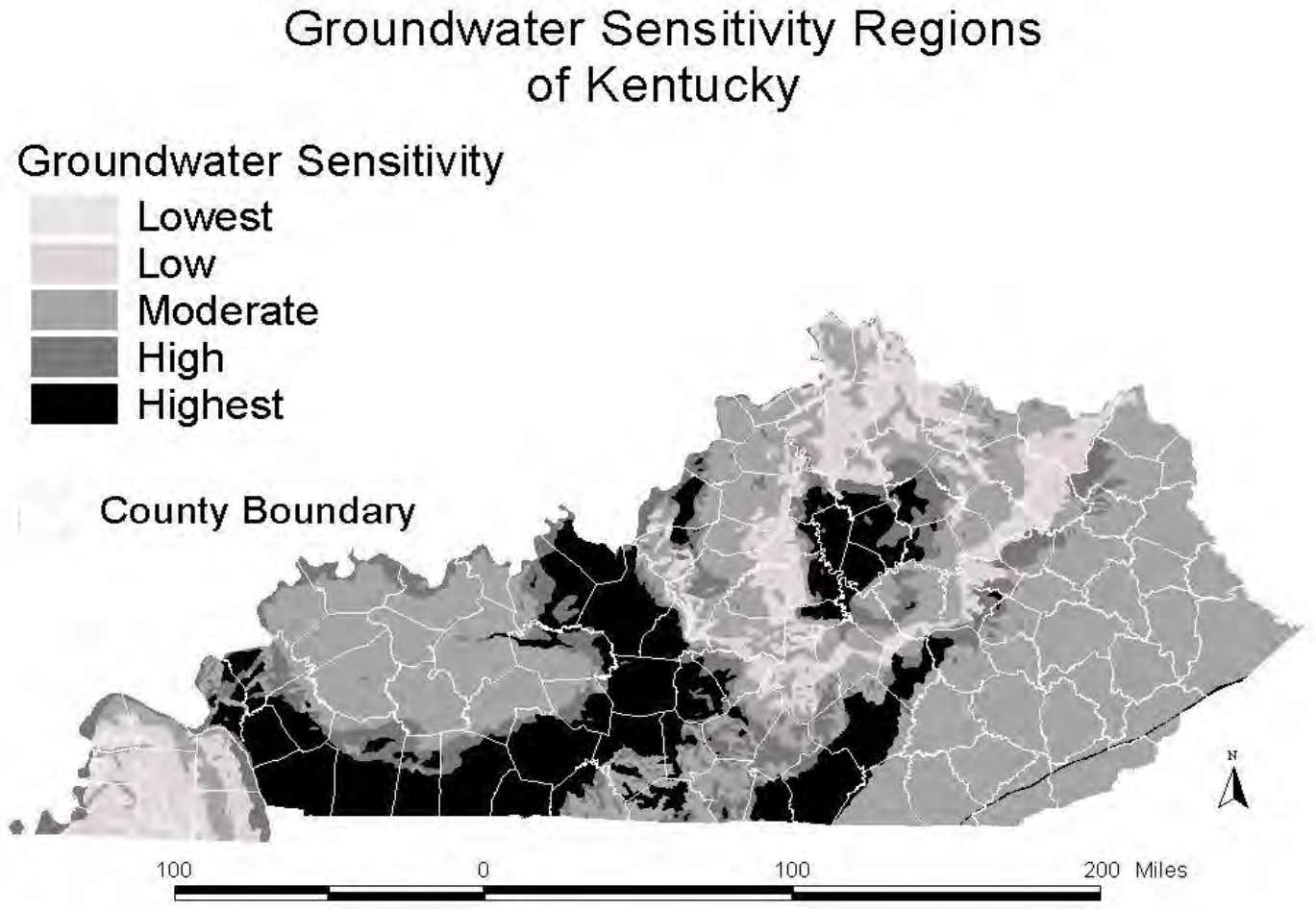


Table 5-4. Summary of ambient groundwater monitoring results.

SUITE	CONSTITUENT	MCL (mg/L)	NUMBER OF SITES	SITES WITH DETECTS	SITES w/ DETECTS < ½ MCL	SITES w/ DETECTS >= ½ MCL	SITES w/ DETECTS > MCL	NUMBER OF SAMPLES	NON-DETECTS	DETECTS < ½ MCL	DETECTS >= ½ MCL	DETECTS > MCL
OTHER	Fluoride	4	139	137	136	5	4	571	27	539	5	4
	Nitrate (as N)	10	139	126	118	28	6	571	65	429	77	9
	Nitrite (as N)	1	136	71	71	0	0	475	327	148	0	0
RCRA METALS	Arsenic	0.010	139	57	52	7	4	579	474	95	10	7
	Barium	2	139	139	139	0	0	579	0	579	0	0
	Cadmium	0.005	139	7	6	1	0	579	566	12	1	0
	Chromium	0.1	139	85	85	0	0	579	337	242	0	0
	Copper	1.0	139	131	131	0	0	579	158	421	0	0
	Iron	0.3	139	133	81	105	87	579	65	213	301	220
	Lead	0.015	139	47	40	12	6	579	500	66	13	7
	Manganese	0.05	139	136	89	83	65	579	54	287	238	162
	Mercury	0.002	139	3	3	0	0	579	576	3	0	0
	Nickel	0.1	139	72	72	0	0	579	412	167	0	0
	Selenium	0.05	139	52	52	0	0	579	483	96	0	0
	Silver	0.1	139	9	8	1	1	579	570	8	1	1
	Zinc	5	139	129	128	1	1	579	196	382	1	1
PCB	Aroclor 1016	0.0005	139	0	0	0	0	567	567	0	0	0
	Aroclor 1221	0.0005	139	0	0	0	0	567	567	0	0	0
	Aroclor 1232	0.0005	139	0	0	0	0	567	567	0	0	0
	Aroclor 1242	0.0005	139	0	0	0	0	567	567	0	0	0
	Aroclor 1248	0.0005	139	0	0	0	0	567	567	0	0	0
	Aroclor 1254	0.0005	139	0	0	0	0	567	567	0	0	0
	Aroclor 1260	0.0005	139	0	0	0	0	567	567	0	0	0
	Aroclor 1262	0.0005	139	0	0	0	0	567	567	0	0	0
	Aroclor 1268	0.0005	139	0	0	0	0	567	567	0	0	0
PESTICIDES	Acetochlor	0.055	139	6	6	0	0	575	564	11	0	0
	Alachlor	0.002	139	8	8	0	0	575	557	18	0	0
	Atrazine	0.003	139	56	55	7	3	575	384	183	8	3
	Atrazine desethyl	0.003	139	46	46	0	0	575	406	169	0	0
	Cyanazine	0.001	139	0	0	0	0	575	575	0	0	0
	Metolachlor	0.1	139	31	31	0	0	575	493	82	0	0
	Simazine	0.004	139	33	32	2	0	575	475	98	2	0
SOC	Anthracene	0.830	94	1	1	0	0	135	134	1	0	0
	Benzo(a)anthracene	0.000034	94	3	0	3	0	135	132	0	3	0
	Benzo(a)pyrene	0.0002	94	4	4	0	0	136	131	5	0	0
	Fluorene	0.110	94	2	2	0	0	135	133	2	0	0
	Naphthalene	0.1	137	1	1	0	0	547	546	1	0	0
VOC	Benzene	0.005	137	1	1	0	0	547	546	1	0	0
	Chlorobenzene	0.017	137	0	0	0	0	547	547	0	0	0
	Methylene chloride	0.005	137	2	1	1	1	547	545	1	1	1
	Ethylbenzene	0.7	137	0	0	0	0	547	547	0	0	0
	MTBE	0.05	137	4	4	0	0	547	540	7	0	0
	Tetrachloroethane (1,1,1,2-)	0.07	137	0	0	0	0	547	547	0	0	0
	Tetrachloroethene[3]	0.010	137	10	10	0	0	547	506	41	0	0
	Toluene	1	137	9	9	0	0	547	538	9	0	0
	Trichloroethane (1,1,1-)	0.2	137	3	3	0	0	547	541	6	0	0
	Trichloroethene	0.002	137	7	5	3	1	547	529	9	9	7
	Vinyl chloride	0.002	137	0	0	0	0	547	547	0	0	0
	Xylene (1,2-)	10	137	0	0	0	0	547	547	0	0	0
	Xylene (1,3- & 1,4-)	10	137	2	2	0	0	547	545	2	0	0

Figure 5.5. Groundwater sensitivity regions of Kentucky.



Similarly to lead, both silver and zinc are uncommon in their occurrence in groundwater, especially at elevated levels. However, zinc and silver are sometimes detected in samples as a result of leaching of silver and zinc from plumbing materials and service lines. Of 579 samples analyzed for zinc, 66 percent of the samples detected some zinc, but only one (1) sample exceeded the secondary MCL, an aesthetic-based standard. Of the 579 samples analyzed for silver only eight (8) samples had any detections of silver, and only one (1) sample exceeded the SMCL. Most likely, these higher concentrations originated not from groundwater, but probably as a result of leaching of zinc and silver from plumbing materials and service lines. As noted previously, the occurrence of significant concentrations of iron and manganese is widespread. Of 579 samples, the majority had detections for iron and manganese, 38 percent of samples exceeded the aesthetic standard for iron and 28 percent exceeded the aesthetic standard for manganese.

Results: Pesticides and PCBs. Polychlorinated bi-phenyls (PCBs) were not detected in any of the 567 samples analyzed for these potent carcinogens. Some of the more commonly used herbicides were detected in samples, the most common being atrazine, with lesser occurrences of alochlor, metolachlor and simazine. Generally, these pesticides occur only in karst springs and do not exceed established health-based standards. Atrazine does appear to be more persistent in groundwater, occurring in 33 percent of 575 samples analyzed. Only three (3) samples exceeded the MCL for atrazine. However, the persistence of atrazine and its impact on some PWSs in Kentucky is raising concerns about its use. Efforts to monitor and assess the impact of atrazine on water quality and use of alternate herbicides are increasing in some areas.

Results: SOCs. Semi-volatile organic compounds do not occur naturally in groundwater and are otherwise uncommon in their occurrence in ambient groundwater monitoring. Minor detections of several poly-aromatic hydrocarbons have occurred over the reporting period. The source for these anthropogenic contaminants is principally fuels, such as diesel fuel and gasoline. Although the occurrences of these contaminants are not at levels that exceed standards, their presence does suggest impacts from point sources (e.g. USTs) and nonpoint sources (e.g. storm water runoff).

Results: VOCs. The occurrence of volatile organic compounds always indicates anthropogenic impacts on groundwater. With the exception of trichlorethene (TCE), there were no significant

occurrences of VOCs in any of the ambient monitoring samples. The TCE, a solvent/degreaser, was detected at levels exceeding the MCLs at Humane Spring in Mercer County. This site is down gradient of a RCRA corrective action facility where TCE contamination is confirmed. The widespread presence of tetrachlorethylene (PCE) in minor amounts is a concern. This solvent is widely used in dry cleaning and as a metal degreaser and is occurring most commonly in urban springs. The occurrence of PCE in a PWS well in the Ohio River alluvial aquifer will be investigated.

5.3.3 Groundwater Quality and Public Water Systems

The Division of Water has collected and analyzed untreated groundwater samples at numerous public water systems (PWSs) to characterize groundwater conditions, including point source and nonpoint source impacts to groundwater at PWSs. This monitoring effort supports both the ambient groundwater monitoring program and the wellhead protection program, providing public water systems valuable information about the quality of their water supplies. A summary of the results of ambient groundwater monitoring for major parameters of concern in Kentucky is presented in Table 5-5. Groundwater quality at PWSs has been exceptional, which is critical to most PWSs that rely on groundwater; the majority of these systems do not treat their source water other than disinfection.

Table 5-6 illustrates the corresponding data for finished water (water distributed) at PWSs using groundwater as a source, either in whole or part. Fifteen (15) PWSs had 48 detections of various volatile organic compounds (VOCs), including P-dichlorobenzene, TCE, PCE, ethylbenzene and xylenes. Two (2) PWSs had detections of VOCs that exceeded the maximum contaminant levels. TCE occurred at one PWS that has had a historic problem with TCE and treats the water using air-scrubbing towers. Another PWS with TCE detections uses a groundwater source that is under the direct influence of surface water and has evidently been impacted by local runoff. Pthlalates and methylene chloride were detected in a number of samples; however, these are considered to be lab and sampling contaminants and not contaminants occurring in the source. These water systems should be conducting or have completed increased monitoring for those contaminants. Thirty-two (32) PWSs had 83 detections of various semi-volatile organic compounds (SOCs), including 2-4 D, atrazine, alachlor, dalapon, diquat, simazine, ethylene di-bromide, dinosab, lindane, toxaphene, diquat, silvex (all

pesticides/herbicides) and benzo-A-pyrene. The herbicides were detected in minor amounts below the MCL and these PWSs were located in karst areas where the groundwater is under the direct influence of surface water, as well as being areas of dense agricultural (row cropping) activity, or the PWS had only a partial groundwater source and the contaminants were being extracted from surface water. None of these detections of SOCs exceeded applicable MCLs.

