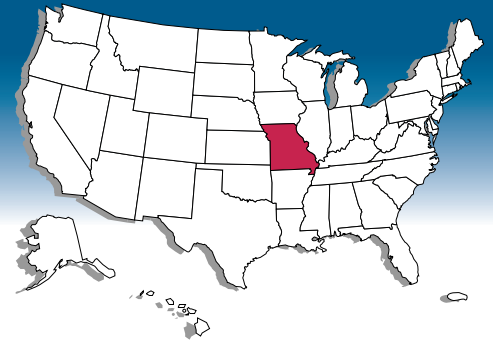




U.S. Geological Survey Programs in Missouri



U.S. Department of the Interior ■ U.S. Geological Survey

For more than 100 years, the U.S. Geological Survey (USGS) has provided earth-science information needed to understand and manage the Nation's energy, land, mineral, and water resources. Such information is the basis for many decisions regarding management of Missouri's natural resources. Information provided by the USGS is used to address major environmental, economic, and health issues, such as hazardous wastes in the environment, the adequacy of suitable water supplies, nutrients in streams and estuaries, the distribution of mineral resources, and the environmental effects of urban development and agriculture.

Land-Use Changes

During the last 100 years, stream channels in the Ozarks have become wider and shallower and deep-water fish habitat has been lost. Historical data indicate that channel disturbances have resulted most directly from clearing of vegetation along stream channels, which decreases bank strength. Because recreational fishing is important to the economy of the Ozarks, degradation of aquatic habitat is of concern to Federal, State, and local land managers. The USGS is involved in a comprehensive, multidisciplinary study to determine the cause-and-effect link between historical land-use changes in the Ozarks and stream instability, to evaluate the effects of stream instability on the quality and stability of physical aquatic habitat, and to develop a predictive understanding of how future land use and climate change will affect the aquatic ecosystem. The study results can be used by land managers to optimize aquatic habitat maintenance and improvement efforts and to plan for the future. Historical and stratigraphic data show that after 1830, Ozarks streams responded to land-use changes by depositing more gravel and less muddy sediment, compared to presettlement conditions. Because less muddy sediment is being deposited on flood plains, many stream-banks now lack cohesive sediments, and, therefore, no longer support steep banks

(fig. 1). Analysis of aerial photographs from the last 50 years indicates that once stream channels have been disturbed, vegetation has a minor role in re-establishing channel recovery. Land-use statistics indicate that the present trend in the rural Ozarks is toward increased populations of cattle and increased grazing density; this trend has the potential to continue the historical stream-channel disturbance by increasing storm-water runoff and sediment supply.

Geologic Mapping

A new set of USGS maps shows geological and geophysical information that can be used by earth scientists and engineers to understand the causes and likely effects of earthquakes in the New Madrid seismic zone of Missouri, Arkansas, Tennessee, and Kentucky. The New Madrid seismic zone is the site of the largest series of earthquakes to strike the continental United States in recorded history. The new maps were made jointly by the USGS, State, university, and private-industry scientists. The maps show, for example, the location of earthquakes, the instruments used to study them, faults and

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other buried geological structures, earthquake-generated features that date from 1811 to 1812, and large prehistoric shocks. Another new USGS map of the central United States shows the main roads, railroads, oil and natural gas pipelines, dams, nuclear facilities, and urban areas that might be at risk from a New Madrid-style (8.4 to 8.7 on the Richter scale) earthquake. This map could be useful for planning responses to regional earthquake emergencies.



