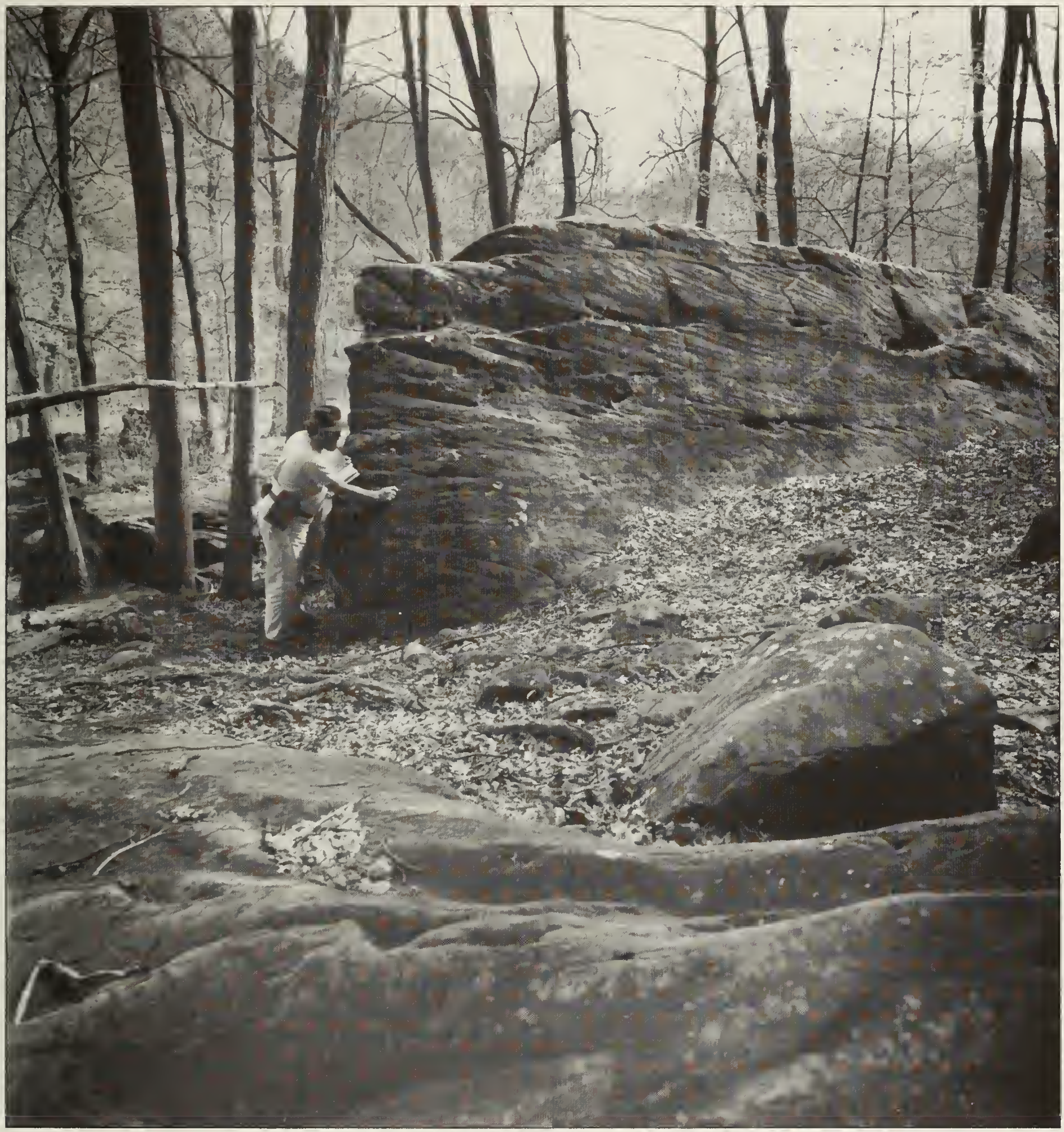
# GEOLOGIC MAPPING FOR THE FUTURE OF ILLINOIS



Department of Energy and Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY



1992 Special Report 1

# GEOLOGIC MAPPING FOR THE FUTURE OF ILLINOIS



**1992 Special Report 1**

prepared in cooperation with
**Senate Working Committee on Geologic Mapping**
assisted by
**Senate Geologic Map Task Force**

Illinois State Geological Survey
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July 1991

**Cover photo** A large slump block of Pounds Sandstone (Caseyville Formation, Lower Pennsylvanian) from adjacent bluff in Ferne Clyffe State Park, Johnson County, Illinois. ISGS geologist Russ Jacobson examines the sandstone grains and crossbed sets to add to his understanding of the nature of the Pounds Sandstone as he maps this unit across the Goreville Quadrangle.

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# GEOLOGIC MAPPING—THE NEED IS NOW

The need for geologic maps has never been greater. The nature, distribution, and structure of earth materials, as shown on geologic maps, is the vital information we need to locate and develop mineral resources, mitigate earth hazards, and protect our environment.

Mapping has been a core mission of the Illinois State Geological Survey since the founding of the modern Survey in 1905. Over the years, the Survey has published many geologic maps at various scales, but detailed maps are available only for selected areas of the state. The more detailed the scale, the smaller the portion of the state that has been mapped. Complete coverage of the state has only been achieved at the scale of 1:500,000—the scale at which 1 inch on the map represents about 8 miles on the ground. These maps give the broad, geologic framework suitable for regional planning.

But for most of today's projects, we need maps showing the details of our surroundings—the pattern of rivers and streams in relation to their deposits, the lowlands and floodplains unsuitable for most construction and development, the wetlands to avoid when building roads, a 1/4-mile mound of sand and gravel supplying water for domestic use or a fractured bedrock aquifer very near the surface—both vulnerable to contamination from infiltrating water. Maps showing where thick sequences of fine-grained materials lie between aquifers and potential sources of contamination would help us select the safest sites for landfills and the best locations to drill for water.

We need maps at the right scale of detail for identifying changes in materials along a hillside and the properties affecting slope stability and susceptibility to landslides. What are the characteristics of materials where we plan to excavate a factory foundation, sink bridge pilings, and build new homes, schools, and businesses? Which materials are likely to fail during a major earthquake? Where are mineral deposits suitable for mining, and where are the limestone and dolomite for construction projects? Are they within 50 feet of the surface?

For practical purposes, these geologic features must be mapped at a much larger scale than 1:500,000. We must have maps at the scale of 1:24,000, which means that 1 inch on the map represents 2,000 feet on the ground, or approximately 2½ inches on the printed sheet represents 1 mile on the landscape.

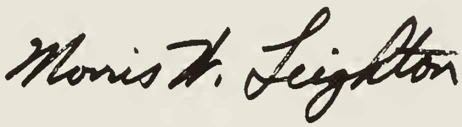
Maps at this scale of detail are needed not only in Illinois, but throughout the nation. The Geologic Mapping Act of 1991, introduced to the U.S. House of Representatives as HR 2763 and to the U.S. Senate as S 1179, will establish a national geologic mapping program and authorize federal matching funds for state geological surveys that participate. This legislation has passed the House and the Senate.

The Illinois State Geological Survey has prepared for passage of federal legislation for several years. In July 1989, the Illinois Geologic Mapping Advisory Committee—IGMAC—was formed to assist us in formulating a comprehensive program and to promote coordinated geologic mapping in Illinois. Serving on the committee are representatives from industry, universities, professional societies, trade associations, consultants, and state and federal agencies.

In March 1991, the Illinois Senate passed Resolution 98, which modified SR 881 as proposed by Senator Forest D. Etheredge in June 1990. These resolutions recognized the pending federal legislation with its component of cooperative geologic mapping and requirement of state matching funds. SR 98 called for the Survey to summarize the state of geologic mapping in Illinois and to identify needs and priorities for future mapping. With the cooperation of the Illinois Department of Energy and Natural Resources, the Department of Transportation, the Environmental Protection Agency, several waste management firms, engineering firms, the coal mining industry, and other mineral extraction companies that use geologic maps, we have prepared this report.

In *Benefits and Costs of Geologic Mapping in Illinois: Case Study of Boone and Winnebago Counties and Its State Applicability*, the ISGS Circular released in February 1992, we documented the benefit-to-cost ratio of geologic mapping in two northern counties of the state. Looking only at the avoidable costs associated with the cleanup of landfills and industrial disposal sites, we found the benefit-to-cost ratio ranged from 5:1 to 54:1. In Kentucky, the only large state with a complete set of 1:24,000-scale geologic maps, the benefit-to-cost ratio of geologic mapping has been estimated to be 50:1.

The Illinois State Geological Survey is well prepared, by legislative mandate and a strong tradition of geologic research and service, to undertake the program to map the geology of the entire state at the scale of detail needed for economic development and environmental protection.



Morris W. Leighton, Chief
*Illinois State Geological Survey*

## ACKNOWLEDGMENTS

State Senate Resolution 98 was adopted on March 6, 1991. SR 98 (Annex 1, this report) superseded Senate Resolution 881 of June 13, 1990, which called for the Illinois State Geological Survey (ISGS) to prepare a document that summarizes the status of geologic mapping in the Illinois.

Assisting the ISGS to develop the report was the Senate Working Committee on Geologic Mapping, which consisted of representatives from industry and State agencies:

James Blumthal
*Illinois Oil and Gas Association*
Richard Cobb
*Illinois Environmental Protection Agency*
George Dirkes
*Illinois Association of Aggregate Producers*
John M. Healy
*Illinois Society of Professional Engineers*
*American Society of Civil Engineers*
William J. Lang
*Illinois Geologic Mapping Advisory Committee*
Morris W. Leighton
*Illinois State Geological Survey, Division of the Illinois Department of Energy and Natural Resources*
Joseph S. Spivey
*Illinois Coal Association*
John R. Washburn
*Illinois Department of Transportation*
William White
*Illinois Department of Conservation*
Thomas F. Zimmerman
*Illinois Emergency Services and Disaster Agency*

The committee met in October and December 1990 to evaluate the report, as prepared by ISGS staff with expertise on key topics. Heinz H. Damberger, chairman of the ISGS Mapping Committee, coordinated compilation of a draft report, which was reviewed by IGMAC at the time of their meeting in November 1990. The final document was completed in February 1991.

# GEOLOGIC MAPPING FOR THE FUTURE OF ILLINOIS

A serious gap exists in the availability of large-scale, detailed geologic maps for use in solving earth-related problems. In this response to SR 98, the Illinois State Geological Survey (ISGS) has summarized the needs, priorities, and plans for geologic mapping in Illinois and outlined the costs and benefits of a recommended mapping program. To assemble the report, a Senate task force assisted a working committee of representatives from industry and State government, including the ISGS as the lead agency for geologic mapping in Illinois.

Geologic maps illustrate the nature and distribution of geologic materials at and below the earth's surface. Knowledge of the nature of materials such as sand and gravel, limestone, dolomite, shale, clay, coal, and other mineral resources is essential to the people of Illinois. Consuming resources may deplete supplies. Constructing roads, dams, and buildings calls for sufficient supplies of earth materials and expert attention to the properties and characteristics of surface and subsurface materials at specific sites. Extracting groundwater and other minerals and disposing of wastes may cause environmental problems. Illinois communities, industries, and government agencies must also deal with the potential for earthquakes, landslides, subsidence of undermined areas, and other geologic hazards.

The Illinois State Geological Survey, a division of the Department of Energy and Natural Resources, has spent considerable effort in preparing regional geologic maps covering the state, in accordance with State mandates. A lack of funding has prevented the statewide development of geologic maps detailed enough for today's planning and decision-making.

The most effective tool for transmitting geologic information to users in the public and private sectors is a detailed map at the scale of 1:24,000, which means that 1 inch on the map represents 2,000 feet on the ground. Only about 3% of the state has been mapped at the 1:24,000 scale.

Detailed maps are required by

- industry and agriculture to locate mineral resources, site facilities, and undertake construction projects;
- private and public sectors to develop and protect groundwater resources and identify hazards and the potential for damage from earthquakes, landslides, subsidence, and coastal erosion;
- community and state schools, libraries, parks, and other facilities to educate and inform;
- municipal, county, state, and federal agencies and governing bodies to select sites for landfills, low-level radioactive waste facilities, hospitals, and schools; develop zoning regulations; assess land and mineral values; provide basic information required to attract industry; and generally assess competing land uses and plan future development.

Focused geologic mapping, now underway at the ISGS, has been functionally and geographically restricted. At the present rate of progress, detailed mapping to meet the state's needs will not be complete for 200 years or more.

## Economic Value of Detailed Geologic Maps

In a definitive study for Boone and Winnebago Counties, the benefits were compared with the costs of mapping. Calculations were based on quantifiable benefits resulting from avoidable costs associated with the cleanup of landfills and industrial disposal sites. The benefit-to-cost analysis excludes other benefits that are not quantifiable at this time; for example, these maps have been used to identify and recover earth resources and to provide industry and government with basic data for siting facilities—data on water supplies, foundation conditions, and areas suitable for septic systems.

Results indicated that the payout on an investment of $300,000 in 1990 dollars was on the order of 23:1 to 54:1 for the best-case scenario and 5:1 to 11:1 for the worst-case scenario. Corresponding benefits ranged from $1.4 to $3.3 million for the worst-case scenario and from $7 to $16 million for the best-case scenario. The worst-case scenario discounts 90% of potential benefits and the best-case scenario discounts 50% of the potential benefits in avoided costs alone.

The scenarios take into consideration improvements in the regulatory procedures and the engineering of disposal facilities. Also accounted for is the fact that geologic mapping—although helpful in the planning and design of these facilities—will not result in avoidance of all cleanup costs at future disposal and industrial sites. Costs can be significantly reduced, however, through the use of geologic maps at the proper scale.

Further analysis indicated that if the results of the Boone and Winnebago study were projected to all of Illinois, the ratio of benefits to costs would range from 1.1 to 2.8 for the worst-case scenario (with 90% of the benefits discounted). For the best-case scenario (with 50% of the quantifiable benefits discounted), the ratio of benefits to costs would range from 6 to 14.

Alternative estimates were made on the basis of statewide mapping costs 2.6 times higher than those indicated by the Boone and Winnebago projection. The benefit-to-cost ratio for the worst-case scenario ranged from 0.5 to 1.1, and for the best-case scenario, from 2.3 to 5.4. It should be emphasized that other benefits, as listed previously, would significantly increase the benefit-to-cost ratios when quantified.

In an example from Kentucky, published information suggested a 50:1 payout on an investment of $21 million to map the whole state in detail—a feat accomplished in 18 years, mainly in the 1960s and 1970s.

## Recommendations

On the basis of an assessment of map coverage and needs (figs. 1A-C) as well as benefits compared to costs, the Illinois Senate Geologic Map Task Force and

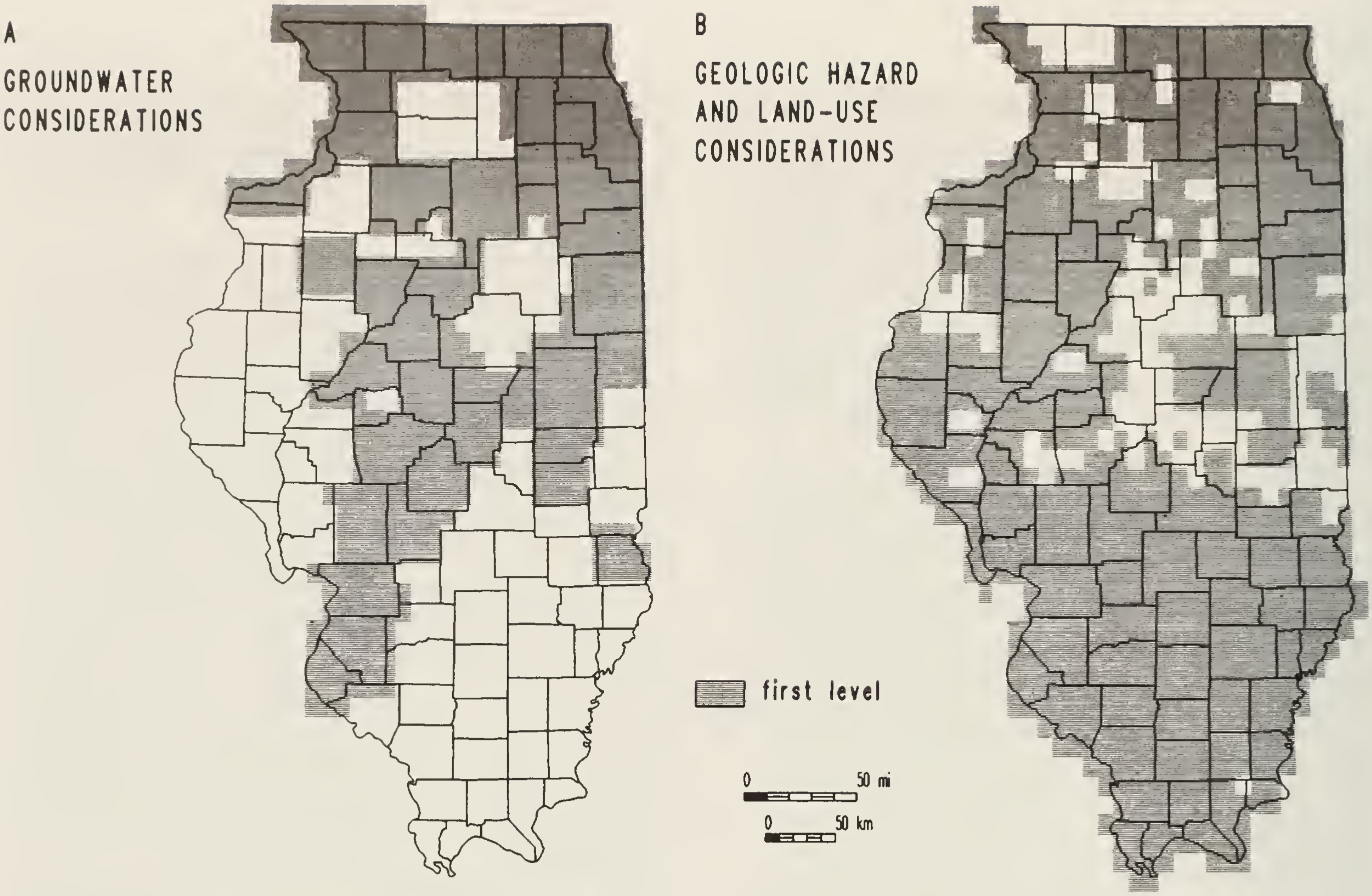




**Figure 1** Summary of first-level needs for geologic mapping: A, groundwater resource assessment and protection, landfill and waste disposal siting, and wetlands evaluation (see figs. 14A-C); B, seismic risk, landslide hazards, coastal erosion, stormwater and coastal flooding, wetlands, unstable foundation conditions, karst, faults, and underground mining (see figs. 18A-I); and C, fluorine, lead and zinc, clay, tripoli, limestone, dolomite, sandstone, sand and gravel, coal, and oil and gas (see figs. 15A-G). Compare with figure 20, which presents the cumulative, weighted need levels for all factors.

Senate Working Committee on Geologic Mapping recommended the following:

- A substantial, well-integrated, systematic program of mapping geologic deposits, both surficial materials and bedrock, should be implemented. Priorities should be based on an orderly approach to state issues.
- Geologic mapping should emphasize detailed, large-scale maps, preferably favoring compilation and availability at the scale of 1:24,000 (1 inch equals 2,000 feet) and publication at the scale of 1:100,000 (1 inch equals 1.6 miles), or more detailed as needed.
- For groundwater resources, geologic mapping should be conducted to ensure sufficient water supplies for present and future requirements.
- For groundwater protection, geologic mapping should be conducted initially in areas of high groundwater usage, for example, in high-priority areas established by the Illinois Environmental Protection Agency. Detailed geologic mapping should also help in assessing the impact that usage of agricultural chemicals has on groundwater quality.
- Detailed geologic mapping to meet county planning needs should commence in the most populated counties. The counties or regions where landfill capacity is most limited and where planning indicates imminent need for suitable landfill sites should be high in priority. Also warranting high priority are rapidly developing industrial corridors.
- Geologic mapping to assist engineering firms in the selection of sites for residential, commercial, industrial, and public development is needed, especially for rapidly growing areas.
- Geologic mapping should permit assessment of geologic hazards, especially the risk of earthquakes (seismic risk), landslides and subsidence, and coastal erosion. Mapping priorities should be based upon the distribution of geologic hazards and the potential severity of their effects.
- Detailed geologic mapping should be extended south of the present COGEOMAP region in southern Illinois to permit assessment of the economic potential for deposits of lead, zinc, fluorspar, and related minerals, as well as limestone, dolomite, and tripoli.
- Geologic map coverage for sand, gravel, limestone, and dolomite deposits should eventually be available for the entire state, but the highest priority areas should include the rapidly expanding metropolitan areas where construction needs are greatest. Sources of agricultural lime also need further definition.
- Geologic mapping should be conducted for coal-bearing strata, primarily west of the Illinois River where the potential for locating low- to moderate-sulfur coal resources is significant.
- The nature and structure, including faulting, of bedrock should be mapped in southernmost Illinois south of the Cottage Grove fault to provide information about that moderately explored area to the oil and gas industry and to aid the State's assessment of seismic risk.
- Detailed geologic maps and instructional pamphlets should be prepared as educational materials for schools and for tourists and visitors to Illinois State Parks, national corridors, and other recreational areas, as part of an effort to introduce the public to the earth science used daily to address earth-related problems.
- Sufficient resources and time (on the order of 10 to 20%) should be allocated annually for contingency mapping to meet unanticipated needs as dictated by development of high-priority state or local issues requiring timely preparation of detailed geologic maps.

The three maps (figs. 1A-C) highlight priority areas that require detailed geologic mapping, as determined from an overall survey of published maps and technical needs. The need is great for additional mapping to aid in economic development, environmental protection, and risk assessment.

The recommended geologic mapping program is designed to meet these expressed needs in priority order. This long-term, multiyear effort requires dedicated funds as a separate line item. Progress of the program should be identifiable and accountable by the ISGS to ENR on an annual basis. Mapping priorities should be reviewed annually by the Illinois Geologic Mapping Advisory Committee (IGMAC); and the program should be reviewed every 5 years by the General Assembly.

The recommended level of state program funding is $1.1 million per year over a period of 50 years.

This level of funding places Illinois in a position to capture significant federal funds should the currently proposed National Geologic Mapping Program legislation be authorized and funds appropriated; the legislation was introduced in the general session of the 87th Congress.

Any available matching funds, whether from federal, county, municipal, or other local or industrial sources, will be added to the base program to shorten the length of the proposed project to about 20 years.

The uses and users of geological maps have been identified in this report. Users include a broad spectrum of industry, agriculture, and other businesses; state and local governments; and the general public. The recommended program of geologic mapping in Illinois will have broad support and represent an essential investment for Illinois.

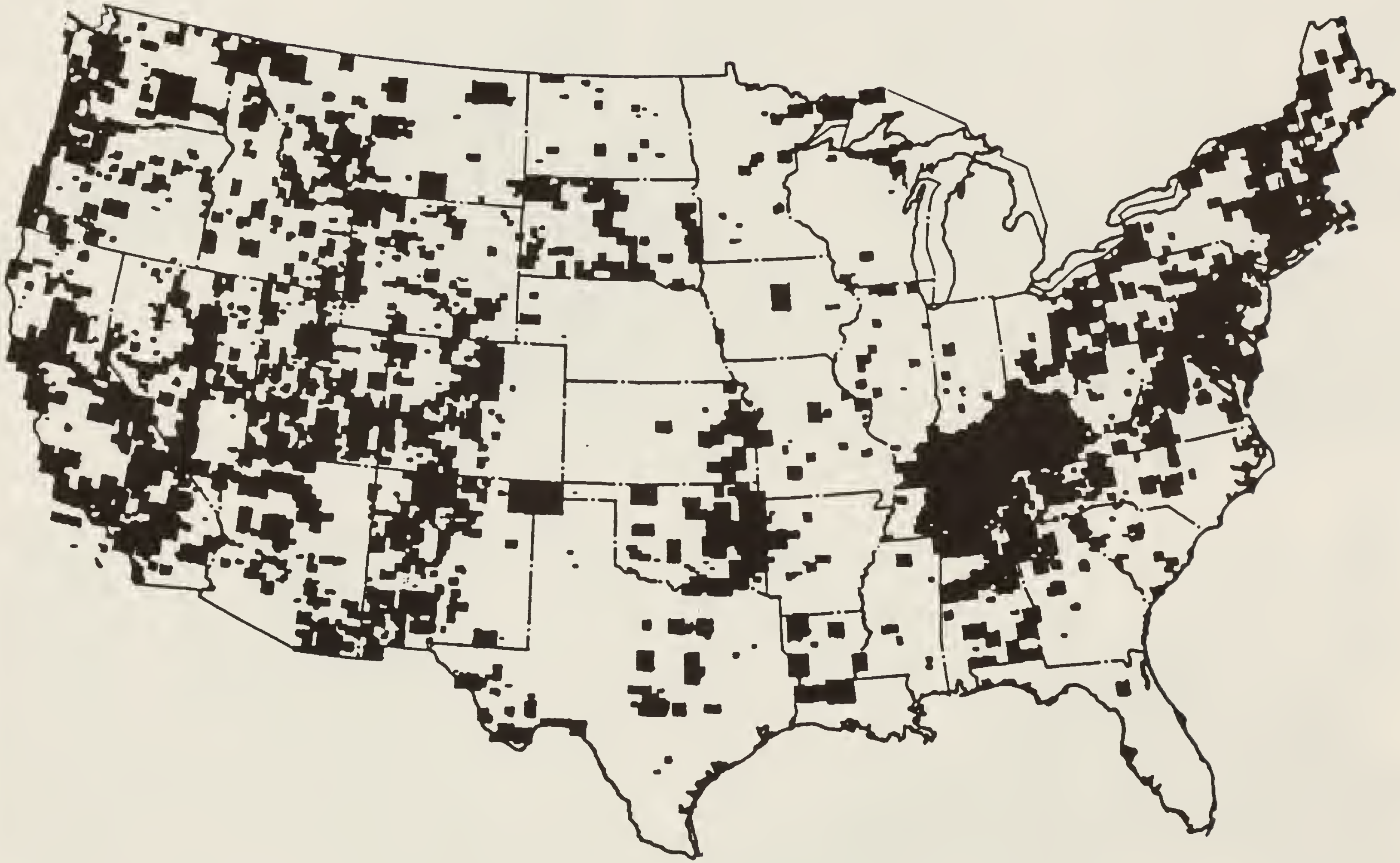


**Figure 2** Geologic maps of the conterminous United States, published since 1950 at 1:63,360 (1 inch equals 1 mile) or more detailed scales (as of September 1989). Source: USGS, 1989.