These PWSs should be conducting or have completed increased monitoring for those contaminants. Seven (7) PWSs had detections of inorganic compounds, including mercury, barium and cyanide, which exceeded MCLs. The three mercury detections above MCLs are being investigated; the occurrence of mercury in groundwater is rare. Both barium and cyanide are naturally occurring. Cyanide is normally oxidized by disinfection. Natural levels of barium can be physically removed by filtration if persistent. These PWSs should be conducting or have completed increased monitoring for those contaminants.

5.3.4. Monitoring Resource Issues

Although Kentucky is among the nation's leaders in coordinating its groundwater activities through its Interagency Technical Advisory Committee, additional resources are necessary to improve efforts to characterize Kentucky's groundwater. Routine monitoring should expand to better capture regional and temporal trends and conduct additional aquifer characterization for pathogens, pharmaceutically active compounds and other emerging pollutants. In addition, Kentucky needs to expand mapping of some aquifers to better assess aquifer quantity. Kentucky has recently invested significant resources to implement new technologies and consolidate data management. Kentucky also needs to expand groundwater education and public outreach.

Table 5-5. Summary of ambient groundwater monitoring results at PWS sites.

SUITE	CONSTITUENT	MCL (mg/L)	NUMBER OF SITES	SITES WITH DETECTS	SITES w/ DETECTS < ½ MCL	SITES w/ DETECTS >= ½ MCL	SITES w/ DETECTS > MCL	NUMBER OF SAMPLES	NON-DETECTS	DETECTS < ½ MCL	DETECTS >= ½ MCL	DETECTS > MCL
OTHER	Fluoride	4	27	27	27	1	1	119	5	113	1	1
	Nitrate (as N)	10	27	27	25	8	1	119	8	86	25	1
	Nitrite (as N)	1	27	20	20	0	0	99	59	40	0	0
RCRA METALS	Arsenic	0.010	27	13	12	2	0	123	102	19	2	0
	Barium	2	27	27	27	0	0	123	0	123	0	0
	Cadmium	0.005	27	1	1	0	0	123	122	1	0	0
	Chromium	0.1	27	12	12	0	0	123	72	51	0	0
	Copper	1.0	27	27	27	0	0	123	25	98	0	0
	Iron	0.3	27	25	18	18	16	123	22	49	52	38
	Lead	0.015	27	10	9	2	2	123	104	17	2	2
	Manganese	0.05	27	27	21	14	10	123	10	73	40	21
	Mercury	0.002	27	1	1	0	0	123	122	1	0	0
	Nickel	0.1	27	18	18	0	0	123	89	34	0	0
	Selenium	0.05	27	15	15	0	0	123	96	27	0	0
	Silver	0.1	27	3	2	1	1	123	120	2	1	1
	Zinc	5	27	24	24	0	0	123	51	72	0	0
PCB	Aroclor 1016	0.0005	27	0	0	0	0	121	121	0	0	0
	Aroclor 1221	0.0005	27	0	0	0	0	121	121	0	0	0
	Aroclor 1232	0.0005	27	0	0	0	0	121	121	0	0	0
	Aroclor 1242	0.0005	27	0	0	0	0	121	121	0	0	0
	Aroclor 1248	0.0005	27	0	0	0	0	121	121	0	0	0
	Aroclor 1254	0.0005	27	0	0	0	0	121	121	0	0	0
	Aroclor 1260	0.0005	27	0	0	0	0	121	121	0	0	0
	Aroclor 1262	0.0005	27	0	0	0	0	121	121	0	0	0
	Aroclor 1268	0.0005	27	0	0	0	0	121	121	0	0	0
PESTICIDES	Acetochlor	0.055	27	0	0	0	0	121	121	0	0	0
	Alachlor	0.002	27	2	2	0	0	121	118	3	0	0
	Atrazine	0.003	27	11	11	2	0	121	70	48	3	0
	Atrazine desethyl	0.003	27	9	9	0	0	121	71	50	0	0
	Cyanazine	0.001	27	0	0	0	0	121	121	0	0	0
	Metolachlor	0.1	27	7	7	0	0	121	104	17	0	0
	Simazine	0.004	27	7	7	0	0	121	89	32	0	0
SOC	Anthracene	0.830	21	0	0	0	0	28	28	0	0	0
	Benzo(a)anthracene	0.000034	21	0	0	0	0	28	28	0	0	0
	Benzo(a)pyrene	0.0002	21	0	0	0	0	28	28	0	0	0
	Fluorene	0.110	21	1	1	0	0	28	27	1	0	0
	Naphthalene	0.1	27	0	0	0	0	118	118	0	0	0
VOC	Benzene	0.005	27	0	0	0	0	118	118	0	0	0
	Chlorobenzene	0.017	27	0	0	0	0	118	118	0	0	0
	Methylene chloride	0.005	27	1	1	0	0	118	117	1	0	0
	Ethylbenzene	0.7	27	0	0	0	0	118	118	0	0	0
	MTBE)	0.05	27	2	2	0	0	118	114	4	0	0
	Tetrachloroethane (1,1,1,2-)	0.07	27	0	0	0	0	118	118	0	0	0
	Tetrachloroethene	0.010	27	5	5	0	0	118	101	17	0	0
	Toluene	1	27	2	2	0	0	118	116	2	0	0
	Trichloroethane (1,1,1-)	0.2	27	1	1	0	0	118	116	2	0	0
	Trichloroethene	0.002	27	2	2	0	0	118	116	2	0	0
	Vinyl chloride	0.002	27	0	0	0	0	118	118	0	0	0
	Xylene (1,2-)	10	27	0	0	0	0	118	118	0	0	0
	Xylene (1,3- & 1,4-)	10	27	0	0	0	0	118	118	0	0	0

Table 5-6. Finished Drinking Water Data at PWSs for Groundwater Systems

Finished Drinking Water Data from Groundwater Sources and Groundwater Sources Under the Direct Influence For Period of 1-1-02 to 12-31-03							
# of Sites	Parameter Group	Total # of Analyses	# of Non-detects < MDL	# of Detects >MDL to < MCL	Less than ½ MCL <=5	5 to <=10	Greater than the MCL
137	VOC	6991	6937	48	----------	----------	4
111	SOC	5738	5646	83	----------	----------	0
138	IOC	2921	2512	330	----------	----------	14
221	NO_3	634	137	----------	412	85	0

5.4 Groundwater Protection Programs

Kentucky has established or is maintaining many programs that protect the Commonwealth's groundwater resources (Table 5-7). Three programs are highlighted in the following paragraphs.

Ambient Groundwater Monitoring Network: Since 1995, the DOW has collected more than 2900 groundwater samples at greater than 400 sites as part of the state's ambient groundwater monitoring program aimed at characterizing ambient groundwater conditions and non-point source impacts to groundwater. Monitoring sites include public and private water supplies, unregulated public access springs (i.e., "roadside springs") and unused springs. Approximately 70 sites are sampled from one to six times per year, depending on the type of aquifer. The Division of Water analysis these samples for a number of water quality parameters, including nutrients, major inorganic ions, metals, volatile organic compounds and semi-volatile organic compounds, including pesticides. Each year the Division of Water also collects approximately 120 samples on a watershed basis as part of an ongoing watershed initiative Section 319(h) cooperative effort. In addition, the DOW conducts quarterly groundwater monitoring at four sites under an agreement with the Division of Pesticide Regulation (DOPR) as part of DOPR's FIFRA grant work plan. The ambient monitoring program supports the Groundwater Protection Plan and Wellhead Protection programs by providing a resource-quality tracking measure and providing raw water data to PWSs using groundwater. In addition, the solid waste, hazardous waste, UST and Superfund programs all rely on the ambient network to characterize ambient conditions and identify potential problems.

Table 5-7. Groundwater Protection Programs[a,b]

Programs or Activities		Implementation Status	Responsible State Agency
Active SARA Title III Program	✔	Continuing Efforts	Department for Environmental Protection Commissioner's Office
Ambient Groundwater Monitoring System	✔	**Continuing Efforts**	**Division of Water**
Aquifer Vulnerability Assessment		*N/A*	*N/A*
Aquifer Mapping	✔	Ongoing	Kentucky Geological Survey/Division of Water
Aquifer Characterization	✔	Ongoing	Kentucky Geological Survey/Division of Water
Comprehensive Data Management System	✔	Established	Division of Water
EPA-endorsed Core Comprehensive State Ground-Water Protection Program (CSGWPP)		*N/A*	*N/A*
Groundwater Discharge Permits	✔	Continuing Efforts	Division of Water
Groundwater Best Management Practices	✔	Established	Division of Conservation
Groundwater Legislation	✔	Implemented	Division of Water/Kentucky Geological Survey
Groundwater Classification		*N/A*	*N/A*
Groundwater Protection Program	✔	**Established**	**Division of Water**
Groundwater Quality Standards	✔	Developing	Division of Water
Groundwater Sensitivity Mapping	✔	Complete	Division of Water
Interagency Coordination for Groundwater Protection Initiatives	✔	Established	Interagency Technical Advisory Committee
Non-Point Source Controls	✔	Established	Division of Water
Pesticides State Management Plans	✔	Developing	Division of Pesticides
Pollution Prevention Program	✔	Implementing	Division of Water
Resource Conservation and Recovery Act (RCRA) Primacy	✔	Established	Division of Waste Management
Source Water Assessment Program	✔	Continuing Efforts	Division of Water
State Superfund	✔	Established	Division of Waste Management
State RCRA Program Incorporating more Stringent Requirements than RCRA Primacy		N/A	N/A
State Septic System Regulations	✔	Established	Cabinet of Health Services
Underground Storage Tank Installation Requirements	✔	Established	Division of Waste Management
Underground Storage Tank Remediation Fund	✔	Established	PSTEAF
Underground Injection Control Program	✔	Fully Established	EPA Region IV

Table 5-7. Groundwater Protection Programs[a,b].

Vulnerability Assessment for Drinking Water/Wellhead Protection	✔	Completed	Division of Water
Well Abandonment Regulations	✔	Continuing Efforts	Division of Water
Wellhead Protection Program (EPA-approved)	✔	**Established**	**Division of Water**
Well Installation Regulations	✔	Continuing Efforts	Division of Water

