

Volatile Organic Compounds

The volatile organic compounds benzene, ethylbenzene, toluene, and xylene can have serious health effects if they are consumed in drinking water. In addition, MTBE (methyl tert-butyl ether) is a compound of concern, although health threats have not yet been established. Any detected amounts of these refined volatile organic chemicals indicate groundwater contamination. VOC occurrences are not primarily controlled by bedrock geology, physiography, or major river watershed.

Volatile organic compounds may be present in groundwater at very low concentrations. 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 for the same well or spring. 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 MTBE analyses for a single site are “< 0.02 mg/L” at one time and “0.01 mg/L” at another time, the maximum value reported would be 0.01 mg/L.

Records from monitoring wells (identified by an AKGWA³ number that begins with “8”; e.g., 80001234) were excluded to avoid any wells drilled to test for leaking underground storage tank contamination. The following summaries of potential sources and health effects of the selected VOC's were taken from the EPA Web page, “Current Drinking Water Standards” (www.epa.gov/safewater/mcl/html) in June 2002.

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

The data repository contained 425 benzene measurements from 224 sites in BMU 3 (Table 29). Fifteen measurements at 10 sites were above analytical detection limits. Benzene concentrations exceeded the MCL at two sites.

Benzene was detected in groundwater in all physiographic regions except the Eastern Pennyroyal (Fig. 119). The two sites where benzene exceeded the MCL are in the Ohio River watershed of the Jackson Purchase (Fig. 119). The small number of measurements that exceed analytical detection limits precludes further data analysis. No relation between benzene concentration and well depth was observed; however, most samples were taken from springs, and few of the sampled wells had a depth recorded. The deepest well in which benzene was found at levels above analytical detection was 185 ft deep.

In summary, occurrences of detectable benzene in groundwater are rare in the project area. Springs are more susceptible to benzene contamination than wells; however, benzene was detected in a well that is 185 ft deep. The presence of detectable amounts of benzene in groundwater confirms some contamination by non-point sources or unidentified underground storage tanks.

Table 29. Summary of benzene values (mg/L).

Measurements	425
Maximum	0.01
75th percentile	< 0.001
Median	< 0.0005
25th percentile	< 0.0005
Minimum	< 0.0005
Interquartile range	na
Sites	224
MCL	0.005
Sites > 0.005	2

