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Siting Selection Study for the Soyland Power Cooperative, Inc. Compressed Air Energy Storage System (CAES)

Environmental Science and Engineering

January 1982

Prepared for
Pacific Northwest Laboratory
under Agreement B-B5494-A-L

Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
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SITING SELECTION STUDY FOR THE SOYLAND POWER COOPERATZVE, INC. COMPRESSED AIR ENERGY STORAGE SYSTEM (CAES)

Environmental Science and. Engineering

January 1982

Prepared for
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under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Richland, Washington 99352

FOREWORD

Compressed air energy storage (CAES) is a technique for supplying electric power to meet peak load requirements of electric utility systems. Using low-cost power from base load plants during off-peak periods, a CAES plant compresses air for storage in an underground reservoir--an aquifer, solution-mined salt cavity, or mined hard rock cavern. During subsequent peak load periods, the compressed air is withdrawn from storage, heated, and expanded through turbines to generate peak power. This relatively new technology offers significant potential for reducing costs and improving efficiency of electric power generation, as well as reducing petroleum fuel consumption.

Based on these potential benefits, the U.S. Department of Energy (DOE) is sponsoring a comprehensive program to accelerate commercialization of CAES technology. The Pacific Northwest Laboratory (PNL) was designated the lead laboratory for the CAES Program. As such, PNL is responsible for assisting the DOE in planning, budgeting, contracting, managing, reporting, and disseminating information. Under subcontract to PNL are a number of companies, universities, and consultants responsible for various research tasks within the program.

An important element of the program is to promote commercialization of CAES technology through the transfer of research results and experience to interested utilities. Toward this end, Environmental Science and Engineering, Inc., of St. Louis, Missouri, performed a study aimed at developing an appropriate methodology for siting CAES facilities. Conducted for the Soyland Power Cooperative, Inc., an Illinois utility actively planning the first CAES facility in the U.S., the study resulted in two reports.

The Technology Assessment Report describes the design and operational features of CAES systems in general and, more specifically, of the proposed Soyland plant. These features are then evaluated in terms of their relationship to environmental siting and licensing considerations. The second document, Siting Selection Study, uses geotechnical and environmental criteria to outline a method for siting **CAES** facilities. The work described is based on detailed analyses of geologic, environmental, regulatory, socioeconomic, and other factors.

Taken together, these two documents provide a case study of the first attempt to commercially develop a **CAES** facility in the U.S. As such, they are intended as a basis upon which other interested utilities can make initial decisions regarding this promising technology.

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EXECUTIVE SUMMARY

This document outlines a method for siting a compressed air energy storage (CAES) system using geotechnical and environmental criteria. The example used for this siting study was a 220-MW(net) water-compensated CAES plant proposed by Soyland Power Cooperative, Inc. of Decatur, Illinois. Serving 15 member rural electric cooperatives in Illinois, Soyland's load growth projections indicate the need for a facility to meet peak demand.

A conservative approach was utilized in the siting study which initially encompassed the entire state of Illinois. Five successive siting steps served to reduce the study area involved to a select number of sites. In the same sequence the level of information required evolved from general statewide or regional knowledge to site-specific data. The five steps in siting were:

1.	Regional Geotechnical Screening	Statewide identification and evaluation for suitable stratigraphic characteristics
2.	Regional Environmental Screening	Statewide environmental favorability rating
3.	Intermediate Analysis	Geotechnical and environmental weighing and ranking of 28 sites
4.	Environmental Fatal Flaw Analysis	Detailed environmental regulatory examination of seven sites
5.	Final Geological Survey	Site-specific geologic review of three sites

Because a site must have suitable rock layers at the correct depth, geologic criteria were given the most importance in the analysis. Thus,

within any stage of siting, a region or specific site could be eliminated from consideration if it were determined to be geotechnically unsatisfactory. This process eliminated much of the Illinois Basin in the Regional Geotechnical Screening stage and five candidate sites in the Intermediate Analysis.

Four levels of favorability were assigned to areas as part of the first two stages; favorable, potentially favorable, potentially favorable with conditions, and restricted for CAES system siting. Twenty-eight sites were selected from areas geotechnically favorable, favorable, and potentially favorable environmentally. Specific environmental rating criteria were utilized within four disciplines (air quality, water resources, ecology, and socioeconomics) as part of the second, third, and fourth siting stages. Quantitative ranking of the sites using these criteria was conducted as part of the Intermediate Analysis. Fatal flaws, such as extensive mitigation, intensive studies, costly delays, or permit denial, were examined in the fourth stage for seven of the sites. Four sites were eliminated by such potential flaws.

Sites in Adams, Pike, and Menard Counties, Illinois, were surveyed using existing regional or site-specific information. Adams and Pike Counties were found to be the most acceptable for further geotechnical investigation for CAES siting.

1.0 INTRODUCTION

Soyland Power Cooperative, Inc. of Decatur, Illinois is proposing the construction of a 220-MW (net) compressed air energy storage (CAES) facility to meet anticipated peak demand loads of its 15 member cooperatives. To comply with Rural Electrification Administration (REA) regulations and to locate an environmentally and geotechnically suitable location for this facility, an extensive siting study was required.

Because CAES is a new energy technological development in the United States, the U.S. Department of Energy, through its Pacific Northwest Laboratory operated by Battelle Memorial Institute, sponsored this siting study for Soyland's proposed 220-MW CAES plant.

The siting study consisted of five separate steps which narrowed down the choice of alternatives while increasing the information base for those remaining sites. The steps were:

1. Regional Geotechnical Screening,
2. Regional Environmental Screening,
3. Intermediate Analysis,
4. Environmental Fatal Flaw Analysis, and
5. Final Geological Survey.

The main selection criteria were geotechnical and environmental suitability relevant to plant design and licensing.

The study was conducted by Environmental Science and Engineering, Inc. (ESE) of St. Louis, Missouri, with assistance by Fenix and Scisson, Inc. of Tulsa, Oklahoma; Gibbs and Hill, Inc. of New York, New York; and PLANTEC, Inc. of Jacksonville, Florida.

2.0 OVERVIEW OF SITING METHODOLOGY

2.1 CRITICAL CAES FEATURES

For the purposes of this study, critical CAES features relevant to siting and licensing were viewed from two aspects: (1) general features pertinent to all CAES systems regardless of owner, size, or geographic area; and (2) a more specific set of CAES parameters associated with the unit which Soyland Power Cooperative, Inc. is proposing. This approach allowed the interdisciplinary siting team an overall appreciation for CAES system operation, while providing specific parameter values as necessary for the quantitative aspects of the siting methodology.

The major CAES system design and operational characteristics reviewed by the team prior to initiation of siting included:

1. Land area required,
2. Operational mode,
3. Compression mode,
4. Fuel type and usage,
5. Atmospheric emissions,
6. Noise,
7. Wastewater discharges,
8. Employment,
9. Surface reservoir characteristics,
10. Cavern requirements and characteristics, and
11. Frequency and periodicity of operation.

More specific quantitative features of the proposed CAES unit utilized for siting purposes are presented in Table 2-1. The values used are typical for siting purposes and may not be the same as those in Soyland's final specifications (Figures 2-1 and 2-2).

Table 2-1. Estimated Compressed Air Energy Storage System Parameters Used for Siting a Plant for Soyland Power Cooperative, Inc.*

Power output	220 MW
Power consumption during compression mode	162.3 MW
Compressed air pressure	800 psig
Temperature	59°C
Flow	300 kg/s
Heat rate	4100 BTW/KWH
Number of turbines	2
Number of compressors	3
Underground storage capacity	213,500 m^3
Power generation cycle	11 hours
Compressor cycle	11 hours
Surface reservoir	175 acre-feet
Depth of the cavern	1,800 - 2,000 feet
Fuel	Number 2 oil
Fuel consumption	7,000 gal/hr
Heat rejected in cooling tower	5.29×10^8 Btu/hr
Cooling water flow	50,000 gpm
Blowdown	320 gpm
Evaporation/drift loss	1,175 gpm

* Values are typical for siting purposes and not necessarily the same as final specifications.

Source: Gibbs and Hill, 1981.

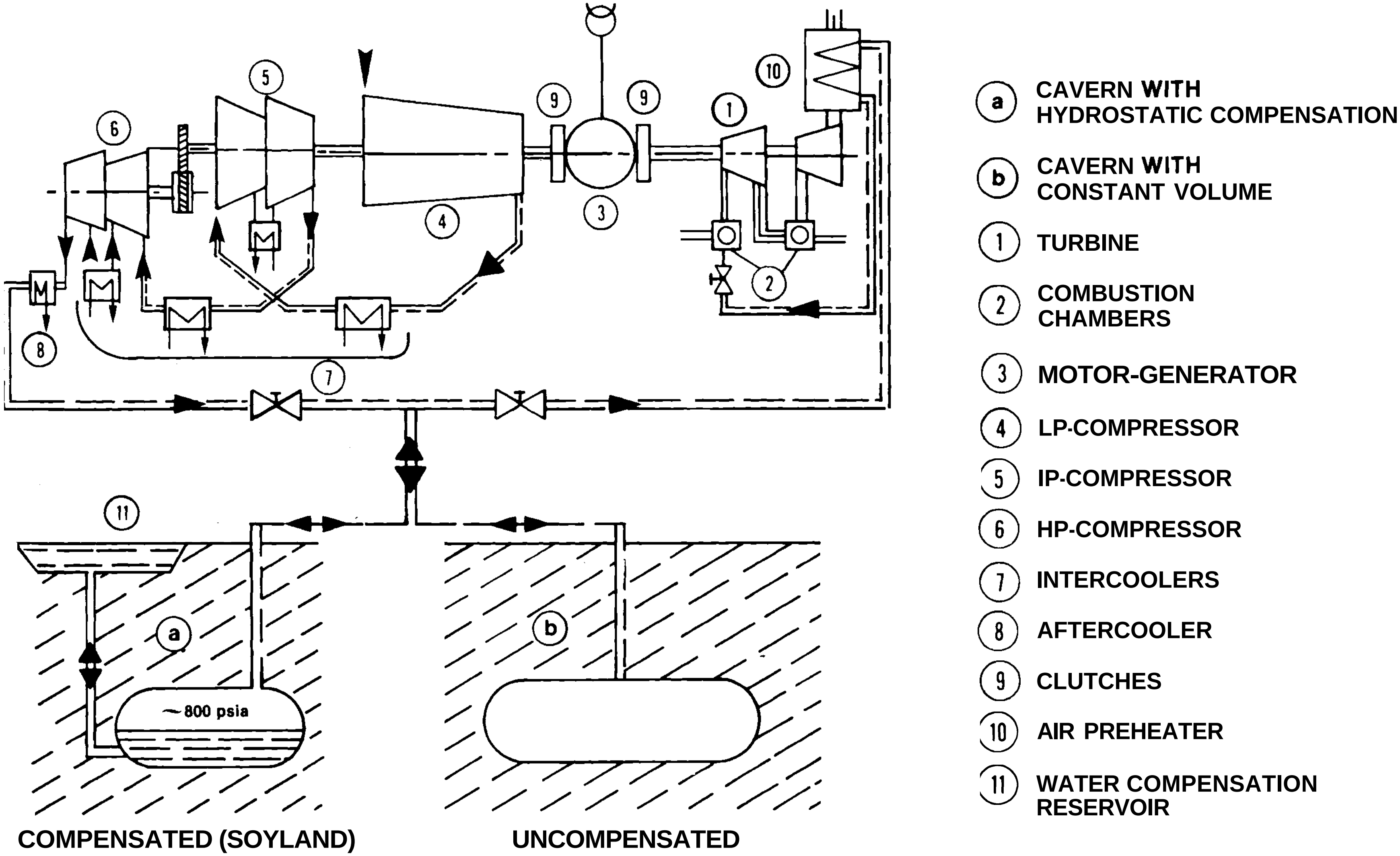

Figure 2-1

GENERAL SCHEMATIC FOR A CAES FACILITY

SOURCE: GIBBS & HILL, INC., 1981.

CAES
SITE SELECTION STUDY

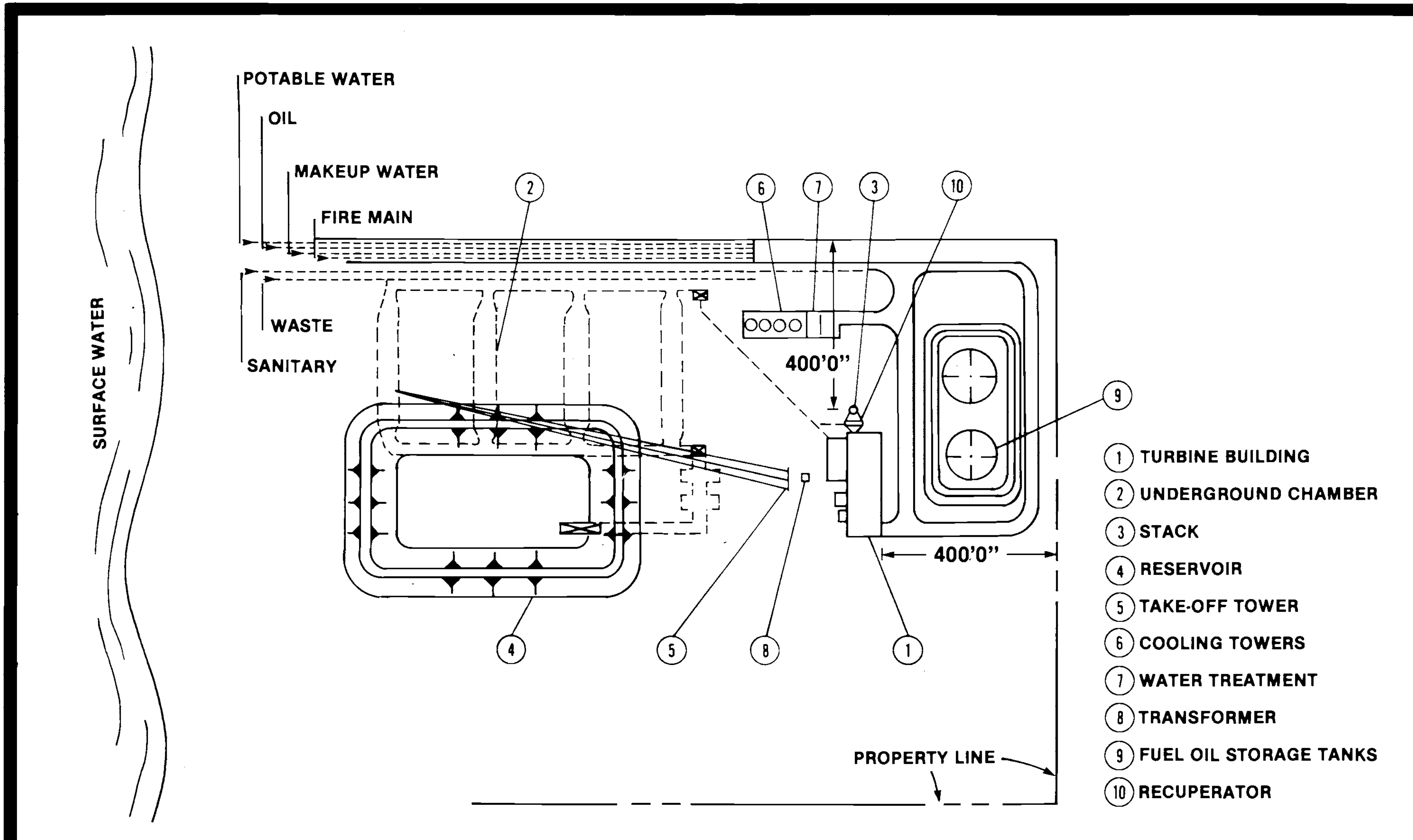

Figure 2-2

TYPICAL 220 MW CAES PLANT LAYOUT

SOURCE: GIBBS & HILL, INC., 1981.

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SITE SELECTION STUDY

2.2 LEVEL OF INFORMATION NECESSARY

The CAES siting study utilized general and easily available information for a large geographic area and also site-specific data requiring extensive literature reviews, agency contacts, and site visits.

The study was designed in five separate stages, with the following level of information required for each stage:

1. Regional Geotechnical Screening--required statewide knowledge of Illinois stratigraphy which was generally available from records and several publications of the Illinois State Geological Survey and individuals employed by the Survey.
2. Regional Environmental Screening--required general statewide environmental information on air quality, water resources, ecology, and socioeconomics. This often included or was supplemented by more site-specific data, especially as related to major pollutant emission areas or other sites restricted from CAES siting.
3. Intermediate Analysis--required more site-specific geotechnical and environmental information for a discrete number of sites (28). This was generally collected by contacting specific agencies [i.e. prime farmland, United States Department of Agriculture (USDA); historic and archaeological sites, Department of Conservation; etc.] or researching specific references for detailed regional or site-specific data.
4. Fatal Flaw Analysis--required site-specific environmental information for a limited number of sites (7) of a known size (<25 square miles). This was collected by visiting the sites, using existing information from past studies, and contacting local agency personnel.

5. Final Geological Survey--was the most data-intensive phase, focusing on three specific sites. The major sources of information were records and drill logs on file with the State Geological Survey. Additional site visits were also conducted to verify the existence of specific geologic and topographical features at each site.

2.3 INTERDISCIPLINARY APPROACH

The siting team consisted of an interdisciplinary group of scientists and engineers. This group was composed of individuals with experience and specific knowledge in five areas:

1. Overall power plant design, operation, and environmental interfaces;
2. Power plant siting techniques employing both federal and state guidelines;
3. CAES system design and operational technology;
4. Geotechnical experience in underground cavern design and development; and
5. Previous power plant siting or other relevant experience in Illinois.

To achieve this staff composition and depth of personnel, ESE was assisted by the following groups:

1. Gibbs and Hill, Inc.--engineers, designers, and constructors skilled in the design and operation of CAES above-ground facilities;
2. Fenix and Scisson, Inc.--geotechnical consultants with expertise in underground cavern design and development with prior experience in Illinois; and
3. PLANTEC, Inc.--skilled in socioeconomic analysis and planning, as well as investigation of cultural and historic resources.

This team worked together to delineate and assess the major physical and operational features of CAES system, determine geotechnical suitability, and evaluate potential environmental impact and licensability. This approach provided a basis for synthesizing a multitude of environmental, economic, and engineering considerations which affect the suitability of areas for CAES plant siting.

Two publications were utilized to design and assure an **interdisciplinary** approach:

1. **REA's** Methodology for Identifying Environmental Constraints in Power Plant Siting (November 1979); and
2. **EPA's** Implementation of Procedures on the National Environmental Policy Act (effective December 15, 1979).

The following individuals and organizations have participated in the preparation and development of this document.