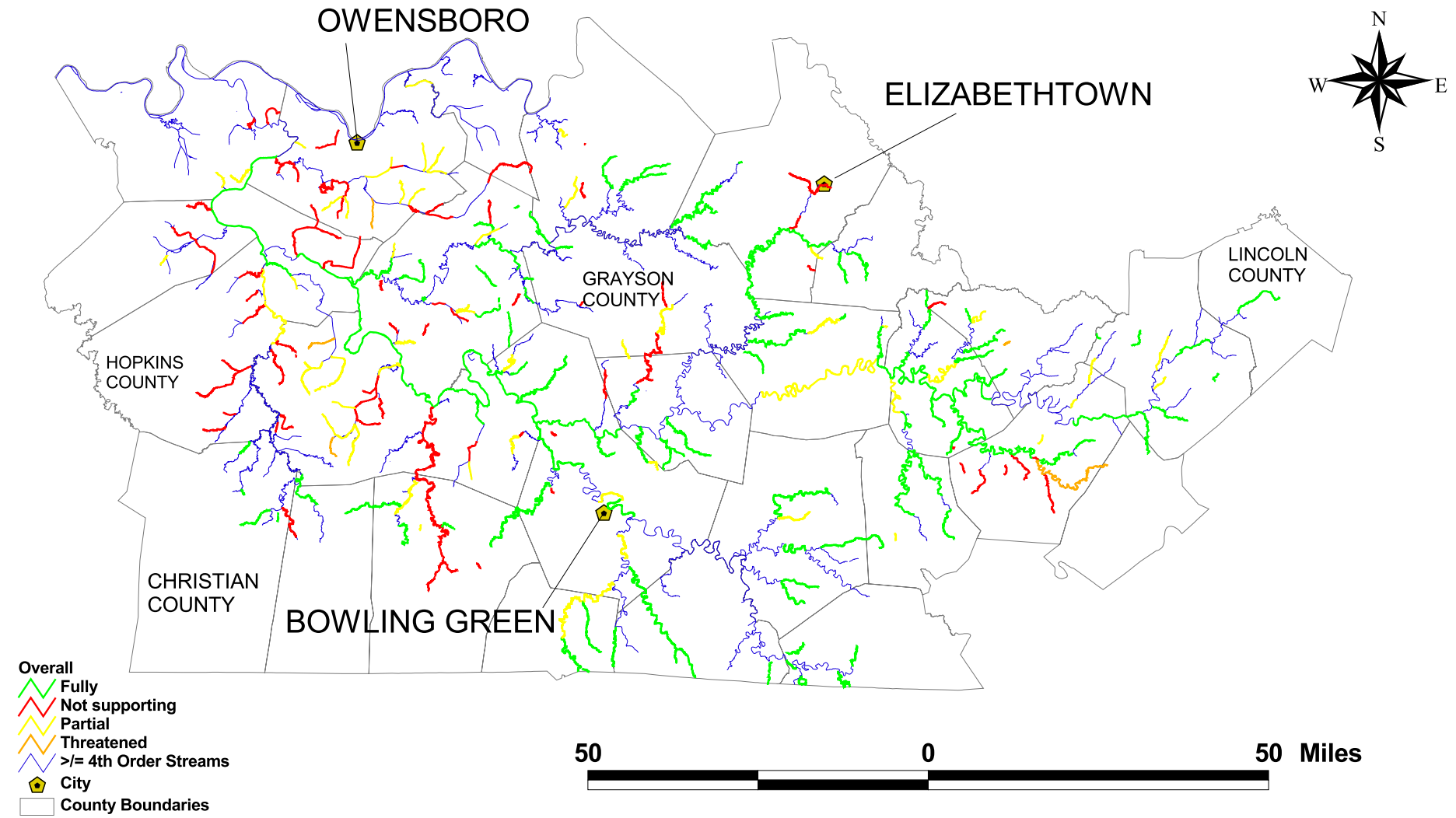
[a]Italicized programs are N/A (Not Applicable) at this time
[b]Bold-faced programs are elaborated on the preceding pages

Groundwater Protection Plan Program: Kentucky's Groundwater Protection Plan regulation requires that entities conducting activities that have the potential to pollute groundwater develop and implement a groundwater protection plan. The plan includes pollution prevention activities such as preventive maintenance and best management practices; spill response plans, record keeping, training and regular inspections to ensure that the protective practices are in place and functioning properly. Kentucky's Agriculture Water Quality BMPs help prevent pollution of the waters of the Commonwealth.

Wellhead Protection Program*:* Kentucky's Wellhead Protection program requires that PWSs that rely on groundwater develop a wellhead protection (WHP) plan for their source water. A WHP plan is designed to delineate the recharge area of the well(s) or spring(s), identify the potential contaminant sources in the recharge area and implement groundwater protection strategies for these areas. Kentucky's WHP program is a fundamental part of its Source Water Assessment Program (SWAP), as required by the 1996 Amendments to the Safe Drinking Water Act. Kentucky has been a national leader in source water protection. Kentucky was the first state in the nation to have its SWAP approved by EPA.

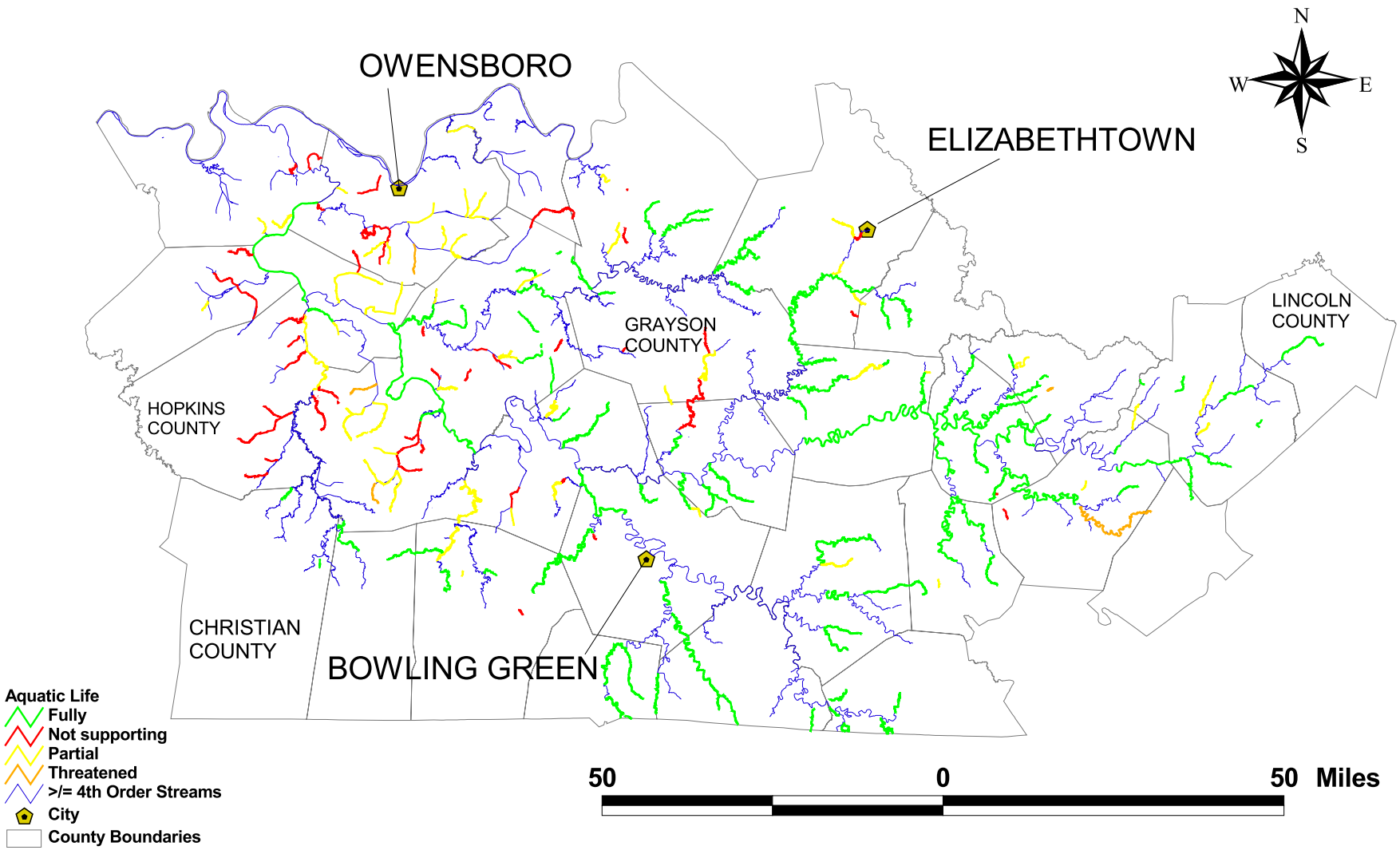
Appendix A. Reach Index Maps for Green River Basin, Tradewater River Basin and adjacent Ohio River Minor Tributaries

Appendix Figure A-1. Combined overview of stream reach indexing for the four assessed uses (Aquatic Life Support, Drinking Water, Fish Consumption and Primary Contact Recreation) in the Green River Basin and adjacent Ohio River minor tributaries.



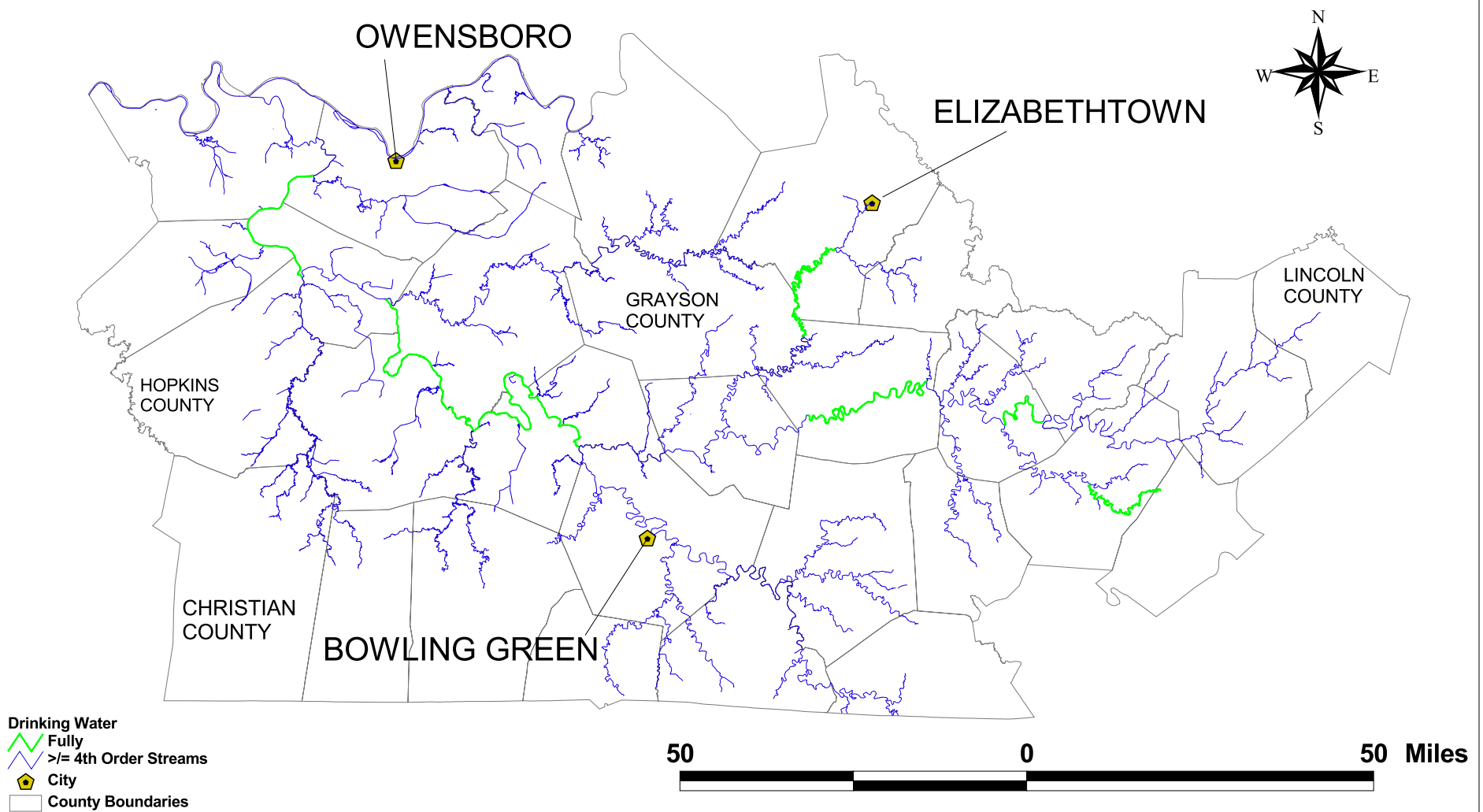
Source 2004 305(b) Report

Appendix Figure A-2. Reach indexing results of streams assessed in the Green River Basin and adjacent Ohio River minor tributaries for Aquatic Life Use.