< means analytical result reported as less than the stated value

³ Assembled Kentucky Ground Water Database

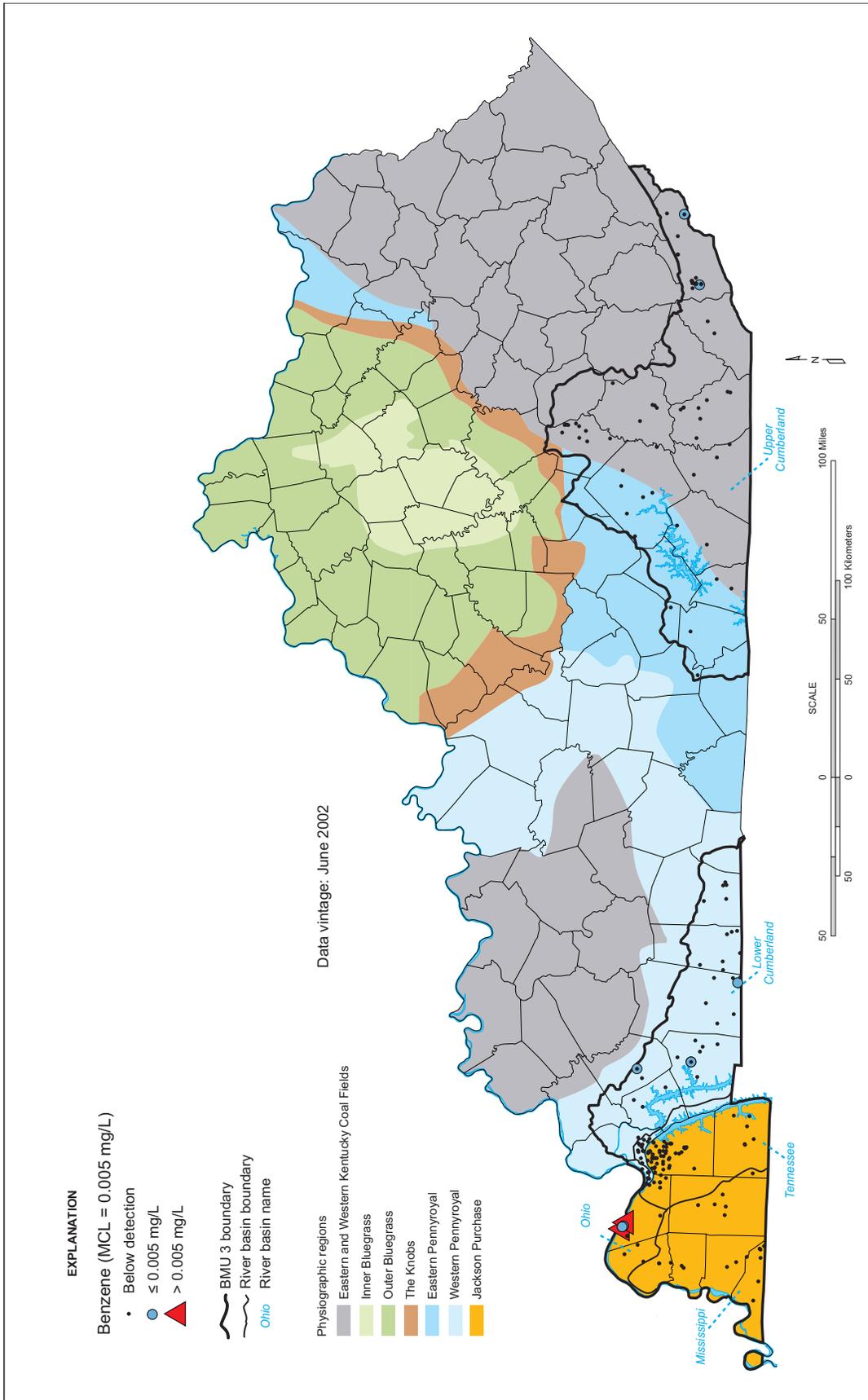


Figure 119. Sample sites and ranges of benzene values. Superimposed symbols indicate that values recorded at different sampling times fell into different ranges.

Ethylbenzene. Common sources of ethylbenzene are discharge from petroleum refineries and leaking underground gasoline storage tanks. The potential health effects include liver or kidney damage. The EPA has set an MCL for ethylbenzene of 0.7 mg/L.

The data repository contained 425 ethylbenzene measurements at 224 sites (Table 30). Ethylbenzene concentrations exceeded analytical detection limits at eight sites. Three of these are springs in the Lower Cumberland River watershed of the Western Pennyroyal Region; four are shallow (less than 60 ft deep) wells in the Ohio River watershed of the Jackson Purchase, and one is a well of unreported depth in the Upper Cumberland River watershed of Eastern Kentucky Coal Field. Ethylbenzene did not exceed the MCL in the project area (Fig. 120).

Table 30. Summary of ethylbenzene values (mg/L).

Measurements	425
Maximum	0.0706
75th percentile	< 0.001
Median	< 0.0005
25th percentile	< 0.0005
Minimum	< 0.0005
Interquartile range	na
Sites	224
MCL	0.7
Sites > 0.7	0

< means analytical result reported as less than the stated value

In summary, detectable levels of ethylbenzene in groundwater are rare in the project area and occur in both springs and shallow wells. The small number of occurrences precludes further data analysis. Any detection of ethylbenzene indicates some contamination of the groundwater resource, however.

