

# **Kentucky Interagency Groundwater Monitoring Network**

## **Annual Report**

**2005–06**

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**September 2006**



# Contents

Executive Summary .....	1
Introduction .....	2
2005–06 Activities and Accomplishments .....	3
Groundwater Data Collection .....	3
Kentucky Division of Water.....	3
Ambient Groundwater Monitoring Program.....	3
U.S. Geological Survey.....	4
Water-Quality Assessment of the Sinking Creek Basin, Breckinridge County .....	4
Louisville Water Company–Ohio River Alluvial Aquifer, Jefferson County .....	4
Kentucky Abandoned Landfills Project .....	5
Regional Karst Hydrology Initiative Project.....	5
Maxey Flats Low-Level Radioactive Waste Repository, Fleming and Rowan Counties ....	5
Water-Level Data Collection .....	5
Kentucky Department of Agriculture .....	5
Sinking Creek Basin Project.....	5
Little River Monitoring Project.....	6
Rough River Project.....	6
Atrazine Research.....	6
Division of Mine Reclamation and Enforcement.....	6
Mine Monitoring.....	6
Kentucky Geological Survey.....	6
Locating and Testing New Water Supplies .....	6
Groundwater Impacts in the Cumberland Gap Tunnel.....	7
Cover-Collapse Sinkholes.....	7
Groundwater Basin Maps.....	7
Karst Geologic Hazards .....	7
Groundwater Quality in Rural Domestic Water Wells, Jackson Purchase and Western Kentucky Coal Field Regions .....	7
Experimental Program to Stimulate Competitive Research.....	7
Expanded Groundwater Monitoring in the Jackson Purchase Region.....	7
Groundwater Quality Characterization.....	8
Groundwater Monitoring for Nonpoint-Source Pollution Assessment in the Upper Cumberland, Lower Cumberland, and Tennessee River Basins, and the Jackson Purchase Region (Basin Management Unit 3) .....	8
Evaluation of Existing Groundwater Quality Data from Watersheds of the Kentucky, Salt, Licking, Big Sandy, and Little Sandy Rivers, and Tygarts Creek (Basin Manage- ment Units 1, 2, and 5).....	8

## Contents (Continued)

Groundwater Quality in Watersheds of the Big Sandy River, Little Sandy River, and Tygarts Creek (Kentucky Basin Management Unit 5).....	8
Statewide Maps of Groundwater Quality .....	8
Karst Potential Index .....	9
Distribution of Groundwater Information .....	9
Publications .....	9
Presentations .....	10
Web Sites .....	10
Interagency Coordination .....	11
Sharing Groundwater Data.....	11
Future Activities.....	12
Summary .....	12
References Cited.....	12

## Figure

1. Map showing major rivers, basin management units, and physiographic regions in Kentucky.....4

# Kentucky Interagency Groundwater Monitoring Network Annual Report 2005–06 Executive Summary

Recognizing that groundwater is an essential natural resource but that groundwater supplies and quality are not adequately known throughout the commonwealth, the 1998 Kentucky General Assembly directed the Kentucky Geological Survey to establish a long-term monitoring network that would characterize the quality, quantity, and distribution of Kentucky's groundwater resources. The monitoring network was charged with five major activities: (1) collect groundwater data, (2) characterize groundwater quality, (3) distribute groundwater information, (4) improve coordination between agencies that collect and use groundwater data, and (5) facilitate sharing of groundwater data.

This information is essential to help locate water supplies in areas where adequate surface water is not available or where supplemental water supplies are needed in times of drought, to help define regions where groundwater is particularly vulnerable to nonpoint-source contamination, and to assist cities and industries in planning water-use and water-disposal practices that most economically meet environmental-protection regulations and water-quality standards.

The Kentucky General Assembly also directed that the groundwater monitoring network activities be carried out in coordination with an Interagency Technical Advisory Committee on Groundwater. The Kentucky Geological Survey was charged with annually reporting network activities to the Governor's Office and the Legislative Research Commission.

This report summarizes activities that occurred during the 2005–06 State fiscal year. Twenty major data-collection programs were under way, and five major groundwater-characterization reports were prepared. Groundwater information was communicated to the scientific and regulatory communities and to the public through presentations and publications, as well as responses to citizens' requests for groundwater information. Use of the Internet to post data and reports continues to increase. Water

maps on the Kentucky Geological Survey Web site were accessed 31,406 times, the groundwater database was searched 7,190 times, and water data were downloaded 274 times.

Quarterly meetings of the Interagency Technical Advisory Committee provided an opportunity to coordinate groundwater-related efforts and share information among agencies. Exchange of groundwater data, including electronic transfer between State and university databases, has proceeded through close cooperation between the Kentucky Division of Water and the Kentucky Geological Survey.

The Kentucky Interagency Groundwater Monitoring Network has now been in existence for 8 years. During this time, significant progress has been made toward collecting and reporting groundwater-quality data and improving interagency cooperation. Important work remains, however. Among the major issues still to be addressed are:

- Developing new monitoring sites in areas where groundwater quality is poorly known
- Optimizing the sampling frequency to account for natural variations in groundwater flow systems throughout the state
- Determining how large an area is represented by a sample at a particular well or spring
- Monitoring the intrusion of nonpoint-source contaminants into groundwater systems
- Investigating the occurrence of bacteria and other pathogens in regional groundwater flow systems
- Investigating the occurrence of pharmaceutical drugs and steroids in groundwater
- Standardizing reporting information about sampling methods, field measurements, and sample-site descriptions
- Developing a water-level monitoring network to track long-term land-use and climate effects on groundwater supplies
- Standardizing laboratory reporting procedures

- Facilitating electronic data sharing among agencies that work with groundwater measurements
- Facilitating public access to groundwater-quality data via interactive Web sites.

