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Occurrence of Volatile Organic Compounds in Selected Urban Streams in the United States, 1995–2003

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Study basics

The U.S. Geological Survey's National Water-Quality Assessment (NAWQA) Program sampled 37 urban streams throughout the United States for volatile organic compounds (VOCs) from 1995 to 2003. These urban streams were selected to (1) characterize stream water quality from areas draining predominantly residential and commercial land uses and (2) determine which natural and human factors affect stream quality. Initial interpretation of the VOC data set is focused on determining which VOCs commonly are found, the range of concentrations, and the temporal distribution (Lopes and Price, 1997).

The 37 urban streams sampled had drainage areas that ranged from 23 to 13,000 square kilometers with a median of 71 square kilometers. The urban streams are located in eight major surface-water regions within the conterminous United States, Alaska, and Hawaii. The urban streams were sampled for VOCs monthly for about 1 year with some storm samples collected at selected sites (Lopes and Price, 1997). A total of 869 samples (410 samples in the warmer months and 459 samples in the cooler months) were collected and were analyzed for 85 individual VOCs. Data are available at *http://infotrek.er.usgs.gov/pls/nawqa/nawqa.home*

Site selection criteria

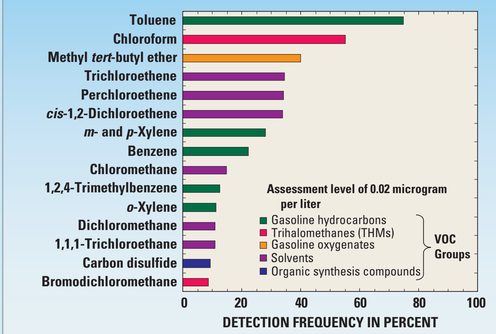
- Urban stream located in a metropolitan statistical area with a population greater than 250,000.
- Urban stream located in a NAWQA study unit.
- Urban stream that has sustained flow and well defined drainages.
- Urban stream that has minimal or no point-source discharges.
- Urban stream that predominantly drains residential/commercial land use.

General findings

- One or more of 85 VOCs were detected in about 89 percent of samples in warmer months (April through September) and in about 95 percent of samples in cooler months (October through March).
- A median of 5 VOCs were detected in warmer months, and 7 VOCs were detected in cooler months.

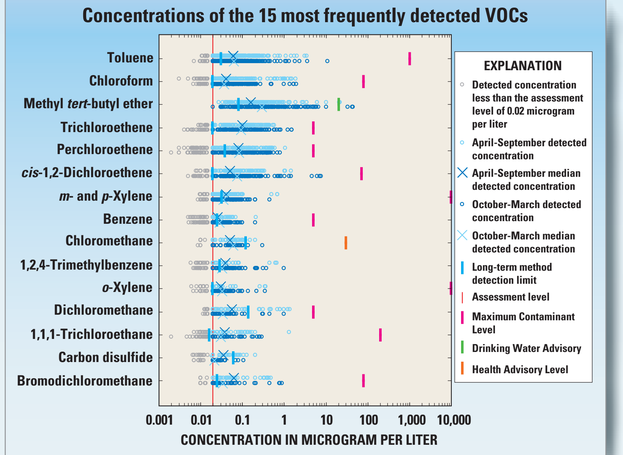
- **Fifty-six different VOCs were detected in urban streams at an assessment level of 0.02 microgram per liter.**
- **Thirteen VOCs had detection frequencies greater than 10 percent.**
- **The 15 most frequently detected compounds are from five predominant use/source groups (gasoline hydrocarbons, trihalomethanes (disinfection by-products), gasoline oxygenates, solvents, and one organic synthesis compound).**

Fifteen most frequently detected VOCs at an assessment level of 0.02 microgram per liter