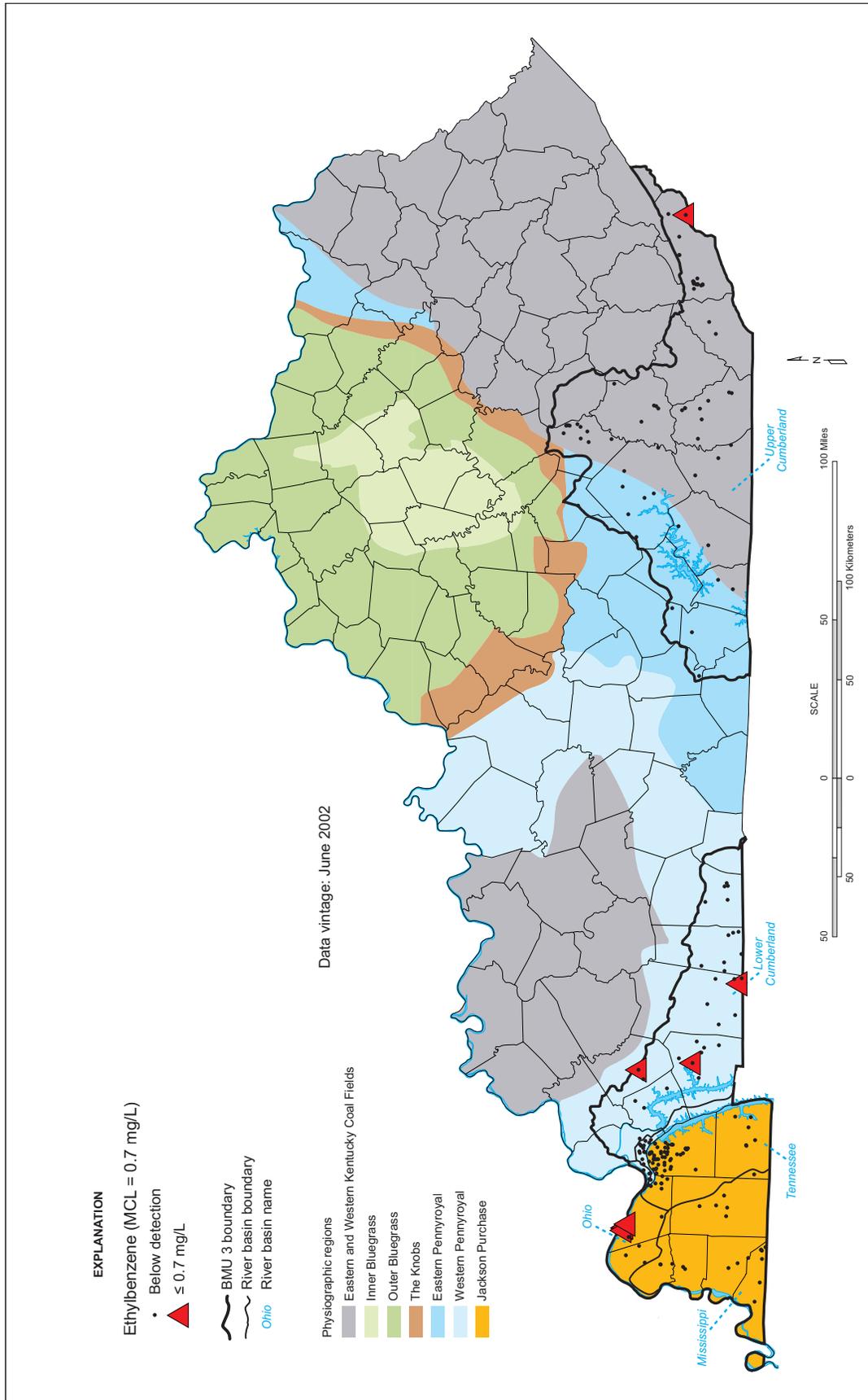


Figure 120. Sample sites and ranges of ethylbenzene values.

