Pesticides

A large number of synthetic organic pesticides (including insecticides, herbicides, and growth regulators) have been developed and applied in agricultural and urban settings. Some, such as the organochlorine insecticide DDT, were banned decades ago but still persist in soils and sediments and could still be released to groundwater systems. Most recently developed pesticides that have been approved for use are less persistent in natural environments; however, they may still have undesirable impacts on human health and groundwater suitability for various uses.

The environmental significance of pesticides in groundwater is difficult to determine precisely for several reasons (U.S. Geological Survey, 1999): (1) standards and guidelines are available for only a small number of individual pesticide chemicals and are generally not available for the equally important degradation products, (2) new pesticides are being developed continually, (3) environmental testing does not account for pesticide mixtures or breakdown products, which may be more potent than the original active ingredients, (4) only a limited suite of health and ecological effects have been tested, (5) concentrations much higher than those used in testing may be introduced to groundwater systems when pesticides are applied after rains, and (6) some detrimental effects such as endocrine disruption and other subtle health effects have not been fully assessed. For these reasons, and because once contaminated, groundwater typically is slow to respond to changes in pesticide type and application methods, it is important to quantify the occurrence of any detectable pesticides in Kentucky groundwater.

According to the 2000 agricultural sales data, atrazine, glyphosate, metolachlor, simazine, and 2,4-D are the top five pesticides sold in Kentucky. Alachlor and cyanazine have also been used extensively in the past. Glyphosate has not been measured in groundwater samples, and so will not be discussed in this report. Toxicological information for pesticides was obtained from the Extension Toxicology Network (ace.orst.edu/info/exotoxnet/pips/) and the U.S. Environmental Protection Agency's Integrated Risk Information System (www.epa.gov/iris/).

2,4-D. The pesticide 2,4-D belongs to the chemical class of phenoxy compounds. Predominant uses are as a systematic herbicide used to control broadleaf weeds in cultivated agriculture, pasture and range land, forest management, home and garden settings, and to control aquatic vegetation. It has a low persistence in soils with a half-life of less than 7 days, and is readily degraded by microorganisms in aquatic environments. The EPA has established an MCL of 0.07 mg/L for 2,4-D because the nervous system can be damaged from exposure at higher levels.

The database contained 114 analyses of 2,4-D from 47 sites in BMU 5 (Table 24). No value exceeded the MCL of 0.07 mg/L. Only 12 values from 11 sites exceeded analytical detection limits; all these sites were wells in the Big Sandy watershed.

Sample-site density was uniform but sparse throughout BMU 5 (Fig. 92). No detection of 2,4-D occurred at any of the sampled sites in the Little Sandy–Tygarts Creek watershed. Because no value exceeded the MCL and concentrations exceeded analytical detection limits at only 11 sites, the data were not analyzed further.

In summary, 2,4-D concentrations do not exceed the MCL in the project area, and are typically less than analytical detection. Detectable amounts of 2,4-D were found in 11 wells, all less than 110 ft deep and all in the Big Sandy watershed. The presence of 2,4-D at some sites in the project area indicates that 2,4-D is entering the groundwater system, although it does not currently present a health hazard.

Table 24. Summary of 2,4-D concentrations (mg/L). MCL=0.07 mg/L.

Number of values	114
Maximum	0.000653
75th percentile	< 0.0001
Median	< 0.0001
25th percentile	< 0.0001
Minimum	< 0.0001
Interquartile range	na
Number of sites	47
Number of where detected	11
Number of sites > 0.07 mg/L	0

< means analytical result reported as less than the stated analytical detection limit

