Volatile Organic Compounds

The volatile organic compounds benzene, ethylbenzene, toluene, and total xylenes are a group of chemicals characterized by a pale to colorless appearance, sweet odor, and high volatilization. They are used as solvents and in the production of plastics, rubber, and resins. They are also components of gasoline, and are most commonly introduced to the environment through spills from leaking gasoline storage tanks, fumes and exhaust from gas-powered engines, and runoff from gasoline- or oil-contaminated surfaces such as highways and parking lots. Local groundwater contamination from these compounds can also result from improper disposal of used oil. MTBE (methyl tertiary-butyl ether) is an oxygenate additive used to promote fuel combustion and reduce carbon monoxide and ozone emissions from vehicles. Releases to the environment are most commonly the result of leaking underground storage tanks and pipelines, other spills, and, to a lesser extent, from air deposition around refineries or urban areas.

VOC occurrences are not primarily controlled by bedrock geology, physiography, or river watershed, because VOC's are synthetic. Any detected amount of these refined volatile organic chemicals indicates groundwater contamination from human activities.

Volatile organic compounds may be present in groundwater at extremely low concentrations, and measurement techniques have improved over time. As a result, some older measurements in the data repository are reported only as less than a detection limit, where the detection limit is larger than some more recently measured values. In such cases, the maximum value reported in the following tables is the maximum value actually measured, not the value of the detection limit. For example, if two VOC analyses are reported as "< 0.02 mg/L" and "0.01 mg/L," the maximum value reported here would be 0.01 mg/L.

In addition to excluding groundwater-quality data from any sampling associated with underground storage tank investigations, all records from monitoring wells (identified by an AKGWA[1] number that begins with "8" (e.g., 80001234) were excluded from this report to ensure that locally contaminated sites are not skewing regional groundwater-quality trends. In the following discussions, summaries of potential sources and health effects of the selected pesticides were taken from the U.S. Environmental Protection Agency (2006, 2007).

Benzene. The most common sources of benzene in groundwater are leaks from underground gasoline storage tanks and landfills, and from improper disposal of oil and gasoline from domestic sources. Potential health effects include anemia, decrease in blood platelets, and increased risk of cancer. For these reasons, the EPA has established an MCL of 0.005 mg/L for benzene.

The data repository contained 127 benzene measurements from 72 sites in BMU 5 (Table 30). No sample exceeded the MCL; only two sites had groundwater with benzene concentrations greater than the analytical detection limit.

The sampled sites were widely but evenly distributed throughout BMU 5 (Fig. 98). Both sites where benzene was detected were in the Big Sandy watershed. Because benzene was detected at only two sites, the data were not analyzed further.

In summary, occurrences of benzene in groundwater were rare and isolated in BMU 5. No widespread pattern of benzene in groundwater was found. The presence of benzene at sites that were not considered locations of point-source releases, however, indicates that the groundwater system is being affected by this volatile organic chemical.

Table 30. Summary of benzene concentrations (mg/L). MCL=0.005 mg/L.

Number of values	127
Maximum	0.003
75th percentile	< 0.0005
Median	< 0.0005
25th percentile	< 0.0005
Minimum	< 0.0005
Interquartile range	na
Number of sites	72
Number of where detected	2
Number of sites > 0.005 mg/L	0

