

# Availability of Coal Resources for Mining in Illinois

Atwater, Collinsville, and Nokomis Quadrangles,  
Christian, Macoupin, Madison, Montgomery,  
and St. Clair Counties

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## EXECUTIVE SUMMARY

This report is part of a series examining the availability of coal resources for mining in Illinois. Coal resources and related geologic features in the Atwater, Collinsville, and Nokomis Quadrangles were described and mapped. Interviews with experts from coal companies, consulting firms, and state government indicated how regulatory restrictions, cultural features, mining technology, geologic conditions, and economic conditions affect resource availability in the three quadrangles. Many of the geologic and physiographic conditions common to the west-central part of the Illinois coal field are found in these quadrangles.

Of the 1.2 billion tons of original resources in the three quadrangles, 47% (549 million tons) is available for mining, 26% (306 million tons) is mined out, 15% (178 million tons) is unavailable because of technical restrictions, and 11% (128 million tons) is unavailable because of land use. Technical restrictions include partings (7% of original resources), thin coal (6%), unstable Energy Shale roof (1%), small block size (1%), and bedrock cover (less than 0.05%). Land use restrictions include towns (6%), proximity to abandoned mines (5%), and interstate highways and cemeteries (both less than 0.5%).

Ongoing community development near the St. Louis metropolitan area will continue to reduce the amount of available resources, including some of the lower sulfur resources in the state, either by directly restricting access to underlying coal or by partitioning the remaining resources into blocks too small for mining. A high percentage of the Herrin Coal resources in rural areas should be available for mining. The major technical factors that restrict underground mining (partings, thin coal, and unstable roof) are associated with the Walshville Channel. Significant resources are also restricted by proximity to abandoned underground mines.

## INTRODUCTION

Accurate estimates of the amount of coal resources available for mining are needed for planning by federal and state agencies, local communities, utilities, mining companies, companies that supply goods and services to the mining industry, and other energy consumers and producers. Current inventories of coal resources in Illinois provide relatively accurate estimates of the total amount of coal in the ground. There is serious doubt, however, regarding the percentage of coal resources that can actually be mined. Environmental and regulatory restrictions, the presence of towns and other cultural resources, current mining technology, geologic conditions, and other factors significantly reduce the amount of coal available for mining.

Recognizing the significant difference between the reported tonnage and the probable tonnage of coal actually available for mining with current technology and mining regulations, the United States Geological Survey (USGS) initiated a program in the late 1980s to assess the amount of available coal. This report is part of an ongoing, cooperative effort between the USGS and the Illinois State Geological Survey (ISGS) to assess the availability of coal resources for future mining in Illinois. It specifically covers the assessments of the availability of coal resources in the Atwater, Collinsville, and Nokomis Quadrangles (fig. 1). The background of the program as well as the framework for the investigations in Illinois has been described in previous reports (Treworgy et al. 1994, 1995).

Treworgy et al. (1994) divided Illinois into seven regions, each representing a distinct combination of geologic and physiographic characteristics. Two to four quadrangles representative of the mining conditions in each region were selected for assessment of their available coal resources. The selection process of quadrangles and the assessment of resources in them focused on resources that have the highest potential for development (e.g., those that are thick or have a lower sulfur content). This approach ensures that the most economically important deposits receive sufficient study and that minimal time is spent assessing resources that are clearly too thin or inaccessible ever to become available for mining.

The assessment of each quadrangle consists of three steps: (1) compilation of data on the geology and coal resources of each quadrangle, (2) identification of the criteria defining available coal, and (3) application of these criteria to each quadrangle to calculate available resources. Insights provided by previous regional investigations of mining conditions, resources, and geology enabled us to compile 1:24,000-scale maps of the major coal seams, related geology, mines, and land use in each quadrangle. These maps were then used to provide the basis for detailed discussions with mining experts to identify the factors that affect the availability of coal in each quadrangle.

The results of these interviews were used to develop a set of rules defining available coal. Application of the rules to the resources in each quadrangle allowed us to calculate the amount of available resources and identify the factors that restrict significant quantities of resources.

## **Coal Resource Classification System**

The ISGS follows the terms and definitions of the USGS coal resource classification system (Wood et al. 1983). With minor modifications to suit local conditions, these definitions provide a standardized basis for compilations and comparisons of nationwide coal resources and reserves. Some ISGS publications written prior to the development of this classification system in 1976 use terms in a different manner. For example, the term *reserves* as used by Cady (1952) is comparable to the term *resources* as now defined.

In this report, resources are defined as all coal in the ground that is 18 or more inches thick and less than 150 feet deep or all coal that is at least 28 inches thick. The term *original* when used as a preface to *resources* or *available resources* refers to the amount of coal present prior to any mining.

The term *available coal* is not a formal part of the USGS system, although it is commonly used by the USGS and many state geological surveys. Available coal, as used in this report, is not meant to imply that particular coal deposits can be mined economically at the present time. Rather, the term is used to designate deposits that have no significant characteristics likely to render them technically, legally, or economically unminable for the foreseeable future. Further engineering and marketing assessments are needed to determine the actual cost and profitability of mining these deposits.

## **Sources of Data**

Geologic data for this study were compiled from drill logs and records of mines on file at the ISGS and data obtained from coal mining companies. Surface elevations were digitized from USGS 7.5-minute topographic maps. Land cover features such as cemeteries, railroads, and towns were digitized from topographic maps and verified by field reconnaissance.

## **Previous Investigations**

In previous studies, the ISGS evaluated the availability of coal resources in the Middletown Quadrangle in the central part of the state (Treworgy et al. 1994), the Galatia Quadrangle in southern Illinois (Treworgy et al. 1995), the Mt. Carmel Quadrangle in southeastern Illinois (Jacobson et al., in press), the Newton Quadrangle in central Illinois (Treworgy et al. 1996), and the Princeville Quadrangle in northwestern Illinois (Treworgy et al. 1996). Sixteen coal seams have been assessed in these studies. The percentage of resources available for mining in each quadrangle, including the results from this report, has ranged from 18% to 79% of the original resources.

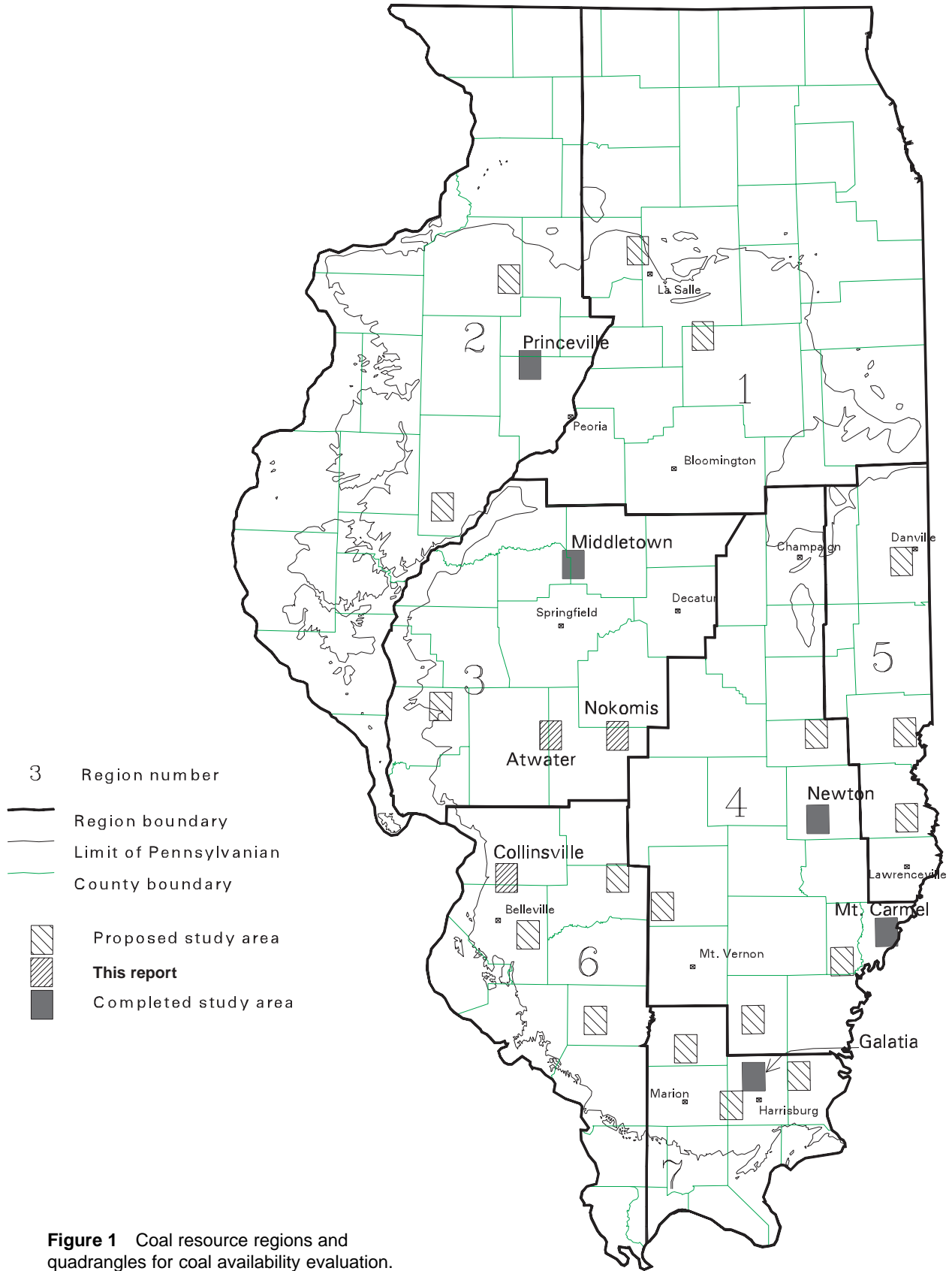
Each quadrangle represents a different geologic and geographic setting in Illinois. The goal of each quadrangle study is to identify and define the factors that influence the availability of resources in that setting. Some factors, such as roof conditions, are different for each seam, while other factors, such as minimum seam thickness, are applicable to all seams. Factors such as cemeteries have the same effect on mining throughout the state, but the effect of other factors, such as roads, is dependent on the region of the state and value of the underlying coal resources.

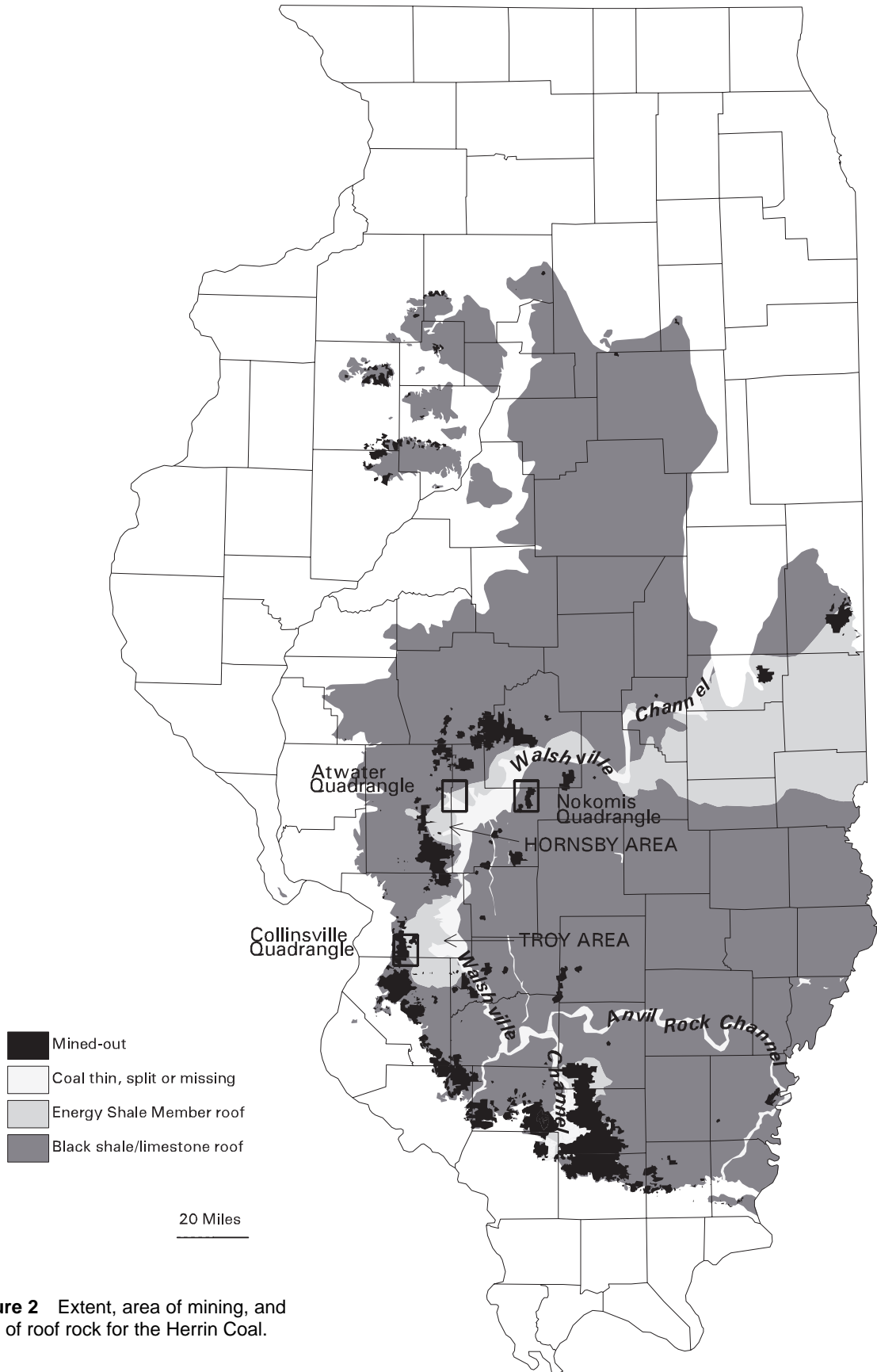
## **GEOLOGIC, PHYSIOGRAPHIC, AND CULTURAL SETTINGS**

The Atwater, Collinsville, and Nokomis Quadrangles contain many of the geologic, physiographic, and cultural settings encountered by mining in the west-central part of the state. The geology and mining conditions in this area have been studied and documented in a number of reports, including Andros (1914), Kay (1922), Krausse et al. (1979), and Nelson (1987). The Herrin Coal is the major resource in all three quadrangles. Although surface minable resources (coals less than 150 feet deep) are present in west-central Illinois, the resources in these three quadrangles (with the exception of minor amounts of resources in the Collinsville Quadrangle), will be mined by underground methods.

All three quadrangles lie adjacent to the Walshville Channel, a paleochannel formed by an ancient river system that flowed through the Herrin peat swamp (fig. 2). The Walshville Channel had a major influence on the deposition of the peat and overlying sediments and, consequently, the







**Figure 2** Extent, area of mining, and type of roof rock for the Herrin Coal.

quality and minability of the coal. The Herrin Coal is thin or missing within the area of the channel and is commonly thin or split by shale partings immediately adjacent to the channel.