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 426 toluene measurements from 224 sites in the project area (Table 31). Fifteen of 426 measured concentrations in BMU 3 were above analytical detection limits; none exceeded the MCL. Toluene concentrations exceeded analytical detection limits at four springs and seven wells. Three of the springs where toluene was detected are in the Lower Cumberland River watershed of the Western Pennyroyal; one is in the Upper Cumberland River watershed of the Eastern Kentucky Coal Field (Fig. 121). Four of the wells where toluene was detected are in the Ohio River watershed of the Jackson Purchase, two are in the Mississippi River watershed of the Jackson Purchase, and one is in the Upper Cumberland River watershed of the Eastern Kentucky Coal Field. Three of these wells are less than 60 ft deep, two are deeper than 140 ft, and two have no depth recorded.

Table 31. Summary of toluene values (mg/L).

Measurements	426
Maximum	0.0100
75th percentile	< 0.001
Median	< 0.0005
25th percentile	< 0.0005
Minimum	< 0.0005
Interquartile range	na
Sites	224
MCL	1.0
Sites > 1.0	0

< means analytical result reported as less than the stated value

In summary, toluene (like the other volatile organic chemicals) has been detected in groundwater in the project area at a few sites. Toluene has entered the shallow groundwater system and probably the intermediate groundwater system, as evidenced by a detectable concentration in a 265-ft-deep well.

