Kentucky Interagency
Groundwater
Monitoring Network

Annual Report 2004–2005

Kentucky Geological Survey
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Kentucky Interagency Groundwater Monitoring Network

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Kentucky Interagency Groundwater Monitoring Network Annual Report 2004–2005

Executive Summary

Recognizing that groundwater is an essential natural resource but that groundwater supplies and groundwater 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.

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 point-source or nonpoint-source contamination, and to assist cities and industries in planning water-use and waste-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 were to 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 2004–2005 fiscal year.

From July 2004 through June 2005, 18 major data collection programs were under way, and five regional groundwater characterization reports were being prepared. Groundwater information was communicated to the scientific and regulatory communities and to the public through more than 50 presentations, publications, and postings on Web sites. 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 7 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 (1) developing new monitoring sites in areas that have not yet been sampled, (2) optimizing the sampling frequency to account for natural variations in different groundwater flow systems throughout the state, (3) determining how large an area is represented by a sample at a particular well or spring, (4) monitoring the intrusion of nonpoint contaminants into groundwater systems, (5) investigating the occurrence of bacteria and other pathogens in regional groundwater flow systems, (6) standardizing reporting information about sampling methods, field measurements, and sample-site descriptions, (7) developing a water-level monitoring network to track long-term land use and climate effects on groundwater supplies, (8) standardizing laboratory reporting procedures, (9) facilitating electronic data sharing among agencies that work with groundwater measurements, and (10) providing 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 staff and funding conditions, however. Most of the progress in the past has been the result of substantial agency commitment of State executive budget funds, one-time grants to the Kentucky Division of Water's Groundwater Branch and the Kentucky Geological Survey, and voluntary cooperation between agencies. Implementing an effective groundwater monitoring plan will require sustained, recurring funding to maintain the long-term effort.

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 more than 300,000 citizens in private households rely on water from wells and springs for drinking, cooking, and washing. An additional 254 public water systems, serving more than 1.25 million people, rely on groundwater as a source of drinking water. This dependence on groundwater resources will continue 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. Currently, the cities of Louisville, Hardinsburg, and Salyersville, and the Greater Fleming Regional Water Supply are 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 also sustains valuable ecosystems by providing base flow to streams, lakes, and wetlands. This is particularly important during droughts such as those that occurred in 1999 and 2005. In the absence of precipitation, groundwater base flow is the only natural source of water to maintain stream flow 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 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, 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 legislature 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 seventh annual report of the Kentucky Interagency Groundwater Monitoring Network.

Previous reports are posted at www.uky.edu/kgs/water/gnet/gnet.htm.

2004–2005 Activities and Accomplishments

Brief summaries of work performed by the ITAC agencies during the 2004–2005 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 sewage, pesticides, fertilizers, and volatile organic compounds have had an impact on the groundwater system. These regional studies are conducted in one or more of the basin management units (Fig. 1) that were established by the Kentucky Division of Water (1997). Site-specific studies are designed to evaluate the effects of particular land uses or unique hydrologic conditions, or the quality of unregulated public water supplies such as roadside springs.

Groundwater Monitoring Programs. The Kentucky Division of Water's Groundwater Branch collected 393 samples from 218 sites during the past year:

- Seventy-nine sites were sampled at various intervals (3-month, 6-month, 15-month) by Groundwater Branch personnel under the statewide Ambient Groundwater Monitoring Program.