Figure 1. Midchannel gravel bar and bank erosion in the Current River near Van Buren. (USGS photo)

The National Geological Mapping Program and the National Earthquake Hazards Reduction Program are providing a basic geologic data base for the area between St. Louis, Missouri, and Memphis, Tennessee, including Missouri, Illinois, Kentucky, Tennessee, and Arkansas. USGS scientists are conducting geologic studies in Missouri in the areas of the Fort Leonard Wood Military Reservation (FLWMR) in south-central Missouri, the Ozark National Scenic Riverways, and the Benton Hills in southeastern Missouri. Fractures found in the geologic formations that are visible at Earth surface in the FLWMR area have been analyzed. The study at the Ozark National Scenic Riverways is being conducted in cooperation with the National Park Service and it is focusing on hydrogeologic features and fracture analysis to provide a data base for future geologic and hydrologic investigation in the area. Geologic studies in cooperation with the Missouri Department of Natural Resources, Division of Geology and Land Survey, in the Benton Hills have evaluated the earthquake potential of the area in relation to the New Madrid seismic zone, which is about 3 miles to the south. Trenches excavated across the English Hill Fault during 1995 document surface rupture along this fault sometime during the past 12,500 years. This is the first identification of such recent earthquake-induced faulting in the middle Mississippi River Valley outside of the New Madrid seismic zone and it indicates that a large region probably is prone to seismic activity.

Topographic Mapping

Among the most popular and versatile products of the USGS are the 1:24,000-scale topographic maps (1 inch on the map represents 2,000 feet on the ground). The maps depict basic natural and cultural features of the landscape, such as lakes and streams, highways and railroads, boundaries, and geographic names. Contour lines are used to depict the elevation and shape of terrain. Map coverage of Missouri consists of 1,299 maps at this scale, which is useful for civil engineering, land-use planning, natural-resource monitoring, and other technical applications. The maps are favorites with the general public for outdoor uses, including hiking, camping, exploring, and back-country fishing expeditions. Today, scientists and engineers depend increasingly on computerized base maps for their research and analyses. Therefore, the USGS has been producing computerized map products in cooperation with Federal and State agencies.

The Mid-Continent Mapping Center (MCMC), located in Rolla, is part of the National Mapping Division of the USGS. It is a production, research, and data management facility for maps and digital cartographic products. The MCMC also houses an Earth Science Information Center (ESIC) and Visitors' Center.

Biological Research

The USGS Biological Resources Division conducts studies relating to systems research, including topics associated with large rivers and their flood plains, statewide biomonitoring, development of methods to use spatial data at the landscape scale, and toxicological and ecological assessment of acidic-mine drainage restoration efforts. Studies of the Missouri River include pallid sturgeon habitat and behavior, contaminant effects on riverine life forms, river channel and flood-plain land-cover patterns, benthic fish database management, and a monitoring plan. A monitoring program for the Upper Mississippi River system, including the part bordering Missouri, is the largest river-related inventory, monitoring, research, spatial analysis, and information-sharing program in the United States. Collected data are being used to assess the potential effects of natural and human-induced activities on the riverine ecosystem. Among individual species covered by studies conducted in the state are mourning doves, bobwhite quail, Canada geese, and various duck species. Other studies include habitat relations of stream sport fishes, effects of pesticides on and recovery of the endangered Indiana bat, recovery of the endangered Niangua darter, and effects of habitat degradation and lead-mining activities on the Neosho madtom. Methods are also being developed for monitoring the biological resources of National Park Service units in Missouri, for documenting the effects of past climate change, and for developing simulations of future change in streams in the Ozarks.

USGS facilities conducting biological research in the State include the Midwest Science Center, the Environmental Management Technical Center, the Missouri Cooperative Fish and Wildlife Research Unit, and the Northern Prairie Science Center.

National Water-Quality Assessment Program

The long-term goals of the National Water-Quality Assessment (NAWQA) Program are to describe the status and trends of the quality of a large representative part of the Nation's surface- and ground-water

resources and to identify the natural and human factors that affect their quality. The NAWQA Program produces water-quality information that can be used by policymakers and water managers at the Federal, State, and local levels.