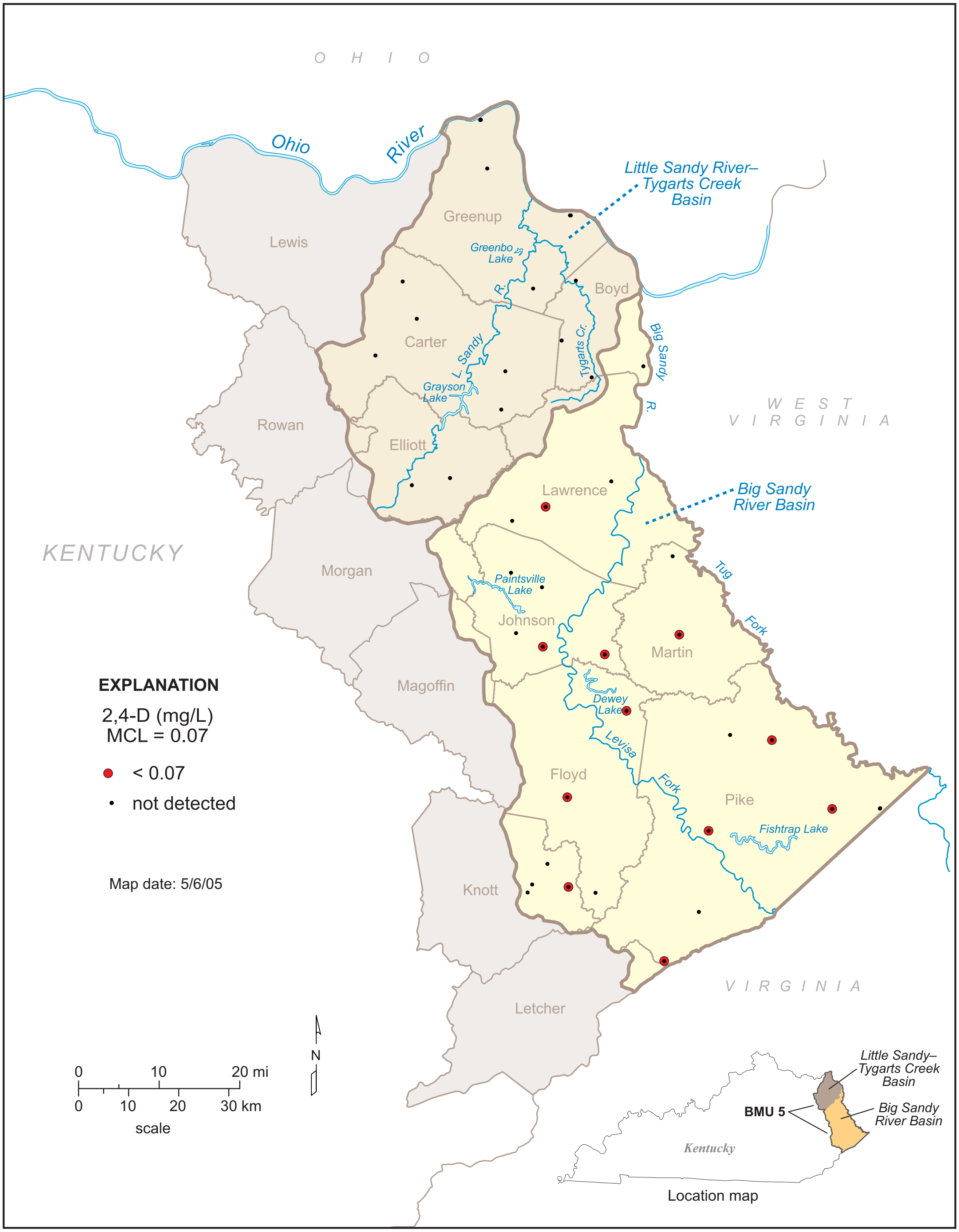

Figure 92. Locations of sampled sites and ranges of 2,4-D values.

Alachlor. Alachlor belongs to the chemical class of analines. Predominant uses are the control of annual grasses and broadleaf weeds in field corn, soybeans, and peanuts. It has a low persistence in soils and a half-life of about 8 days. It is moderately mobile in sandy and silty soils and breaks down rapidly in natural water due to microbial activity. The breakdown is significantly slower under reducing conditions. The EPA has found alachlor to pose a risk for skin and eye irritation on short-term exposure, and to potentially cause damage to the liver, kidneys, spleen, lining of the nose and eyelids, and possibly cause cancer on long-term exposure. For these reasons, the EPA has set an MCL of 0.002 mg/L for alachlor.

The data repository contained 136 measurements of alachlor from 49 sites in BMU 5 (Table 25). No value exceeded the MCL; all results were below analytical detection limits.

Sample-site density was uniform but sparse throughout BMU 5 (Fig. 93). Because alachlor was not detected, the data were not analyzed further.

Table 25. Summary of alachlor concentrations (mg/L). MCL=0.002 mg/L.