The Kentucky Interagency Groundwater Monitoring Network will continue to address these issues. Significant advances are difficult under current staffing and funding conditions, however.

## Introduction

Kentucky groundwater is used extensively for domestic, agricultural, commercial, and industrial purposes. Groundwater is also essential to the health of surface-water ecosystems because groundwater feeds rivers, lakes, and wetlands. Monitoring the quality of this critical resource and protecting it from contamination are important to the future of water resources in the commonwealth and to its citizens.

Information provided by the Kentucky Division of Water indicates that 185 public water-supply systems use groundwater to supply about 1.5 million people – more than one-quarter of Kentucky’s population. An additional 415,000 citizens rely on private sources, including wells, springs, and cisterns. This dependence on groundwater resources will increase into the foreseeable future. Many public water-supply systems are considering switching from surface-water to groundwater sources because the required treatment and monitoring are less extensive and less expensive. Recently, the cities of Louisville, Hardinsburg, and Salyersville, and the Greater Fleming Regional Water Supply, were either considering switching to groundwater sources or are supplementing surface-water supplies with groundwater. Furthermore, many people who now rely on wells or springs for private domestic water supplies will remain dependent on groundwater because of the high cost of extending public water-supply systems to rural areas, and because groundwater supplies are abundant in some parts of the commonwealth.

Significant quantities of groundwater are used for commercial and industrial applications, crop irrigation, livestock watering, mining, and thermoelectric power generation. Groundwater

Most of the progress to date has been the result of substantial agency commitment of State Executive Budget funds, one-time grants to the Kentucky Division of Water and the Kentucky Geological Survey, and voluntary cooperation between agencies. Implementing an effective groundwater monitoring plan will require sustained, recurring funding to maintain a long-term effort.

also sustains valuable ecosystems by providing base flow to streams, lakes, and wetlands. This is particularly important during times of drought. In the absence of rainfall, groundwater base flow is the only natural source of water to maintain streamflow and lake levels, and to preserve riparian and wetland ecosystems.

Recognizing the importance of groundwater, the 1998 Kentucky General Assembly directed the Kentucky Geological Survey to establish a long-term, interagency groundwater monitoring network to characterize the quality, quantity, and distribution of groundwater in Kentucky (Kentucky Revised Statutes 151.620 and 151.625). The major goals of the Interagency Groundwater Monitoring Network are to (1) collect groundwater data, (2) characterize groundwater quality, (3) distribute groundwater information, (4) improve coordination between agencies that collect groundwater data, and (5) facilitate sharing of groundwater data (Interagency Technical Advisory Committee on Groundwater, 1996).

The 1998 General Assembly also established an Interagency Technical Advisory Committee on Groundwater to assist the Kentucky Geological Survey in the development, coordination, and implementation of a groundwater monitoring network (KRS 151.629). The following agencies and organizations were asked to appoint a representative to the committee:

- 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, Department of Agriculture
- Kentucky Division of Waste Management
- Kentucky Division of Water
- University of Kentucky, Kentucky Geological Survey
- University of Kentucky, College of Agriculture
- University of Kentucky, Kentucky Water Resources Research Institute
- U.S. Geological Survey, Louisville office

The 1998 legislation also directed the Kentucky Geological Survey to provide an annual summary of groundwater monitoring activities to the governor and the Legislative Research Commission. This is the eighth annual report of the Kentucky Interagency Groundwater Monitoring Network. Previous reports are posted at [www.uky.edu/kgs/water/gnet/gnet.htm](http://www.uky.edu/kgs/water/gnet/gnet.htm).

## 2005–06 Activities and Accomplishments

Brief summaries of work performed by the ITAC agencies during the 2005–06 State fiscal year are given below. Activities are organized to show how the major goals of the network are being addressed. Additional information regarding these projects can be obtained by contacting the responsible agency.

### Groundwater Data Collection

Collecting and analyzing water samples from wells and springs, measuring water levels in wells, and mapping recharge and discharge areas of karst systems provide the basic data needed to determine current groundwater quality, detect changes in groundwater quality over time, and evaluate hydrogeologic hazards. Two types of groundwater data-collection programs were conducted during the reporting period. Statewide and regional monitoring programs were conducted to describe the quality of groundwater that is not affected by point-source contamination and to determine whether nonpoint-source chemicals such as sew-

age, pesticides, fertilizers, and synthetic organic chemicals have had an impact on the groundwater system. These regional studies were conducted in one or more of the basin management units (Fig. 1) that were established by the Kentucky Division of Water's watershed management framework (Kentucky Division of Water, 1997). These are:

Basin Management Unit	Watersheds
1	Kentucky River
2	Salt River, Licking River
3	Upper Cumberland River, Lower Cumberland River, Tennessee River, Jackson Purchase Region
4	Green River, Tradewater River
5	Big Sandy River, Little Sandy River, Tygarts Creek

Site-specific studies were conducted in smaller regions to evaluate the effects of various land uses, define unique hydrologic conditions, or assess the quality of unregulated public water supplies such as roadside springs.

### *Kentucky Division of Water*

**Ambient Groundwater Monitoring Program.** The Groundwater Branch of the Kentucky Division of Water collected and analyzed 327 samples from 202 wells and springs.