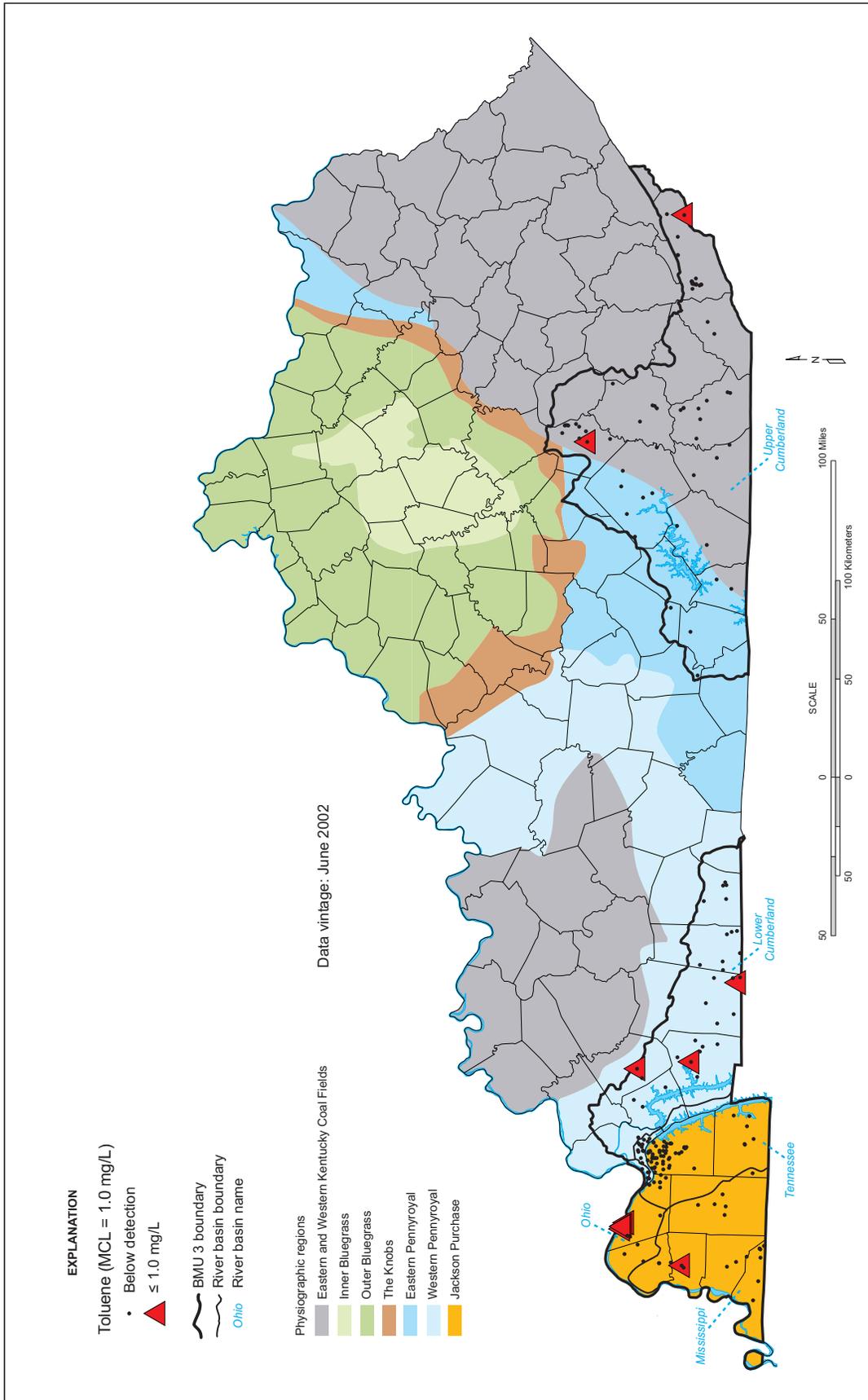


Figure 121. Sample sites and toluene values. Superimposed symbols indicate that values recorded at different sampling times fell into different ranges.

Xylenes (Total). 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.

The data repository contains 872 such measurements from 223 sites in BMU 3 (Table 32). Xylene analyses in the data repository are reported as "1,3-xylene and 1,4-xylene," "1,4-xylene," "M-xylene," "O-xylene," "P-xylene," "total xylene," "xylene," and "xylene mixed isomers." The variety of analyte names for xylene isomers in the data repository makes calculating total xylenes necessary at each site for a given sample collection.

Nineteen laboratory measurements for xylenes were above analytical detection limits; none were above the MCL. Nine sites had xylene concentrations greater than the analytical detection limit (Fig. 122). Of these, four are springs in the Lower Cumberland River watershed of the Western Pennyroyal, one is a spring in the Upper Cumberland River watershed of the Eastern Kentucky Coal Field, three are wells in the Ohio

Table 32. Summary of xylene values (mg/L).

Measurements	872
Maximum	< 0.5
75th percentile	< 0.001
Median	< 0.0005
25th percentile	< 0.0005
Minimum	0.000275
Interquartile range	na
Sites	223
MCL	10.0
Sites > 10.0	0

< means analytical result reported as less than the stated value

River watershed of the Jackson Purchase, and one is a well in the Upper Cumberland River watershed of the Eastern Kentucky Coal Field. Three of the wells have reported depths of less than 60 ft and one has no reported depth.

In summary, few sampled sites had total xylene concentrations that were above analytical detection limits. Springs and shallow wells are most likely to have detectable xylene levels, indicating that the shallow groundwater system has been affected in some areas.