In many areas adjacent to the channel, the immediate roof of the Herrin Coal is the Energy Shale Member, a sequence of shale, siltstone, and sandstone interpreted to be splay deposits (Johnson 1972, Treworgy and Jacobson 1985). These deposits are typically lobate in form and extend as much as 20 miles from the channel (fig. 2). Two large deposits of Energy Shale are present in west-central Illinois. The areas associated with these deposits have distinctive mining conditions and better quality Herrin Coal. The area covered by the northern deposit is referred to as the Hornsby area (Nelson 1987), and the southern deposit is known as the Troy area (Breyer 1992).

The Energy Shale is thickest adjacent to the channel (as much as 60 feet thick in west-central Illinois and more than 100 feet thick in southern Illinois) and thins abruptly at the margins of the splay deposits. Away from the channel and the splay deposits, the Herrin Coal is commonly overlain by a marine sequence of black shale and limestone (Krausse et al. 1979). The marine sequence overlaps and pinches out on the thick Energy Shale deposits.

The sequence of roof rocks above the Herrin Coal has a bearing on both the quality and minability of the coal. Coal underlying the marine black shale and limestones generally has a high sulfur content, in the range of 3% to 5% (dry basis). Coal overlain by 20 or more feet of Energy Shale generally has a sulfur content of less than 2.5%, and sulfur content is as low as 0.5% in some areas (Gluskoter and Simon 1968).

Marine rocks typically make a good mine roof. Except for local anomalies, such as rolls, the thick and massively bedded facies of the Energy Shale generally also makes a good roof (Krausse et al. 1979). Unstable roof conditions are encountered under laminated shale and siltstone facies of the Energy Shale or at the margins of the large deposits of Energy Shale (where it is less than 20 feet thick). Mining conditions in some of these areas have been sufficiently unstable to curtail mining. Small lenses of the Energy Shale (20 to 500 feet across and 3 to more than 8 feet thick) have been found tens of miles away from the large splay deposit of the Hornsby area (DeMaris and Nelson 1990).

The Atwater and Nokomis Quadrangles are on opposite sides of the Walshville Channel: Nokomis on the inside of a large bend and Atwater about 13 miles directly west on the outside of the bend. Both Atwater and Collinsville (the latter located about 25 miles to the south) include portions of the large splay deposits of Energy Shale found adjacent to the channel.

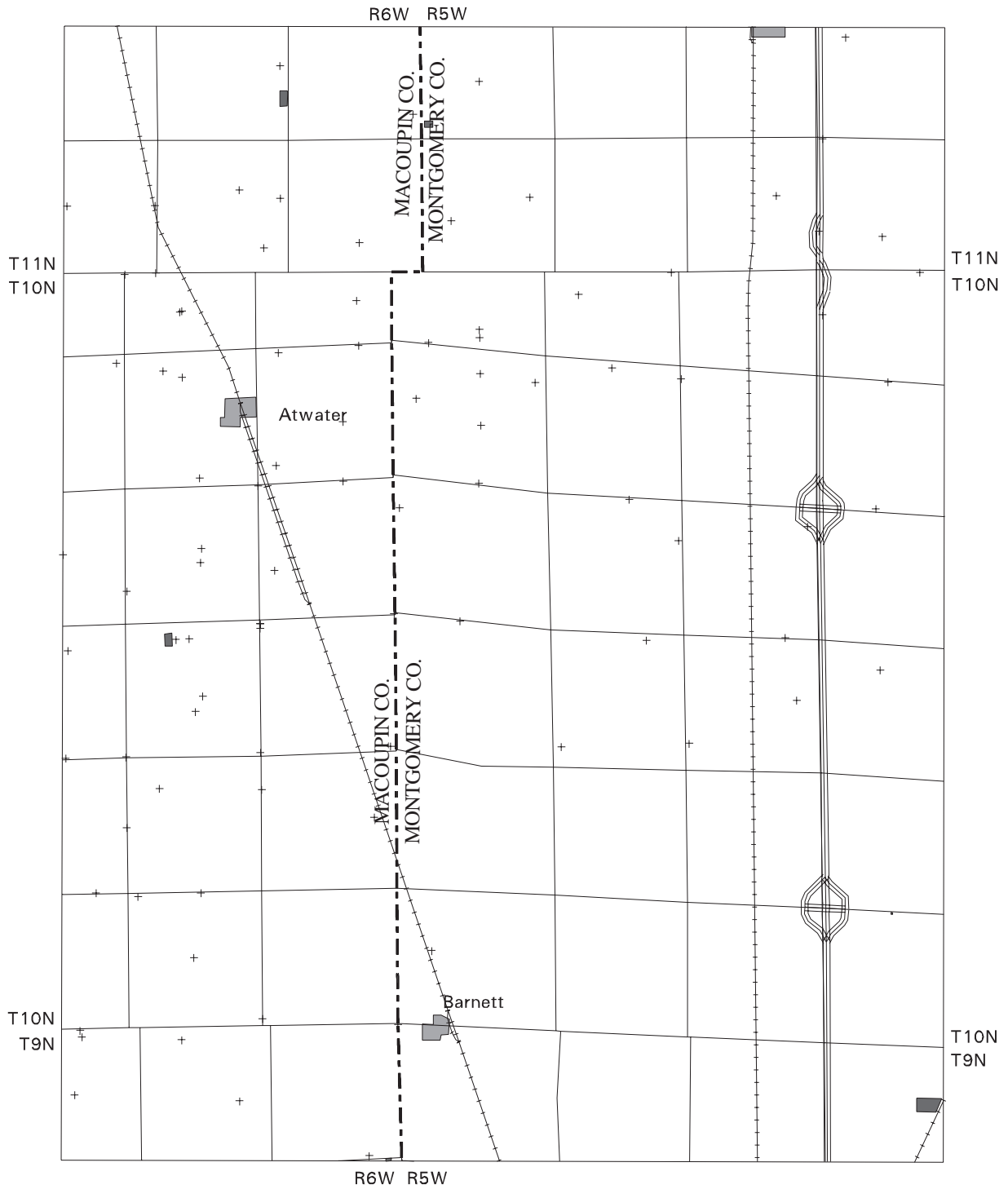
### **Atwater Quadrangle**

The Atwater Quadrangle is a rural area about midway between the cities of St. Louis and Springfield. Except for the interstate highway, two rail lines, a few small cemeteries, and a few buildings comprising the communities of Barnett and Atwater (fig. 3), the area consists almost entirely of flat farmland.

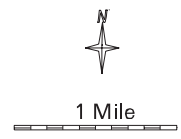
The quadrangle is located about 30 miles from the western margin of the coal field just north of a sharp bend in the Walshville Channel (fig. 2). Unconsolidated deposits of alluvium and glacial material cover the uppermost bedrock units of the lower Bond Formation (fig. 4). The unconsolidated deposits are commonly 20 to 80 feet thick, but they reach more than 180 feet thick in buried bedrock valleys. The only resources mapped in the quadrangle are in the Herrin Coal. Data on coals below the Herrin are limited. Mapping for this project is based on records from 304 drill holes located within 4 miles of the quadrangle. All but 20 of these holes are coal tests, and 87 of the holes are within the quadrangle.

The Herrin Coal ranges in depth from slightly less than 300 feet on the west side of the quadrangle to somewhat more than 425 feet on the east (fig. 5). Thickness of the coal varies from a few inches to about 8.5 feet (fig. 6). The coal is thickest away from the Walshville Channel (northward) and thinnest adjacent to the channel (southward). Thin shale partings (0.5 feet or less) were noted in the coal in a few drill holes along the margin of the Energy Shale, but no extensive areas of partings were identified.

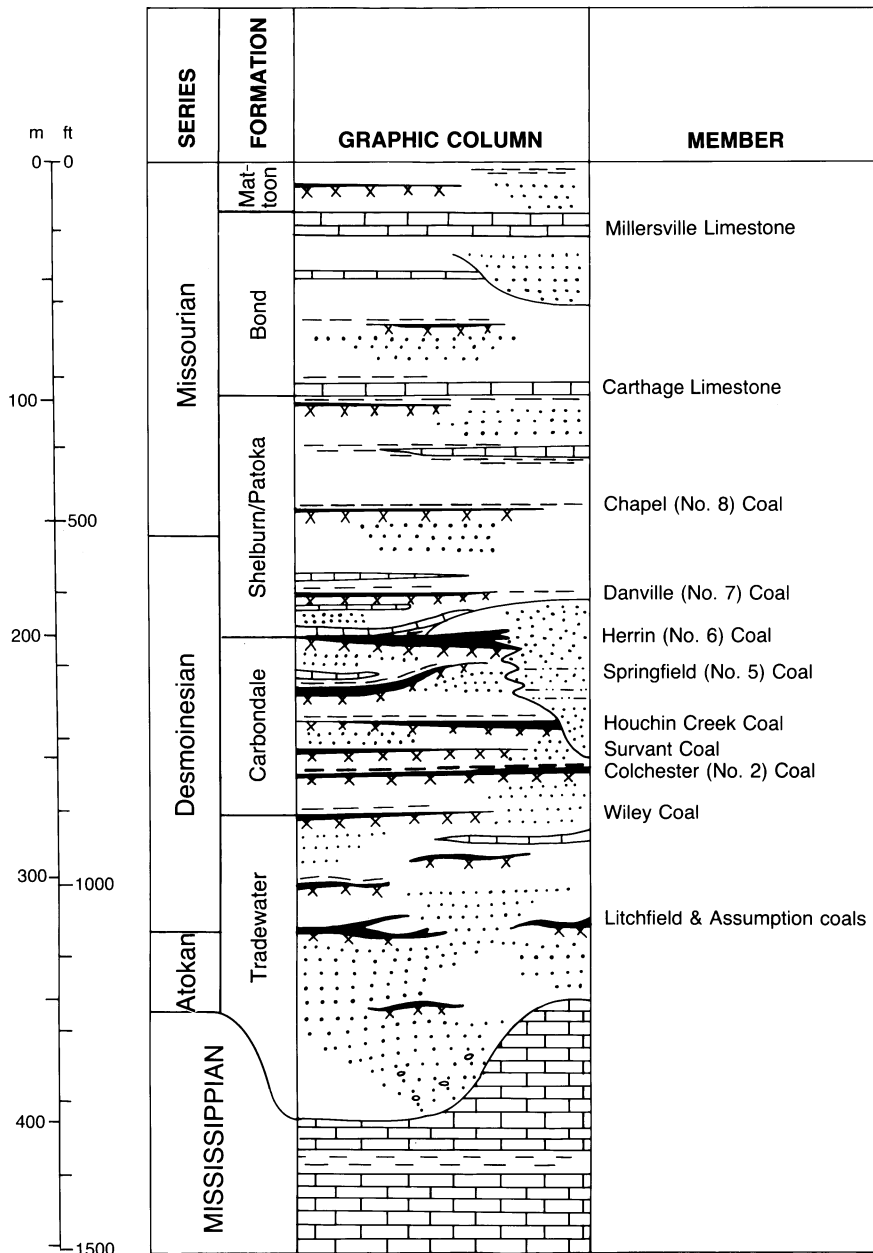
No mining has been done in the quadrangle, but millions of tons of Herrin Coal have been produced from mines within a 20-mile radius. The Standard Coal and Mining Company mine, just west of the quadrangle, mined the Herrin Coal from 1919 to 1948. Nearby active mines are the



- Railroads
- ==== Interstate highway
- Towns
- Cemeteries
- + Drill holes



**Figure 3** Surface features in the Atwater Quadrangle.



**Figure 4** Generalized stratigraphic column of Pennsylvanian rocks in the study area (modified from Nelson 1987).

Monterey Coal Company No. 1 Mine, located a few miles southwest of the quadrangle, and the Freeman United Coal Mining Company Crown II Mine, about 10 miles north of the quadrangle.

As noted previously, the Atwater Quadrangle is part of the Hornsby area, an area in which the Herrin Coal is overlain by the Energy Shale. In the southern two-thirds of the quadrangle, the shale forms a wedge-shaped deposit somewhat more than 60 feet thick at the southern and southeastern edges of the quadrangle (fig. 7). In the northern third of the quadrangle, the shale is present as isolated, small lenses probably a few tens or hundreds of feet across. Information from drill holes is insufficient to map these lenses, but their presence is inferred from occurrences of Energy Shale in scattered drill holes in the northern part of the quadrangle and detailed mapping by DeMaris and Nelson (1990) of the Crown II and III mines just to the northwest.