- One hundred forty-four samples from 60 sites were collected as part of the statewide Ambient Groundwater Monitoring Program.
- Twelve samples from four sites were collected quarterly and analyzed as part of the second round of sampling in the Kentucky River watershed. Four of those sites were then selected for further sampling, following surface-water sampling protocol: the sites are sampled monthly for 1 year, and bacteria are sampled for 5 months during the recreational season. This sampling schedule was adopted in recognition of the interrelationship between groundwater and surface water.
- Thirty samples were collected and analyzed from 10 sites in the Green River and Tradewater River watersheds. This sampling program also

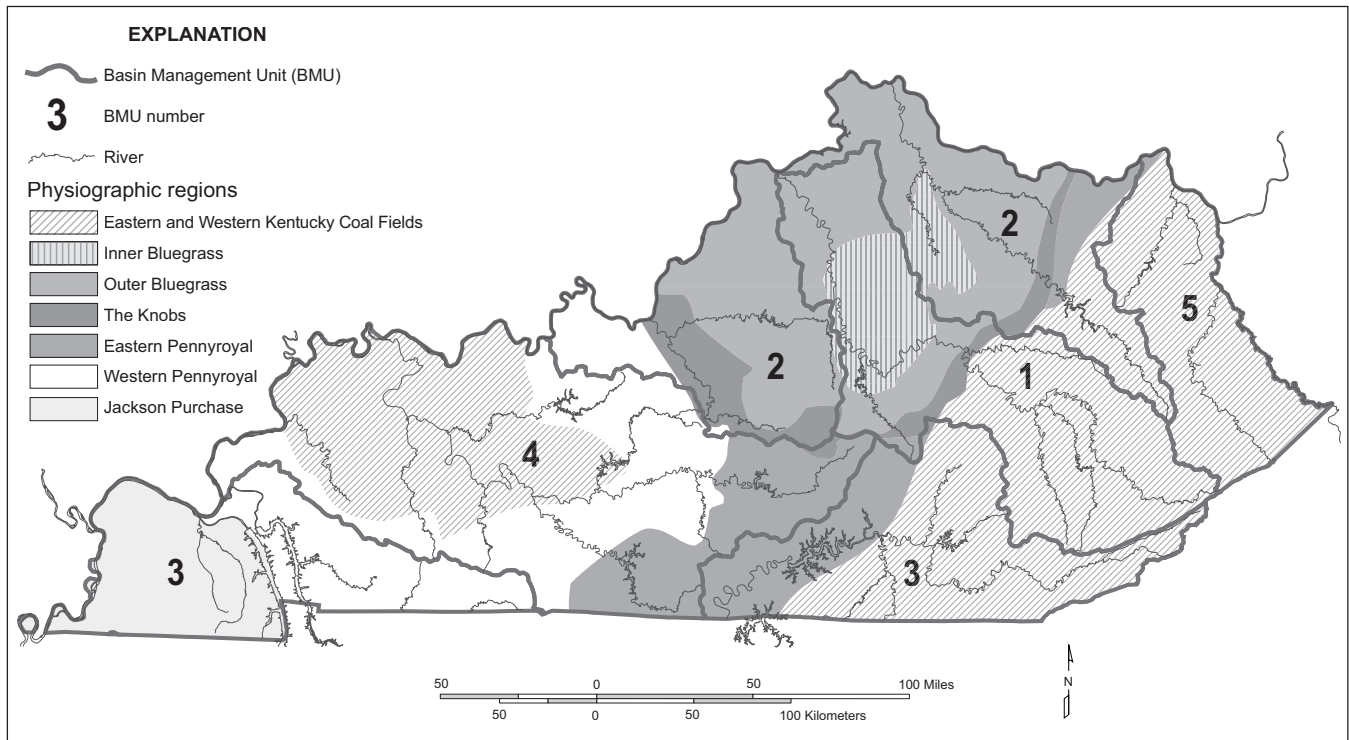


Figure 1. Major rivers, basin management units, and physiographic regions in Kentucky.

followed protocols established for surface-water monitoring.

- Sixteen samples were collected and analyzed from four sites under an agreement with the Division of Pesticide Regulation. Samples were collected quarterly to assess the impact of pesticides on shallow groundwater systems.
- Sixty-seven samples were collected and analyzed to investigate complaints and environmental incidents, to support the Wellhead Protection Program, and for special projects.
- Sixty sites in the Jackson Purchase Region were sampled over a 2-day period and analyzed for bacteria.
- Four springs in the South Fork of the Elkhorn River Basin are undergoing sampling, following surface-water protocols, and dye traces are being conducted.
- One hundred fifty samples have been collected and analyzed for the pesticide glyphosate. The capability to measure glyphosate was recently added to the Division of Environmental Services' laboratory because glyphosate is one of the most commonly used pesticides in Kentucky.

All these samples were analyzed at the Kentucky Division of Environmental Services laboratory. The results are entered into the Division of Water's groundwater-quality database and subsequently copied to the Kentucky Groundwater Data Repository at KGS.

### **U.S. Geological Survey**

**Water-Quality Assessment of the Sinking Creek Basin, Breckenridge County.** This study is being conducted in cooperation with the Kentucky Department of Agriculture, and is supported by State 319 nonpoint-source program funding. The project objectives are to evaluate water-quality conditions in the karstic upper Sinking Creek Basin. Pesticide, nutrient, sediment, discharge, and precipitation data are being collected over a 3-year period (2004–06). Data collected during 2004 have been compiled and are available as a USGS Open-File Report (see "Distribution of Groundwater Information," below).

**Louisville Water Company–Ohio River Alluvial Aquifer, Jefferson County.** In October 1997, the U.S. Geological Survey and the Louisville Water



Company began a cooperative program to monitor groundwater levels in the northeastern part of the Ohio River alluvial aquifer in Jefferson County. Since then, the cooperative program has expanded with the addition of new tasks and the testing of new techniques designed to gain a better understanding of ground- and surface-water interaction and river-bank infiltration. As the cooperative program enters its ninth year, there is a need to ensure that the baseline of groundwater-level monitoring is maintained in the northeastern part of the aquifer for the continued management of the groundwater resources. A total of 26 wells are monitored on a quarterly basis; eight of these wells are equipped with continuously recording pressure transducers. Hydrogeologic characteristics and recent water-level data collected from observation wells completed in the northeastern part of the aquifer are available as a USGS Open-File Report (see "Distribution of Groundwater Information," below).