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

[1]Assembled Kentucky Ground Water Database

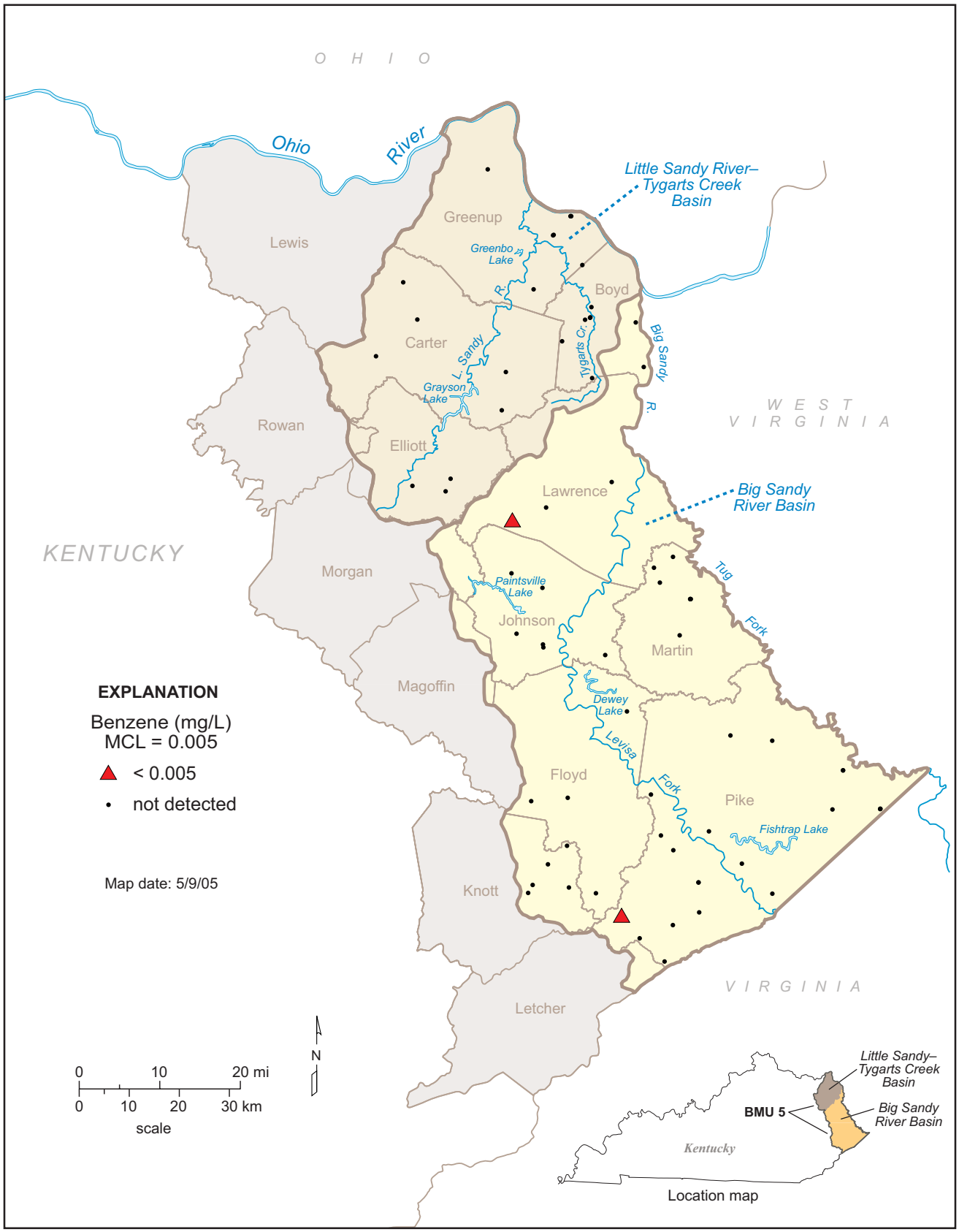

Figure 98. Locations of sampled sites and ranges of benzene values.

Ethylbenzene. Common sources of ethylbenzene are discharges from petroleum refineries and leaking underground gasoline storage tanks. Because ethylbenzene can have health effects such as liver or kidney damage, the EPA has set an MCL for ethylbenzene of 0.7 mg/L.

The data repository contained 127 ethylbenzene measurements at 72 sites in the project area (Table 31). Two sites produced detectable ethylbenzene; no samples exceeded the MCL.

The sampled sites were widely but evenly distributed throughout BMU 5 (Fig. 99). Both sites where ethylbenzene was detected were in the Big Sandy watershed. Because ethylbenzene was detected at only two sites, the data were not analyzed further.

In summary, detectable levels of ethylbenzene in groundwater are isolated and rare in the project area. No widespread pattern of ethylbenzene occurrence in groundwater was found. The presence of ethylbenzene at sites that were not considered locations of point-source releases, however, indicates that the groundwater system is being affected by this volatile organic chemical.