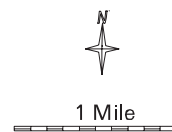
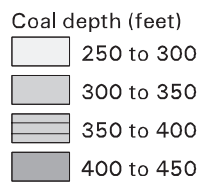
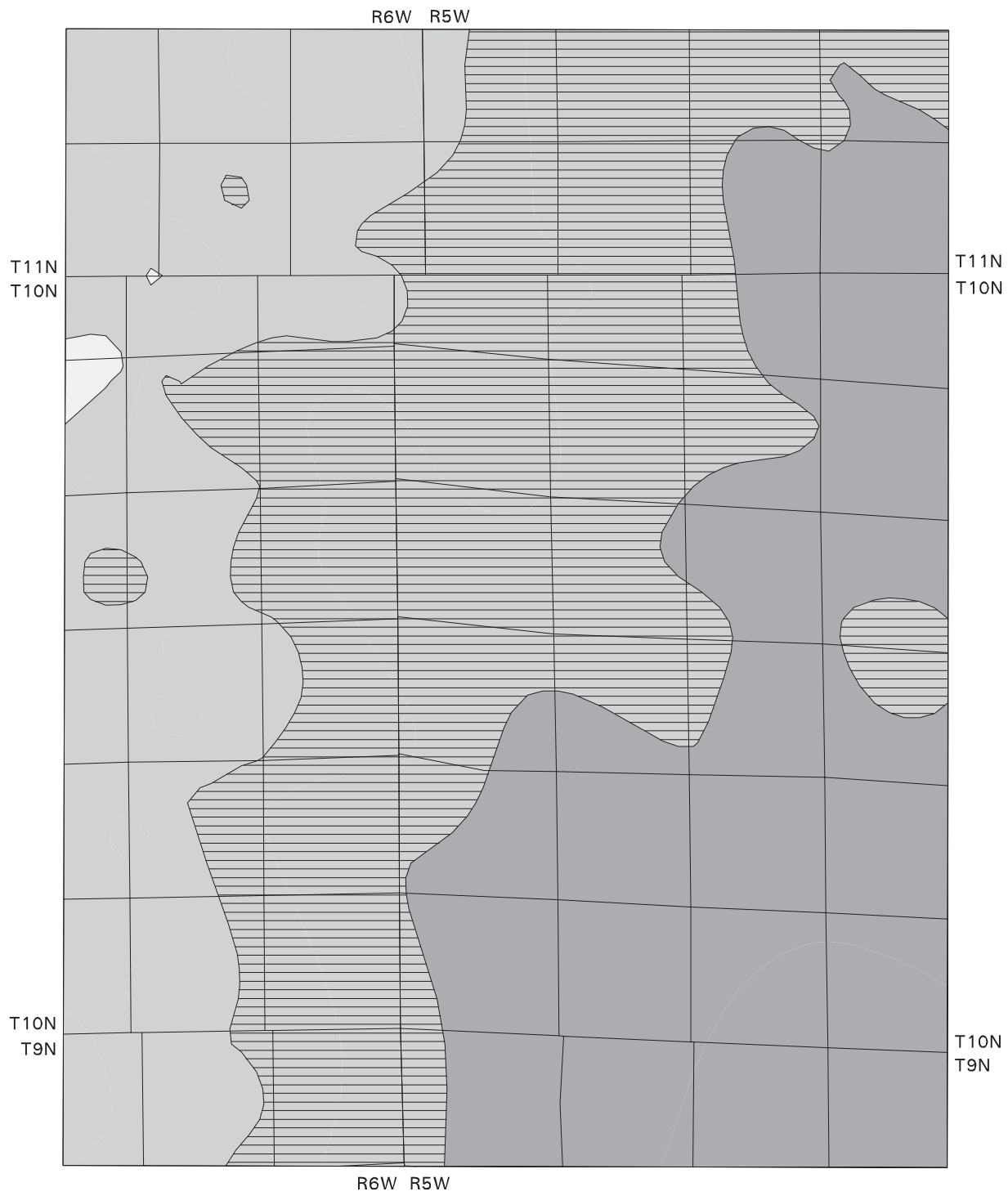
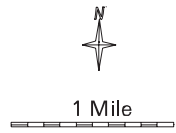
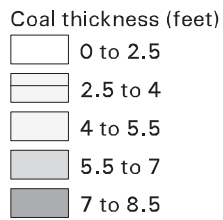
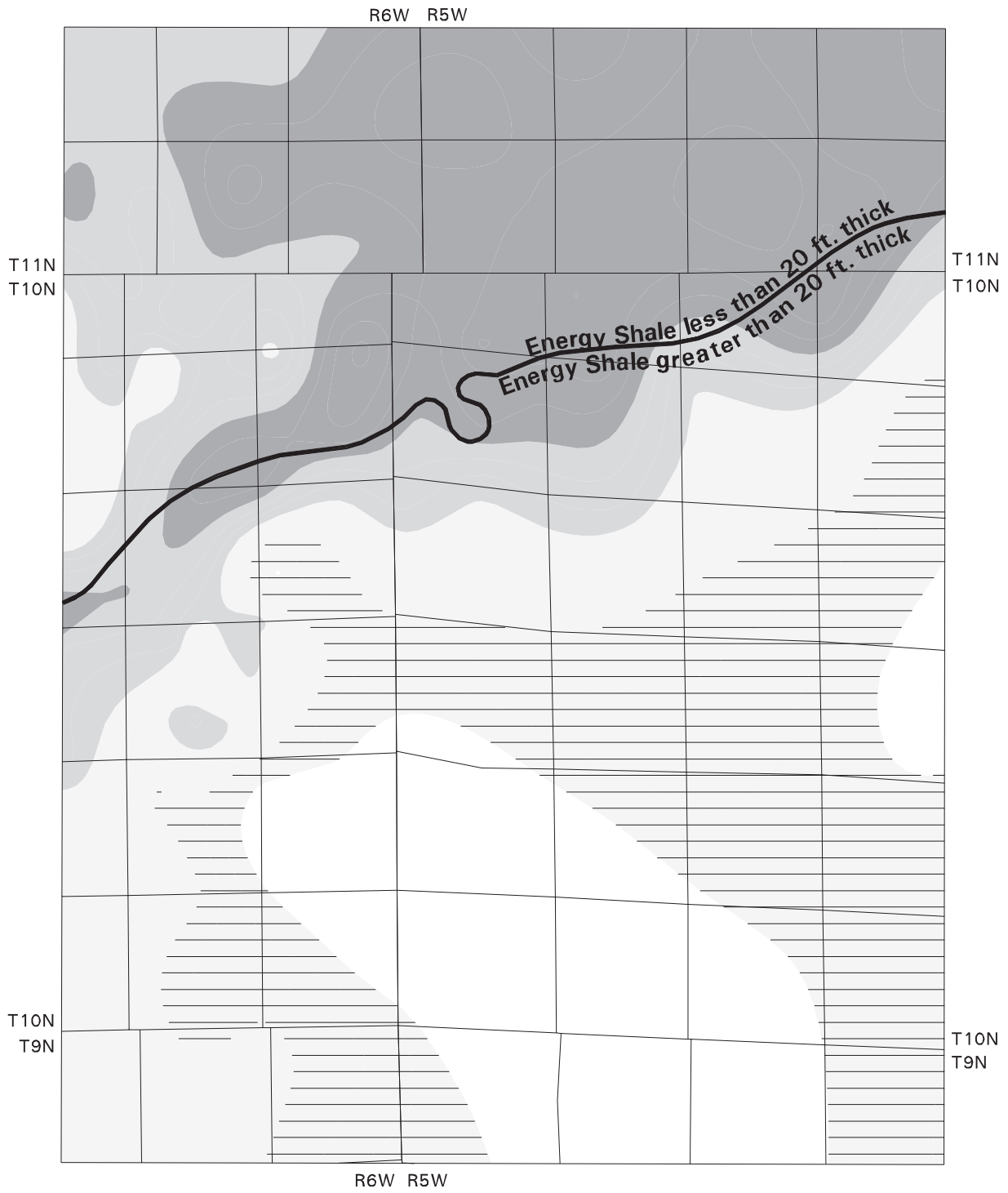
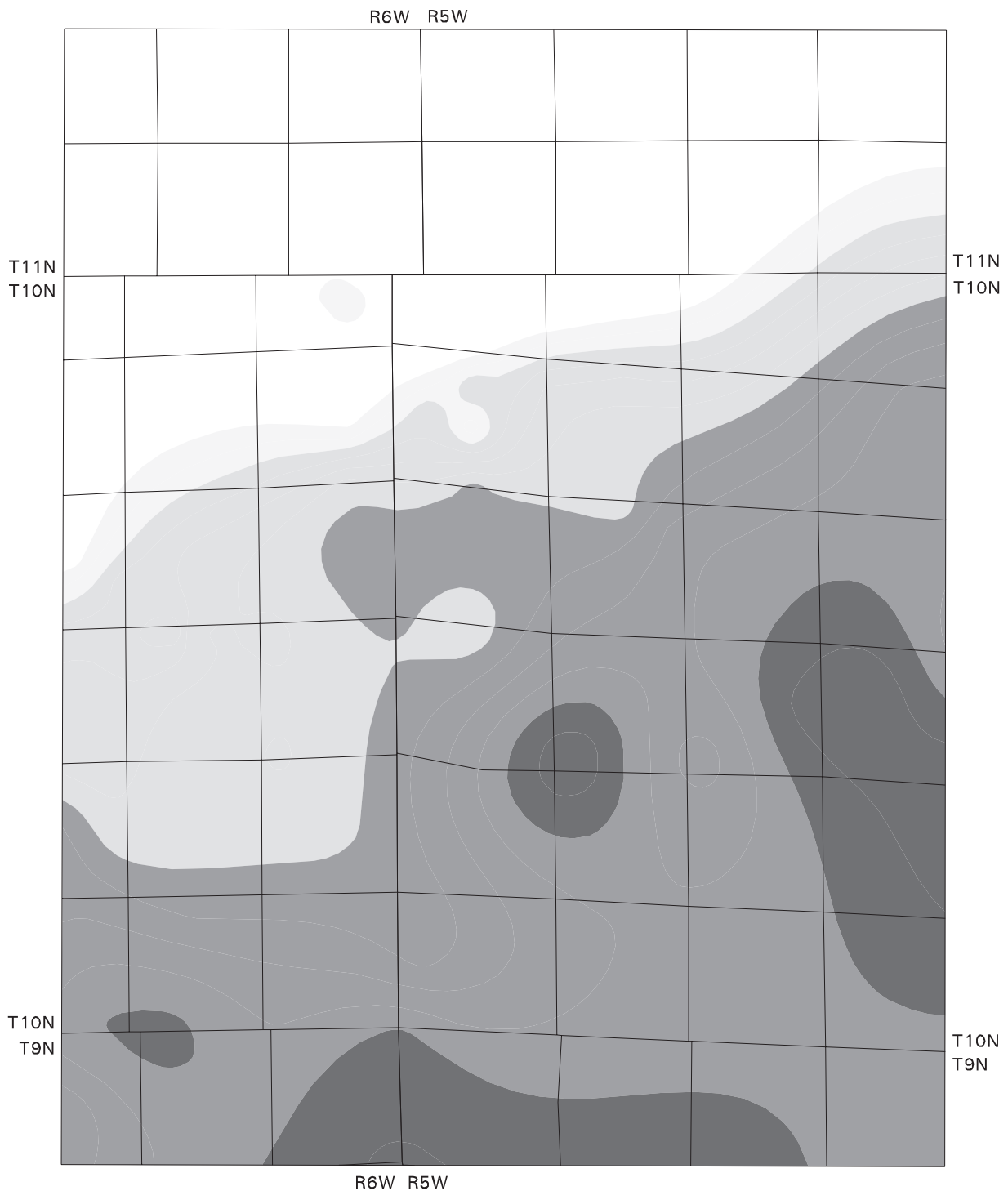


Figure 5 Depth of the Herrin Coal in the Atwater Quadrangle.

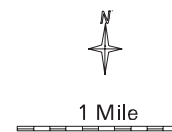


**Figure 6** Thickness of the Herrin Coal in the Atwater Quadrangle.



Thickness of shale (feet)

0 to 10
10 to 20
20 to 40
40 to 60
60 to 80



**Figure 7** Thickness of the Energy Shale in the Atwater Quadrangle.



## **Collinsville Quadrangle**

The Collinsville Quadrangle is located on the western margin of the Illinois coal field near the St. Louis metropolitan area. Major interstate highways and rail lines cross the quadrangle (fig. 8). The cities of Collinsville and Troy and the town of Maryville cover about 47% of the quadrangle. Because of the proximity and transportation links to St. Louis, the area is growing rapidly with new subdivisions and commercial development. Several subdivisions containing large, expensive homes are being constructed in wooded areas at some distance from town boundaries. This development pattern is checkering the quadrangle with areas incompatible with mining operations.

Data from drilling records of 90 locations in the quadrangle and 145 locations in a 4-mile buffer around the quadrangle were used to map the coal resources and related geology in the Collinsville Quadrangle. All but eight of these records were from coal tests or mines. More than half the data are proprietary.

The bedrock in the area is covered by relatively thin glacial and alluvial sediments (typically less than 50 feet thick). The Pennsylvanian-age coal-bearing strata are as little as 350 feet thick and are entirely eroded a few miles west of the quadrangle. Uppermost bedrock units in the quadrangle are in the lower part of the Shelburn Formation (fig. 4).

The only coal resources are in the Herrin seam, which averages just over 6 feet thick in this quadrangle. The Collinsville Quadrangle lies on the west side of the Walshville Channel, and the thinning of the coal to the east (fig. 9) reflects the influence of the channel. The Herrin Coal ranges in depth from less than 100 feet to more than 275 feet (fig. 10). Coal less than 150 feet deep is potentially surface minable. The regional dip of strata is to the east. No major faults are known in the quadrangle.

The Energy Shale overlies the Herrin Coal in the east half of the quadrangle (fig. 11). As noted previously, this is part of a large splay deposit covering a multi-county area referred to as the Troy area. The Energy Shale is more than 70 feet thick in this area, but it thins and pinches out along the margin of the splay.

Several underground mines operated in the Herrin Coal in the Collinsville Quadrangle from 1874 to 1958 (fig. 9). The Herrin Coal is currently mined within 40 miles of the quadrangle. There has been no surface mining in the quadrangle.

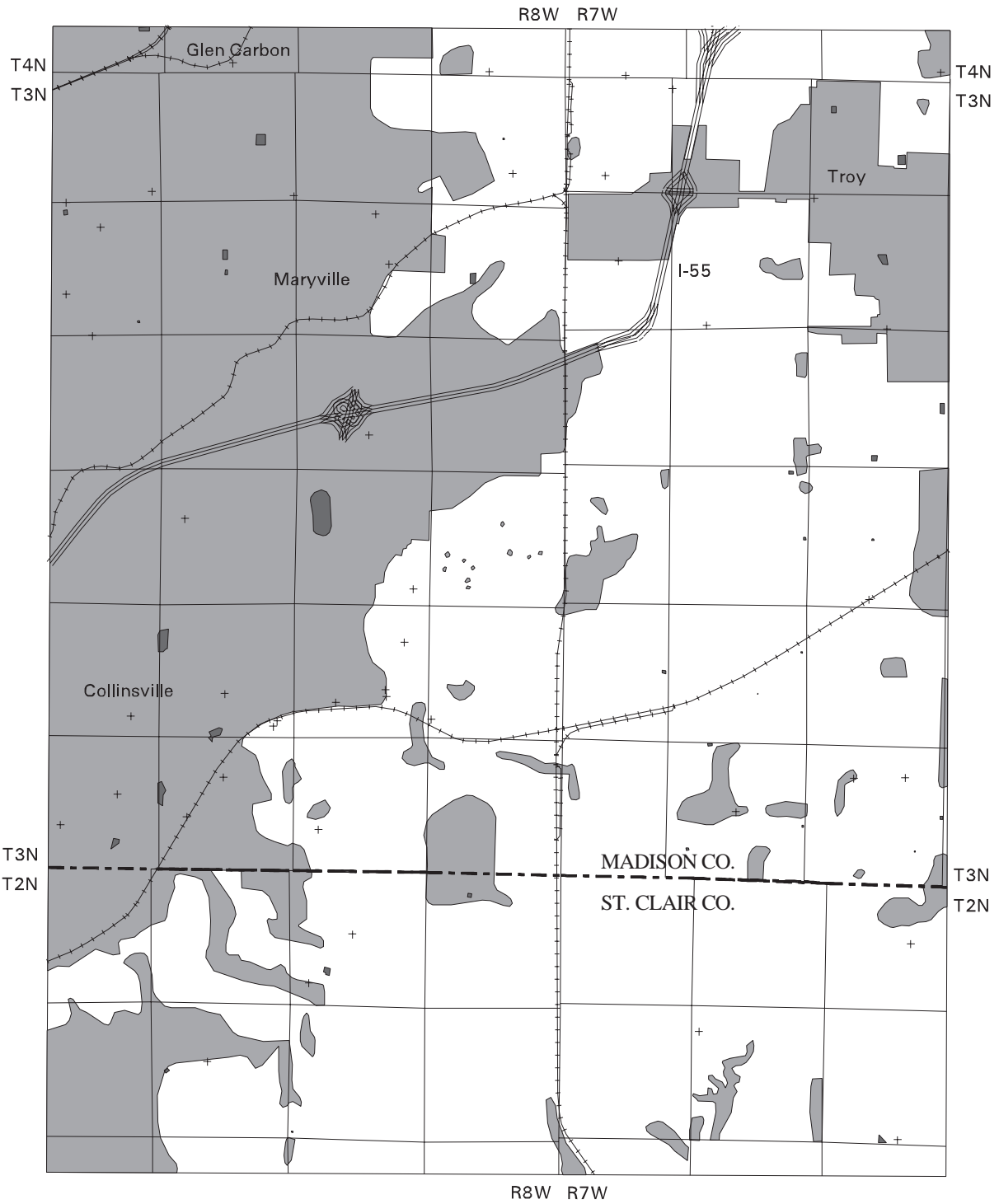
## **Nokomis Quadrangle**

The Nokomis Quadrangle is located 13 miles directly east of the Atwater Quadrangle. The towns of Coalton, Nokomis, Wenona, and Witt cover about 4% of the quadrangle (fig. 12). Mines underlying these towns provided employment for hundreds of men from 1898 to 1940. Probably because of the loss of jobs when the mines closed, Coalton and Wenona appear to have decreased in size. Nokomis and Witt, although apparently stable and healthy communities, have not expanded significantly during the past 50 years. The remaining land in the quadrangle is predominantly flat, high quality farmland.