Number of values	136
Maximum	< 0.00027
75th percentile	< 0.00004
Median	< 0.00004
25th percentile	< 0.00004
Minimum	< 0.00002
Interquartile range	na
Number of sites	49
Number of where detected	0
Number of sites > 0.002 mg/L	0

< means analytical result reported as less than the stated analytical detection limit

In summary, alachlor was not detected at any of the 49 sites where groundwater was sampled in BMU 5. Alachlor use is probably very limited in the project area because corn, soybeans, and peanuts are not produced in this part of Kentucky.

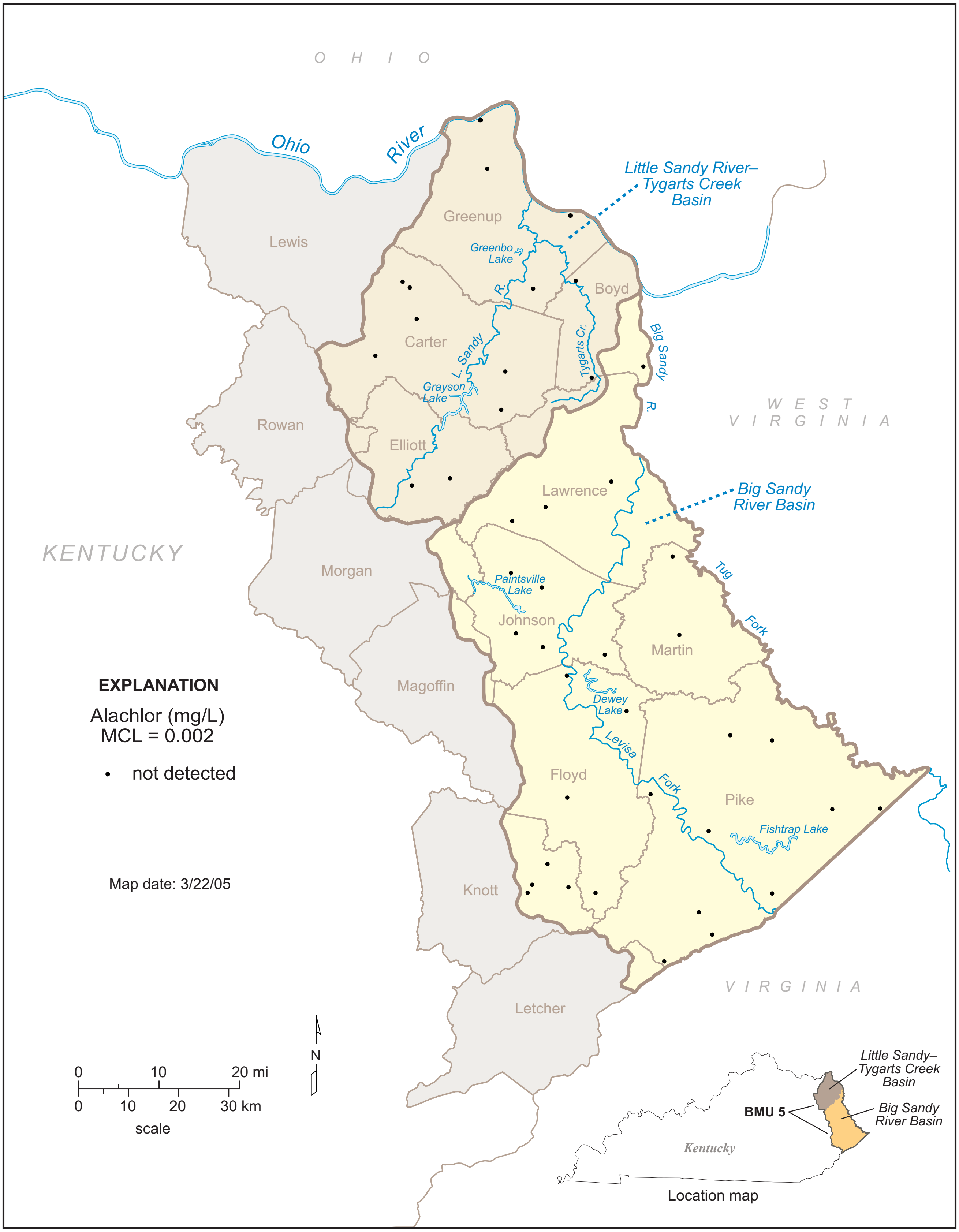

Figure 93. Locations of sampled sites and ranges of alachlor values.

Atrazine. Atrazine belongs to the chemical class of triazines. Predominant uses are to control broadleaf and grassy weeds in corn, sorghum, and other crops and in conifer reforestation plantings. It is highly persistent in soils, moderately soluble in water, and not readily sorbed to sediments.