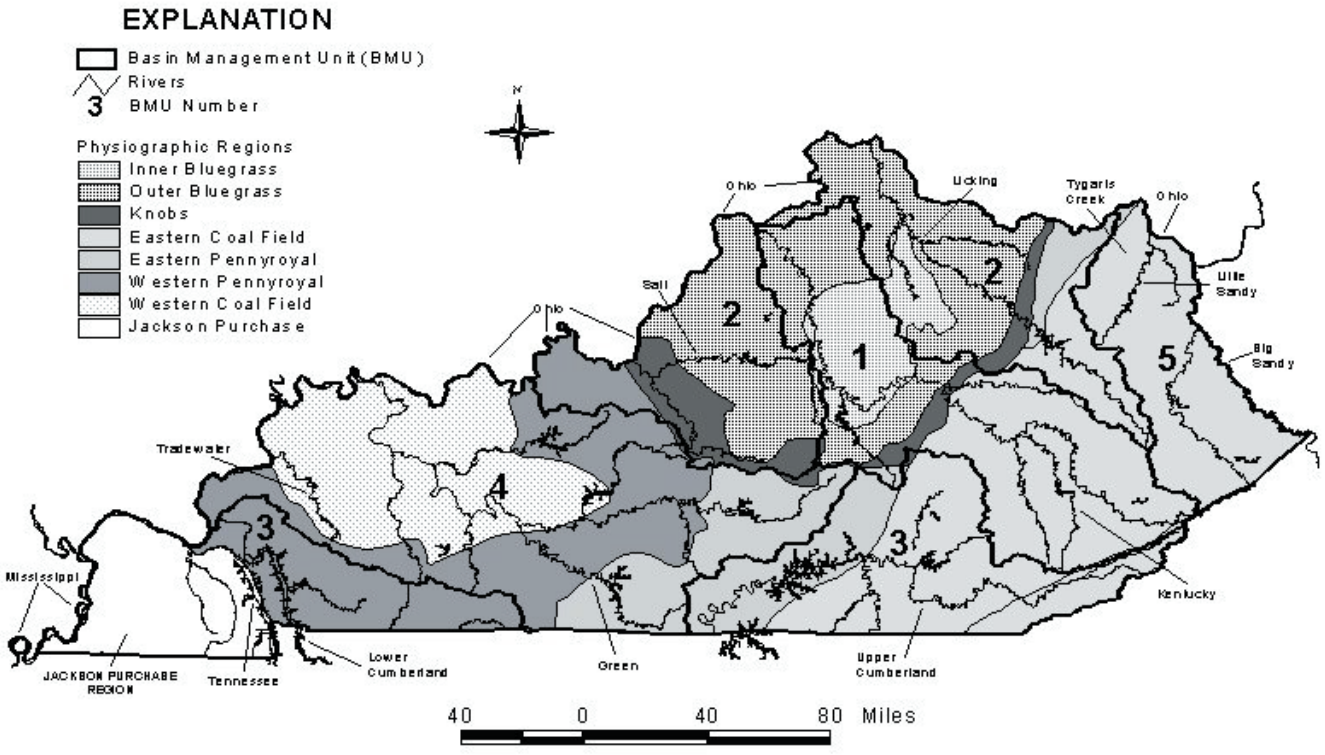

Figure 1. Major rivers, basin management units, and physiographic regions in Kentucky.

- One hundred thirty-five sites were sampled quarterly by Groundwater Branch and Kentucky Geological Survey personnel under Non-Point Source Assessment (Clean Water Act Section 319(h)) projects.
- Four sites were sampled quarterly by Groundwater Branch personnel under a Memorandum of Agreement with the Division of Pesticide Regulation.

Water-Quality Assessment in the Sinking Creek Basin, Breckinridge County, Kentucky. The U.S. Geological Survey, in cooperation with the Kentucky Department of Agriculture, is evaluating water-quality in the karst groundwater system of the upper Sinking Creek Basin. Pesticides, nutrients, streamflow, precipitation, and sediment data are being collected over a 2-year period (2004–2005). Water-quality samples (for pesticides and nutrients) and suspended-sediment samples were collected in 2004 at two fixed-station sites on Sinking Creek and at five karst springs. The first-year findings were published in the USGS 2004 Kentucky Annual Water-Resources Data Report (McClain and others, 2005). The second year of water-quality and suspended-sediment sampling began in spring of 2005 and will end in the fall of 2005. Future work will focus on developing a water-quality runoff model to evaluate potential pollutant sources and processes within the upper Sinking Creek Basin. This work is funded by a one-time grant from the U.S. Environmental Protection Agency, administered by the Division of Water's Nonpoint Source Section.