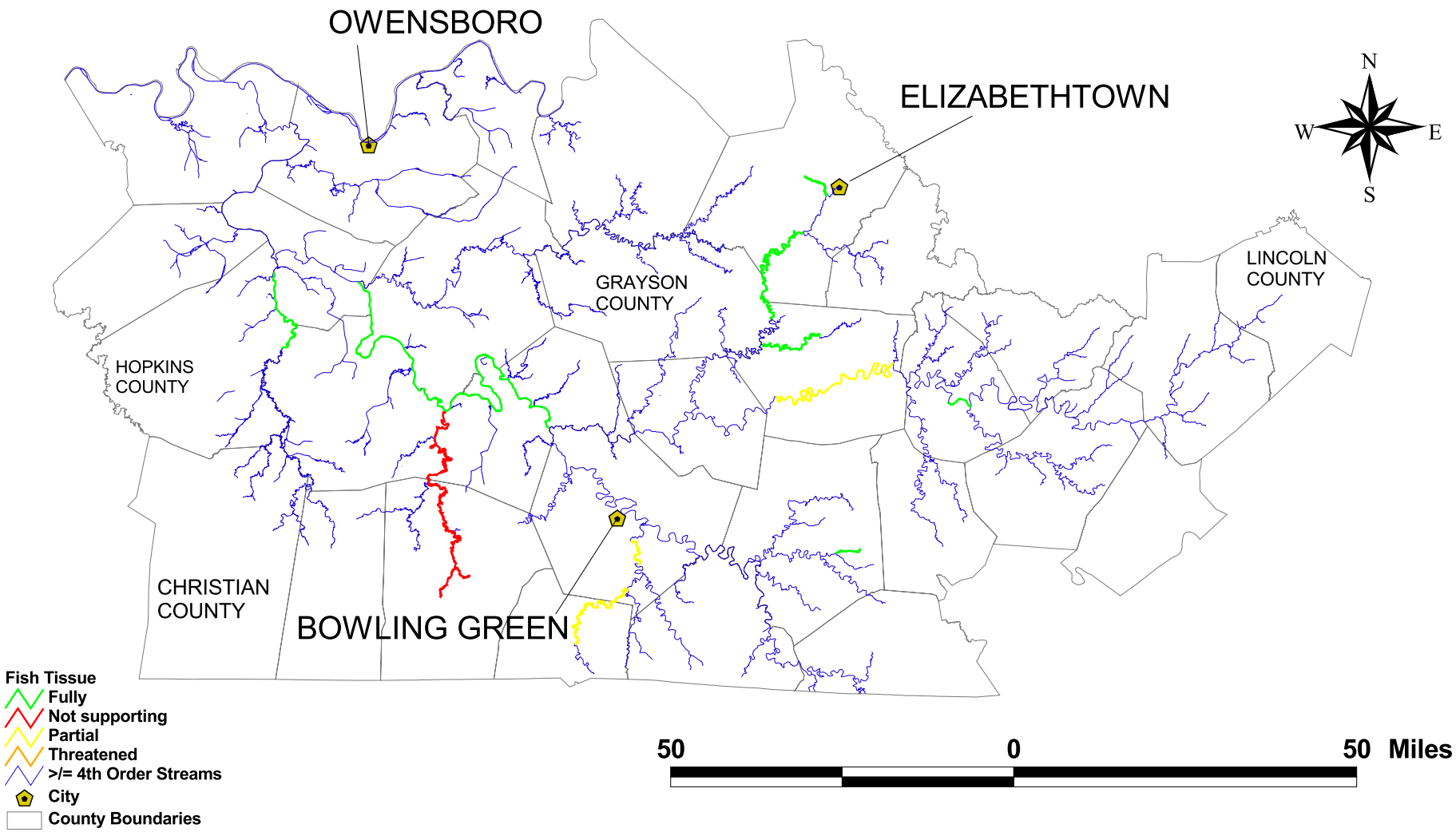
Source 2004 305(b) Report

Appendix Figure A-3. Reach indexing results of streams assessed in the Green River Basin and adjacent Ohio River minor tributaries for Drinking Water Use.



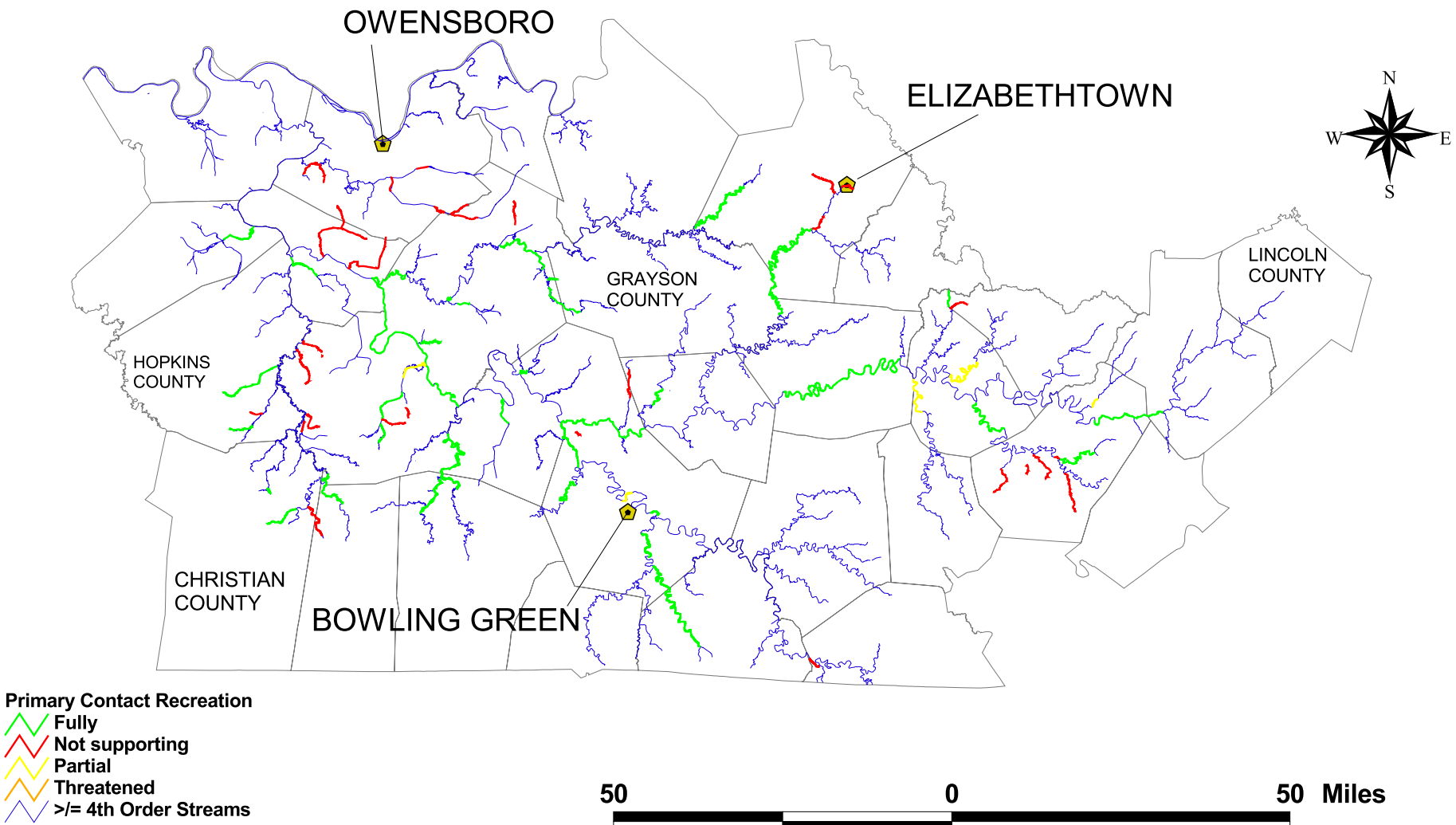
Source 2004 305(b) Report

Appendix Figure A-4. Reach indexing results of streams assessed in the Green River Basin and adjacent Ohio River minor tributaries for Fish Consumption Use.



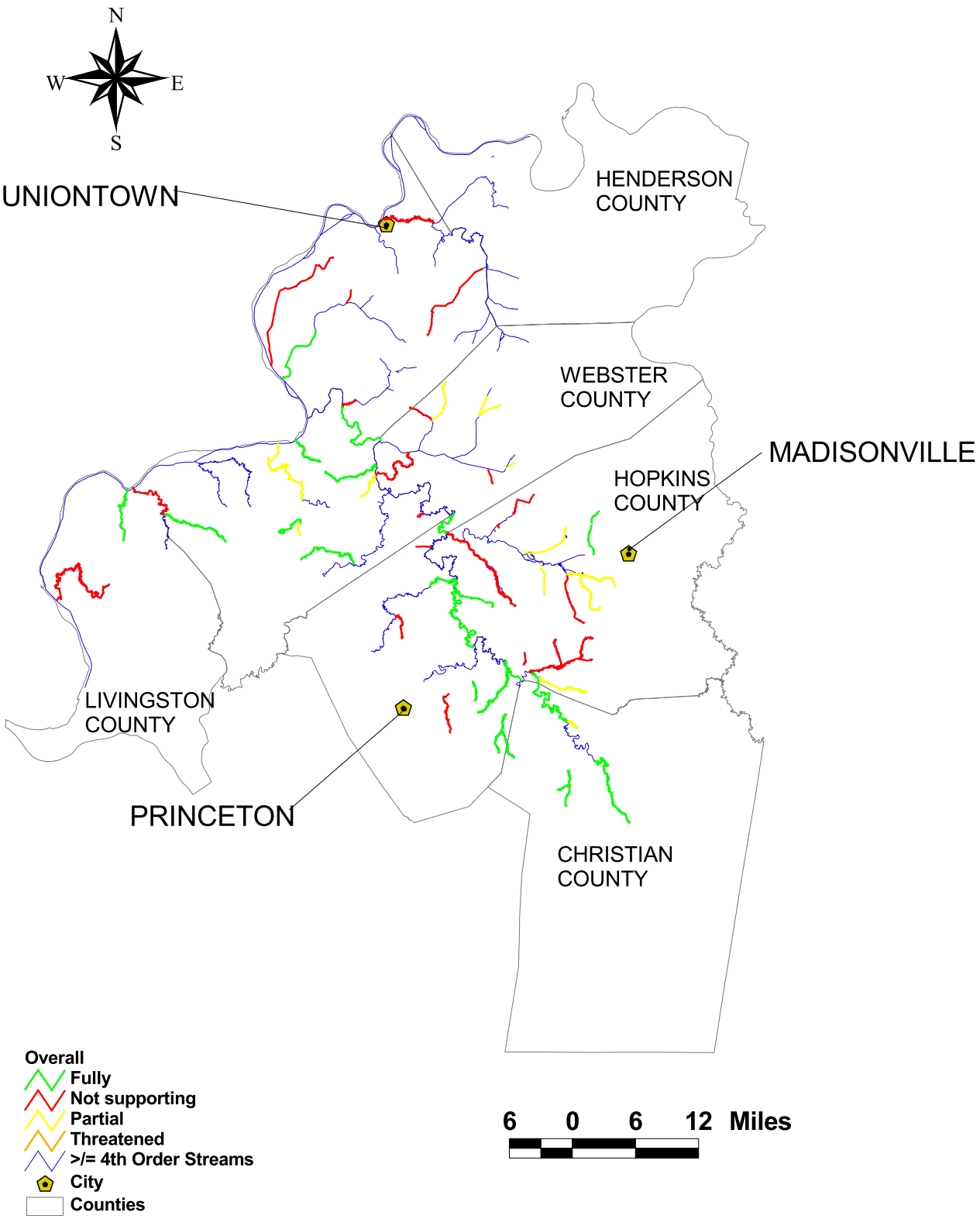
Source 2004 305(b) Report

Appendix Figure A-5. Reach indexing results of streams assessed in the Green River Basin and adjacent Ohio River minor tributaries or Primary Contact Recreation Use.