2.4 GEOTECHNICAL CRITERIA

Geotechnical conditions at a specific site were recognized as being the most important aspect of siting regardless of other environmental, engineering, or economic conditions. Lack of adequate strata for cavern construction eliminates any specific area from CAES plant placement. Therefore, a conservative approach, using geologic suitability as the most critical feature in siting, was employed. Under this approach, any area or site could be eliminated at any time or stage of the siting analysis if it were found to be geotechnically unsuitable for a CAES plant. This conservative approach is further exemplified by the incorporation of the geotechnical site analysis into three of the five steps in the siting study.

The two major geotechnical criteria were:

1. Quality of the rock strata, including water and air tightness, suitability for either boring or room-and-pillar construction, and other CAES-specific criteria; and
2. A cavern depth from 1,700 to 2,500 feet beneath ground surface for the proposed 220-MW facility. This allows adequate water-compensated cavern pressure for the design range of turbomachinery in the power house.

These two criteria were incorporated into the Stage I Geotechnical Screening, Stage 111 Intermediate Analysis, and Stage V Geologic Survey sections of the siting study. Other more specific geological criteria were evaluated in these stages. Additionally, karst topography, existence of coal mining, and seismic risk were also evaluated in the Regional Environmental Screening stage.

2.5 ENVIRONMENTAL CRITERIA

Four major environmental disciplines were identified and evaluated by the siting team in each phase of the study:

1. Air Quality--included analysis of the presence and density of pollutant sources, Class II PSD increments, ambient air quality, Class I visibility standards, and noise.
2. Water Resources--focused primarily on water quality and availability, evaluating stream low-flow characteristics, flood frequency, and floodplain regulation.
3. Ecological Resources--examined terrestrial and aquatic biological communities and, specifically, the presence of threatened or endangered species or their habitat, natural areas, habitat diversity, and species diversity.
4. Socioeconomics--analyzed land use and zoning, community structure and potential impacts, historical and archaeological resources, presence and significance of federal and state land use areas, and transportation.

The evaluation of these disciplines in each stage was designed to be:

1. Relevant to power plant and CAES siting, especially in Illinois;
2. Integrative and interactive in evaluating multidisciplinary siting constraints;
3. Sensitive to environmental conditions in Illinois;
4. Flexible for necessary updates as siting constraints change;
5. Responsive to regulatory requirements;
6. Rational in decision-making and objective as possible; and
7. Capable of verification and documentation.

2.6 STEP-WISE EXCLUSIONARY PROCESS

The siting process employed in this study utilized a step-wise approach which reduced the site options, while maximizing environmental and geotechnical acceptability of these site options. This technique can be summarized by a 3-step approach:

1. Regional Screening--Examines a large area (service area) for general suitability for environmental, economic, and engineering suitability;
2. Intermediate Analysis--Selects a number of sites for closer examination (<50), collects data, weighs criteria, and ranks sites; and
3. Site-Specific Analysis--Rigorously examines a limited number of sites (<10) for engineering, environmental fatal flaws, and a future scenario analyses.

Due to the overriding geotechnical requirements of a CAES plant, this study was modified to include a starting and finishing step which emphasized geology. The resulting siting study was therefore composed of five steps with a decreasing study area size:

Process Steps	Study Area Size
1. Regional Geotechnical Screening	Statewide
2. Regional Environmental Screening	3/4 of state
3. Intermediate Analysis	28 sites
4. Environmental Fatal Flaw Analysis	7 sites
5. Detailed Geological Survey	3 sites

3.0 APPLICATION OF SITING METHODOLOGY TO A USER

3.1 SOYLAND POWER COOPERATIVE, INC. CAES

Soyland Power Cooperative, Inc. is an electric power generation and transmission cooperative organized in 1963 to serve 15 distribution cooperatives within Illinois. The Soyland headquarters is located in Decatur, Illinois. The distribution cooperative members of Soyland and the location of their headquarters are as follows:

* Clay Electric Co-operative, Inc., Flora
* Clinton County Electric Cooperative, Inc., Breese
* Coles-Moultrie Electric Cooperative, Mattoon
* Corn Belt Electric Cooperative, Inc., Bloomington
* Eastern Illinois Power Cooperative, Paxton
* Edgar Electric Co-operative Association, Paris
* Farmers Mutual Electric Company, Geneseo
* Illini Electric Cooperative, Champaign
* Illinois Valley Electric Cooperative, Inc., Princeton
* McDonough Power Cooperative, Macomb
* Monroe County Electric Co-Operative, Inc., Waterloo
* Shelby Electric Cooperative, Shelbyville
* Southwestern Electric Cooperative, Inc., Greenville
* Tri-County Electric Cooperative, Inc., Mt. Vernon
* Wayne-White Counties Electric Cooperative, Fairfield

The overall aim of Soyland and its member cooperatives is to provide their member-owners in the rural areas of Illinois with a reliable and economical source of electric energy.

Figure 3-1 shows the general areas within Illinois served by the Soyland cooperative members.

Soyland Power Cooperative, Inc. has investigated several alternative forms of peak-power generation systems to supplement planned baseload

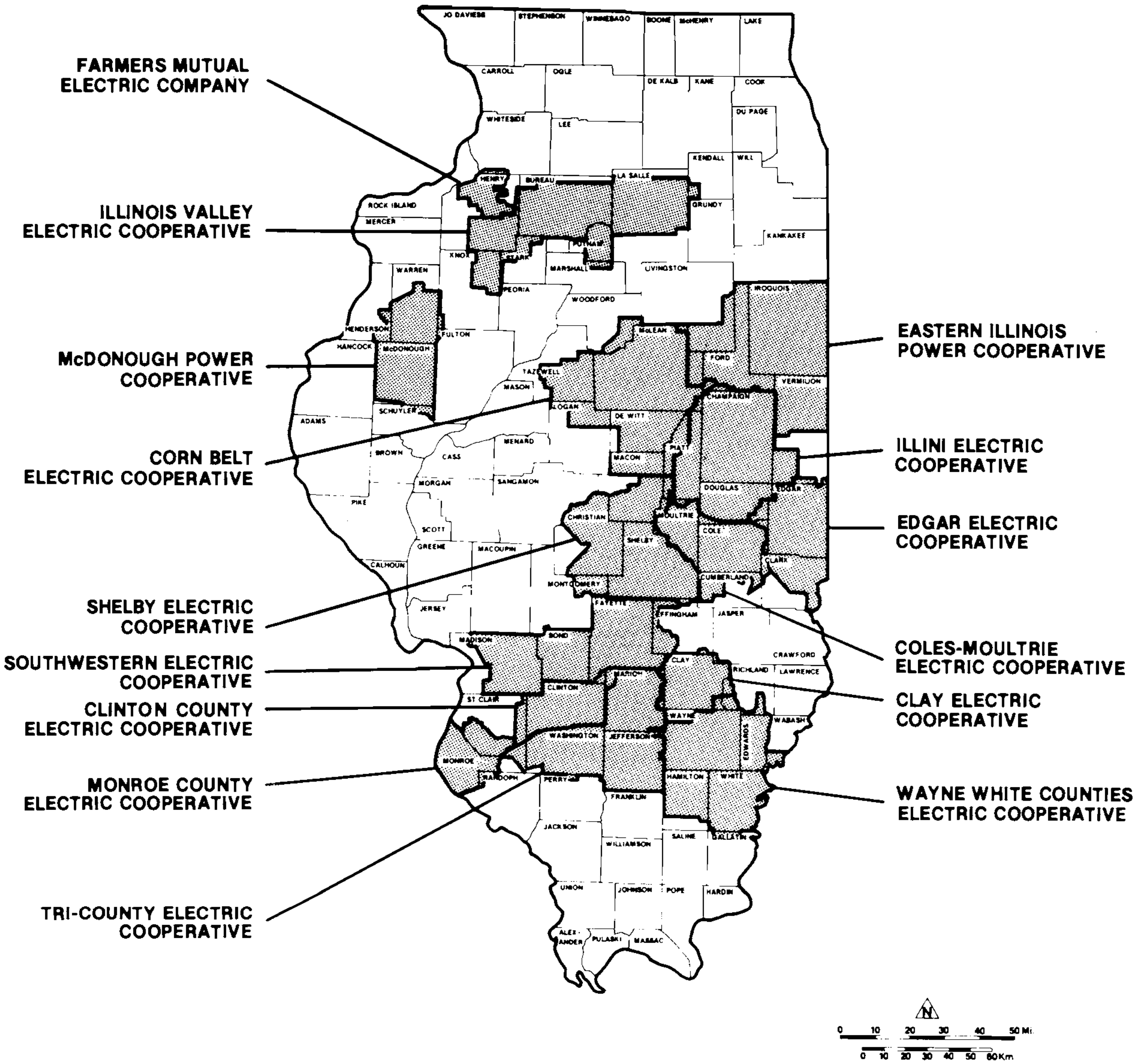

Figure 3-1

SERVICE AREAS OF THE SOYLAND DISTRIBUTION COOPERATIVE MEMBERS

SOURCE: **SOYLAND** POWER COOPERATIVE INC., 1981

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generation capabilities. Soyland's management has decided that a CAES plant may provide a feasible and economical supply of peaking power for its member cooperatives. Soyland's justification for investigating a CAES peak-load plant is that it will provide peaking power from baseload power sources, reduce the amount of petroleum fuel needed from that of a conventional peak unit, and reduce maintenance costs on baseload units by allowing them to operate more efficiently at a constant steady rate.

An early and key step in Soyland's planning was the approval of a Permanent Fuel Use Mixtures Exemption from the Economic Regulatory Administration within the U.S. Department of Energy. This allows Soyland to use petroleum or natural gas otherwise prohibited by the Power Plant and Industrial Fuel Use Act of 1978.

Soyland has also contracted with Reynolds, Smith and Hills, Inc. for a study entitled "Evaluation of Peaking Power Alternatives." Initial results indicate that the CAES alternative is significantly lower in cost than other options considered.

3.2 STUDY AREA

The study area chosen for this siting study included the entire state of Illinois, or approximately 54,000 square miles. Thus, the study area was not limited to the service area of Soyland, indicated in Figure 3-1. The major factors determining the study area were:

1. The study region should include sufficient land area to allow the evaluation of areas with differing environmental characteristics and to enhance the probability of locating potentially suitable sites and alternatives; and
2. The study region should not include so much land area that substantial resources are required to evaluate the suitability of the area when an adequate number of suitable sites are available in a smaller area.

3.3 OBJECTIVES OF STUDY

The principal objective of the study was to locate a site in Illinois for Soyland's proposed 220-MW CAES plant. Within this general objective were three secondary needs:

1. Locate a site or sites with a high potential of containing the necessary rock strata at the proper depth for CAES cavern development;
2. Locate a site or sites which are environmentally acceptable for permitting without extensive mitigation, studies, or other delays; and
3. Select a site using a technique and having the characteristics which meet the following comprehensive policies and guidelines as they pertain specifically to Soyland:
   * The National Environmental Policy Act of 1969 (NEPA) and the Council on Environmental Quality regulations for implementation of NEPA procedures, effective July 30, 1979;
   * The Rural Electrification Administration (REA) procedures for implementing NEPA (REA Bulletin 20-21) and any forthcoming revision to these procedures;
   * Other pertinent federal and state laws such as the Clean Air Act; and
   * Other pertinent Executive Orders such as E.O. 11988 (Floodplains).

4.0 STAGE I--GEOTECHNICAL SCREENING

4.1 OBJECTIVE

The objective of the Stage I Geotechnical Screening was to identify those areas within Illinois which could be expected to meet the specific geotechnical requirements of a CAES facility. As identified in Section 2.4, the underground aspects of a CAES unit require excavations in natural bedrock at a depth specific to the required air pressure entering the turbine. Therefore, during this initial stage, a general survey was conducted to identify the regional stratigraphic characteristics of Illinois. Levels of favorability were assigned to each specific area or stratigraphic unit. The result was to be a gross regional screening indicating areas either favorable or restricted from siting a CAES plant.

Plant specific parameters were those of Soyland's proposed 220-MW CAES facility. The survey was conducted using existing information.

4.2 APPROACH AND METHODOLOGY

Due to the physical and operational aspects of the CAES system, geologic suitability was assigned the first priority in the initial screening process. This superseded any other environmental, economic, or engineering criteria. This was predicated by the fact that if sufficient geologic conditions at a site were not available, then siting was not possible. No acceptable degree of economic, engineering, or environmental favorability defined in later stages could offset the geologic unfavorability of a site.

This geologic survey was conducted utilizing existing geologic information for Illinois. The major source of this information was the Illinois Institute of Natural Resources, State Geologic Survey in Urbana. Staff members were consulted during this stage and documents and other materials published or cataloged by this organization were referenced.

While the available geologic information for Illinois is extensive and accurate from a regional scale, it is not necessarily site specific. Therefore, it should be noted that this initial survey was conducted on a macro-scale with limited data input specific to any one area or potential site. The character of individual stratigraphic units may vary considerably within a few hundred horizontal feet. Within this distance, one rock stratum may increase or decrease in thickness and depth significantly, depending on undetected variations in the underlying bedrock structures. As a result, the final product from this stage of the siting process would not provide a definitive positive or negative response for a specific site. Instead, the results were to be a comparison of regions of similar favorability.

To aid in the identification of suitable rock strata in Illinois, three broad parameters were established by the siting team:

1. The rock formation must be massive, relatively impermeable, and capable of supporting underground mining. (It was determined early in this review that Precambrian granites, massive dolomites, and massive limestones were the most likely to satisfy these criteria.)
2. The stratigraphic unit must be at least 100 feet thick to allow sufficient vertical room for excavation while not jeopardizing the integrity of the structure.
3. The rock strata must occur between 1,700 and 2,500 feet below ground surface. This will allow sufficient head for water compensation to provide the desired approximate 800 psia for power generation.

Regarding the first item, specific geologic qualities of the rock strata included in the analysis were potential of folding, faulting and jointing, degree of schistosity, and rock mass permeability. The latter factor is significant, as air could escape a compressed cavern by percolating through a rock mass of relatively low permeability. This would result in increased operating costs during the compression cycle and decreased pressure (or energy) in the generation mode. Rock strata suitable for either room and pillar or boring methods of cavern construction were considered.

The required rock strata thickness was a function of the planned geometry of the Soyland CAES facility. The final cross-sectional area, tunnel length, and design would depend on the structural properties of the rock being mined. However, the planned scheme was for tunnels of the storage cavern to be arch shaped, 80 feet high in the center, and approximately 60 feet wide at the base. This necessitated the requirement that the rock strata be at least 100 feet thick vertically.

Having established the above three rock strata criteria, a 3-phase study was conducted to locate and rate favorable strata in Illinois:

1. Determine which stratigraphic units occurring in Illinois (regardless of depth, thickness, or spatial location) met the first criterion listed previously.
2. Estimate where these stratigraphic units would occur in Illinois at the desired depths (1,700 to 2,500 feet) and at vertical thickness (100 feet minimum).
3. The final step was to develop a favorability rating for the available stratigraphic units as they related to a composite regional screening.

The last step would result in a ranking system in which areas within Illinois could be assigned different favorability ratings. In this way the entire state could be assigned a favorability level in a method similar to later steps. The following favorability rating system was developed for this last phase of regional geologic screening:

1. <u>Favorable</u>--Areas with a high potential of containing suitable strata occurring at the required depth and thickness.
2. <u>Potentially Favorable</u>--Areas with a moderate potential of containing suitable strata occurring at the required depth and thickness.
3. <u>Potentially Favorable With Conditions</u>--Areas with a low potential containing suitable strata at the required depth and thickness.
4. <u>Restricted</u>--Areas with no potential of containing suitable strata at the required depth and thickness.

4.3 RESULTS

Discussions with the staff of the Illinois State Geological Survey (1981) and review of the available literature indicated that five major units were determined to have the potential to satisfy the established criteria for Soyland's CAES plant. These units, indicated by age and rock unit, include:

Age	Rock Unit
Precambrian	All granites
Cambrian	Lombard Dolomite of the Eau Claire Formation
Cambrian	Knox Dolomite Megagroup
Ordivician	Ottawa Limestone Megagroup
Silurian and Devonian	Hunton Limestone Megagroup

No Mississippian or Pennsylvanian strata were found to meet the criteria over a significant geographic area of Illinois.

A detailed description of each of the five rock units follows.

1. Precambrian Granite--Precambrian formations serve as the basement rocks for Illinois, being the oldest formation of those five identified as potentially acceptable. The uppermost surface of these rocks ranges from depths of 14,000 feet in southern Illinois (in the Illinois Basin) to approximately 2,000 feet in northern and northwestern Illinois. Most of the Precambrian rocks in Illinois are granites or other intrusive igneous rocks (Willman *et al.*, 1975). The buried upper surface of the Precambrian strata is hilly, having a known relief of as much as 800 feet (Atherton, 1971) in Illinois. Therefore, vertical differences may potentially be significant over a rather short horizontal distance. As indicated in Figure 4-1, those areas of the Precambrian of the desired thickness and depth occur primarily in the northwestern corner of the state and in central Pike County.

Figure 4-1

PRECAMBRIAN GRANITES

**SOURCES: ILLINOIS STATE GEOLOGICAL SURVEY, 1981.
ESE, 1981.**

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2. Knox Dolomite Megagroup--Consisting of relatively pure dolomite, the Knox Megagroup underlies all of Illinois except small areas of northern Illinois. This formation is thinnest near the northern part of the state, ranging from 300 to 500 feet thick. In this area, it also contains thin layers of limestones. Outcrops of these strata occur in La Salle and Lee Counties in northern Illinois. Towards southern Illinois the limestones disappear and the megagroup thickens, reaching a maximum thickness of 6,000 feet along the bottom tier of counties (Willman et al., 1975). Formations of the Knox Dolomite Megagroup occurring at the desired depth and thickness were estimated to occur along a line northward from Monroe County to Woodford County, then eastward (Figure 4-2).
3. Lombard Dolomites of the Eau Claire Formation--The Eau Claire Formation consists of dolomite, dolomitic sandstone, and shale (Walcott, 1914). Underlying all of Illinois, it ranges from 300 feet in thickness in the western part of the state to more than 1,000 feet in the southeast. However, the Lombard Dolomite Member ranges from a few to 150 feet thick. It consists primarily of grayish brown partly sandy dolomite containing some shale. Sandstone is more prevalent in the west and north, becoming more shaly in the south (Willman et al., 1975). For purposes of this study, the most suitable strata occurred along the western edge of Illinois and then through north-central Illinois (Figure 4-3).
4. Ottawa Limestone Megagroup--This megagroup consists dominantly of carbonate rocks and occurs throughout Illinois. The thickest deposits occur in southern Illinois where it may attain a depth of 1,300 feet. Thinnest deposits are in western and north-central sections of the state. In these areas, thickness may range below 300 feet, with occasional outcrops and erosion occurring. For CAES siting, the most favorable depths and thicknesses of this formation were determined to occur in an arching north-south line from Randolph County to Dewitt County and then westward through southern Vemillion County (Figure 4-4).