# STATUS AND FUTURE NEEDS

## GEOLOGIC MAPS

We need to know the nature and distribution of earth materials because we live on them and we depend on them. We extract water and fuel and nonfuel minerals from them. We deposit wastes in them. We build on them—using earth materials to construct roads, dams, and buildings; and we are exposed to landslides, subsidence, and earthquakes—the natural and manmade hazards involving geologic materials.

Geologic maps depict the nature and distribution of earth materials, and thus provide the information needed to locate mineral resources and solve problems related to earth materials. Yet according to the U.S. Geological Survey, only a small portion of the nation —in fact, only a small portion of Illinois—is covered by geologic maps at appropriate, detailed scales (fig. 2).

The principal source of geologic maps for Illinois is the State Geological Survey (ISGS), by virtue of State mandates and the ISGS tradition of investigating and documenting the geology of Illinois.

### What Geologic Maps Show

Geologic maps, which complement topographic maps, are usually presented on a topographic base. They provide information on earth materials: the horizontal and vertical distribution, composition, relative age, and properties of individual units at and below the ground surface. Earth materials represented on geologic maps include soils, sand and gravel, sandstones and limestones, coals and other mineral resources, and varieties of glacial drift. Since groundwater, oil, gas, and brines fill pores and fractures in earth materials, their occurrence is closely related to the distribution of earth materials. Structural features that control the continuity and attitude of the mapped units are also depicted on these maps.

The geologic map is the basic format used by geologists to show the user the distribution of various types of rocks and other earth materials. It shows the occurrence and physical boundaries of identifiable units of rock or other earth materials and the relationship between the units at or near the surface of the earth and units to a given depth. Names of the units, relative ages, sequence of deposition, accuracy of boundaries, and explanation of the symbols appear in the legend. A graphic column usually accompanies the map and shows the sequence, character, vertical relationships, and thickness of the mapped units. Brief descriptions of the physical properties of mapped units accompany the graphic column. One or more cross sections commonly illustrate the geometry of mapped units and their vertical and lateral relationships.

Geologic maps evolve and become more accurate as new data become available. Using computers to store geologic data and maps facilitates updating.

### Why Geologic Maps Are Needed

The most effective tool for transmitting geologic information to users in the public and private sectors is a detailed map on which 1 inch is equivalent to 2,000 feet on the ground (scale of 1:24,000).

- Business and industry require detailed geologic maps to locate, assess, and develop geologic resources; and to site and construct facilities.
- Municipal, county, state, and federal government agencies require geologic maps to select areas for landfills and hazardous waste facilities, develop zoning ordinances, choose safe sites for hospitals and schools, and assess land and mineral values.
- Counties require detailed geologic maps to develop plans for the disposal of their solid wastes. Plans must be submitted to the State for approval by 1995—a mandate that will greatly increase the demand for reliable information on the distribution and properties of earth materials relative to their suitability for disposal of wastes on and in them. Similarly, implementation of the Groundwater Protection Act requires detailed information on earth materials.

The growing density of human populations in many suburban areas of Illinois is forcing local government agencies and community leaders to deal with conflicts between the demand for and the preservation of earth resources. Suburban development converts prime farmland into housing tracts. Growing towns require more space for waste-handling facilities such as landfills and sewage treatment plants. Also, increasing populations use more cement and aggregate in constructing houses, roads, sewers, and other structures. Unrestrained development may overtax the local groundwater supply, exceed the capacity of soils to adsorb drainage from septic leach fields, or sequester valuable earth resources beneath housing tracts. Detailed geologic maps and the interpretive maps derived from them provide community officials and leaders with data for weighing conflicting social needs and assessing sustainable development.

The need for detailed geologic maps of many areas has been recognized at the national level in recent years. Less than 20% of the nation has been mapped at the 1:24,000 scale. Only Kentucky, Massachusetts, and Puerto Rico have complete coverage by geologic maps at the 1:24,000 scale. The Midwest has generally not been mapped at the desirable degree of detail (fig. 2). Recognition of deficiencies has led the American Association of State Geologists (AASG) and the U.S. Geological Survey to develop a cooperative national program for geologic mapping. In Illinois, only 39 quadrangles out of a total of 1,071 have been geologically mapped at the scale of 1 inch equals 2,000 feet (1:24,000). This represents only 3% of the state.

### Users and Uses of Geologic Maps

The community of users of geologic maps includes industry, government planners and regulators, educators, scientists, engineers, and private citizens (table 1). Respondents to a questionnaire distributed in spring 1990 to a wide spectrum of users of geologic maps in

**Table 1** Potential users of geologic maps

*Industries*

- Waste managemen/disposal firms
- Construction and engineering firms
  - Waste disposal facilities
  - Construction
- Consulting firms
- Water companies
- Industrial minerals companies
  - Stone
  - Sand and gravel
  - Industrial sand
  - Clay
  - Tripoli (microcrystalline quartz)
  - Fluorspar
- Other mining companies
  - Lead and zinc
- Coal mining companies
- Petroleum industry
  - Exploration
  - Underground gas storage
  - Waste disposal
- Insurance companies
  - Mine Subsidence Insurance Fund

*Local, County, and Regional Government*

- County planning agencies
- County zoning boards
- Solid waste disposal associations
- Sanitary districts
- Drainage districts
- Conservation districts
- County departments of public health
- Regional and county planning commissions and boards (i.e. Northern Illinois Planning Commission)
- Illinois Municipal League
- East/West Coordinating Council (Planning agency MO/IL-St. Louis)

*Colleges and Universities*

- Northern Illinois University
- Eastern Illinois University
- Southern Illinois University
- Illinois State University
- University of Illinois
- Western Illinois University
- University of Chicago
- Northwestern Illinois University
- Northeastern Illinois University
- Sangamon State University
- Private colleges
- Community colleges

*State Departments and Agencies*

- Department of Energy and Natural Resources
  - State Geological Survey
  - State Water Survey
  - Office of Research and Planning
  - Hazardous Waste Research Information Center
  - Energy and Environmental Affairs
  - Office of Solid Waste, Renewable Resources
  - State Museum
  - Natural History Survey
- Department of Transportation
- Environmental Protection Agency
- Department of Nuclear Safety
- Department of Commerce and Community Affairs
- Department of Agriculture
- Department of Conservation
- Department of Mines and Minerals
- Emergency Services and Disaster Agency
- Department of Public Safety
- Department of Public Health

*Federal Agencies*

- U.S. Geologic Survey
  - Water Resources Division
  - Mineral Resources Branch
  - Coal Resources Branch
  - Oil and Gas Branch
- U.S. Environmental Protection Agency, Region 5
- U.S. Department of Agriculture
  - Soil Conservation Service
  - Forest Service, Eastern Region and Shawnee National Forest
- U.S. Bureau of Mines
  - Branch of Engineering and Economic Analysis
  - Minerals Evaluation Group
- U.S. Fish and Wildlife Service
- Federal Emergency Management Agency
- U.S. Department of Defense
- U.S. Corps of Engineers
- Argonne National Laboratory
- Fermi National Accelerator Laboratory

*General Public*

- Schools
- Environmental groups
- Recreational groups
- Farmers
- Homeowners and landowners
- Small businesses

Illinois named siting, resource development and exploration, and planning and environmental protection as principal application categories. Specific uses frequently mentioned as applications of geologic maps were siting of waste disposal facilities and industrial projects, developing and protecting groundwater resources, planning for transportation, identifying geologic hazards, and land-use planning in general (table 2).

## STATUS: GEOLOGIC MAPPING IN ILLINOIS

Publication of geologic maps has been a mission of the Illinois State Geological Survey (ISGS) since its inception in 1905. Over the years, the ISGS has published many general and special purpose geologic maps. The 1990 catalog, *Publications of the Illinois Geological Survey*, contains 32 pages of listings of geologic and miscellaneous maps, excluding topographic maps.

Geologic maps come in the same standard scales as topographic base maps, on which they are compiled. The scale of a map determines how much geologic detail can be shown.

The geology of the entire state on one sheet of paper, even if it is a large wall map, does not permit much detail to be shown. On the 1:500,000-scale state geologic map, for example, 1 inch on the map represents about 8 miles on the ground; 1/32 inch, about the thickness of a heavy line on the map, is still equal to 1,320 feet on the ground.

Geologic maps that permit representation of greater detail are the 1:24,000-scale 7.5-minute topographic quadrangle maps. On these maps, 1 inch on the map represents 2,000 feet on the ground, permitting about 20 times the resolution of statewide 1:500,000-scale maps. A line that is 1/32-inch wide on these detailed maps still represents about 62 feet on the ground. Representing single homes or standard-size plots in towns on these maps poses problems; but city blocks can be shown without difficulty. The effect of scale on detail is dramatically shown on figures 3A and 3B.

The following sections present an overview of the geologic maps that have been published to date, the areas that are not mapped, and the maps that are required. The information is provided first by map scale, then by topic.

### Status of Geologic Mapping by Map Scale

**Maps at 1:24,000 scale (1 inch equals 2,000 feet)** Only 3% of the state is covered by published maps at the detailed scale of 1 inch equals 2,000 feet (1:24,000), the scale required for many current applications. The only sizeable areas with adequate coverage at the scale of 1 inch equals 2,000 feet are the Illinois-Kentucky Fluorspar District of southeastern Illinois, adjacent areas of the southern Illinois coal field, and the Chicago area of northeastern Illinois (figs. 4 and 5). The maps are accompanied by detailed geological reports. The Chicago-area maps were published in the 1940s, the Fluorspar District maps in the 1960s, and maps of the southern Illinois coal field in the 1980s and 1990s.

**Table 2** Selected uses of geologic maps

*Groundwater studies*
- locate and protect resources
- identify regions with vulnerable aquifers
- assess contamination potential

*Mineral resource studies—oil and gas, coal, construction materials and metallic and nonmetallic minerals*
- assess, explore, develop, and recover
- evaluate future potential

*Facility siting studies—waste disposal, power plant, and residential, commercial, and industrial development*
- avoid environmentally sensitive areas
- select favorable areas for construction and operation

*Hazards studies*
- locate faults and unconsolidated materials; assess earthquake risk
- locate caves and sinkholes (karst)
- identify areas prone to landslides
- locate flood zones
- locate mined-out areas; identify subsidence risk

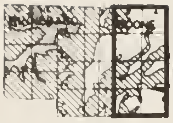
The latter maps are part of an ongoing geologic mapping program supported by the USGS and the State of Illinois under the Cooperative Geological Mapping Program (COGEOMAP) since 1985. The plan of this program includes the publication of sixteen 7.5-minute geologic quadrangles (fig. 5); six of these have been published, and three more are currently in production.

Table 3 shows the number of 7.5-minute quadrangles published for each decade since the 1940s when the first maps were released at this scale. Also shown are the square miles represented on these maps, the percentage of area of the state for which maps were published in each decade, and each respective total.

At the rate of publishing during the past 50 years, it would take more than 1,000 years for maps at this detailed scale to become available for the entire state. However, ISGS geologists have commonly compiled their information on 1:24,000-scale work maps, then published at a smaller, less detailed scale. Not only have publication costs been a consideration, but the amount of information available for compiling the maps often has not justified the degree of detail and resolution of a 1:24,000-scale map. Generally, the work maps for projects have been filed in the ISGS Map Library and are accessible to the public. Nevertheless, the amount of information compiled and available at this detailed scale is limited.

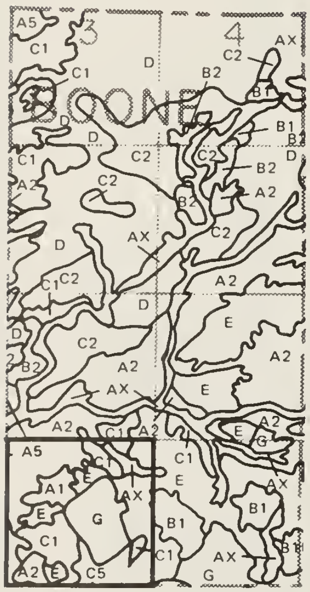
**Maps at 1:62,500 scale (1 inch equals 1 mile)** Maps at the 1:62,500 scale of the 15-minute topographic quadrangles have been more widely used in Illinois and throughout the United States. These maps were produced by both the USGS and ISGS. The first 15-minute

A



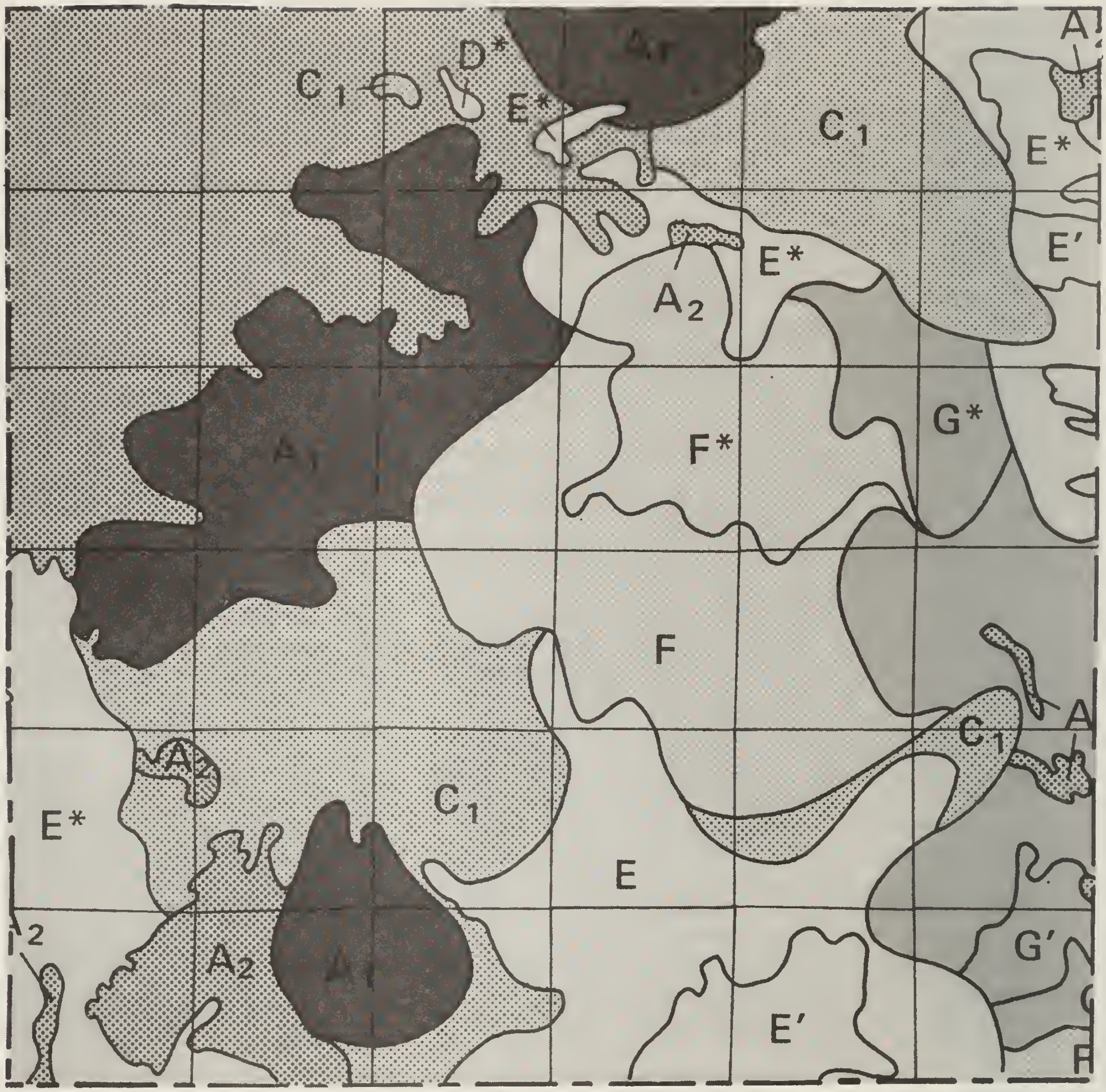
1:2,000,000

1 inch equals approximately
32 miles




1:500,000

1 inch equals approximately
8 miles




1:62,500
1 inch equals approximately
1 mile

**Figure 3** Effect of scale on the detail that can be shown on a geologic map:

A Area (T43N, R3E) of south-central Boone County from the 1:62,500-scale map shows the classification of geologic materials for land burial of wastes. Each square represents 1 square mile; small maps on left show how the same area is portrayed at 1/8 (1:500,000) and 1/32 (1:2,000,000) of the scale.

B Area of northern Johnson County from the Creal Springs Quadrangle in southern Illinois shows different rock formations, coal beds, faults, structural contours, mined areas, and other geologic information. The small insert map at the top left shows the lack of detail on a statewide map at about 1/20 of the scale.

B

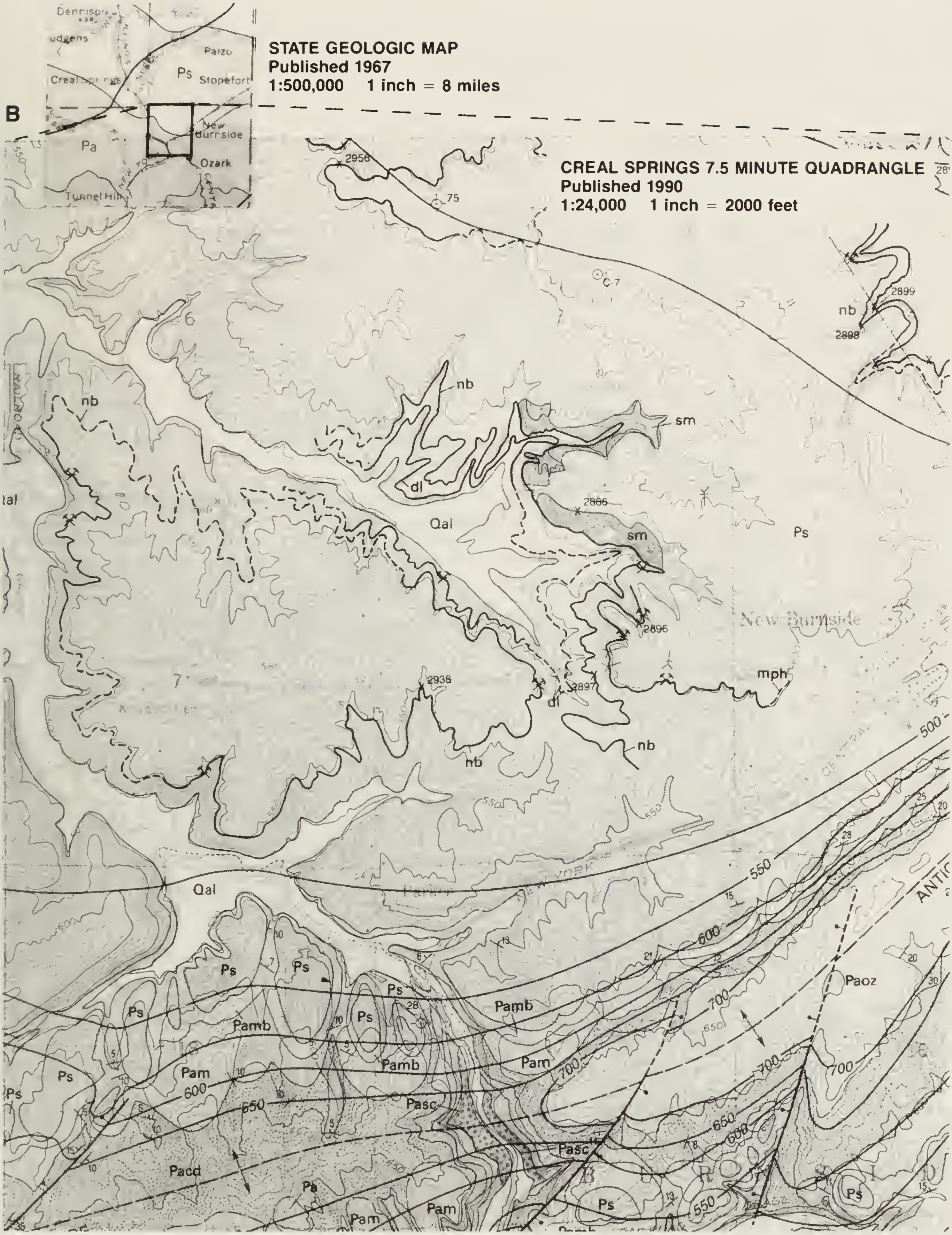

STATE GEOLOGIC MAP
Published 1967
1:500,000 1 inch = 8 miles
CREAL SPRINGS 7.5 MINUTE QUADRANGLE
Published 1990
1:24,000 1 inch = 2000 feet
Creal Springs
Stonefort
New Burnside
Ozark
Tunnel Hill
Ps
Pa
Qal
nb
sm
dl
mph
Paoz
Pamb
Pam
Pasc
Pacd
New Burnside
500
550
600
650
700

Table 3 Rate of publishing 7.5-minute geologic quadrangles at the 1:24,000 scale (1 inch equals 2,000 feet)

| *Decade* | *Number* | *Square miles* | *% area of state Decade* | *Cumulative* |
|---|---|---|---|---|
| 1940-49 | 24 | 1,064 | 1.9 | 1.9 |
| 1950-59 | 0 | 0 | 0 | 1.9 |
| 1960-69 | 9 | 333 | 0.6 | 2.5 |
| 1970-79 | 0 | 0 | 0 | 2.5 |
| 1980-89 | 3 | 168 | 0.3 | 2.8 |
| 1990 | 3 | 175 | 0.3 | 3.1 |
| *Total* | *39* | *1,740* | 3.1 | |


**Figure 4** Standard multicolor geologic maps of Illinois, published at 1:24,000 scale (1 inch equals 2,000 feet).

geologic quadrangle map was published in 1902; much of this map series was published prior to 1930 (fig. 6, table 4). All maps are accompanied by substantial reports; and although many reports and maps are now outdated and much information has been accumulated since their publication, they represent a valuable reference.