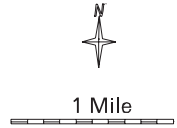
Coal resources in the quadrangle were mapped using records from the quadrangle (14 coal tests, 5 geophysical logs from oil tests, and 46 mine measurements) and from a 4-mile buffer around the quadrangle (10 coal tests and 8 geophysical logs from oil tests).

The Nokomis Quadrangle is located on the east side of the Walshville Channel on the edge of a large, thick reserve of Herrin Coal (fig. 2). In the late 1960s and early 1970s, there was much interest in developing this area for synthetic fuels production. The Herrin Coal is thin or absent along the margin of the channel near the west edge of the quadrangle (fig. 13). Away from the channel, the coal is commonly more than 7 feet thick and reaches as much as 10 feet thick in small areas. Reflecting the regional dip of beds into the basin, the coal ranges in depth from somewhat less than 500 feet in the northwest corner of the quadrangle to about 750 feet in the southeast (fig. 14).

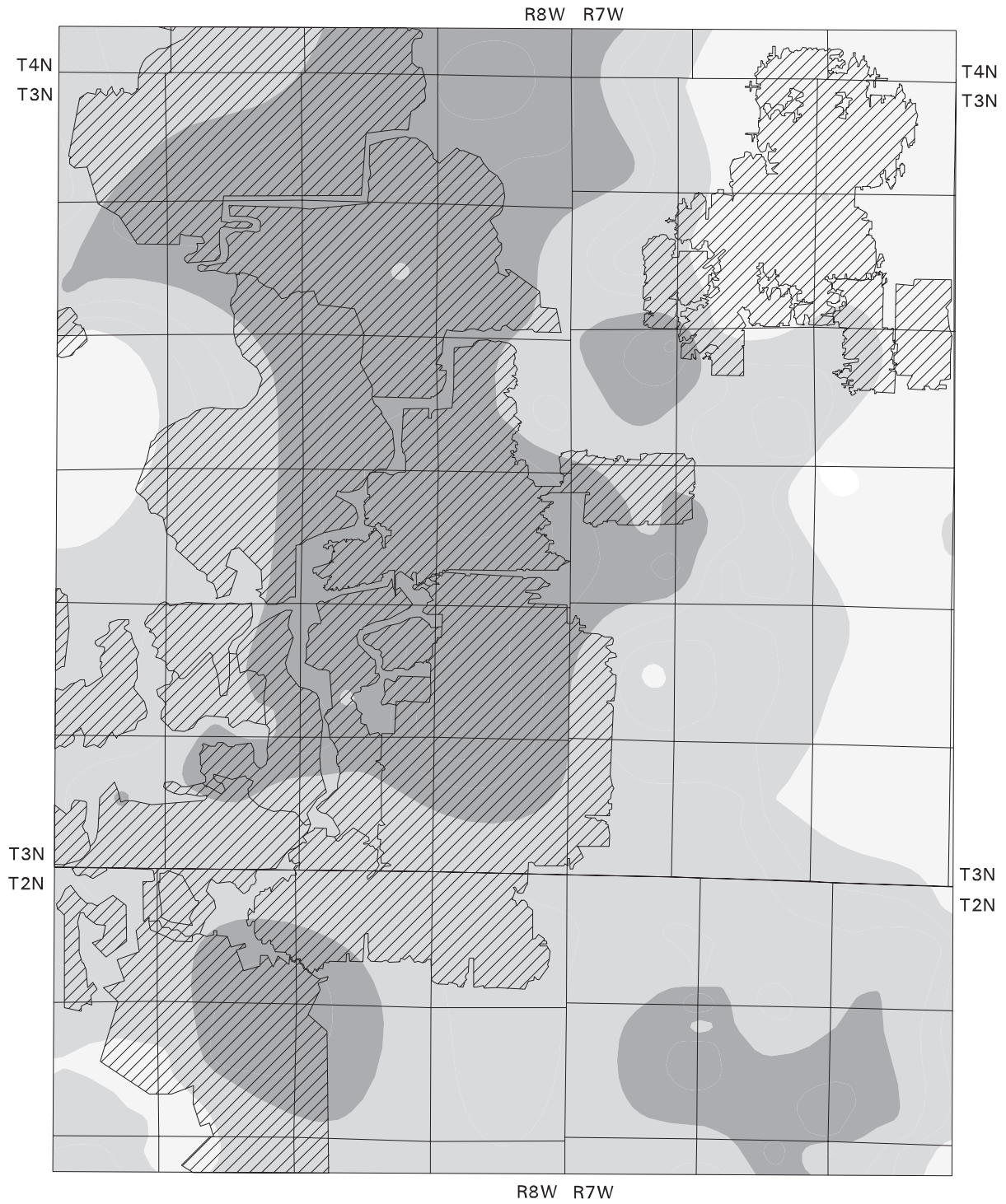
The Herrin Coal in the quadrangle was mined in four mines, all now abandoned. Although the nearest active mine to the Nokomis Quadrangle is the Monterey No. 1 Mine (24 miles to the west), the Herrin Coal was mined at Hillsboro (10 miles to the southwest) as recently as 1983.



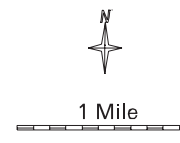
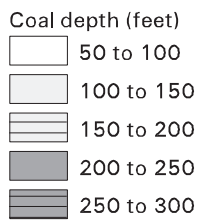
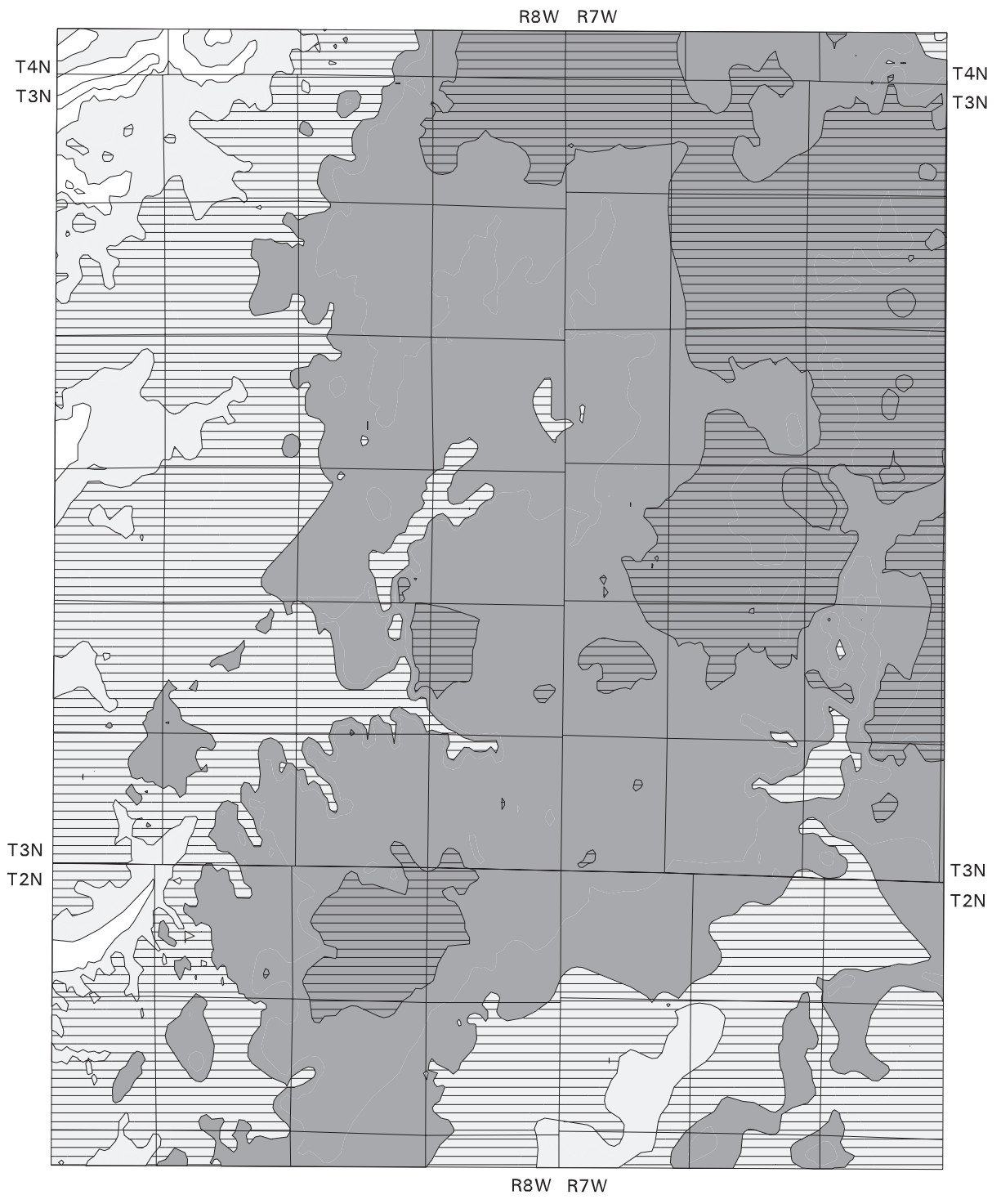
- Towns and subdivisions
- Cemeteries
- Railroads
- Interstate highway
- Non-confidential drill holes



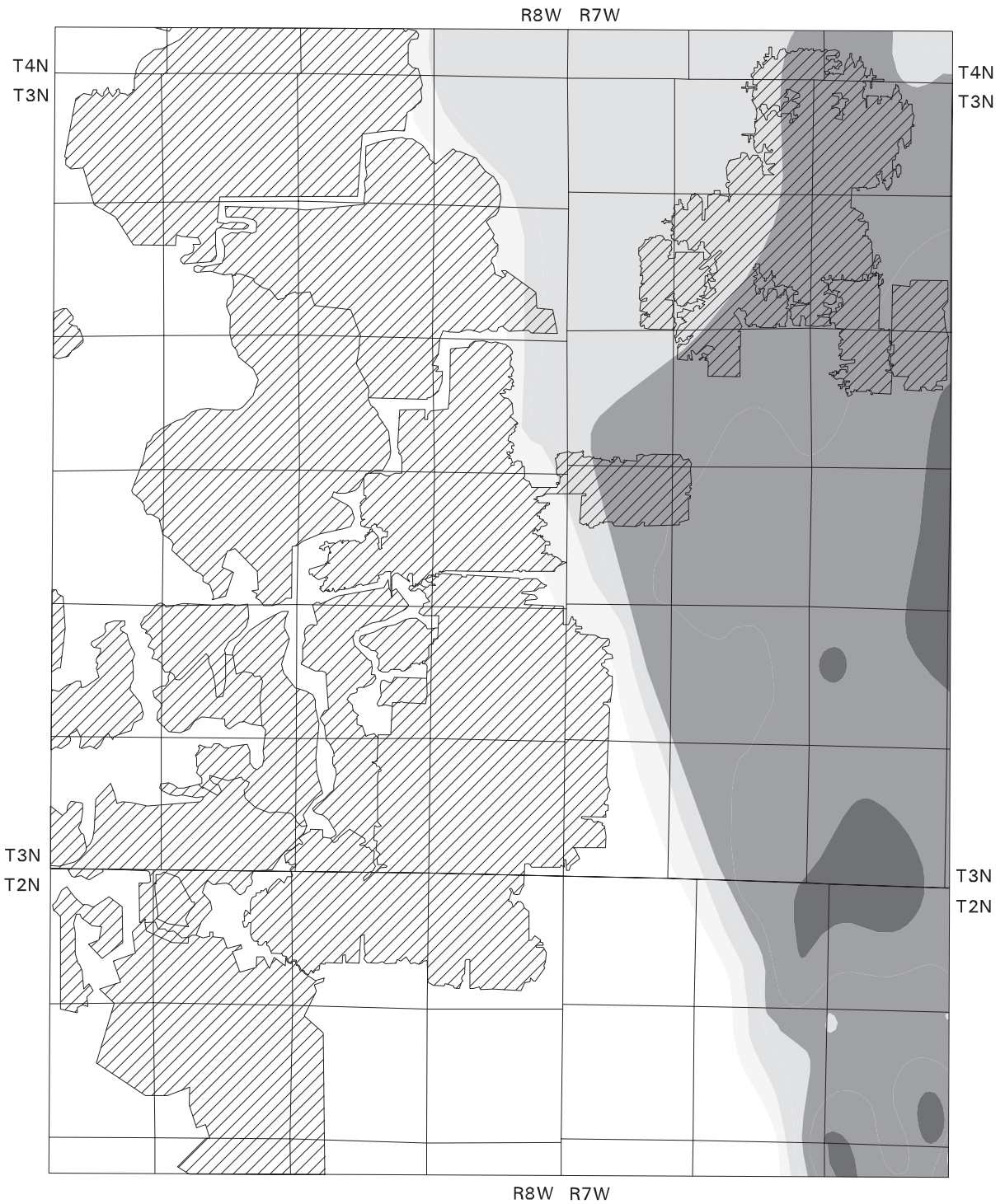
**Figure 8** Surface features in the Collinsville Quadrangle.