**Kentucky Abandoned Landfills Project.** The USGS, in cooperation with the Kentucky Division of Waste Management–Solid Waste Branch, is providing technical assistance to the State by characterizing the hydrogeology and potential for contaminant migration at selected abandoned landfill sites. As part of this project, in fiscal year 2006, water-level measurements and water-quality samples were collected from wells in the area of the Trigg County landfill, and discharge measurements and water-quality samples were collected at the water-supply spring for the city of Cadiz.

**Regional Karst Hydrology Initiative Project.** The USGS Ground-Water Resources Program is currently involved in a regional study of the karst aquifers in Kentucky, Alabama, Illinois, Indiana, and Tennessee. In fiscal year 2006 a regional karst GIS database was developed that compiled data about sinkhole catchment areas, karst springs, and reported dye-trace tests. GIS data-processing methods were described in a USGS Scientific Investigations Report (see "Distribution of Groundwater Information," below). One product obtained thus far from this regional study is a digital data file of sinkhole catchment areas mapped by watersheds for the karst areas in Kentucky. This data file can be accessed by water-resources managers, regula-

tory agencies, and the general public through the "Hydrology of Kentucky" Web site at [kygeonet.ky.gov/kyhydro/main.htm](http://kygeonet.ky.gov/kyhydro/main.htm). Additional information about the USGS Ground-Water Resources Program and the Karst Hydrology Initiative Project can be found at [water.usgs.gov/ogw/gwrp](http://water.usgs.gov/ogw/gwrp).

**Maxy Flats Low-Level Radioactive Waste Repository, Fleming and Rowan Counties.** The USGS continues to provide technical assistance to the Environmental and Public Protection Cabinet–Division of Waste Management in regard to oversight of the closure of the Maxey Flats Repository. The USGS maintains continuous water-level data recorders in 15 monitoring wells at the site. Five of these monitoring wells are also sampled semi-annually for tritium concentrations. Water levels are measured periodically in 14 other monitoring wells. Of these, two wells are sampled quarterly for tritium, and the remaining 12 are sampled annually.

**Water-Level Data Collection.** As part of basic water-level data collection activities, the USGS maintains a real-time continuous water-level station at an observation well located in Graves County; this well is included in the USGS National Ground-Water Climate Response Network, a nationwide network intended to monitor the effects of droughts and other climate variability on groundwater resources. The water-level data for this well can be accessed via the Internet at [groundwaterwatch.usgs.gov](http://groundwaterwatch.usgs.gov) or [ky.water.usgs.gov](http://ky.water.usgs.gov). In addition, two observation wells in downtown Louisville (at the library and courthouse locations) are maintained by the USGS and are used to collect continuous water-level data from the central part of the Ohio River alluvial aquifer. These data, historical water-level data from other observation wells, and additional information about the activities of the USGS–Kentucky Water Science Center are available on the USGS Web site at [ky.water.usgs.gov](http://ky.water.usgs.gov).

**Kentucky Department of Agriculture Sinking Creek Basin Project.** The USGS, in cooperation with the Kentucky Department of Agriculture, has been sampling surface water and karst springs in the Sinking Creek Basin in Breckinridge and Meade Counties for the past 2 years. The USGS

is evaluating relations between pesticides, nutrients, stream flow, sediment, and precipitation. This is a rain-event monitoring project in which the data will be used to develop and apply a rainfall-runoff model to predict saturation excess and infiltration of surface runoff. Atrazine and simazine were the most frequently detected pesticides. Twenty-four percent of atrazine samples collected in April, May, and June exceeded the maximum contaminant level (mcl) of 3.0 parts per billion. Also, the median concentration of atrazine was higher in 2005 than for samples collected in April, May, and June 2004. A summary report of pesticide, nutrient, and suspended-sediment results from 2004 and 2005 is available online at [ky.water.usgs.gov](http://ky.water.usgs.gov).

**Little River Monitoring Project.** The USGS, in cooperation with the Kentucky Department of Agriculture, studied seasonal and spatial variables involving pesticides and nutrients in the Little River Basin in western Kentucky. The Department of Agriculture will recommend the application of additional best management practices based upon the USGS's data analysis and findings. A USGS Scientific Report indicated that herbicides were detected more frequently than insecticides or fungicides. Fifteen of 24 pesticides detected in the basin were herbicides. Atrazine exceeded the MCL in 17 percent of the samples and simazine exceeded its MCL in 2 percent of the water samples.

**Rough River Project.** This project is coordinated by Western Kentucky University in cooperation with the Department of Agriculture, local partners in Grayson County, and the University of Kentucky's Cooperative Extension Service, which is responsible for educational outreach. This project has been important in showing the runoff of atrazine into the Rough River.

**Atrazine Research.** Syngenta Corp. and the Department of Agriculture's Pesticide Workgroup have been working for several years with communities in small watersheds, monitoring their water systems. The most responsive system has been Marion Community System in Crittenden County, in which atrazine levels have been reduced with the assistance of the Corn Growers Association, who have involved the local farmers in an "Atrazine Free" effort. This is primarily a surface-water

program, but the results also have important implications for shallow groundwater quality. It has expanded to other community systems in which the workgroup is monitoring pesticides on an ongoing basis. Data are coming from Marion in Crittenden County, the Webster County Community System, and the Leitchfield Community System in Grayson County. Recently, Syngenta's monitoring program has expanded to simazine in the Livermore Community System in McLean County. The effort is examining both raw and finished water in public water-supply systems.