Table 31. Summary of ethylbenzene concentrations (mg/L). MCL=0.7 mg/L.

Number of values	127
Maximum	0.0045
75th percentile	< 0.0005
Median	< 0.0005
25th percentile	< 0.0005
Minimum	< 0.0005
Interquartile range	na
Number of sites	72
Number of where detected	2
Number of sites > 0.7 mg/L	0

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

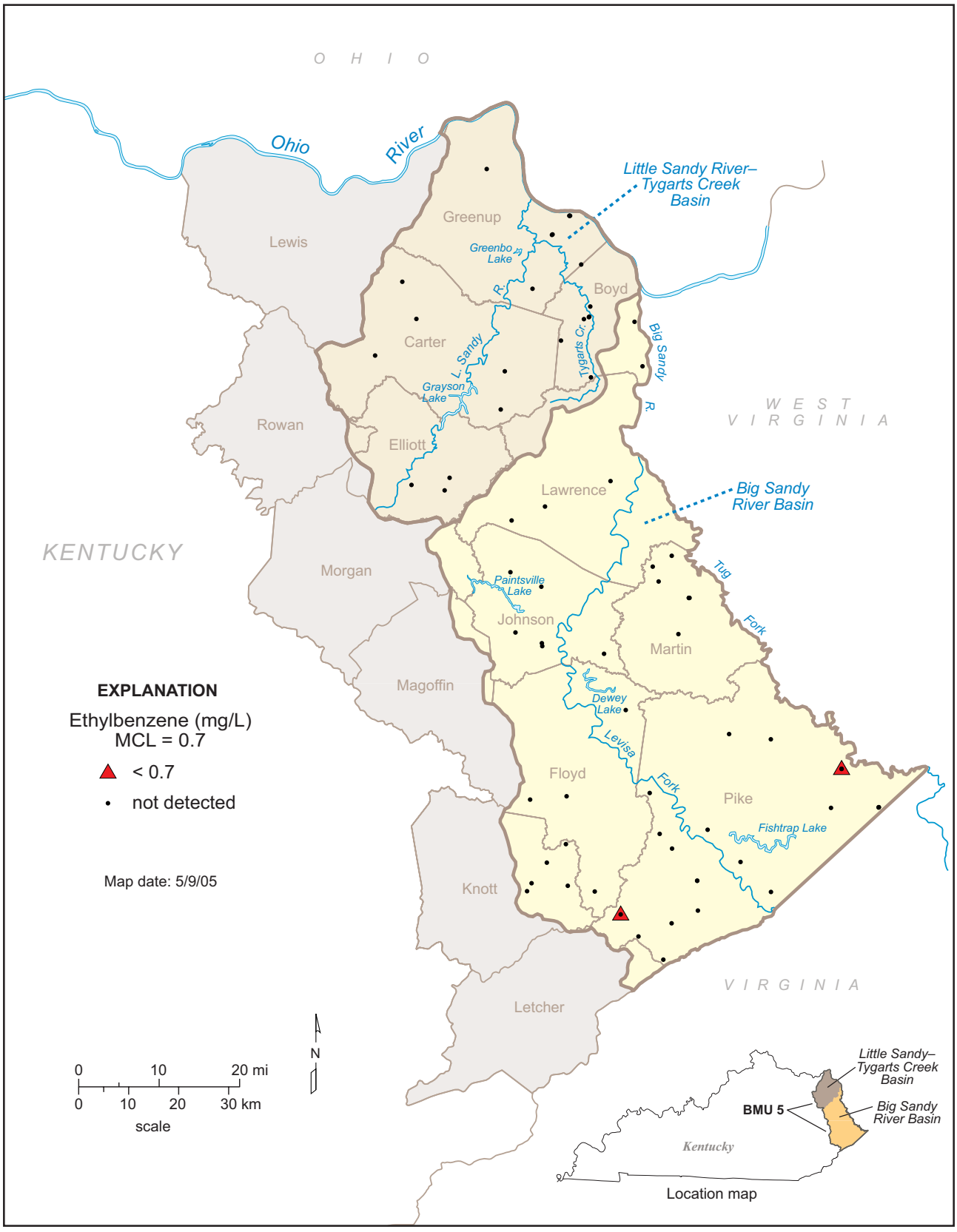

Figure 99. Locations of sampled sites and ranges of ethylbenzene values. Superimposed symbols indicate that values recorded at different sampling times fell into different ranges.