The EPA has set an MCL of 0.003 mg/L for atrazine. Atrazine can cause a variety of acute health effects from acute exposures at higher levels. These effects include congestion of the heart, lungs, and kidneys; hypotension; reduction of urinary output; muscle spasms; weight loss; and adrenal degeneration. Atrazine also has the potential to cause weight loss, cardiovascular damage, retinal and some muscle degeneration, and mammary tumors from a lifetime exposure at levels above the MCL.

The data repository contained 76 reports of atrazine concentrations from only 14 sites in BMU 5 (Table 26). No reported value exceeded the MCL of 0.003 mg/L. Only five of the 76 measurements exceeded analytical detection limits, and only two wells and one spring yielded groundwater with an atrazine concentration greater than the analytical detection limit.

Sample-site density was very sparse (Fig. 94). The data were not analyzed further because only five values were above analytical detection and because there were so few sampled sites.

Table 26. Summary of atrazine concentrations (mg/L). MCL=0.003 mg/L.

Number of values	76
Maximum	0.00194
75th percentile	< 0.0003
Median	< 0.0003
25th percentile	< 0.0005
Minimum	< 0.0004
Interquartile range	na
Number of sites	14
Number of where detected	3
Number of sites > 0.003 mg/L	0

< means analytical result reported as less than the stated analytical detection limit

In summary, only 14 sites were sampled for atrazine in BMU 5. None of the samples had an atrazine concentration above the MCL; only three sites produced water with detectable levels of atrazine. Atrazine use is probably very limited in the project area because the types of crops atrazine is used on are not grown in this part of the state. Nevertheless, the presence of any detectable atrazine in the project area indicates that some atrazine is entering the groundwater system.