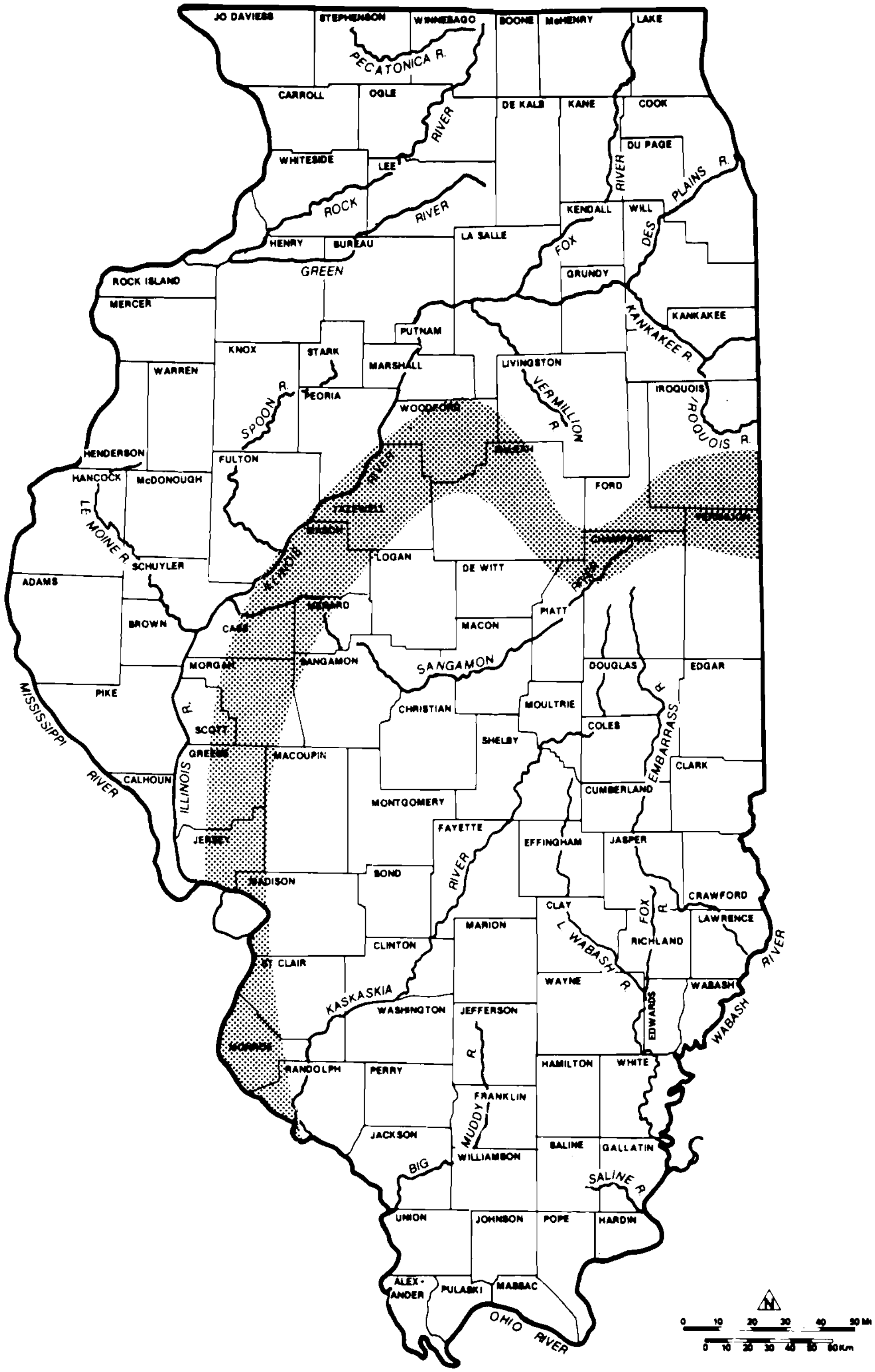

Figure 4-2

KNOX DOLOMITE MEGAGROUP WITHIN ILLINOIS

SOURCES: ILLINOIS STATE GEOLOGICAL SURVEY, 1981.
ESE, 1981.

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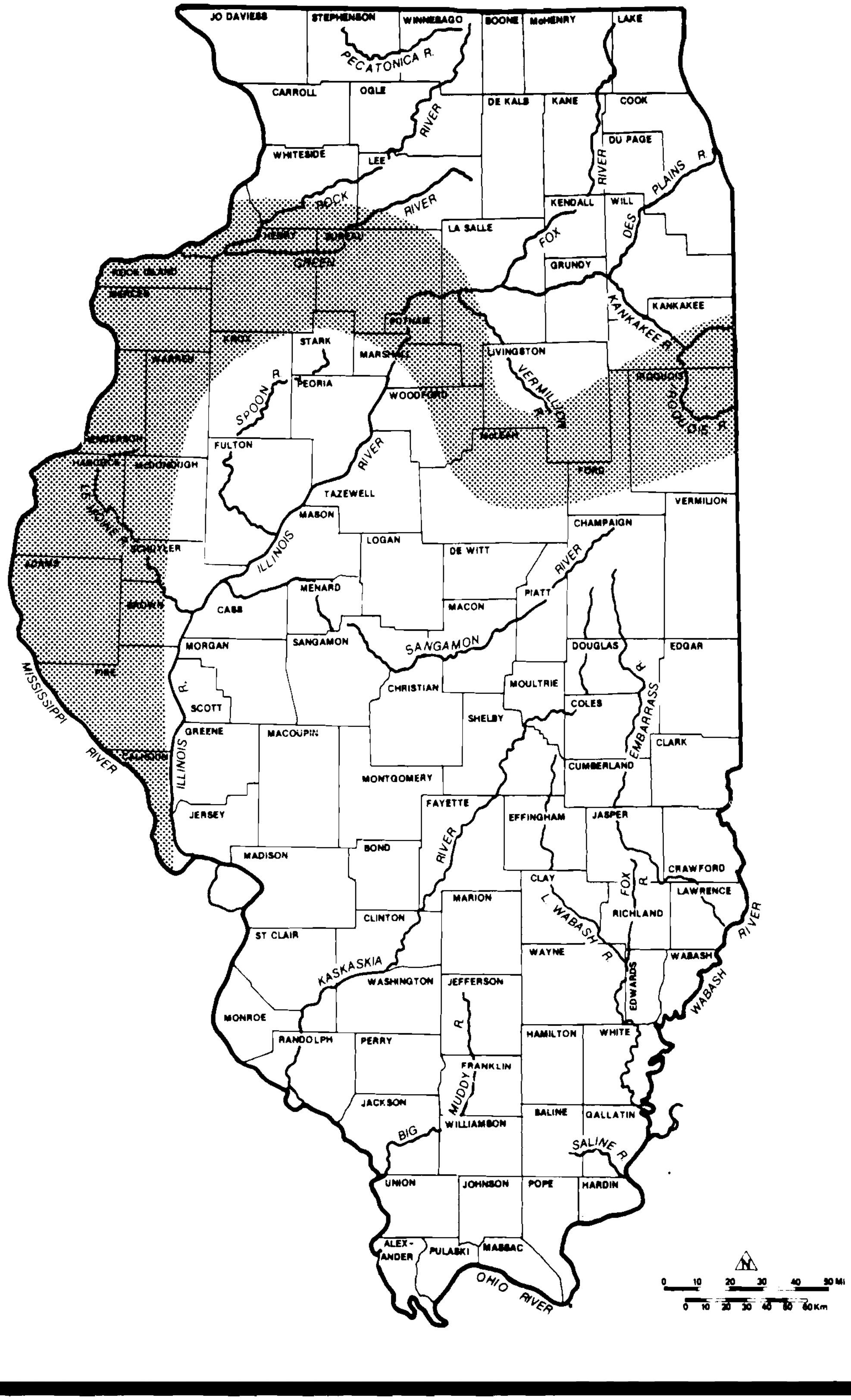

Figure 4-3

LOMBARD DOLOMITES OF THE EAU CLAIRE FORMATION WITHIN ILLINOIS

SOURCES: ILLINOIS STATE GEOLOGICAL SURVEY, 1981. ESE, 1981.

CAES

SITE SELECTION STUDY

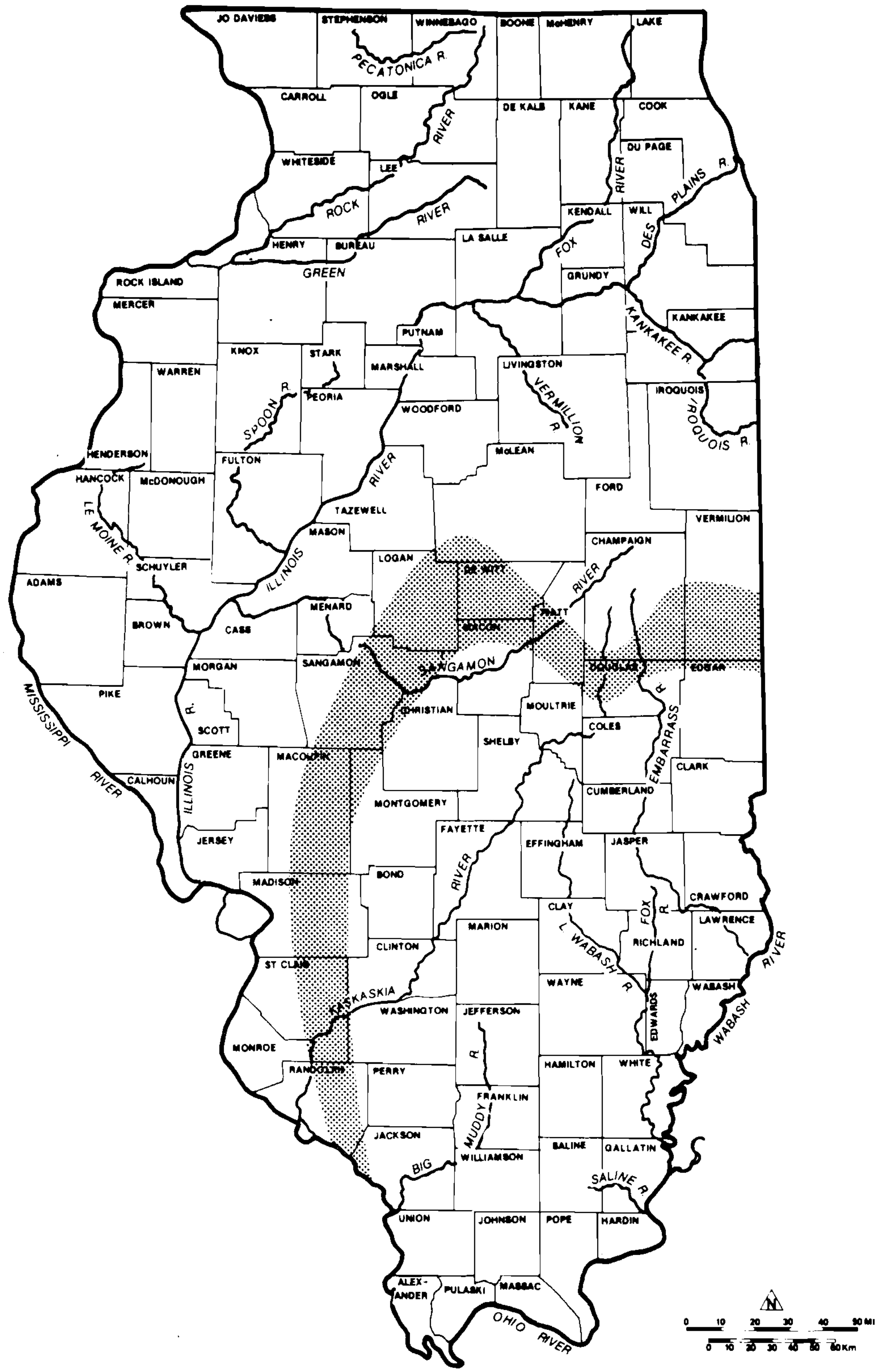

Figure 4-4

OTTAWA LIMESTONE MEGAGROUP WITHIN ILLINOIS

SOURCES: ILLINOIS STATE GEOLOGICAL SURVEY, 1981. ESE, 1981.

CAES

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5. Hunton Limestone Megagroup--The Hunton strata occur throughout Illinois, although they are absent in the north-central region and in small parts of western and southern Illinois. The thickest deposits (with thicknesses of 1,800 feet in some areas) occur in southeastern Illinois. In northern Illinois this megagroup is almost entirely dolomite, whereas in southern Illinois limestones are more common (Willman et al., 1975). For purposes of CAES plant siting, the most favorable areas in terms of depth and thickness occur in an area from Alexander County northward to Macon County, the east towards Edgar County (Figure 4-5).

The five rock units were all determined to be rated favorable for siting the Soyland CAES plant, given proper depth and thickness. Therefore, the areas indicated in Figures 4-1 through 4-5 were all favorable for further inclusion in the siting study. The favorability specifications as related to Illinois were thus outlined:

Favorable Areas--Regions of the state having deposits of Precambrian granites, the Knox Dolomite Megagroup, the Lombard Dolomites of the Eau Claire Formation, the Ottawa Limestone Megagroup, or the Hunton Limestone Megagroup at suitable depths (1,700 to 2,500 feet below ground surface) and thicknesses (100 feet minimum) were classified as favorable (Figure 4-6). Such regions would be carried to the next stage of siting and evaluated by different criteria.

2. Potentially Favorable--Regions of the central and northern parts of Illinois bordered or enclosed by favorably rated areas were rated as being potentially favorable. The reasons for this rating were:

   a. All of the favorable rock units identified for CAES in Illinois occur in this region and may, in fact, occur in proper thickness and depth. The five strata, however, are generally thinner and nearer the ground

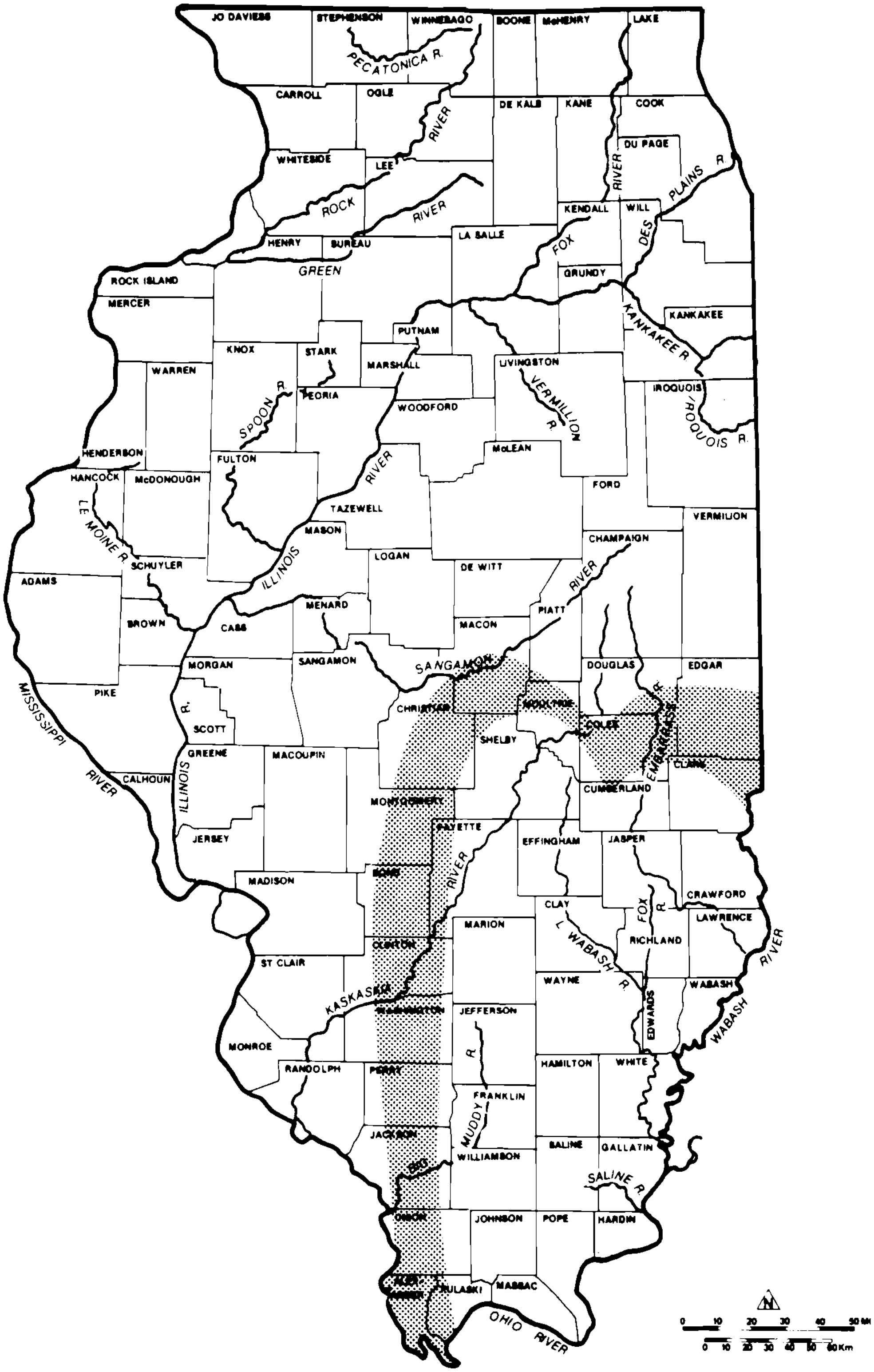

Figure 4-5

HUNTON LIMESTONE MEGAGROUP WITHIN ILLINOIS

SOURCES: ILLINOIS STATE GEOLOGICAL SURVEY, 1981. ESE, 1981.