Louisville Water Company, Jefferson County, Kentucky. The USGS, in cooperation with the Louisville Water Company, maintains a network of 16 water-level observation wells in the northeastern part of the Ohio River alluvium in Jefferson County. Seven of the wells are equipped with continuously recording pressure transducers that measure depth to water and water temperature. Water-level measurements are taken at the other nine observation wells on a quarterly basis. These data are assisting the water company's efforts to design and implement river-bank infiltration using a network of water-supply wells constructed to draw and naturally filter river water through the sand and gravel aquifer near the Payne Water-Treatment Plant.

Kentucky Abandoned Landfills. The Kentucky Division of Waste Management–Solid Waste Branch has recently contracted with the USGS to characterize the hydrogeology and potential for contaminant migration at a selected number of abandoned landfills. Preliminary work has begun at three sites—Trigg County Landfill, Owensboro Municipal Landfill in Daviess County, and Bardwell Landfill in Carlisle County—and will continue into the next fiscal year.

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. During the first phase of the project (fiscal year 2004–06), a special emphasis is being placed on developing geographic information system technology to improve the utilization and integration of karst geospatial and time-series data, and on new methods to improve the estimation of karst water budgets. Two spring basins in Kentucky, the McCracken Spring Basin in Meade County and the Graham Springs Basin in Warren and Edmonson Counties, are being used as demonstration sites for this effort. A variety of available data about karst springs in other parts of Kentucky is also being collected and synthesized with data from the other states as part of the regional study. Additional information about the GWRP can be obtained at water.usgs.gov/ogw/gwrp/.

Maxey 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 fourteen other monitoring wells. Of these, two are sampled quarterly for tritium, and the remaining 12 are sampled annually.

Groundwater-Level Data Collection. The USGS collects real-time continuous water-level measurements from an observation well in Graves County, Ky., that is included in the USGS National Ground-Water Climate Response Network: a network of wells intended to monitor the effects of droughts and other climate variability on the nation's groundwater resources. The water-level data for this well can be accessed at groundwaterwatch.usgs.gov/ or ky.water.usgs.gov/index.htm.

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 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 at ky.water.usgs.gov/.

Karst Studies. The Kentucky Geological Survey is conducting groundwater investigations in two areas where natural karst systems may affect highway construction: the delineation of the Miller Cave karst groundwater basin for the relocation of Ky. 163, Monroe County, and the delineation of karst groundwater basins along the proposed Interstate 66 corridor, Pulaski County. Both studies are using dye traces to determine recharge and discharge areas of karst groundwater flow systems.

The Kentucky Geological Survey continued work on a demonstration project for maps showing the probability of cover-collapse sinkholes using aerial photos taken 10 years apart. KGS staff counted existing cover-collapse sinkholes that were not shown on the earliest photograph and identified some reported sinkholes that occurred but were filled during the 10-year period between photographs. This work is ongoing. KGS staff also continued work to develop an indexing methodology for the degree of karst development in the state.

Evaluating High-Yield Well Potential in the Eastern Kentucky Coal Field. The Kentucky Geological Survey continued its study of the hydrologic properties of the Corbin Sandstone in Magoffin County to help the county and the city of Salyersville locate drilling sites for high-yield wells to supplement their water supplies. Two wells were drilled in different hydrogeologic conditions, and both yielded large quantities of water of better quality than had been reported in previous investigations. Additional wells will be drilled and sampling will be performed in 2005–06. A substantial amount of this work is funded by the Kentucky Infrastructure Authority.