The extensive karst features of the Ozarks create a complex hydrologic system that results in rapid interactions between surface and ground water. The Ozark Plateaus NAWQA study, initiated in 1991, determined that the factors that affect water quality are climate, physiography, soils, water use, land use, population, and geology. Poultry, cattle, and swine production, in addition to septic tanks and sewage-treatment plants, have affected water quality by increasing concentrations of nutrients and bacteria in water. Surface- and ground-water quality has been significantly degraded by drainage from abandoned lead and zinc mines in the Tri-State District of Kansas, Missouri, and Oklahoma and the Old Lead Belt in southeastern Missouri. Recent lead mining in the New Lead Belt in southeastern Missouri has caused concerns about water quality in the area. Increased concentrations of radionuclides have been detected in water from many wells throughout the study area, and highly saline ground water along the western boundary has caused some wells to be abandoned.

Contamination at Weldon Spring

Trinitrotoluene (TNT) and other munitions compounds were produced at the 17,232-acre Weldon Spring Ordnance Works (WSOW) in St. Charles County in eastern Missouri from 1941 to 1945. The WSOW produced more than 700 million pounds of TNT and smaller quantities of dinitrotoluene (DNT) during its operation. The 1,665-acre U.S. Army Weldon Spring Training Area is within the former ordnance works. Fifteen of 18 TNT production lines, both DNT production lines, and almost all of the major production-support facilities were located within the Training Area boundary. The remaining three TNT production lines were on a 217-acre tract east of the Training Area that is currently (1997) owned by the U.S. Department of Energy (DOE) and which is known as the Weldon Spring Chemical Plant (WSCP). The three TNT production lines at the WSCP were demolished in 1955 during construction of a U.S. Atomic Energy Commission Uranium Feed Materials Plant that was operated from 1957 to 1966. Operations at the WSOW and the WSCP have resulted in localized soil and ground-water contamination.

In 1990, the USGS began a water-quality study in cooperation with the U.S. Army, Corps of Engineers (USACE) in the Weldon Spring Training Area. Large concentrations of TNT and lead have been detected in soils and near WSOW buildings. Widespread contamination of the shallow ground water at the Training Area with low-level (less than a few micrograms per liter) concentrations of TNT and other munitions-related compounds was also detected. Munition compounds also have been detected in water samples from nearby springs.

From 1994 through 1996, the USGS, in cooperation with the DOE, measured ground-water levels in 56 piezometers and monitoring wells in the St. Charles County well field, which is 3 miles southwest of the WSCP and 0.75-mile south of Weldon Spring Quarry where low-level radioactive wastes from the WSCP were placed from 1957 to 1966. The water-level measurements were used to assess ground-water flow from the abandoned quarry to the St. Charles County well field.

Ground-Water Flow in the Missouri River Valley

The Missouri River alluvial aquifer in the Kansas City metropolitan area supplies all or part of the drinking water for more than 900,000 people in 90 municipalities and public-water-supply districts. The Missouri River alluvial aquifer is the only aquifer in the area that can supply large quantities of ground water for public and industrial use. The Mid-America Regional Council, which is a planning association comprised of city and county governments in the metropolitan area, is developing a regional protection plan for the Missouri River aquifer. In 1991, the USGS, in cooperation with the Mid-America Regional Council, initiated a study to provide hydrogeologic information to aid in development of an aquifer-protection plan.

The USGS has developed a regional geographic information system for the Missouri River valley. Ground-water levels have been measured during different seasons and stages of the Missouri River to help delineate ground-water-recharge areas around municipal well fields in the Kansas City area. Areas of the alluvial aquifer that are the most susceptible to contamination from the land surface have been identified. A ground-water flow model has been used to evaluate the response of ground-water levels, ground-water travel times, contributing recharge areas of well fields, and directions of ground-water flow to changes in pumping and river stage.