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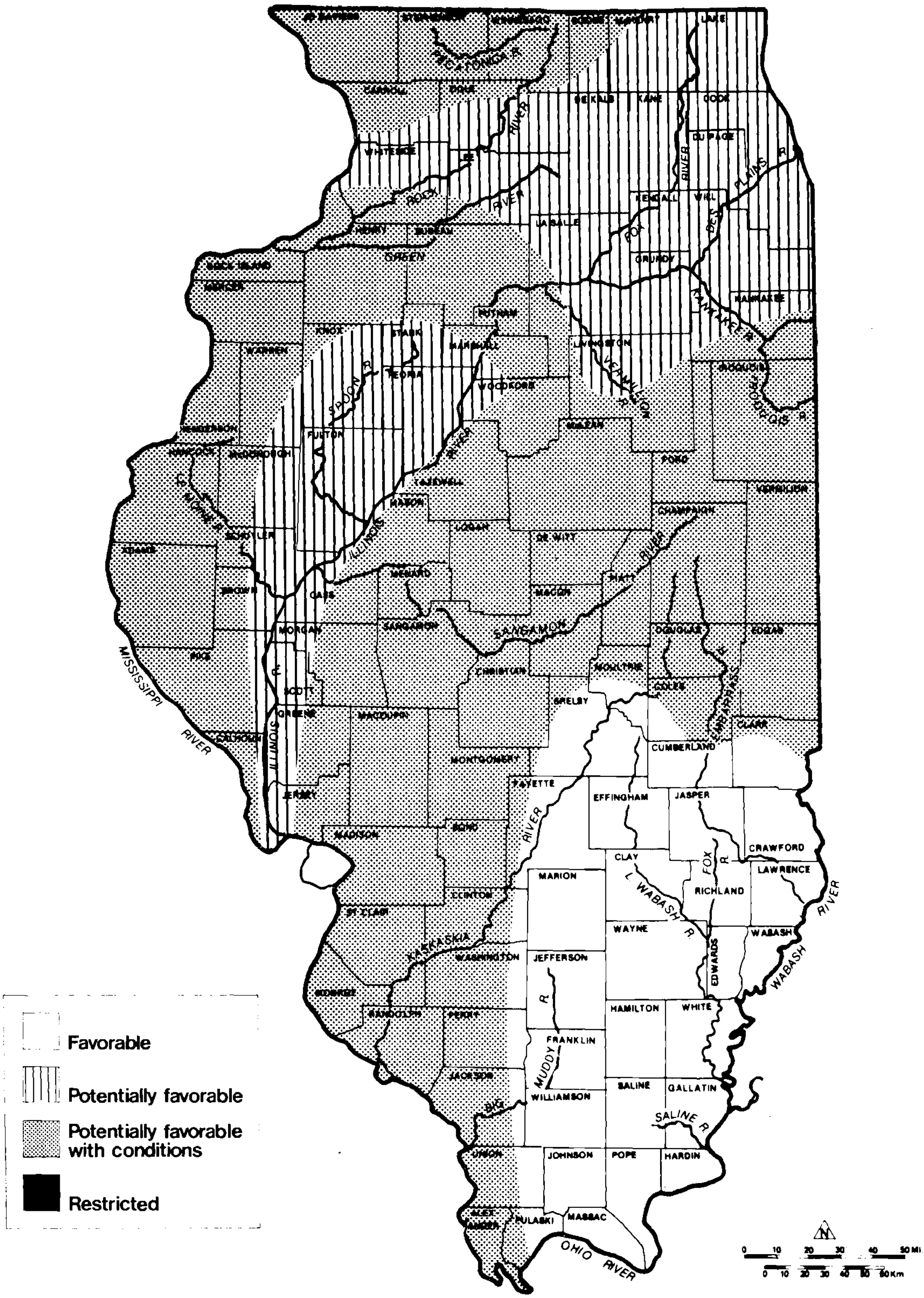

Figure 4-6

COMPOSITE MAP OF GEOLOGIC FAVORABILITY FOR CAES IN ILLINOIS

SOURCE: ESE, 1981.

CAES
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surface than in the suspected favorable areas.

b. The level of accuracy for determining the favorable rock units was such that definitive boundaries were difficult to assign, especially in the north.

c. While not as high as in the favorably rated areas, there is a strong potential for finding a geologically acceptable CAES plant site in this area.

3. Potentially Favorable with Conditions--That region south and east of the Hunton Limestone Megagroup in southeast Illinois was rated potentially favorable with conditions. The primary reason for this classification was the predominance of the Mississippian and particularly the Pennsylvanian Systems in this region of the state. These encompass much of the Illinois Basin, which is also characterized by extensive coal and gas deposits. The Pennsylvanian System is composed of sandstones (approximately 60 percent), siltstone, and shale. Where the Pennsylvanian reaches a maximum thickness in excess of 2,500 feet, it is characterized by many vertical, often abrupt, changes in lithology that produce more than 500 distinguishable units. Because of this geologic complexity and potential for conflict between CAES operation and energy extraction activities, the southeastern region of Illinois was rated as being potentially favorable with conditions. Therefore, the chance of finding a suitable CAES site, geologically speaking, was moderate. This did not mean, however, that such sites did not exist, but rather the chance of finding a suitable site was much lower than in areas rated favorable or potentially favorable.

4. Restricted--Because of the lack of detailed geologic information assuring that a CAES plant site was not possible in a region, no part of Illinois was rated as being restricted.

After the previously-mentioned ratings were assigned to various regions of Illinois (as shown in Figure 4-61, it was decided that the Illinois Basin, or that region rated potentially favorable with conditions, should be eliminated from further consideration in the siting process for the following reasons:

1. Large areas of the state were rated favorable or potentially favorable geologically for CAES, thus allowing a high potential of finding a geologically adequate CAES plant site.
2. The chance of finding a suitable CAES plant site in the Illinois Basin was significantly less than the favorable or potentially favorable areas. The high cost of test drilling prior to final site confirmation could be prohibitive if multiple boring programs were required.

Therefore, the result of the Stage I Geotechnical Screening was to eliminate the Illinois Basin from further consideration for CAES siting. This left much of western and northern Illinois, which was rated favorable or potentially favorable, available for further analysis.

5.0 STAGE 11--REGIONAL ENVIRONMENTAL SCREENING

5.1 OBJECTIVE

The objectives of the Stage 11--Regional Environmental Screening analysis were to screen the land area of the study region for its specific relative environmental suitability for siting a 220-MW CAES plant and to identify within the study region approximately 20 to 25 potential siting areas with the most suitable environmental conditions.

5.2 APPROACH AND METHODOLOGY

Regional Environmental Screening was performed at the macrogeographic scale by using the overlay mapping technique. The entire study region resulting from the geotechnical screening was examined from a multidisciplinary viewpoint and was systematically categorized into areas of relative suitability for siting a CAES power plant. The region was screened for each of the following major environmental categories:

1. Air Quality,
2. Water Availability,
3. Geotechnical Suitability,
4. Ecological Quality, and
5. Socioeconomic/Land Use Compatibility.

For each of these categories, the relative suitability of the study region was rated according to a 4-level favorability rating system. This system indicated the relative degree of restriction or favorability of areas for CAES plant siting. The ratings were based on the degree of modification (including special engineering/design or regulatory approval considerations) required in siting, constructing, and operating a CAES plant because of the existing environmental conditions.

The four levels of favorability ratings were defined as follows:

1. Favorable--Areas of the study region which met all category criteria, with minimum modification necessary. A CAES facility can comply with all regulations and conditions that affect siting with a minimum of outside influences requiring modification of siting or additional studies.
2. Potentially Favorable--Areas which met all category criteria, but would require moderate modifications. The CAES facility can comply with all regulations and conditions affecting siting with some minor outside influences requiring modification or additional study.

3. Potentially Favorable with Conditions--Areas of the region which met all category criteria but would require substantial CAES siting modifications because of economic, environmental, regulatory, institutional, or technological constraints. The CAES plant could not locate in this area unless considerable effort were expended to comply with regulations or conditions affecting siting. This rating still allows changes in technology and variances from state and local regulations.
4. Restricted--At least one siting criterion of the five environmental categories restricts use of areas. Furthermore, no changes in this restriction are anticipated. A CAES facility could not locate in this area. No changes beyond those specified for the previous rating could be made.

A CAES favorability specification rating table was developed for each of the five environmental categories examined. These tables and the rationale for criteria used to develop these tables are discussed in Sections 5.3 through 5.7. Based on these favorability specifications and relevant technical data, environmental resource maps delineating areas according to their favorability for CAES plant siting were prepared for each of the environmental categories. In Stage II, all mapping was done at the scale of 1:500,000 using a USGS base map. These large-scale base resource maps were integrated to form a composite screening map of favorability for each environmental category.

The next step in the regional environmental screening process was the integration of the five environmental category composite maps to form a single overall composite map. For this overall composite map, each area in the study regions was assigned the most restrictive favorability rating from the five individual environmental category maps. Through this process, areas which are most favorable for siting in relation to all environmental categories were identified. Areas identified as "Restricted" on the overall composite map were excluded from further consideration in the site selection study.

After the overall composite map was prepared, the next task in the site selection process was the identification of potential siting areas for Stage III analysis. Since the regional environmental screening identified large land areas of varying sizes and configurations, it was necessary to divide these large land areas into more discrete and smaller land units for the more detailed analysis in Stage III. These small discrete land units, or candidate siting areas, were approximately 20 to 25 square miles in size.

5.3 AIR QUALITY

5.3.1 RELATIONSHIP OF AIR QUALITY CONSIDERATIONS TO POWER PLANT SITING

The atmospheric emissions from an oil-fired gas turbine power plant of 220-MW capacity can affect a significant impact on the air resources in the general area of the plant. The extent of this impact is largely dependent on the size (capacity) of the plant, on the design of the combustion components (fuel consumption), and on the mode of operation (number of hours of operation per day; load factor, etc.). Other factors that affect emissions, and consequently impact on air quality, include fuel sulfur content, meteorology, and basic plant design factors such as stack height, exit velocity, exit temperature, emission control systems, and arrangement and proximity of major plant structures relative to the stack. The consequence of the impacts resulting from such a facility is further dependent on site-specific factors such as proximity to major sources of air pollutant emissions, existing ambient air quality, and status of Prevention of Significant Deterioration (PSD) increment consumption in the area of influence.

Since air quality impacts potentially affect vegetation, soils, animal and human health, visibility, and other values, regulations have been implemented which protect the general public against known harmful effects with an adequate margin of safety. Therefore, the focal point of the air quality considerations in a siting study is the applicable local, state, and federal air quality regulations. Factors which can affect compliance with these regulations must be identified and related to favorability ratings based upon currently available information. A synopsis of applicable air quality regulations for siting a power plant in the State of Illinois is presented in the following sections.

5.3.2 <u>FEDERAL REGULATIONS</u>

5.3.2.1 AMBIENT AIR QUALITY STANDARDS

The U.S. Environmental Protection Agency (EPA) has enacted Ambient Air Quality Standards (AAQS) applicable to all areas of the country (Table 5-1). Primary standards were promulgated in order to protect human health, with an adequate margin of safety.

Secondary standards were promulgated to protect against adverse welfare effects, i.e., effects on vegetation, animals, soils, visibility, etc.

Areas of the country shown to be in violation of these standards are designated as nonattainment areas, and new sources located there or nearby may be subject to stringent air permitting requirements. An oil-fired gas turbine power plant will have measurable impacts on sulfur dioxide and nitrogen dioxide air quality levels, but will have minor impacts on air quality levels of the other criteria pollutants.

5.3.2.2 PREVENTION OF SIGNIFICANT DETERIORATION (PSD)

The U.S. Congress passed amendments to the Clean Air Act in 1977 which included provisions for prevention of significant deterioration (PSD) of air quality. The President signed the amendments into law on August 7, 1977 (Public Law 95-95). On June 19, 1978, U.S. EPA promulgated revised PSD regulations (<u>Federal Register</u>, Vol. 43, No. 118) in order to implement the Clean Air Act Amendments of 1977. On August 7, 1980, as a result of a decision of the U.S. Court of Appeals for the D.C. Circuit in Alabama Power Company vs. Costle, EPA further amended the PSD regulations as per 40 CFR 51.24, 52.21. On this same date, changes affecting new source review in nonattainment areas and requirements under EPA's Emissions Offset Interpretive Ruling (40 CFR Part 51, Appendix S) also became effective. The major air quality limiting feature of the PSD regulations is the maximum allowable increase in levels of sulfur dioxide and suspended particulate matter. The maximum allowable increase is dependent on area classification (Table 5-2). Most areas of the country are Class II, while certain national parks and national wilderness areas are designated as Class I.

Table 5-1. National Ambient Air Quality Standards (ug/m^3)

Pollutant	Averaging Time	Primary Standard	Secondary Standard
Suspended Particulate Matter	Annual Geometric Mean	75	60
	24-Hour Maximum	260*	150*
Sulfur Dioxide	Annual Arithmetic Mean	80	N/A†
	24-Hour Maximum	365*	N/A†
	3-Hour Maximum	N/A†	1,300*
Carbon Monoxide	8-Hour Maximum	10,000*	10,000*
	1-Hour Maximum	40,000*	40,000*
Hydrocarbons	3-Hour Maximum (6 to 9 A.M.)	160*	160*
Nitrogen Dioxide	Annual Arithmetic Mean	100	100
Ozone	1-Hour Maximum	235*	235*

* Maximum concentration not to be exceeded more than once per year.
† N/A = No standard exists.

Source: Code of Federal Regulations, Title 40, Part 50.

Table 5-2. Federal Prevention of Significant Deterioration Increments ($\mu g/m^3$)

Pollutant/Averaging Time	Class I	Class II	Class III
Particulate Matter			
Annual Geometric Mean	5	19	37
24-hour Maximum*	10	37	75
Sulfur Dioxide			
Annual Arithmetic Mean	2	20	40
24-hour Maximum*	5	91	182
3-hour Maximum*	25	512	700

*Increment can be exceeded once per year for each class.

Sources: Public Law 95-95, Clean Air Amendments of 1977.
Federal Register, Vol. 43, No. 118, June 19, 1978.

The PSD allowable increments are significant in that a new power plant cannot exceed the increments, either singly or in combination with other major new or modified sources in the area.

5.3.2.3 EMISSION LIMITING STANDARDS

New fossil-fueled power plants greater than 250 x 10^6 Btu/hr heat input must meet Federal New Source Performance Standards (NSPS) for particulate matter, sulfur dioxide, and nitrogen oxides (Table 5-3). In addition to NSPS, such new power plants must undergo a Best Available Control Technology (BACT) review as part of the PSD analysis and new source review. The BACT review establishes an emission control system/emission limit based upon environmental, energy, social, and economic impacts. NSPS are used as a starting point (maximum emission limit) for BACT determinations. The BACT review could result in more stringent emission standards. Meeting emission standards, however, is no guarantee that AAQS or PSD increments will be met, as many factors must be considered.

5.3.2.4 NONATTAINMENT AREAS

Nonattainment areas were designated by the U.S. EPA on March 3, 1978 (Federal Register, Vol. 43, No. 43), and in subsequent revisions. These promulations identified all areas of the country which were shown to be in violation of one or more of the applicable AAQS, either by measured ambient air quality or through atmospheric dispersion modeling.

The EPA also promulgated an Emissions Offset Interpretive Ruling (Federal Register, Vol. 44, No. 11, January 16, 1979), which established stringent requirements for major new sources and major modifications locating in or near these nonattainment areas. These requirements impose stringent emissions conditions and emissions offsets to be met if certain significance-of-impact levels (Table 5-4) are exceeded within the nonattainment area by the proposed new source or modification.

Table 5-3. Federal New Source Performance Standards for Stationary Gas Turbines (>100 million Btu per hour)

Pollutant	Existing Standards
Sulfur Dioxide	(a) $\leq$0.015 percent by volume at 15 percent oxygen, on a dry basis (b) Fuel sulfur content $\leq$0.8 percent by weight
Nitrogen Oxides	$0.0075 \frac{(14.4)}{Y^{(1)}} + F^{(2)}$

(1) Y = manufacturer's rated heat rate at manufacturer's rated load (kilojoules per watt hour); Y shall not exceed 14.4 kilojoules per watt hour.

(2) F = NO_x emission allowance for fuel-bound nitrogen.

Sources: Code of Federal Regulations, Title 40, Part 60, Subpart D.
Federal Register, Vol. 44, No. 113, June 11, 1979.

Table 5-4. Significance of Impact Levels for Nonattainment Areas as Established by the U.S. Environmental Protection Agency

Pollutant	Significance Level (ug/m^3)				
	Annual	24-hour	8-hour	3-hour	1-hour
Sulfur Dioxide	1	5	--	25	--
Suspended Particulate Matter	1	5	--	--	--
Nitrogen Oxides	1	--	--	--	--
Carbon Monoxide	--	--	500	--	2,000

Source: Federal Register, Vol. 44, No. 11, January 16, 1979.

As amended August 7, 1980, offset provisions include obtaining more than one-for-one emission offsets from existing sources in the area, demonstrating a net air quality benefit for the area, and meeting an emission rate equivalent to the Lowest Achievable Emission Rate (LAER). For a new power plant to meet all such restrictions may not be possible or may not be economically feasible. As in the case of AAQS, the sulfur dioxide and nitrogen oxides significance levels are of major concern in relation to siting a new oil-fired gas turbine power plant.

5.3.2.5 STACK HEIGHT REGULATIONS

The U.S. EPA has proposed regulations which limit the "creditable" stack height, i.e., the height for which credit can be granted in dispersion modeling for purposes of determining compliance with air quality regulations (Federal Register, Vol. 44, No. 9, January 12, 1979). Creditable stack height is defined on the basis of "good engineering practice," which means the stack height required to avoid aerodynamic downwash effects. These regulations, if promulgated, would place an upper limit on creditable stack heights for all new power plants, and thus would restrict increasing stack height as a dispersion technique to reduce ground-level air quality impacts.

5.3.2.6 STACK HEIGHT RESTRICTIONS

The Federal Aviation Administration (FAA) has designated certain areas in the vicinity of airports as restricted flight areas. Thus construction of large structures, such as power plant stacks, would be limited in these areas.

5.3.3 STATE OF ILLINOIS REGULATIONS

5.3.3.1 AMBIENT AIR QUALITY STANDARDS

State of Illinois AAQS are identical to U.S. EPA AAQS.

5.3.3.2 PREVENTION OF SIGNIFICANT DETERIORATION

State of Illinois PSD regulations are essentially identical to those for U.S. EPA.

5.3.3.3 EMISSION LIMITING STANDARDS

State of Illinois emission limiting standards applicable to new gas turbine power plants are identical to current federal NSPS for this source category.

5.3.3.4 NONATTAINMENT AREAS

The State of Illinois adopted nonattainment regulations on April 24, 1979, and revised these regulations on January 16, 1980. These regulations follow current federal regulations for nonattainment areas.

5.3.4 LOCAL REGULATIONS

There are currently no restrictive local air quality regulations in Illinois which affect the siting of a new gas turbine power plant. The following local agencies in Illinois assist Illinois EPA in carrying out various functions and programs of the state:

- Bedford Park Environmental Quality Control Board
- Bensenville Pollution Control Department
- Chicago Department of Environmental Control
- Cook County Department of Environmental Control
- Crystal Lake Pollution Control Department
- East St. Louis Air Pollution Control
- Evanston Department of Inspection and Permits
- Granite City Air Pollution Control Board
- McCook Environmental Board
- North Riverside Pollution Control Department
- Will County Health Department

These agencies, however, have not promulgated air quality regulations which are more restrictive than EPA regulations.

