Kentucky Interagency Groundwater Monitoring Network: Annual Report, 2000–2001

Executive Summary

Groundwater produced from wells and springs throughout the Commonwealth is vital to the economy of the state and to the health and well-being of its citizens. Approximately 60 percent of the public water-supply companies use groundwater, more than 25 percent of the population depends on groundwater for household use, and more than 226 million gallons of groundwater are consumed daily by individuals, municipalities, utilities, businesses, and farms. Groundwater will continue to be important to Kentuckians because economic and logistical factors make it expensive to replace groundwater with surface-water supplies, particularly in rural areas, and because groundwater supply systems are generally less expensive to install, operate, and maintain than surface-water supply systems.

Groundwater quality and its suitability for various uses must be known so that responsible decisions can be made regarding resource management, water development policy, pollution prevention, and groundwater protection. Only recently, however, have there been concerted efforts to describe and evaluate the quality of groundwater in Kentucky.

In 1990, the Kentucky General Assembly created the Kentucky Groundwater Data Repository, housed and maintained at the Kentucky Geological Survey (KGS), to archive groundwater information collected by State and Federal agencies and other researchers. The Kentucky Division of Water (DOW) began a systematic program of sampling and analyzing water from wells and springs throughout the state in 1994. In 1998 the Kentucky legislature directed that KGS establish a groundwater monitoring network to characterize the quality, quantity, and distribution of groundwater in Kentucky. That legislation also requires KGS to annually report groundwater data collection and data analysis activities to the governor and the Legislative Research Commission. This is the third annual report of the Kentucky Interagency Groundwater Monitoring Network.

During the 2000–2001 fiscal year, the network:

- Assisted the Kentucky Water Resource Development Commission in preparing strategic plans for water resources and sewer systems
- Collected and analyzed samples to evaluate the impact of the Martin County slurry pond spill on local groundwater
- Collected and analyzed groundwater samples as part of a hydrogeologic investigation of the limestone aquifer in south-central Louisville
- Conducted a monthly program of groundwater quality monitoring of the Ohio River alluvial aquifer
- Continued a program to delineate groundwater basins and capture areas in the Western Pennyroyal Region
- Continued an evaluation of water-quality data from wells and springs in basins of the Upper Cumberland, Lower Cumberland, Tennessee, Tradewater, and Green Rivers, and in the Jackson Purchase Region
- Continued quarterly sampling of approximately 100 wells and springs that comprise the Division of Water's ambient groundwater monitoring network
- Continued to investigate on-site waste disposal and groundwater quality in Letcher County
- Contributed a statewide map of water hardness for a publication by the University of Kentucky College of Agriculture, Cooperative Extension Service
- Established a Web site for the Kentucky Interagency Groundwater Monitoring Network

- Evaluated abandoned coal mines as potential water supplies in eastern Kentucky
- Evaluated the effectiveness of voluntary best management practices to protect groundwater in karst aquifers
- Installed wells and collected water samples to assist the Army National Guard in developing a groundwater protection plan for training facilities
- Investigated sources of high nitrate concentrations in western Kentucky wells
- Investigated the occurrence and distribution of pesticides and nutrients in springs in the Green River Basin
- Prepared maps and statistical summaries of pH and hardness in groundwater
- Published a one-page introduction to the Kentucky Interagency Groundwater Monitoring Network for general distribution
- Sampled 30 wells and springs quarterly in the Salt and Licking River Basins
- Sampled 30 wells and springs quarterly in the Upper Cumberland, Lower Cumberland, and Tennessee River Basins, and in the Jackson Purchase Region
- Used remote-sensing and inclined-drilling methods to locate high-yield wells for water supplies in eastern Kentucky.

The results of the above investigations were circulated as written reports and presentations at conferences and meetings.

Introduction

Groundwater Use

Groundwater is extensively used throughout Kentucky. The 1990 census data show

- Approximately 26 percent of the population relies on groundwater for domestic use
- 206,520 households (536,952 residents) rely on private wells
- 1,144 public supply wells serve Kentuckians
- 415,849 residents are served by public systems that combine groundwater and surface water, and
- Approximately 60 percent of Kentucky's public water-supply companies use groundwater.

In addition, more than 226 million gallons of groundwater are used each day by commercial and industrial operations, farmers and ranchers, mining operations, and thermoelectric power generators (Table 1).