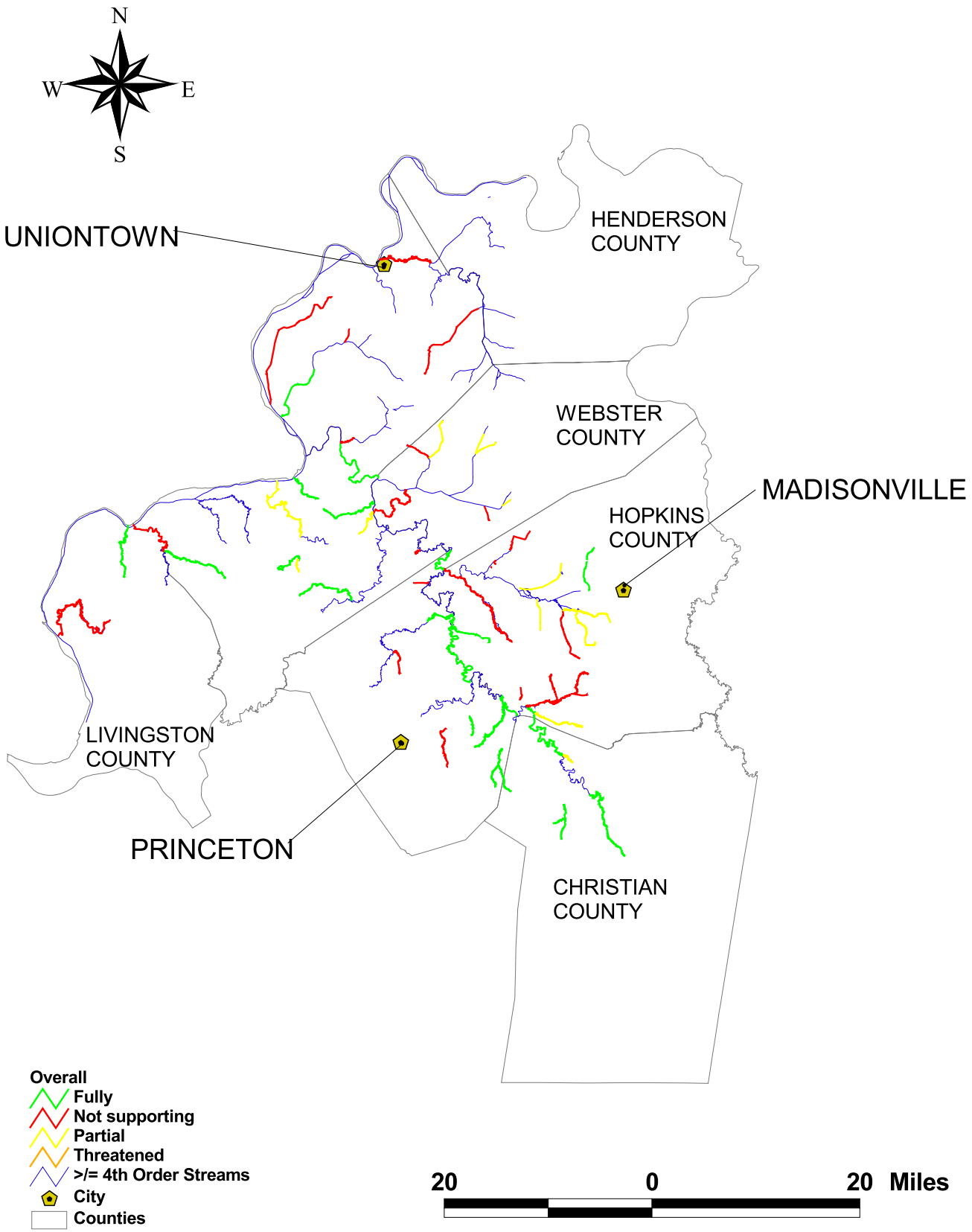
Source 2004 305(b) Report

Appendix Figure A-6. Combined overview of stream reach indexing for the three assessed uses (Aquatic Life Support, Drinking Water and Primary Contact Recreation) in the Tradewater River Basin and adjacent Ohio River minor tributaries.



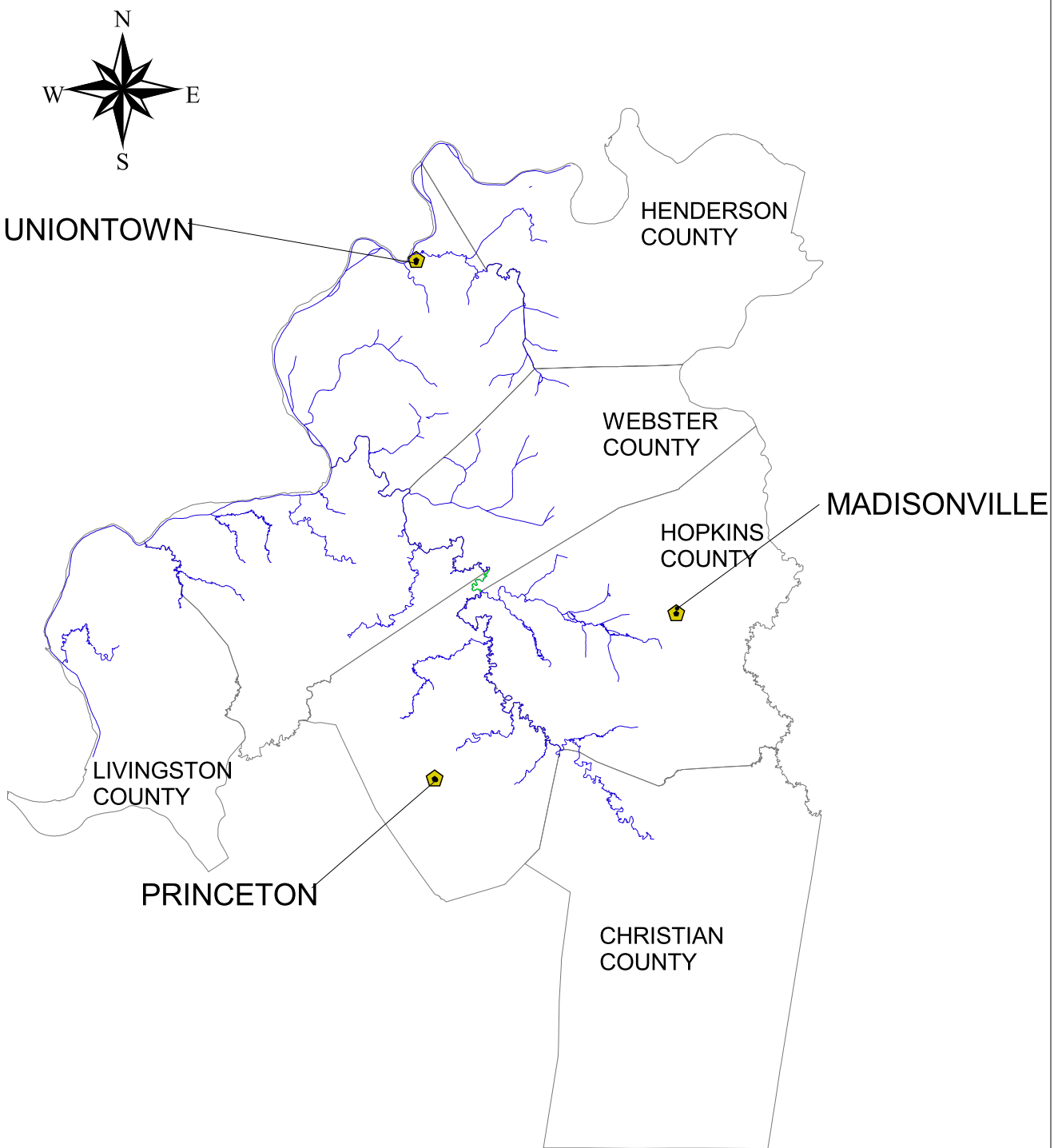
Source 2004 305(b) Report

Appendix Figure A-7. Reach indexing results of streams assessed in the Tradewater River Basin and adjacent Ohio River minor tributaries for Aquatic Life Use.



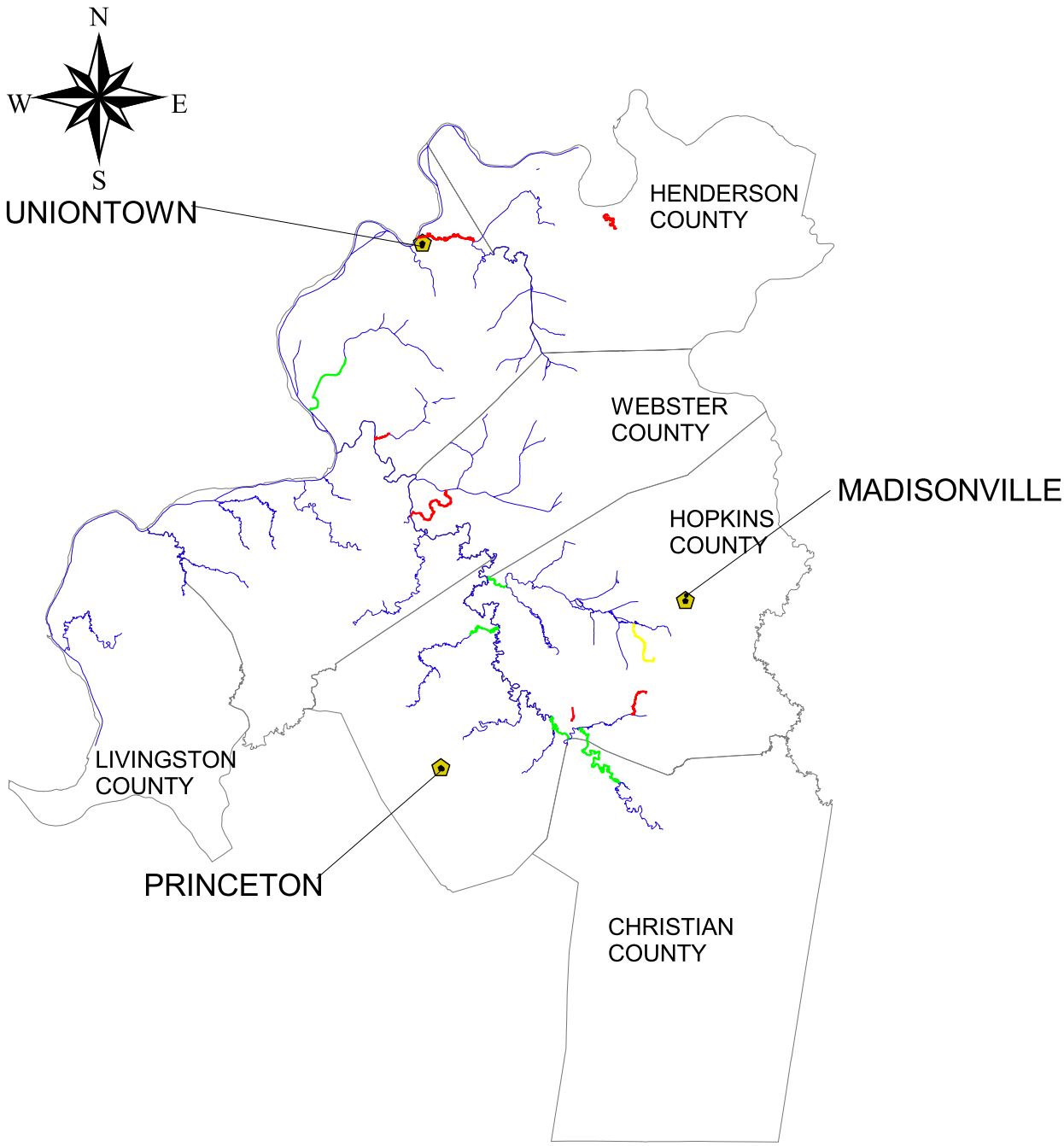
Source 2004 305(b) Report

Appendix Figure A-8. Reach indexing results of streams assessed in the Tradewater River Basin and adjacent Ohio River minor tributaries for Drinking Water Use.



Source 2004 305(b) Report

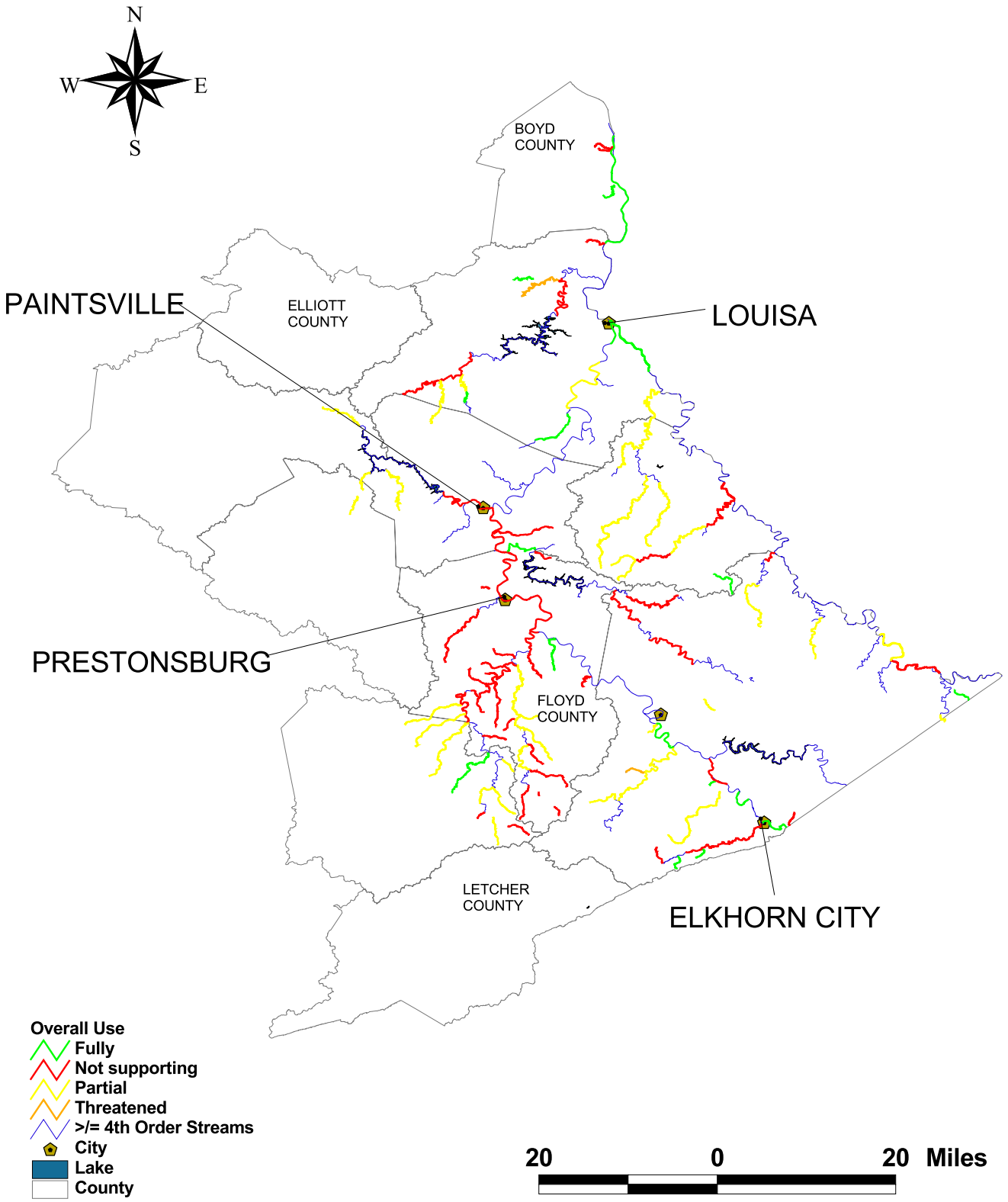
Appendix Figure A-9. Reach indexing results of streams assessed in the Tradewater River Basin and adjacent Ohio River minor tributaries for Primary Contact Recreation Use.