In addition to the multicolor 15-minute geologic quadrangle maps, some black-and-white preliminary geologic maps and several special maps were also published at this scale as part of the ISGS Geology-for-Planning program, including maps of resource assessments for industrial minerals such as limestone and sand and gravel (fig. 6). Counties covered by geology-for-planning maps at the 1:62,500 scale are Cook, Du Page, Kane, Lake, McHenry, and Will; these maps were

**Table 4** Publication of geologic quadrangles at the 1:62,500 scale (1 inch equals 1 mile)

| Decade | Number of 15-minute quads | Square miles |
|---|---|---|
| *Multicolor, 15-minute geologic quadrangles* | | |
| 1900-09 | 1 | 196 |
| 1910-19 | 15 | 3,292 |
| 1920-29 | 19 | 4,009 |
| 1930-39 | 0 | 0 |
| 1940-49 | 3 | 660 |
| 1950-59 | 8 | 1,598 |
| 1960-69 | 6 | 686 |
| *Subtotal* | 52 | *10.441* |
| *Black/white preliminary geologic maps* | | |
| 1930-39 | | 1,314 |
| 1940-49 | | 1,246 |
| *Subtotal* | | *2,560* |
| *Geology-for-planning geologic maps* | | |
| 1970-79 | | 2,593 |
| 1980-89 | | 850 |
| *Subtotal* | | *3,443* |
| *Grand total for the state* | | *16,829* |

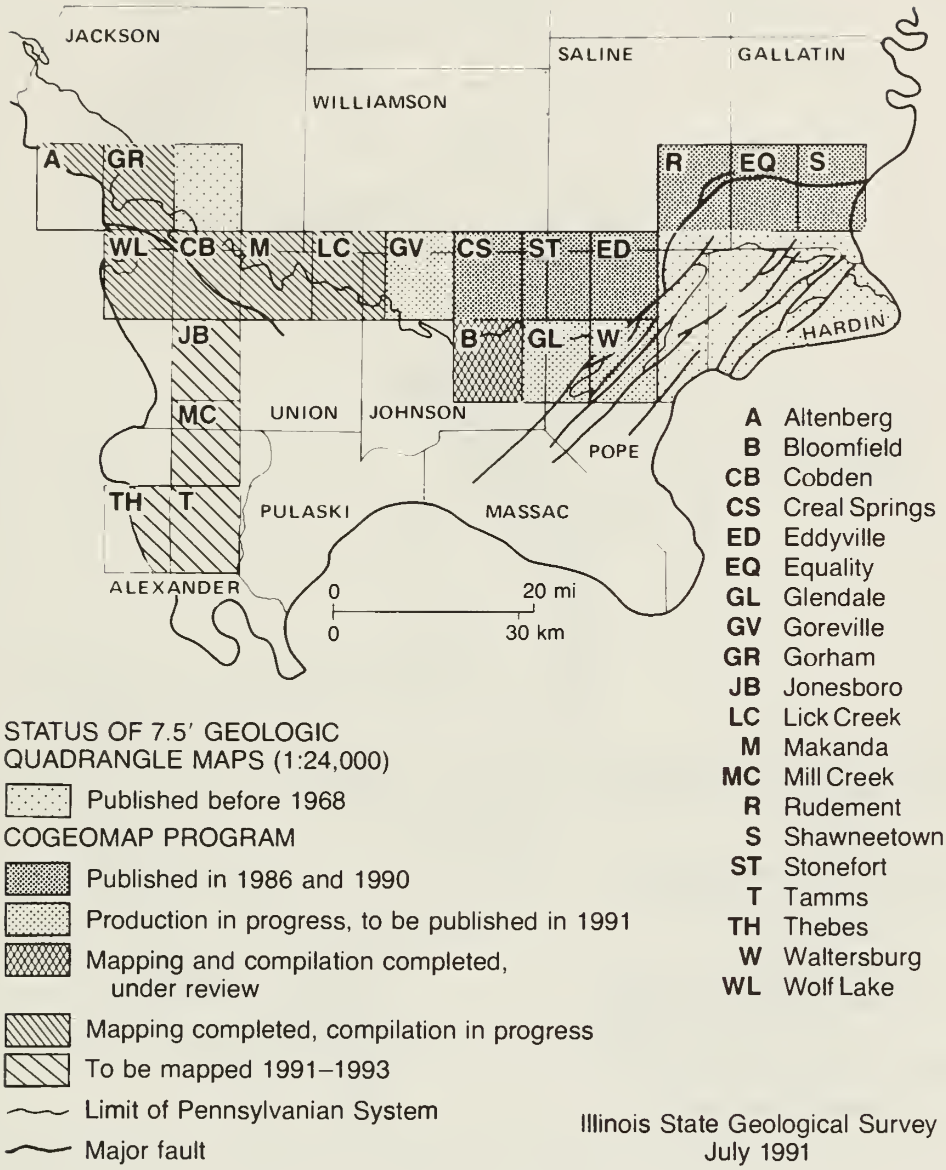



**Figure 5** Current geologic mapping program in southern Illinois is supported under COGEOMAP, a USGS program.

released in 1976 and 1977 as blueline prints (fig. 6). Several geology-for-planning county reports, published since 1969, are accompanied by 1:62,500-scale maps (Boone, Lake, and Winnebago Counties of northern Illinois).

The topographic maps at the scale of 1:62,500 (1 inch equals 1 mile) will not be updated in the future. Geologic maps will therefore be published either at the detailed scale of 1:24,000 or at the new intermediate scale of 1:100,000, depending on the degree of detail required. Topographic maps are available for the entire state at the detailed 1:24,000 scale and for most of the state at the intermediate 1:100,000 scale.

Table 4 summarizes the publication history of 15-minute quadrangle maps.

**Maps at 1:125,000 scale (1 inch equals about 2 miles)**
Maps at the smaller, intermediate and less detailed scale of 1:125,000 have been used commonly in publications to illustrate regional geology (fig. 7), especially in the ISGS Geology for Planning publications that cover the Springfield-Decatur metropolitan area and Boone, De Witt (scale of 1:156,250), McHenry, Rock Island, St. Clair, and Winnebago Counties, including the Moline, East St. Louis and Rockford metropolitan areas. The first report was published in 1969, and the most recent one in 1984. In addition to the more detailed, larger-scale geologic quadrangle maps (1 inch equals 2,000 feet or 1 inch equals 1 mile) mentioned above, a second set of maps that covers the same areas was produced at this less-detailed scale to provide the

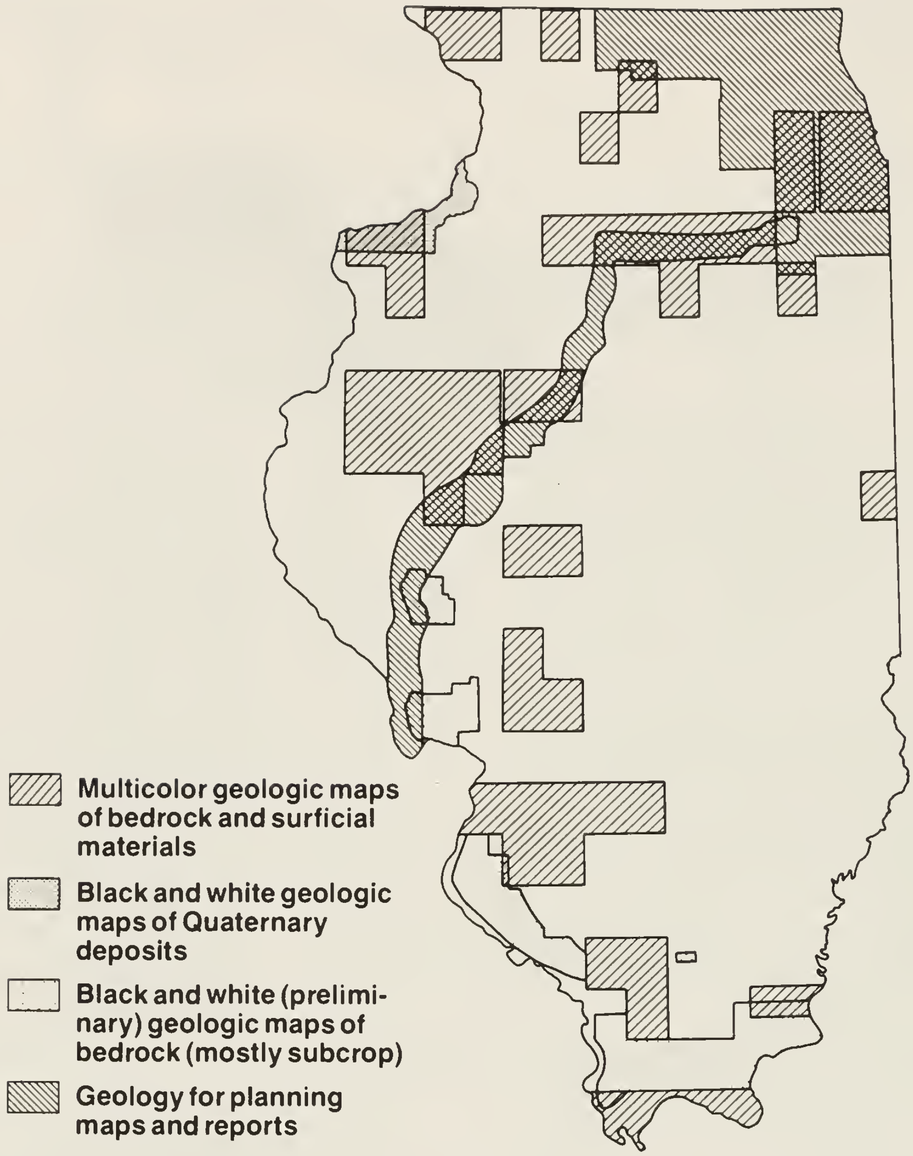



**Figure 6** Geologic maps of Illinois, published at 1:62,500 scale (1 inch equals about 1 mile).

regional overview or to otherwise supplement the larger-scale maps. Another map (published 1967) shows the sand and gravel deposits along the Rock River. Two black-and-white geologic maps of glacial deposits in east-central Illinois were published in 1952 and 1979 at this scale.

Other 1:125,000-scale maps, not identified in figure 7, depict surface-minable coal resources of Illinois. Most were published between 1957 and 1981 at this intermediate scale. They show where known coal seams crop out at the surface or lie below a cover of glacial and alluvial deposits to a depth of about 150 feet. The maps provide information on coal thickness, coal depth below surface, and in most cases, structure on the coal seam; known faults interrupting the continuity of coal seams are also shown.

The 1:125,000 scale was first used in 1862, and it has been used since for a variety of general and special-purpose geologic maps identified as "miscellaneous geologic maps" on the index map (fig. 7). Maps at this scale do not provide the resolution required to solve many of today's earth-related problems.

In the future, the 1:100,000 scale will generally replace the 1:125,000 scale as the standard, as illustrated on a map (fig. 8) recently produced for Champaign County in a pilot study conducted cooperatively by the county (the Intergovernmental Solid Waste Association) and the ISGS.

**Maps at 1:250,000 scale (1 inch equals about 4 miles)** The next smaller, even less detailed standard scale is 1:250,000 (1 inch represents about 4 miles). This relatively small scale provides the regional geological context useful in regional planning (figs. 9 and 10).

The greater Chicago area is covered by several sets of 1:250,000-scale geologic maps that were published

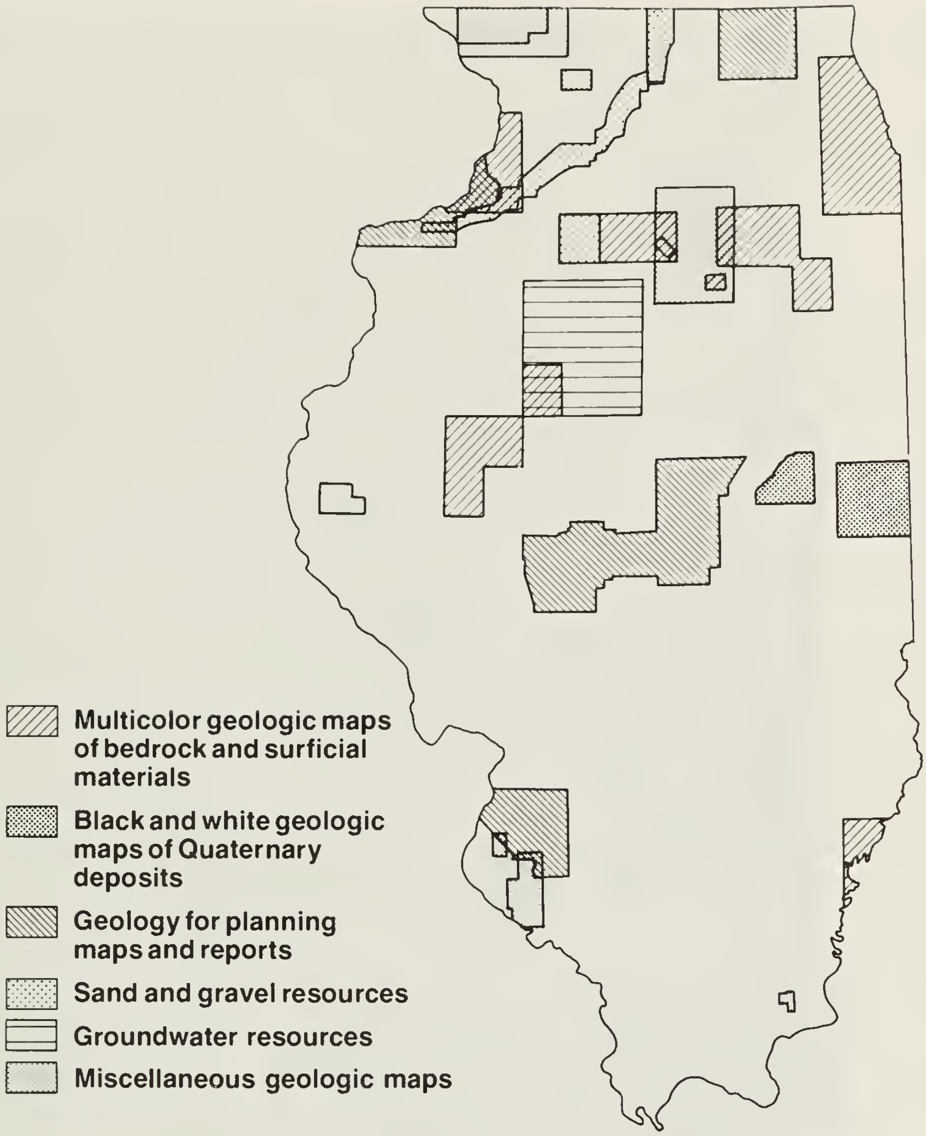



**Figure 7** Geologic maps of Illinois, published at 1:125,500 scale (1 inch equals about 2 miles; actual scales range from 1:92,750 to 1:156,000 or 1 inch equals about 1.5 to 2.5 miles).

between 1899 and 1971. In 1970 and 1979, four geologic maps of the 1° × 2° quadrangle map series were published for a narrow strip along the eastern border of Illinois by the Indiana Geological Survey in cooperation with the Illinois State Geological Survey. Each quadrangle map consists of three sheets, showing both the geology of the bedrock and the overlying unconsolidated deposits of glacial drift and river systems. Over the years, the geology of selected other areas was also depicted at this scale.

A set of four "stack-unit" maps for the entire state was recently published by the ISGS at the 1:250,000 scale (fig. 10). These maps show how geologic materials are stacked down to a depth of 50 feet. The maps are available on paper and as digital files.

Currently, CUSMAP, a cooperative project between the USGS and the state geological surveys of Illinois, Indiana, Kentucky, and Missouri is producing geologic information, summarized on maps at the 1:250,000 scale (from its original compilation scale of 1:100,000), for Illinois south of Benton and DuQuoin.

**Maps at 1:500,000 scale or less detailed (1 inch equals about 8 miles or more)** Statewide geologic maps are generally published at a scale of 1:500,000 (1 inch represents about 8 miles) (fig. 11 ) or at a smaller, even less detailed scale. The two fundamental geologic maps at the 1:500,000 scale are the maps for bedrock and for glacial and alluvial deposits. (Both maps are also available in digital form.) Many statewide or regional interpretive maps have been generated, generally by computer, from these two basic geologic maps, the statewide stack-unit geologic maps, and various ISGS computerized databases. These derivative maps show important properties of earth materials, such as the contamination potential of shallow aquifers (fig. 12).

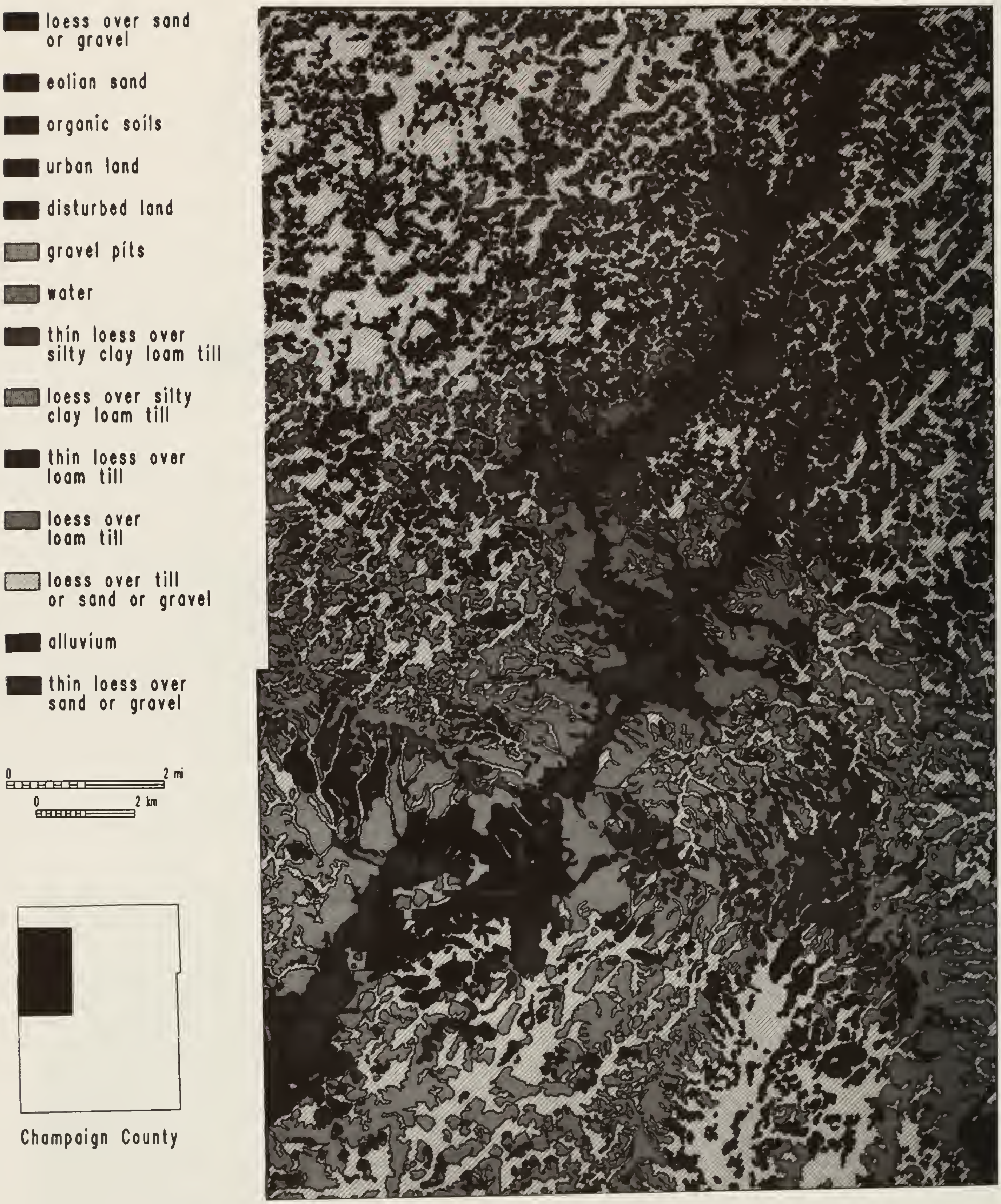



**Figure 8** Shallow geologic materials in western Champaign County: segment from a recently produced 1:100,000-scale geologic map.

Like 1:250,000-scale maps, 1:500,000-scale state maps are screening tools. Because of their small scale, these regional and statewide maps are highly generalized. They cannot be used in site-specific analyses, which normally require much more detailed maps, such as the 1:24,000-scale, 7.5-minute quadrangle maps.

Significant new information on bedrock geology has accumulated since the 1:500,000-scale geologic map of Illinois was published in 1968. The ISGS Mapping Committee has recommended the statewide bedrock geology map be revised and published in the 1990s.

**Current geologic mapping effort and rate of progress**
The ISGS FY91 geologic mapping effort, operating under General Revenue Funds, involved a staff of 2.9 full-time equivalents (FTEs) with an annual expenditure of approximately $170,000. During the decade of 1982-1991, the ISGS will have mapped 43 quadrangles (7.5-minute) and published them at a scale of 1 inch equals 1 mile or more detailed. Included are about 16 quadrangles in Boone and Winnebago Counties, about 18 in Champaign County, and nine in the coal field area of southern Illinois. At the present rate, mapping Illinois at a detailed scale will take more than 200 years.

*Finding* State coverage at regional and statewide scales is reasonably adequate, but large gaps occur in coverage at scales detailed enough for today's demands. Focused geologic mapping is underway at the ISGS under the COGEOMAP and pollution prevention programs; but the total effort is small and restricted geographically and functionally. The current rate of progress suggests that mapping of the state at a sufficiently detailed scale will not be completed for more than 200 years.

*Recommendation* A substantial, integrated geologic mapping program is warranted to deal with state issues on the basis of established priorities. Emphasis in geologic mapping should be on larger scale, detailed maps compiled at a scale of 1:24,000 and published at scales of 1:100,000 or 1:24,000. Open file maps of the 1:24,000-scale compilations should be maintained.

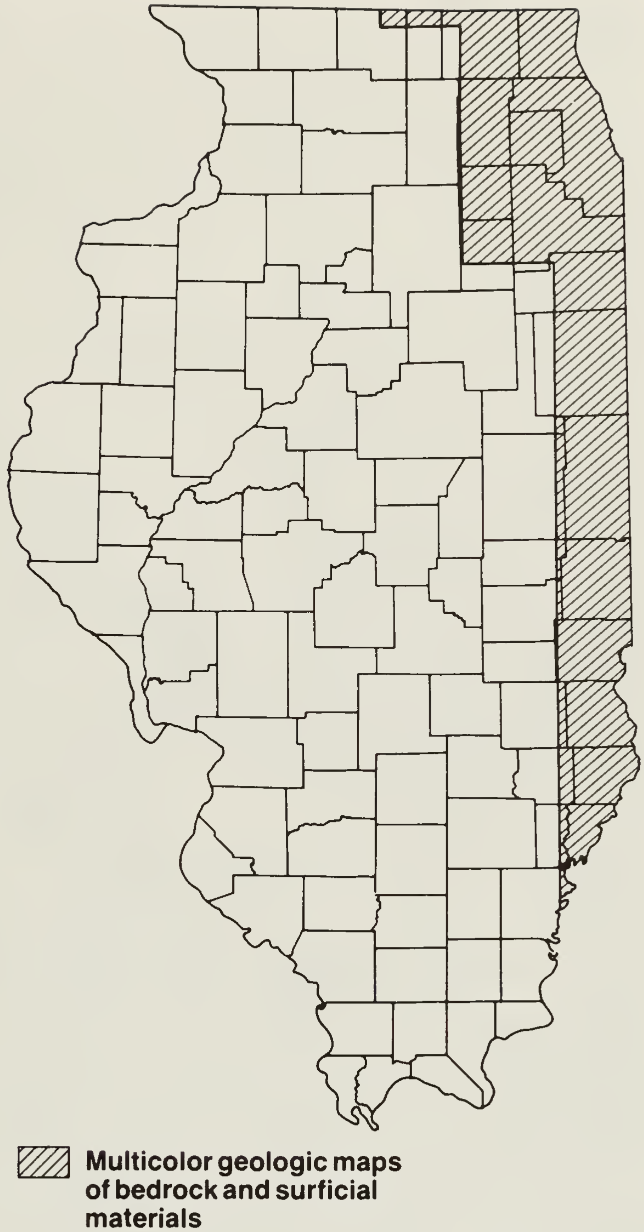



**Figure 9** Geologic maps of Illinois, published at a scale of 1:250,000 (1 inch equals about 4 miles); multicolor standard geologic maps show both bedrock and surficial materials along the eastern border to Indiana.

## Status of Geologic Mapping for Groundwater Assessment, Development, and Protection

The study of groundwater resources depends upon the availability of geologic maps. Mapping delineates units of earth materials, establishes chronological boundaries between the units, and delineates regional trends in groundwater quality, availability, and contamination potential. Figures 11 and 13A-D summarize where the ISGS and Illinois State Water Survey (ISWS) have conducted statewide, regional, and large-scale studies relating to groundwater resource delineation and protection. The larger (more detailed) the scale, the fewer are the studies on groundwater resources and protection.

Recent ISGS studies of groundwater resources delineate aquifers primarily at statewide and regional scales (figs. 11 and 13A), and to a lesser extent, at county scales (fig. 13B). Statewide groundwater protection assessments were conducted to evaluate the contamination potential of aquifers from municipal waste disposal and to support a statewide pesticide monitoring plan. On a regional scale (multicounty areas), bedrock topography has been remapped with an emphasis on redefining potential bedrock valley aquifers. Shallow bedrock aquifers in northern Illinois have also been better defined. There have been only a few studies related to groundwater protection at detailed subcounty scales (figs. 13C and 13D). Mapping efforts at this scale are either process-oriented (for example, landfill liner and cap studies), or related to siting of waste disposal facilities and to characterizing

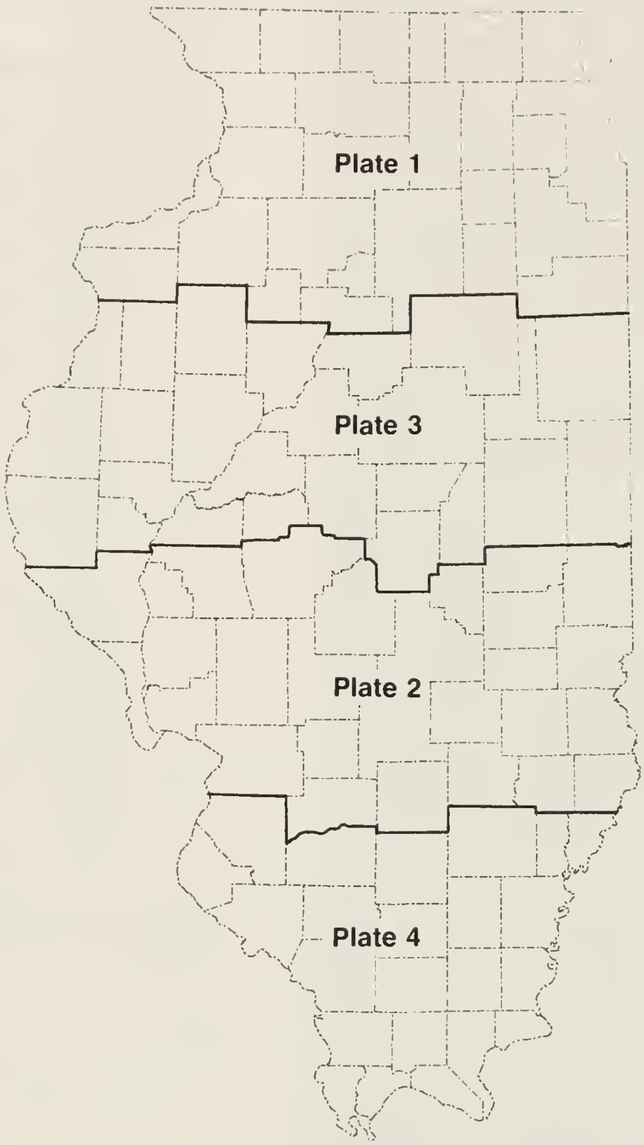



Figure 10 *Stack-Unit Map of Illinois* (1:250,000 scale or 1 inch equals 4 miles), in four plates, covers the entire state.