Groundwater use in Kentucky will continue to be important because in many cases it is not economical or efficient to replace groundwater supplies with surface water. Groundwater also provides base flow to rivers, streams, and lakes, particularly during times of drought. Groundwater therefore sustains important ecosystems and contributes to recreational uses such as fishing, boating, and swimming.

Groundwater Investigations

If groundwater systems become unsuitable for a particular use, it is difficult and expensive to restore them to their original state, and the process may take decades to accomplish. Because of the importance of groundwater to Kentucky and the difficulty of remediating contaminated groundwater systems, it is critical that the current quality of groundwater resources be determined and protected.

Until recently there was little systematic effort to describe groundwater quality and to make that information widely available. Such information is needed to identify and preserve groundwater supplies, delineate areas where groundwater quality has been impaired, and to evaluate the natural and man-made factors that control groundwater quality.

The Kentucky Groundwater Data Repository was created in 1990 by action of the Kentucky General Assembly (KRS 151:035) to archive groundwater data collected by State and Federal agencies, universities, and other researchers. KGS uses this central repository of groundwater data to provide information as a public service to citizens, organizations, and businesses.

In 1994 the Kentucky General Assembly appropriated funds for the DOW to establish and maintain a groundwater monitoring network that samples wells and springs, analyzes the water, and reports the results. The DOW samples approximately 70 wells and springs each

Table 1. Groundwater use (million gallons per day).

Public water supplies	55
Individual households	23
Commercial and industrial uses	100
Irrigation and livestock	3
Mining	7
Thermoelectric power generation	38
Total	226

quarter under this program. An additional 30 sites in a selected basin management unit (BMU) are sampled quarterly for 1 year in coordination with the Kentucky Watershed Management Framework (Kentucky Division of Water, 1997). This expanded monitoring program is funded through Section 319(h) (Nonpoint Source Pollution) of the Clean Water Act.

The Kentucky Interagency Groundwater Monitoring Network developed from the realization that there was not sufficient information available to make informed decisions regarding groundwater management and protection. Following the creation of a Groundwater Consensus Committee in 1993 by the secretary of the Kentucky Natural Resources and Environmental Protection Cabinet, a bill was drafted to establish a long-term groundwater monitoring network and an advisory committee on groundwater issues. The proposed legislation did not pass then, but interest in groundwater persisted.

An ad hoc advisory committee, led by the director of the Kentucky Water Resources Research Institute, met throughout 1995 and 1996 and published a framework for the Kentucky Groundwater Monitoring network in 1996 (Interagency Technical Advisory Committee on Groundwater, 1996). In 1998, the Kentucky legislature directed KGS to establish a groundwater monitoring network (KRS 151.620, 151.621,151.625, and 151.629) and established an Interagency Technical Advisory Committee on Groundwater (ITAC; Table 2) to assist KGS in developing, coordinating, and implementing the network.

The goals of the Kentucky Interagency Groundwater Monitoring Network are to

- Collect groundwater data
- Characterize groundwater quality
- Distribute the resulting information
- Improve coordination among agencies that conduct groundwater monitoring, and
- Facilitate electronic transfer of groundwater data.

This annual report of activities of the Kentucky Interagency Groundwater Monitoring Network is structured around these five goals.

Table 2. Agencies comprising the Interagency Technical Advisory Committee on Groundwater.

- Kentucky Department for Environmental Protection
- Kentucky Department for Natural Resources
- Kentucky Department for Surface Mining Reclamation and Enforcement
- Kentucky Department of Mines and Minerals
- Kentucky Division of Conservation
- Kentucky Division of Environmental Health and Community Safety
- Kentucky Division of Forestry
- Kentucky Division of Pesticide Regulation
- Kentucky Division of Waste Management
- Kentucky Division of Water
- Kentucky Geological Survey
- U.S. Geological Survey
- University of Kentucky College of Agriculture
- University of Kentucky Water Resources Research Institute

2000–2001 Activities and Accomplishments

Groundwater Data Collection

Brief summaries of programs conducted during the 2000–2001 fiscal year are listed below.