Toluene. Common sources of toluene in groundwater are discharge from petroleum refineries and leaking underground gasoline storage tanks. The potential health effects are damage to the nervous system, kidneys, or liver. The MCL for toluene is 1.0 mg/L.

The data repository contained 131 toluene measurements at 77 sites in the project area (Table 32). No values exceeded the MCL; nine sites yielded detectable toluene.

The samples sites were widely but evenly distributed throughout BMU 5 (Fig. 100). Sites where toluene was detected were not geographically close. Because toluene was detected at only nine sites, the data were not analyzed further.

In summary, like the other volatile organic chemicals, toluene was not commonly detected in groundwater in the project area. The presence of toluene at sites that were not considered locations of point-source releases, however, indicates that the groundwater system is being affected by this volatile organic chemical.

Table 32. Summary of toluene concentrations (mg/L). MCL=1.0 mg/L.

Number of values	131
Maximum	0.008
75th percentile	< 0.0005
Median	< 0.0005
25th percentile	< 0.0005
Minimum	< 0.0005
Interquartile range	na
Number of sites	77
Number of where detected	9
Number of sites > 1.0 mg/L	0

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

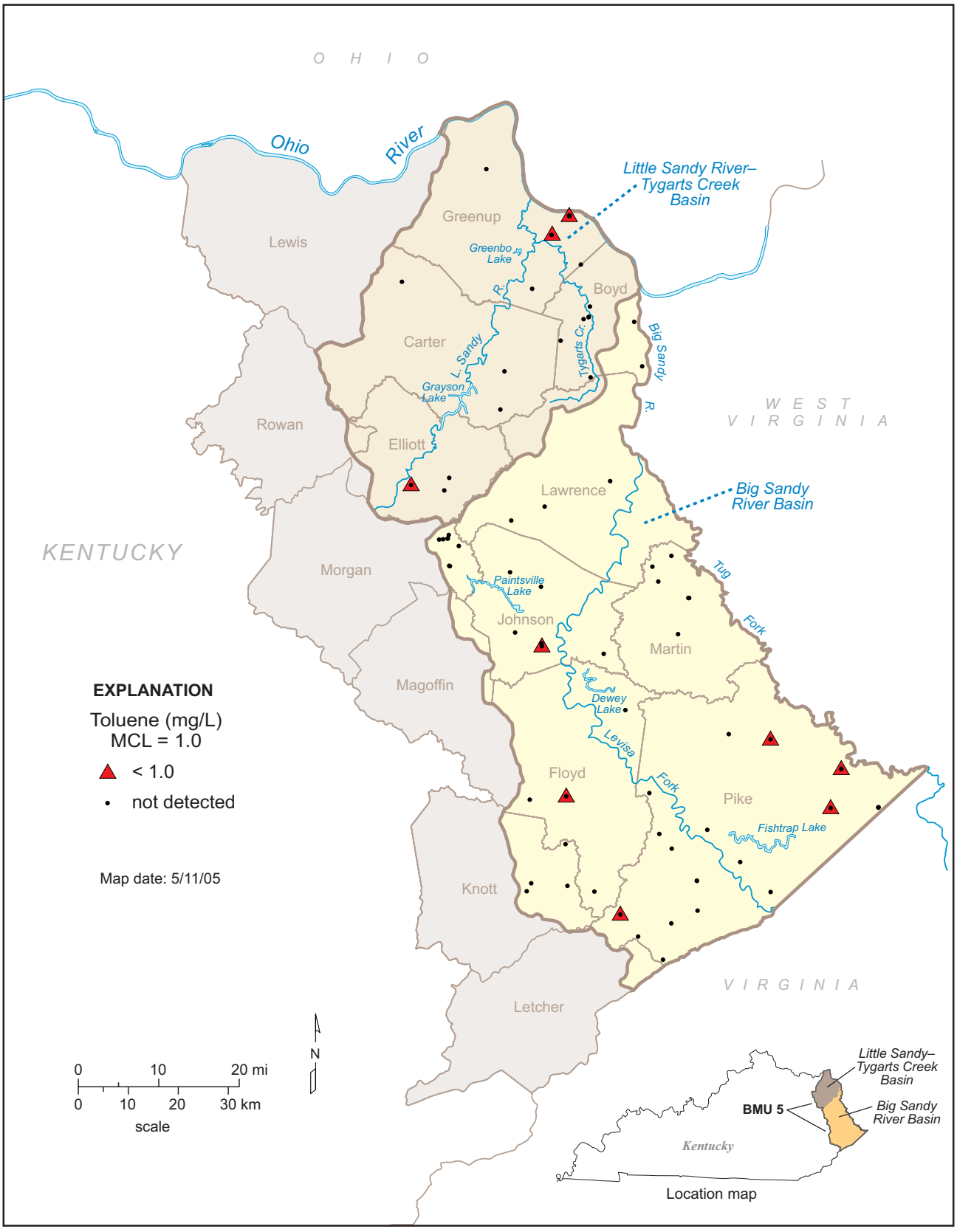

Figure 100. Locations of sampled sites and ranges of toluene values. Superimposed symbols indicate that values recorded at different sampling times fell into different ranges.