Evaluating Water Quality at the Kentucky Army National Guard Training Facilities. The Kentucky Geological Survey concluded work with the Kentucky Department of Military Affairs in the assessment of water quality at the Kentucky Army National Guard training facilities in Muhlenberg, Powell, and Knox Counties. Contract reports were completed that addressed the impact of previous and current activities on surface water and groundwater at the site. A Kentucky Geological Survey publication is being written concerning the water quality at the Wendell H. Ford site in Muhlenberg County. Water levels in monitoring wells will continue to be measured at this site on a bi-annual basis. This work was principally funded by the Kentucky Department of Military Affairs, with ancillary support from the Kentucky Geological Survey.

Agricultural Contaminant Movement through Closed-Depression Sinkholes. The Kentucky Geological Survey and the University of Kentucky College of Agriculture are in the initial phases of a new program to assess the movement of potential pollutants derived from agricultural activities in closed-depression sinkholes. In some locations, these sinkholes may be several acres in extent, and are used to raise row crops, grains, and feed, and to graze livestock. Soil amendments and waste from animals are concentrated in these sinkholes as a result of rainfall, and the resulting temporal ponds drain slowly to the groundwater system. The transport and fate of potential pollutants will be studied in various hydrogeologic conditions.

Groundwater Quality Associated with Rural Domestic Water Wells in the Jackson Purchase and Western Kentucky Coal Field Regions. In order to assess the groundwater quality associated with domestic water wells in the Jackson Purchase

Region, 173 wells were sampled and analyzed for nitrate-N, three herbicides, total coliform, and Escherichia coli (E. coli). Of the 173 wells sampled, 145 were bored (large diameter) wells and 28 were drilled (small diameter) wells. To better determine the source of elevated nitrate-N in the groundwater, 20 wells (three drilled, 17 bored) were sampled for nitrogen isotopes, and 29 wells (two drilled, 27 bored) were sampled for caffeine. Ten bored wells were traced using bromide to determine the influence, if any, of well construction on groundwater quality. Groundwater-quality data are mailed to the respective well owners along with pertinent educational materials.

Expanded Groundwater Monitoring in the Jackson Purchase Region. Approximately 60 wells are being sampled in the spring and again in the fall 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 the groundwater supplies.

Water-Monitoring Agreement between the Kentucky Department of Agriculture and the Kentucky Division of Water. The Division of Water, in cooperation with the Department of Agriculture, is collecting samples quarterly from two karst springs and two monitoring wells in the Little River watershed, Crittenden and Trigg Counties, for the Department of Agriculture. The samples are then analyzed at the Division of Environmental Services Laboratory for pesticides of concern, primarily atrazine and simazine. The same sites will be sampled for several years to provide a longer assessment that could reflect changes in pesticide levels of those monitoring sites. The information will be used to determine whether any contamination of the karst spring could also be observed in the nearby monitoring wells.

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 health effects of some chemicals in water is therefore a very important activity of the Kentucky Interagency Groundwater Monitoring Network. This section lists reports that are currently being prepared or recently completed.

Groundwater Monitoring for Nonpoint-Source Pollution Assessment in the Kentucky River Basin (Basin Management Unit 1) . The Division of Water completed a summary and interpretation of the results of expanded groundwater monitoring activities in the Kentucky River watershed (Webb and others, 2004). In cooperation with the Division of Water's Watershed Management Framework, Groundwater Branch staff sampled approximately 30 wells and springs quarterly, and the samples were analyzed by the Division of Environmental Services Laboratory for major and minor inorganic chemicals, nutrients, pesticides, and volatile organic chemicals. These wells and springs were in addition to the sites normally sampled as part of the Division of Water's Ambient Groundwater Monitoring Program.