Source 2004 305(b) Report

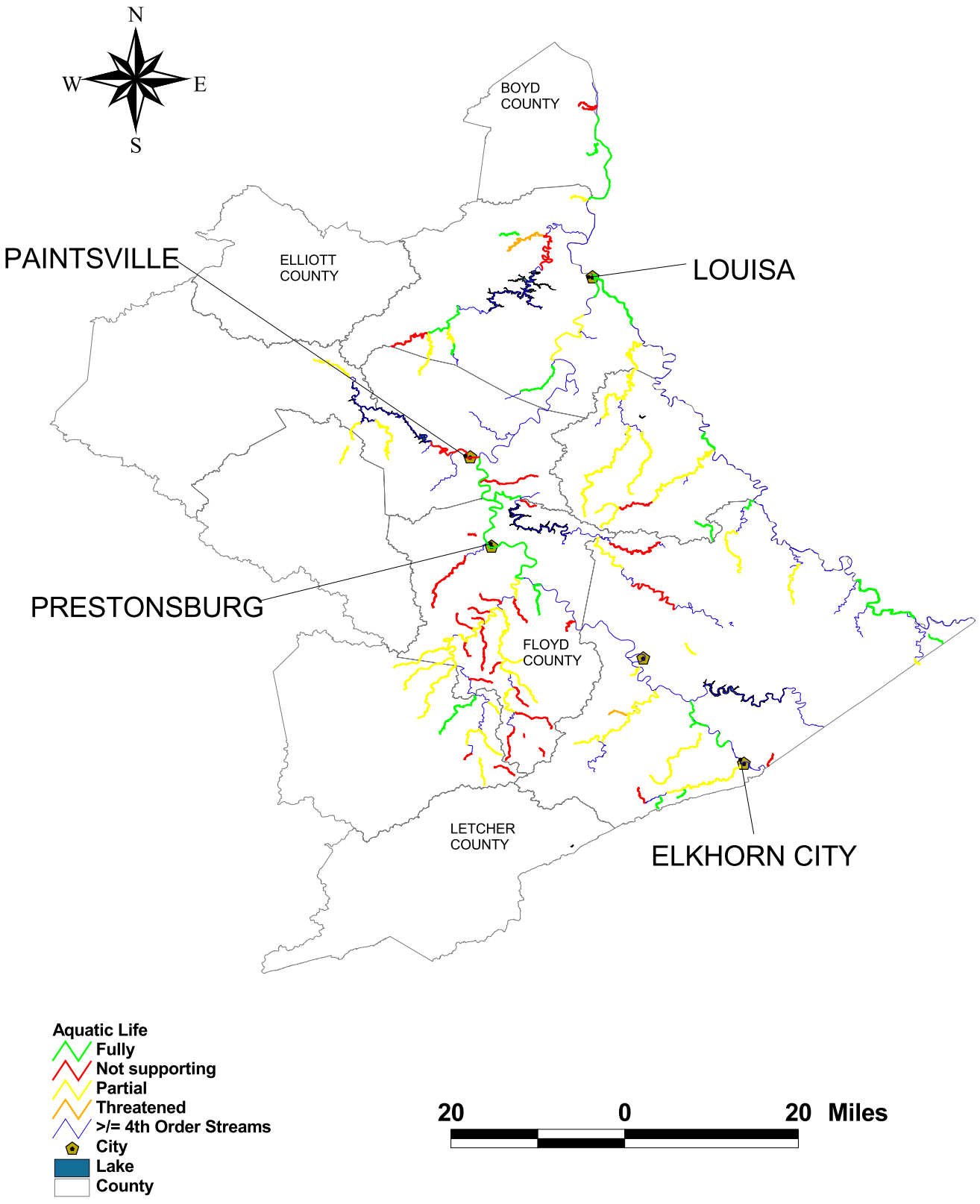
Appendix B. Reach Index Maps for Big Sandy River Basin, Little Sandy - Tygarts Basin and adjacent Ohio River Minor Tributaries

Appendix Figure B-1. Combined overview of stream reach indexing for the four assessed uses (Aquatic Life Support, Drinking Water, Fish Consumption and Primary Contact Recreation) in the Big Sandy River Basin.



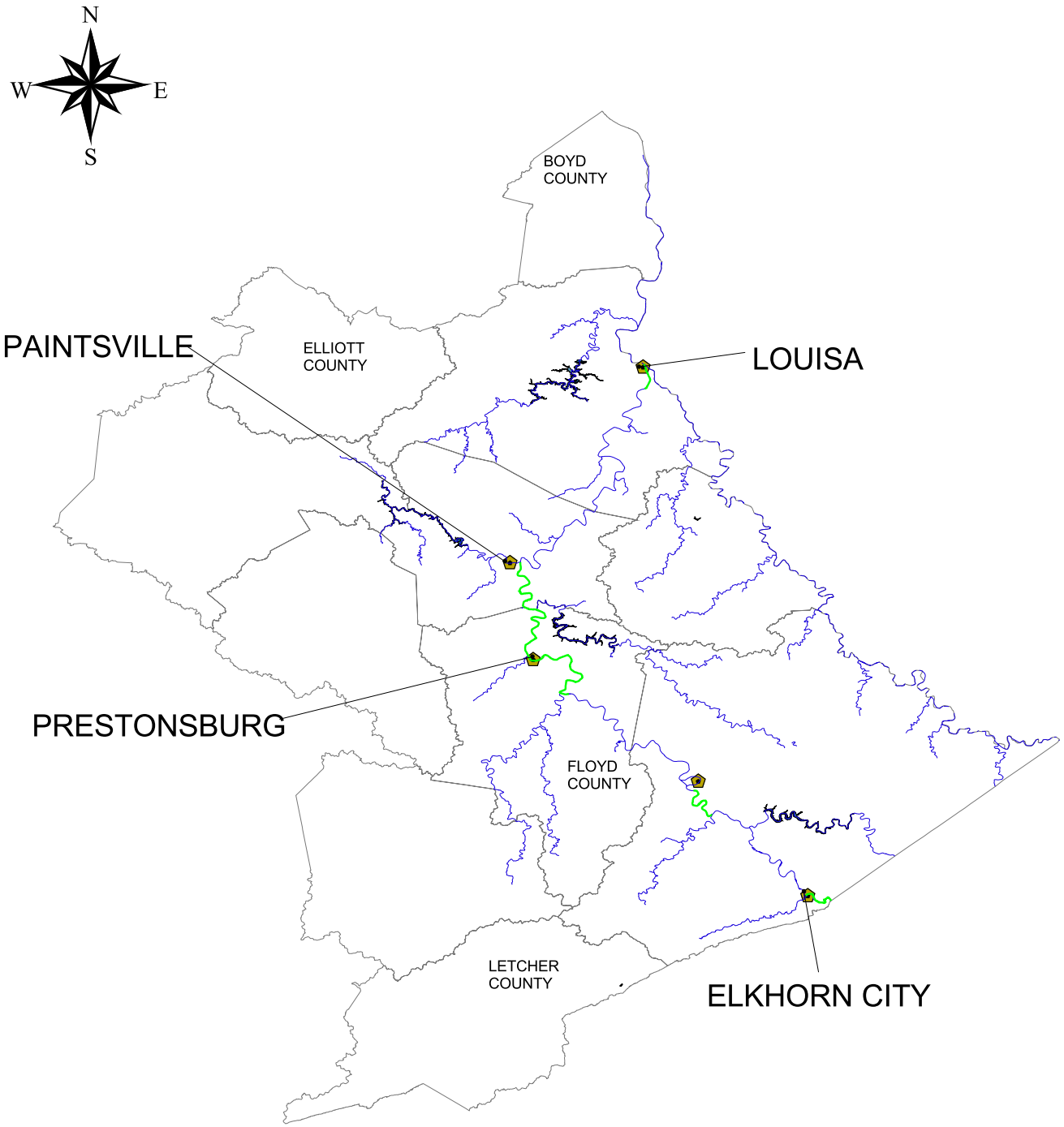
Source 2004 305(b) Report

Appendix Figure B-2. Reach indexing results of streams assessed in the Big Sandy River Basin for Aquatic Life Use.



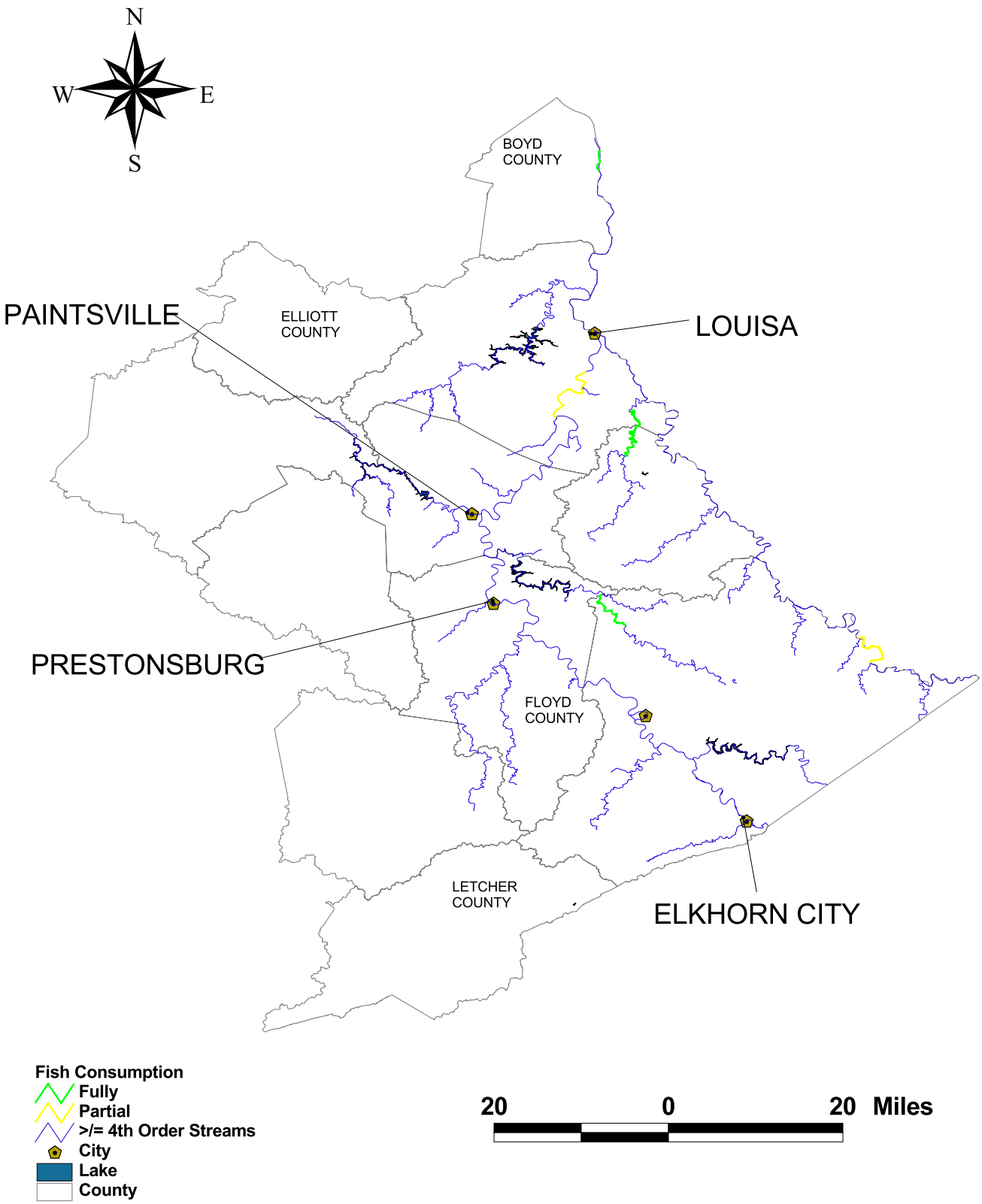
Source 2004 305(b) Report

Appendix Figure B-3. Reach indexing results of streams assessed in the Big Sandy River Basin for Drinking Water Use.