5.3.5 DEFINITION OF SITING CRITERIA AND RATINGS

The air quality siting criteria developed for the Stage II analysis reflect the factors considered important in siting a gas turbine power plant. These criteria provide a first-step analysis in rating each area of the state according to its relative favorability for power plant siting, while not requiring specific construction and design details for the gas turbine plant. Definitions of each siting criterion used in Stage II of the siting study follow.

1. Existing Ambient Air Quality--The status of present air quality levels in relation to the AAQS, determined through either available ambient air monitoring data or dispersion modeling studies. For the Stage II analysis, only sulfur dioxide and nitrogen dioxide were considered to be of major concern for siting a gas turbine facility. Dispersion modeling analyses have shown that suspended particulate matter air quality impacts are not significant for gas turbine facilities of the size considered in this study. Criterion descriptors for ambient air quality are given in Table 5-5.

   Density of Air Pollution Sources--The number and size of air pollution sources in an area. This criterion is an indicator of air pollution levels, both in magnitude and geographical extent. Only sulfur dioxide, particulate matter, and nitrogen oxide sources were considered in the Stage II analysis, since these are the major pollutants affecting power plant siting. "Source" is defined as an industrial facility comprising one or more individual air pollution sources, i.e., an entire plant.

   Because of the large size of the study area (most of Illinois) which contains hundreds of sources, it is not practical to identify all permitted air pollution sources in the Stage II analysis. As a result, only "major" sources (emissions of any one pollutant greater than 1OO tons per day) were identified as affecting CAES plant siting. A "large" major source was defined as a source with emissions of any one pollutant exceeding 1OO tons per day. Based

Table 5-5. Favorability Categories and Category Descriptors for the Existing Ambient Air Quality Siting Criterion

Pollutant/ Averaging Time	Category Descriptor (Concentration Range in ug/m^3) Low	Moderate	High	Above Standards
Sulfur Dioxide				
Annual Average	0-30	30-60	60-80	>80
24-Hour Maximum*	0-150	150-300	300-365	>365
3-Hour Maximum*	0-500	500-1,000	1,000-1,300	>1,300
Nitrogen Dioxide				
Annual Average	0-50	50-80	80-100	>100
Favorability Category	Favorable	Potentially Favorable	Potentially Favorable with Conditions	Restricted

* Based upon second-highest concentration, consistent with the AAQS.

Source: ESE, 1981.

on this terminology, the following criterion definitions were developed:

a. Pristine--No major sources located within 20 kilometers (km).
b. Low-Area extending from 5 to 10 km surrounding a major source, or area extending from 10 to 20 km surrounding a large major source.
c. Moderate--Area extending out to 5 km surrounding a major source, or area extending from 5 to 10 km surrounding a large major source.
d. High--Area extending out to 5 km surrounding a large major source.

The radial distances included in the criterion definitions were based on past impact analysis experience which shows that maximum air pollution impacts due to industrial facilities occur within 5 km of the source, with concentrations rapidly decreasing out to about 20 km. Beyond this distance, relatively low concentrations exist (compared to maximum impact concentrations), but concentrations decrease relatively slowly with increasing distance from the source.

3. Class II PSD Increments--The status or degree of PSD increment consumption for a particular area. Class II increments, which have been promulgated for sulfur dioxide and suspended particulate matter only, are presented in Table 5-2. Any major new or modified sources or increases in allowable emissions from existing sources occurring since January 6, 1975, consume PSD increments. Increment consumption is determined on the basis of atmospheric dispersion modeling results. The following criterion descriptors were used to indicate increment consumption for the Stage II analysis:

   a. All available--No Class II increments have been consumed in the area.
   b. Majority available--Less than 10 percent of Class II increments has been consumed in the area.

c. Majority not available--Between 50 and 90 percent of Class II increments has been consumed in the area.

d. All not available--90 percent or more of the Class II increment has been consumed in the area.

The category limits for this criterion were based on the predicted impacts of the 220-MW gas turbine power plant evaluated in the site selection study. These impacts were in the range of 4 percent to 6 percent of the PSD increments and occurred within 2.5 km of the plant location. The average impact was about 2 percent of the allowable PSD increments. With this result and the knowledge that these maximum impacts occur in a specific direction from the plant, with lower impacts in other directions, the "majority available" category was defined as those areas in which less than 10 percent of the PSD increments have been consumed. Therefore, the 220-MW gas turbine power plant could be located in these areas with, at most, only minor modifications, i.e., slight changes in plant locations (less than 1 km).

By similar reasoning, in an area where a large portion of the PSD increments are already consumed, it would be difficult to site a new power plant. In order to be conservative, a level of 90-percent increment consumption was chosen for the "all not available" or "restricted" category. The Stage II analysis was not sufficiently rigorous to provide detailed values of increment consumption for every increment-consuming source in the study area. The "majority not available" category logically falls between the 50-and 90-percent levels of increment consumption, corresponding to the "Potentially Favorable with Conditions" rating.

To determine the extent of area designations, an approach similar to that used for the Density of Air Pollution Sources criterion was utilized. An area of 2.5-km radius surrounding an increment-consuming source was designated the same as the poorest rating given the source. An area extending from a 2.5- to 10-km radius about the source was given the next highest rating, and the area 10- to 20-km outward was designated with the next highest rating. These radii were based upon the observation that maximum impacts of the 220-MW gas turbine power plant occur within 2.5 km of the plant.

4. Restrictive Air Quality Regulations or Stack Height Limitations--Local air quality regulations more restrictive than state and federal regulations which would affect the siting of a gas turbine power plant, or regulations restricting the stack height such a facility could employ.

The Federal Aviation Administration (FAA) has established guidelines governing minimum approach distances as a function of approach height for all airports having instrument approach capabilities (i.e., a control tower). The guidelines require a rate of approach of 50 feet horizontally to each 1 foot of vertical ascent or descent for the first 2 miles from the airport, and a rate of 40 to 1 from 2 miles out to 5 miles. Based on these criteria, the proposed 220-MW gas turbine power plant with a stack height of 95 feet would need to be located about 1.5 km from the airport, if it were located in a direct line with the runway. Since this distance is short, and the probability that the plant would be located in a direct line with an airport runway at this distance is very low, any further consideration of this criterion was determined to be unnecessary.

Furthermore, since no restrictive local regulations or limitations were identified that would apply to the siting of a gas turbine power plant, no other investigation of this criterion was deemed necessary. This determination thereby resulted in assigning a "favorable" designation for most of Illinois.

5. Impact on Nonattainment Areas--The sulfur dioxide and suspended particulate matter air quality impact the proposed gas turbine CAES plant will have on designated nonattainment areas. Areas were rated on the following basis:

   a. No Significant Impacts--Impacts based upon promulgated NSPS (Table 5-3) are less than the significance of impact levels set by U.S. EPA (Table 5-4).
   b. Significant Impacts (LOW)--Impacts require that emissions be reduced by up to 50 percent below the promulgated NSPS in order to meet the significance of impact levels.

Since the air pollutant emission rates from the CAES gas turbine plant are relatively low, only these two rating criteria were deemed necessary in order to properly assess site suitability.

In order to implement this air quality criterion, a dispersion modeling analysis of a 220-MW capacity gas turbine CAES power plant was conducted. As it was anticipated that little or no significant impact would be observed in the dispersion modeling analysis, only 1 year of meteorological data representing one meteorological zone (Central Illinois) was selected for the dispersion modeling effort. The modeling analysis confirmed the expected results, showing that the maximum predicted values for sulfur dioxide concentrations were just slightly above significance levels (25.5 ug/m^3 for a 3-hour averaging period, and 6.8 ug/m^3 for 24 hours), and the highest-second highest values were at or below the significance levels (21 ug/m^3 for 3 hours, and 5.7 ug/m^3 for 24 hours).

Based upon previous power plant studies and on the results obtained in this study, particulate matter impacts were judged not to exceed significance levels at any location. Also, NSPS for stationary gas turbines do not specify any particulate emissions limitations. Therefore, total suspended particulate matter nonattainment areas were not a limiting criterion for gas turbine power plant siting in the study region.

Since the sulfur dioxide modeling results showed ambient impact levels at or near the significance levels, sulfur dioxide nonattainment areas were considered in the siting analysis employing the two criterion descriptors given.

The following stack parameters and emissions for a 220-MW capacity CAES gas turbine power plant were used in the modeling evaluation:

Sulfur Dioxide Emission Rate (lb/hr)	616
Particulate Matter Emission Rate (lb/hr)	30
Stack Height (ft)	95
Stack Diameter (ft)	20
Gas Flow Rate (ACFM)	831,000
Exit Gas Velocity (FPS)	44
Exit Gas Temperature (°F)	350

6. Impact on Class I Areas--The sulfur dioxide and suspended particulate matter impacts the proposed CAES gas turbine power plant will have on nearby Class I PSD areas. Since the dispersion modeling results showed that the maximum level of impact as a result of emissions from the CAES gas turbine plant would be at or below the significance levels at a distance of less than 2.5 km, and since the nearest Class I area is located in Missouri approximately 65 km from the nearest Illinois state border, analysis of impacts on Class I areas were deemed unnecessary for purposes of this siting study.

5.3.6 RATIONALE FOR CRITERIA AND FAVORABILITY SPECIFICATION RATINGS

In the previous section, six criteria were identified as important in selecting potential sites for a CAES gas turbine power plant:

1. Existing ambient air quality;
2. Density of air pollution sources;
3. Class II PSD increments;
4. Restrictive air quality regulations or stack height limitations;
5. Impact on nonattainment areas; and
6. Impact on Class I PSD areas.

The rationale for selecting these factors as important criteria in the site selection process is discussed in this section.

Existing ambient air quality levels affect power plant siting since such levels can effectively limit the maximum air quality impact a new power plant may have in an area. Air quality levels cannot exceed the AAQS in any area; therefore, if pollutant levels are already near the AAQS, a new power plant could cause standards to be exceeded. As a result, the higher the existing air quality levels are in an area, the less favorable the area is for siting a power plant. Areas of Illinois currently near or above the AAQS would not be suitable for siting a gas turbine power plant.

The density of air pollution sources in an area is, indirectly, an indicator of existing air quality levels. Actual air quality impacts are a complex function of emissions, stack parameters, locations of sources, and meteorology. Because data regarding existing ambient air quality levels (i.e., ambient monitoring data) are not always available in the vicinity of pollution sources, the occurrence and magnitude of such sources can be used as a general indicator of air quality levels. A high density of air pollution sources or a large single air pollution source would indicate low air quality levels and a corresponding small capacity for industrial growth, and such areas would be less favorable for power plant siting.

The Class II PSD increment consumption in an area can be related to CAES plant siting in much the same way as AAQS. PSD regulations limit increases in air quality concentrations of sulfur dioxide and particulate matter above a certain specified baseline concentration level. Therefore, if Class II PSD increment consumption has occurred in an area due to major new or modified sources, future air quality impacts in the area could be limited to well below the allowable PSD increment values. The greater the PSD increment consumption in an area, the less favorable the area is for plant siting. Identification of areas in Illinois where large increment consumption has occurred can effectively eliminate these areas from further consideration, since a power plant of any appreciable size could not be sited at such locations.

Restrictive local (i.e., county or city) air quality regulations or stack height restrictions should be considered in the Stage II screening since such regulations could prohibit the siting of a CAES plant in an entire county or city area. Local air pollution agencies may have more stringent emission or air quality standards than the state and federal agencies, or may have other restrictions such as a restriction on fuel usage. Stack height restrictions exist in the immediate vicinity of airports with control towers, as required by FAA guidelines. Although stack height restrictions could adversely affect the impact of a CAES plant upon ground-level air quality concentrations, as discussed in Section 5.3.5, the low stack height required by the CAES facility to achieve acceptable dispersion and therefore minimize impact on air quality will not result in any significant restrictions. This restriction may therefore be removed from any further considerations.

The locations of designated nonattainment areas exceeding federal AAQS areas in relation to potential plant sites can also limit air quality impacts from such facilities.

If U.S. EPA's significance-of-impact levels (Table 5-4) for nonattainment areas are exceeded by a new source, the source could be subject to stringent permitting requirements. U.S. EPA policy requirements could restrict a CAES plant from locating near these areas or make siting unfavorable due to stringent siting requirements. Nonattainment areas should be identified in the Stage II analysis and criteria established to define favorability areas around each nonattainment area based upon expected plant impacts.

The locations of and air quality impacts upon designated Class I PSD areas affect plant siting in a similar manner as nonattainment areas. Class I increments are similar to EPA significance-of-impact levels for nonattainment areas, and are low in comparison to Class II increments and AAQS. New power plants would be restricted from locating near these Class I areas in order to prevent exceedances of allowable increments. Based upon expected plant impacts, restricted areas surrounding Class I areas can be defined in the Stage II analysis and eliminated from further analysis.

In summary, the primary objective of the Stage II air analysis was to identify those areas in Illinois in which the siting of a 220-MW capacity CAES gas turbine power plant would be prohibited. However, Stage II analysis should not eliminate any areas from further consideration by classifying them as "restricted," if the proposed CAES plant could be located in these areas, even though extremely stringent conditions might apply.

Table 5-6 summarizes the favorability specification ratings for the air quality siting category. The specifications are listed in terms of the siting criteria and criterion descriptors previously discussed.

The "Favorable" category reflects the most favorable conditions for siting: minimum air quality impacts with excellent existing air quality conditions, such that all air quality regulations can be met without reducing emissions or changing plant design criteria. Each less favorable category reflects progressively worse existing air quality conditions or air quality impacts, such that more restrictive emissions limits and/or changes in plant design criteria are necessary to comply with all regulations. The "Restricted" category includes conditions where extreme emission reductions, below those likely to be feasible, and plant design changes would be required to meet all existing and anticipated future air quality regulations.

Table 5-6. Favorability Rating Specifications—Air Quality
(Compressed Air Energy Storage Facility)

Siting Criterion	Ratings: Favorable	Potentially Favorable	Potentially Favorable with Conditions	Restricted
1. Existing Ambient Air Quality	Low	Moderate	High	Above Standards
2. Density of Air Pollution Sources	Pristine	Low	Moderate	High
3. Class II PSD Increments	All Available	Majority Available	Majority not Available	All not Available
4. Restrictive Air Quality Regulations or Stack Height Limitations	No Restrictive Regulations/ Limitations	No Restrictive Regulations/ Limitations	Moderately Restrictive Regulations/ Limitations	Highly Restrictive Regulations/ Limitations
5. Impact on Nonattainment Areas	No Significant Impacts	Impacts Low	Impacts Moderate	Impacts High
6. Impact on Class I PSD Areas	No Significant Impacts	Small Emissions Reductions Required		

Source: ESE, 1981.

5.3.7 AIR QUALITY SCREENING RESULTS

The air quality Stage II screening results for each of the individual air quality criteria and the composite air quality favorability ratings are presented in this section.

For the air quality criterion, areas in Illinois were rated according to existing ambient levels of sulfur dioxide and nitrogen dioxide. Ambient monitoring data for these pollutants were obtained from Illinois EPA's 1980 Annual Air Quality Report. This annual report, which presents a summary of all ambient data entered into the state data banks in 1980, includes both state and industrial monitoring data. Although all four of the ambient air quality pollutant concentration descriptors (low, moderate, high, and exceeding AAQS) were observed throughout the state, because dispersion modeling results showed sulfur dioxide air quality impacts to be only slightly above PSD significance levels, the categories for this siting criterion were reduced to favorable (combining the low, high, and moderate air quality descriptors) and restricted (exceeding AAQS). Also, as modeling analyses of the particulate emissions showed the impacts to be well below the significance levels, ambient suspended particulate matter concentrations were not considered to be of concern in siting the CAES gas turbine power plant.

Many major sources emitting greater than 100 tons per day are located both in Illinois and along the boundaries of adjacent states. The majority of these sources are power plants, located along the Mississippi and Illinois Rivers. Several large major sources, emitting greater than 500 tons per day of any one pollutant, are also located in Illinois and along the state lines in adjoining states. These sources were identified by reviewing emission inventory files for Illinois and for surrounding states, by discussions with appropriate state agencies, by compiling a list of all power plants located in Illinois and adjacent areas, and by reviewing Illinois EPA modeling and nonattainment area studies.

Major PSD increment-consuming sources located in Illinois were identified by reviewing Illinois EPA permit files, source emission inventories, PSD permit logs, and by discussions with agency personnel. One "restricted" area for increment consumption was identified in Illinois, located in Bureau County on the Illinois river. Other areas of lower increment consumption and correspondingly more favorable ratings are located in Lake, Cook, Dewitt, Perry, Vermilion, and Randolph Counties.

Sulfur dioxide nonattainment areas in Illinois are located in Peoria and Tazwell Counties. In addition, sulfur dioxide nonattainment areas exist near or adjacent to Illinois in St. Louis, Missouri; extreme northern Indiana; Vigo County, Indiana; Dubuque, Iowa; and several areas of Kentucky. Nitrogen dioxide nonattainment areas are located in Cook County (central core area of Chicago) and in Will County, Illinois.

The nonattainment areas identified in bordering states are those that will affect power plant siting in Illinois. Favorability ratings were determined on the basis of the predicted impacts of the 220-MW capacity CAES gas turbine power plant. These impacts were determined by utilizing appropriate atmospheric dispersion modeling.

The favorability ratings reflect relatively small restricted areas, on the order of 5 km, surrounding the nonattainment areas. "Favorable" areas encompass about 90 percent of the state.

Currently, there exist no designated Class I PSD areas in Illinois or in bordering states that would influence power plant siting in the state. The nearest such area is Mingo National Wildlife Refuge, located in northwestern Stoddard County, Missouri. Therefore, all areas of Illinois were rated as "Favorable" for this air quality criterion.

The composite siting map for the air quality criteria was developed by overlaying individual criterion maps. This overlay method results in a composite air quality map depicting the favorability areas in Illinois for locating a 220-MW capacity CAES gas turbine power plant (Figure 5-1).

As shown in Figure 5-1, large "Favorable" siting areas exist throughout most of Illinois. A portion of the study area is rated as "Potentially Favorable," due primarily to the identified sulfur dioxide nonattainment areas located within and near the study area. Other "Potentially Favorable" areas occur in the vicinity of major sources and increment-consuming sources.

"Restricted" siting areas are generally limited to small (on the order of 15 km) areas in the immediate vicinity of sulfur dioxide nonattainment areas and also occur in the immediate vicinity of major large sources, and major increment-consuming sources.