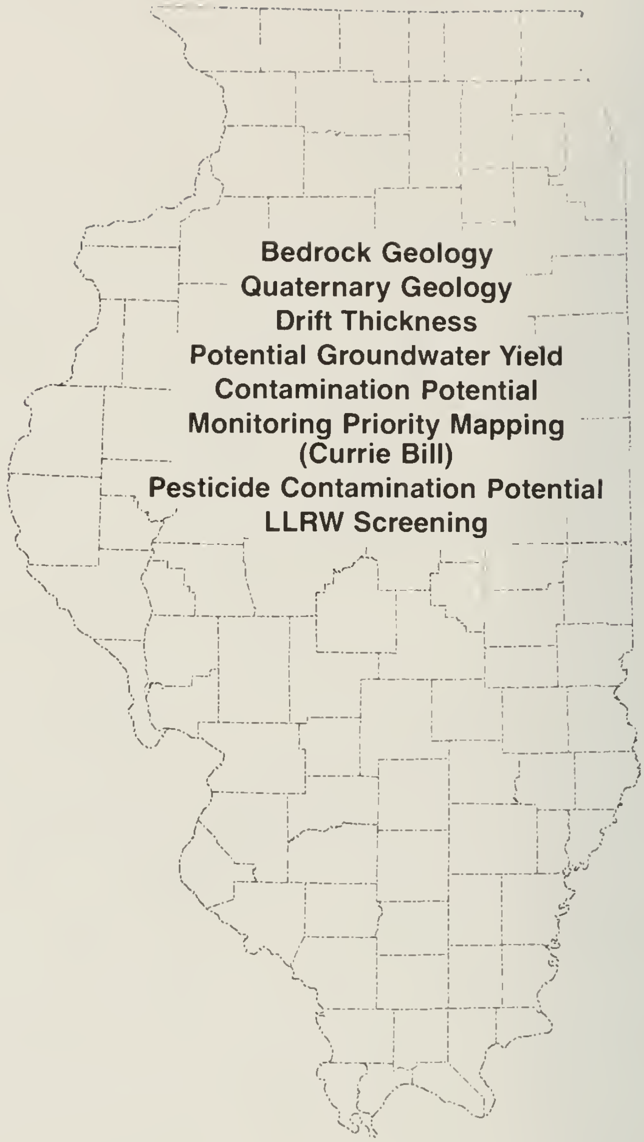



Figure 11 Statewide geologic maps (scale 1:500,000 or 1 inch equals about 8 miles).

specific sites (for example, the low-level radioactive waste disposal sites of Wilsonville and Sheffield, and landfill report evaluations). Recent geology-for-planning studies at the ISGS come closest to meeting most county needs. Mapping for this program has involved detailed stratigraphic and aquifer delineation. A recently published study of shallow groundwater resources of Kane County is being supplemented with local studies to provide more detail generally along the Fox River.

Additional regional reconnaissance mapping studies have been conducted by the ISGS in support of the Illinois Groundwater Protection Act. To date, the ISGS has concentrated on assisting state agencies to target areas of critical need. For instance, by combining a map that interpreted the statewide geologic maps for aquifer recharge with a location map of sources of potential contamination, the IEPA obtained the necessary statewide information to establish and prioritize groundwater protection planning regions. The objective of this short-term, mandated study was to provide a regional perspective of groundwater vulnerability and thus allow prioritization of the state for more detailed studies of contamination potential, extent and quality, recharge, and protection of the resource.

The ISGS also completed a preliminary regional mapping project to estimate the potential for contamination from use of agricultural chemicals by farmers.

Groundwater resource assessment, development, and protection depend heavily upon knowledge of the geologic framework, which is presented in detail on geologic maps at the scale of 1:24,000 (1 inch equals


**Figure 12** Central Illinois: segment from the 1984 state map, published at a scale of 1:500,000, shows the potential for contamination of shallow aquifers from land burial of municipal wastes.

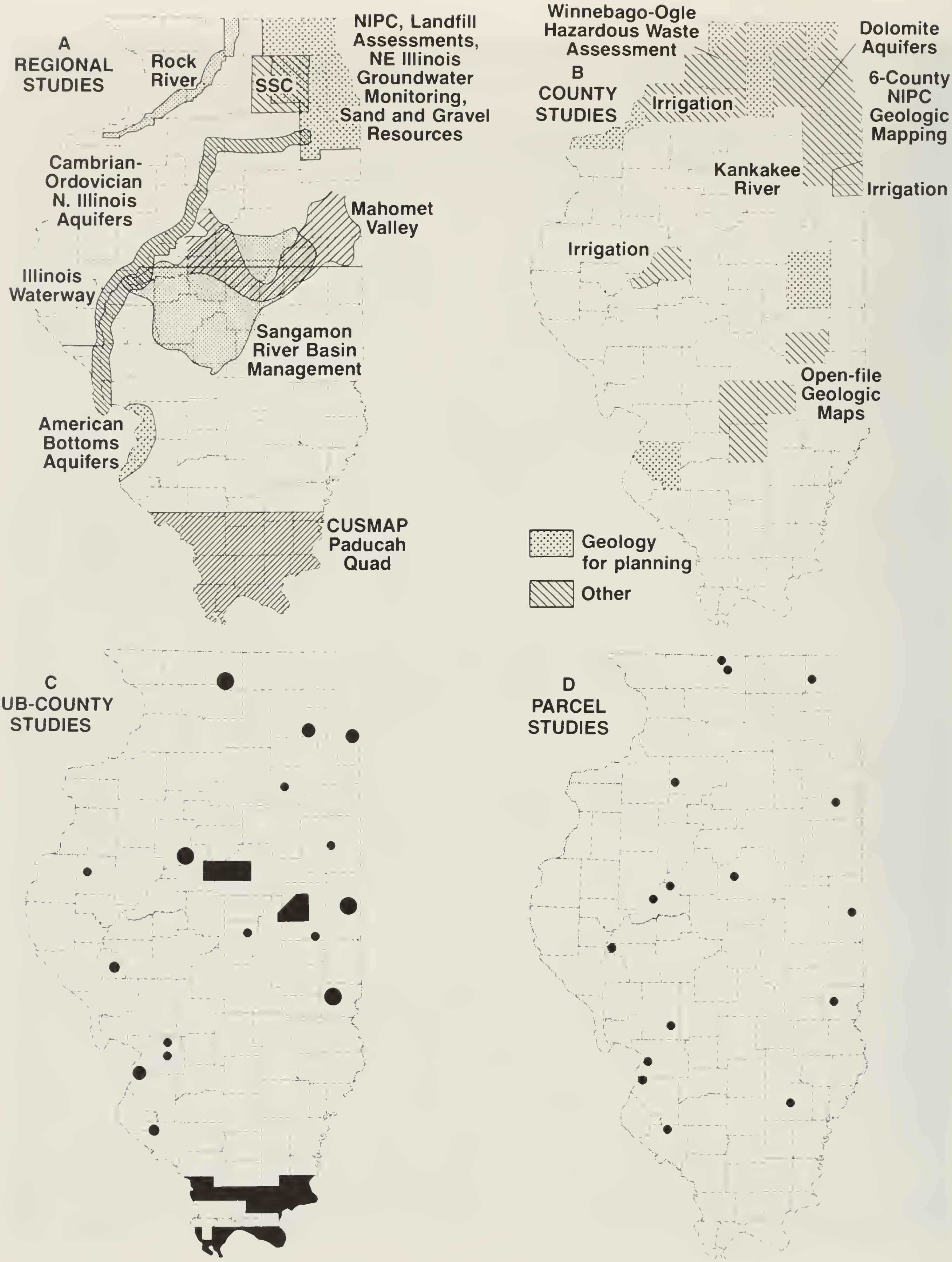



Figure 13 Studies for groundwater protection: A, maps for regional studies at the scale of 1 inch equals 2 to 4 miles; B, maps for county studies generally at scales larger than 1:125,000 (1 inch equals 2 miles); C, maps for subcounty studies at scales larger than 1:62,500 (1 inch equals 1 mile); and D, parcel studies, with maps at scales larger than 1:62,500 (1 inch equals 1 mile).

2,000 feet). To date, only small, selected areas have been mapped at the required detailed scale (figs. 13C and 13D).

*Finding* State coverage by detailed, large-scale maps—at least 1:62,500 (1 inch equals 1 mile), preferably 1:24,000 (1 inch equals 2,000 feet)—is currently inadequate to meet requirements for groundwater development and protection. Most available maps can only be used to identify regional trends.

*Recommendation* Detailed, large-scale geologic mapping for groundwater resource assessment and protection should be concentrated initially on those areas identified as having first-level needs (figs. 14A and 14B). Mapping that addresses groundwater protection is required in McHenry, Boone, Winnebago, Peoria, Tazewell, Mason, and Woodford Counties, and for the East St. Louis metropolitan area. Rural regions that are geologically vulnerable to nitrate and pesticide contamination should also be considered high-need areas for groundwater protection.

Detailed mapping for groundwater resources should be conducted in expanding metropolitan areas (for example, central Illinois), areas with high potential for groundwater resources (for example, central Illinois along the Mahomet-Teays buried bedrock valley—the major aquifer of Illinois), and areas deficient in good-quality groundwater resources (for example, much of southern and western Illinois).

## Status of Geologic Mapping for Siting Waste Disposal Facilities

A State mandate requires counties to define plans for their solid waste landfills by 1995. For planning, counties need to know the nature and distribution of earth materials within their boundaries; such information is most efficiently summarized in geologic maps.

Geologic maps illustrate horizontal and vertical distribution of units of earth material (stack-unit maps) and permit evaluation of the potential for geologic units to become contaminated by given waste disposal practices.

The potential for contaminating groundwater resources is a critical concern in Illinois. Contamination may result from waste disposal practices such as land burial of municipal wastes and surface or subsurface disposal of wastes. When chemical or biological agents from wastes enter surface water or groundwater, they represent potential health hazards.

Maps can be prepared to indicate contamination potential. The stratigraphic position of geologic materials with distinct hydraulic properties must be mapped to identify areas having potential for aquifer contamination. Distinctions must be made between porous, coarse-grained or fractured earth materials that yield groundwater to wells drilled into them (aquifers) and less porous, finer grained materials.

Several interpretive maps depicting the entire state have been derived from basic geologic stack-unit maps (figs. 10 and 12). In the construction of one interpretive map, 18 sequences of geologic materials were mapped throughout the state and rated for the susceptibility of these materials to contamination from municipal waste disposal (published in 1984). An important element in this map was the identification of permeable earth materials within 50 feet of the surface. Such sequences occur mostly in northern, northwestern, western, and extreme southern Illinois. Sequences with the lowest contamination potential contain either relatively impermeable bedrock, uniform glacial till, or other fine-grained earth materials; they cover much of northeastern and central Illinois. Maps depicting these sequences are useful for regional assessment but are not suitable for selecting specific sites.

Thirteen sequences were mapped and evaluated for their potential for contamination by septic systems, surface spreading of wastes, and land application of fertilizers and pesticides. Critical to the construction of this particular statewide map were the properties of the top 20 feet of earth materials. Uniform glacial till or other fine-grained earth materials are the least susceptible to contamination; whereas sand, gravel and permeable bedrock are strongly susceptible. Permeable earth materials are common near the surface in northeastern and central Illinois; earth materials with low permeability are found near the surface principally in north-central, northwestern, and southern Illinois.

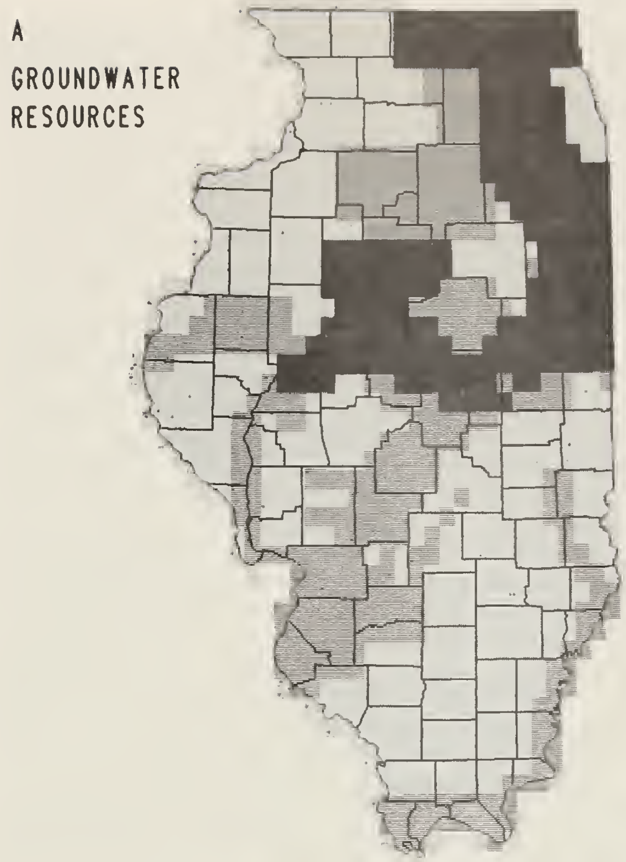
As with the statewide maps rated for groundwater contamination potential from municipal waste disposal, these maps are useful for screening purposes but not for detailed siting investigations.

Although the ISGS has conducted numerous statewide and regional reconnaissance studies to evaluate the contamination potential of aquifers from waste disposal practices, this type of information is generally lacking at the county scale (1 inch equals 2,000 feet or 1 inch equals 1 mile). Reliable information must be made available to local planners and decision-makers at a scale sufficiently detailed for effective land-use planning. Determining groundwater flow rates and directions, mapping aquifer boundaries, evaluating application rates for agricultural chemicals on fields, establishing well-head protection zones, and determining groundwater quality, both ambient and monitored over time, all require detailed geologic mapping at the county, subcounty, and municipal levels.

Screening at the regional scale has identified regions that contain large percentages of land vulnerable to contamination. More detailed geologic maps are required to locate landfills and hazardous waste sites, and to assess the potential for groundwater contamination from existing sites and other point and nonpoint sources. Such detailed geologic maps will help counties meet new mandates to develop solid waste disposal plans and deal with waste disposal activities.

*Finding* Available regional-scale geologic maps are inadequate to meet the needs for locating specific sites for landfills, disposal of hazardous wastes, and similar purposes. Detailed geologic maps are available only for limited areas of the state.

*Recommendation* Detailed geologic mapping, preferably at the scale of 1:24,000 (1 inch equals 2,000



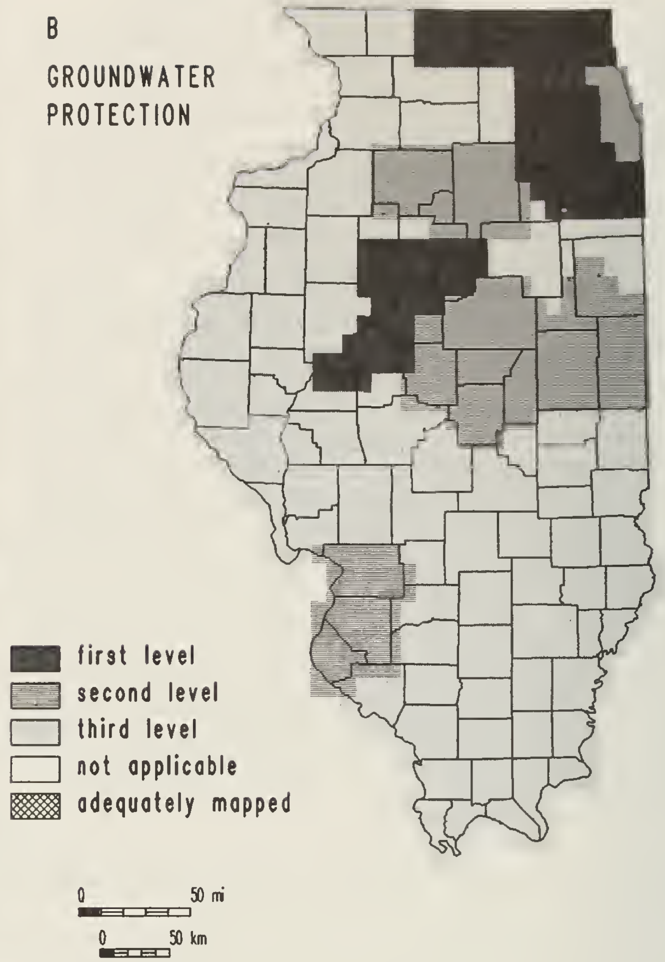





**Figure 14** First, second, and third levels of need for detailed geologic mapping for
A groundwater resource assessment and development,
B groundwater protection,
C siting landfills and waste disposal facilities.

feet), is required to meet county needs for development planning. Mapping would commence with the counties that have the greatest populations and need based on landfill capacity requirements and the urgency of those requirements (fig. 14C).

## Status of Geologic Mapping for Assessing Mineral Resources

**Fluorspar, lead, zinc, and other mineralization** The entire Illinois-Kentucky Fluorspar District has been mapped at the detailed scale of 1:24,000 (1 inch equals 2,000 feet), both in southeastern Illinois and in neighboring western Kentucky (fig. 15A).

Fluorspar occurs along with appreciable amounts of recoverable lead (galena), zinc (sphalerite), copper (chalcopyrite), and barium (barite) mineralization within certain favorable geologic intervals in fissure-vein deposits within faults and in bedding-replacement deposits near faults. Maps showing the location, amount, and direction of movement along faults, and the identity of geologic formations at the surface play an important role not only in the recognition of potential for vein deposits but also for planning exploration projects. Bedding-replacement fluorspar deposits occur within relatively pure limestone beds. Geologic maps also indicate where the limestone beds most likely to contain bedding-replacement fluorspar crop out and are most accessible for exploration.

Ore bodies in the northwestern Illinois portion of the Upper Mississippi Valley Zinc-Lead District are found to occur along downfolded geologic intervals that can be located by detailed surface mapping, especially where augmented by drilling information. Further exploration on the western flanks of the Illinois Basin between the Upper Mississippi Valley Zinc-Lead District and the Missouri Lead-Zinc District could be enhanced by detailed geologic maps of bedrock in that area (fig. 15A).

The tripoli or silica deposits of Alexander and Union Counties in southwestern Illinois represent an important resource. Recent detailed mapping revealed a prominent, mappable chert bed at or near the top of the Clear Creek Chert in an area with commercial tripoli. The existence of such a bed may be a guide to exploration in other areas. The need for more mapping of tripoli deposits is indicated in figure 15B.

*Finding* Detailed geologic maps of the Illinois-Kentucky Fluorspar District have been widely used in mineral exploration (fig. 15A). Mapping in the district, as currently delineated, is sufficient for the immediate future; but recent 1:24,000-scale mapping for COGEOMAP (fig. 5) revealed structures that may also be mineralized west of the established district. Similarly, the Conterminous United States Mineral Assessment Program (CUSMAP) for the Paducah 1° × 2° sheet of southernmost Illinois is demonstrating that the potential for fluorspar and metal mineralization in southern Illinois is more widespread than previously suspected.

The Upper Mississippi Valley Zinc-Lead District has been mapped at the scale of 1:62,500 (1 inch equals 1 mile) but those maps are dated. The Dubuque 1° × 2° sheet (1:250,000 scale) that includes the Zinc-Lead District is being considered for mapping and analysis within CUSMAP. Modern 7.5-minute geologic maps (1:24,000 scale) of that area and to the south along the western flank of the Illinois Basin should encourage exploration in those areas.

*Recommendation* Detailed 7.5-minute quadrangle mapping (1:24,000 scale, 1 inch equals 2,000 feet) adjacent to the Illinois portion of the Illinois-Kentucky Fluorspar District should be extended to include areas south of present COGEOMAP activities, starting with the Brownfield, Reevesville, Mermet, Karnak, and Vienna 7.5-minute quadrangles (fig. 15A). Geologic mapping should be considered for key 7.5-minute quadrangles within the Upper Mississippi River Zinc-Lead District (in conjunction with the Dubuque 1° × 2° sheet proposed as part of CUSMAP) and key areas extending southward along the western flank of the Illinois Basin.

*Finding* The Tripoli District and surrounding areas of southwestern Illinois have not been mapped in detail, except for preliminary mapping (1:62,500 scale, 1 inch equals 1 mile) in the 1930s (fig. 15B) and recent, limited reconnaissance mapping. Consequently, the extent and the amount of tripoli resources are unknown. The detailed mapping conducted recently led to a new interpretation of the origin of these deposits, and it should permit future mapping to more accurately delineate tripoli potential. Available maps are not detailed enough to permit accurate assessment of the mineral potential.

*Recommendation* In the near future, the geology of the Tripoli District and surrounding areas should be mapped in detail at the scale of 1:24,000 (1 inch equals 2,000 feet) (fig. 15B).

**Limestone, dolomite, sandstone, and clay deposits** Limestone and dolomite are essential carbonate rock commodities used as aggregate in Portland cement for construction of buildings and roads (concrete and black-top), a source of agricultural lime, and a component in various manufacturing and chemical processes. Sustainable supplies of limestone (mainly restricted to the southern two-thirds of the state) and dolomite (predominantly in the northern one-third) are required to maintain a strong construction industry and fill the demand from agriculture and other industries.

Illinois sandstone deposits are quarried at a few localities to provide material for the silica sand industry and local building-stone markets.

Use of clay and clay products is based on the chemical, mineralogical, and physical attributes of specific clays and clay minerals. Raw clay materials from Pulaski County in southern Illinois are processed for various uses, according to their absorbency (kitty litter, floor cleaners, and oil-retention compounds). Other Illinois clays are burned to produce structural clay products (brick, floor tile, field tile) and pottery.

Standard, multipurpose geologic maps, mostly of southern Illinois (figs. 5, 15C-E), are available at the scale of 1:24,000 (1 inch equals 2,000 feet); they provide information on the limestone, dolomite, sandstone, and clay resources occurring in areas of carbonate and clay-bearing bedrock. Similar maps at 1:62,500 scale (1 inch equals 1 mile) cover part of southern Illinois and can also be used in prospecting for clays within the Mississippi Embayment sediments (fig. 15C). Single-commodity resource maps, mostly at the scale of 1 inch equals 1 mile, have been compiled for some Illinois counties.

*Finding* Detailed mapping with application to quarriable limestone, dolomite, sandstone, and clay resources is largely restricted to unglaciated, rural areas in southern and western Illinois where mapping has been related to other commodities (fluorspar, coal). Less effort has been expended in areas where bedrock is covered by glacial drift and around rapidly expanding urban areas where demand for crushed stone, in particular, is high.

*Recommendation* The bedrock surface in the counties surrounding rapidly expanding urban areas should be mapped at the scale of 1:24,000 (1 inch equals 2,000 feet) to help locate limestone, dolomite, sandstone, and clay resources (figs. 15C-E). In areas with thick glacial deposits, mapping should incorporate all available subsurface information and adapt stack-unit principles as appropriate. Detailed mapping (1:24,000 scale) should be extended to areas underlain by older carbonate rocks in southern Illinois and along the Ohio, Mississippi, and Illinois Rivers, and to Mississippi Embayment sediments that potentially contain significant clay resources (fig. 15C).

**Sand and gravel deposits** Deposits of sand and gravel in Illinois are largely restricted to glacial terrain and to areas in or adjacent to major water courses. Some nonglacial sand and gravel occurs within the Mississippi Embayment sediments in extreme southern Illinois. Knowledge of the areal extent and character of these highly variable deposits is important to the assessment of potential sources of aggregate needed to maintain current levels of public and private construction and to supply additional materials required to rebuild the deteriorating infrastructure in Illinois, as recognized in the 5-year plan created by the Illinois Department of Commerce and Community Affairs. Information on sand and gravel deposits that serve as aquifers is also essential for groundwater assessment, development, and protection.

Sand and gravel resource maps have been compiled at the scale of 1:62,500 (1 inch equals 1 mile) for selected Illinois counties and at smaller scales (1 inch equals 2 miles) for certain multicounty regions. ISGS geology-for-planning publications also include maps on sand and gravel deposits.

*Finding* Map coverage of Illinois' sand and gravel resources is incomplete, especially where such information is most needed—in areas of rapid urban growth (fig. 15E).