Xylenes. Xylenes in groundwater are usually the result of discharge from petroleum refineries or chemical factories, or leaking underground gasoline storage tanks. The primary health effect is damage to the nervous system. The MCL is 10 mg/L for the sum of O-xylene, P-xylene, and M-xylene.

Xylene analyses in the data repository are reported as "1,3-xylene & 1,4-xylene," "1,4-xylene," "M-xylene," "O-xylene," "P-xylene," "total xylene," "xylene," and "xylene mixed isomers." The data repository contained 115 such measurements at 45 sites in the project area (Table 33). No samples exceeded the MCL of 10 mg/L. Two sites produced detectable xylenes.

The sampled sites were widely but evenly distributed throughout BMU 5 (Fig. 101). Both sites where xylene was detected were in the Big Sandy watershed. Because xylene was detected at only two sites, the data were not analyzed further.

In summary, xylenes were detected at two widely separated sites. None of the groundwater samples had xylene concentrations above the established MCL. Xylene has no natural sources, however, so any detection in groundwater is an indication that volatile organic chemicals are entering the groundwater system.

Table 33. Summary of total xylenes concentrations (mg/L). MCL=10.0 mg/L.

Number of values	115
Maximum	0.0305
75th percentile	< 0.001
Median	< 0.0005
25th percentile	< 0.0005
Minimum	< 0.0005
Interquartile range	na
Number of sites	45
Number of where detected	2
Number of sites > 10.0 mg/L	0