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). The Kentucky Geological Survey completed a summary and interpretation of the results of expanded groundwater monitoring in the Upper Cumberland, Lower Cumberland, and Tennessee River Basins and the Jackson Purchase Region (Fisher and others, 2004). In cooperation with the Division of Water's Watershed Management Framework, the Kentucky Geological Survey sampled approximately 30 wells and springs

quarterly, and the samples were analyzed by the Division of Environmental Services Laboratory for major and minor inorganic chemicals, nutrients, pesticides, and volatile organic chemicals. These wells and springs were in addition to the sites normally sampled as part of the Division of Water's Ambient Groundwater Monitoring Program.

Evaluation of Existing Groundwater-Quality Data from Wells and Springs in 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 is summarizing existing groundwater-quality data for samples taken from sites in the Kentucky River, Salt River, Licking River, Big Sandy River, and Little Sandy River and Tygarts Creek watersheds. The KGS 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.

Karst Geologic Hazards. Kentucky Geological Survey researchers are continuing to develop a Web site explaining karst geologic hazards (www.uky.edu/KGS/water/general/karst/kgeohazard.html). The Web site provides information about sinkhole development and flooding, groundwater contamination, and definitions of karst features.

Karst Potential Index Map. Kentucky Geological Survey researchers developed a karst potential index that evaluates the potential of different bedrock types throughout Kentucky to develop karst features. This index can be used to develop map coverages for digital maps, and can be used by the public to evaluate potential problems associated with land development in various regions of Kentucky.

Distribution of Groundwater Information

One of the most important functions of the Groundwater Monitoring Network is converting analytical data from water-level measurements and groundwater sample analyses to readily available, useful information. During the past fiscal year, groundwater information was communicated via the following reports, presentations at meetings and conferences, and placement on Web sites.

Publications

Beck, E.G., Dinger, J.S., and McMeans, M., 2005a, Groundwater-quality comparisons between bored and drilled wells in the Jackson Purchase Region, Kentucky [abs.]: Kentucky Water Resources Annual Symposium, Abstracts with Program, p. 31–32.

Beck, E.G., Dinger, J.S., and McMeans, M., 2005b, Using a bromide tracer to determine if groundwater quality in the Jackson Purchase Region, Kentucky, is influenced by well construction [abs.]: Kentucky Water Resources Annual Symposium, Abstracts with Program, p. 37.

Beck, E.G., Dinger, J., McMeans, M., Thom, W., and Henken, K., 2005, Status report: Bacteria and other contaminants in domestic water wells in the Jackson Purchase Region: University of Kentucky Cooperative Extension Service, Environmental and Natural Resource Issues Report ENRI-221, 6 p.

Beck, E.G., and Henken, K., 2004, Disinfecting your well water: University of Kentucky Cooperative Extension Service, Environmental and Natural Resource Issues Fact Sheet, ENRI-222, 3 p.

Currens, J.C., Paylor, R.L., and Wilhelm, B., 2005a, Delineation of Miller Cave karst groundwater basin, for relocation of Ky. 163, Monroe County, Kentucky: Kentucky Transportation Cabinet, Project ID 3-276, Final Report, 23 p., 2 plates.

Currens, J.C., Paylor, R.L., and Wilhelm, B., 2005b, Delineation of karst groundwater basins along the proposed I-66 corridor, Pulaski County: Kentucky Transportation Cabinet, Interim Report, 30 p., 4 plates.

Davidson, B., and Fisher, R.S., 2004a, Groundwater quality data for selected parameters in Kentucky [abs.]: Kentucky Water Resources Annual Symposium, Abstracts with Program, p. 65.