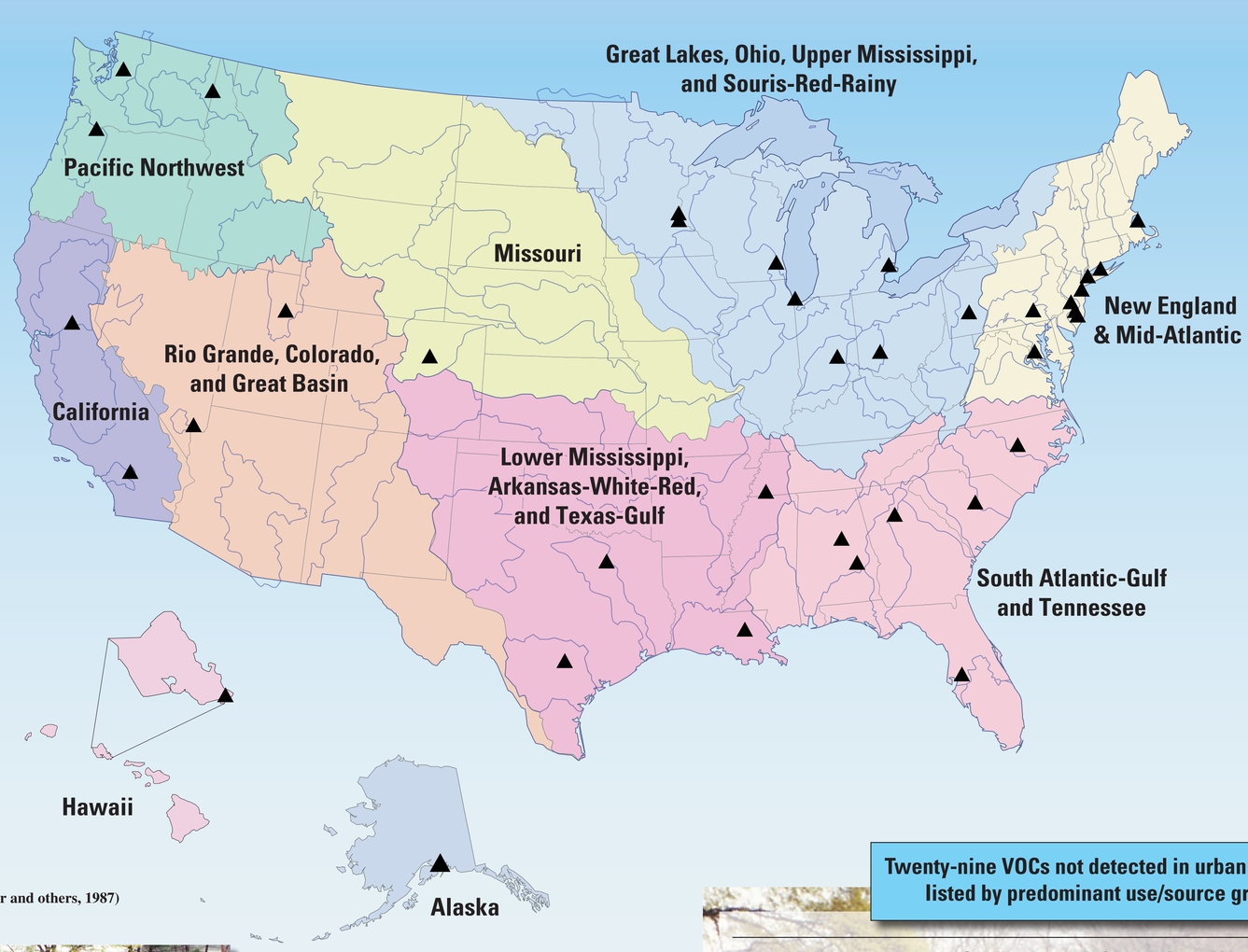


- **Concentrations were typically less than 1 microgram per liter.**
- **No concentrations were larger than U.S. Environmental Protection Agency's (USEPA) Maximum Contaminant Levels (U.S. Environmental Protection Agency, 2004).**
- **Methyl *tert*-butyl ether had some concentrations larger than the lower limit of USEPA's Drinking Water Consumer Advisory of 20-40 micrograms per liter (U.S. Environmental Protection Agency, 2004).**