**Figure 9** Thickness of the Herrin Coal in the Collinsville Quadrangle.



**Figure 10** Depth of the Herrin Coal in the Collinsville Quadrangle.



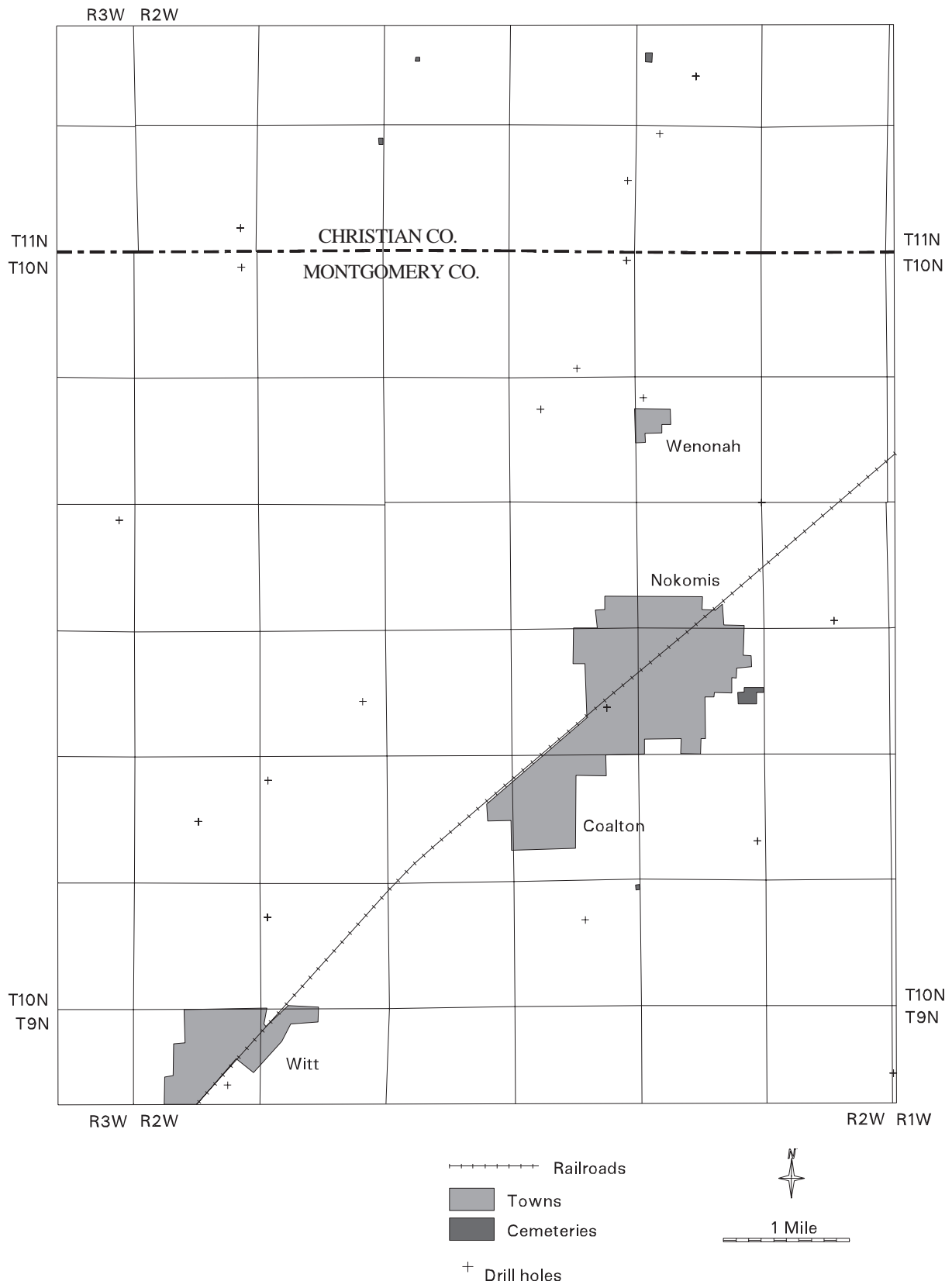
Thickness of shale (feet)

- 0 to 10
- 10 to 20
- 20 to 40
- 40 to 60
- 60 to 80
- Mined-out

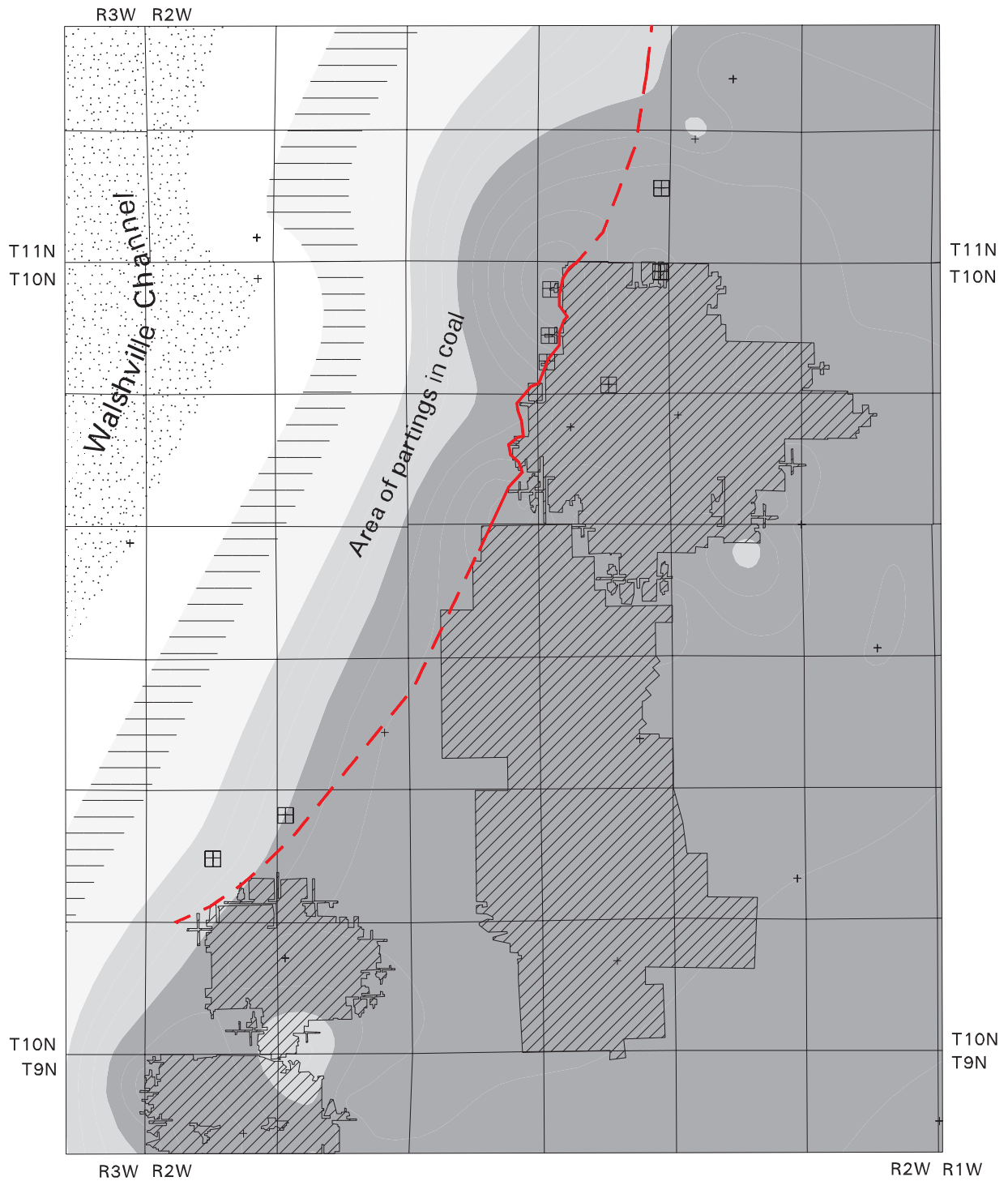


1 Mile

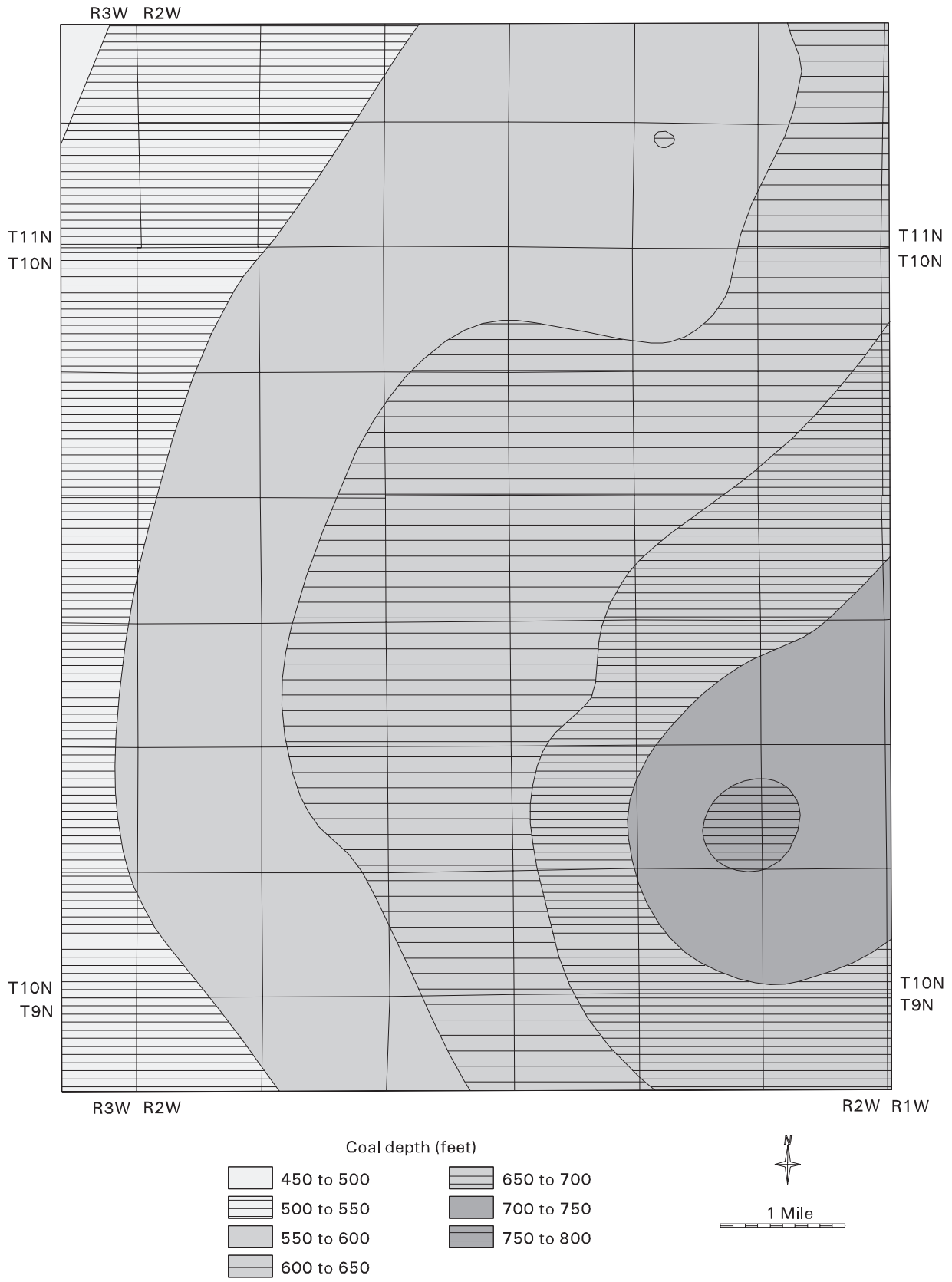
**Figure 11** Thickness of the Energy Shale in the Collinsville Quadrangle.



**Figure 12** Surface features in the Nokomis Quadrangle.



**Figure 13** Thickness of the Herrin Coal in the Nokomis Quadrangle.



**Figure 14** Depth of the Herrin Coal in the Nokomis Quadrangle.



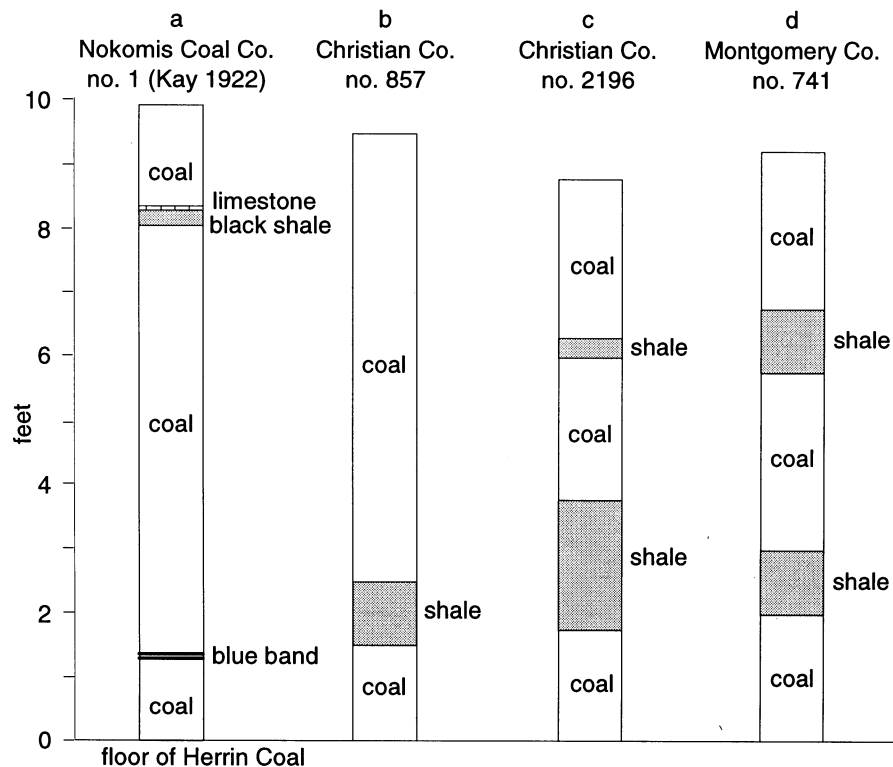
A parting of “dirt” (assumed to be shale) was reported in the Herrin Coal along the north and west sides of Indiana and Illinois Coal Corporation Mine No. 10 (fig. 13). This parting was reported to be as thick as 17 inches and sometimes to occur in two bands. Kay (1922) described the parting as near the top of the seam in the Nokomis Coal Company No. 1 (fig. 15). The bench of coal above this parting was reported to be “very dirty” and was not mined. Notations on the map of Mine No. 10 indicate that mining in the area containing the parting apparently was avoided.

Although there is no record of the other mines in the area encountering partings in the coal, the irregular pattern of mining along the western boundaries of several of the mines and the alignment of the western boundaries (fig. 13) indicate that several of the mines may have encountered partings that led to the cessation of mining to the west. Drillers’ logs and geophysical logs in this area indicate that one or two partings are present in the seam throughout the area north and west of the mines (fig. 15). The partings are either near the top or in the lower half of the seam.