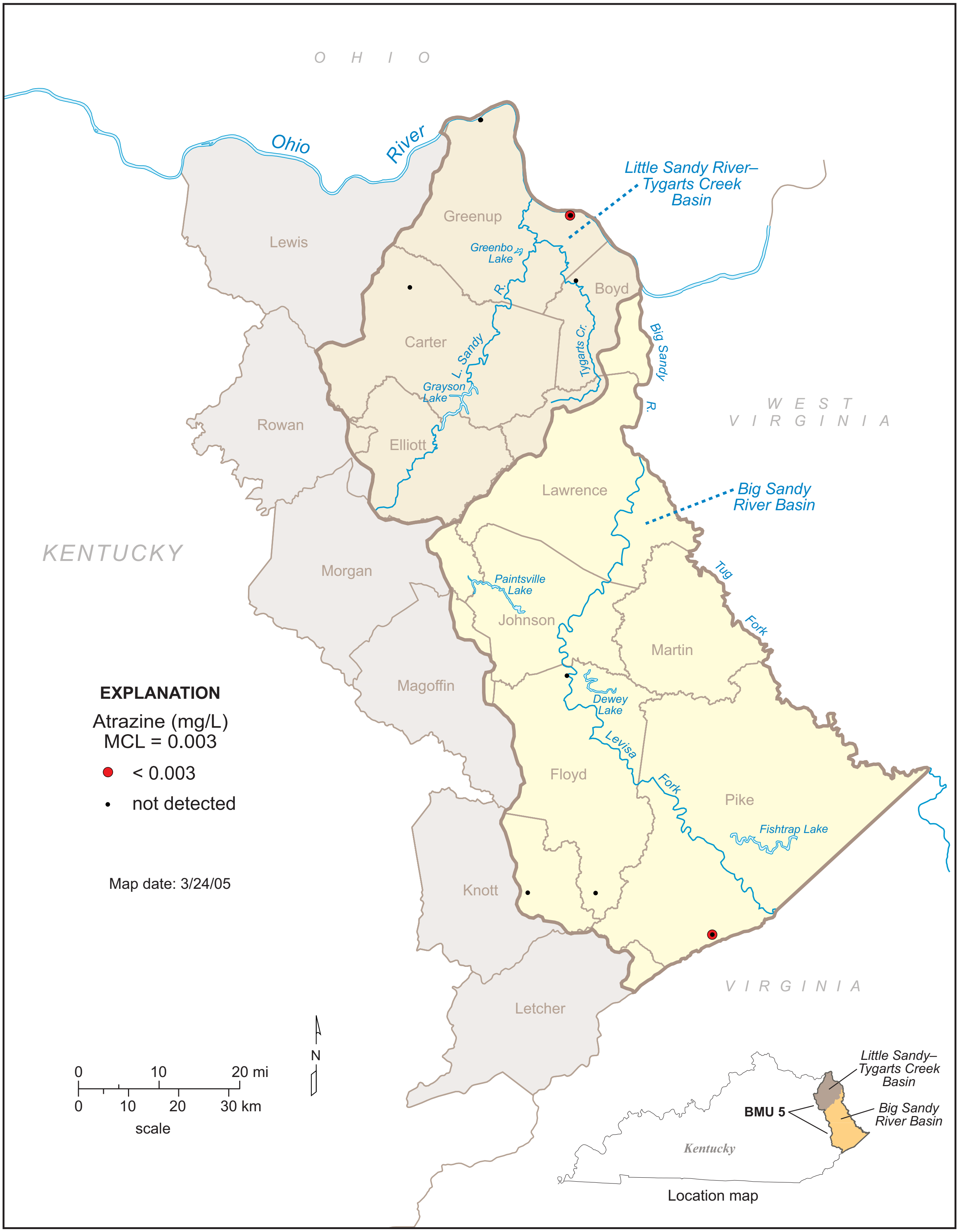

Figure 94. Locations of sampled sites and ranges of atrazine values.

Cyanazine. Cyanazine belongs to the chemical class of triazines. It is used mainly to control annual grasses and broadleaf weeds in corn. It has low to moderate persistence in soils and is rapidly degraded by microbial activity. Cyanazine has a half-life of 2 to 14 weeks, depending on soil type, and is stable in water. There is no MCL for cyanazine; however, the Division of Water has set a health advisory limit of 0.001 mg/L.

The groundwater data repository contained 128 results of cyanazine analyses from 47 sites in the project area (Table 27). Only one value exceeded analytical detection limits; this site (a spring) also exceeded the HAL. Sampled sites were widely spaced (Fig. 95). Because only one cyanazine concentration was greater than the analytical detection limit, the data were not analyzed further.

In summary, only one of 47 sites in the project area produced water with detectable cyanazine, and at that site the cyanazine concentration was greater than the HAL. Cyanazine use is probably very limited in the project area because the types of crops cyanazine is used on are not grown in this part of the state. The presence of cyanazine in the project area indicates that some pesticides are entering the groundwater system, however.

Table 27. Summary of cyanazine concentrations (mg/L). HAL=0.001 mg/L.

Number of values	128
Maximum	0.00126
75th percentile	< 0.00005
Median	< 0.00004
25th percentile	< 0.00004
Minimum	< 0.00004
Interquartile range	na
Number of sites	47
Number of where detected	1
Number of sites > 0.001 mg/L	1

< means analytical result reported as less than the stated analytical detection limit