### ***Division of Mine Reclamation and Enforcement***

**Mine Monitoring.** The Division of Mine Reclamation and Enforcement monitored a partially flooded, above-drainage underground mine in Pike County from March 2004 through June 2006 in order to determine the effects of seasonal variations in precipitation and evapotranspiration on the mine pool elevation. Water level, temperature, and specific conductivity of the mine pool, as well as local precipitation, were monitored for 14 months prior to draining the mine pool. An additional 12 months of monitoring was conducted as the water level in the mine pool was lowered. Data analysis is ongoing. The findings will be useful for future investigations of mine pools and groundwater resources from deep mines.

### ***Kentucky Geological Survey***

**Locating and Testing New Water Supplies.** The Kentucky Geological Survey continued work in conjunction with the Kentucky Infrastructure Authority to identify sources of water for public water supplies for small communities and rural neighborhoods. KGS completed drilling and hydraulic testing of the Corbin Sandstone in Long Branch, Magoffin County, to aid in planning future water supplies for the city of Salyersville and the Magoffin County Water District. A draft report was started on the hydrogeologic characteristics of the Corbin Sandstone. In addition, a report was completed on the use of abandoned underground coal mines as sources of water supply in the Eastern Kentucky Coal Field. Initial efforts have begun to help the cities of Campton (Wolfe County) and Evarts (Harlan County) locate additional ground-

water supplies. Investigations at these sites are in cooperation with the Kentucky Rural Water Association.

**Groundwater Impacts in the Cumberland Gap Tunnel.** The Kentucky Geological Survey, in coordination with the Cumberland Gap Tunnel Authority, the Federal Highways Administration, the Kentucky Transportation Cabinet, the University of Kentucky Transportation Center, and Vaughn and Melton Engineers Inc., began dye-tracing and drilling programs to determine the groundwater flow path, levels, and velocities in the sub-base gravels and bedrock beneath the road surface in the Cumberland Gap Tunnel. These conditions are thought to be related to road-surface deflection caused by movement of the sub-base materials. The deflection constitutes the beginning of a geologic hazard that may have serious implications for future traffic use of the tunnel.

**Cover-Collapse Sinkholes.** KGS has a long-term interest in determining the frequency of occurrence of cover-collapse sinkholes, sites where underground voids propagate to the land surface. A test case comparing aerial photography taken in 1971 with aerial photography taken in 1991 for part of Christian County, followed up by field visits to suspected sites, was previously completed. This work continues as time and staffing levels permit.

**Groundwater Basin Maps.** Groundwater in karst systems sometimes flows beneath the topographic divides that are used to define river basins, surface-water drainage patterns, and groundwater basins in nonkarst regions. As a result, dye tracing is needed to delineate groundwater basins in karst systems so that the potential for flooding and contaminant transport can be assessed. The major activity during the past year focused on defining groundwater flow systems in Hardin County, near the city of Radcliff.

**Karst Geologic Hazards.** Karst groundwater basins were investigated to determine the potential for geologic hazards resulting from the relocation of Ky. 163 in Monroe County and the proposed Interstate 66 corridor in Pulaski County. KGS is developing a Web site that explains karst geologic hazards ([www.uky.edu/KGS/water/general/karst/kgeohazard.html](http://www.uky.edu/KGS/water/general/karst/kgeohazard.html)).

**Groundwater Quality in Rural Domestic Water Wells, Jackson Purchase and Western Kentucky Coal Field Regions.** The goals of this project are to determine the source and the extent of nitrate and pesticide contamination in shallow groundwater systems (less than 100 feet below land surface) in various hydrologic settings in the Jackson Purchase Region, and assess the effect of remediation on an abandoned feedlot in the Western Kentucky Coal Field. In the Jackson Purchase, 54 domestic water wells were sampled for nitrate, chloride, herbicides, bacteria, and other field parameters. Fifty-one previously sampled domestic wells were sampled for total dissolved metals, sulfate, fluoride, and bicarbonate. Twenty-eight were sampled for nitrogen isotopic composition of nitrate, and 111 wells were sampled for caffeine. Preliminary data indicate that the possible sources of elevated nitrate in the Jackson Purchase Region are fertilizers, septic waste, and animal waste. In the coal field, one domestic well and seven monitoring wells were sampled monthly for nitrate and chloride to determine if concentrations are decreasing after remediation of an abandoned feedlot. Since remediation, nitrate and chloride concentrations beneath the feedlot have dropped approximately 70 and 170 mg/L, respectively, suggesting that remediation has been effective.

**Experimental Program to Stimulate Competitive Research.** KGS helped University of Kentucky students locate and sample water wells for two projects: "Environmental Monitoring and Assessment of Selected Inorganic Elements in Groundwater Samples from Calloway County" and "Environmental Monitoring and Assessment of Selected Inorganic Ions in Groundwater Samples from Calloway County."

**Expanded Groundwater Monitoring in the Jackson Purchase Region.** To assist the Division of Water's Statewide Ambient Groundwater Monitoring Program, KGS sampled 60 wells in the spring of 2004 and again in the fall of 2005 to identify sources of nonpoint-source contamination of groundwater in the Jackson Purchase Region. Concentrations of inorganic solutes and nonpoint-source chemicals are being evaluated with respect to well construction, depth and type of water-producing strata, land cover and land use, crop type if in an agricultural

setting, proximity to on-site wastewater systems, and other factors that may promote or reduce activities or conditions conducive to nonpoint-source chemical use. This information may then be used to design and implement best management practices to reduce or eliminate nonpoint-source contamination of groundwater supplies.

## Groundwater Quality Characterization

Uninterpreted results of data collection programs are of little value to most citizens, agencies, and organizations that are concerned with regional groundwater quality and supply. Placing results of such investigations into the context of natural conditions, regional variations in bedrock type and land use, potential impact of human activities, and the possible impacts on human health is therefore an important activity of the Kentucky Interagency Groundwater Monitoring Network. This section lists reports that are currently being prepared or have been recently completed.