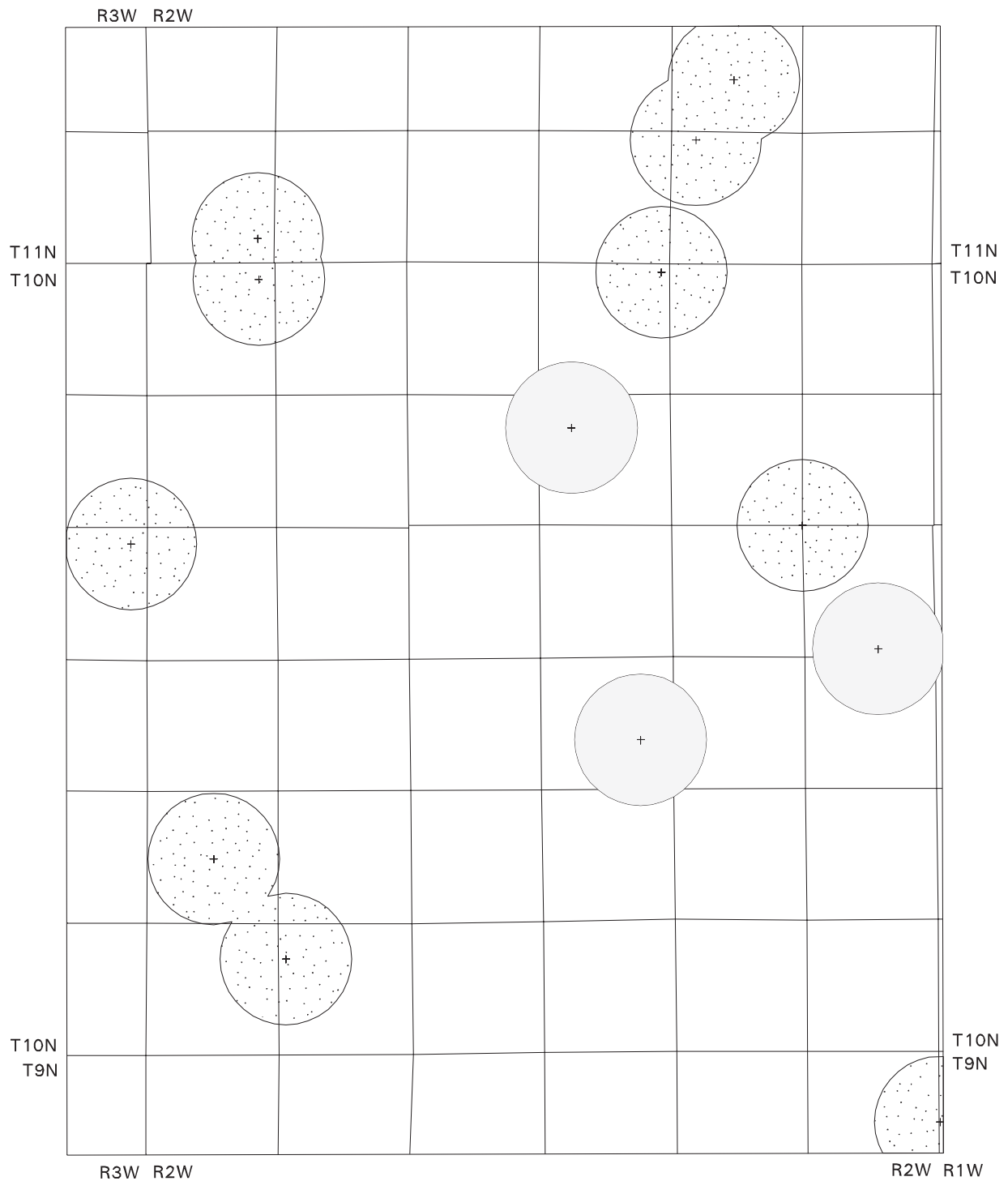
Experience with near-channel settings in other parts of the state has shown that partings can change dramatically in number, thickness, and position within the seam over very short lateral distances. Adjacent to the channel, abrupt changes in the dip of the seam and unfavorable roof conditions are likely to be encountered (Krausse et al. 1979, Nelson 1983). Even closely spaced drilling may not be sufficient to predict these conditions in advance of mining. The approximate area of partings has been delineated (fig. 13) on the basis of mine map notations, drillers’ logs, and geophysical logs in and adjacent to the quadrangle.

Other minor resources are present in the Nokomis Quadrangle in the Danville, Colchester, and Seelyville Coals. None of these coals has been mined in this area. The Danville Coal is commonly thin in this area and meets the minimum thickness for classification as a resource (28 inches) in only three coal test holes (fig. 16). The coal is about 30 feet above the Herrin Coal.

A coal 4.58 feet and 4.75 feet thick is reported in two coal test holes at depths of 684 and 704 feet, respectively, in the northwest corner of the quadrangle (fig. 17). Although this coal is classified as the Colchester Coal, it may be the Seelyville Coal. Only three other coal test holes in the quadrangle were drilled deep enough to penetrate the Colchester Coal horizon. The coal was thin or absent in these three holes.

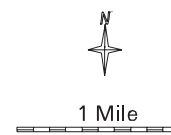


**Figure 15** Examples of partings observed in mines or logs in the vicinity of the Nokomis Quadrangle.

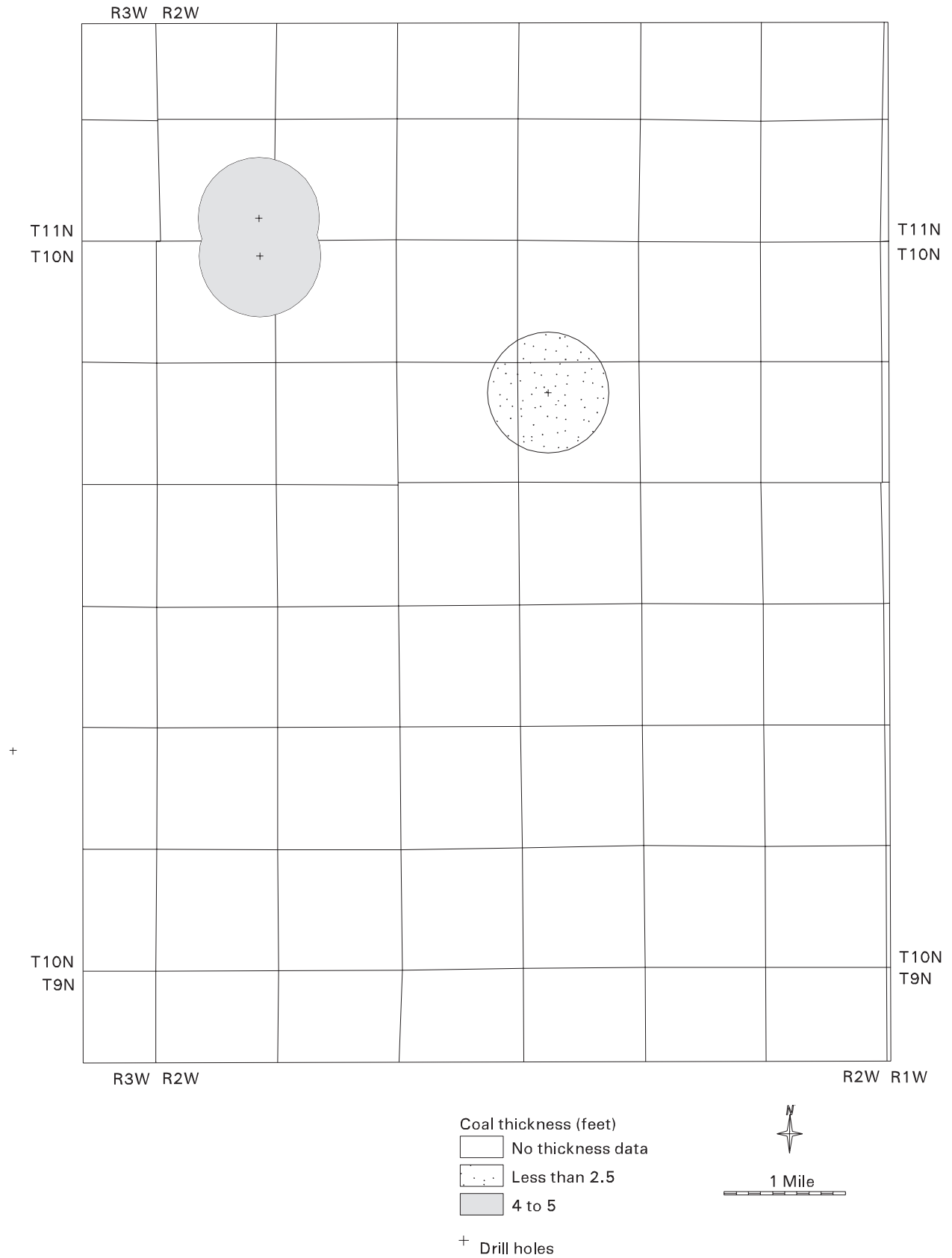


Coal thickness (feet)  
 □ No thickness data  
 ▨ Less than 2.5  
 ■ 2.5 to 4

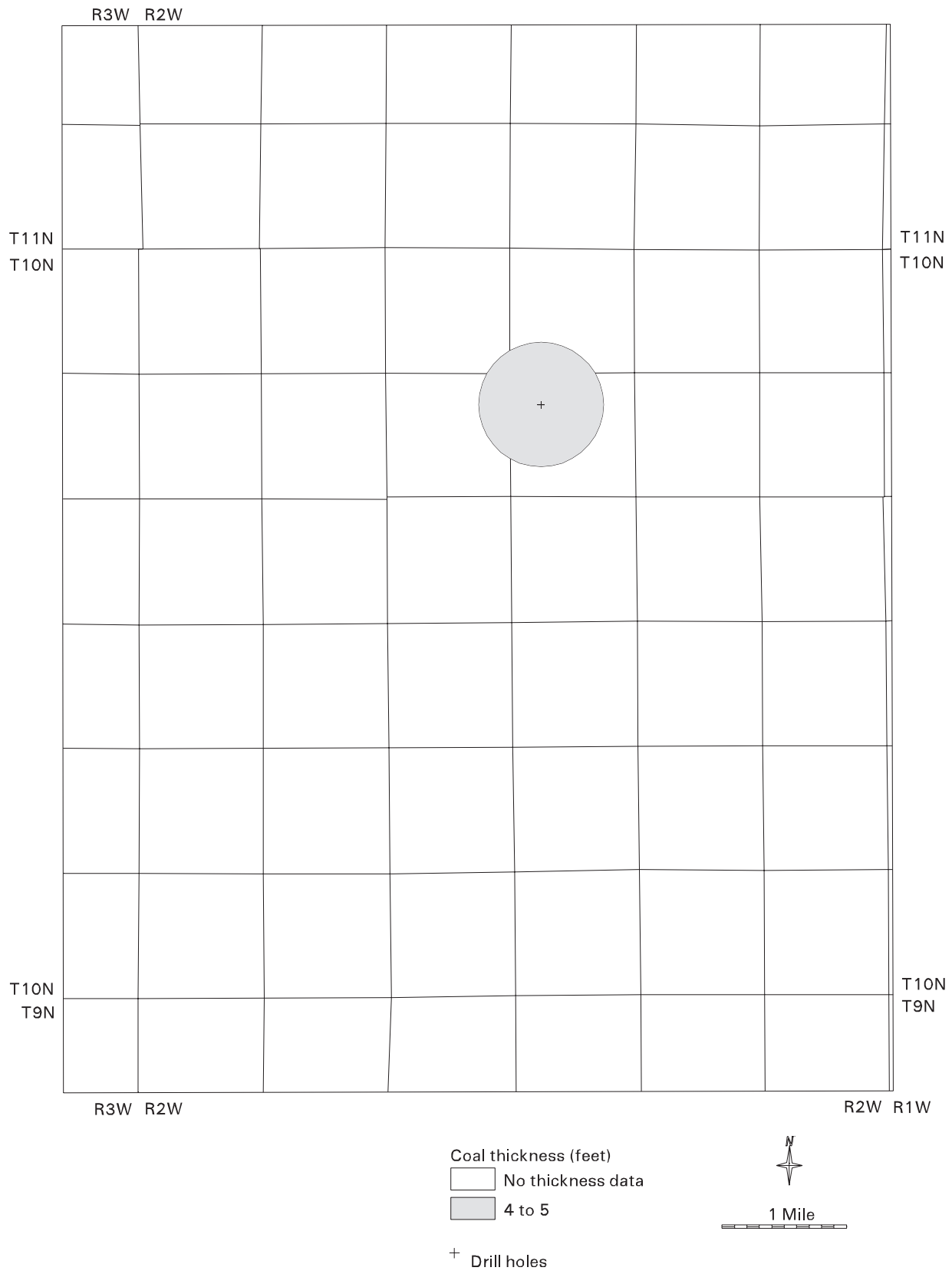
+ Drill holes



**Figure 16** Thickness of the Danville Coal in the Nokomis Quadrangle.



**Figure 17** Thickness of the Colchester Coal in the Nokomis Quadrangle.



**Figure 18** Thickness of the Seelyville Coal in the Nokomis Quadrangle.

The Seelyville Coal is 4.17 feet thick and 783 feet deep in one coal test (fig. 18). The seam includes a 0.5-foot-thick parting 0.5 foot below the top of the coal. Partings are common in the coal in east-central Illinois. The Seelyville Coal is 10 to 20 feet below the Colchester Coal. Only four other coal tests in this quadrangle have been drilled deep enough to penetrate the Seelyville horizon. The Seelyville Coal is either not present in these holes or, as noted above, has been misclassified as the Colchester Coal.

Channel samples of the Herrin Coal mined in the Nokomis Quadrangle indicate that the sulfur content of the coal is generally 4% to 5% and heating content is approximately 12,100 to 12,600 Btu/lb (dry basis, ISGS files). Chemical analyses and geology (e.g., deposits of the Energy Shale) provide no indication that lower sulfur coal may be present adjacent to the channel.

Regional trends indicate the chlorine content of the coal is 0.2% to 0.4% (dry basis) (Chou 1991). This chlorine content is higher than that of the resources in the Atwater and Collinsville Quadrangles, as well as higher than much of the coal currently mined in the state. This relatively high chlorine content may make this coal less attractive to some users. No chemical analyses are available for the Danville, Colchester, or Seelyville Coals.

## FACTORS AFFECTING THE AVAILABILITY OF COAL

The factors that affect the availability of coal were identified from interviews with mining engineers, geologists, and mining consultants from two mining companies and one consulting firm. Staff from the Illinois Department of Mines and Minerals, the state agency responsible for permitting and inspecting mines, were also interviewed. The mining experts reviewed maps and cross sections of the coal resources and related geology of the quadrangles and then discussed the criteria their companies would use to delineate minable coal in these quadrangles. The criteria varied somewhat between companies because of their different mining experience, investment goals, and corporate policies.

The criteria explained below and listed in table 1 are a composite set of rules developed on the basis of our findings from these interviews in addition to previous interviews with eight other mining companies. Because surface minable resources are found only in the Collinsville Quadrangle and are very limited in their extent and quantity, this report focuses exclusively on factors that affect the availability of underground resources.