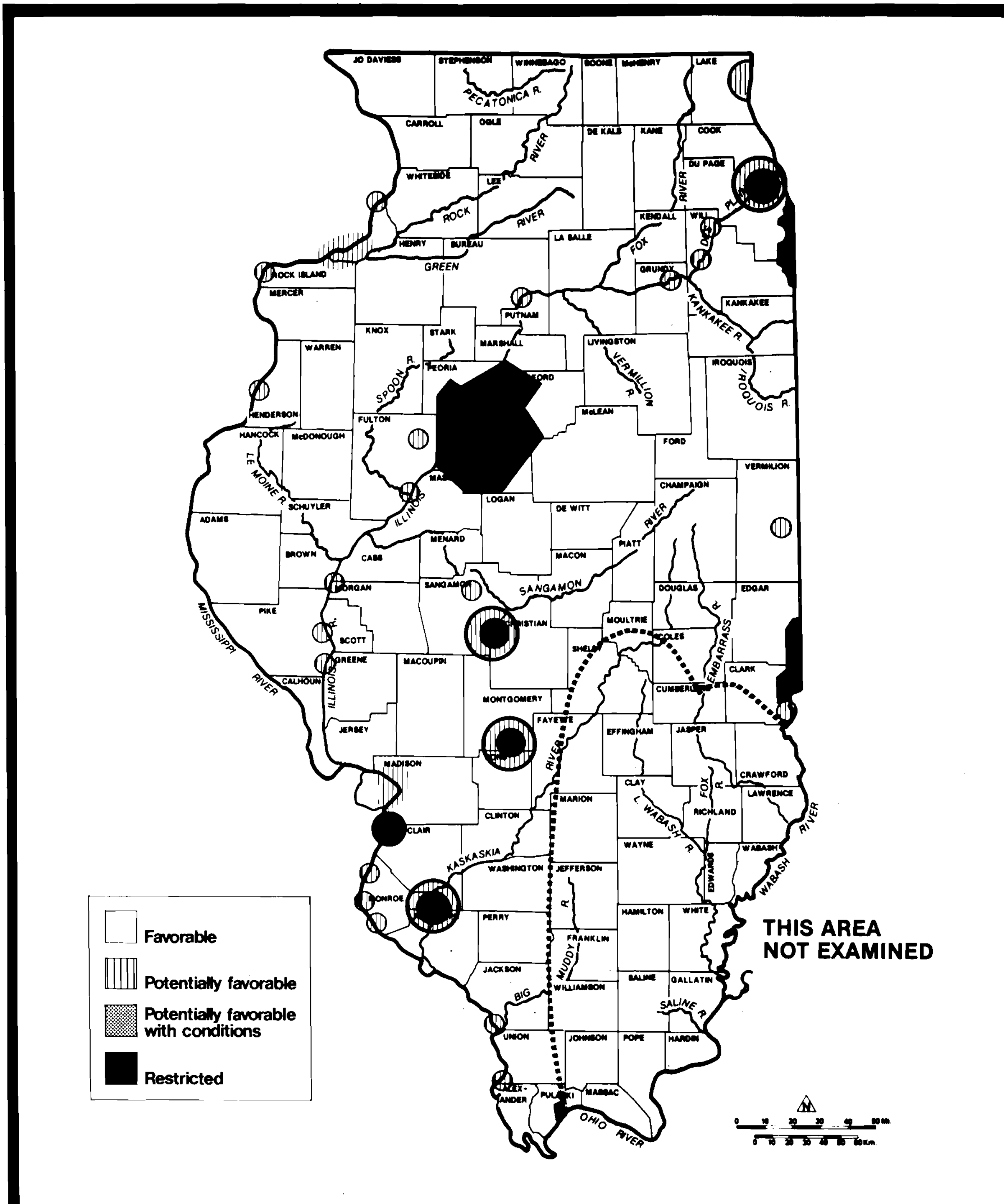

Figure 5-1

COMPOSITE CAES REGIONAL SCREENING MAP: AIR RESOURCES

SOURCE: ESE, 1981.

CAES

SITE SELECTION STUDY

5.4 WATER RESOURCES

5.4.1 RELATIONSHIP OF WATER RESOURCES SITING CATEGORY TO COMPRESSED AIR ENERGY STORAGE FACILITY SITING

Water resources are important in CAES facility siting for the following reasons:

1. Water is needed for potable water, to dissipate heat, to compensate for evaporation losses, and to provide hydrostatic compensation for compressed air.
2. Access to the plant site by water may provide an alternate means of transporting fuels and other supplies to the facility.
3. Flooding conditions in the area must be analyzed to ensure that plant facilities are not adversely affected and that plant facilities do not impact floodplain areas.
4. Local hydrological conditions must be examined to determine their impact on the overall water balance and facility design.

The quantity and quality of the water resources influence the design, construction, and operation of a CAES facility. The design of cycles of concentration in a cooling tower or other system must take into account the dissolved minerals in the water source and the need of the blowdown to meet water quality standards. Specifications for certain equipment and components which come into contact with water must take water quality into account to ensure design life. Demineralized water for intercooler needs must have special water quality characteristics. The treatment equipment must be designed to handle the range of constituents of the water source. Water intake and discharge facilities must be designed to fit unique site conditions relative to surface water or groundwater systems in order that existing water uses, relating to both man and the environment, will not be adversely impacted.

The dynamics of a water resource is also important in the design, construction, and operation of a CAES facility. Flooding and drainage conditions must be anticipated for both design and construction of the facility. Water quality will vary depending on flow conditions and seasons. The nature of these variations will depend upon specific drainage basin characteristics and uses. The hydraulic and mixing charcteristics of a riverine system vary from low-flow to high-flow conditions. These characteristics will influence the waste assimulative and heat dissipation capabilities of the river, and will affect the water intake and discharge system designs. Sediment movement must be analyzed to determine its effect on facilities in or adjacent to the watercourse.

Navigability of major rivers must be analyzed to determine whether or not the use of barges to import fuel and supplies to the site is feasible.

For Stage II CAES analysis, the major water resource siting criterion was water supply. At the Stage 111 and Stage IV levels of analyses, the following water resource criteria were considered:

1. Floodplains,
2. Water quality,
3. Wastewater disposal,
4. Thermal effluent disposal, and
5. River navigation.

Since these criteria are secondary to water supply, and because of the macro-level of screening in Stage II, these criteria are not used in the CAES regional screening analysis.

Availability of water for cooling is the critical potential constraint on siting a CAES facility. Other water needs (potable, plant service, and makeup to the water-compensating reservoir) are negligible in comparison. The only exception might be makeup to the water-compensating reservoir during periods of extreme drought. Because of the cyclic nature of the CAES facility the water to the compensating reservoir could be made up during the generation cycle (approximately 11 hours out of 24) when cooling requirements are not needed. For the above reasons the water use requirements were based solely on cooling water needs during the compression cycle.

The type of cooling system selected for use at the proposed facility is the major determining factor on the water use needs. The type of cooling systems initially considered were:

1. Cooling ponds,
2. Once-through cooling, and
3. Cooling towers.

Cooling ponds require large surface areas in order to dissipate heat to the atmosphere. As a general rule, cooling pond requirements can be assumed to be 1 acre per installed megawatt capacity (Gehm and Bregman, 1976). Land use requirements for the CAES facility, using one of the other cooling systems, are estimated to less than 100 acres. Cooling ponds would increase land use requirements of the CAES facility by at least 200 percent and therefore were eliminated from further consideration. Once-through cooling systems have existing and proposed environmental restrictions concerning thermal and residual chlorine discharges. These restrictions, coupled with large withdrawal requirements, have placed once-through cooling in a "not recommended" status by state and federal agencies, particularly in Illinois. Therefore, cooling tower water needs were the only criteria used for Stage II analysis.

Total water use requirements of a facility may be supplied by any combination of surface water from rivers, streams, lakes, ground water (potable and non-potable), and recycling of treated municipal or industrial wastewaters.

5.4.2 DEFINITION OF SITING CRITERIA AND RATINGS

The analysis of water availability for Stage II review was based solely on the potential use of surface waters (including Lake Michigan) and fresh ground waters as sources of cooling and service water. Non-potable ground water was not considered to be a viable source of water and was not included in the analysis for the following reasons:

1. High cost of production and treatment prior to use,
2. High cost of treatment and disposal of blowdown, and
3. Insufficient information on water availability throughout the study area.

Reuse is considered to be a potentially viable method of supplying at least partial water supply needs to the proposed CAES facility. However, at the Stage II level of analysis, it was determined that it was not feasible to collect the detailed site-specific information needed to adequately address this issue. Furthermore, it was determined that recycled wastewaters would not be the primary source of cooling or service waters at the facility since most existing dischargers (except dischargers around the Chicago area) were not large enough to supply water to meet the needs of the entire facility. In addition, wastewater discharges occur as streamflow and are considered indirectly in the analyses of sites downstream from the discharges. Therefore, at the level of detail of the Stage 11 analysis, the availability of wastewater for recycle was not considered in the analysis.

Surface water availability analysis was conducted from streamflow records published by the U.S. Geological Survey, Water Resources Data for Illinois, Water Year 1979. All stations with a period of record of five or more years were used in the analysis. The surface water data were subdivided into four criteria categories:

1. Minimum daily streamflow for period of record equal to or greater than 2.7 cfs (1,200 gpm);
2. Minimum daily streamflow for period of record less than 2.7 cfs (1,200 gpm), but excess flow equal to or greater than 2.7 cfs (1,200 gpm);
3. Lake Michigan; and
4. All other surface waters in the CAES siting area.

Excess flow was defined as the average annual flow minus the minimum daily flow. This calculation was used with data obtained from the period of record for each station with a minimum daily flow less than 2.7 cfs.

The four criteria categories were developed for the following reasons:

1. Areas with a dependable supply of 2.7 cfs or greater are candidate sites for the cooling tower option. On-site water storage facilities are not needed during essentially all drought periods;
2. Areas with an excess flow equal to or greater than 2.7 cfs but minimum daily streamflow of record less than 2.7 cfs are suitable for a compressed air facility; however, major on-site water storage facilities (i.e., lakes or ponds) are required to assure a dependable water supply. Water sources in this category are less dependable than the previous category;
3. Areas along Lake Michigan are given special attention because of the widespread public/regulatory interest in environmental licensing of a compressed air facility. The water source is dependable and has adequate volume for a compressed air facility; and
4. Areas which did not fall in the three categories above would not have adequate surface water for a CAES facility.

Groundwater availability analysis was based entirely on aquifer yields obtained from the State of Illinois report entitled, "Coal and Water Resources for Coal Conversion in Illinois'' (Smith and Stall, 1975). This analysis included consideration of potable ground waters only. Aquifer yield maps were used to delineate areas where water well systems could be constructed to yield an estimated 14 mgd.

Ground waters were subdivided into the following criterion categories:

1. Fresh groundwater yields equal to or greater than 2.7 cfs (1,200 gpm), and
2. Fresh groundwater yields of 2.7 cfs (1,200 gpm) are not probable.

Total water use is defined as the total amount of water that is withdrawn from the source waters for cooling and service water uses. Consumptive water use is water which is lost to the site as evaporation through the cooling system and nonpoint runoff and wastewater discharges which are lost to the downstream drainage network. In a compressed air facility, most consumptive water losses are due to evaporation from the cooling cycle. For Stage II analysis, service water use was considered negligible when compared to cooling water use.

In evaluating land areas in proximity to water sources, a distance of 10 miles from the water source to the compressed air facility was assumed as a maximum practical distance for transporting water.

5.4.3 RATIONALE OF CRITERIA SELECTION D FA RABILITY SPECIFICA RATINGS

Water availability is a major constraint in selecting the location for a compressed air facility. The siting criteria were selected to provide the information needed to give full consideration to sources of cooling and service waters. The excess flow (Q_E) calculation was designed to indicate those watersheds where construction of water storage would be required to meet the water use requirements of closed-cycle offstream cooling. The minimum daily flow (Q_{min}) provides the basis for estimating the amount of water which could be safely and continuously withdrawn from the source waters without construction of storage facilities.

Fresh ground water was assumed to be adequate to supply all cooling and service water needs in areas where potential aquifer yields exceeded 2.7 cfs (1,200 gpm).

The criteria developed for surface and groundwater availability were combined to form the favorability specification ratings listed in

Table 5-7. The potential cooling systems for areas which may be used within the four favorability ratings are presented in the following listing:

Specification	Potential Cooling Water Sources
Favorable	Closed cycle using only surface water
Potentially Favorable	Closed cycle using ground water
Potentially Favorable with Conditions	Closed cycle using surface water with storage or Lake Michigan
Restricted	None

The favorable specification designates areas where use of ground water would not be required and where closed-cycle systems could be used for cooling.

The potentially favorable specification assumes that ground waters could be used for a closed-cycle system.

For the potentially favorable with conditions specification, surface waters would be used to develop the required water supplies for the closed cycle with storage cooling option; or Lake Michigan could be used for a closed-cycle system.

The restricted specification is applied to areas where there is not sufficient water to cost-effectively support on a long-term basis any wet technology, closed-cycle cooling system.

Table 5-7. Favorability Rating Specifications--Water Availability (Compressed Air Energy Storage Facility)

Favorable	Potentially Favorable	Potentially Favorable With Conditions	Restricted
Surface Water Flow:			
Minimum daily streamflow equal to or greater than 2.7 cfs for the period of record and area within 10 miles of such source of water		Excess flow (defined as average annual flow minus minimum daily flow) equal to or greater than 2.7 cfs, but minimum daily streamflow less than 2.7 cfs, and area within 10 miles of such source of water	Excess flow less than 2.7 cfs
Groundwater Availability:			
	Fresh groundwater yield equal to at least 1,200 gpm (2.7 cfs) and areas within 10 miles of such source of water		Fresh groundwater yield less than 1,200 gpm (2.7 cfs)
Lake Michigan:			
		Areas within 10 miles of Lake Michigan	

Source: ESE, 1981.

Table 5-7. The potential cooling systems for areas which may be used within the four favorability ratings are presented in the following listing:

Specification	Potential Cooling Water Sources
Favorable	Closed cycle using only surface water
Potentially Favorable	Closed cycle using ground water
Potentially Favorable with Conditions	Closed cycle using surface water with storage or Lake Michigan
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The favorable specification designates areas where use of ground water would not be required and where closed-cycle systems could be used for cooling.

The potentially favorable specification assumes that ground waters could be used for a closed-cycle system.

For the potentially favorable with conditions specification, surface waters would be used to develop the required water supplies for the closed cycle with storage cooling option; or Lake Michigan could be used for a closed-cycle system.

The restricted specification is applied to areas where there is not sufficient water to cost-effectively support on a long-term basis any wet technology, closed-cycle cooling system.

Table 5-7. Favorability Rating Specifications--Water Availability (Compressed Air Energy Storage Facility)

Favorable	Potentially Favorable	Potentially Favorable With Conditions	Restricted
Surface Water Flow:			
Minimum daily streamflow equal to or greater than 2.7 cfs for the period of record and area within 10 miles of such source of water		Excess flow (defined as average annual flow minus minimum daily flow) equal to or greater than 2.7 cfs, but minimum daily streamflow less than 2.7 cfs, and area within 10 miles of such source of water	Excess flow less than 2.7 cfs
Groundwater Availability:			
	Fresh groundwater yield equal to at least 1,200 gpm (2.7 cfs) and areas within 10 miles of such source of water		Fresh groundwater yield less than 1,200 gpm (2.7 cfs)
Lake Michigan:			
		Areas within 10 miles of Lake Michigan	

Source: ESE, 1981.

This level of analysis assumes that appropriate steps can be developed during the site planning and facility design process to mitigate adverse ecological and environmental impacts that could result from the assumed levels of total water use and consumptive use for the compressed air energy storage facility.

5.4.4 WATER AVAILABILITY SCREENING RESULTS

Figure 5-2 presents the results of the regional screening and rating of the CAES study area based on the water availability criteria. As expected, the more favorable areas for CAES facility siting are located in proximity to the major rivers in the area. The Mississippi, Illinois, Rock, and Kankakee Rivers in their entirety in the study area have minimum daily flows greater than 2.7 cfs and are rated as "Favorable." In addition, the following rivers at least in some portions in the study area have minimum daily flows greater than 2.7 cfs and are rated as "Favorable":

* Pecatonica	*Kaskaskia	*Spoon	*Iroquois
* Fox	*Sangamon	*Vermilion	*Kishwaukee
* Des Plaines	*La Moine	*Du Page	

These "Favorable" areas have sufficient water available for closed-cycle cooling, i.e., cooling towers.

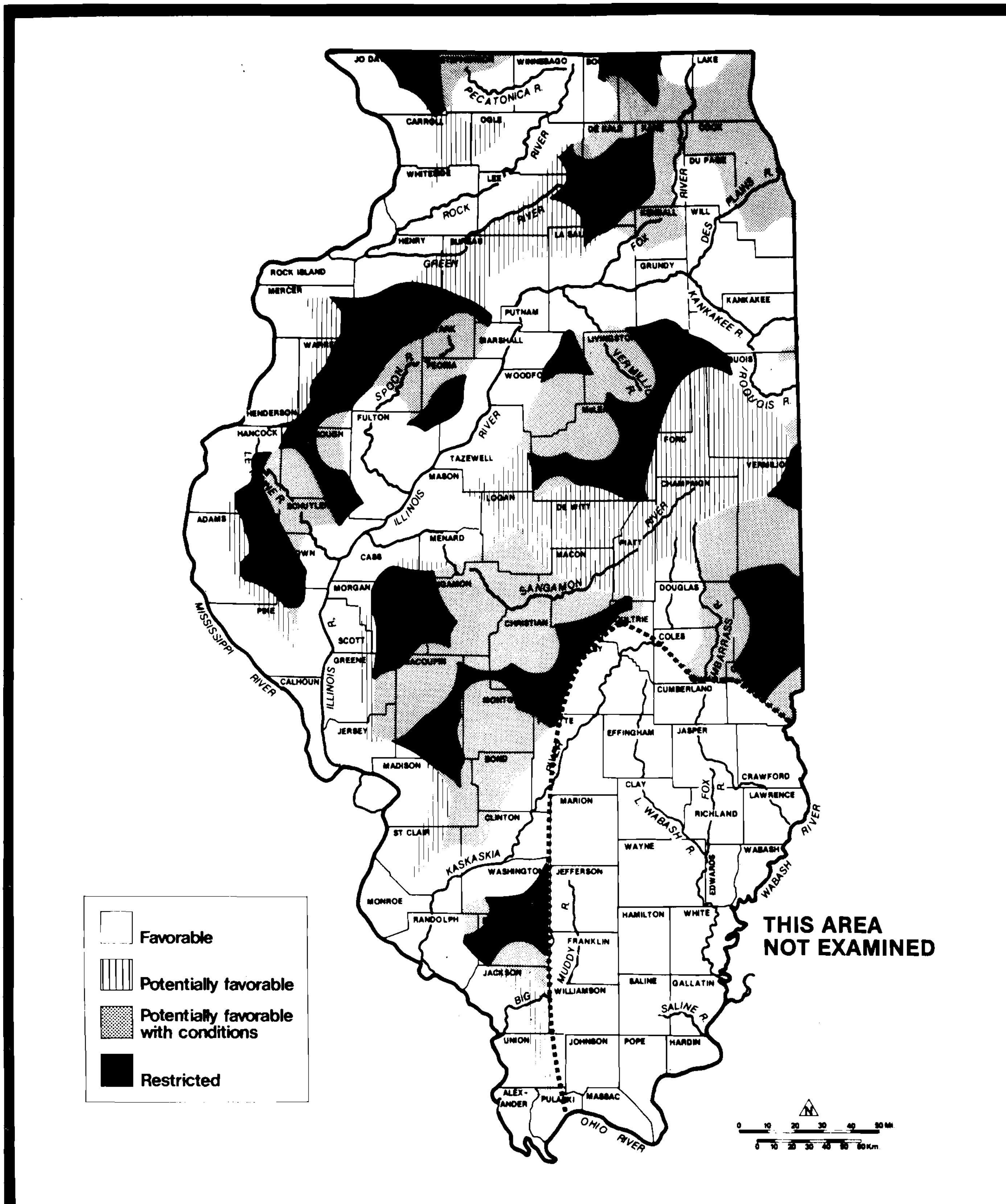

Figure 5-2

COMPOSITE CAES REGIONAL SCREENING MAP: WATER AVAILABILITY

SOURCE: ESE, 1981.

