

The Quality of Our Nation's Waters

# **Volatile Organic Compounds in the Nation's Ground Water and Drinking-Water Supply Wells**

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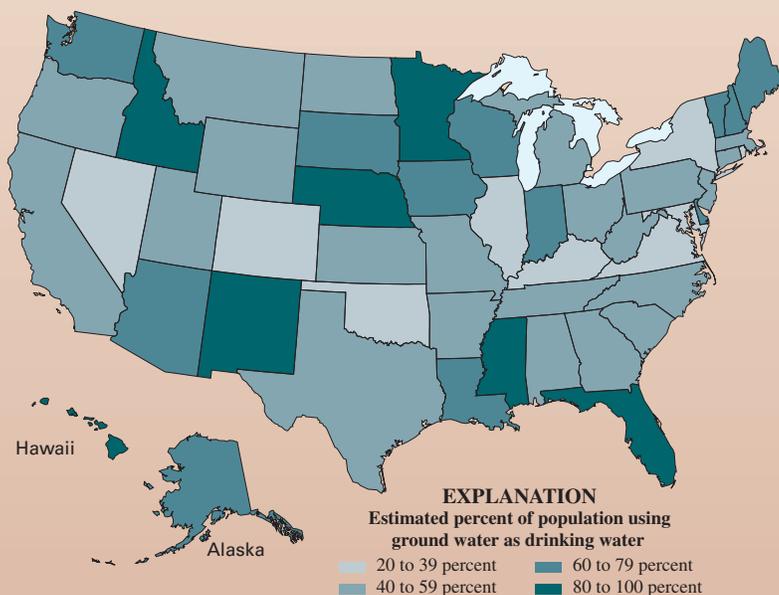
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Estimated use of ground water for drinking water (adapted from data source<sup>(1)</sup>)

*Ground water is among the Nation's most important natural resources. Very large volumes of ground water are pumped each day for industrial, agricultural, and commercial use. Also, ground water is a drinking-water source for about one-half of the Nation's population, including almost all residents in rural areas. Ground water is important as a drinking-water supply in every State.*

*Information on the quality and quantity of ground water is important because of the Nation's increasing population and dependency on this resource. Although the population that used domestic wells for drinking-water supplies decreased between 1950 and 2000, estimated withdrawal increased by about 70 percent during that time period. The population dependent on public water systems that used ground water for drinking-water supplies increased between 1950 and 2000, and the estimated withdrawal increased about five-fold during that time period.*

*The quality and availability of ground water will continue to be an important environmental issue for the Nation's citizens. Long-term conservation, prudent development, and management of this natural resource are critical for preserving and protecting this priceless national asset. Continued research by scientists, guidance and regulation by governmental agencies, and pollution abatement programs by industry are necessary to preserve the Nation's ground-water quality and quantity for future generations.*

*Donna N. Myers  
 Chief, National Water-Quality Assessment (NAWQA) Program  
 U.S. Geological Survey*

### Foreword

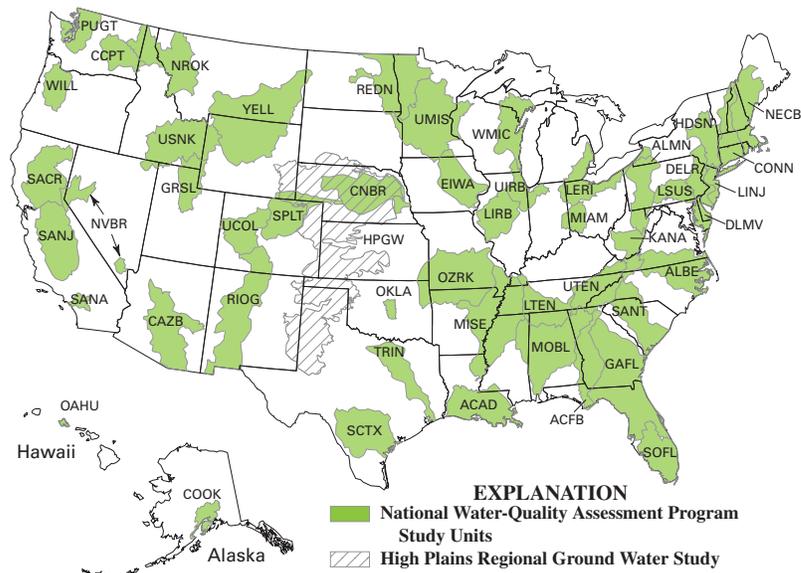
The U.S. Geological Survey (USGS) is committed to serving the Nation with accurate and timely scientific information that helps enhance and protect the overall quality of life, and facilitates effective management of water, biological, energy, and mineral resources (<http://www.usgs.gov/>). Information on the quality of the Nation's water resources is of critical interest to the USGS because it is so integrally linked to the long-term availability of water that is clean and safe for drinking and recreation and that is suitable for industry, irrigation, and habitat for fish and wildlife. Escalating population growth and increasing demands for the multiple water uses make water availability, now measured in terms of quantity and quality, even more critical to the long-term sustainability of our communities and ecosystems.