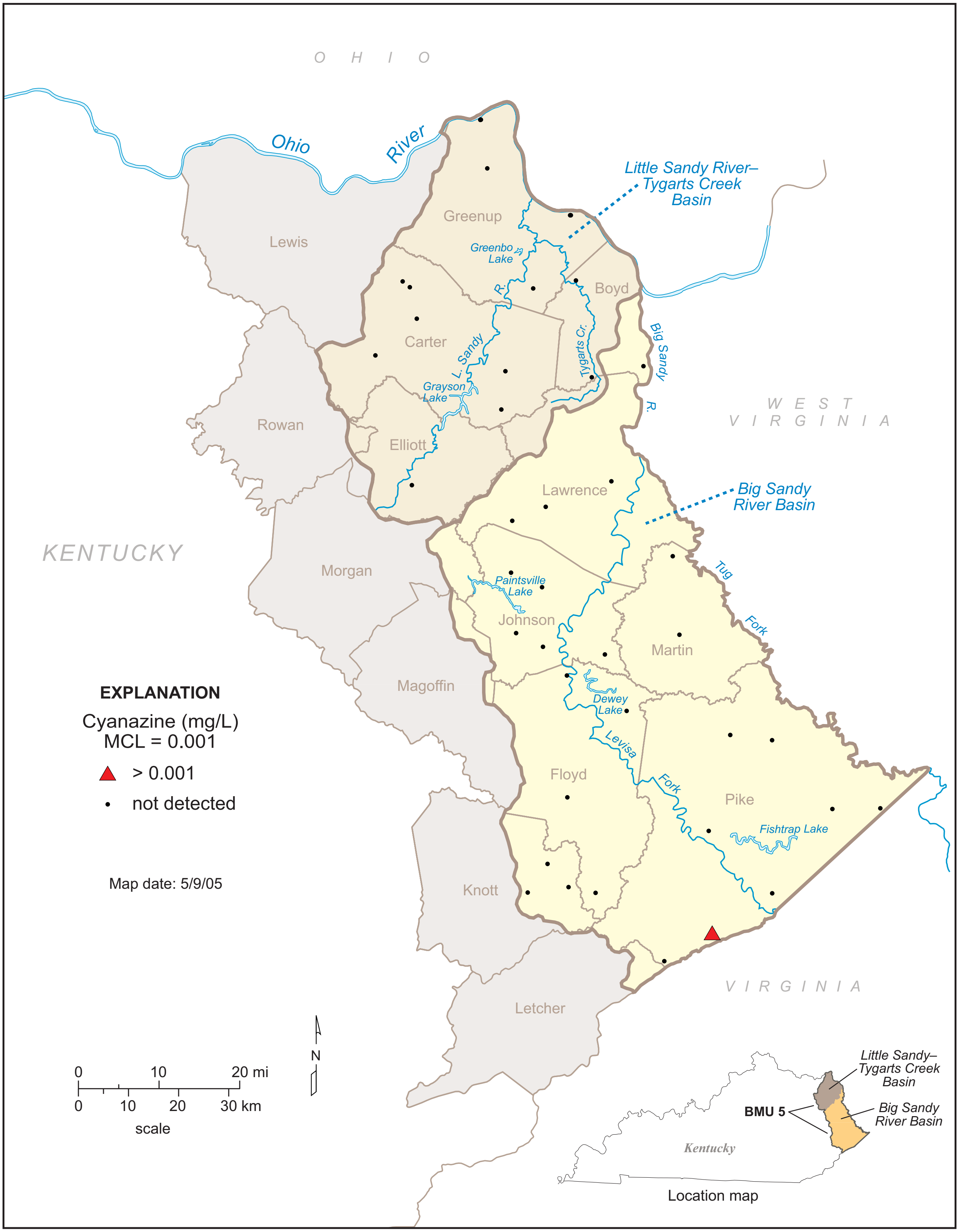

Figure 95. Locations of sampled sites and ranges of cyanazine values.

Metolachlor. Metolachlor belongs to the chemical class of amides. It is predominantly used to control broadleaf and grassy weeds in field corn, soybeans, peanuts, grain sorghum, potatoes, pod crops, cotton, safflower, stone fruits, nut trees, highway rights-of-way, and woody ornamentals. It is moderately persistent in soils with a half-life of 15 to 70 days, and is highly persistent in water. There is no MCL for metolachlor; the Division of Water has set a health advisory limit of 0.1 mg/L.

The data repository contained 135 metolachlor concentrations from 48 sites in BMU 5 (Table 28). No values exceeded the HAL. Metolachlor was detected at only one site (Fig. 96), a shallow well in the Big Sandy watershed. Because metolachlor was detected at only one site, the data were not analyzed further.

In summary, metolachlor is probably not used much in the project area; it was detected at only one site. The presence of detectable metolachlor in the project area indicates that some of this synthetic organic chemical has entered the groundwater system.

Table 28. Summary of metolachlor concentrations (mg/L). HAL=0.1 mg/L.

Number of values	135
Maximum	0.000022
75th percentile	< 0.0002
Median	< 0.00005
25th percentile	< 0.00004
Minimum	< 0.00004
Interquartile range	na
Number of sites	48
Number of where detected	1
Number of sites > 0.1 mg/L	0

< means analytical result reported as less than the stated analytical detection limit