CAES
SITE SELECTION STUDY

5.5 GEOTECHNICAL SUITABILITY

5.5.1 RELATIONSHIP OF GEOTECHNICAL SITING CATEGORY TO CAES PLANT SITING

The criteria used for Stage II geotechnical suitability included:

1. Seismic Risk,
2. Geologic Structure,
3. Karst Topography, and
4. Coal Mine Operations.

The following sections define these criteria and discuss their relation to CAES plant siting.

5.5.2 DEFINITION OF SITING CRITERIA

5.5.2.1 SEISMIC RISK

Seismic risk is an important criterion because it is an accepted measure of the likelihood of structural damage resulting from seismic events for geographically-specific areas. The siting of a CAES plant in a seismic risk area requires design considerations to accommodate anticipated vertical and/or horizontal displacement both above and below ground surface. The risk assessment considers several parameters; (1) the probability of a damaging seismic event occurring, (2) the probability of structurally destructive displacement occurring in a given area, (3) the maximum epicentral intensity, and (4) evidence of structural control on epicenter distribution.

Seismic risk categories as developed by National Oceanographic and Atmospheric Administration (NOAA) and by Hadley and Devine (1974) are regional concepts and thus are appropriate as macro-siting criteria. Risk categories include 0 (no risk) to 4 (severe risk). Within Illinois, seismic risk categories 1 through 3 are present. For this study, category 1 was considered "Favorable" and categories 2 and 3 were considered "Potentially Favorable.'' It should be emphasized that the boundaries between the seismic risk areas are arbitrary in that there actually are gradations between areas, not discrete lines.

5.5.2.2 GEOLOGIC STRUCTURE

As with seismic risk, the location of a selected site relative to structural features might dictate special construction and design to compensate for potentially unstable conditions.

Geologic structures, such as faults, folds, domes, basins, and arches, are indicators of zones of crustal movement or weakness. Sudden, permanent displacement in response to large-scale stresses within the crust or relatively slow displacement due to differential settling or materials failure has occurred in the geologic past. The degree to which structural features remain active today is difficult to quantify. The majority of known epicenter locations which have been active within the last 50 years do not provide much evidence of structural control on epicenter distribution for the study area as a whole. The Mississippi Embayment trough (including parts of western Kentucky, southern Illinois/southeastern Missouri centered around St. Louis) is an exception (Hadley and Devine, 1974). The earthquakes in the Mississippi Embayment are believed to be related to movements of members of the northeast-trending New Madrid and Wabash River fault systems. A group of epicenters in the St. Louis area suggests that earthquakes have been produced on a branching fault or faults on the southwest flank of the Illinois Basin. There seems to be, however, no geologic record of a major fault with this location or orientation (Hadley and Devine, 1974). McCracken (1971) shows the St. Louis Fault to be in this area.

According to Willman et al. (1975), and Willman and Frye (1970), Illinois is underlain by relatively old consolidated rocks. These rocks crop out in a few places but generally are covered with alluvium outwash and glacial deposits. In the alluvial floodplains, the consolidated rocks are overlain by alluvium deposited by the streams. This alluvial material in the valleys of the larger streams is the only important source of large quantities of ground water.

The bedrock units vary greatly in thickness and in characteristics and range in age from Precambrian to Tertiary. Depth to the bottom of the Paleozoic bedrock system is greatest near the center of the Illinois Basin (i.e., south-central Illinois, which is partially included in the study area). Precambrian crystalline basement rocks crop out in centers of uplift--the Superior Upland (i.e., northern Wisconsin) to the north and the Ozark Dome (i.e., southeastern Missouri) to the southwest. The Kankakee arch also is a center of uplift in Illinois, although the Precambrian is not exposed. The slope of the basement complex is the central feature controlling the slope, dip, and structure of the younger bedrock units overlying the basement. Surface expressions of the bedrock topography have been obscured by a blanket of glacial deposits. More geologic structures (i.e., faults) are associated with these uplift areas.

The axes of major folded structures, in combination with buffer zones 10 miles to either side of the axes, delineate areas which were considered potentially favorable. These broad up- or down-warpings of the bedrock were formed at a time when crustal instability characterized this area of the continent. The area is currently relatively stable, although under constant mid-continent tectonic stresses. The areas within 10 miles of major fault zones were also classified as potentially favorable. Faults are proven zones of crustal weakness, and as such, may respond to crustal stress more readily than other structures.

The 10-mile radius from a linear feature is judged to be the major portion of the stressed area around a given lineament; (i.e., sufficient structure occurs in the zone on a micro-scale to justify use of this size buffer zone).

5.5.2.3 KARST TOPOGRAPHY

Karst topography is a descriptive term used for areas where calcareous sedimentary beds have in part been dissolved to form caves and sinkholes. Such areas must be considered in the siting of major facilities due to the geologic hazards present (potential for rock cavern roof collapse). Information on the location of caves and other solution features has not been extensively developed for the Illinois siting area. However, the presence of near-surface occurrences and exposures of limestone bedrock, which indicate a potential for solutioning, are well mapped (Lamar, 1967). Such areas were zoned as potentially favorable and the remainder of the siting area as favorable.

5.5.2.4 COAL MINE OPERATIONS

The locations of existing and abandoned coal mine operations are important siting considerations because of the geologic hazard potential (shaft roof collapse, soil and slope failure). Locations of mines are available through the Illinois Geological Survey and can be utilized for macro-screening. Townships in which mining is currently being conducted or has taken place have been singled out and zoned as potentially favorable. The portion of the study area for which mine operations have not been recorded was considered favorable.

Table 5-8 summarizes the favorability rating specifications for each criterion used for the geotechnical suitability screening in Stage II.

5.5.3 GEOTECHNICAL SUITABILITY SCREENING RESULTS

For the seismic risk criterion, the more restrictive areas with higher seismic risk occur in the southern portion of the study area, and the least restrictive areas with low risk occur in the northern half of the state.

Table 5-8. Favorability Rating Specifications--Geotechnical Suitability (Compressed Air Energy Storage Facility)

Favorable	Potentially Favorable	Potentially Favorable With Conditions	Restricted
Seismic Risk:			
Seismic Risk <2	Seismic Risk 2 & 3		Seismic Risk 4
Geologic Structure:			
No major structural features within 10 miles	Areas within 10 miles of a major folded structure, or fault zone		
Mining Activity:			
Areas where deep and/or surface mining have not occurred	Areas where deep and/or surface mining are known to have occurred within the township		

Source: ESE, 1981.

Structural features and epicenter locations occur throughout the study area. However, the highest concentrations occur in the southern and southeastern sections of the state and the lowest concentrations in the northern and northwestern sections.

Areas with Karst topographic conditions which were rated as "Potentially Favorable" areas occur along the western boundary and extreme southern portion of the state as well as in an area southwest of Chicago.

Townships in which coal mining is currently being conducted or is known to have occurred are primarily located within the southern two-thirds of the state. These townships were rated as "Potentially Favorable." Areas in the state for which no mining operations are recorded occur in the northern counties and in local areas in the southern two-thirds of the state.

Figure 5-3 presents the composite screening map for the geotechnical suitability criteria.

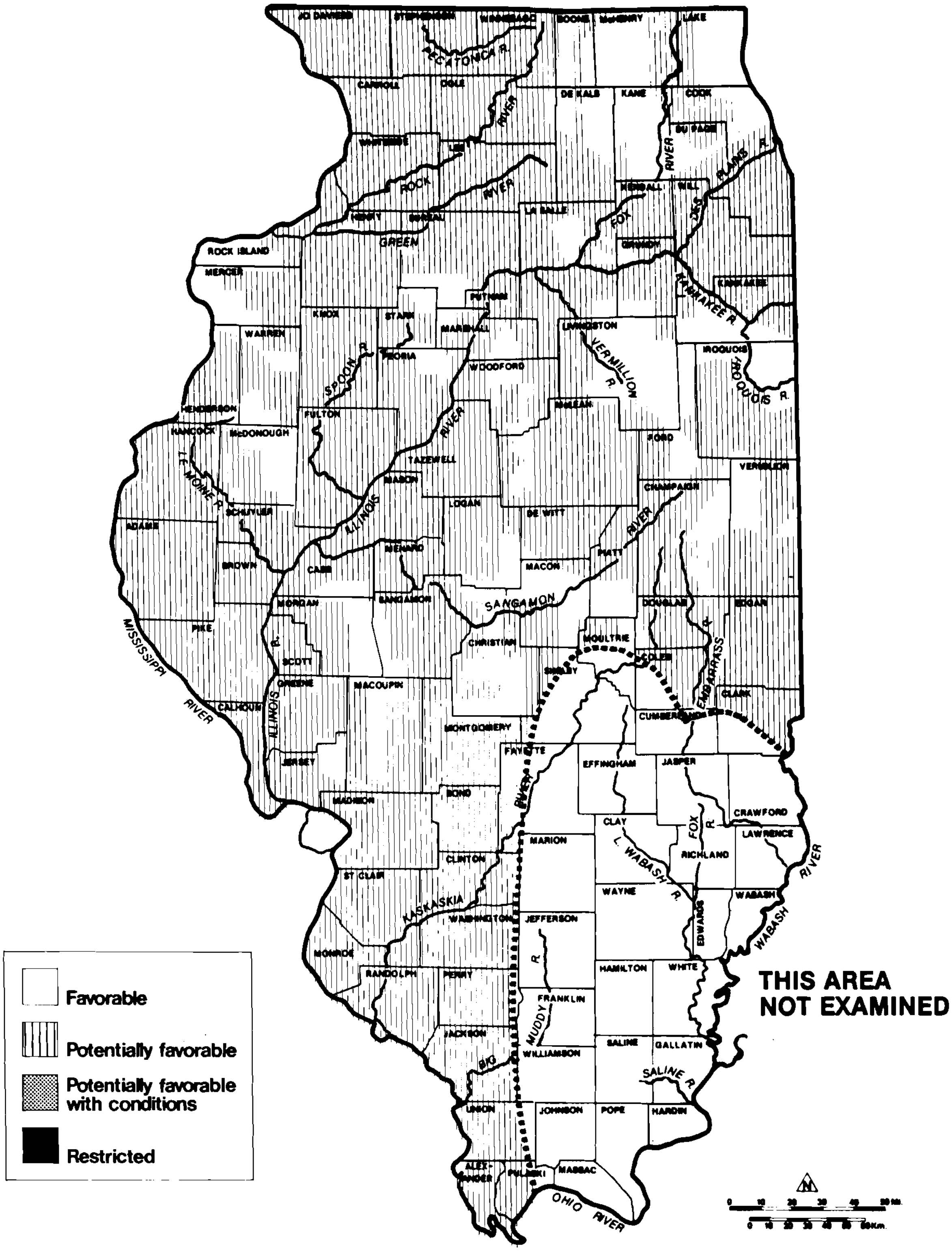

Figure 5-3

COMPOSITE CAES REGIONAL SCREENING MAP: GEOTECHNICAL FAVORABILITY

SOURCE: ESE, 1981.

CAES

SITE SELECTION STUDY

5.6 ECOLOGICAL QUALITY

5.6.1 RELATIONSHIP OF ECOLOGICAL QUALITY TO CAES PLANT SITING

The proposed CAES facility will require approximately 100 acres of land and will alter or impact some of the existing biological systems on and near the site. Because of this alteration, the potential effects upon habitats and natural ecosystems must be considered in the site selection process.

Ecological impacts are important for several reasons:

1. The elimination and alteration of habitats directly affects wildlife populations associated with those habitats;
2. Habitat perturbations can affect other important environmental conditions, in particular, water quality;
3. Wildlife populations have an indirect but tangible economic value which is expressed via outdoor recreational activities (e.g. hunting and fishing);
4. The general public has demonstrated awareness of and concern for wildlife, plants, and environmental quality; and
5. Many natural areas and conservation-related lands are owned or under the jurisdiction of private organizations or federal, state, or local governments.

Two major types of impacts are associated with the proposed CAES facility; (1) construction impacts which are typically short-term but acute, and (2) operation impacts which result in long-term effects upon the natural systems.

The major impact of construction to natural systems is the alteration and elimination of habitats. Existing vegetation which forms an integral part of diverse natural communities may be replaced by artificial structures or converted to single-species communities lacking diversity. Not only will the construction of the plant and associated structures directly affect and displace resident wildlife populations, but the same structures may disrupt natural movements of wildlife through the area.

CAES plant operation may affect surrounding habitats and wildlife populations through cooling water withdrawal, generation of noise, and increased vehicular traffic. Cooling water withdrawal (though limited) and subsequent return to a lake, pond, or stream can have significant adverse effects on aquatic biota due to temperature changes, chemical additives, impingement, and entrainment. These effects could include reduction in forage or sport-fish populations, reduced primary productivity, increased fish toxicity and disease problems, and lowered aquatic species diversity. Air emissions may have adverse effects on soil, vegetation, and wildlife. Severe noise may repel some wildlife species from the area.

The major ecological concern in siting the proposed facility is the quantity and quality of ecological habitats which will be affected. Siting restrictions under the ecology siting category will minimize the effects of the CAES plant construction and operation on the natural biological communities of Illinois.

5.6.2 DEFINITION OF SITING CRITERIA

Four criteria were established for evaluating sites on the basis of ecological suitability.

5.6.2.1 THREATENED OR ENDANGERED SPECIES

Presence of a plant or animal designated as threatened or endangered by the federal government was considered in siting the CAES facility. For regional environmental screening, information on species presence could be identified practically only on a county basis. However, the actual area utilized by a species may be quite small. Therefore, for Stage II screening, counties known to support threatened or endangered species were considered potentially favorable for siting the proposed CAES facility, and all other counties were regarded as favorable. Later screening will identify locations of species habitat and restrict specific areas from consideration.

State-designated threatened and endangered species were not considered because specific information on locations of important habitat is not readily available for all species. Also, many of the species are listed as imperiled based upon political boundaries (i.e. Illinois) rather than the species' total range.

5.6.2.2 UNIQUE HABITATS

This category, which is exclusive of the threatened and endangered species category, includes areas which are unique because of their community structure, flora and fauna, energy flows, diversity, productivity, or sensitivity to stress. Included are areas identified by the Illinois Natural Areas Inventory, U.S. Forest Service Rare Lands, and high quality streams.

5.6.2.3 PUBLIC AND PROTECTED LANDS

The areas designated in this category were evaluated not entirely on biological integrity, but also on land use. This is not to imply that lands under the jurisdiction of state or federal agencies and private groups are not biologically significant, as many such tracts were initially set aside based on ecological considerations. In other controlled tracts, the change in land use which has occurred because of such protection has promoted the establishment of unique ecosystems. Areas considered include state parks and conservation areas, county conservation areas, and national forests and wildlife refuges.

5.6.2.4 FOREST COVER

The availability of forest cover, particularly in most of the northern two-thirds of Illinois, where it is often at a premium, serves to enrich the vegetative composition of the local flora and provides a greater diversity of habitats for both flora and fauna. For Stage II screening, forest cover was evaluated on a county-wide basis. An arbitrary level of 15 percent forest cover was used to separate,favorable and potentially favorable counties.

5.6.3 RATIONALE FOR CRITERIA AND FAVORABILITY SPECIFICATION RATING

The favorability ratings for the ecological quality category rely on both qualitative and quantitative criteria. These criteria and their use in determining the favorability of areas for the CAES facility siting are discussed in this section.

5.6.3.1 FAVORABILITY SPECIFICATIONS

Information collected for the Stage 11 analysis was general and often applicable only to large segments of the study area. For several criteria, the most specific information was available only at the county level. Consequently, entire counties were assigned one of the four favorability ratings.

The areas identified by the Illinois Natural Areas Inventory as natural areas are considered restricted from site development due to the presence of unique or valued natural habitats or features.

Areas under ownership or administration of governmental agencies or private organizations, with the exception of national forestland, are considered restricted from siting considerations. Some national forestlands may be considered as potentially favorable with conditions.

Private recreation areas or natural areas are restricted from siting consideration to maintain the goal of minimizing effects on biological communities.

The endangered and threantened plant and animal species considered in this study are those listed by the U.S. Fish and Wildlife Service, U.S. Department of the Interior, under the Endangered Species Act of

1973 and 1978 (Federal Register, May 20, 1980, and December 15, 1980). Data for the protected species were available only on the county level, even though such species are usually restricted to localized and definable habitats within that county. Site-specific analysis for each species within counties was not used for the macroscreening of the Stage II analysis, but will be included in Stage III and IV analyses. Specific definitions for these categories follow:

1. Endangered--In danger of extinction throughout all or a significant portion of its range.
2. Threatened--In danger of becoming endangered throughout all or a significant portion of its range.

RARE lands are those identified by the Roadless Area Review and Evaluation project of the U.S. Forest Service for consideration of inclusion in the Federal Wilderness Systems. These lands would be considered wilderness areas or areas relatively undisturbed by man's activities. Such lands in the Illinois study area are limited to the Shawnee National Forest in the southern one-third of the state.

The stream ratings utilized are those given in a publication of the Illinois Natural History Survey (Smith, 1971), which rates Illinois streams on the basis of fish species present and potential for species to occur. These ratings consider the overall quality of the aquatic habitat in terms of flora, fauna, and water quality. In the CAES study, streams given an excellent rating are classified as restricted, and those given a good rating are classified as favorable with conditions.