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

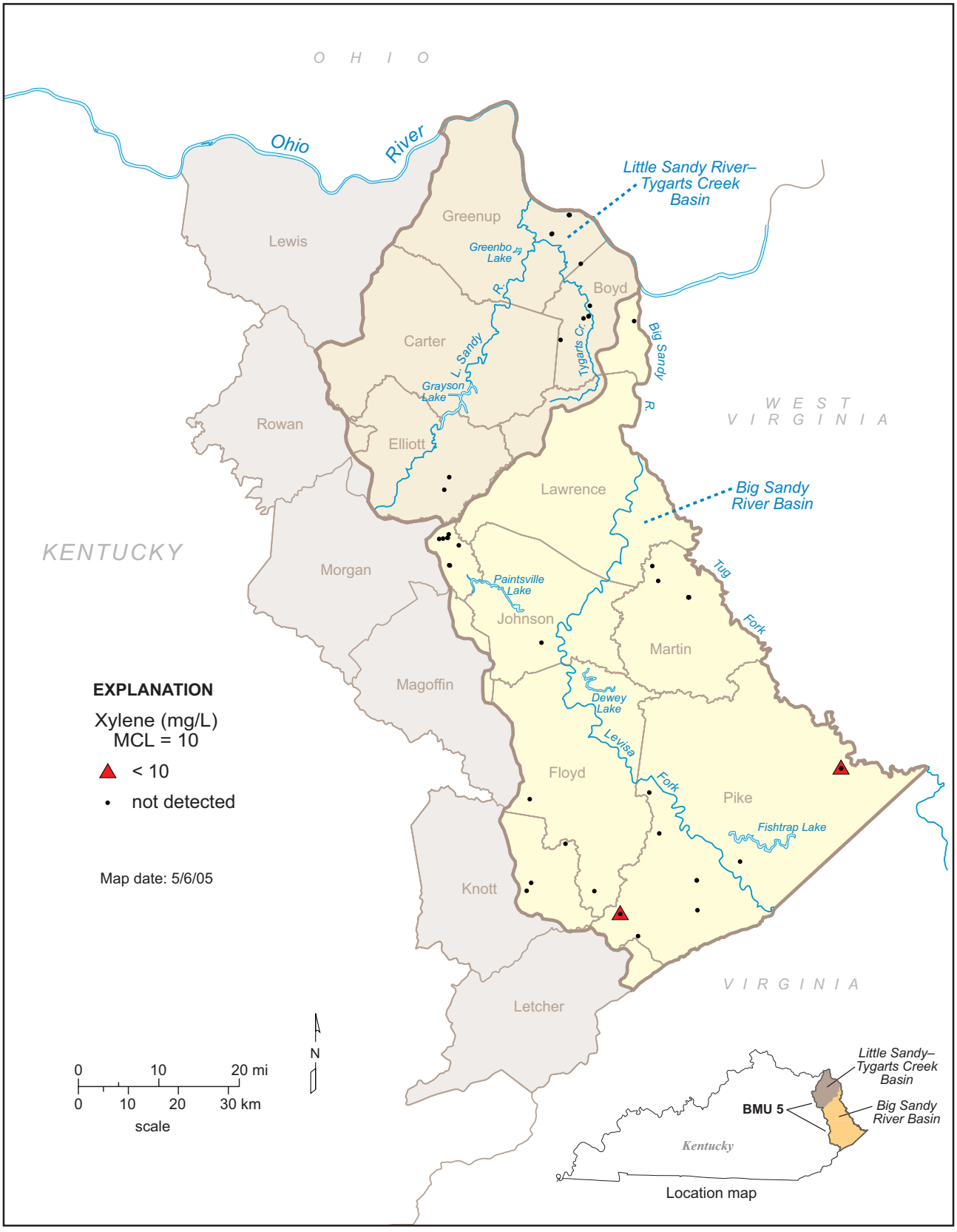

Figure 101. Locations of sampled sites and ranges of total xylenes values. Superimposed symbols indicate that values recorded at different sampling times fell into different ranges.

MTBE. MTBE (methyl tertiary-butyl ether) is a gasoline additive used to promote combustion and reduce emissions. The primary sources of MTBE in groundwater are leaks from gasoline storage tanks or gasoline spills; atmospheric fallout of exhaust gases is also a potential source. Potential health effects have not been established; however, the Division of Water has set a risk-based water-quality standard of 0.05 mg/L.

The data repository contained 138 MTBE measurements at 61 sites in BMU 5 (Table 34). No groundwater exceeded 0.05 mg/L; however, MTBE was detected at three sites in the Big Sandy watershed.

The sampled sites were widely but evenly distributed throughout BMU 5 (Fig. 102). Sites where MTBE was detected are in the far southern part of the Big Sandy watershed. Because MTBE was detected at only three sites, the data were not analyzed further.

In summary, MTBE generally does not occur at detectable levels in water from wells and springs in the project area. The presence of detectable MTBE at two sites shows that some contamination of groundwater is occurring, however.

Table 34. Summary of MTBE concentrations (mg/L). DOW recommendation=0.05 mg/L.