The USGS implemented the National Water-Quality Assessment (NAWQA) Program (<http://water.usgs.gov/nawqa/>) to support national, regional, and local information needs and decisions related to water-quality management and policy. Shaped by and coordinated with ongoing efforts of other Federal, State, and local agencies, the NAWQA Program is designed to answer: What is the condition of our Nation's streams and ground water? How are the conditions changing over time? How do natural features and human activities affect the quality of streams and ground water, and where are those effects most pronounced? By combining information on water chemistry, physical characteristics, stream habitat, and aquatic life, the NAWQA Program aims to provide science-based insights for current and emerging water issues and priorities. NAWQA results can contribute to informed decisions that result in practical and effective water-resource management and strategies that protect and restore water quality.

Since 1991, the NAWQA Program has implemented interdisciplinary assessments in more than 50 of the Nation's most important river basins and aquifers, referred to as Study Units (<http://water.usgs.gov/nawqa/nawqamap.html>)<sup>1</sup>. Collectively, these Study Units account for more than 60 percent of the overall water use and population served by public water supply, and are representative of the Nation's major hydrologic landscapes, priority ecological resources, and agricultural, urban, and natural sources of contamination.

Each assessment is guided by a nationally consistent study design and methods of sampling and analysis. The assessments thereby build local knowledge about water-quality issues and trends in a particular stream or aquifer while providing an understanding of how and why water quality varies regionally and nationally. The consistent, multi-scale approach helps to determine if certain types of water-quality issues are isolated or pervasive, and allows direct comparisons of how human activities and natural processes affect water quality and ecological health in the Nation's diverse geographic and environmental settings. Comprehensive national assessments on pesticides, nutrients, volatile organic compounds, trace elements, and aquatic ecology are developed through national data analysis and comparative analysis of the Study-Unit findings (<http://water.usgs.gov/nawqa/natsyn.html>).

The USGS places high value on the communication and dissemination of credible, timely, and relevant science so that the most recent and available knowledge about water resources can be



Study Units where the NAWQA Program has completed an occurrence study of volatile organic compounds in aquifers.<sup>2</sup>

applied in management and policy decisions. We hope this NAWQA publication will provide you the needed insights and information to meet your needs, and thereby foster increased awareness and involvement in the protection and restoration of our Nation's waters.

The NAWQA Program recognizes that a national assessment by a single program cannot address all water-resource issues of interest. External coordination at all levels is critical for a fully integrated understanding of watersheds and for cost-effective management, regulation, and conservation of our Nation's water resources. The Program, therefore, depends extensively on the advice, cooperation, and information from other Federal, State, interstate, Tribal, and local agencies, non-government organizations, industry, academia, and other stakeholder groups. The assistance and suggestions of all are greatly appreciated.

Robert M. Hirsch  
Associate Director for Water

<sup>1</sup>Summaries of water-quality studies for the 51 Study Units assessed in the first decade of the NAWQA Program, as well as Study Units scheduled for assessments in the Program's second decade, are available at <http://water.usgs.gov/nawqa/>.

<sup>2</sup>The name of each Study Unit and other areas are given in Appendix 1.

# Introduction to this report and the NAWQA series

## The Quality of Our Nation's Waters

### Pesticides



Photograph by Charles G. Crawford,  
U.S. Geological Survey

### Nutrients



Photograph by Janet M. Carter,  
U.S. Geological Survey

### Trace Elements



Photograph courtesy of South Dakota  
Department of Environment and  
Natural Resources

### VOCs



Photograph by Janet M. Carter,  
U.S. Geological Survey

### Ecology



Photograph by Stephen R. Moulton II,  
U.S. Geological Survey

This report is one of a series of publications, *The Quality of Our Nation's Waters*, that describe major findings of the National Water-Quality Assessment (NAWQA) Program on water-quality issues of national and regional concern. This report is on volatile organic compounds (VOCs) in ground water and drinking-water supply wells. It is a synthesis of NAWQA and other investigations. Fifty-five VOCs are emphasized in NAWQA's field studies, and these compounds are the focus of this report. During NAWQA's first decade of Study-Unit investigations, samples from more than 2,500 wells were analyzed for VOCs. In addition, carefully selected VOC data from more than 1,700 well samples were compiled from other agencies or collected in other USGS studies. Collectively, these VOC analyses are the basis for this report's assessment, which is (1) the first national assessment of a large number of VOCs in the Nation's aquifers and (2) the most recent national characterization of VOCs in samples from domestic and public wells used for drinking water.

Subsequent reports in this series will cover other water-quality constituents of concern, such as pesticides, nutrients, trace elements, as well as physical and chemical effects on aquatic ecosystems. Each report will build toward a more comprehensive understanding of national and regional water resources as additional investigations are completed and as scientific models and tools that link water-quality conditions, dominant sources, and environmental characteristics are developed.

The information in this report is intended primarily for scientists and engineers interested or involved in resource management, conservation, regulation, and policy making at national, regional, and State levels. In addition, the information in this report is intended for public health agencies and water utilities who wish to know more about specific contaminant groups such as VOCs.

P. Patrick Leahy, Acting Director  
U.S. Geological Survey

# Contents

The first chapter provides an overview of major findings and conclusions for ground-water management, monitoring, and policies. The second chapter describes the assessment's purpose, scope, and approach. More detailed findings for ground water are given in the third chapter, and findings for samples from drinking-water supply wells are presented in the fourth chapter. Additional information for some frequently and widely detected compounds is presented in the fifth chapter.

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A list of acronyms is included as Appendix 2. A glossary of common terms used in this report is included on p. 62–65. Beginning in Chapter 2, glossary terms are presented in boldface type when first used in the text.