- **Collected and analyzed groundwater samples quarterly from 30 wells and springs in the Upper Cumberland, Lower Cumberland, and Tennessee River Basins, and in the Jackson Purchase Region.**
  KGS, in cooperation with DOW, sampled groundwater in the Upper Cumberland, Lower Cumberland, and Tennessee River Basins, and in the Jackson Purchase Region to determine groundwater conditions and assess the effects of nonpoint-source contaminants. Analytical results were added to both the DOW database and the KGS data repository, and a final report is being prepared. This work was funded by a onetime grant from the U.S. Environmental Protection Agency (EPA), administered by the DOW Nonpoint Source Section.
- **Collected and analyzed samples to evaluate the impact of the Martin County slurry pond spill on local groundwater.**
  DOW committed significant staff time and resources to determine the effect of the slurry pond spill on local groundwater.
- **Collected and analyzed groundwater quality samples as part of a hydrogeologic investigation of the limestone aquifer in south-central Louisville.**
  The U.S. Geological Survey (USGS) collected and analyzed groundwater samples during 2000–2001 as part of a hydrogeologic investigation of the limestone aquifer in south-central Louisville. A detailed examina-

tion of variations in the water chemistry in the limestone aquifer is being included in a forthcoming USGS Water-Resources Investigations Report.

- **Concluded quarterly sampling of 30 wells and springs in basins of the Salt and Licking Rivers.**
  DOW staff concluded a 1-year program of groundwater sampling and analysis in the Salt and Licking River watersheds to determine groundwater conditions and assess the effects of nonpoint-source contaminants. Analytical results were added to both the DOW database and the KGS data repository. This work was funded by a onetime grant from the U.S. Environmental Protection Agency, administered by the DOW Nonpoint Source Section.
- **Conducted a monthly program of groundwater quality monitoring of the Ohio River alluvial aquifer.**
  The USGS, in cooperation with the Louisville Water Company, conducted a monthly program of groundwater quality monitoring of the Ohio River alluvial aquifer at the B.E. Payne Water Treatment Plant near Prospect. Water samples were analyzed to help evaluate the potential for river-bank infiltration and development of the aquifer for public water supply.
- **Continued an ongoing program investigating on-site waste disposal and well water quality in Letcher County.**
  DOW staff continued to investigate the effects of various on-site waste-disposal practices on groundwater quality.
- **Continued an ongoing program to delineate groundwater basins and capture areas in the Western Pennyroyal Region around Bowling Green.**
  DOW continues to investigate groundwater sources for wells and springs in western Kentucky.
- **Continued quarterly sampling of approximately 100 wells and springs that comprise the DOW groundwater monitoring network.**
  The DOW continued monitoring to determine groundwater quality throughout the state. Analytical results were added to both the DOW database and the KGS data repository.
- **Evaluated the effectiveness of voluntary measures to protect groundwater in karst aquifers.**
  A 3-year study by KGS in Logan County documented the effectiveness of voluntary best management practices in reducing pesticide and nutrient levels in groundwater. This work was funded by a onetime grant from the U.S. Environmental Protection Agency, administered by the DOW Nonpoint Source Section.
- **Installed wells and collected water samples to assist the Kentucky Army National Guard in developing groundwater protection plans.**
  Following a survey of surface-water quality at three Army National Guard training facilities, KGS researchers extended the investigation to include groundwater quality at the Wendell Ford training facility in Muhlenberg County. This work was funded by a grant from the Kentucky Army National Guard.
- **Investigated sources of elevated nitrate concentrations in wells in western Kentucky.**
  KGS is investigating high nitrate concentrations in wells in western Kentucky and the relation between high nitrate in groundwater and abandoned animal feedlot operations. This work was funded by a grant from the University of Kentucky College of Agriculture.
- **Investigated the occurrence and distribution of pesticides and nutrients in springs in the Green River Basin.**
  The USGS, in cooperation with the Kentucky Department of Agriculture, began a study to investigate the occurrence and distribution of agricultural nonpoint-source pollutants (pesticides and nutrients) in eight springs in the Green River Basin. Results will be published in a USGS fact sheet and annual data report.
- **Located deep mines that can provide water supplies in eastern Kentucky.**
  The capacity of abandoned underground mines to provide municipal water supplies in eastern Kentucky was evaluated by KGS researchers. This work was funded by a grant from the Kentucky River Authority.
- **Located high-yield wells for water supplies in eastern Kentucky.**
  KGS scientists used remote sensing and image analysis, coupled with inclined drilling methods, to locate high-yield wells at the intersections of fractures in eastern Kentucky. This work was funded by a grant from the Kentucky River Authority.