**Groundwater Monitoring for Nonpoint-Source Pollution Assessment in the Upper Cumberland, Lower Cumberland, and Tennessee River Basins, and the Jackson Purchase Region (Basin Management Unit 3).** KGS completed a summary and interpretation of the results of groundwater monitoring activities in the Upper Cumberland, Lower Cumberland, and Tennessee River Basins, and the Jackson Purchase Region (see "Distribution of Groundwater Information," below). KGS sampled 30 wells and springs quarterly, and the samples were analyzed for major and minor inorganic chemicals, nutrients, pesticides, and volatile organic chemicals. The results were combined with data from the Kentucky Groundwater Data Repository to assess quality and impacts of 30 point-source chemicals on the groundwater system. This report was previously submitted to the Division of Water and accepted as the final contract deliverable. It is in the process of being released as a formal KGS serial publication, and will be placed on the KGS Web site for easy accessibility.

**Evaluation of Existing Groundwater Quality Data from Watersheds of the Kentucky, Salt, Licking, Big Sandy, and Little Sandy Rivers, and Tygarts Creek (Basin Management Units 1, 2, and 5).** The

Kentucky Geological Survey summarized existing groundwater-quality data for samples taken from sites in the Kentucky River, Salt River, Licking River, Big Sandy River, Little Sandy River, and Tygarts Creek watersheds. The Kentucky Groundwater Data Repository is the source of the analytical records. Analytical results for water properties, major and minor inorganic ions, nutrients, pesticides, and volatile organic compounds are summarized for each basin management unit, physiographic region, and major river basin (see "Distribution of Groundwater Information," below). This report was previously submitted to the Division of Water and accepted as the final contract deliverable. It will be released as a formal KGS serial publication, and will be placed on the KGS Web site for easy accessibility.

**Groundwater Quality in Watersheds of the Big Sandy River, Little Sandy River, and Tygarts Creek (Kentucky Basin Management Unit 5).** KGS completed a summary and interpretation of the results of groundwater monitoring activities in watersheds of the Big Sandy River, Little Sandy River, and Tygarts Creek in eastern Kentucky (see "Distribution of Groundwater Information," below). KGS sampled 32 wells and springs quarterly, and the samples were analyzed for major and minor inorganic chemicals, nutrients, pesticides, and volatile organic chemicals. The results were combined with data from the Kentucky Groundwater Data Repository to assess quality and impacts of nonpoint-source chemicals on the groundwater system. This report was previously submitted to the Division of Water and accepted as the final contract deliverable. It will be released as a formal KGS serial publication, and will be placed on the KGS Web site for easy accessibility.

**Statewide Maps of Groundwater Quality.** KGS continues to prepare statewide maps and summaries showing concentrations of specific chemicals in groundwater, which are published as Information Circulars. Each Information Circular describes the natural occurrence of the chemical, how it is used in industrial or agricultural applications, and potential harmful effects if present in drinking water at significant levels. Maps show sampled sites and ranges of concentrations, and a summary of all analytical results for wells and springs

throughout Kentucky is included. Data for these reports are taken from the Kentucky Groundwater Data Repository. Summaries for iron, manganese, and atrazine were prepared during the past year (see "Distribution of Groundwater Information," below).

**Karst Potential Index.** KGS researchers developed a karst potential index, which rates the solubility of bedrock based on geologic descriptions from maps or other publications. This index can then be used to assign a GIS attribute for karst-related hazards to regional geologic maps. This work is ongoing.

## Distribution of Groundwater Information

One of the most important functions of the Kentucky Interagency Groundwater Monitoring Network is converting analytical data from groundwater sample analyses to readily available, useful information, and distributing that information through presentations and publications. During the past fiscal year, groundwater information was communicated in the following reports, presentations at meetings and conferences, and Web sites.

### Publications

- Beck, E.G., and Dinger, J.S., 2006, Groundwater-quality assessment and shallow aquifer model of Calloway County, Kentucky [abs.]: Kentucky Water Resources Annual Symposium Abstracts, p. 13-14.
- Beck, E.G., Dinger, J.S., and Inkenbrandt, P.C., 2006, Summary of groundwater quality data in the Jackson Purchase Region, Kentucky [abs.]: Kentucky Water Resources Annual Symposium Abstracts, p. 11-12.
- Crain, A.S., 2006, Concentrations of nutrients, pesticides, and suspended sediment in the karst terrane of the Sinking Creek Basin, Kentucky, 2004: U.S. Geological Survey Open-File Report 2006-1091, 15 p. ([pubs.usgs.gov/of/2006/1091](http://pubs.usgs.gov/of/2006/1091)).
- Cumbie, D.H., Dinger, J.S., and Davidson, B., in press, Assessing water-supply potential of abandoned underground coal mines in eastern Kentucky: Kentucky Geological Survey, ser. 12, Report of Investigations 12.
- Davidson, B., and Fisher, R.S., 2005, Groundwater quality in Kentucky: Barium: Kentucky Geological Survey, ser. 12, Information Circular 11, 4 p.
- Davidson, B., and Fisher, R.S., in press, Groundwater quality in Kentucky: Atrazine: Kentucky Geological Survey, ser. 12, Information Circular 16.
- Fisher, R.S., and Davidson, B., in press, Groundwater quality in Kentucky: Iron: Kentucky Geological Survey, ser. 12, Information Circular 13.
- Fisher, R.S., and Davidson, B., in press, Groundwater quality in Kentucky: Manganese: Kentucky Geological Survey, ser. 12, Information Circular 14.
- Fisher, R.S., Davidson, B., and Goodmann, P.T., in press, Groundwater quality in watersheds of the Big Sandy River, Little Sandy River, and Tygarts Creek (Kentucky Basin Management Unit 5): Kentucky Geological Survey, ser. 12, Report of Investigations.
- Fisher, R.S., Davidson, B., and Goodmann, P.T., in press, Groundwater quality in watersheds of the Kentucky River, Salt River, Licking River, Big Sandy River, Little Sandy River, and Tygarts Creek (Kentucky Basin Management Units 1, 2, and 5): Kentucky Geological Survey, ser. 12, Report of Investigations 16.
- Fisher, R.S., Davidson, B., and Goodmann, P.T., in press, Regional groundwater quality in watersheds of the Upper Cumberland, Lower Cumberland, and Lower Tennessee Rivers, and the Jackson Purchase Region (Kentucky Basin Management Unit 3): Kentucky Geological Survey, ser. 12, Report of Investigations 15.
- Ray, J.A., and Blair, R.J., 2005, Large perennial springs of Kentucky: Their identification, base flow, catchment, and classification, *in* Beck, E.G., ed., Sinkholes and the engineering and environmental impacts of karst: American Society of Chemical Engineers Geotechnical Special Publication 144, p. 410-422.
- Taylor, C.J., Nelson, H.L., Hileman, G., and Kaiser, W.P., 2005, Hydrogeologic framework mapping of shallow, conduit-dominated karst—Components of a regional GIS-based approach, *in* Kuniansky, E.L., ed., U.S. Geological Survey Karst Interest Group Proceedings, Rapid City, South Dakota, September 12-15, 2005: U.S. Geological