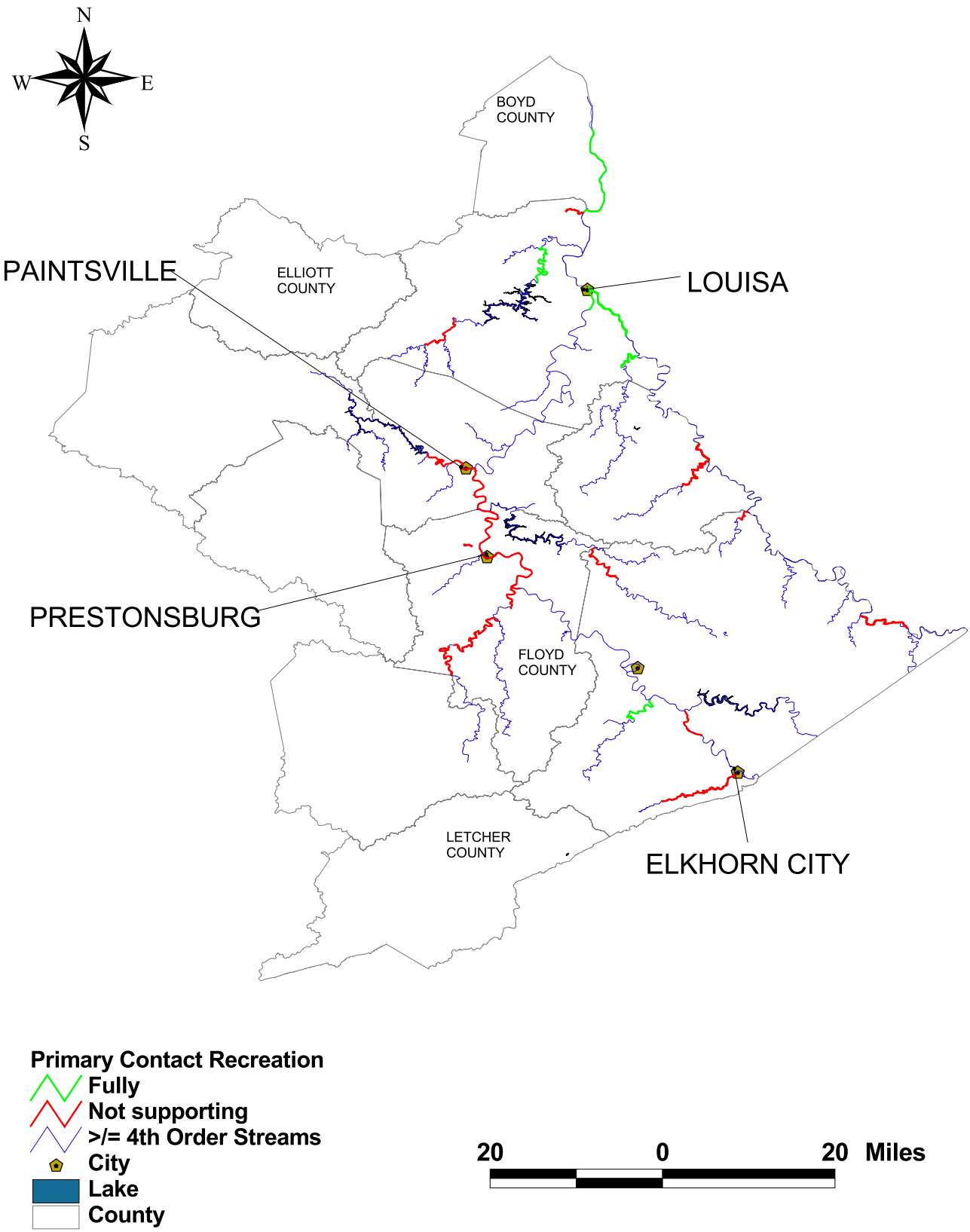
Source 2004 305(b) Report

Appendix Figure B-4. Reach indexing results of streams assessed in the Big Sandy River Basin for Fish Consumption Use.



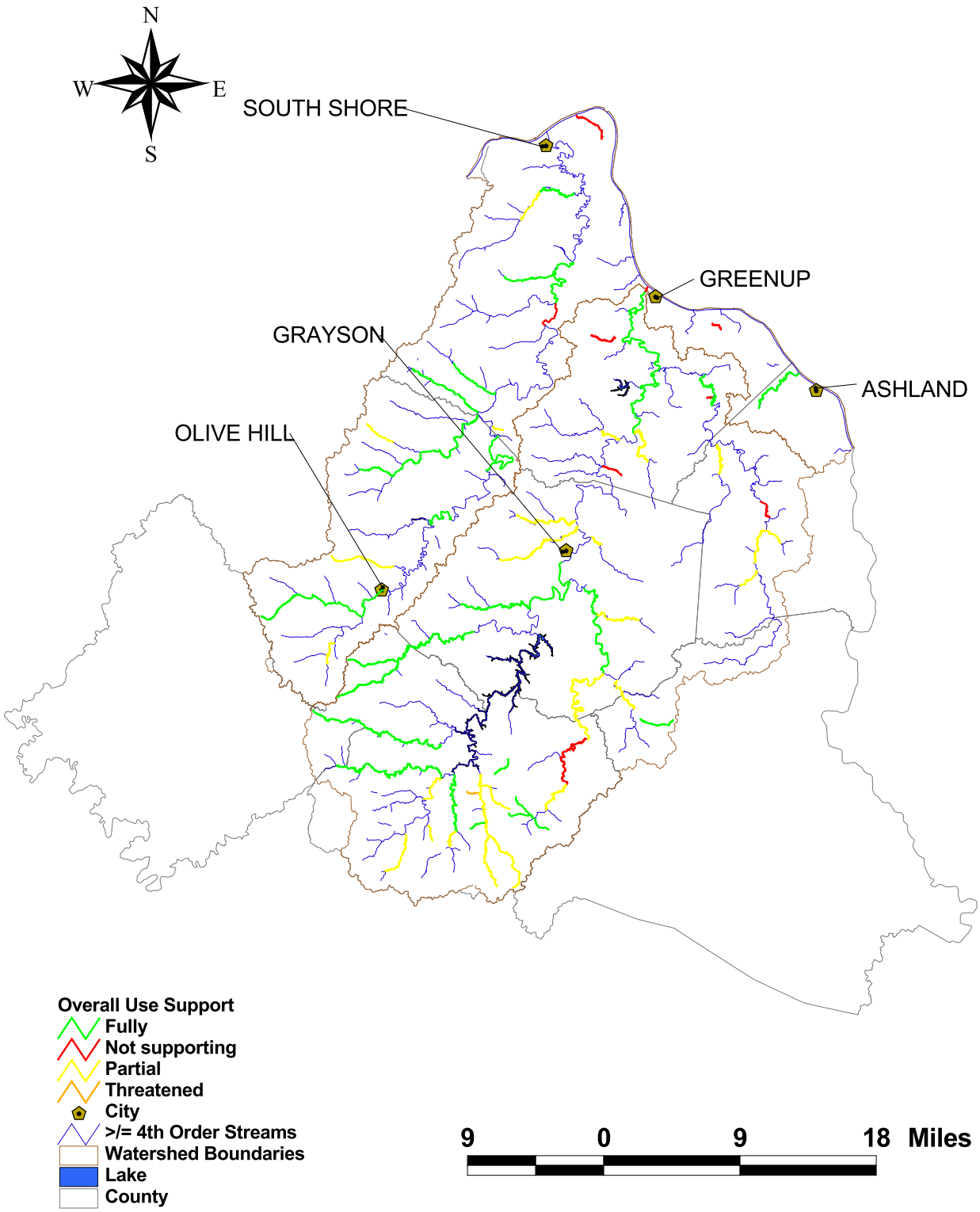
Source 2004 305(b) Report

Appendix Figure B-5. Reach indexing results of streams assessed in the Big Sandy River Basin for Primary Contact Recreation Use.



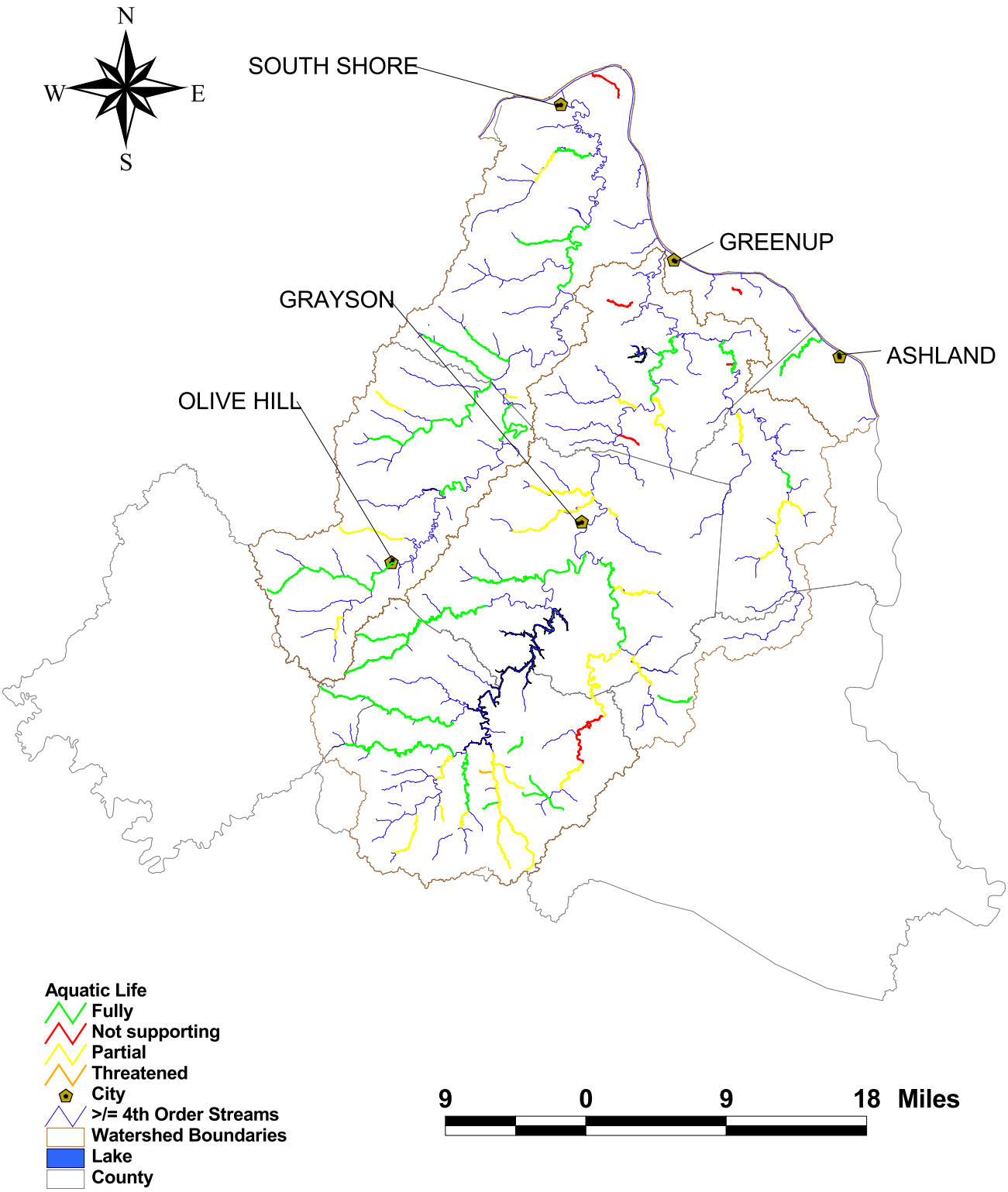
Source 2004 305(b) Report

Appendix Figure B-6. Combined overview of stream reach indexing for the four assessed uses (Aquatic Life Support, Drinking Water, Fish Consumption and Primary Contact Recreation) in the Little Sandy -Tygarts Basin and adjacent Ohio River minor tributaries.