Groundwater Characterization

Analytical results from groundwater samples are examined and interpreted by DOW, KGS, and USGS researchers to characterize the quality of the resource. During the fiscal year:

- **KGS prepared maps and statistical summaries of Kentucky groundwater quality.**
  Statewide maps of pH, arsenic, atrazine, and hardness in groundwater were prepared, using records stored in the Kentucky Groundwater Data Repository.
- **KGS assisted the Kentucky Water Resource Development Commission, in cooperation with the Kentucky Infrastructure Agency, in preparing strategic plans for water resources and sewer systems.**
  KGS researchers contributed maps and evaluations of water supplies, including groundwater, to the commission's final report. This work was funded by a grant from the Kentucky Water Resource Development Commission.
- **KGS and DOW continued an evaluation of groundwater quality in the Upper Cumberland, Lower Cumberland, Tennessee, Tradewater, and Green River Basins, and in the Jackson Purchase Region.**
  As part of a project funded through the DOW Nonpoint Source Section, KGS and DOW are mapping and statistically summarizing groundwater quality data stored in the Kentucky Groundwater Data Repository. This work was funded by a onetime grant from the EPA, administered by the DOW Nonpoint Source Section.
- **DOW prepared reports on groundwater quality in the Kentucky, Salt, and Licking River Basins.**
  DOW is preparing reports on groundwater quality in these watersheds, following completion of expanded monitoring to determine conditions and to assess the effects of nonpoint-source contamination. This work was funded by a onetime grant from the U.S. Environmental Protection Agency, administered by the DOW Nonpoint Source Section.

Distribution of Groundwater Information

Groundwater information must be circulated in a form that is useful and understandable to diverse audiences. During the past fiscal year, information has been distributed via Web sites, presentations at meetings and conferences, and printed reports.

- KGS established and updated a Web site for the Kentucky Interagency Groundwater Monitoring Network (www.uky.edu/kgs/water/gnet/gnet.htm). This site contains maps and data summaries of nitrate and fluoride concentrations, maps of pH and hardness, a location map showing wells and springs that have been analyzed for various water-quality parameters, and previous annual reports of the network. The site also has links to the Web sites of the ITAC agencies and organizations.
- KGS contributed a statewide map of water hardness for a publication by the University of Kentucky College of Agriculture, Cooperative Extension Service (2001).
- KGS prepared a poster that describes karst aquifer systems and explains why they are susceptible to nonpoint-source pollution. This work was funded by a onetime grant from the U.S. Environmental Protection Agency, administered by the DOW Nonpoint Source Section.
- KGS prepared an explanation of groundwater network activities for general circulation and to inform citizens which agencies are involved in groundwater investigations. This handout will be circulated at the Kentucky State Fair educational exhibit, "2001: A Water Odyssey," and at other educational forums.
- DOW and KGS staff communicated the results of groundwater investigations and programs to professional audiences and citizens of the Commonwealth through oral and poster presentations at meetings and conferences, as well as through written publications. Presentations and publications are listed in Appendix A.

Interagency Coordination

Cooperation among agencies and research organizations that collect, analyze, and use groundwater data is essential to reduce monitoring costs, improve program efficiency, and promote data sharing. The Kentucky Interagency Groundwater Monitoring Network provides a forum for organizations that participate in the Interagency Technical Advisory Committee to meet regularly and discuss issues of mutual interest. In addition, KGS researchers serve on the following committees and work groups:

- Certified Water Well Drillers' Advisory Committee
- Cumberland River Basin and Four Rivers Region Team

- Interagency Monitoring Workgroup
- Kentucky River Basin Team
- Onsite Sewage Disposal Advisory Committee
- Watershed Steering Committee

Electronic Data Transfer

The Kentucky Interagency Groundwater Monitoring Network relies on two separate databases. Groundwater quality data collected by the DOW and other State agencies are entered into the DOW database for use in regulatory and public information applications. These data are also transferred to the Kentucky Groundwater Data Repository, housed and maintained at the KGS. In addition to information provided by State agencies, the Kentucky Groundwater Data Repository contains groundwater analyses obtained from the USGS, EPA, National Uranium Resource Evaluation Program, KGS and university researchers, and others. KGS staff use the data repository to answer public inquiries, and as the information source for evaluations of existing groundwater quality data. In addition, KGS and DOW are cooperating in projects that take data from the Kentucky Groundwater Data Repository, map statewide concentrations of inorganic species, pesticides, and nutrients, summarize the concentration of these constituents, and prepare reports for distribution. Because of these complementary uses of groundwater data by DOW and KGS, regular and routine data transfers are essential.

In the past, such data transfers have been difficult and time-consuming, largely because of differences in database structures and computer system formats. KGS and DOW have been working to make data transfers more routine. In June 2001, KGS received all the analytical results for samples collected by DOW through the year 2000. This most recent data transfer required approximately 1 month of KGS staff time to assimilate the new and modified records into the data repository, after DOW staff worked approximately the same amount of time to prepare the data sets. KGS and DOW will continue to work to make these transfers more efficient. Future data transfers are expected to occur at least twice each year so that reports can be made using current information.