Survey Scientific Investigations Report 2005-5160, p. 103–113 ([pubs.er.usgs.gov/usgspubs/sir/sir20055160](http://pubs.er.usgs.gov/usgspubs/sir/sir20055160)).

Unthank, M.D., and Nelson, H.L., Jr., 2006, Summary of available hydrogeologic data for the northeast portion of the alluvial aquifer at Louisville, Kentucky: U.S. Geological Survey Open-File Report 2006-1146, 60 p. ([pubs.usgs.gov/of/2006/1146](http://pubs.usgs.gov/of/2006/1146)).

Webb, S.E., Dinger, J.S., and Cumbie, D.H., in press, Fish tissue study at the Kentucky Army National Guard Wendell H. Ford Western Kentucky Training Site, Muhlenberg County, Kentucky: Kentucky Geological Survey, ser. 12, Information Circular 12.

Webb, S.E., Dinger, J.S., Cumbie, D.H., and Russo, L.K., in press, Water-quality and -quantity data for abandoned underground coal mines located in eastern Kentucky: Kentucky Geological Survey, ser. 12, Information Circular 15.

### **Presentations**

Beck, E.G., 2005, Downhole camera workshop: Southern Region Water Quality Conference, Lexington, Ky., October 23–26.

Beck, E.G., 2006, Well installation and maintenance: Rural Living Clinic, Marshall County Extension Service Office, March 27.

Beck, E.G., and Dinger, J.S., 2006, Groundwater-quality assessment and shallow aquifer model of Calloway County, Kentucky: Kentucky Water Resources Annual Symposium, Lexington, Ky., March 2.

Beck, E.G., Dinger, J.S., and Inkenbrandt, P.C., 2006, Summary of groundwater quality data in the Jackson Purchase Region, Kentucky: Kentucky Water Resources Annual Symposium, Lexington, Ky., March 2.

Dinger, J.S., 2006, Karst consequences in Kentucky: Keynote address: Kentucky Environmental Quality Commission, Annual Awards Ceremony, Lexington, Ky., April 21.

Fisher, R.S., and Davidson, B., 2006, New groundwater publications from the KGS Water Resources Section: Kentucky Geological Survey Annual Meeting, Lexington, Ky., April 21.

Ray, J.A., and Blair, R.J., 2006, Little River watershed delineation and “misbehaved” karst

drainage: Kentucky Water Resources Annual Symposium, Lexington, Ky., March 2.

Vendrell, P., Pagan, T., Beck, E.G., and Thom, W., 2005, Beyond traditional wellhead inspections with a down-well camera: Southern Region Water Quality Conference, Lexington, Ky., October 23–26.

Webb, J., Oliver, B., and Goodmann, P., 2006, A brief history and current state of groundwater protection in Kentucky: Kentucky Water Resources Annual Symposium, Lexington, Ky., March 2.

### **Web Sites**

The Kentucky Geological Survey provides online access to public information about water wells and springs at [kgsweb.uky.edu/DataSearching/Water/WaterWellSearch.asp](http://kgsweb.uky.edu/DataSearching/Water/WaterWellSearch.asp). This information is useful to the public, well drillers, consultants, and researchers. KGS also maintains and regularly updates a Web site for the Kentucky Interagency Groundwater Monitoring Network ([www.uky.edu/KGS/water/gnet/gnet.htm](http://www.uky.edu/KGS/water/gnet/gnet.htm)). This site contains data summaries and maps showing concentrations of nitrate, fluoride, arsenic, mercury, and selenium; 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 Interagency Technical Advisory Committee on Groundwater agencies and organizations. The Kentucky Geological Survey has compiled information about hydrology, geology, topography, water supply, and water quality from maps, reports, and data collected from 1940 to 2000 and posted it for public access at [www.uky.edu/KGS/water/library](http://www.uky.edu/KGS/water/library). All the water-quality analyses stored in the Kentucky Groundwater Data Repository have been placed online by the Kentucky Geological Survey. This repository was established to archive all groundwater data collected throughout Kentucky by State and Federal agencies, university researchers, and others. These data may be downloaded at [kgsweb.uky.edu/DataSearching/watersearch.asp](http://kgsweb.uky.edu/DataSearching/watersearch.asp). During the 2005–06 fiscal year, Internet maps of water data were visited 31,406 times, the groundwater database was searched 7,190 times, and groundwater data were downloaded 274 times.