**Table 1** Criteria used to delineate available coal in the Atwater, Collinsville, and Nokomis Quadrangles.

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### Underground Mining

- Minimum seam thickness: 4 feet
- In-seam partings
  - Maximum thickness: 1 foot
  - Individual benches will not be mined if the clean coal yield for that bench is less than the weight of parting material that must be mined.
- No maximum depth
- Minimum block size: 80 million tons in place
- Unstable roof conditions: Reduce available tonnage by 75% in areas where the Energy Shale is 10 to 20 feet thick.
- Minimum bedrock thickness: 75 feet
- Land use restrictions
  - 200 feet around towns, cemeteries, and interstate highways
  - 300 feet around abandoned works of underground mines

### Surface Mining\*

- Maximum depth: 175 feet
  - Minimum block size: 5 million tons in place
  - Land use restrictions: 0.5 mile around towns
- 

\*Because it was obvious that the depth, block size, and town buffer would restrict all surface minable-resources in this area, no effort was made to develop a complete set of rules for these resources.

## **Depth of Seam**

All other factors being equal, shallower coals are less expensive to mine. However, for the depth range of the coals in these three quadrangles (all less than 1,000 feet deep), depth does not limit the availability of the coal. Coal less than 175 feet deep can be mined by either surface methods or underground methods (provided there is sufficient bedrock cover).

## **Thickness of Seam**

In this study, 4 feet was used as the minimum thickness of available coal. Underground mining of thinner seams is considered unfeasible due to a combination of several of the following factors: larger reserve blocks are required, movement of miners and equipment is more difficult, the yield of clean coal per ton of material mined is lower, and the tonnage produced per mining cycle is reduced. These factors make it difficult to extract coal at a competitive cost and sufficient rate to recover the capital investment in facilities for a modern underground mine.

## **Energy Shale**

The Energy Shale generally forms a stable roof in mines in the southern and eastern areas of the state. However, it makes a very unstable mine roof in the Hornsby area, which includes the Atwater Quadrangle (Nelson 1987, Breyer 1992, Beerkircher 1994). In Monterey's Mine No. 1 (just to the southwest of the Atwater Quadrangle), the coal beneath the Energy Shale is being successfully mined using longwall methods. Because of the difficulty of holding the shale with roof bolts, however, the number and size of development entries and crosscuts have been minimized and steel mesh is used to support the roof.

Little is known about the characteristics of the Energy Shale in the Troy area. With the exception of a few mines, most of the mines in the Collinsville Quadrangle did not extend under the edge of the Energy Shale, presumably because of poor roof conditions (fig. 11). The only active mine in the vicinity of the Troy deposit (Monterey No. 2) has not yet mined under the Energy Shale roof.

Our interviews and reports from other studies (Krausse et al. 1979, Nelson 1987) indicate that the areas where mining under the Energy Shale is most difficult are along the margins of the deposit where the shale is less than 20 feet thick. In these areas, the Energy Shale does not support itself well and separates easily from the overlying rock. In areas where it is less than 10 feet thick, the Energy Shale can be supported by bolting it into the overlying Brereton Limestone (if it is present). Where the Energy Shale is more than 10 feet thick, the Brereton Limestone commonly is not present or is too thin or too far above the coal to be used for anchoring roof bolts. The deposits of Energy Shale thicker than 20 feet form a reasonably stable roof if they are massively bedded and undisturbed by rolls.

Because of these roof control problems, only 25% of the tonnage of coal in areas that underlie 10 to 20 feet of Energy Shale is defined as available for mining; the remaining 75% is classified as restricted by roof conditions. Although severely unstable roof conditions may be encountered in local areas with thicker or thinner Energy Shale, these areas are difficult to identify in advance of mining, and no estimate can be made of the amount of coal that may have to be left unmined because of conditions in these areas. The area that underlies 10 to 20 feet of Energy Shale is a narrow, readily identifiable zone. Many companies will avoid or limit extraction in and near this zone. We consider our calculation to be a reasonable estimate of the amount of coal that will be unavailable as a result of this practice.

## **Thickness of Bedrock Cover**

Some bedrock cover is needed for underground mining to support the mine roof and seal the mine from water seeping down from the surface. If the bedrock cover is too thin (or possibly weathered), the mine roof may not be strong enough to support the overburden. In addition to the dangers and expense of roof failures, fractures resulting from failure of the mine roof may extend to the bedrock surface and allow water to enter the mine. Our interviews indicate that the minimum thickness of bedrock for underground mining in these study areas is 75 feet. In addition, the thickness of bedrock overburden should exceed the thickness of unconsolidated overburden.

Along the west side of the Illinois coal field where the coal is at relatively shallow depths, the thin bedrock cover may restrict the availability of coal. This restriction was not readily apparent in the study areas; only the Collinsville Quadrangle held such shallow coal, and for the most part, this

coal was mined out or overlain by towns. Only a small amount of coal in the Collinsville Quadrangle is restricted by thin bedrock cover.

### **Size and Configuration of Mining Block**

Mine blocks must contain sufficient tonnage to allow companies to recover the costs of developing a mine (e.g., land acquisition, construction of surface facilities and shafts, purchase of equipment, and drilling). Development costs for a mine in these quadrangles will be relatively high. Because of the variable geologic conditions in areas adjacent to the Walshville Channel, extensive drilling is required to verify the presence and thickness of the coal, identify the locations of major partings and unstable roof conditions, and map the distribution of coal quality. Shafts or slopes must be constructed to gain access to the coal bed, and a preparation plant would more than likely be needed to remove noncombustibles from the mined product (e.g., from partings and roof falls) and reduce the sulfur content. Mine blocks must also have dimensions that are suitable for layout of a mine. Narrow blocks of coal with convoluted shapes between abandoned mines or other unminable zones cannot be safely and economically mined by most mining methods.

Current thinking among mining experts familiar with this area is that longwall mining techniques are the only safe and economical way to mine under the Energy Shale. Because of the high capital costs for exploration and development of a mine in this area, the minimum reserve block is 40 to 50 million tons of clean coal, or about 80 million tons of coal in-place.

### **Partings in Seams**

Partings of rock material within a coal seam reduce the productivity of a mine, increase the wear of mining and coal preparation equipment, reduce the efficiency of the mine's preparation plant, and increase the amount of waste material that must be stored in waste piles and slurry ponds. Partings more than a few inches thick in coal left in the mine as pillars tend to rash and reduce the stability of the pillars. Over time, this may result in roof falls in the mine and subsidence damage to surface property.

Partings vary in number, thickness, and position within the seam. If a thick, persistent parting is near the top or base of a seam, the miners may choose to leave the parting and the thin bench of coal separated from the main seam. Small areas of thick partings are mined if necessary to access other reserves. Large areas with excessive parting material are not mined.

One foot of parting material is considered the maximum that is feasible to mine for any extended area. In addition, only individual benches of coal will be mined if the tonnage of the clean coal recovered exceeds the tonnage of the parting material that must be handled. Figure 15b shows a 7-foot seam that contains a 1-foot parting 1.5 feet above the base of the seam. In this example, the parting and lower bench of coal will probably not be mined because the tonnage recovered from the lower bench of coal would be less than the tonnage of the parting (parting material has a specific gravity of about 2.6; bituminous coal has a specific gravity of about 1.3). The lower bench of coal would be minable if the parting were less than 0.8 foot thick.

If the parting is near the top of the seam, as in figure 15a, the upper bench of coal is likely to fall if not removed by the mining process. In this example, the bench above the parting was reported to be "very dirty." It is possible that the entire seam may be undesirable for mining because, to recover the lower 8 feet of coal, the upper 2 feet of parting and "dirty coal" must be mined as well to ensure a stable roof. In figure 15c, only the upper two benches of coal would be mined. The lower bench of coal would be left because the amount of parting that would have to be mined is too thick. In figure 15d, the entire seam is unminable because the partings are too thick to mine and none of the individual benches of coal is thick enough to mine alone.

### **Surface Features**

Although any surface feature may be undermined if a company obtains permission from the owner and agrees to repair damages, companies generally find it impractical to mine under towns and cemeteries. Limited extraction may take place under small towns such as Atwater. However, unless such an area is crucial to development of the mine layout, it will be avoided. All coal under towns and cemeteries was considered to be restricted from mining in this study.

Previous studies of quadrangles in this series have excluded railroads from available coal. However, two longwall mines in Illinois, including the Monterey No. 1 Mine just southwest of the

Atwater Quadrangle, have begun extracting coal underlying railroads. Therefore, coal underlying railroads is considered by this study to be available for mining.

A buffer of unmined coal must be left around any property or surface feature that cannot be subsided. The size of the buffer depends on the depth and thickness of the coal, the composition of the overburden, and the angle of draw used to calculate the area that could be affected by subsidence. For underground mining, we used a 200-foot buffer for towns and cemeteries in all three quadrangles. In practice, the required buffer might be slightly smaller for the Collinsville Quadrangle and slightly larger for the Nokomis Quadrangle. Surface mining requires a larger buffer around towns because of the potential disturbance of dust, vibrations from blasting, and potential disruption of water wells. In practice, surface mining would be kept at least ½ mile from these features.

### **Abandoned Mine Workings**

Illinois law requires that companies leave an unmined barrier of coal 200 feet wide around abandoned underground mine workings. Because of the age of the old works in the Collinsville and Nokomis Quadrangles, the uncertainty of the mine maps, and the possibility that the old works could be filled with water, the companies we interviewed recommended leaving a 300-foot buffer around mines.

### **AVAILABLE RESOURCES**

The criteria for defining available coal were applied to the coal resources in each of the three quadrangles to estimate the amount of coal available or restricted by some factor. Because these quadrangles were not randomly selected, they should not be considered a statistical sample, and the results of this assessment should not be directly extrapolated to larger regions. The results illustrate the diversity of factors that limit availability of coal for mining and provide an indication of the significance of individual factors. When viewed collectively and comparatively with the results of previous quadrangle studies, some important patterns are apparent.

### **Cumulative Results for All Three Quadrangles**

Of the 1.2 billion tons of original resources in the Atwater, Collinsville, and Nokomis Quadrangles, 47% (549 million tons) is available for mining, 26% (306 million tons) is mined out, 15% (178 million tons) is unavailable because of technical restrictions, and 11% (128 million tons) is unavailable because of land use (fig. 19). Technical restrictions include partings (7% of original resources), thin coal (6%), unstable Energy Shale roof (1%), small block size (1%), and thin bedrock cover (less than 0.05%). Land use restrictions are towns (6%), proximity to abandoned mines (5%), and interstates and cemeteries (both less than 0.5%). All of the available resources are in the Herrin Coal. The resources of the Danville, Colchester, and Seelyville Coals in the Nokomis Quadrangle are too thin, occur in blocks too small in size, or underlie towns.

Seventy-seven percent (231 million tons) of the resources in the Atwater Quadrangle is available for mining as compared with 31% (135 million tons) in the Collinsville Quadrangle and 42% (183 million tons) in the Nokomis Quadrangle (figs. 20–22). Much of the difference in the amount of available coal results from the mining that has already taken place in the Collinsville and Nokomis Quadrangles. The original available resources in both the Collinsville and Nokomis Quadrangles (calculated as available resources plus resources mined out or left as barriers between mines) are 84% and 73%, respectively, of the original total resources.

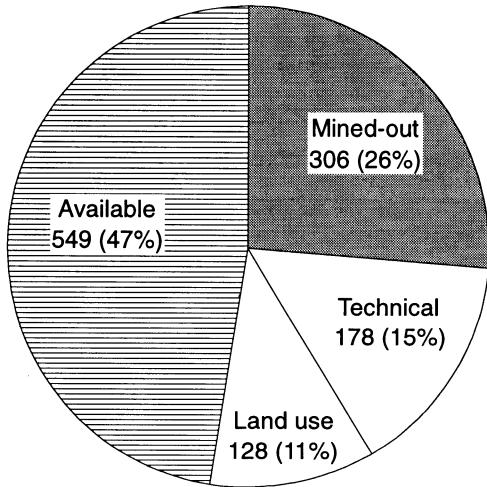
### **Atwater Quadrangle**

The restrictions on mining of resources differ significantly among the quadrangles. In the Atwater Quadrangle, the major restrictions are technical factors: thin coal (52 million tons, 17% of original resources) and unstable roof conditions related to the thickness of the Energy Shale (9 million tons, 4% of original resources; figs. 20, 23; table 2). Land use does not significantly restrict mining because of the rural setting of the quadrangle.

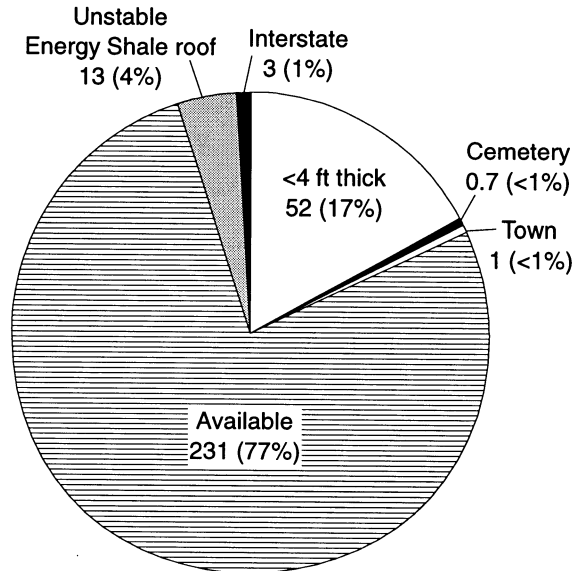
### **Collinsville Quadrangle**

The major restrictions on mining in the Collinsville Quadrangle are related to land use (towns, 58 million tons, 13% of original resources) and proximity to abandoned mines (36 million tons, 8% of original resources; figs. 21, 24; table 2). Forty-five percent of the resources has already been mined. Technical restrictions (block size, unstable roof, and thin coal) account for only 2% of the

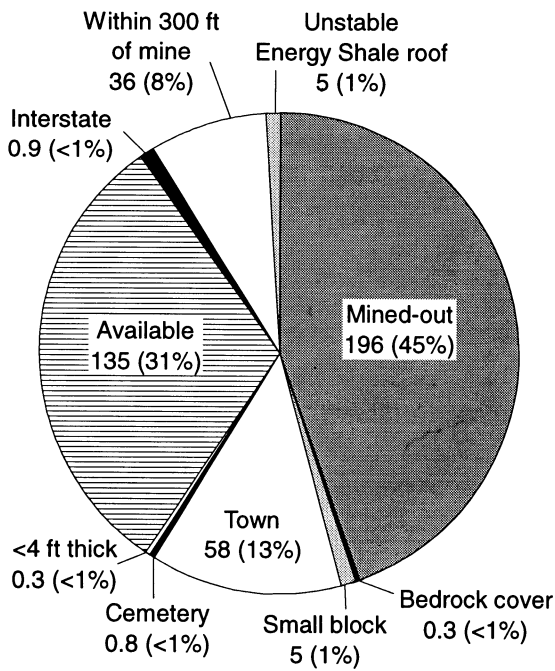




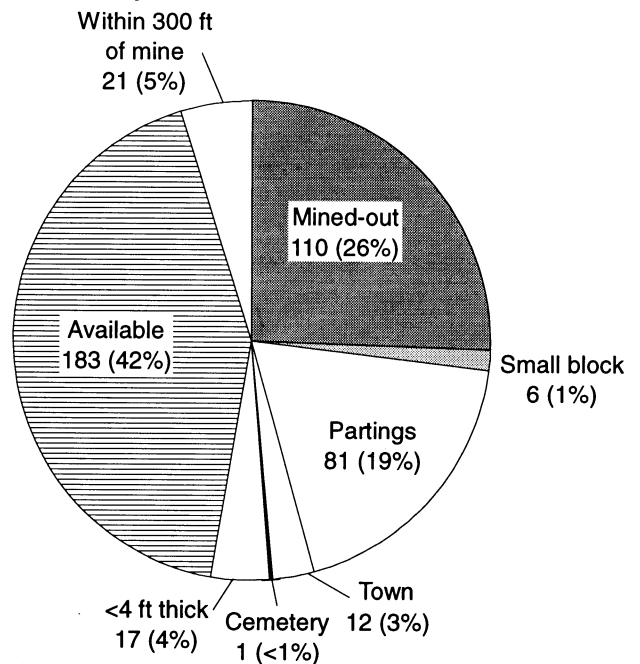
**Figure 19** Availability of coal in the Atwater, Collinsville, and Nokomis Quadrangles (percent of original resources and millions of tons).



