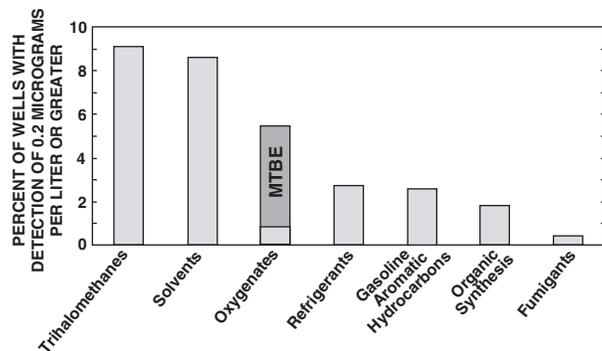


MTBE and other volatile organic compounds—New findings and implications on the quality of source waters used for drinking-water supplies

How frequently are VOCs detected in ground water?

Volatile organic compounds (VOCs), which are widely used in the manufacture of many products including refrigerants, plastics, adhesives, paints, and petroleum products, have been detected in about one-third of the wells sampled by the National Water-Quality Assessment (NAWQA) Program of the U.S. Geological Survey (USGS).¹ Chloroform and other trihalomethanes, the most commonly detected compounds, were found in about 9 percent of the sampled wells. Solvents, particularly chlorinated solvents, were found in about 8 percent of sampled wells. VOCs predominantly occur in urban areas, often in mixtures; specifically, 2 or more compounds were found in about one quarter of the sampled urban wells.

A commonly detected VOC is methyl *tert*-butyl ether (MTBE), which is a gasoline oxygenate designed to add oxygen to decrease vehicular carbon monoxide emissions and ozone levels in the atmosphere. MTBE has the highest production volume of all fuel oxygenates.



Trihalomethanes, solvents, and gasoline oxygenates are the most commonly detected volatile organic compounds in ambient ground water.

How often is MTBE detected in ground water?

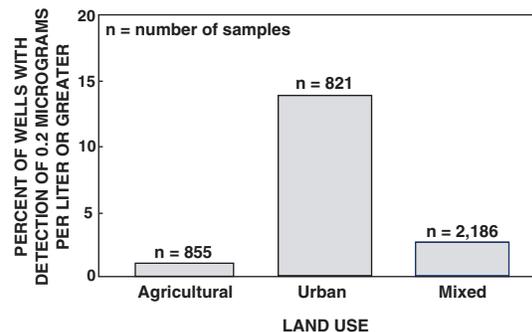
MTBE was detected in about 5 percent of ground-water samples collected by NAWQA across the Nation. The concentrations typically were low, well below the U.S. Environmental Protection Agency (EPA) drinking-water consumer advisory concentra-

¹ Detection does not necessarily translate to risk. The NAWQA Program measures chemicals at very low concentrations, often 10 to 100 times lower than EPA standards and health advisories. For example, the detection frequency for MTBE is based on an assessment level of 0.2 micrograms per liter, which is 100 times lower than EPA's drinking-water consumer advisory. Low-concentration sampling is used to detect and evaluate contaminants of concern, to track contaminant concentrations over time, and to determine natural and human factors related to chemical occurrence.

tion of 20 to 40 micrograms per liter, which is based on taste and odor thresholds. In fact, less than 1 percent of samples included in the USGS studies exceeded the EPA consumer advisory concentration of 20 micrograms per liter. Still uncertain, however, are possible human health effects. EPA has tentatively classified MTBE as a possible human carcinogen, but because of insufficient toxicity studies has not instituted a drinking-water health advisory or standard. EPA is using NAWQA findings, along with other investigations and research, to investigate possible drinking-water and human-exposure issues.

Where is MTBE most likely found?

NAWQA findings indicate that MTBE is most frequently detected in ground water underlying urban areas in comparison to agricultural and mixed land-use settings. MTBE was detected in about 14 percent of wells sampled in urban areas. In addition, incidence of MTBE increases in high-use areas. Most of MTBE's high use occurs in Reformulated Gasoline (RFG) areas, where gasoline contains 11-percent MTBE by volume. MTBE has been detected about 4 to 6 times more frequently in the high-use areas than elsewhere.



The detection frequency of MTBE in ambient ground water is highest in urban land use.

Is MTBE in drinking water?

