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NATIONAL WATER-QUALITY ASSESSMENT PROGRAM, NATIONAL SYNTHESIS ON VOLATILE ORGANIC COMPOUNDS in cooperation with the U.S. Environmental Protection Agency, Office of Ground Water and Drinking Water

Occurrence and Distribution of Volatile Organic Compounds in Drinking Water Supplied by Community Water Systems in the Northeast and Mid-Atlantic Regions of the United States, 1993-98

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Data on volatile organic compounds (VOCs) in drinking water supplied by community water systems (CWSs) are available for 12 Northeast and Mid-Atlantic States from 1993-98. The data are from 2,110 CWSs representing a 20 percent random selection of the total 10,749 active CWSs in the region. The data were collected for compliance monitoring under the Safe Drinking Water Act from both surface- and ground-water sources and largely represent samples of finished drinking water collected prior to distribution. Overall, 39 percent of the 2,110 randomly selected CWSs reported a detection of one or more VOCs at or above 1.0 µg/L (micrograms per liter).

Although differences in analytical coverage complicate comparisons, in the 1,543 CWSs with THM data at or above 1.0 µg/L, 42 percent reported an occurrence of one or more THMs. The common detection of THMs in finished drinking water probably is related to their formation through the chlorination of drinking-water supplies. Comparatively, solvents, the next most frequently detected VOC group, were reported in 9.8 percent of 2,097 CWSs with solvent data at or above 1.0 µg/L, and gasoline components were detected in 9.0 percent of 2,098 CWSs with data at or above 1.0 µg/L.

Individually, the THMs—chloroform, bromodichloromethane, chlorodibromomethane, and bromoform—were the most frequently detected VOCs ranging from 33 to 8 percent. The most frequently detected non-THM compound was methyl tert-butyl ether, which was identified in 8 percent of CWSs. Of the 2,110 randomly selected CWSs, 6 percent had at least one sample with one or more VOCs with a concentration above a Maximum Contaminant Level, Health Advisory, or Drinking-Water Advisory.

VOCs were more frequently detected in drinking water from systems that are supplied by surface-water sources, or both surface- and ground-water sources, than in systems that are supplied exclusively by ground water, and from systems serving very large and large populations (serving >3,300 people) compared to systems serving medium and small populations (serving ≤3,300 people).

Introduction

Identifying and understanding the occurrence of volatile organic compounds (VOCs) in drinking water is important. Contamination of drinking-water supplies by VOCs is a human health concern because many are toxic or are known or suspected human carcinogens (U.S. Environmental Protection Agency, 2000). The occurrence of VOCs in surface- and ground-water resources is widespread (Delzer and others, 1996; Lopes and Dionne, 1998; Squillace and others, 1999; Lopes and others, 2000) and the occurrence of VOCs in public drinking water has been noted for some time (Westrick and others, 1984). In a recent national survey of community water systems (CWSs), 38 percent of CWSs identified VOCs as potential contaminants in their source waters (U.S. Environmental Protection Agency, 1997). In that same survey, 23 percent of CWSs with exclusively surface-water sources and 27 percent of CWSs with exclusively ground-water sources indicated that they used some type of treatment in at least one facility to remove organic contaminants (U.S. Environmental Protection Agency, 1997).

Under the Safe Drinking Water Act (SDWA), the U.S. Environmental Protection Agency (USEPA) has established Maximum Contaminant Levels (MCLs) for 21 VOCs in drinking water supplied by CWSs. Drinking water supplied by CWSs is required to be monitored for compounds with MCLs. The data from the compliance monitoring of CWSs provide an important resource of information on the occurrence and distribution of both regulated and unregulated VOCs in drinking water from surface- and ground-water sources.

The primary purpose of this fact sheet is to describe the occurrence and distribution of VOCs in public drinking water. To achieve this, the U.S. Geological Survey (USGS), in cooperation with the USEPA, Office of Ground Water and Drinking Water, conducted an assessment of the quality of drinking water from CWSs in 12 Northeast and Mid-Atlantic States. The Northeast and Mid-Atlantic regions were selected for this study because they are generally highly populated, have a long-term history of urbanization, and are areas with high use of public water supply. The samples were collected during 1993-98 to meet the requirements of the SDWA and primarily represent finished drinking water collected prior to distribution. Information provided here on the occurrence and distribution of VOCs in drinking water within the study area summarizes a more comprehensive report by Grady and Casey (2001).

Design Approach and Data Set

The number, size, source, and location (by State) of CWSs selected for this study represented the actual distribution of CWSs in the region. A stratified random design was chosen to select the systems to be included in the data inventory, review, and analysis (Grady and Casey, 1999). This design allowed for a statistical comparison of data by State,

Table 2. Volatile organic compounds that equaled or exceeded regulated or recommended maximum concentrations in drinking water from randomly selected community water systems in the study area, 1993-98

[µg/L, micrograms per liter; MCL, Maximum Contaminant Level; HA, Health Advisory; DWA, Drinking-Water Advisory; CWSs, community water systems]

Volatile organic compound	Drinking-water regulation or recommended maximum concentration		Number of CWSs reporting concentrations that equaled or exceeded value
	Value, in µg/L	Type	
Total trihalomethanes	100	MCL	46
Tetrachloroethene	5	MCL	32
Trichloroethene	5	MCL	25
Chloromethane	3	HA	11
Methyl *tert*-butyl ether	20	DWA (lower limit)	10
Dichloromethane	5	MCL	8
1,1-Dichloroethene	7	MCL	6
1,2-Dibromoethane	0.05	MCL	5
Chloroethene	2	MCL	4
Dibromochloropropane	0.2	MCL	3
1,2-Dichloropropane	5	MCL	3
Benzene	5	MCL	2
1,2-Dichloroethane	5	MCL	2
cis-1,2-Dichloroethene	70	MCL	2
1,1,2,3,4,4-Hexachloro-1,3-butadiene	1	HA	1
Tetrachloromethane	5	MCL	1

Conclusions and Implications

The detection of VOCs at or above 1.0 µg/L in water supplied by CWSs was fairly common. The frequent detection of THMs as a group and as individual compounds is not surprising considering that many CWSs use chlorination for disinfection of drinking water. However, other anthropogenic or natural sources could be responsible for at least some of the concentrations of these compounds detected in drinking water. Further work may help to clarify the potential contribution of THMs from other sources and lead to a better understanding of their transport to drinking-water wells. Compounds in groups that are commonly used such as solvents and gasoline components were frequently detected. The frequent detection of MTBE was related to its common use as a fuel oxygenate in the regions. Because some drinking water has been affected by the occurrence of VOCs from various groups, it would be beneficial for purveyors of drinking water to consider strengthening or enhancing plans for protecting source waters from contamination, in addition to treatment, as a means of further enhancing the quality of drinking water. Although only a relatively small percentage of CWSs had one or more samples with a concentration of a VOC above a health standard, some compounds such as total THMs, tetrachloroethene, and trichloroethene exceeded standards fairly frequently. Because health standards or criteria have been exceeded in some drinking water, a better understanding of the sources, transport, and receptors of VOCs that exceed these values would help in developing plans for better protecting source waters from contamination.

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