Concentrations of the 15 most frequently detected VOCs



National Map Showing Urban Stream Sites in Major Surface-Water Regions

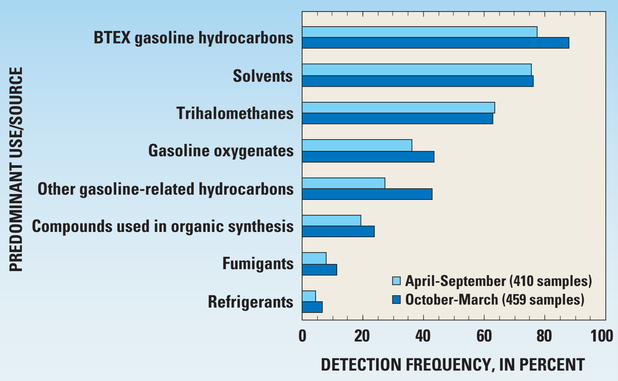


(from Seaber and others, 1987)

Aberjona River, Winchester, Massachusetts. (Photograph by K.W. Campo, U.S. Geological Survey)

- **BTEX (benzene, toluene, ethylbenzene, and xylenes), other gasoline-related hydrocarbons, and gasoline oxygenates were detected more frequently in cooler months.**
- **Compounds used in organic synthesis, fumigants, and refrigerant compounds also were detected more frequently in cooler months.**
- **Solvents and trihalomethanes did not differ markedly between the warmer and cooler months.**

Detection frequency of VOC predominant use/source groups at an assessment level of 0.02 microgram per liter



Twenty-nine VOCs not detected in urban streams listed by predominant use/source group

Fumigants	Gasoline hydrocarbon	Compounds used in organic synthesis	Solvents
Bromomethane	*tert*-Butylbenzene	2-Propenenitrile	Dibromomethane
trans-1,3-Dichloropropene		Hexachlorobutadiene	1,1,1,2,2,2-Hexachloroethane
cis-1,3-Dichloropropene		Methyl acrylate	1,1,2-Trichloroethane
1,2-Dibromoethane		Bromoethene	1,2,4-Trichlorobenzene
1,2,3-Trichloropropane		*trans*-1,4-Dichloro-2-butene	2-Hexanone
		Ethyl methacrylate	4-Chlorotoluene
		1,1-Dichloropropene	1,1,1,2-Tetrachloroethane
		2,2-Dichloropropane	Bromobenzene
		1,3-Dichloropropane	
		Bromochloromethane	
		Iodomethane	
		3-Chloro-1-propene	
		Methyl acrylonitrile	
		Methyl methacrylate	
		1,2,3-Trichlorobenzene	

Conclusions

- One or more VOCs were frequently detected in urban stream samples.
- More VOCs were detected in urban stream samples in cooler months (median of 7 VOCs) than in warmer months (median of 5 VOCs).
- A large number of individual VOCs (56) were detected at least once in urban stream samples.
- Gasoline hydrocarbons are the most frequently detected compounds in urban streams.
- Most concentrations are less than 1 microgram per liter.
- No VOCs had concentrations greater than USEPA's Maximum Contaminant Levels or Health Advisory Levels.

References

Lopes, T.J., and Price, C.V., 1997, Study plan for urban stream indicator sites of the National Water-Quality Assessment Program: U.S. Geological Survey Open-File Report 97–25, 15 p.

Seaber, P.R., Kapinos, F.P., and Knapp, G.L., 1987, Hydrologic unit maps: U.S. Geological Survey Water-Supply Paper 2294, 63 p.

U.S. Environmental Protection Agency, 2004, 2004 Edition of the drinking water standards and health advisories: Washington, D.C., Office of Water, EPA 822-R-04-005.