In addition to its studies of ambient ground water, USGS is conducting focused studies to assess MTBE concentrations associated with drinking-water supplies. In cooperation with EPA's Office of Ground Water and Drinking Water, USGS examined data on finished drinking water from selected communities in 12 states in the Northeast and Mid-Atlantic Regions. The data show that MTBE was detected in 9 percent of the community water systems. Consistent with USGS studies of ambient ground water, concentrations were low; less than 1 percent exceeded the EPA consumer advisory concentration.

USGS presently is conducting a special study of source waters used for community drinking-water systems. This 4-year study, currently in its last year, is being performed in cooperation with the Metropolitan Water District of Southern California, the Oregon Graduate Institute of Science and Environmental Engineering, and the American Water Works Association Research Foundation (AWWARF), and includes about 1,000 water utilities across the Nation. Findings are consistent with previous NAWQA studies. Specifically, MTBE has been detected in low concentrations, and less than 1 percent of the samples exceed the EPA consumer advisory concentration. This study, which includes samples of both surface-water and ground-water sources for drinking water, shows that MTBE was detected more frequently in surface-water samples (14 percent) than in ground-water samples (5 percent). This finding can be explained, in part, by the inclusion of many samples from large rivers and reservoirs that are associated with substantial use of recreational watercraft. Older models of watercraft motors are known to release a fraction of non-combusted gasoline to water.

Increased occurrence of MTBE in large community water systems is also reported in this study. Specifically, MTBE was detected in about 4 percent of community water systems serving less than 10,000 people, and in nearly 15 percent of systems serving greater than 50,000 people. Wells providing drinking water for the larger community water supplies often are co-located in urbanized settings, which are associated with a higher incidence of MTBE. In addition, rates and amounts of pumping likely play a role because increased pumping rates draw water from extended areas, which thereby increases the likelihood of intercepting a source of MTBE.

Significance of findings

- MTBE was detected in ground water and drinking water at low concentrations, typically at lower concentrations than the EPA drinking-water consumer advisory concentration for taste and smell. Less than 1 percent of the samples exceeded the concentration in this advisory. Toxicity studies are not complete, however, and human health issues, including non-carcinogenic and carcinogenic effects, have not been clearly outlined. As a result, there is a continued need to monitor and assess the presence of MTBE as the Nation moves forward with the development of a health advisory and water-resource strategies that reflect the occurrence and distribution of MTBE.
- The distribution of MTBE contamination is not uniform. For example, the frequency of MTBE detection increases with its use, which is typically associated with urban and populated areas. MTBE has been detected in about 1 out of 5 wells in MTBE high-use areas. These findings suggest that continued routine monitoring of this chemical is needed for drinking-water supplies, especially in the MTBE high-use areas.
- Some areas are more vulnerable to MTBE contamination than others. For example, the frequency of detecting MTBE increases with larger community water systems, specifically those serving greater than 50,000 people. The difference in vulnerability is, in part, attributed to natural features, land use, and human activities, such as pumping and watercraft usage.

This type of information is essential in the prioritization and development of source-water and drinking-water protection strategies, and in optimal and cost-effective delivery of water.

Future directions and needs

- *Sources:* Both point and nonpoint sources contribute to MTBE contamination. Improvements in management of this chemical will depend on increased knowledge of the different sources. Key questions include: What are the relative contributions of point sources, such as leaking tanks, compared to nonpoint sources, such as those related to stormwater runoff, watercraft, vehicular use, and the atmosphere? Do existing pollution abatement programs adequately address all of the important sources of MTBE to ground water and surface water?
- *Aquifer vulnerability and transport:* Because of the complex nature and slow rate of ground-water flow, and the high solubility and mobility of MTBE, the future distribution patterns of this relatively new chemical, representing only about 10 to 15 years of use, is unknown. A greater understanding is needed of its transport in different aquifers and environmental settings under various pumping scenarios before its presence in future drinking-water supplies can be fully anticipated. Differences in natural factors, such as soils, geology, hydrology, and water chemistry, can result in very different degrees of aquifer vulnerability to contamination and in different rates at which improved management can lead to lower incidence of contamination. Key questions include: What factors control the transport of MTBE as it moves from its sources, such as an underground tank, to shallow ground water and to underlying deeper aquifers? What affects the degree and timing of its occurrence in drinking-water supplies?

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Technical information supporting this fact sheet, as well as access to other NAWQA publications, data, and maps, are provided on the Internet at:

<http://wwwsd.cr.usgs.gov/nawqa/vocns/>

Information on the objectives and scope of the NAWQA Program is provided on the Internet at:

<http://water.usgs.gov/nawqa>

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