Davidson, B., and Fisher, R.S., 2005a, Groundwater quality in Kentucky: Cadmium: Kentucky

Geological Survey, ser. 12, Information Circular 9, 4 p.
Davidson, B., and Fisher, R.S., 2005b, Groundwater quality in Kentucky: Mercury: Kentucky Geological Survey, ser. 12, Information Circular 8, 4 p.
Davidson, B., and Fisher, R.S., 2005c, Groundwater quality in Kentucky: Selenium: Kentucky Geological Survey, ser. 12, Information Circular 10, 4 p.
Davidson, B., and Fisher, R.S., 2005d, Mapping and serving online groundwater-quality data for Kentucky [abs.]: Kentucky Water Resources Annual Symposium, Abstracts with Program, p. 35
Dinger, J.S., Beck, E.G., Grove, J.H., Carey, D.I., and Inkenbrandt, P., 2005a, Groundwater quality associated with rural domestic water wells in the Jackson Purchase and Western Kentucky Coal Field Regions: SB-271 annual progress report for 2004–2005.
Dinger, J.S., Beck, E.G., Grove, J.H., and McMeans, M.L., 2005b, Groundwater quality associated with large diameter bored wells in the Jackson Purchase Region: SB-271 annual progress report for 2003–2004.
Dinger, J.S., Hutcheson, S.M., Kipp, J.A., and Sendlein, L.V.A., 2005c, Hydrostratigraphic controls in longwall mining, Eastern Kentucky Coal Field, Cumberland Plateau [abs.]: Kentucky Water Resources Annual Symposium, Abstracts with Program, p. 5–6.
Fisher, R.S., Davidson, B., and Goodmann, P.G., 2004a, Summary and evaluation of groundwater quality in the Upper Cumberland, Lower Cumberland, Tennessee, and Mississippi River watersheds: Kentucky Geological Survey Open-File Report OF-04-04, 169 p.
Fisher, R.S., Goodmann, P.T., and Webb, J., 2004b, Evaluating statewide and regional groundwater quality using archived data and ongoing monitoring [abs.]: Geological Society of America Abstracts with Programs, v. 36, no. 5, p. 186.
Fisher, R.S., Goodmann, P.T., and Webb, J., 2004c, Monitoring groundwater quality in Kentucky: From site selection to published information [abs.]: 2004 National Water Quality Monitoring Council Conference program, p. 211
Fisher, R.S., Davidson, B., Goodmann, P.T., and Webb, J.S. 2005, Evaluating groundwater quality in Kentucky: Data, methods, and results [abs.]: Kentucky Water Resources Annual Symposium, Abstracts with Program, p. 33.
Goodmann, P.T., Webb, J.S., and Fisher, R.S. 2004, The Kentucky Ambient Groundwater Monitoring Program: A collaborative characterization effort that is used to inform public policy [abs.]: Geological Society of America Abstracts with Programs, v. 36, no. 5, p. 185.
Paylor, R.L., and Currens, J.C., 2004, Royal Spring karst groundwater travel time investigation: Kentucky Geological Survey final report, 5 maps, 24 p.
Ray, J.A., O'dell, P.W., Moody, J.R., Blanset, J.M., and Blair, R.J., 2005, 319 report: Identification and prioritization of karst groundwater basins in Kentucky for targeting resources for nonpoint pollution prevention and abatement: Kentucky Division of Water, 136 p.
Webb, J.S., Blanset, J.M., and Blair, R.J., 2004, 319 report: Expanded groundwater monitoring for nonpoint source pollution assessment in the Kentucky River Basin: Kentucky Division of Water, 126 p.

Presentations

Beck, E.G., 2004, Groundwater quality associated with bored water wells in the Jackson Purchase Region: 2003–2004 data: Interagency Technical Advisory Committee on Groundwater, Frankfort, Ky., December 14.
Beck, E.G., 2005, Bacteria and other contaminants in domestic water wells in the Jackson Purchase Region, Kentucky: Marshall County Board of Health meeting, Draffenville, Ky., May 12.
Beck, E.G., 2005, Herbicide data collected from drilled and bored water wells in the Jackson Purchase Region: 1998–2004 data: Pesticide Work Group meeting, Frankfort, Ky., January 27.
Blair, R.J., and Blanset, J.M., 2005, Preliminary results for a nonpoint source groundwater study, South Fork Elkhorn Creek Basin, Kentucky: Kentucky Water Resources Annual Symposium, Lexington, Ky., March 3.