*Recommendation* Detailed sand and gravel maps at a scale of 1:24,000 (1 inch equals 2,000 feet) should eventually be available for the entire state because construction using these low unit-cost materials is required throughout the state. Of highest priority are densely populated, rapidly developing metropolitan areas, as identified on figure 15E.

**Coal deposits** Maps showing the currently known extent of most major coal seams have been published at a scale of 1:500,000. Maps indicating the location of coals considered surface minable (within 150 feet of the surface) have been published at a scale of 1:125,000. Recent detailed mapping (1:24,000 scale) in southern Illinois significantly refined information on known coal deposits and delineated previously unknown or unmapped deposits.

*Finding* Considerable uncertainty remains about the location of coals in several areas of the state, particularly western and southwestern Illinois. Detailed geologic mapping would contribute greatly to the accuracy of ISGS coal resource maps.

*Recommendation* The geology of the area underlain by coal-bearing strata west of the Illinois River and in the vicinity of Murphysboro in southern Illinois should be mapped in detail (scale 1:24,000, 1 inch equals 2,000 feet). These areas contain potentially significant amounts of coal that have a low to moderate sulfur content—coal now in demand due to clean air legislation (fig. 15F).

**Oil and gas resources** In Illinois, geologic mapping is of greatest benefit to oil and gas resource studies in areas broadly defined by the presence or absence of rock exposures. Surface geologic mapping is primarily used in hydrocarbon exploration by examining the character, distribution, and continuity of exposed bedrock outcrops, and by analyzing the structure and geometry of these rocks. Rocks in outcrop may be compared to rocks within hydrocarbon reservoirs, allowing development of improved models for exploration and recovery of the state's oil and gas resources.

Over much of Illinois, relatively thick glacial and alluvial sediments obscure bedrock exposures, limiting the application of geologic maps to oil and gas resource studies. Seismic and subsurface geologic mapping methods are normally used to explore for and develop hydrocarbons. The seismic method uses sound-wave information obtained by emitting vibrations at the earth's surface, then measuring the returning sound waves that bounce off buried rock layers. These data allow interpretation of buried structures and changes in rock properties at depth. Subsurface geologic mapping uses drill-hole information, such as wireline logs, cores, and rock sample cuttings. Geologic maps portraying the geology at ground surface may be used in coordination with subsurface data, particularly for planning seismic programs, comparing deeply buried rocks to surface exposures, and planning strategic layout routes for seismic data acquisition.

*Finding* Geologic maps of the surface or near surface will be useful in oil and gas exploration primarily where bedrock lies at the surface or close to it beneath glacial and unconsolidated sediments. Uses of geologic maps will be in delineating structures and identifying the properties and characteristics of rock outcrops that are not directly observable in their counterparts in deeply buried hydrocarbon reservoirs. Fluid movement in hydrocarbon reservoirs may be controlled by barriers that occur at the inch to microscopic scale; outcrops offer three-dimensional views of these features, otherwise not directly observable in the subsurface.

*Recommendation* Detailed bedrock mapping should be undertaken in high-priority areas, as shown in figure 15G, south of the Cottage Grove and Rough Creek-Shawneetown Fault System of southern Illinois, in rocks exposed along the western margin of Illinois, and in selected areas in northern Illinois. Mapping should be conducted to determine the geometry and character of rocks that are known to or may contain hydrocarbon reservoirs, and also to characterize rocks that are potential hydrocarbon sources.

These areas should initially be mapped at a scale of 1:24,000 (1 inch equals 2,000 feet); however, rocks equivalent to hydrocarbon reservoirs will require even more detailed mapping. Through geologic mapping, more accurate observations and interpretations are possible than are obtainable from drill logs, and maximizing the use of this information may lead to new hydrocarbon discoveries and improved hydrocarbon recovery methods in Illinois.

**Planning mineral resource development** Illinois, which is rich in mineral resources, needs to protect and develop its resources for the future. Geologic maps provide information on the occurrence and nature of mineral resources in a concise and useful manner suitable for planning and development.

Almost all counties of the state have some mineral production; many counties produce two or more commodities (fig. 16A). The value of minerals extracted from the ground in Illinois is more than $2.6 billion per year. In terms of value, the leading mineral commodity is coal, followed by oil, stone, sand and gravel, and clays. Nationwide, Illinois ranks first in the production of fluorspar, industrial sand, and tripoli (microcrystalline quartz); third in the production of peat; fourth in coal; seventh in stone and lime; and eighth in sand and gravel.

Figures 15A-G identify areas where detailed information on the geology is most needed for assessing the potential for mineral discovery, and in the case of construction materials, for sustaining supplies to metropolitan areas in the future.

Counties that have significant coal production, particularly from surface mines (fig. 16B), most need mineral resource planning for development. The need is also great in counties that have significant sand and gravel (fig. 16C) and stone production (fig. 16D). Production of minerals such as tripoli, fluorspar, and peat is restricted to a few counties (fig. 16A). Oil production, which requires relatively small parcels of land, does not have such restrictions on location.

Information on the occurrence of surface-minable coal resources with a high potential for development in the near term was provided through ISGS Circular 504 (1978): 185 blocks of potentially minable reserve blocks of coal were identified in this publication (fig. 17A); some have been actively mined since the publication date of 1978. Publication of detailed geologic maps of the areas surrounding these mining blocks would be desirable, especially for the areas of active permitting and mining in recent years.

The discovery of mineral commodities in such areas calls attention to the need for further geological research to aid the logical development of resources, including the selection of land suitable for mines and mining facilities.

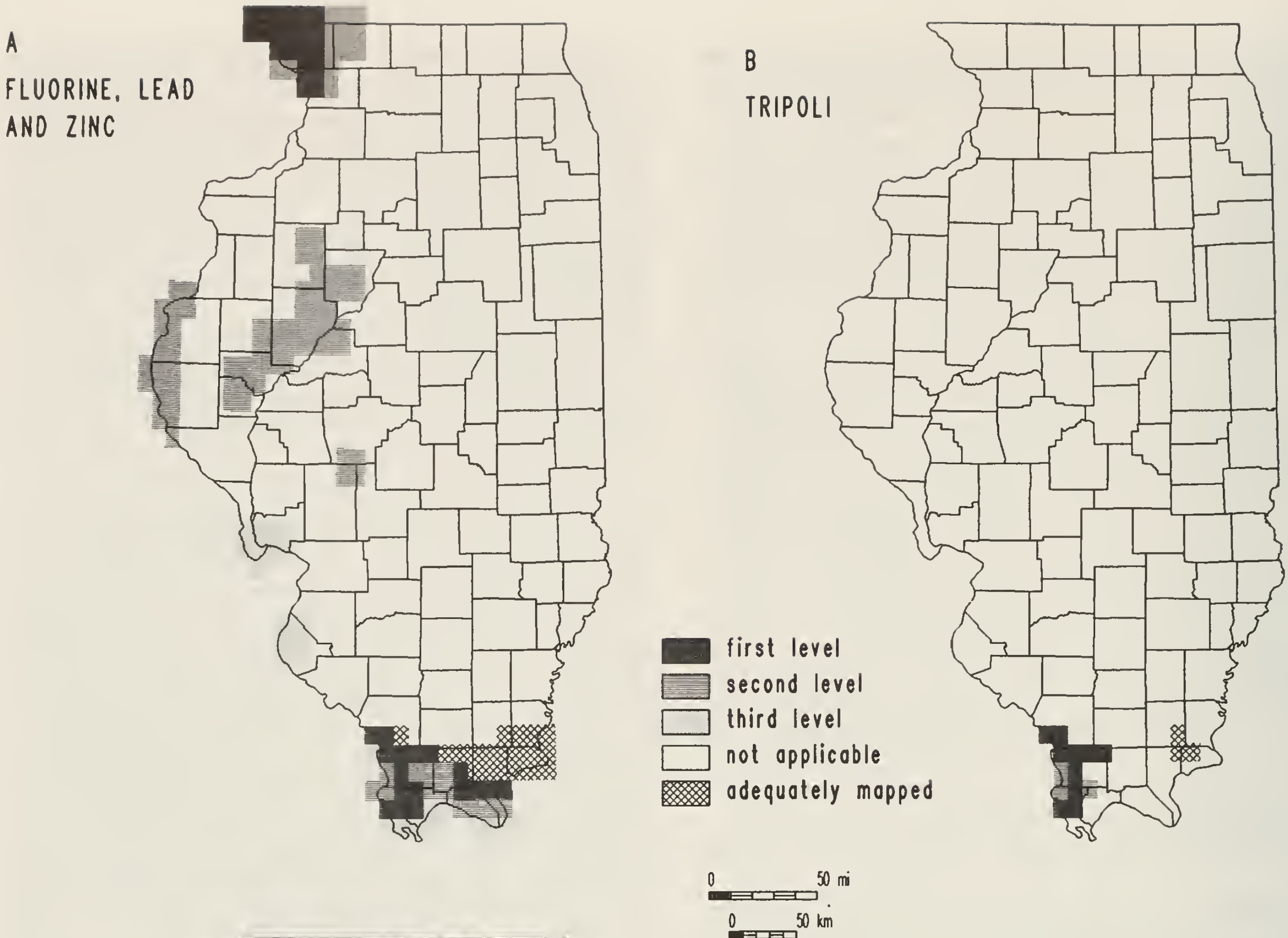
*Finding* Mineral resource development requires geologic information to plan the direction of development and ensure suitable locations for needed surface facilities. Geologic maps are the most concise, useful medium to present information on mineral resources.

*Recommendation* Areas with a strong potential for mineral resource development, which could encompass large blocks of land, should receive high priority for geologic mapping. Areas with current production of coal, stone, sand and gravel, and other commmodities are most likely to continue to attract mineral producers and should be mapped first. Quadrangles in central Illinois containing metropolitan areas that lack adequate local, near-surface sources of stone also demand high priority. Areas containing blocks of coal reserves potentially suitable for surface mining (fig. 17B) should be considered for detailed mapping.

## Status of Geologic Mapping for Economic Development and Environmental Planning

Extractable minerals such as limestone, gravel, metals, and coal can be identified by means of geologic maps, which should be used early in the planning process. When used to detect hazards, geologic maps help ensure the safety and protect the vital economic interests of Illinois citizens. Landslides, faults, flooding, sinkholes, caves, and other natural hazards as well as undermined areas, abandoned landfills, waste sites associated with abandoned gas plants, and other manmade hazards appear clearly on detailed geologic maps. Statewide and regional, small-scale maps are not helpful in detecting these hazards because they contain insufficient detail for making decisions. Data on geologic maps are also useful for assessing conditions prior to siting major industrial facilities such as the Diamond Star plant in Bloomington.

Detailed large-scale geologic maps, such as the 7.5-minute quadrangle maps at a scale of 1:24,000 (1 inch equals 2,000 feet), permit identification of certain natural hazards and assessment of the risks posed to a project. For instance, maps showing steep or unstable slopes where landslides have occurred nearby indicate that engineering geology and geotechnical studies should be performed to determine where buildings can be safely constructed and where land usage should be restricted. Also, geologic maps may show the presence



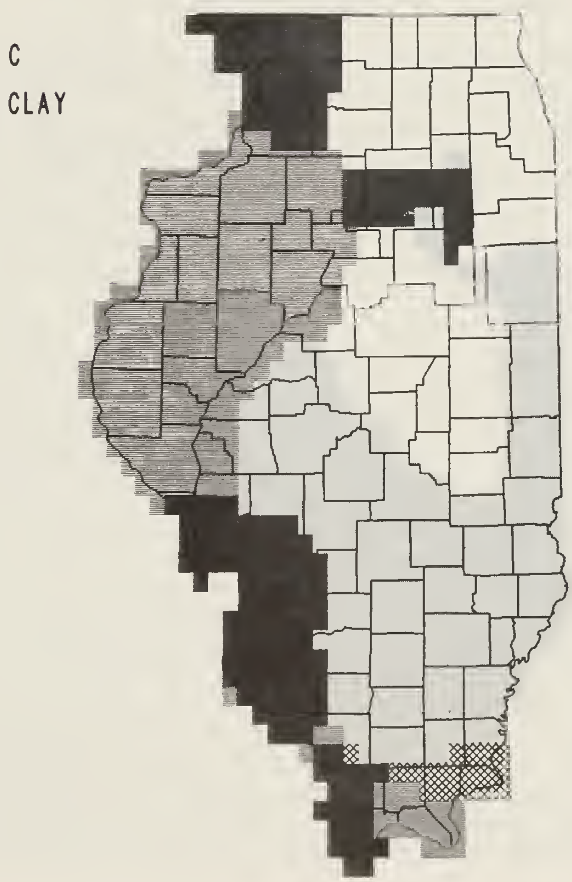
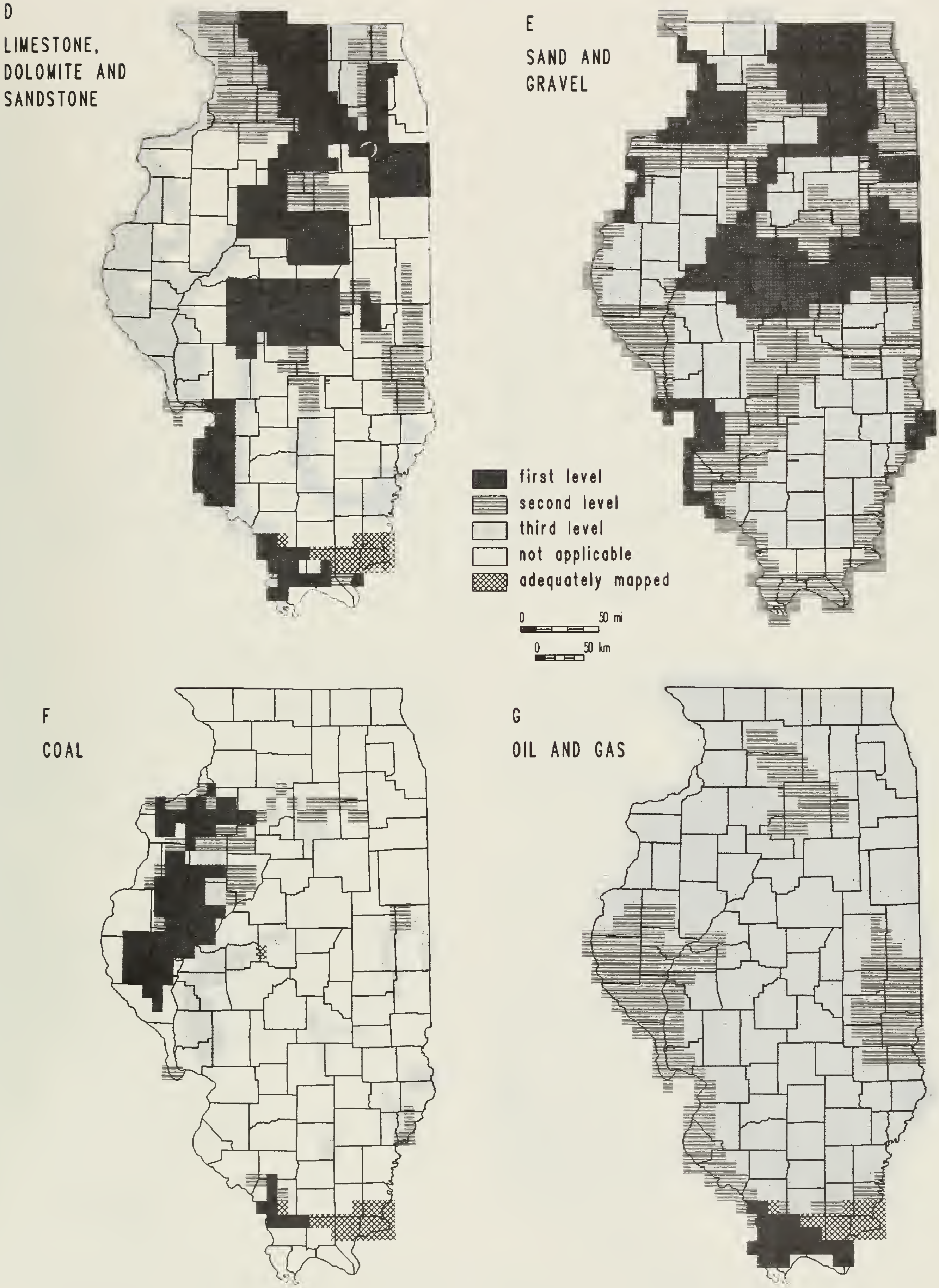




**Figure 15** First, second, and third levels of need for detailed geologic mapping for assessing
A fluorine, lead, and zinc mineralization,
B tripoli mineralization,
C clay resources,
D limestone, dolomite, and sandstone deposits,
E sand and gravel resources,
F near-surface coal resources,
G potential oil and gas resources.


D
LIMESTONE, DOLOMITE AND SANDSTONE
E
SAND AND GRAVEL
first level
second level
third level
not applicable
adequately mapped
0 50 mi
0 50 km
F
COAL
G
OIL AND GAS

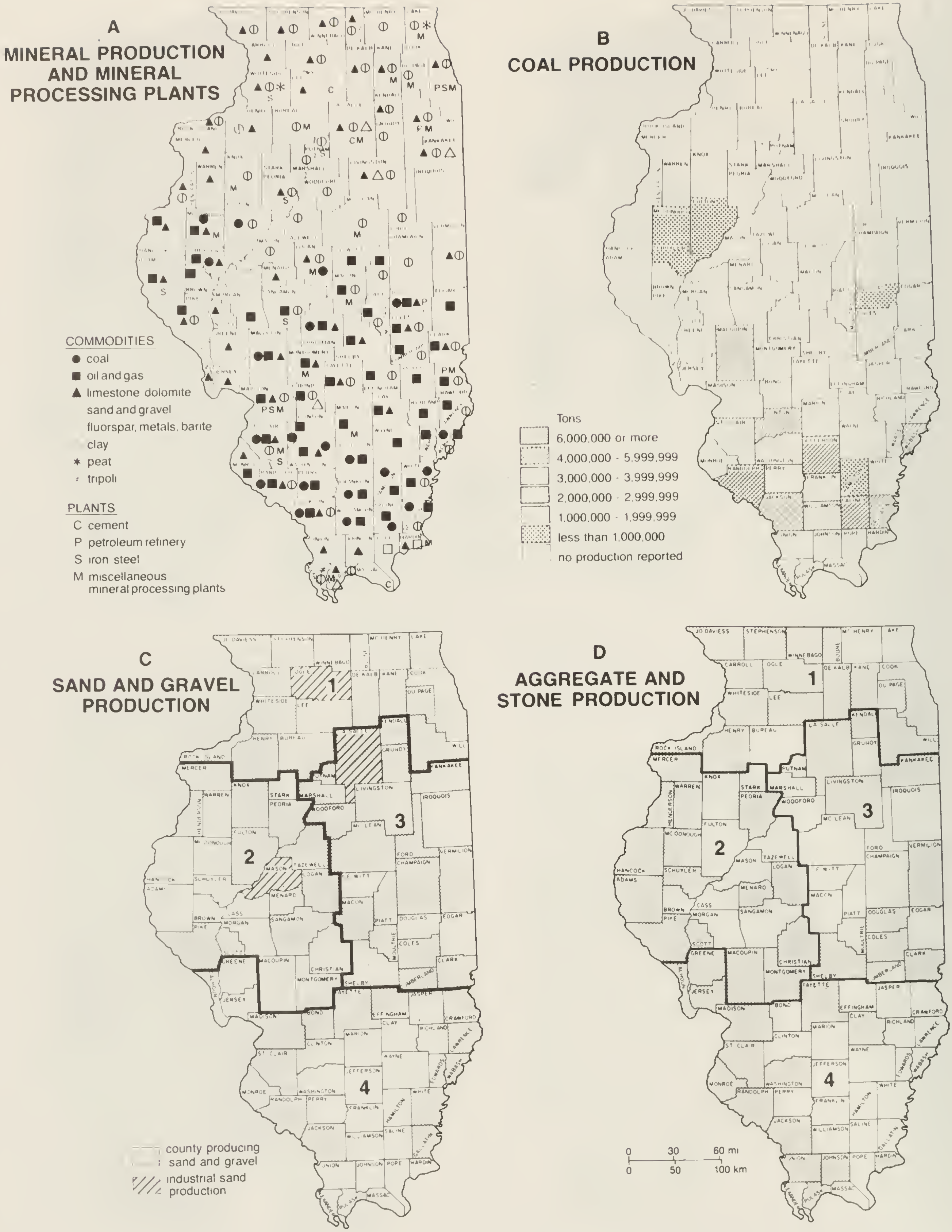
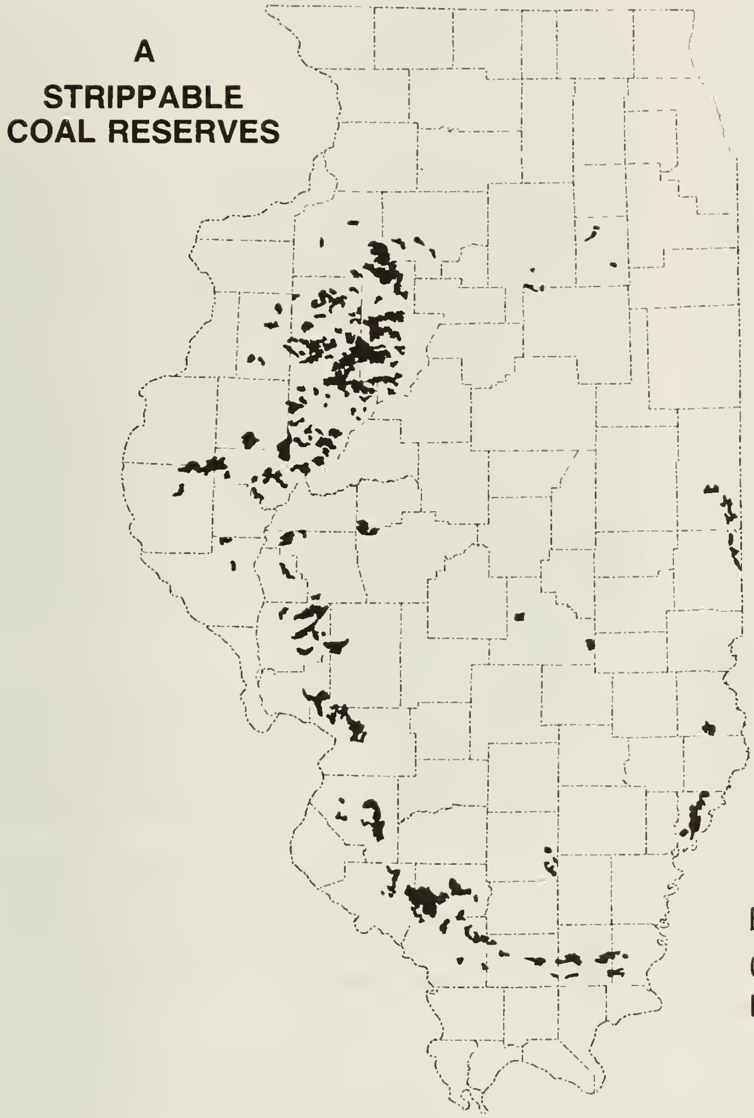



Figure 16 Mineral production in Illinois in 1988: A, commodities and processing plants; B, coal production; C, sand and gravel production; and D, aggregate and stone production. Numbers 1 to 4 in figures C and D refer to U.S. Bureau of Mines reporting districts.



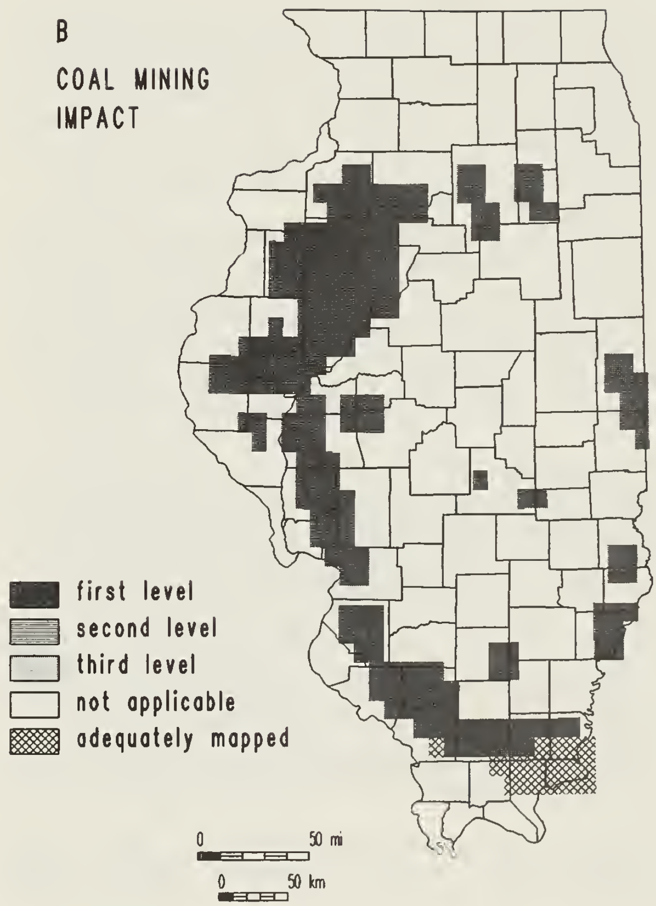




**Figure 17**
A strippable coal reserve blocks with high development potential;
B quadrangles containing or adjacent to the surface-minable coal reserve blocks shown in figure 17A. These quadrangles should be mapped to assist in planning for future mining of coal.

of shallow extractable coal in a formation that has been mined at other locations. Although no records show mining in the area of interest, a field investigation for shallow underground mining would be appropriate to avoid possibly unstable building foundations.