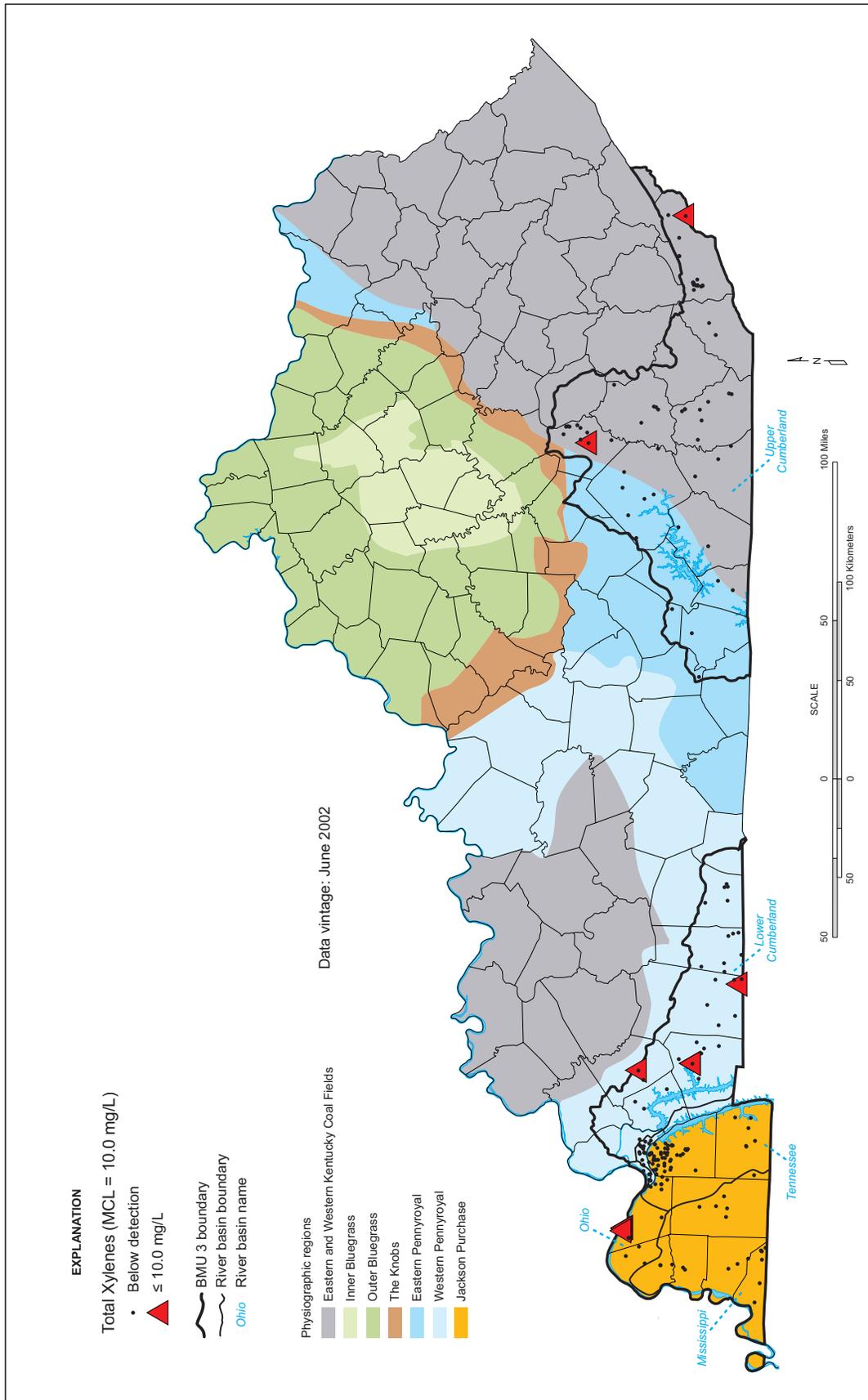


Figure 122. Sample sites and total xylene values. Superimposed symbols indicate that values recorded at different sampling times fell into different ranges.

MTBE (methyl tertiary-butyl ether). MTBE 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. Potential health effects have not been established; however, the Division of Water has set a risk-based water-quality standard of 0.050 mg/L.

The data repository contained 329 MTBE measurements at 106 sites in BMU 3 (Table 33). Seven of the reported values were greater than analytical detection limits; none exceeded the Division of Water-recommended level of 0.050 mg/L. MTBE exceeded the DEP recommended value at two springs and one well of unrecorded depth in the Lower Cumberland River watershed of the Western Pennyroyal, and one well of unrecorded depth in the Upper Cumberland River watershed of the Eastern Kentucky Coal Field (Fig. 123).

In summary, MTBE generally does not occur at detectable levels in water from wells and springs in the project area. Three of the four sites where MTBE was detected are springs or shallow wells in the carbonate, karst terrain of the Western Pennyroyal Region.

Table 33. Summary of MTBE values (mg/L).