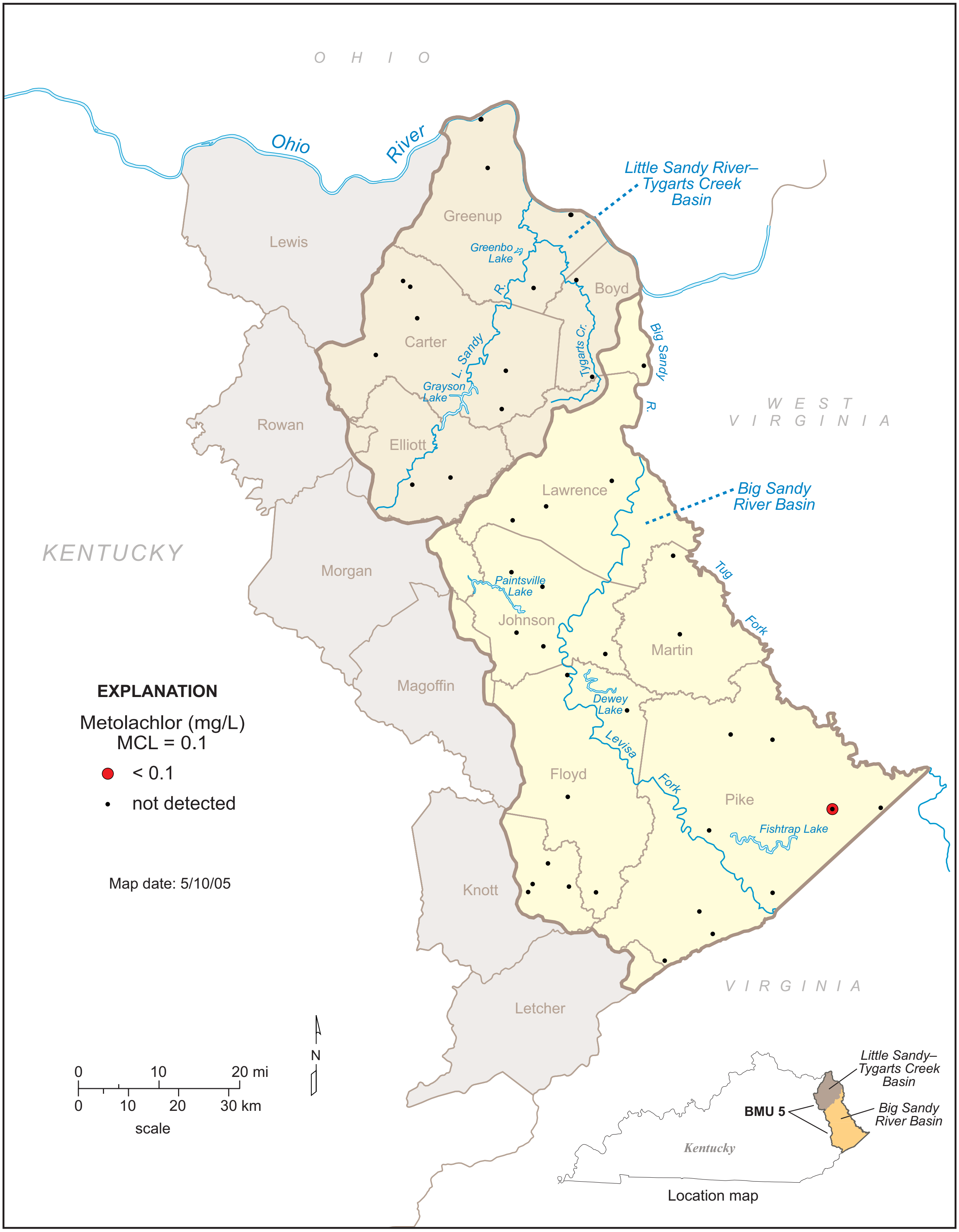

Figure 96. Locations of sampled sites and ranges of metolachlor values.

Simazine. Simazine belongs to the chemical class of triazines. It is predominantly used to control broadleaf weeds and annual grasses in fields where berry fruits, nuts, vegetables, and ornamental crops are grown, and on turfgrass. It is moderately persistent in soils, with a half-life of about 60 days, and is moderately persistent in water, with a half-life that depends on the amount of algae present.

The MCL for simazine is 0.004 mg/L. At levels above 0.004 mg/L, long-term exposure to simazine can cause tremors; damage to the testes, kidneys, liver, and thyroid; and gene mutations. There is some evidence that simazine may have the potential to cause cancer from a lifetime exposure at levels above the MCL.

The data repository contained 151 simazine measurements from 48 sites in the project area (Table 29). No measurement exceeded 0.004 mg/L. Only two sites, one spring and one shallow well, had simazine concentrations that exceeded analytical detection limits. The sampled sites were widely distributed throughout BMU 5 (Fig. 97). Because of the very small number of sites where simazine exceeded analytical detection limits, the data were not analyzed further.

Table 29. Summary of simazine concentrations (mg/L). MCL=0.004 mg/L.