The geologic hazards listed here may adversely affect construction. Large-scale geologic maps will help in recognizing and avoiding risks related to geologic hazards and permit the development of sound building codes or mitigating procedures to respond to hazards.

**Seismic risk** (fig. 18A) If an earthquake occurred along the New Madrid Fault Zone in southern Illinois, the areas likely to experience ground shaking intense enough to produce significant damage to structures (equivalent to a modified Mercalli intensity of VI) within 50 years are identifiable on detailed geologic maps. Some earth materials may undergo liquefaction, which will reduce their strength or bearing capacity under certain seismic conditions. There are no detailed maps of this hazard.

**Landslides** (fig. 18B) Some areas of Illinois are prone to slope movement (landslides) because of local geologic conditions. Landslides can endanger man-made structures. Detailed geologic maps will show historical and ancient slides, flows, and falls, which indicate possible instability. There are no detailed maps of this hazard.

**Coastal and stream erosion** (fig. 18C) Stretches of Lake Michigan shoreline that experience pounding waves as well as storm-elevated water levels are subjected to additional risk. This hazard has already been mapped at the scale of 1:2,400 (1 inch equals 200 feet). Additional mapping would provide baseline data for problems related to coastal and stream erosion.

**Stormwater and coastal flooding** (fig. 18D) Precipitation that cannot be absorbed by the soil or does not evaporate into the air may temporarily collect in depressions. Where high-volume runoff occurs, erosion or flooding may damage property. Sediments deposited by previous floods give clues of what to expect in an area. There are no detailed maps of this hazard.

**Wetlands** (fig. 18E) Seasonally inundated land areas with soils that support moisture-loving vegetation are now being considered for preservation. Wetlands information is available from the Illinois Department of Conservation. Geologic maps assist in understanding how different types of wetlands function, why they occur in certain areas, what hydrogeologic conditions control them, and how they function in groundwater systems. While maps of wetlands are available for most of Illinois, detailed maps of the hydrogeologic conditions that need to be considered in the preservation of wetlands are generally not available.

**Unstable foundation conditions** (fig. 18F) Earth materials may possess insufficient strength, high swelling properties, or other adverse properties that expose structures erected on them to various degrees of risk. No standard detailed maps illustrate this condition.

**Karst** (fig. 18G) Karst is found in areas where deep weathering of carbonate bedrock has taken place. Karst results in irregular bedrock topography, poor surface drainage, occasionally rapid water loss, and unexpected surface subsidence above sinkholes, caves, and pinnacled bedrock. No standard detailed maps delineate areas with karst.

**Faulting** (fig. 18H) In faulted areas, the rocks were ruptured and displaced some time in the geologic past. Because the ruptures are zones of weakness in the rock mass, they may be displaced during earthquakes. Across a fault zone, rock strength may be greatly reduced, or permeability greatly increased, causing water reservoirs to leak or groundwater to flow into underground mine openings. Detailed maps of faults are available for only a few areas.

**Underground mining** (fig. 18I) Some undermined areas are subject to subsidence risk. The ISGS maintains maps that show undermined areas and give information on the type of mining, including the mineral mined, the depth and thickness of the deposit, and the years when mining occurred.

The current set of mined-out-area maps was originally compiled at a scale too small to be a reliable planning tool, except for reconnaissance. A new set of more detailed maps at a scale of 1:24,000 (1 inch equals 2,000 feet) has been designed and produced for two pilot 7.5-minute quadrangles.

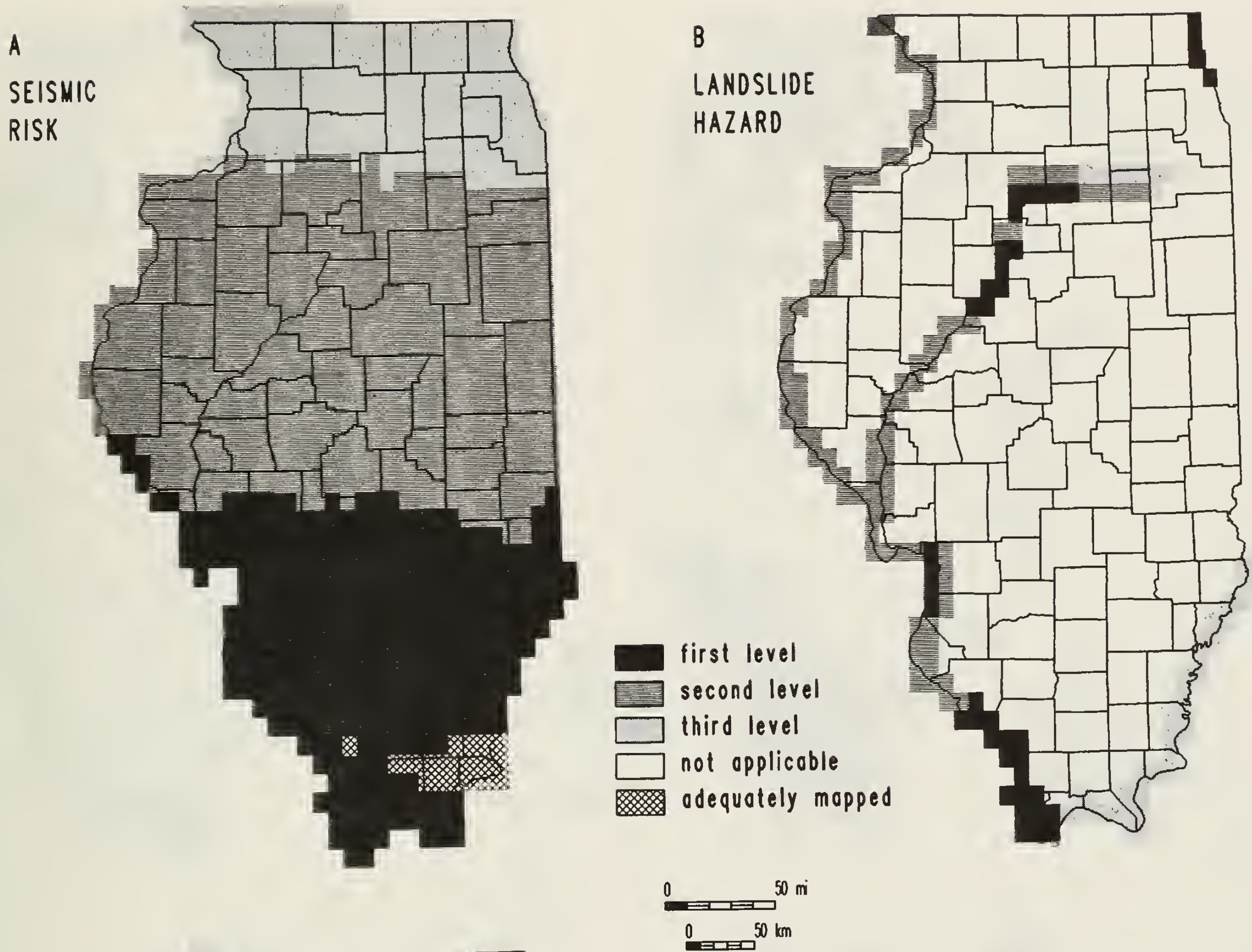
*Finding* For construction planning, detailed geologic maps are needed as the bases for interpretive maps to assess such geologic and related hazards as seismic risk, fault activity, karst areas, landslides, unstable foundation conditions, coastal flooding and erosion, and underground mining. Currently, such maps are only available for selected areas.

*Recommendation* Detailed geologic mapping at a scale of 1:24,000 (1 inch equals 2,000 feet) should be extended to areas with a high level of need for mapping because of geologic hazards, including areas of high seismic risk, landslide susceptibility, and stormwater flooding.

## Status of Geologic Mapping for Identifying Naturally Occurring Health Hazards

Some naturally occurring hazards may add risks to the health of Illinois citizens. Among these are concentrations of metallic ions in groundwater supplies and radon in soils.

**Inferior water quality** Under certain conditions in some areas, groundwater and surface water may fail to meet public drinking water standards. For example, high concentrations of radium and barium have been



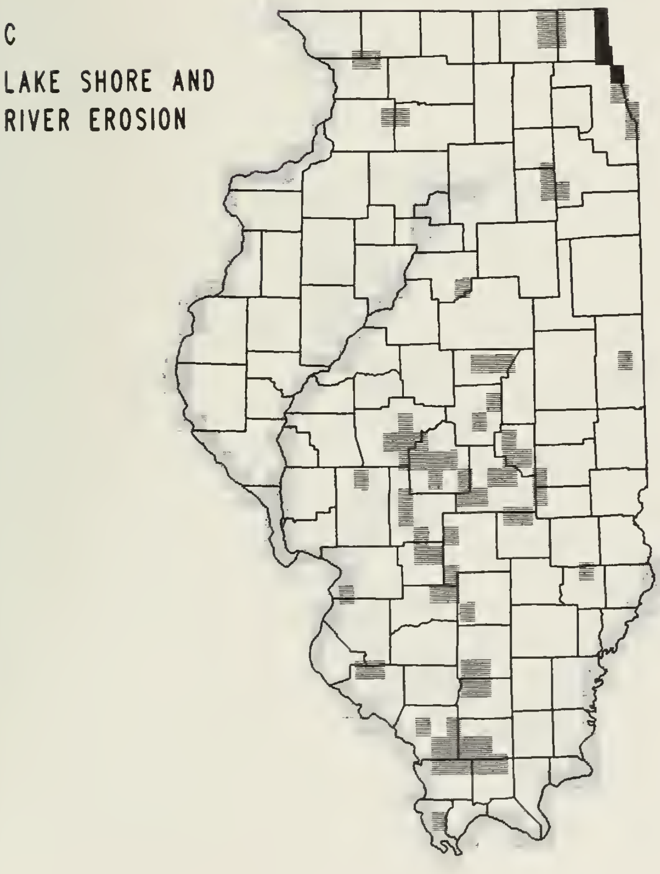
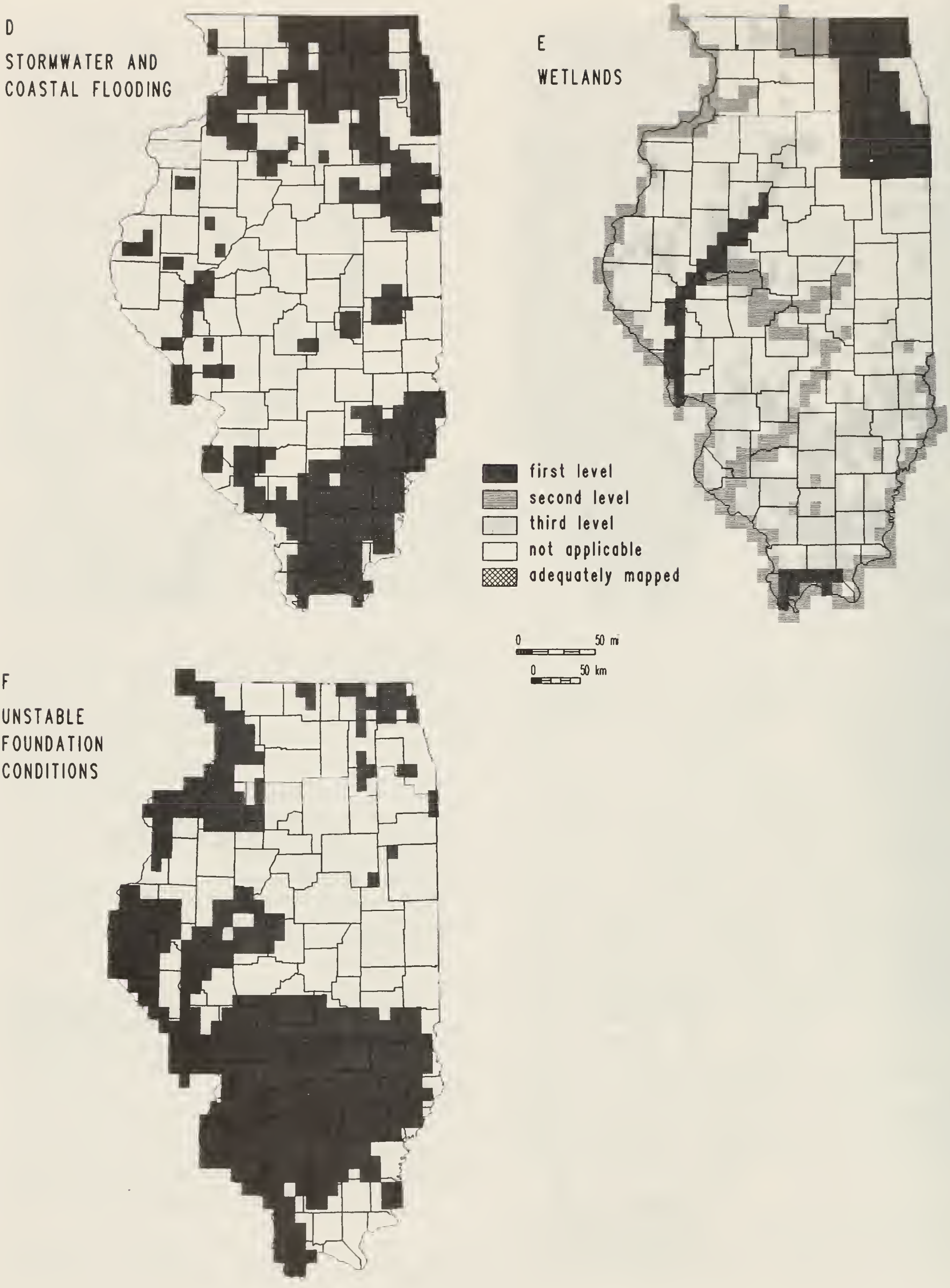
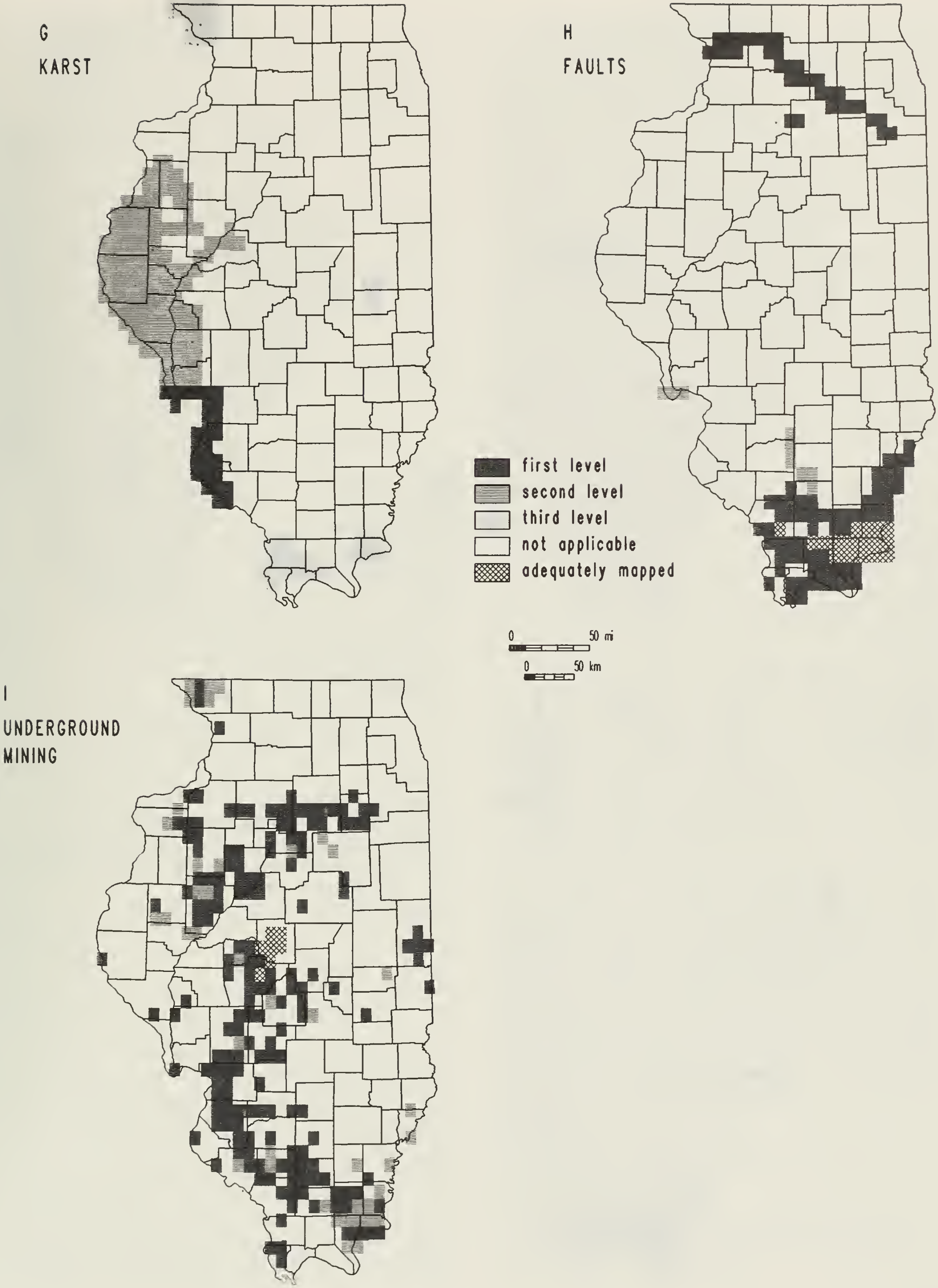
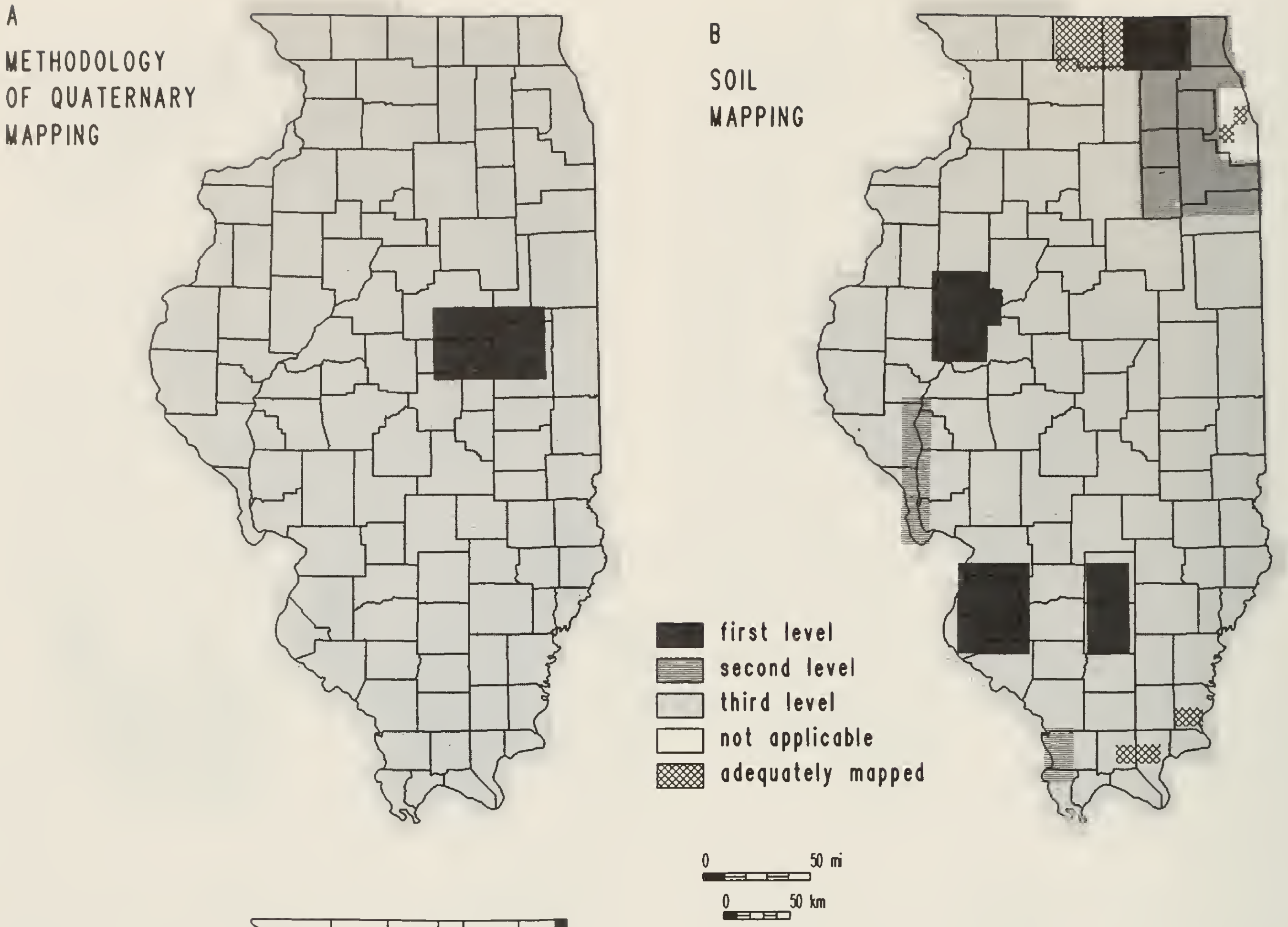




**Figure 18** First, second, and third levels of need for detailed geologic mapping for assessing
A damage from earthquakes (seismic risk),
B probability of landslides,
C coastal and stream erosion,
D susceptability to stormwater and coastal flooding
E hydrogeologic conditions,
F unstable foundation conditions,
G karst features,
H faulted areas,
I quadrangles with underground mines (coal and other minerals). Mined-out areas have been mapped but not at the detailed 1:24,000 scale; mined-out areas will be shown on published geologic maps.


D
STORMWATER AND
COASTAL FLOODING
E
WETLANDS
first level
second level
third level
not applicable
adequately mapped
0
50 mi
0
50 km
F
UNSTABLE
FOUNDATION
CONDITIONS



G
KARST
H
FAULTS
first level
second level
third level
not applicable
adequately mapped
0
50 mi
0
50 km
I
UNDERGROUND
MINING



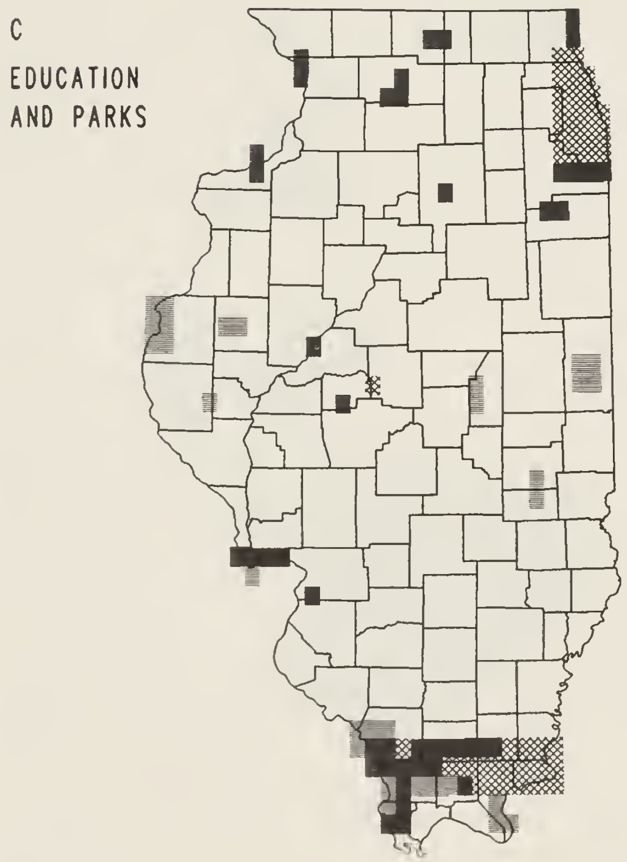




**Figure 19** First, second, and third levels of need for detailed geologic mapping to support
A methodology of Quaternary (surficial) mapping,
B Soil Conservation Service soil mapping program,
C education and parks.

detected in bedrock in certain aquifers in areas of northeastern Illinois.

No known detailed or small-scale maps depict these geologic conditions. Detailed geologic maps are needed to delineate areas where water of inferior quality occurs naturally and areas where water has been contaminated by human activities.

Radon The radioactive gas, radon, is a product of the decay of uranium in soils. Exposure to high levels of radon in homes has been linked with lung cancer. The U.S. Environmental Protection Agency has proposed that the action level for indoor radon be no higher than 4 pCi/1; however, an estimated 20% to 40% of homes in Illinois exceed this guideline.

Detailed maps of the occurrence of radon gas in soils and glacial materials could be used to guide remediation and recommend changes in building codes to reduce indoor radon to safe levels.

## Status of Geologic Mapping of Surficial (Quaternary) Deposits and Soils

Because surficial deposits cover nearly all of Illinois to depths as much as 600 feet, mapping techniques to show the distribution of these various deposits at depth are vital for groundwater resource development and protection as well as many other applications.