Measurements	329
Maximum	0.00689
75th percentile	< 0.001
Median	< 0.001
25th percentile	< 0.001
Minimum	0.00051
Interquartile range	na
Sites	106
DOW recommended value	0.05
Sites > 0.05	0

< means analytical result reported as less than the stated value

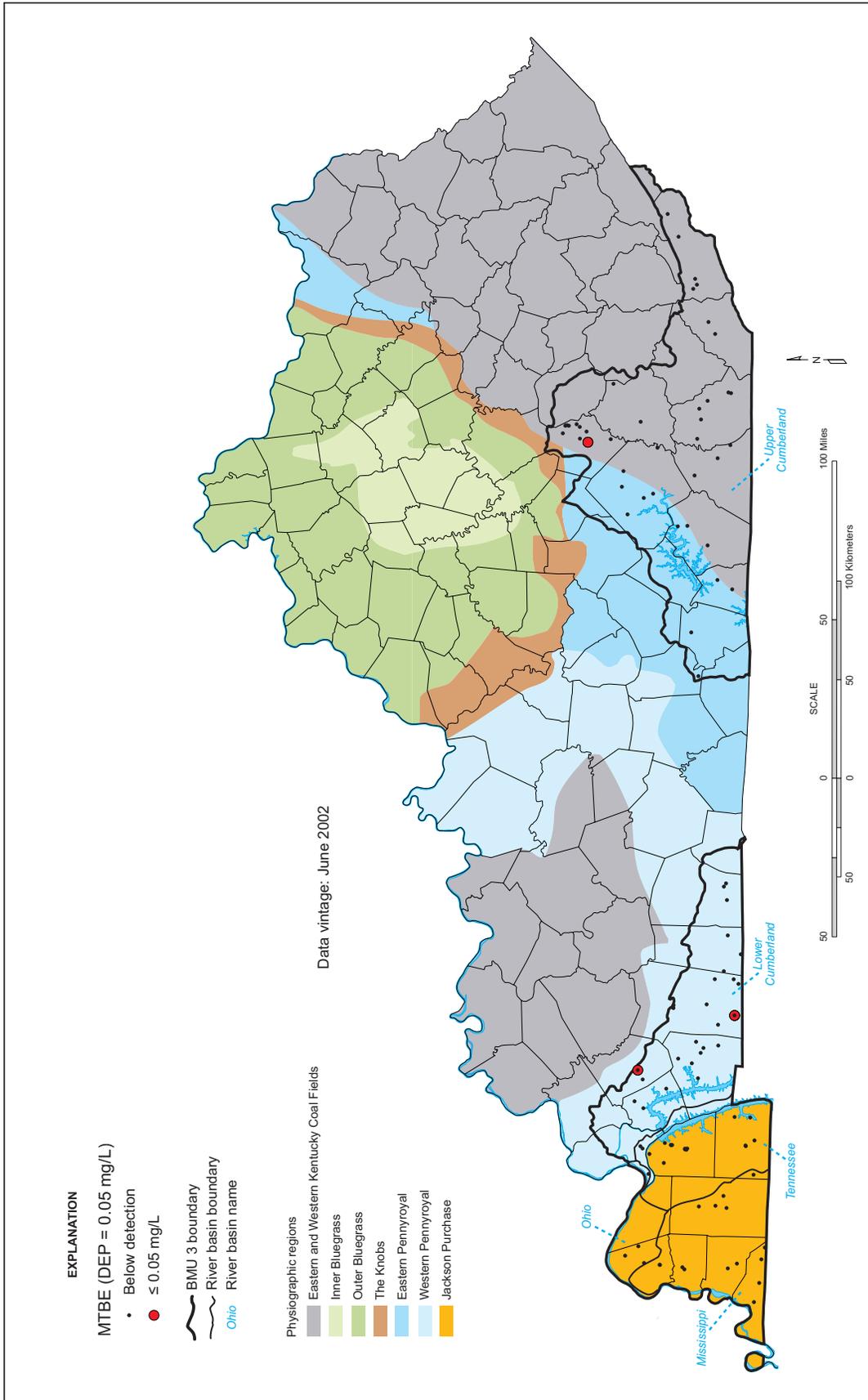


Figure 123. Sample sites and MTBE values. Superimposed symbols indicate that values recorded at different sampling times fell into different ranges.