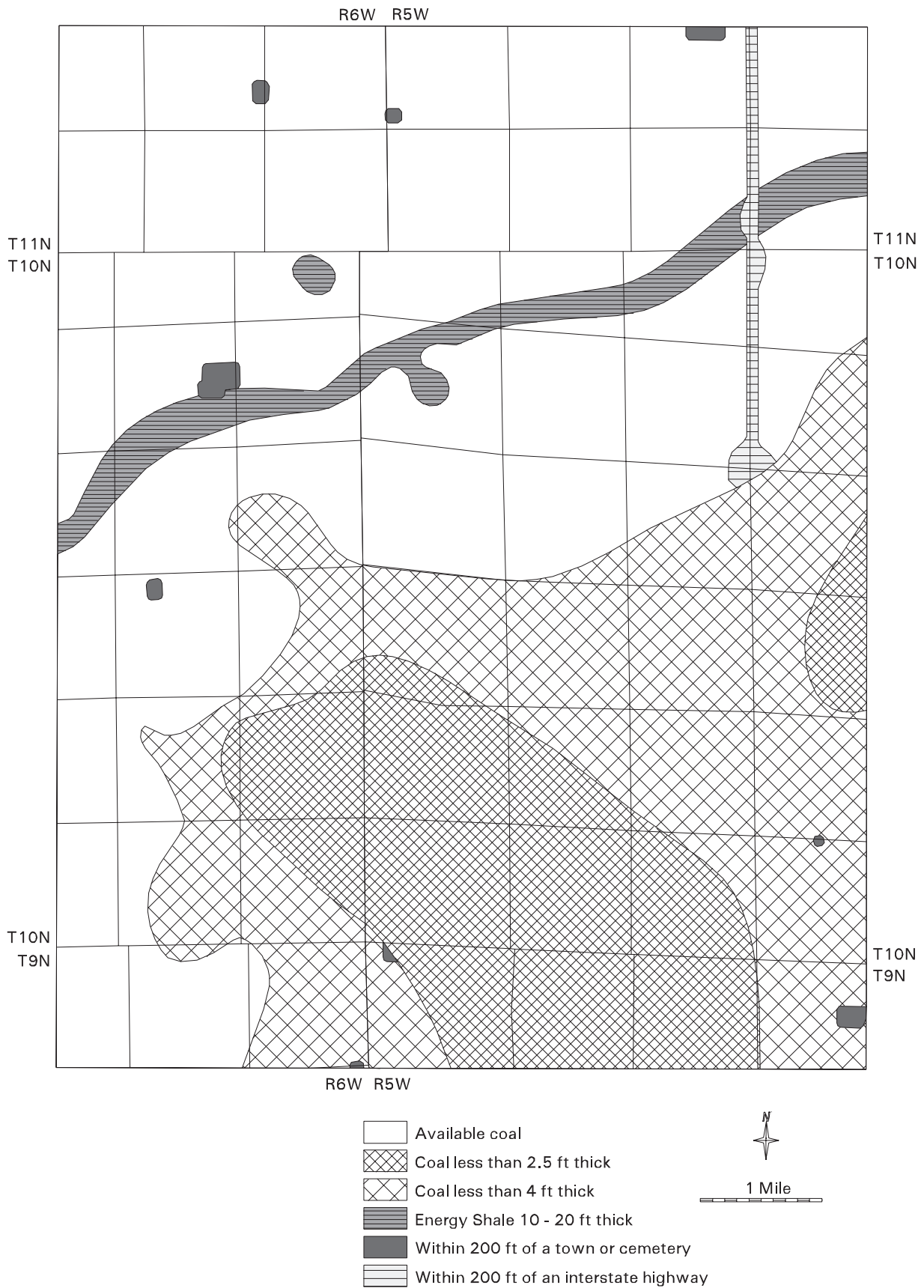
**Figure 20** Availability of coal in the Atwater Quadrangle (percent of original resources and millions of tons).



**Figure 21** Availability of coal in the Collinsville Quadrangle (percent of original resources and millions of tons).



**Figure 22** Availability of coal in the Nokomis Quadrangle (percent of original resources and millions of tons).



**Figure 23** Availability of Herrin Coal resources for underground mining in the Atwater Quadrangle.



**Figure 24** Availability of Herring Coal resources for underground mining in the Collinsville Quadrangle.

**Table 2** Underground minable resources in the Atwater and Collinsville Quadrangles (thousands of tons; all resources are in the Herrin Coal).

	Atwater	Collinsville
Original	301,404	436,377
Available	231,128	135,371
<b>Mined out</b>		195,528
<b>Land use restrictions</b>		
Near mines		35,790
Towns	1,025	57,610
Cemeteries	678	825
Interstate	3,459	906
Total	5,161	95,131
<b>Technical restrictions</b>		
Coal <4 ft	51,679	252
Block size		5,149
Bedrock cover		288
Unstable roof	13,435	4,657
Total	65,114	10,346

restrictions on resources. No resources are available for surface mining. The surface minable resources that are not under towns are within ½ mile of towns or subdivisions.

The percentage of resources restricted by surface development (towns, subdivisions, interstate highways, and cemeteries) in the Collinsville Quadrangle is much smaller than the area of the quadrangle occupied by surface development (14% versus 47%). This is because much of the developed area is already mined out.

The effect of surface development on future availability of coal is probably greater than indicated by our criteria. The area underlain by available resources is checkered with subdivisions and cemeteries (fig. 24). Several subdivisions were under construction at the time of our field reconnaissance in late 1995. Continued growth of these developments will soon partition the available resources into blocks too small or convoluted to be mined.

The pastoral setting of the area combined with nearby community services and excellent trans-

portation links to the St. Louis metropolitan area provide a strong basis for continued housing development and population growth. Any mining conducted in the immediate area will have to be done with careful consideration of community relations. Even if it is possible to design an efficient mine plan between the existing surface developments, opposition from concerned property owners may be encountered.

### Nokomis Quadrangle

Major restrictions on mining in the Nokomis Quadrangle are both technical and land use related (table 3). The Herrin Coal west of the abandoned mines is considered unminable because of the presence of partings (81 million tons, 19% of original resources). Companies typically design mines so that problematic areas such as this are on the fringe of mine areas and can easily be abandoned if conditions prove to be unfavorable. The positions of the abandoned mines on the east of this coal and the channel on the west of it allow access to the coal only from the north or

**Table 3** Underground minable resources in the Nokomis Quadrangle (thousands of tons).

	Danville	Herrin	Colchester	Seelyville	Total
Original	7,420	413,116	5,645	3,304	429,485
Available	0	182,503	0	0	182,503
<b>Mined out</b>		110,172			
<b>Land use restrictions</b>					
Towns	1,996	9,581			11,576
Cemeteries		734			734
Near mines		21,298			21,298
Total	1,996	31,612	0	0	33,608
<b>Technical restrictions</b>					
Coal <4 ft	5,424	11,158			16,583
Partings		77,338		3,304	80,641
Block size		333	5,645		5,977
Total	5,424	88,829	5,645	3,304	103,202

south. Some of the coal with partings north of the mined area can be mined because of the thickness of the upper bench of coal. However, the thickness and location of the partings in the Nokomis Mine and drill holes to the north of this quadrangle indicate that partings probably become too thick for mining west of the mines.

Partings also restrict mining of the Seelyville Coal. In the one drill hole that penetrated the seam, a 0.5-foot-thick parting divided the seam into two benches: a 3.67-foot lower bench and 0.5-foot upper bench. Neither bench is individually thick enough to mine, and the total coal thickness is just over the minimum of 4 feet. The large amount of rock material that will have to be extracted and separated from the coal prohibits mining of this seam.

Thin coal restricts 4% of original resources in the Nokomis Quadrangle (17 million tons; figs. 22, 25). More than half of the thin coal (11 million tons) is in the Herrin seam adjacent to the Walshville Channel. In addition to being thin, the coal in this area can be expected to have partings and unstable roof conditions. The remaining thin coal is in the Danville Coal.

Because of the large mined area in the quadrangle (26% of resources mined out), proximity to abandoned mines was a significant factor in limiting the availability of resources (21 million tons, 5% of original resources).

Land use (primarily towns) restricts less than 3% of the resources (12 million tons). As in the Collinsville Quadrangle, the amount of coal restricted by towns would have been higher, had not much of the coal underlying the towns already been mined out.

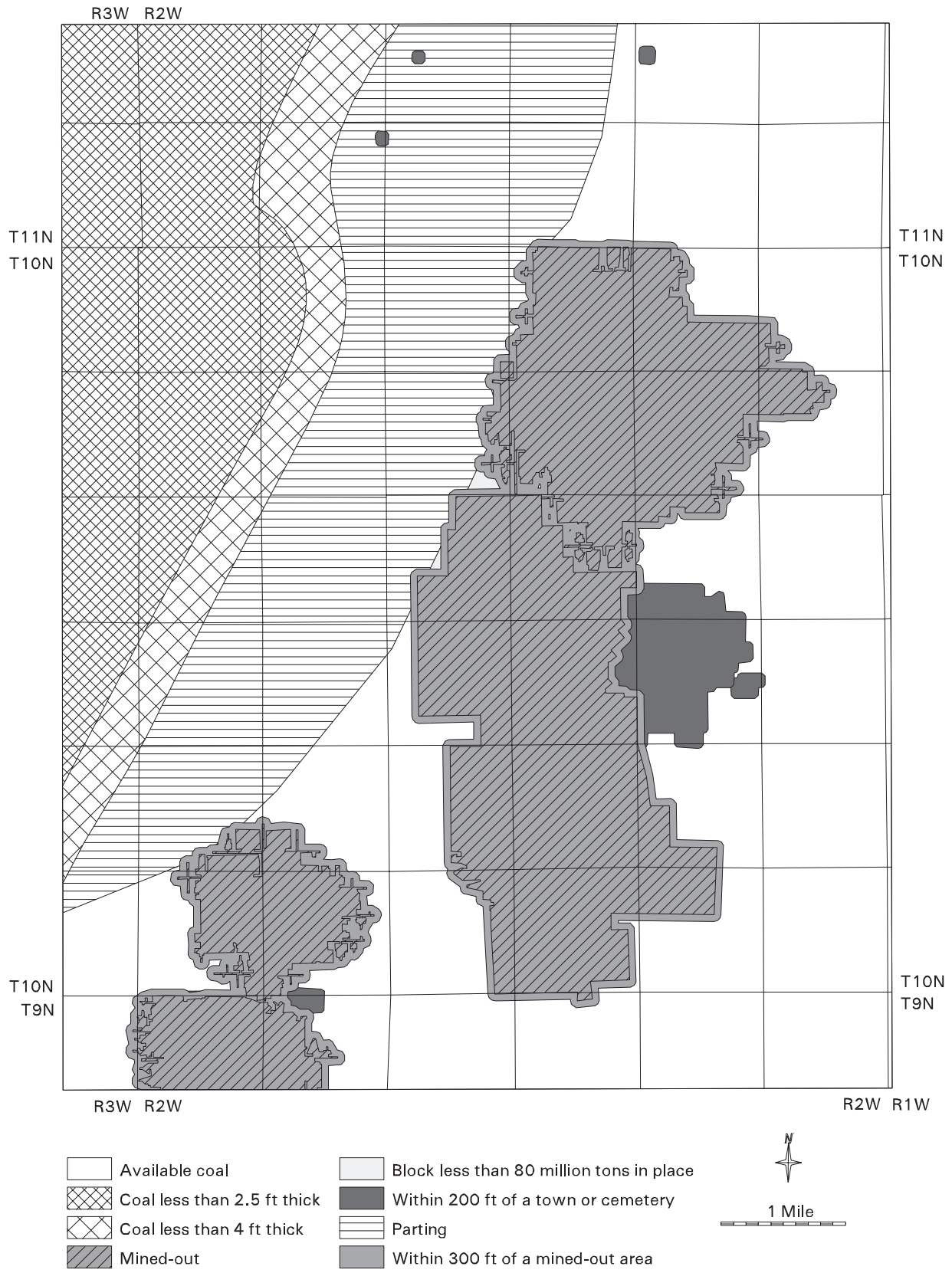
## **CONCLUSIONS**

The Herrin Coal is the major resource in west-central Illinois and includes some of the state's largest deposits of medium- to low-sulfur coal. Significant quantities of the Herrin Coal are not available for mining because of many land use and technical factors.

Resources near the St. Louis metropolitan area are restricted from mining by surface land use (towns, interstate highways, and cemeteries). The amount of resources restricted is not as great as it might otherwise be because much of the development is on land that has already been under-mined. Ongoing community development will, however, continue to reduce the amount of available resources, including some of the lower sulfur resources in the state, either by directly restricting access to underlying coal or by partitioning remaining resources into blocks too small for mining.

A high percentage of the Herrin resources in rural areas should be available for mining. The major technical factors that restrict mining (partings, thin coal, and unstable roof) are associated with the Walshville Channel. Along the west side of the basin where the coal is at relatively shallow depths, lack of a sufficient thickness of bedrock cover is a restriction. This restriction was not readily apparent in the three quadrangles reported on in this study because only the Collinsville Quadrangle had shallow coal, and this shallow coal was for the most part mined out or overlain by towns.

Large areas of west-central Illinois have been mined out by underground mines. The amount of resources restricted by the proximity of these mines is significant. Coal must be left as a buffer around mines, and many small (and in some cases large) blocks of resources between mines are inaccessible. The Nokomis Quadrangle illustrates how the location of large mined-out areas coupled with technical restrictions (e.g., partings, thin coal, and unstable roof) restricts access to resources. Resources that are otherwise available may not be mined because of the risk or marginal reward of attempting to mine these areas.



**Figure 25** Availability of HERRIN Coal resources for underground mining in the Nokomis Quadrangle.

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