The ISGS and USGS are collaborating on a demonstration project to develop data on the surface (including soils) and subsurface, and methodologies to define and characterize all Quaternary deposits to bedrock. The project will use and expand existing techniques in three-dimensional mapping (combining the vertical sequences and areal extent of geologic materials). The area selected for mapping is the Champaign Quadrangle (1:100,000 scale; fig. 19A). A major sand and gravel aquifer underlies this area at depth.

Soils and geologic mapping are interdependent because soils are the altered, uppermost part of surficial geologic deposits. Collaborative studies between the ISGS and the U.S. Department of Agriculture, Soil Conservation Service (SCS) support the publication of county soil reports and soil maps. The priority for soil mapping in recent years in Illinois has been to identify the distribution of prime farmland. This mapping at 1:15,840 scale will be completed about 1995. As of October 1990, 62 counties have published maps; 28 counties have reports in preparation; and the remaining 12 are in the mapping stage.

The SCS is updating its mapping program to meet the demand for more detailed information at scales of 1:12,000 or larger. Higher resolution is needed for land-use planning and management, particularly in areas of urban development and other major changes involving water and mineral resources. Updating has been started in St. Clair and McHenry Counties and will eventually be needed in most counties (fig. 19B).

*Finding* Showing the distribution of surficial (Quaternary) deposits at land surface, near the surface, and at depth is essential for applications to land usage and resource development. Continuous development of methodologies to characterize and map these deposits three dimensionally is a necessary part of a modern geologic mapping program. Soil maps and surficial geologic mapping are complementary. Standard soil maps produced before the updating program do not provide sufficient detail for present needs in all cases. A geologic survey, conducted in advance of soil mapping, would be helpful for optimum field efficiency. Also, the high quality of soils mapping would greatly enhance the quality of detailed geologic interpretations derived from soil maps.

*Recommendation* Detailed geologic mapping of the Champaign Quadrangle should be conducted both to develop advanced mapping methologies and to provide a basic geologic map of the region. Mapping should also focus on the East St. Louis region, around Mt. Vernon, and Fulton and McHenry Counties to help meet immediate priorities of the Soil Conservation Service (SCS) to develop methodologies and coordinate efforts (fig. 19B). Prime farmland over the rest of the state will then require major attention by the SCS.

## Status of Geologic Mapping for Education

Geologic maps at various scales have been used by teachers, students, and others to learn more about the geology, landforms, and mineral resources of Illinois. Most published geologic maps in the state are useful to teachers only for presenting a broad overview of the geology of an area. For classroom exercises and field trips, detailed geologic maps at a scale of 1:24,000 (1 inch equals 2,000 feet) are essential.

Sites for state parks and other public access areas were selected partly for their educational value. Therefore, those facilities close to major population centers are commonly used by schools and other educational groups as field trip sites.

*Finding* Little geologic information is now available for those visiting state parks and other recreational facilities. No coordinated effort exists to provide such information to the public.

*Recommendation* In close cooperation with the Illinois Department of Conservation, the ISGS should develop pamphlets describing the geology of the area surrounding state parks and distribute them at park and other recreational facilities. Issues involving the environment and mineral development should be presented in these pamphlets, accompanied by large-scale geologic maps that would permit visitors to identify geologic formations and learn about the earth materials in the immediate vicinity of parks (fig. 19C).

Most in need of detailed geologic mapping are these parks and recreational areas:

*First level of need*
- Starved Rock/Buffalo Rock State Parks
- Illinois Beach State Park
- New Salem State Park
- Rock Cut State Park
- Lowden/Castle Rock/White Pines State Parks
- Black Hawk State Park/Augustana College
- Kankakee River State Park

- Dickson Mounds Museum
- Cahokia Mounds and Horseshoe Lake State Parks
- Mississippi River Palisades State Park
- Pere Marquette State Park/Great River Road/ Principia College
- Crab Orchard National Wildlife Refuge

*Second level of need*
- Robert Allerton Park
- Nauvoo State Park/Great River Road/Montebello Access Area/Ft. Edwards State Memorial
- Argyle Lake State Park/Western Illinois University
- Siloam Springs State Park
- Kickapoo State Park/Camp Drake Boy Scout Camp
- Fox Ridge State Park/Eastern Illinois University

The densely populated area of northeastern Illinois is where earth science is most often taught in elementary and secondary schools. The area has been adequately mapped; black and white geologic maps at a scale of 1:24,000 have been compiled by the ISGS for the Northeastern Illinois Planning Commission (NIPC).

Detailed, color geologic maps of the NIPC area would be especially useful for inner-city school teachers who may have difficulty taking their students on field trips. Available geologic data, perhaps with some minor spot field checking, should be used to compile and publish new color geologic maps for the Chicago region.

### Summary of Needs for Geologic Mapping

The maps (figs. 1A-C) with the Executive Summary summarize all first-level mapping needs for earth resources, groundwater resources and protection, geological hazards, and mineral resource considerations. These maps show the areas with the greatest need for environmental protection, identification of geologic risk, and economic development.

## SUMMARY OF PRIORITIES FOR GEOLOGIC MAPPING IN ILLINOIS

Geologic mapping is essentially a State effort, but all who benefit may wish to participate. For example, at the county or community levels, cooperative funds may be available to contribute to the program. Also, state and local funds may be matched by federal funds on a 1:1 basis and thus magnify funding generated within the State.

To give everybody an opportunity and reasonable access to the program within a reasonable period of time, we recommend that needs and priorities be established on a base of funding that includes incentives to participate, funds to meet emergencies, and support for counties or local units that cannot provide cooperative funds:

- 20% of the annual general revenue funds allocated for the geologic mapping program be utilized by the ISGS to meet emergencies, urgent requests, or mandatory requirements for geologic mapping during a given year;

- up to 40% be designated for an incentive program to match funds contributed at the county, township, and/or municipal level;

- the remainder be designated for identified priority areas not in the incentive program because the base of local funding is insufficient.

Such a program should encourage the participation of local governments that can share the costs of geologic mapping, but it should not disqualify localities that cannot afford to support mapping, despite their critical needs. All regions that have high priority for geologic mapping must be given an opportunity to participate in the program.

### Establishing and Reviewing Priorities

Various regions of the state have various needs for information, depending on economic and sociocultural conditions. There is potential for competition among regions of the state for geologic mapping unless mechanisms are provided for hearing and weighing the demands and for responding to legitimate emergency needs for assistance. Priorities derived from analyzing needs—concerning the environment, resources, and/or the economy—should be considered by the ISGS together with representatives of all governmental agencies, industry, and other users of geologic maps.

The recently organized Illinois Geologic Mapping Advisory Committee (IGMAC) may be called upon annually by the ISGS to help develop and guide statewide geologic mapping and to advise it on priorities for the program. The members of IGMAC represent a broad cross section of state agencies, local government agencies, universities, engineering firms, industrial associations, and professional societies in Illinois that use and produce geologic maps (Annex 2). IGMAC has already provided significant counsel to the ISGS and is in a position to serve as a principal source of information for assessing the progress of the geologic mapping program and reviewing mapping priorities.

*Finding* The priority for geologic mapping in any region of the state is commonly made up of many components varying in importance. Priorities will change over the life of the program because of regional economic and cultural shifts and the gradual completion of geologic mapping of the state. The potential exists for competition among regions of the state in the course of the mapping program unless mechanisms are provided for responsible and reasonable consideration of legitimate needs for geological information.

*Recommendation* The Illinois State Geological Survey (ISGS) should have primary responsibility for gathering information necessary to design and implement an orderly, cost-effective geologic mapping program. The Illinois Geological Mapping Advisory Committee (IGMAC) should assist the ISGS in gathering information about geologic mapping needs. The ISGS and IGMAC should annually review the progress of the geologic mapping program, and as part of that review, reassess priorities for mapping various regions.

## Mechanism for Establishing and Reviewing Priorities for Geologic Mapping

The maps and comments in the preceding section have shown areas of the state where various needs for detailed geologic mapping have been rated as first, second, or third level. These levels of need were derived by the working committee in consultation with ISGS scientists and IGMAC representatives. Specific criteria included the potential for contamination of groundwater resources, discovery and development of additional resources of mineral commodities, susceptibility of areas to natural hazards, and need for assistance in siting waste disposal facilities and other public and private enterprises.

Each criterion must also be considered in the context of major requirements that the ISGS must meet when establishing mapping priorities among regions of the state. The ISGS must provide the data needed to (1) meet its mandates and contractural obligations; (2) support state, regional, and local government planning in areas undergoing rapid demographic changes; (3) respond to local and regional problems such as siting major public or private facilities (for example, the proposed Superconducting Super Collider or Diamond-Star Motors plant) or combating unusual groundwater resource or groundwater pollution problems (for example, the Lake Calumet area); (4) develop and implement statewide plans (for example, the 5-year economic development plan of the Department of Commerce and Community Affairs); and (5) manage the geologic mapping program in the most procedurally correct, logistically efficient, and cost-effective manner to accomplish the other four requirements.

Needs and priorities must also be tempered by logistical and scientific considerations. From the standpoint of logistics, some aspects of field work can be made simpler or more cost effective when two or more contiguous counties are mapped in a single operation. From a scientific standpoint, geologic mapping requires the development of procedures and/or a regional framework through which various scientific hypotheses can be tested and refined; however, the area of a geologic quadrangle is generally not large enough to provide the basis for developing the procedures for scientific validation or building a regional framework.

*Finding* Cost-effective, efficient design and operation of the State's basic geologic mapping program will necessitate reasonable weighing of logistical and scientific considerations against the immediacy of local needs for geologic information.

*Recommendation* Policy formulation and implementation need to be orderly to arrive at priorities and establish an annual work program for the proposed geologic mapping effort. IGMAC (established in 1989) would seem to be the logical choice for overseeing the implementation of an orderly prioritization process.

## Guidelines for Weighing Priorities

The maps of figures 14 to 19 summarize both past geologic mapping activities and the needs for future detailed geologic mapping on a topic by topic basis. Needs are expressed relative to the benefit that could be gained from detailed geologic mapping for the topic of the map and relative to the perceived need for the information on a short-term basis (less than 5 years, first level of need), medium-term basis (5 to 10 years, second level of need), and long-term basis (more than 10 years, third level of need). The maps were compiled utilizing the expertise of ISGS staff, IGMAC, and the Senate Working Committee on Geologic Mapping.

Population density was a significant factor in establishing needs. For instance, a higher level of need was assigned to determining the occurrence of sand and gravel deposits or the risk of unstable foundation conditions in rapidly expanding, highly populated areas rather than to determining their occurrence in rural, sparsely populated areas.

In other cases, special geologic conditions became a strong factor in assigning a high level of need, for example, to a quadrangle with shallow aquifers that have a high potential for contamination, or to an area with potentially economic mineralizations that have not been adequately studied and mapped.

State and federal mandates also were considered, in particular those relating to the protection of groundwater and surface water from various contamination sources. For instance, a recent screening process performed for the Illinois Environmental Protection Agency identified groundwater recharge areas that were likely to be vulnerable to contamination. These areas were flagged as high priority areas on the groundwater protection map as targets for detailed geologic mapping.

Experts with different backgrounds weigh various mapping factors differently, but they generally agree on overall direction. For example, a first level of need on the karst map should not carry the same weight as a first level of need on the groundwater resource map. Also, the geologic mapping contemplated for the proposed program will have only limited use in tripoli exploration for most of the state due to the nature of the geology of the state; whereas mapping should be very beneficial to the assessment of limestone or sand and gravel resources. Therefore, the first levels of need on the limestone and sand and gravel maps should carry more weight than the first levels of need on the tripoli map.

This reasoning permitted the assignment of three levels of weight (1-3) to the 23 need factors listed in table 5 and illustrated on the 23 need-level maps. The weights of table 5 were combined with these need levels to assign a score between one and nine to each 7.5-minute quadrangle. These scores became the basis for subdividing the 1,071 quadrangles of Illinois into three equal groups (fig. 20): quadrangles with the highest score are *high priority*; those with intermediate scores are *moderate priority*; and those with the lowest score are *low priority*.

*Finding* Figure 20 illustrates a technical evaluation of mapping priorities based on levels of need for economic and environmental assessments from a geo-

**Table 5** Need factors for geologic mapping and weights applied for cumulative weighting to develop priorities

| *Need factor* | *Weight** | *Need factor* | *Weight** |
|---|---|---|---|
| Groundwater resources | 3 | Earthquake risks | 2 |
| Groundwater protection | 3 | Landslides | 1 |
| Waste disposal | 3 | Coastal and stream erosion | 3 |
| Fluorine, lead, zinc | 1 | Stormwater and coastal flooding | 1 |
| Tripoli | 1 | Wetlands | 1 |
| Clay | 1 | Unstable foundation conditions | 1 |
| Limestone, dolomite, sandstone | 2 | Karst | 1 |
| Sand and gravel | 2 | Faults | 1 |
| Coal | 2 | Underground mines | 1 |
| Oil and gas | 2 | Quaternary mapping methodology | 1 |
| Coal development planning | 3 | Soils | 1 |
| | | Education | 1 |

* 3 = greatest, 1 = least weight

logical perspective and on the weights assigned to such factors. No process yet exists, however, to identify areas that should be mapped in the first, second, third, and subsequent years of the geologic mapping program. IGMAC, which has representatives from all identified user groups in the state, could provide the organizational structure for developing such priorities.

*Recommendation* Weighing priorities derived from analyses of mineral commodity potential or environmental issues should be discussed annually for further refinement by the ISGS within the framework of IGMAC and with representatives of all governmental agencies, industry, and other users of geologic maps.

## POSITION OF ILLINOIS IN A NATIONAL GEOLOGIC MAPPING PROGRAM

Recently, the National Research Council of the National Academy of Sciences and the Association of American State Geologists, representing all 50 states, voiced their strong concern about the lack of large-scale, detailed geologic maps through much of the United States (fig. 2). They consider it a serious national problem, which inhibits planning for the future. Only Kentucky, Massachusetts, and Puerto Rico have been mapped completely at the detailed scale of 1:24,000 (1 inch equals 2,000 feet).

The Midcontinent lacks adequate coverage. Substantial efforts must be undertaken to respond to increasing concerns about the environment and economic development—concerns leading to the pressing need for detailed geologic maps.

A National Geologic Mapping Program (NGMP) is being developed in response to these recognized needs. Legislation (The Cooperative Geologic Mapping Act of 1991), scheduled for introduction during the general session of the 87th Congress, has been designed "to stimulate the production of geologic map information in the United States through a national association of Federal, State, and academic participants." The maps are to "be applied to resolution of issues related to land-use management, assessment, utilization and conservation of natural resources, groundwater management, and environmental protection." The USGS and the Association of American State Geologists (AASG) have drafted a plan for the NGMP describing objectives, infrastructure, and management of the program in detail.

Ultimate funding at a level of $55.5 million per year has been proposed for the NGMP in the legislation introduced into Congress. The most significant component of the NGMP is COGEOMAP—the Cooperative Geologic Mapping Program involving the USGS and the 50 state geological surveys. Under the initial proposal, federal funds increasing from $15 to $25 million over 4 years would be made available to the state surveys on a 1:1 federal and nonfederal matching basis. This structure is similar to the successful national topographic mapping program that produces the standard topographic maps. Illinois' potential share of these federal funds is at least one-fiftieth, or $0.5 million per year. Population, size, and need suggest a higher proportion of the total amount appropriated by Congress for COGEOMAP should be expected. A small but successful COGEOMAP program has been in place since FY 1985. Federal funding of COGEOMAP in FY 1990 was $1.5 million; Illinois received $75,000.

Illinois is no exception to other midcontinental states as it also lacks geologic maps at a suitable scale of detail (figs. 2 and 4). IGMAC was thus established in July 1989 "to provide counsel and advice to the Illinois State Geological Survey on matters related to geologic mapping. IGMAC is to serve as a forum for the development and coordination of a viable geologic mapping program in Illinois to ensure the building of increasingly comprehensive geological databases to support wise economic resource development and protection of the environment" (Bylaws of IGMAC). The committee has met several times since July 1989. Nearly 50 organizations are represented by voting members (Annex 2), who come from the user community of geologic maps in Illinois, as well as mapmakers and others interested in the use of geologic

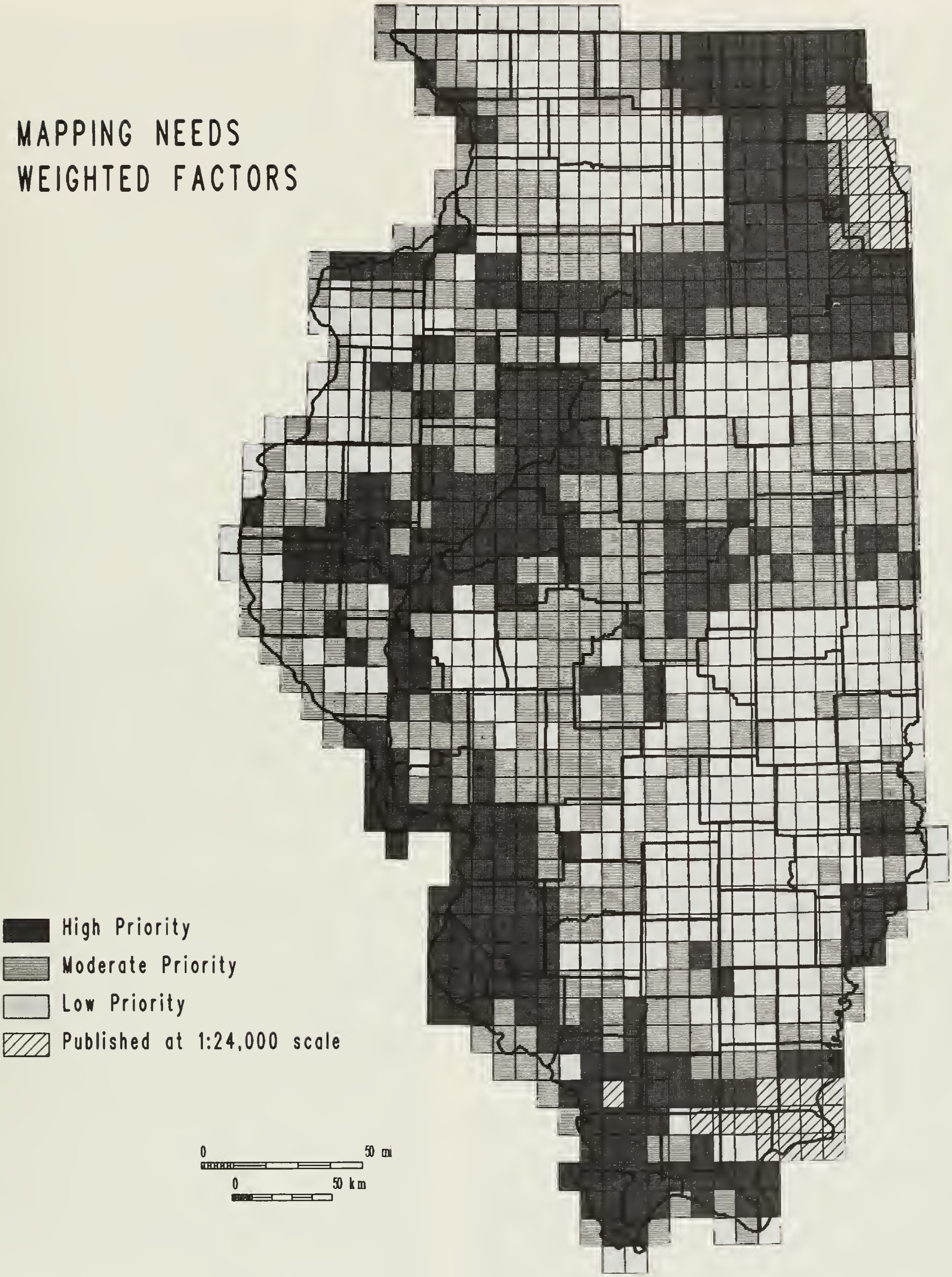



**Figure 20** Weighted cumulative needs derived by considering both the weights assigned to the 23 mapping factors (table 5, p. 36) and the need levels established for the individual mapping factors for each quadrangle (figs. 14, 15, 17-19). The resulting scores for each quadrangle were used to subdivide the 1,071 quadrangles of Illinois into three equally large groups. The top third may be considered to have a high priority for mapping, the middle third a moderate priority, and the bottom third a low priority.

maps. The NGMP implementation plan requires the establishment of committees similar to IGMAC in states that want to participate in COGEOMAP.

The Senate Working Committee on Geologic Mapping has recognized that geologic mapping is a national issue and that the ISGS is in a position to be a strong participant in the proposed NGMP. The ISGS should continue its aggressive efforts to make Illinois' mapping needs and priorities known and to seek matching federal funds to enhance the State's efforts.

## SCOPE OF RECOMMENDED GEOLOGIC MAPPING PROGRAM

The deficiency in the availability of detailed geologic maps (fig. 4) is considerable at this time.

Consequently, the Senate Working Committee on Geologic Mapping has recommended that a comprehensive, multiyear, geologic mapping program be funded by the General Assembly and carried out for the State of Illinois by the Illinois State Geological Survey, in close cooperation with the community of users of geologic information. The program should make detailed geologic maps, supporting reports, and related digital databases widely available to those who require the information. The entire state should be mapped in sufficient detail within a reasonable period of time, depending upon available funding.

The program should be comprehensive, covering all elements of modern geologic mapping: field mapping and support activities such as collecting and analyzing samples, drilling to provide raw data as well as to verify draft maps, digitizing and computerizing map data, developing syntheses (models) and reports to accompany maps, and supplying the resources to publish maps, reports, databases, and computer-generated maps.

Computers will be critical to management and organization of geologic data as well as development, production, and distribution of geologic maps and derivative products. Computers will be used to store and retrieve the thousands of drill records, field descriptions, sample analyses, and other data collected by field geologists. Computers will assist geologists to analyze and interpret the data through such tasks as creation of structure and isopach maps, projection of subcrop lines of key rock units, and display of three-dimensional models of the subsurface.

Conventional, printed maps will remain important products of this program, but digital map products and digital copies of the raw data used in constructing geologic maps will be increasingly in demand. Computers will not only be used in digitizing and reproducing geologic maps, but become an important tool in developing derivative maps for specific applications. Inventories and assessments of mineral, water, and oil resources, evaluation of site suitability, and delineation of geologic and seismic hazards require the capacity to combine various geologic and engineering parameters with other data on land use, topography, soils, vegetation, and cultural infrastructure.

Products of this innovative, multifaceted program include

- multicolored, multipurpose geologic maps on topographic bases at scales of 1:24,000 (1 inch equals 2,000 feet) to 1:100,000 (1 inch equals 1.6 miles), printed in quantity on standard presses or individually on an electrostatic plotter, depending on need and demand for publication and distribution;
- reports to accompany the maps and document the framework, classification, nomenclature, and sequence of rock units;
- computerized geologic map databases, available on floppy disk or tape, or accessible by remote terminal for research or other purposes;
- computerized databases of geologic point sources (drill holes, springs, outcrops);
- maps created from computerized databases and customized for the researcher or other client who might specify, for example, a map highlighting areas with geologic materials suitable for waste disposal;
- computer programs that analyze and display geologic data in two and three dimensions (using the Geographic Information System [GIS] and other analytical software).

The ISGS, as a leader in using computers to manage geologic data and to develop and distribute map products, is positioned to capitalize on an appropriately funded geologic mapping program. The ISGS is reasonably well equipped for current needs, although the use of computer technology to support expanded geologic mapping teams and to produce the needed digital products will require some increase of computer resources—hardware, software, and support staff. High-speed computer workstations running Arc/Info (GIS software), a scanning device for map digitizing, and plotters for output of high-quality paper maps will be needed. Additions to staff will include specialists in geologic applications of GIS as well as field mapping crews and other support staff.

The contemplated geologic mapping program will cost $55 million (1990 dollars). At $1.1 million per year, the proposed program can be completed in 50 years. With matching funds from nonstate sources (local or federal government, industry), the timetable can be trimmed to 25 years or less. To do the work in 50 years will require approximately 20 geologists and support staff. To complete the effort in a more reasonable time of 25 years will require the commitment of about 40 geologists and other support personnel. This estimate is based on the experience with detailed geologic mapping programs in Illinois and other states.

The corresponding annual funding for a $55-million program amounts to about $1.1 million per year for 50 years or $2.2 million per year for 25 years. If the federal NGMP materializes as anticipated, and state internal funds can be matched with federal funds on a 1:1 basis, the cost to Illinois drops to about $25 million.

Federal funds may also be matched by funds from local and regional governments or industry and thus further reduce the eventual cost to the State.

A level rate of State funding will maintain an efficient, cost-effective program, whether federal funds become available or not. Annual State funding of $1.1 million will ensure completion of the program within about 50 years. Contributions from government and industry can then be used to reduce the time required to complete the program; for example, federal matching funds can reduce the completion period to 25 years. Adding local funds will cut the time still further.

## BENEFITS AND COSTS OF MAPPING

The northern Illinois counties of Boone and Winnebago, where detailed geologic mapping was conducted in 1980-1981, were selected for the benefits-to-costs (B/C) study requested in SR 98. The study was designed to assess the costs and some of the quantifiable and nonquantifiable benefits from geologic mapping in the two-county area. The quantifiable benefits used in the calculation of B/C ratios in this study were derived from potentially avoidable clean-up costs at some waste disposal sites and contaminated industrial locations.