## Interagency Coordination

Cooperation among agencies and research organizations that collect, analyze, and use groundwater data is essential in order to reduce monitoring costs, improve program efficiency, and promote data sharing. The Kentucky Interagency Technical Advisory Committee on Groundwater provides a forum for participating organizations to meet quarterly and discuss groundwater issues.

Cooperation and interaction within the ITAC agencies and between ITAC agencies and other groups and organizations is routine. Many programs benefit from the Division of Water's willingness to collect and analyze groundwater samples in support of various projects. Recent examples include the Division of Water coordinating with the Kentucky Geological Survey to collect groundwater samples at a drilling site in Salyersville, and the Division of Water's regular sampling of Royal Spring, the focus of a Kentucky Geological Survey travel-time study. The Division of Water also samples groundwater and surface water for nonpoint-source constituents in support of projects for the Division of Pesticide Regulation. The Division of Water and the Kentucky Geological Survey regularly answer inquiries from the public and communicate with staff of the Kentucky Rural Water Association. The Kentucky Geological Survey has been meeting with County Extension Service agents and Area Development Districts throughout the commonwealth to promote awareness of hydrogeologic issues. Many of the ITAC agencies are also members of the Kentucky Agricultural Water Quality Authority, or cooperate with the authority and participate in its meetings. Staff of both the Division of Water and the Kentucky Geological Survey regularly participate in meetings of State and Federal agencies and citizens' groups that have interests in groundwater resources.

## Sharing Groundwater Data

Sharing groundwater data is an essential function of the Kentucky Interagency Groundwater Monitoring Network. Data transfers between agencies provide each group access to a larger database than any agency could develop independently, thereby improving evaluations of groundwater quality and suitability for various uses, threats to groundwater quality, and the effects of mining,

logging, agricultural practices, urbanization, waste disposal, and oil and gas production. Sharing data also reduces the overall expense and increases the efficiency of monitoring efforts.

Data have been transferred electronically between the Division of Water groundwater database and the Kentucky Groundwater Data Repository, and between the Kentucky Geological Survey analytical laboratory and the Division of Water's Groundwater Branch since 1992. There has also been a high level of collaboration and data sharing between the Kentucky Geological Survey and the Groundwater Branch during the reporting period, because the agencies are jointly reporting on groundwater quality throughout the state.

In 2006 KGS has been restructuring the Kentucky Groundwater Data Repository database. Groundwater quality information from three primary sources have been updated: the Kentucky Division of Water (Department for Environmental Protection Consolidated Groundwater Database), the U.S. Geological Survey (National Water Information System database on groundwater for Kentucky), and the U.S. Environmental Protection Agency (Storet Modern and Storet Legacy). Following completion of the new database, the repository will be the most complete available on groundwater in Kentucky, and will serve these data to the public through the KGS Web site. The data will include information on over 70,000 water wells, 6,000 springs, and 58,000 groundwater-quality samples containing over 1.3 million individual analyte results.

The Kentucky Department for Environmental Protection is installing and testing a new lab data software program called COMPASS, which is intended to become a seamless interface with its internal tracking and permitting database, TEMPO. COMPASS is currently undergoing a pilot project, both with the State laboratory and with an external consulting firm and two subcontract labs. Procedures are currently being developed, and bugs in the program and interface are being worked out. The long-term goal is for most or all environmental lab data to be submitted electronically so that they can be accessed and evaluated in an electronic format.

## Future Activities

Current activities will continue into the 2006–07 State fiscal year. In addition, the Division of Water has received two new grants to study nonpoint-source chemicals in groundwater. One will take place in basin management unit 4 (watersheds of the Green River and Tradewater River), and field work will begin in 2006. The second study will take place in basin management unit 5 (watersheds of the Big Sandy River, Little Sandy River, and Tygarts Creek); field work will begin in 2007.

In addition to continuing these existing projects, the following activities are urgently needed and will be initiated as funding becomes available:

- Evaluating the optimal sample collection frequency for wells and springs in different flow systems to 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 groundwater-level and groundwater-quality data from paper files to the electronic database
- Expanding the number of sampled wells and springs to improve coverage of the state
- Using groundwater-quality data to help delineate groundwater basins and wellhead protection areas
- Begin building a database on bacteria and other pathogens in groundwater
- Begin sampling for drugs, steroids, and other synthetic organic chemicals from human use or confined animal-feeding operations
- Delineating areas where different groundwater flow systems prevail. It is essential to distinguish between shallow, intermediate, and deep flow systems and between the laminar flow

conditions that occur in porous media and the turbulent flow that can occur in karst systems so that nonpoint-source best management practices and groundwater vulnerability can be better assessed.

## Summary

The Kentucky Interagency Groundwater Monitoring Network was very active during the reporting period. Programs to collect statewide ambient groundwater-quality data, as well as to investigate specific problems of karst hydrology and aquifer sensitivity, potential nonpoint-source contamination of groundwater supplies, and the effects of agricultural practices on groundwater resources, were completed or are in progress. One major report and one Information Circular were completed, and four summary reports on ambient groundwater quality are in preparation.

Most of the activities conducted during the reporting period were largely investigations of identified or suspected groundwater-quality problems, and were possible only because the agencies involved were able to obtain funding from outside sources. As noted in previous annual reports, the availability of these funds is decreasing. A stable source of recurring funding is essential if groundwater issues are to be addressed on a proactive basis, which will best serve the needs of citizens, resource managers, and environmental regulators.

## References Cited

- Interagency Technical Advisory Committee on Groundwater, 1996, Framework for the Kentucky Groundwater Monitoring Network: A report of the Interagency Technical Advisory Committee: University of Kentucky, Kentucky Water Resources Research Institute, 29 p.
- Kentucky Division of Water, 1997, Kentucky watershed management framework: Kentucky Division of Water, various pagination.