Proposed Future Activities

The following reports are expected to be completed during the next fiscal year:

- *Results of Expanded Groundwater Monitoring for Nonpoint-Source Contamination in Basin Management Unit 1 (Kentucky River Watershed),* by DOW
- *Results of Expanded Groundwater Monitoring for Nonpoint-Source Contamination in Basin Management Unit 2 (Salt and Licking River Watersheds),* by DOW
- *Results of Expanded Groundwater Monitoring for Nonpoint-Source Contamination in Basin Management Unit 3 (Upper Cumberland, Lower Cumberland, and Tennessee River Watersheds, and the Jackson Purchase),* by KGS
- *Evaluation of Existing Groundwater Quality Data from Basin Management Units 3 and 4 (Upper Cumberland, Lower Cumberland, Tradewater, Green, and Tennessee River Watersheds, and the Jackson Purchase),* by KGS.

DOW will expand groundwater monitoring in BMU 4 (Tradewater and Green River watersheds) starting in the fall of 2001.

KGS and DOW have received funding through the EPA's 319 Nonpoint Source Pollution Program for two additional cooperative studies. One is quarterly sampling of 30 wells and springs in BMU 5 (Big Sandy River, Little Sandy River, and Tygarts Creek Basins). The second will support evaluation of existing groundwater data from basins of the Kentucky, Salt, Licking, Big Sandy, and Little Sandy Rivers, and in the watershed of Tygarts Creek (BMU's 1, 2, and 5).

The Kentucky Department of Agriculture's Division of Pesticide Regulation, in cooperation with the USGS, will investigate the presence and persistence of pesticides in the Green and Cumberland River Basins.

Other planned future activities include:

- Producing and distributing statewide water-quality maps and data summaries
- Evaluating the optimal sample collection frequency for a variety of wells and springs so that the efficiency of monitoring programs can be increased
- Developing a network to record water levels in strategically located wells
- Developing a common set of data elements for recording information about sample sites, sample collection procedures, and field-measured water-quality parameters
- Transferring data from paper files to the electronic database if funding becomes available
- Developing a plan for a coordinated statewide groundwater monitoring network and estimating the resources needed to support it
- Seeking sustained funding to support the Kentucky Interagency Groundwater Monitoring Network.

Summary

Groundwater accounts for more than 30 percent of the public and domestic water supplies in the Commonwealth, as much as 90 percent of all rural domestic supplies, and is used by approximately 60 percent of public water-supply companies. Groundwater is also used extensively for commercial and industrial applications as well as in thermoelectric power generation. Furthermore, groundwater is the major source of water in Kentucky's rivers and streams, and is particularly important during periods of drought. Pure groundwater is generally taken for granted; however, groundwater systems are difficult to remediate once contaminated. To intelligently manage and protect this precious natural resource, current groundwater quality must be assessed and evaluated.

The Kentucky Interagency Groundwater Monitoring Network was established by legislation in 1998 to characterize the quality, quantity, and distribution of groundwater in Kentucky. Since that time, KGS and DOW have been working closely to meet these goals, with the oversight of the ITAC. Significant progress has been made in characterizing statewide groundwater quality and reporting the results.

Important work remains. The sample coverage of the Commonwealth must be improved before background conditions can be determined and both pristine and contaminated areas can be identified. The monitoring program should be reviewed, and site distribution and sampling frequency reevaluated to improve efficiency. Important historical water-quality data that exist only as hard copy must be added to the electronic databases. Most important, a regular program of sample collection and analysis, data evaluation, and distribution of groundwater quality information through presentations, publications, and Web sites is needed, and this information must be reviewed and updated regularly.

Many of the ongoing and recently completed groundwater investigations are the result of cooperative efforts between DOW and KGS; this allows both organizations to accomplish more than they could separately. This cooperation must continue and increase for the benefit of the citizens of Kentucky. Recent accomplishments in characterizing groundwater quality and circulating the findings have largely been accomplished through the use of nonrecurring funds obtained from a variety of sources. Availability of these funds is decreasing, and it is likely that the current level of groundwater investigations cannot be sustained without a new source of funding. It is essential that the Kentucky Interagency Groundwater Monitoring Network receive recurring funding to continue this important work.

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Appendix A: Presentations and Publications

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