Mapping Partnerships

The USGS continues to fund and produce both maps and computerized cartographic data in cooperation with Federal and State agencies in Missouri. The resulting products can be used by Federal, State, and local agencies to address natural resources planning and conservation, waste disposal, emergency, hazards, and other environmental and societal issues confronting the State. Aerial photographs are being acquired for Missouri as part of the National Aerial Photography Program (NAPP). The NAPP was established to coordinate the acquisition of standard format aerial photographs for the United States between Federal and State agencies. The NAPP photographs are used to support map revision, computerized image production, natural resource planning, land management, and agricultural monitoring.

Contamination at U.S. Department of Defense Sites

The USGS conducted a geohydrologic assessment of the FLWMR to describe the geologic controls on ground-water flow and contaminant transport. Ground-water levels and flow directions beneath the FLWMR are similar during conditions of high and low base flow and have been modified in the central and northeastern parts of the FLWMR by substantial karst features such as subterranean drainage conduits, caves, and sinkholes. Fractures commonly do not extend through the full thickness of bedrock formations and there is little evidence of chemical weathering of the bedrock. Natural chemical weathering of some dolostone formations in southern Missouri has caused the overlying sandstone-rich rocks to collapse and has provided pathways for ground-water flow. Water samples collected from regional ground- and surface-water sources indicate that there is little difference in water quality during high and low base-flow conditions, but that the shallow ground water is susceptible to contamination from surficial sources.

In 1992, the U.S. Air Force began deactivating the Minuteman II missile system at the Whiteman Air Force Base in west-central Missouri. The deactivation process at the launch facilities could contaminate ground water, and water-quality and ground-water data are necessary to determine the water quality in the area before deactivation and to determine the water quality after deactivation. To provide the data, the USGS has completed an on-site reconnaissance and well inventory within a 1-mile radius of each of the 150 missile silos. The general geology

of the area has been defined using existing geologic information. The potential for ground-water flow between regional geohydrologic units was determined and ground-water quality data have been summarized.

Agricultural Chemicals

Ground water is used throughout Missouri as a source of drinking water. The USGS, in cooperation with the Missouri Department of Health, collected and analyzed water samples from 1986 to 1994 from 854 domestic wells and 36 springs to determine the occurrence and distribution of nitrate and selected pesticides in ground water (fig. 2). The data from the study can be used by State and local officials and citizens to make decisions about how to mitigate the effects of agricultural chemicals on water supplies.

Nitrate concentrations were detected in ground water much more frequently and at much higher concentrations than were pesticide concentrations. Based on the results of the study, as many as 84,000 domestic wells (24 percent) in the State may have nitrate concentrations greater than the U.S. Environmental Protection Agency (USEPA) drinking-water criterion or may have detectable concentrations of one or more pesticides. However, elevated nitrate and pesticide concentrations in ground water were significantly related to the source of the water, well depth, and water level below land surface.

Water samples from wells that were less than 75 feet deep and where the ground-water level was within 50 feet of the land surface had significantly higher nitrate concentrations and were more prone to pesticide occurrence than other samples. Water samples from wells that were less than 0.25 mile from a feedlot and from wells where chemicals were mixed within 100 feet of the

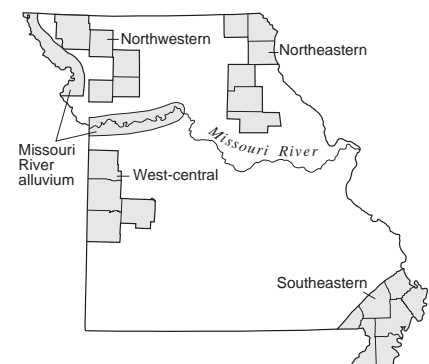


Figure 2. Agricultural chemical study areas.

For More Information

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Additional earth science information can be found by accessing the USGS Home Page on the World Wide Web at <http://www.usgs.gov/>

For more information on all USGS reports and products (including maps, images, and computerized data), call **1-800-USA-MAPS**

The **USGS** provides maps, reports, and information to help others meet their needs to manage, develop, and protect America's water, energy, mineral, biological, and land resources. We help find the natural resources needed to build tomorrow, and supply the scientific understanding needed to help minimize or mitigate the effects of natural hazards and environmental damage caused by natural and human activities. The results of our efforts touch the daily life of almost every American.