Geologic and economic conditions in the study area were compared with the rest of Illinois, and the results were extrapolated from the two counties to the entire state.

Geologic maps produced for Boone and Winnebago Counties have been used for environmental planning and remedial action, zoning decisions in land-use planning, geological consulting, water well drilling, mineral resource planning, and education—to name only the documented uses. About 55 actual and potential users in Boone and Winnebago Counties were interviewed to identify how and how often geologic maps are used, what benefits the user derives from geologic maps, and how the benefits are documented by the user.

In the benefits assessment, geologic maps were treated as a public good: using geologic maps helps to avoid future expenses and renders direct, present economic benefits.

Data representing benefits were categorized according to the confidence level that could be assigned. Assigning the confidence level was based on the generally accepted convention that feasibility studies are ±30% accurate. Consequently, data from feasibility studies were assigned ±30% accuracy and classified as category 3. Past expenditures, well documented by accurate accounting, were accepted without doubt, that is, with zero uncertainty; these were assigned the category 1. Category 2 data, with some uncertain documentation, were accepted at a ±10% level of accuracy. Finally, category 4 included all other data from expert estimates assumed to be only ±50% accurate.

Most quantifiable information available was in the area of avoidable future costs. A conservative approach was taken, however, by assuming that technical, regulatory, logistical, or political problems could produce a 10-year delay in benefits realization. Even then, the potential benefits were discounted in three scenarios. In scenario 1, benefits were reduced by 50% to account for incomplete use of geologic information and/or delays in establishing geologic requirements for siting industrial facilities. In scenario 2, benefits were discounted by 75% under the assumption that some progress would be made toward requiring the use of geologic data for siting industrial facilities, improving the regulatory procedures for siting waste disposal facilities, and improving the engineering design of these facilities. In scenario 3, benefits were discounted by 90% under the assumption that most contamination would be prevented as a result of regulations on siting industrial and waste disposal facilities, and of improvements to the engineering designs of facilities.

The cost of geologic mapping was accurately reflected in the budget of the mapping program in Boone and Winnebago Counties. Potential social costs in the form of lost investment opportunities or secondary effects of using geologic maps for planning could not be quantified. They were listed along with other non-quantifiable costs for consideration.

Benefit-to-cost (B/C) ratios for the Boone and Winnebago study were calculated after discounting future cash benefits to 1990 dollars:

| *Scenario* | *Assumed benefit reduction (%)* | *B/C ratio* for category 1* | *Cumulative B/C ratios* for all categories* |
|---|---|---|---|
| 1 | 50 | 1.65 | 23.5 - 54.5 |
| 2 | 75 | 0.83 | 11.7 - 27.2 |
| 3 | 90 | 0.33 | 4.7 - 10.9 |

* B/C ratios for waste disposal clean-up only.

These ratios indicate that the $300,000 investment in the geologic mapping of the Boone and Winnebago Counties would yield a minimum of $1.5 million in benefits in category 4 of scenario 3, the most conservative scenario. B/C ratios included only the benefits from avoidable clean-up of waste disposal and industrial sites. Future costs for clean-up could be significantly reduced by using geologic maps—not that geologic mapping will result in avoidance of all costs at all future waste disposal and industrial sites. The calculations do not include the widely recognized but not readily quantifiable benefits of geologic maps such as reduction in cost of groundwater and mineral exploration and increased efficiency in the selection of sites for construction or waste disposal.

The statewide extrapolation of results from Boone and Winnebago Counties was based on the following premises: (1) mapping programs in other counties will be similar to those in Boone and Winnebago Counties, and (2) benefits in the area of clean-up of contaminated sites will be in proportion to the groundwater contamination potential and the county area. Under these assumptions, the cost of statewide geologic mapping was estimated to be about $21 million.

In an alternative scenario, benefits were projected in the same manner as above, but the cost of statewide mapping was estimated to be 2.6 times higher than in

| *Scenario* | *Assumed benefit reduction (%)* | *Statewide B/C ratio* for category 1* | | *Statewide B/C ratio* for category 4* | |
|---|---|---|---|---|---|
| | | Lower cost | Higher cost | Lower cost | Higher cost |
| 1 | 50 | 0.4 | 0.2 | 6.0 -14.0 | 2.3 - 5.4 |
| 2 | 75 | 0.2 | 0.1 | 3.0 - 7.0 | 1.2 - 2.7 |
| 3 | 90 | 0.1 | -- | 1.2 - 2.8 | 0.5 - 1.1 |

* B/C ratios for waste disposal clean-up only.

the first case. The increase in cost of mapping was attributed to the increase in detail and scope of mapping beyond that undertaken for the Boone-Winnebago study: more detailed collection and compilation of data, greater computerization of data, and larger scale maps that would be more useful in site planning. The results of the two statewide projections of B/C ratios are summarized in the table above.

These B/C ratios indicate that the benefits of geologic mapping comfortably exceed costs in all cases except one. Only in the most conservative scenario 3 does the B/C ratio fall below unity, and then only when the lower end of the range of benefits is considered—and scenario 3 is the least likely to occur.

Again, it must be emphasized that these benefit-to-cost ratios are solely for one category of benefit: the avoidance of costs for clean-up at waste disposal and industrial sites. Many other benefits are evident but not readily quantifiable. (A report of the complete benefit-cost study is available as ISGS Circular 549.)

A benefit-cost study of the Kentucky geologic mapping program was undertaken by McGrain (1979). This program—the first to generate detailed geologic maps for an entire state—was estimated to have a payout of 50:1 on an investment of $21 million over an 18-year period. Significant benefits included the discovery and delineation of new coal and oil resources, the location of new fluorspar deposits, avoidance of costs in landslide-prone areas, assistance in safe siting of facilities, assistance to farmers in siting farm ponds, attraction of industries for economic development, and income from sales of the maps. None of these benefits was considered quantitatively in the Boone-Winnebago study because they could not be quantified rigorously.

## PROGRAM IMPLEMENTATION

### Provision for Stable, Long-Term Funding

The need to map the geology of the state in detail exists whether or not there is a coordinated National Geologic Mapping Program. The State of Illinois should be prepared to commit enough funds to the program each year to maintain a core staff of mapping experts and sustain the program operations needed to ensure orderly progress toward the ultimate goal of mapping the entire state within 50 years. Appropriation amounts and authorizations for expenditures for the State's basic geologic mapping program must not depend upon the existence and amount of matching funds provided by the federal or local governments. Because the amount of funding available from nonstate sources may change significantly from year to year, supplemental funds must not be used to replace the State dollars needed to sustain a stable program. Any contributions to the State's geologic mapping program should be used to increase the rate at which the geologic mapping task is accomplished, and thereby reduce the time and ultimate cost to the State.

### Impact of Other Legislative Mandates for Geologic Mapping

The ISGS is authorized, under the basic powers and duties in Illinois Revised Statutes [Chapter 961/2, Paragraph 7403 (b)], to geologically map the state. Other mandates also require the ISGS to organize and conduct a program of geologic mapping:

- Under Section 7 (b) (2) of the Groundwater Protection Act, PA 85-863, the Department of Energy and Natural Resources is required to "develop and administer an ongoing program of basic and applied research relating to groundwater," including the "...location of groundwater resources, mapping of aquifers, identification of appropriate recharge areas and evaluation of baseline groundwater quality."
- Under Section 6 (a) and (b) of the Solid Waste Management Act (PA 84-1319), the Illinois Department of Energy and Natural Resources (ENR) is authorized to use "...the Department's Geographic Information System to provide analysis of natural resources, land use and environmental impacts," and "to provide technical assistance in siting regional pollution control facilities, defined as any waste storage site, sanitary landfill, waste disposal site, waste transfer station or waste incinerator."

Several cross-cutting issues related to implementation of programs set forth in ENR's transition document could also be furthered by a geologic mapping initiative. These include pollution prevention, solid waste management, groundwater protection, and resource definition. Other agency programs may have similar needs.

Implementing and adequately supporting a coordinated program of geologic mapping will build the database of detailed information needed by the ISGS to respond efficiently and effectively to the requirements of all mandates, powers, and duties. Furthermore, these mandated information requirements must be taken into account in setting priorities for geologic mapping.

## Provision for Geologists Trained in Geologic Mapping

Providing the necessary number of field mappers for a state and national geologic mapping program will require close coordination and cooperation with universities. These institutions will play a vital role in training geologists in field mapping. Support for higher education is envisioned as one of the components of the National Geologic Mapping Program proposed at the federal level of $3 million annually. It may also be achieved through employment of students and faculty by the ISGS during field seasons. Internships sponsored by the ISGS would help to ensure an adequate supply of trained geologic mappers.

## Beneficiaries of Geologic Mapping

All segments of the geologic map user community will benefit from an organized program to complete the detailed geologic mapping of the entire state (table 1). Among these are other State agencies including the Department of Conservation, Department of Commerce and Community Affairs, Department of Public Health, Environmental Protection Agency, Department of Transportation, Department of Mines and Minerals, and Emergency Services and Disaster Agency; engineering consulting firms; producers of coal, oil and gas, and other mineral resources; local governments and taxing districts; environmental groups; water well drillers; and teachers and those interested in outdoor recreational activities.

A focused, prioritized, integrated program of detailed geologic mapping by the Illinois State Geological Survey is in the best interests of the State. Such a program, adequately funded, would meet broad needs of the private, public, and government sectors.

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# ANNEX 1
## SENATE RESOLUTION 98

*STATE OF ILLINOIS*
*EIGHTY-SEVENTH GENERAL ASSEMBLY*
*SENATE*

*Senate Resolution No. 98*

*Offered by Senator Forest D. Etheredge*

*WHEREAS, The Association of American State Geologists has resolved "that a national cooperative geologic mapping program be implemented by the Association of American State Geologists in equity partnership with the U.S. Geological Survey," and that public and private sectors' input into the establishment of priorities be ensured; and*

*WHEREAS, The United States Geological Survey is supporting a nationwide geologic mapping program in concert with the states through its Geologic Division, and recognizes this effort as a distinct and separate need from its topographic program and digital cartography program carried out by its National Mapping Division; and*

*WHEREAS, The Illinois State Geological Survey has recognized the need to interact with State authorities, the USGS through its Geologic Division, and the American Association of State Geologists on matters of geologic mapping; and*

*WHEREAS, The Illinois State Geological Survey, by virtue of its mandates, interests, qualifications, and leadership role in geologic mapping within the State of Illinois, is in a position to establish the State's geologic mapping needs and priorities and mapping standards through input from both the private and public sectors, including government agencies; therefore, be it*

*RESOLVED, BY THE SENATE OF THE EIGHTY-SEVENTH GENERAL ASSEMBLY OF THE STATE OF ILLINOIS, that the ISGS, in cooperation with the Department of Energy and Natural*

*Resources, Department of Transportation, Environmental Protection Agency, Department of Conservation, Emergency Services and Disaster Agency, waste management firms, engineering firms, the coal mining industry, and other mineral companies that utilize geologic maps, prepare a document for this Body summarizing the status of geologic mapping in the State of Illinois and the needs and priorities for future geologic mapping; and be it further*

*RESOLVED, That the ISGS, with the advice of said agencies, industries, and institutions, provide recommendations to this Body on the cost of geologic mapping to meet Illinois mapping requirements and a cost-benefit study of the recommended programs; and be it further*

*RESOLVED, That a Geologic Map Task Force be created to assist the above said agencies and industries in studying the status of geologic mapping in the State of Illinois; and be it further*

*RESOLVED, That this task force consist of six members of the Senate, three appointed by the President of the Senate and three appointed by the Minority Leader; and be it further*

*RESOLVED, That this task force, said agencies and industries submit reports of its findings to the General Assembly by no later than July 1, 1991.*

*Adopted by the Senate, March 6, 1991.*

Philip J. Rock
*President of the Senate*

Linda Hawker
*Secretary of the Senate*

# ANNEX 2

## MEMBER ORGANIZATIONS OF THE ILLINOIS GEOLOGIC MAPPING ADVISORY COMMITTEE (IGMAC)

| Organization | Representative (R)/Alternate (A) |
|---|---|
| American Institute of Professional Geologists<br>Illinois-Indiana Section<br>P.O. Box 254<br>Carmi, IL 62821 | Mr. Chris A. Mitchell (R)<br>(618)382-2343 or 2344 |
| Argonne National Laboratory, ES 372/TR2<br>9700 S. Cass<br>Argonne, IL 60431 | Dr. Lyle McGinnis (ER)<br>(708)972-8722<br>David M. Diodato<br>(Sabbatical) |
| Association of Engineering Geologists<br>North Central Section<br>Woodward-Clyde Consultants<br>122 S. Michigan Ave., Suite 1920<br>Chicago, IL 60603 | Mr. Caner Zanbak (R)<br>Pres. Elect<br>(312)939-1000 |
| Augustana College<br>Department of Geology<br>Rock Island, IL 61201 | Prof. Richard C. Anderson (R)<br>(309)794-7218 |
| Eastern IL University<br>Department of Geography & Geology<br>Charleston, IL 61820 | Prof. R. Gary Wallace (R)<br>Chairman<br>(217)581-2626 |
| Federal Emergency Management Agency<br>175 W. Jackson, 4th Floor<br>Chicago, IL 60604 | Ms. Jeanne Millin (ER)<br>(312)408-5540 |
| Hazardous Waste Research and Information Center<br>Hazardous Materials Lab, MC-676<br>1 E. Hazelwood Drive<br>Champaign, IL 61820 | Dr. David Thomas, Director (R)<br>(217)333-8569 |
| IL Association of Aggregate Producers<br>522 W. Burlington Ave.<br>LaGrange, IL 60525 | Mr. George Dirkes (R)<br>(708)354-8838 |
| IL Association of County Officials<br>DeKalb County Administration Bldg.<br>Sycamore, IL 60178 | Mr. Terry Desmond (R)<br>President<br>(815)895-9161 |
| IL Coal Association<br>212 South Second Street<br>Springfield, IL 62701 | Mr. Joseph Spivey (R)<br>(217)528-2092<br>Clarence Klassen (A) |

| Organization | Representative/Alternate |
|---|---|
| IL Department of Agriculture<br>Bureau of Environmental Programs<br>State Fairgrounds<br>Springfield, IL 62794-9281 | Mr. Warren D. Goetsch (R)<br>Chief<br>(217)785-8217 |
| IL Dept. of Commerce & Community Affairs<br>620 East Adams, 3rd Floor<br>Springfield, IL 62701 | Mr. Wally Biermann (R)<br>(217)782-1438<br>Mr. David Braddock (A)<br>Div. of Research & Analysis<br>(217)524-4144 |
| IL Department of Conservation<br>Lincoln Tower Plaza, Rm. 310<br>524 South Second<br>Springfield, IL 62701-1787 | Mr. William P. White (R)<br>(217)782-3715 |
| IL Dept. of Energy & Natural Resources<br>Office of Coal Development & Marketing<br>325 West Adams, Suite 300<br>Springfield, IL 62704-1892 | Mr. Kim Underwood (R)<br>(217)782-6051<br>Mr. Wayne Bahr (A)<br>(217)782-9741 |
| IL Dept. of Energy & Natural Resources<br>Geologic Information System<br>325 West Adams, Suite 300<br>Springfield, IL 62704-1892 | Mr. Tim Johnson (R)<br>(217)785-8578<br>Mr. Will Hinsman (A)<br>(217)785-8578<br>Mr. Robert Lindquist (A)<br>(217)785-8586 |
| IL Dept. of Energy & Natural Resources<br>Office of Solid Waste & Renewable Resources<br>325 West Adams, Suite 300<br>Springfield, IL 62704-1892 | Mr. Chris Burger (R)<br>(217)782-3718 |
| IL Dept. of Mines & Minerals<br>Underground Injection Control<br>300 W. Jefferson St., Suite 300<br>P.O. Box 10137<br>Springfield, IL 62701-0137 | Mr. Larry Bengal (R)<br>(217)782-7756<br>Mr. Todd Buchanan (A)<br>(217)782-3718 |
| IL Dept. of Nuclear Safety<br>Office of Environmental Safety<br>1035 Outer Park Drive<br>Springfield, IL 62704 | Mr. Gordon Appel (R)<br>(217)785-0512<br>Dr. Keith Earnshaw (A)<br>(217)782-1322 |
| IL Dept. of Public Health<br>535 W. Jefferson, 4th Floor<br>Springfield, IL 62761 | Mr. Jerry Dalsin (R)<br>(217)782-4977 |
| IL Dept. of Public Health, Region 6<br>2125 South Fifth Street<br>Champaign, IL 61820 | Mr. Mark Kuechler (R)<br>(217)333-6914<br>Mr. Mark Sterrett (A)<br>(217)333-6914 |

| Organization | Representative/Alternate |
|---|---|
| IL Department of Transportation<br>Division of Highways<br>DOT Administration Bldg., 2nd Floor<br>2300 South Dirksen Parkway<br>Springfield, IL 62764 | Mr. Ralph Wehner (R)<br>(217)782-7074<br>Mr. John R. Washburn (A)<br>(217)782-7074<br>Mr. Alan Goodfield (A)<br>(217)782-2713 |
| IL Department of Transportation<br>Division of Water Resources<br>DOT Administration Bldg., 3rd Floor<br>2300 South Dirksen Parkway<br>Springfield, IL 62764 | Mr. Donald R. Vonnahme (R)<br>Director (217)782-0690<br>Mr. Gary Clark (A)<br>(217)782-2152 |
| IL Emergency Services & Disaster Agency<br>110 East Adams<br>Springfield, IL 62706 | Mr. Thomas F. Zimmerman (R)<br>(217)782-4448<br>Mr. Michael Arbise (A)<br>(217)782-6229 |
| IL Environmental Protection Agency<br>Groundwater Section, Div. of Public Water Supplies<br>2200 Churchill Road, P.O. Box 19276<br>Springfield, IL 62794-9276 | Mr. Carl Kamp (R)<br>Environmental Protection Specialist (217)785-4787 |
| IL Geological Society<br>c/o Shakespeare Oil Co.<br>202 W. Main, Box 669<br>Salem, IL 62881 | Mr. Dale Helpingstine (R)<br>President<br>(618)548-1585 |
| IL Oil and Gas Association<br>Box 419<br>Olney, IL 62450 | Mr. James Blumthal (R)<br>(618)395-7023 |
| IL Society of Professional Engineers & American Society of Civil Engineers<br>Hanson Engineers, Inc.<br>1525 South Sixth Street<br>Springfield, IL 62703 | Mr. Jack Healy (R)<br>(217)788-2450 |
| IL State Geological Survey<br>Natural Resources Bldg.<br>615 East Peabody Drive<br>Champaign, IL 61820<br>(217)333-4747 | Dr. H. H. Damberger (ER)<br>Mr. P. B. DuMontelle (ER)<br>Dr. J. P. Kempton (ER)<br>Dr. M. W. Leighton (ER)<br>Dr. E. D. McKay (ER)<br>Dr. J. W. Baxter (EA)<br>Dr. R. C. Berg (EA)<br>Mr. J. J. Eidel (EA)<br>Mr. C. J. Stohr (EA)<br>Mr. C. G. Treworgy (EA) |

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| IL State Museum<br>State Museum Bldg., Rm. 200<br>Springfield, IL 62704 | Dr. Bruce McMillan, Dir. (R)<br>(217)782-7386<br>Mr. Russell Graham (A)<br>(217)785-4844 |
| IL State Natural History Survey<br>Natural Resources Bldg.<br>607 East Peabody Drive<br>Champaign, IL 61820 | Dr. Lorin I. Nevling (R)<br>Chief (217)333-6830<br>Dr. Warren Brigham (A)<br>(217)333-0954 |
| IL State University<br>Department of Geography-Geology<br>Normal, IL 61761 | Prof. James G. Kirchner (R)<br>(309)438-8922 |
| IL State Water Survey<br>2204 South Griffith Drive, MC 674<br>Champaign, IL 61820 | Mr. Richard G. Semonin (R)<br>Chief (217)333-2210<br>Ellis Sanderson (A)<br>(217)333-4300<br>Mr. Michael Terstriep (A)<br>(217)333-4959 |
| Kane County Development Board<br>719 South Batavia Avenue<br>Geneva, IL 60134 | Phillip S. Bus (R)<br>Executive Director<br>(708)232-3480 |
| Material Service Corporation<br>222 North LaSalle Street<br>Chicago, IL 60601 | Lyndon L. Dean (R) |
| Northern Illinois University<br>Department of Geology<br>DeKalb, IL 60115 | Prof. Donald Davidson (R)<br>Chairman<br>(815)753-0523<br>Clarence Casella (A)<br>(815)753-7939 |
| Northern Illinois University<br>Department of Geography<br>DeKalb, IL 60115 | Dr. Richard E. Dahlberg (R)<br>(815)753-0827 |
| Northwestern University<br>Department of Geological Sciences<br>Evanston, IL 60201 | Chairman/Geo. Dept. (R) |
| Ozark-Mahoning Co.<br>Mining Division<br>Bohn Street<br>Rosiclare, IL 62982 | Mr. Eric Livingston (R)<br>(618)285-6282 |
| Principia College<br>Department of Earth Sciences<br>Elsah, IL 62028 | Prof. Frederick Marshall (R)<br>Chairman<br>(618)374-2131 |

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| Sangamon State University<br>Geology Department<br>Public Affairs Center, Rm. 556<br>Springfield, IL 62794-9243 | Chairman of Geology Dept. (R) |
| Society of Petroleum Engineers<br>IL Basin Chapter<br>c/o Stewart Producers Inc.<br>Box 546, 1st Bank & Trust Bldg.<br>Mt. Vernon, IL 62864 | Mr. Robert Stewart (R)<br>President<br>(618)244-3754 |
| Southern Illinois University, Carbondale<br>Department of Geology<br>Carbondale, IL 62901 | Dr. John Utgaard (R)<br>Chairman (618)453-3351<br>Dr. Steven P. Esling (R)<br>(618)453-7363 |
| Southern Illinois University, Edwardsville<br>Department of Geography & Earth Science<br>Edwardsville, IL 62026-1001 | Mr. Philip Smith (R)<br>(618)692-3620 |
| Strata Power Company<br>153 S. Harrison<br>Aurora, IL 60506 | Dr. William J. Lang (R)<br>President<br>(708)892-1665 |
| USDA Forest Service, Eastern Region<br>310 W. Wisconsin Ave., Rm. 500<br>Milwaukee, WI 53203 | Mr. Jack B. Jacks (ER)<br>Regional Geologist<br>(414)291-3614 |
| USDA Forest Service, Shawnee National Forest<br>901 S. Commercial Street<br>Harrisburg, IL 62946 | Mr. Andrew Rorick (ER)<br>Forest Geologist<br>Mineral Examiner<br>(618)253-7114 |
| USDA Soil Conservation Service<br>1902 Fox Drive<br>Champaign, IL 61820 | Mr. Robert McLeese (ER)<br>(217)398-5265 |
| US EPA Region 5<br>230 S. Dearborn Street<br>Chicago, IL 60604 | Mr. Valdas V. Adamkus (ER)<br>Regional Administrator<br>(312)886-2406 |
| US EPA Region 5<br>Office of Groundwater<br>230 S. Dearborn Street<br>Chicago, IL 60604 | Ms. Rita Bair(ER)<br>(312)886-2406<br>Mr. Wm. Melville (EA)<br>(312)886-1504<br>Mr. George Hudak (EA)<br>(312)353-4142 |

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| U.S. Geological Survey<br>Special Assist. for Mapping Requirements<br>National Mapping Division<br>Mid-Continent Mapping Center<br>MS 308, 1400 Independence Road<br>Rolla, MO 65401 | Mr. Bill Good (ER)<br>(314)341-0896 |
| U.S. Geological Survey<br>Office of Regional Geology<br>National Center, WGS, MS 908<br>12201 Sunrise Valley Drive<br>Reston, VA 22092 | Mr. Mitchell Reynolds (ER)<br>Chief<br>(703)648-6960 |
| U.S. Geological Survey<br>Water Resources Division, IL District<br>102 East Main, 4th Floor<br>Urbana, IL 61801 | Mr. Stephen F. Blanchard(ER)<br>(217)398-5353<br>Ms. Kelly Warner (EA)<br>(217)398-5368<br>Mr. Charles F. Avery (EA)<br>(217)398-5368 |
| University of Illinois<br>Department of Geology<br>234 Natural History Bldg., MC 102<br>1301 West Green<br>Champaign, IL 61820 | Dr. Ralph Langenheim (R)<br>(217)333-1338 |
| University of Illinois<br>Dept. of Urban & Regional Planning<br>American Planning Assoc., IL Chapter<br>907½ West Nevada, MC 034<br>Urbana, IL 61801 | Lewis D. Hopkins (R)<br>(217)244-5359 |
| Waste Management, Inc., Midwest Region<br>Environmental Affairs<br>3003 Butterfield Road<br>Oak Brook, IL 60521 | Mr. Charles T. Grigalauski (R)<br>Manager (708)654-8800<br>Mr. Phil Gagnard (A)<br>(708)572-3071<br>Ms. Teresa Dvorsky (A)<br>(708)572-1107 |
| Western Illinois University<br>Department of Geology<br>Macomb, IL 61455 | Prof. Peter L. Calengas (R)<br>Chairman<br>(309)298-1151 |

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(R) = Representative
(A) = Alternate to Representative
(ER) = Ex-Officio Representative
(EA) = Alternate to Ex-Officio Representative