Number of values	151
Maximum	0.000689
75th percentile	< 0.0003
Median	< 0.00004
25th percentile	< 0.00004
Minimum	0.00003
Interquartile range	na
Number of sites	48
Number of where detected	2
Number of sites > 0.04 mg/L	0

< means analytical result reported as less than the stated analytical detection limit

In summary, simazine is probably not used much in the project area. It is rarely detected in groundwater. When found, it is more common in springs than in wells. The presence of detectable simazine in the project area indicates that some pesticides are entering the groundwater system.

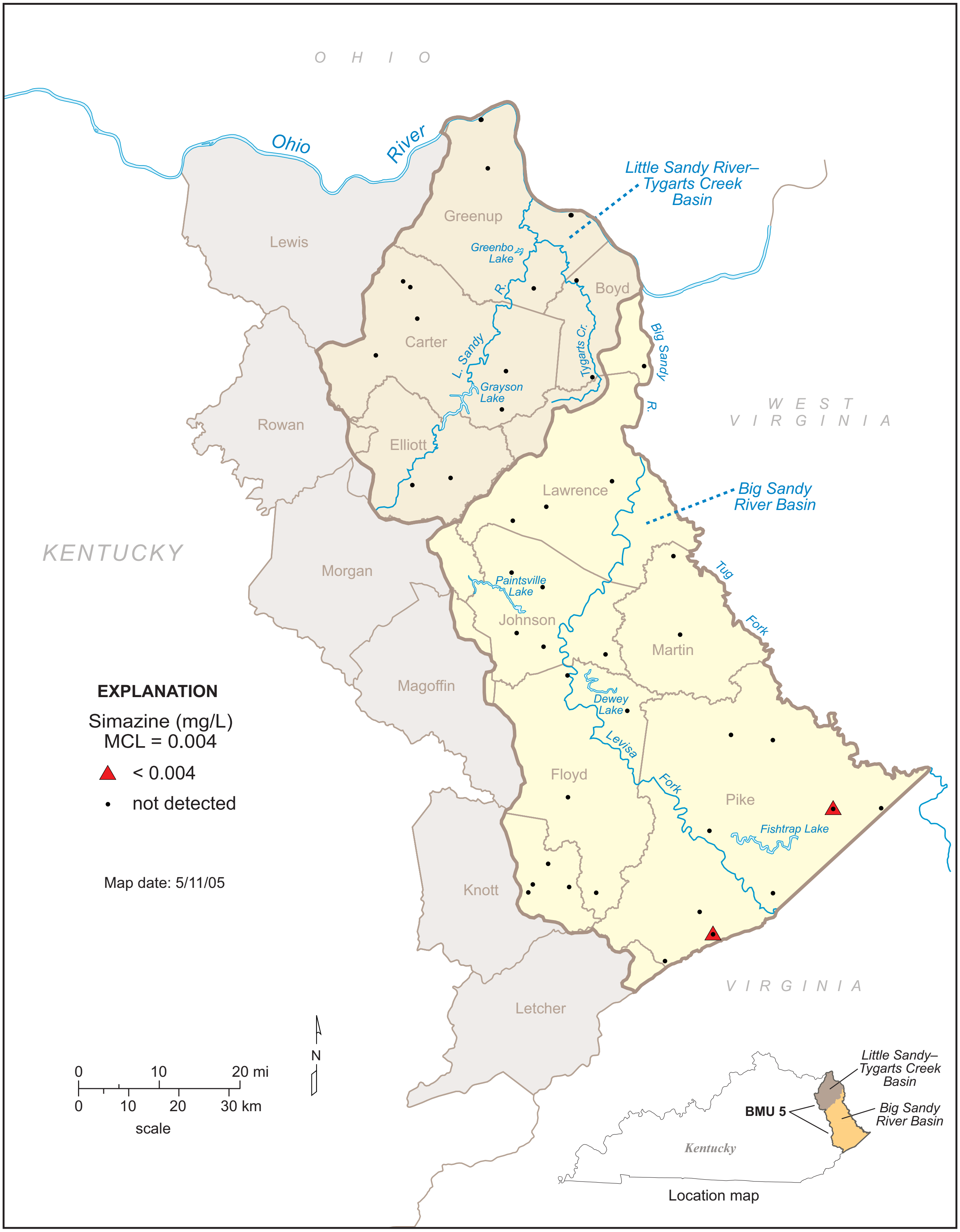

Figure 97. Locations of sampled sites and ranges of simazine values.