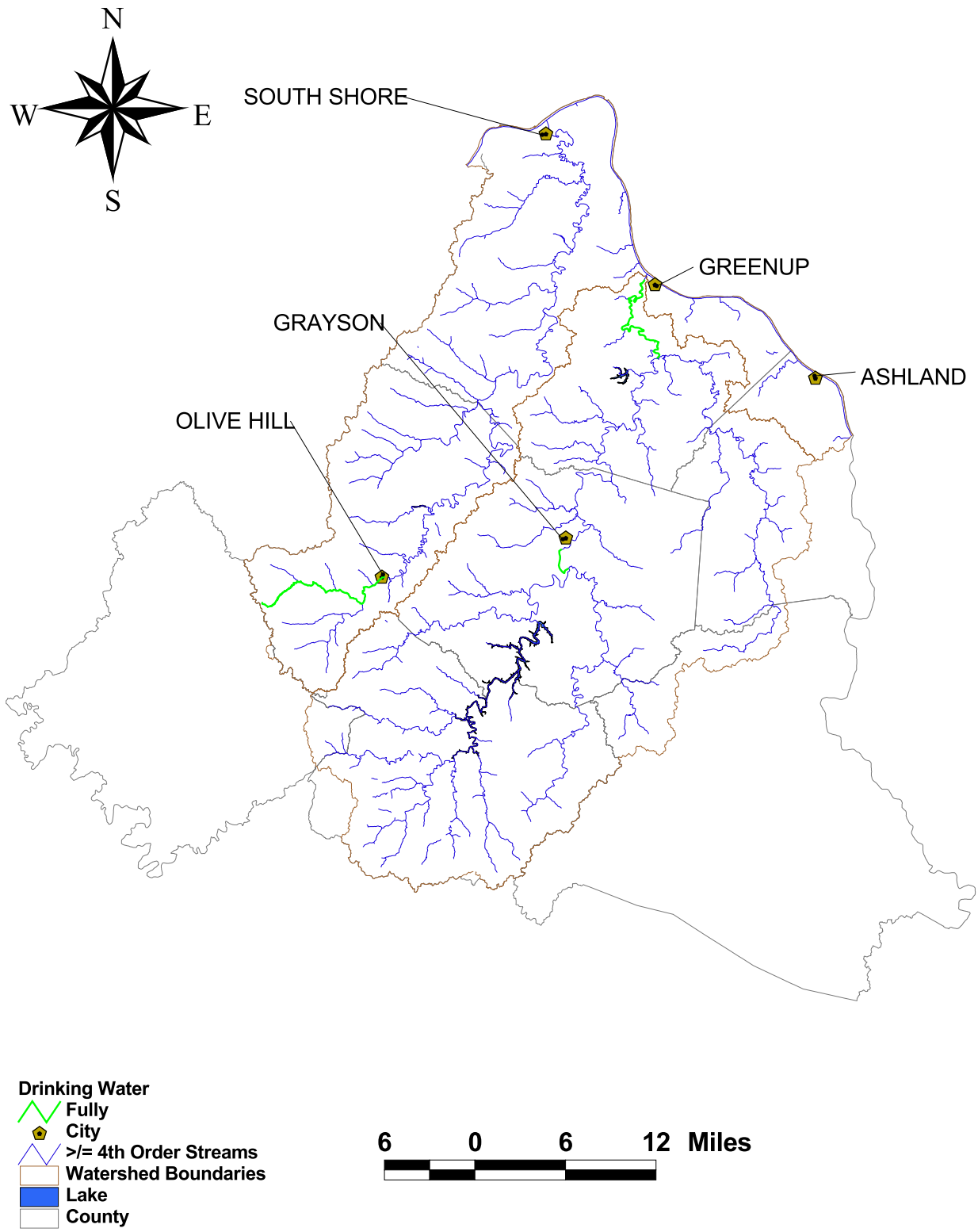
Source 2004 305(b) Report

Appendix Figure B-7. Reach indexing results of streams assessed in the Little Sandy - Tygarts Basin and adjacent Ohio River minor tributaries for Aquatic Life Use.



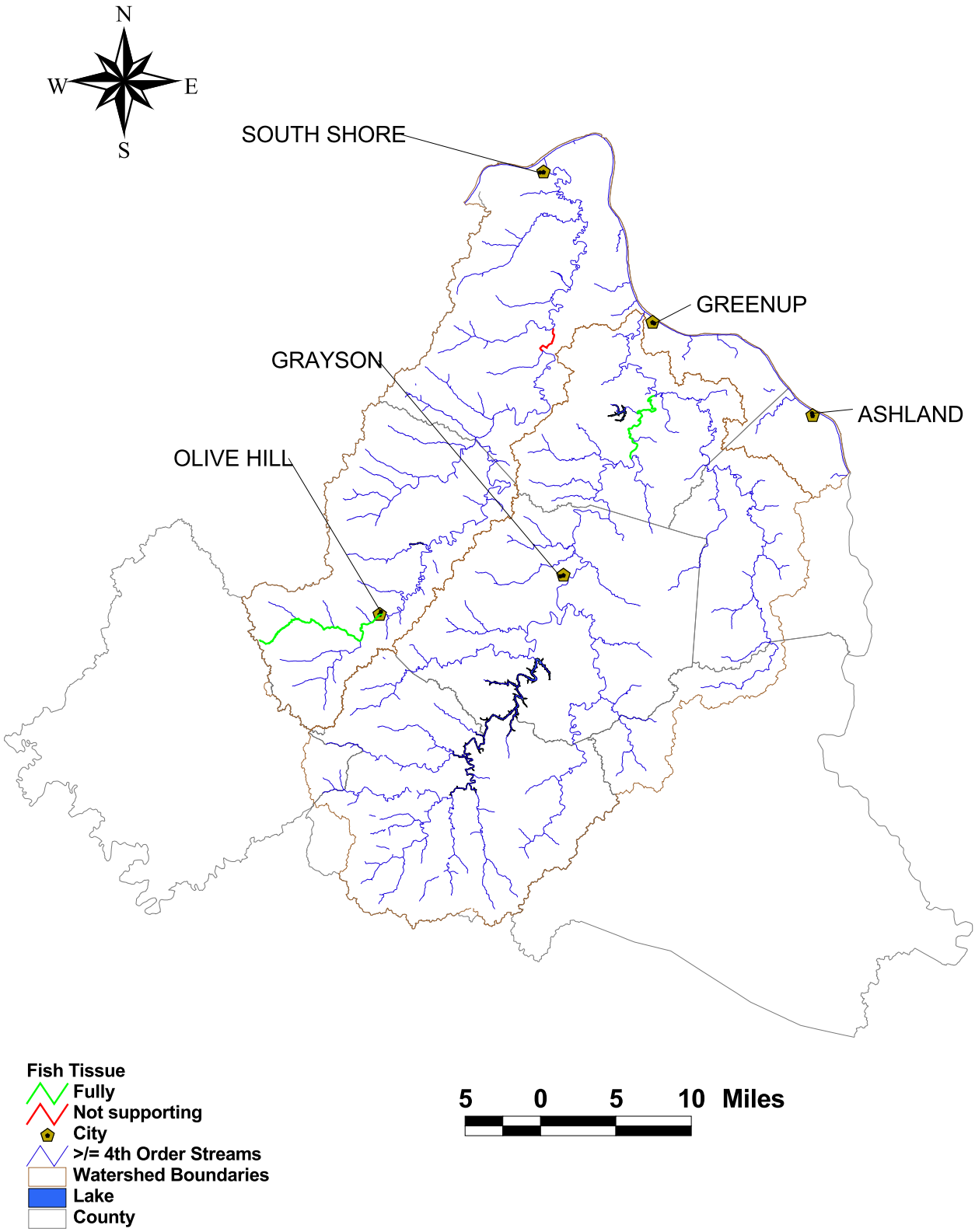
Source 2004 305(b) Report

Appendix Figure B-8. Reach indexing results of streams assessed in the Little Sandy - Tygarts Basin and adjacent Ohio River minor tributaries for Drinking Water Use.



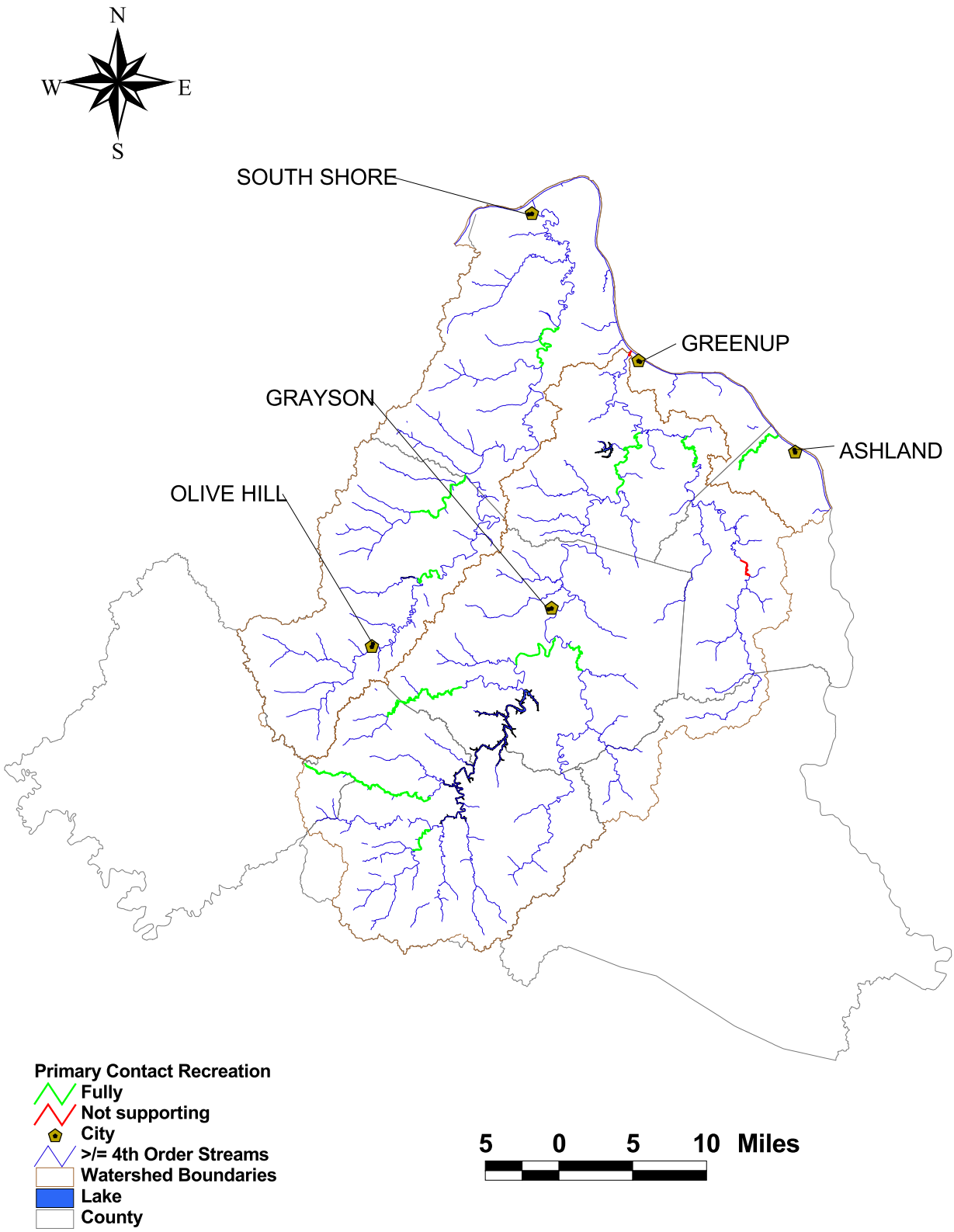
Source 2004 305(b) Report

Appendix Figure B-9. Reach indexing results of streams assessed in the Little Sandy -Tygarts Basin and adjacent Ohio River minor tributaries for Fish Consumption Use.



Source 2004 305(b) Report

Appendix Figure B-10. Reach indesing results of streams assessed in the Little Sandy -Tygarts Basin and adjacent Ohio River minor tributaries for Primary Contact Recreation Use.



Source 2004 305(b) Report