Number of values	138
Maximum	0.002
75th percentile	< 0.001
Median	< 0.001
25th percentile	< 0.001
Minimum	< 0.001
Interquartile range	na
Number of sites	61
Number of where detected	3
Number of sites > 0.05 mg/L	0

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

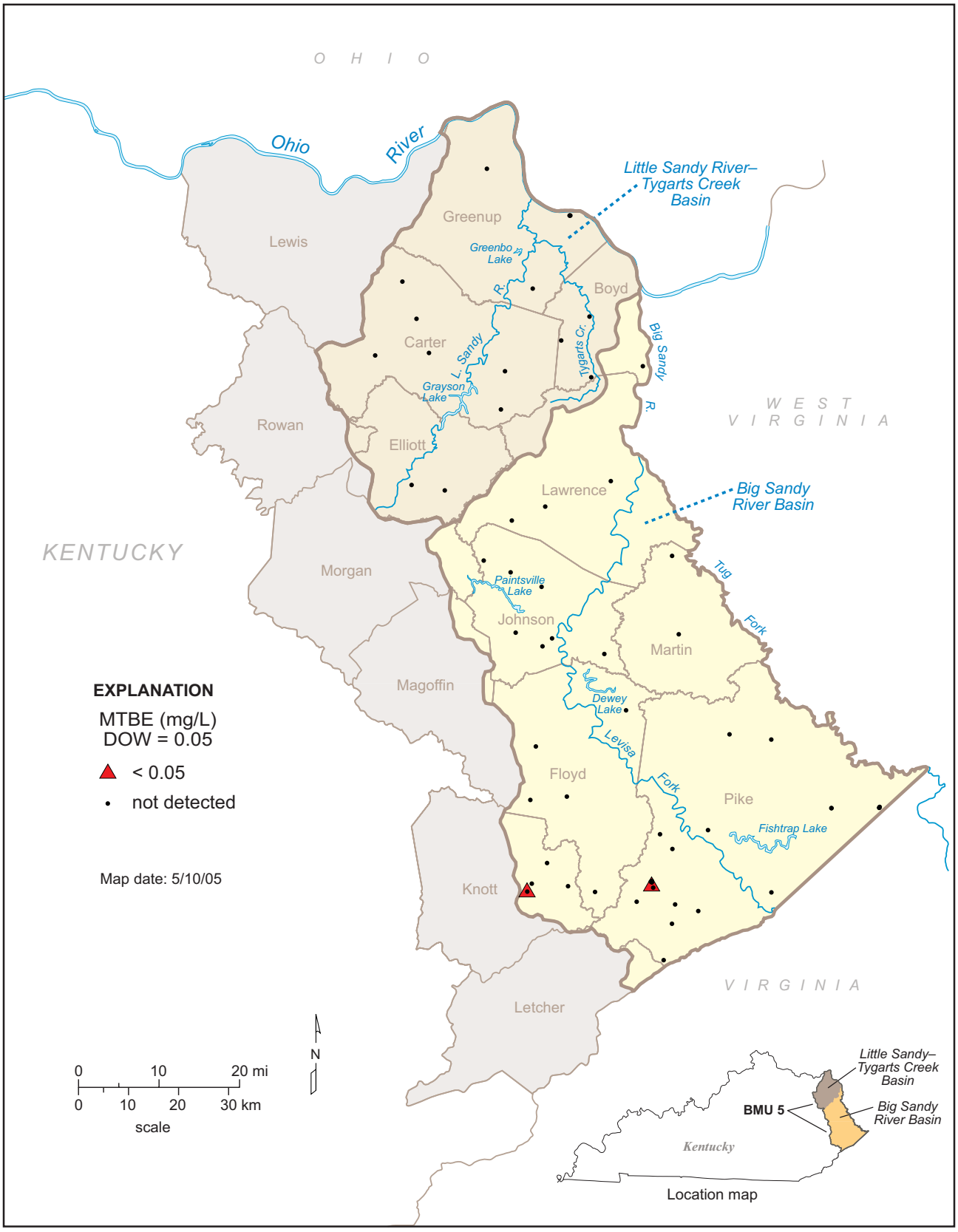

Figure 102. Locations of sampled sites and ranges of MTBE values. Superimposed symbols indicate that values recorded at different sampling times fell into different ranges.