Blair, R.J., and Moody, J.R., 2004, The Ambient Groundwater Monitoring Network, karst hydrogeology and the water quality and hydrogeology at Sinking Spring, Larue Co.: Abraham Lincoln Birthplace National Historic Site, June 10.

Davidson, B., and Fisher, R.S., 2005, Mapping and serving online groundwater-quality data for Kentucky: Kentucky Water Resources Annual Symposium, Lexington, Ky., March 3.

Davidson, B., and Fisher, R.S., 2005, Metals in Kentucky's groundwater: Looking for trends using the Kentucky Groundwater Data Repository: Kentucky Geological Survey annual meeting, Lexington, Ky., April 29.

Dinger, J.S., 2004, Effects of longwall mining on hydrogeology, Cumberland Plateaus, Eastern Kentucky Coal Field: Hydrologic Issues Workshop, Longwall Mining, sponsored by U.S. Office of Surface Mining Reclamation and Enforcement, Morgantown, W.Va., August 4.

Dinger, J.S., 2005, The role of lock and dam structures on the Kentucky River: Jessamine County Public Library, Nicholasville, Ky., February 10.

Dinger, J.S., 2005, Water supply in central Kentucky: Kiwanis Club, Lexington, Ky., February 10.

Ellison, E., and McKinney, B., 2005, Case studies of Kentucky's Wellhead Protection Program: Kentucky Water Resources Annual Symposium, Lexington, Ky., March 3.

Fisher, R.S., 2004, Carbon dioxide sequestration in saline aquifers: Project Advisory Review Committee, Urbana, Ill., September 14.

Fisher, R.S., 2004, Evaluating statewide and regional groundwater quality using archived data and ongoing monitoring: Geological Society of America annual meeting, Denver, Colo., November 8.

Fisher, R.S., 2004, The Kentucky Ambient Groundwater Monitoring Network: A collaborative characterization effort used to inform public policy: Geological Society of America annual meeting, Denver, Colo., November 8.

Fisher, R.S., and Davidson, B., 2005, Using groundwater data available through the KGS for water-quality studies: Kentucky Geological Survey annual seminar workshop, Lexington, Ky., April 29.

Fisher, R.S., Davidson, B., Goodmann, P.T., and Webb, J.S., 2005, Evaluating groundwater quality in Kentucky: Data, methods, and results: Kentucky Water Resources Annual Symposium, Lexington, Ky., March 3.

Fisher, R.S., Goodmann, P.T., and Webb, J., 2004, Monitoring groundwater quality in Kentucky: From site selection to published information: 2004 National Water Quality Monitoring Council Conference, Chattanooga, Tenn., May 17–20.

Goodmann, P.T., 2005, Kentucky groundwater and public health issues: American Ground Water Trust Workshop, Lexington, Ky., March 31.

McKinney, B., 2005, Kentucky's Wellhead Protection Program: Western Kentucky University Source Water Protection Workshop, Barren River Area Development District, Bowling Green, Ky., January 26.

McMeans, M., Beck, E.G., and Dinger, J.S., 2005, Groundwater quality and distribution of domestic water wells sampled in the Jackson Purchase Region, Kentucky, between 1998 and 2004: Kentucky Water Resources Annual Symposium, Lexington, Ky., March 3.

Moody, J.R., Blanset, J.M., Webb, J.S., and Shuttleworth, J., 2004, Reference springs in Kentucky: Midwest Groundwater Conference, Bloomington, Ind., October 27–29.

O'dell, P.W., and Webb, J.S., 2004, Assessment of nonpoint source pollution impacts on groundwater in the headwaters of the North Fork of the Kentucky River Basin: An overview: Midwest Groundwater Conference, Bloomington, Ind., October 27–29.

Ray, J.A., 2004, A proposed definition of cutoff spring: Examples in Kentucky: Friends of Kentucky Karst Symposium, Lexington, Ky., September 15.