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well had significantly higher nitrate concentrations. Water samples from wells where chemicals were mixed less than 100 feet from the well were 3.4 times as likely to have a pesticide occurrence than water from wells where pesticides were mixed at distances greater than 0.25 mile from the well. Water from wells susceptible to elevated pesticide concentrations also had significantly higher nitrate concentrations.

Collection of Hydrologic Data

Several major rivers, including the Mississippi, the Missouri, the Osage, the Current, the Meramec, the Spring, the Grand, and the Salt, supply water not only to users within Missouri, but to several downstream States. The USGS, in cooperation with more than 20 Federal, State, and local agencies, collects streamflow or water-quality data or both at sites throughout the State (fig. 3). These data are critical for day-to-day administration and management of water resources, for determining the extent and severity of droughts, for characterizing and predicting conditions during floods, and for monitoring the effects of human activities on streamflow and water quality. The data also are essential to interpretive studies that provide information for making decisions about water issues that affect millions of people.

Flood Preparedness

After the floods that devastated the Midwest in 1993, scientists from the USGS, the USEPA, the USACE, the Federal Emergency Management Agency, and the National Oceanic and Atmospheric Administration joined in the Scientific Assessment and Strategy Team High Resolution Digital Elevation

Model (DEM) project. This project is developing high-density DEM's for about 2 million acres (3,400 square miles) along the Missouri and the Mississippi Rivers. About 85 to 90 percent of the project area is within Missouri. Improved hydraulic models can more accurately predict water flow at river junctions, such as the Missouri, the Illinois, and the Ohio, where flows and distributions are complex. The models can then be used for simulating levee breaches and overtoppings, flood management and recovery decisions, flow predictions, and flood prevention.

Earth Science Information Centers

The USGS ESIC provides information about the USGS, its programs, products, and technological developments to users who are concerned with earth science topics. The USGS Rolla-ESIC, located at the USGS office in Rolla, offers nationwide information and sales service for USGS map products and earth science publications and can fill orders for custom products, such as aerial photographs, orthophotoquads, and map separates. The State ESIC, also located in Rolla at the Missouri Department of Natural Resources, Division of Geology and Land Survey (DGLS) office, was established under a cooperative agreement between the USGS and the DGLS and has USGS map products available for purchase for the entire State. As part of the national ESIC network, these offices provide information on such topics as cartography, geography, digital data, remote sensing, geology, geophysics, geochemistry, hydrology, geohydrology, aerial photography, and land use. The USGS provides each ESIC with reference materials, technical assistance, training and outreach activities, and access to data bases.

National Coal Resources Data System

The USGS National Coal Resources Data System (NCRDS) provides data points for compiling geologic maps of coal beds, determining the quality of coal, and calculating coal resources and reserves. The USGS and the DGLS have cooperated since 1979 to enter into the NCRDS about 6,500 data points from drill holes and have measured stratigraphic sections to include in the NCRDS. These data points consist of coal thickness, stratigraphic information, and coal quality. In addition, coal croplines and mined areas have been delineated. This program has included all major, active coal-mining areas in Missouri.

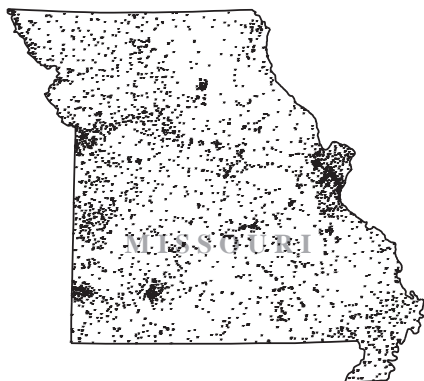


Figure 3. Streamflow and water-quality data-collection sites.