Ray, J.A., 2004, Water Watch karst training presentations: Cumberland Falls State Park, Whitley County, Ky., November 15.

Ray, J.A., 2005, Water Watch karst training presentations: Great Saltpeter Cave, Rockcastle County, Ky., April 15.

Ray, J.A., 2005, Evaluation of the recharge area and surface-water influence for fracture-flow

wells in karst terrane: Mississippian Plateau, Kentucky: Kentucky Water Resources Annual Symposium, Lexington, Ky., March 3.

Ray, J.A., and Blair, R.J., 2005, Large perennial springs identified in Kentucky: Diverse sources for karst groundwater basin and stream cutoff springs: Kentucky Water Resources Annual Symposium, Lexington, Ky., March 3.

Ray, J.A., O'dell, P.W., Moody, J.R., Blanset, J.M., and Blair, R.J., 2005, Identification and prioritization of karst groundwater basins in Kentucky for targeting resources for nonpoint source pollution prevention and abatement: Kentucky Division of Water, Frankfort, Ky., January 14.

Ray, J.A., O'dell, P.W., Moody, J.R., Blanset, J.M., and Blair, R.J., 2005, Identification and prioritization of karst groundwater basins in Kentucky for targeting resources for nonpoint source pollution prevention and abatement—A project summary: Kentucky Water Resources Annual Symposium, Lexington, Ky., March 3.

Web Site Information

The Kentucky Geological Survey provides online access to public information about water wells and springs at kgsweb.uky.edu/DataSearching/Water/WaterWellSearch.asp. During the past year the Division of Water–Groundwater Branch imaged all water-well records and provided digital files of the images to the Kentucky Geological Survey for placement on its Web site. The images are useful to the public, well drillers, consultants, and researchers.

The Kentucky Geological Survey maintains and annually updates 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, fluoride, arsenic, mercury, and selenium 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 other ITAC 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/webintro.html.

The Kentucky Geological Survey has mapped locations of water wells and springs for all the 30 x 60 minute quadrangles in Kentucky. These maps are now available online at kgsweb.uky.edu/PubsSearching/PubsSimpleSearch.asp.

The Kentucky Geological Survey has placed online all the water-quality analyses stored in the Kentucky Groundwater Data Repository. 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.

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 Technical Advisory Committee on Groundwater provides a forum for organizations that participate in the Interagency Technical Advisory Committee 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 to support 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 ground 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 have been meeting with County Extension Service agents and Area Development Districts throughout the Commonwealth to promote awareness of hy-

drogeologic issues. Many of the ITAC agencies are also members of the Kentucky Agricultural Water Quality Authority, or cooperate with the Authority and participate in their 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.

Groundwater Data Sharing

Sharing groundwater data is an essential function of the 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, and providing information about 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 from the Division of Water groundwater database have been transferred regularly to the Kentucky Groundwater Data Repository, and from the Kentucky Geological Survey analytical laboratory to the 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.

Future Activities

Preparing and distributing reports that summarize the results of groundwater investigations in terms that are readily understood by the public will remain an important function of the Kentucky Interagency Groundwater Monitoring Network. A report describing the results of expanded groundwater monitoring in watersheds of the Big Sandy River, Little Sandy River, and Tygarts Creek (basin management unit 5) will be completed in 2005, as well as a summary and evaluation of groundwater-quality data from wells and springs in watersheds of the Kentucky River, Salt River, Licking River, Big Sandy River, Little Sandy River, and Tygarts Creek (basin management units 1, 2, and 5). Quarterly sampling of the wells and springs that make up the Division of Water's Ambient Groundwater Monitoring Network will continue, as will focused sampling of wells in the Jackson Purchase Region.

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 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 groundwater-level and -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
- 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 best management practices for nonpoint-source pollution 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 proactively, which will best serve the needs of citizens, resource managers, and environmental regulators.

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