Known habitats for fish species which are endangered or threatened are limited to exact locations or stream reaches which have documented populations of the species in question. Where a larger area (county or larger) is given as a general known range of that species, the area is classified as potentially favorable.

5.6.4 ECOLOGICAL QUALITY SCREENING RESULTS

Table 5-9 summarizes the criteria and favorability specification ratings for ecological quality used for the Stage II analyses. Mapping of the information from the Stage II ecological analysis resulted in having most of the study area in either "Favorable" or "Potentially Favorable" areas. Scattered throughout the CAES study area are small land areas which are restricted because of their designation as parks or preserves. The greatest concentrations of these areas are in the southern part of the state and along the Mississippi and Illinois Rivers.

As noted above, forest cover data were available only on a county-by-county basis. The counties with significant forest cover are most common in the southern one-quarter of the state and in the west-central section of the state.

Threatened and endangered flora and fauna designations are also available only on a county-by-county basis. Therefore, many counties are rated as being less than favorable for CAES plant siting, based on the existence of limited habitat areas and populations of these specific species. More detailed information gained in Stage III delineates the specific locations of threatened and endangered species habitat within the counties.

Natural areas designated as "restricted" for CAES facility siting are numerous (greater than 1,100 within the study area), but they are generally small and can be easily avoided in plant siting. Many of the natural areas from the Illinois Natural Areas Inventory are congregated along specific segments of rivers or bluffs or otherwise located in areas that would not allow siting based on economic or engineering criteria. A large percentage of the areas designated as restricted are less than 40 acres, and only a small number exceed 1,000 acres. Specific data for these restricted areas will be gathered in the Stage III analysis, when more detailed siting areas are identified.

Figure 5-4 presents the composite map resulting from screening the CAES study area for all the ecological quality criteria.

Table 5-9. Favorability Rating Specifications--Ecological Quality Suitability (Compressed Air Energy Storage Facility)

Favorable	Potentially Favorable	Potentially Favorable With Conditions	Restricted
Threatened or Endangered Species: (by County)			
Presence of threatened or endangered species not recently documented	Presence of threatened or endangered species recently documented		
Unique Habitat:			
No unique or remnant habitats		"Good" rating in terms of fishery populations	Unique scientific, natural, geologic, or scenic areas "Excellent" rating in terms of fishery populations RARE lands

Table 5-9. Favorability Rating Specifications--Ecological Quality Suitability (Compressed Air Energy Storage Facility) (continued, Page 2 of 2)

Favorable	Potentially Favorable	Potentially Favorable With Conditions	Restricted
Public/Protected Lands:			
No ownership by governmental agencies or private organizations	National forest proposed purchased	National forest Soil and water conservation district areas Private hunting, fishing, or game areas Areas around lakes not established as management or public areas	Private nature preserves; public refuges or management areas and preserves Public hunting and fishing areas State forests Recreation areas such as river accesses, picnic areas, and campgrounds Protected or managed wetlands
Forested Area (by County):			
15 percent or less forested	Over 15 percent forested		

Source: ESE, 1981.

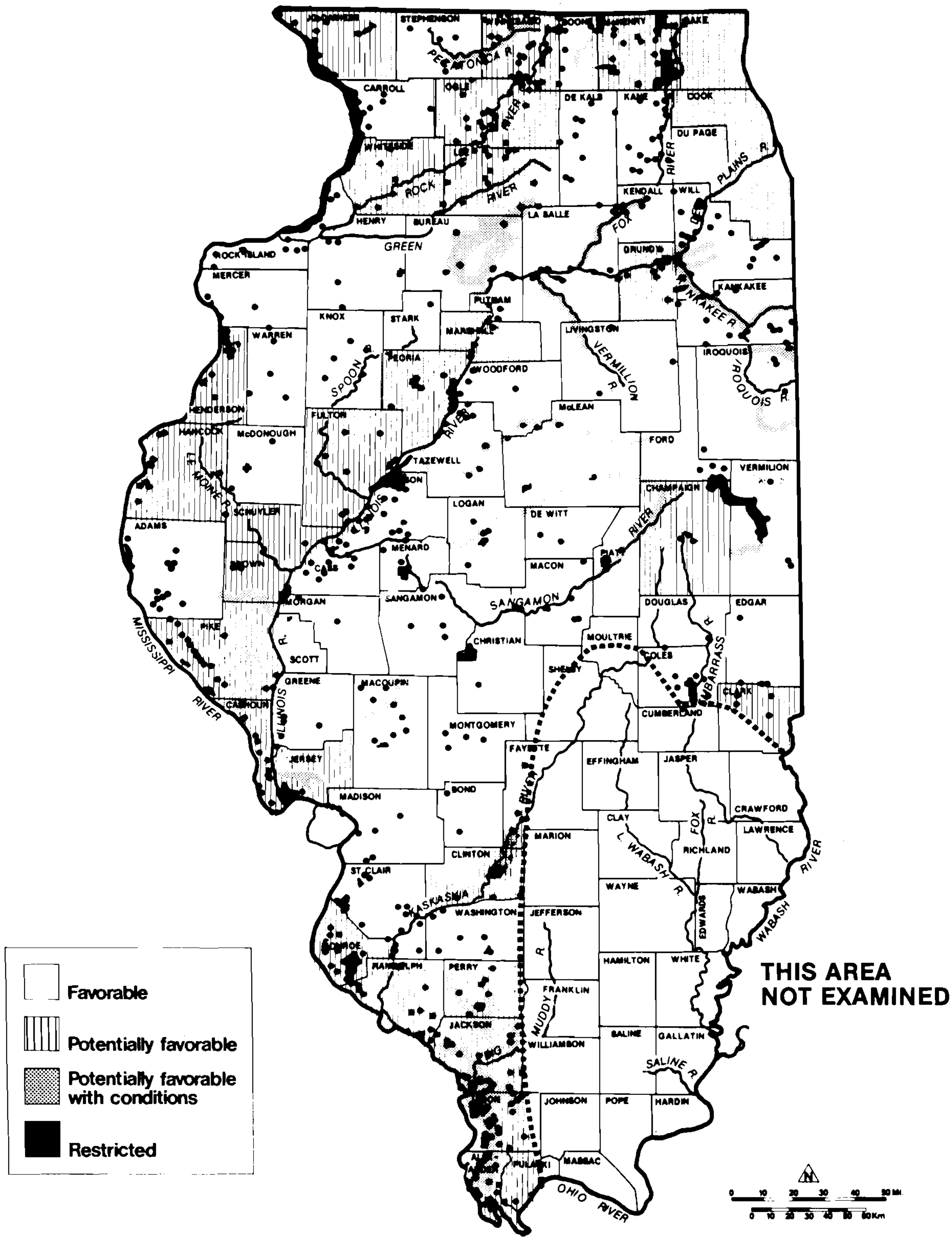

Figure 5-4

COMPOSITE CAES REGIONAL SCREENING MAP: ECOLOGICAL QUALITY

SOURCE: ESE, 1981.

CAES

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5.7 SOCIOECONOMIC/LAND USE COMPATIBILITY

5.7.1 DEFINITION OF SITING CRITERIA AND RATINGS

The Stage II socioeconomic screening process addressed three major categories of land use: (1) urbanized developed areas, (2) public land use areas, and (3) prime agricultural land. The purpose of this stage was to eliminate from further consideration those areas that pose obvious land use conflicts in terms of a CAES system construction and operation. In-depth documentation was not attempted at this level of analysis, and site-specific impact and zoning problems will be considered during subsequent analyses.

The mapping scale (1:500,000) used in this stage of analysis allows indication of only the larger urbanized areas and the public lands where CAES plant siting would be restricted. The smaller urban and public land areas are considered in subsequent stages of analysis. Because of the size of the area under consideration and the availability of data, only general patterns of prime farmland are shown, and more site-specific interpretations within some counties were not possible at this time.

5.7.1.1 MAJOR URBAN AREAS

Urban areas are rated as restricted because of the lack of sufficient available land. Since many of the urban areas initially delineated were too small for graphic illustration at this scale, only those urban areas covering more than 5 square miles are delineated for the Stage II analysis. The smaller urban areas will be considered during the more detailed evaluation of the Stage III analysis.

The urban areas were delineated by using the Sectional Aeronautical Charts of Illinois, produced by the National Oceanic and Atmospheric Administration (NOAA). These maps are comparable in scale to USGS maps (1:500,000) and are current and accurate (September 1978).

5.7.1.2 PUBLIC LAND USE

This category of land use encompasses several restrictions, depending on the different uses and the particular government agency involved. Restrictions and conditions applied to public lands--particularly national and state parks and conservation areas--include many more than are discussed here. There is a substantial overlap of these conditions with the environmental criteria.

National forests and wildlife refuges, state parks, forests, conservation areas, and military bases are included in this category. These unacceptable areas for plant siting are relatively small and scattered throughout the study area, with the exception of the Shawnee National Forest in Southern Illinois. Contacts with the Illinois Departments of Transportation and Conservation and the Office of Economic Adjustment, as well as National Forest Service maps, 1980 highway maps, and USGS state maps, were used to identify and delineate public land areas.

National Forests and National Forest Proclamation Area

The Shawnee National Forest in southern Illinois was placed in the restricted category primarily because non-national forest developments are limited to 80 acres under the Special Use provisions of the National Forest Plan. In addition, major projects must comply with other provisions of the National Forest Plan, including U.S. EPA review, because of numerous criteria such as land use compatibility. The Shawnee National Forest is the largest publicly-owned property and comprises approximately 255,000 acres of land.

The National Forest Proclamation Area joining the two sections of Shawnee National Forest was categorized as potentially favorable with conditions. This area is earmarked for purchase by the National Forest Service (NFS) Lands Section to eventually become part of the National Forest. Sites in this area may not be currently restricted, but they would be subject to review in terms of the long-range goals of the

National Forest Plan. In addition, privately-owned lands within national forests should be considered as undesirable because of the public acceptance considerations of locating a CAES plant within a national forest.

National Wildlife and Fish Refuges

National wildlife and fish refuges were categorized as restricted because of their incompatibility with the land use activities of a CAES system.

Wildlife management and habitat protection in the federal refuges is administered by the U.S. Fish and Wildlife Service. Various federal programs assisting in the protection of wildlife habitats in the National Wildlife Refuge System are; Pittman-Robertson Federal Aid in Wildlife Restoration, Endangered Species Act, Heritage Conservation and Recreation Service, National Environmental Policy Act, Water Pollution Control Act, and the Fish and Wildlife Coordination Act.

Specific provisions and applications of the program policies are not described in this section because the criteria are primarily ecological and are therefore explored in greater detail under the appropriate section of this report. Four National Wildlife and Fish Refuges were noted, including Upper Mississippi, Mark Twain, Lake Chautauqua, and Crab Orchard in Illinois.

Military Reservations

The military reservations are categorized as restricted areas because of the priority of federal ownership and the incompatibility of land use. The four military reservations in Illinois include two U.S. Army reservations and two U.S. Air Force bases. Joliet Army Ammunition Depot is considered restricted because safety arc requirements and the existing facilities would not yield a sufficient amount of land for development. Savanna Army Depot is a National Wildlife and Fish Refuge. The five installations are restricted through military ownership.

Major State Parks, Forests, and Conservation Areas

Areas in this category have been classified as potentially favorable with conditions. These areas would have to be considered carefully during any subsequent phases of site-specific analysis. Although the state statutes do not specifically exclude CAES plants from these areas, they provide policies of conservation and preservation of natural areas, including flora and fauna. For example, policy statements contained in the Illinois Comprehensive Outdoor Recreation Plan emphasize the conservation of existing state preservation areas, as well as their expansion and the acquisition of new areas. The state's recreational policy will also stress greater controls directed toward the protection of wilderness and recreation areas.

Sources for this category included the document, Outdoor Recreation in Illinois, from the Illinois Department of Conservation (December 1978).

5.7.1.3 PRIME AGRICULTURAL LAND

Nonagricultural development in rural, agricultural areas is an example of a situation in which development can lead to conflicts with existing resources or uses. Most communities traditionally have taken a permissive attitude with regard to development in rural areas, although recognition of the inherent conflicts between agricultural uses and rural residential or industrial uses has led to some re-evaluation of this position. In addition, there has been growing awareness of the soils devoted to agricultural production as a limited and increasingly valuable resource. In recent years, state and regional planning agencies have begun to reformulate their development controls and land use decisions in this regard.

The USDA has established a formal policy to protect prime farmland from premature or unnecessary conversion to nonagricultural use. Development is geing directed toward areas where soil characteristics limit their suitability for row crop agriculture. It is, therefore, in the public's interest to avoid prime farmland, especially since federal actions emphasize the undesirability of using prime agricultural land for siting of a power plant (Knebel, 1976; Peterson, 1976).

Prime agricultural land use was categorized under three rating classifications--Favorable, Potentially Favorable, and Potentially Favorable with Conditions--depending upon the level of land use incompatibility involved. "Prime farmland" was identified by the USDA Soil Conservation Service through detailed soil surveys. It was then mapped according to the percentage of prime farmland present; less than 25 percent, 25 to 75 percent, or over 75 percent. Siting modification would become more difficult as the percentage of prime farmland increases.

Extensive areas of Illinois are suitable for use as prime agricultural farmland, defined as areas where more than 75 percent of the acreage is of prime quality with the potential for high crop yields. Areas of prime agricultural farmland are located mainly in the northern half of the state.

The source for location and delineation of prime farmland was the USDA Soil Conservation Service State Office. The location of prime farmland is based on soil characteristics and other physical criteria, and not on current usage. These general prime farmland maps can be used for broad planning purposes only and should not be used to determine the amount of prime farmland located in a specific area.

5.7.2 SOCIOECONOMIC/LAND USE COMPATIBILITY SCREENING RESULTS

Table 5-10 presents the favorability rating specifications for the socioeconomic/land use compatibility category. Except for urban areas and certain public land use areas, the rating criteria do not restrict substantial land areas.

Figure 5-5 presents the composite map resulting from screening the CAES study area for all socioeconomic/land use compatibility criteria.

Table 5-10. Favorability Rating Specifications--Socioeconomics/Land Use Compatibility (Compressed Air Energy Storage Facility)

Favorable	Potentially Favorable	Potentially Favorable With Conditions	Restricted
Urban Built-Up Areas:			
Urban areas of less than 5 square miles and nonurbanized areas			Major urban built-up areas, having no contiguous vacant area large enough for plant site
Public Controlled Lands:			
Areas with no national forest/wildlife parcels Areas with only small parcels or no state forest/conservation areas		National forest proclamation areas State forests and parks State wildlife conservation areas	National forests National wildlife refuge areas
Military reservations:			
Areas with no military reservations			Military reservations
Prime Farmland:			
Less than 25 percent prime farmland	25 to 75 percent prime farmland		

Source: PLANTEC Corporation, 1981.

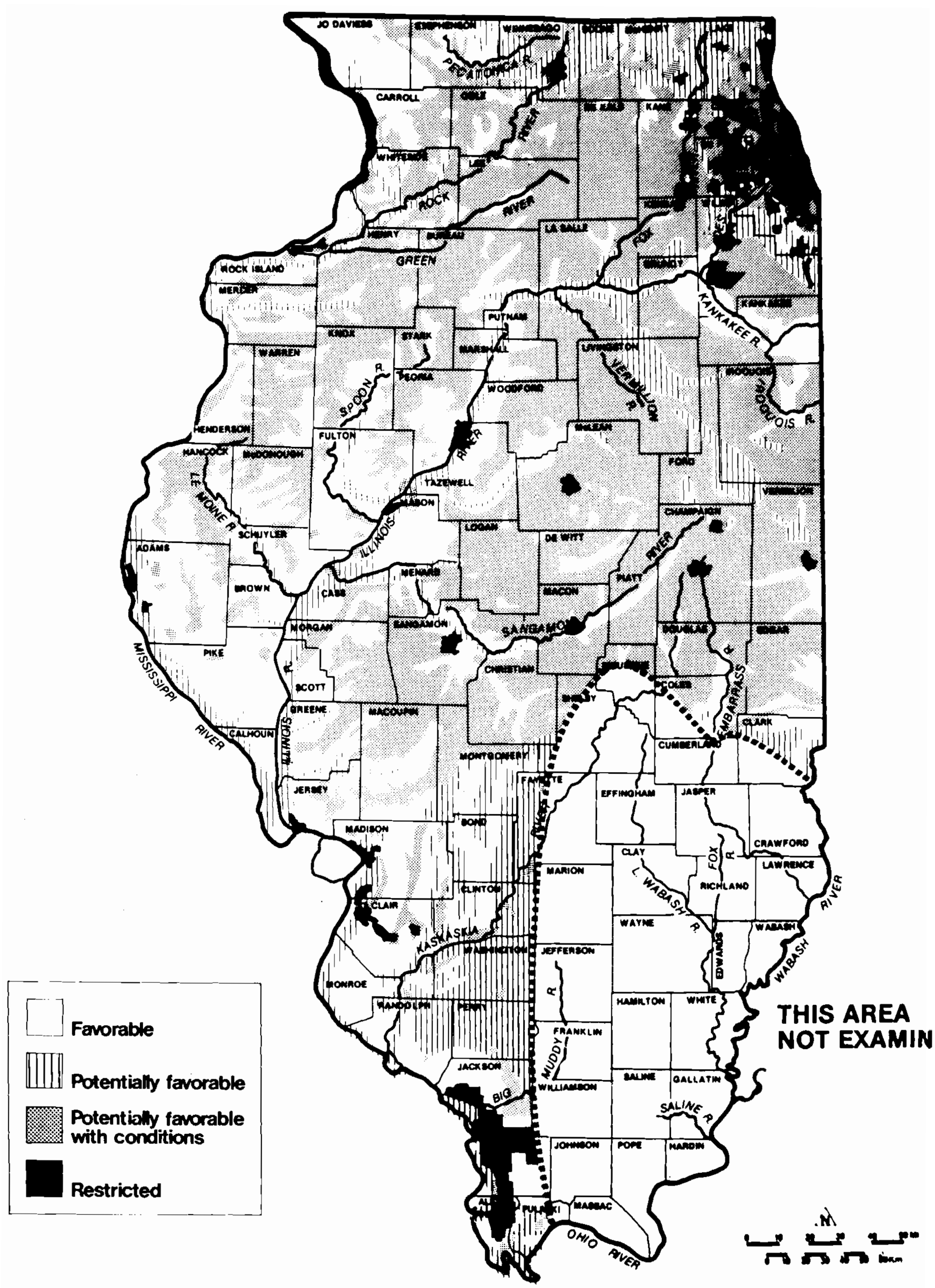


Figure 5-5

COMPOSITE CAES REGIONAL SCREENING MAP: SOCIOECONOMIC/LAND USE COMPATIBILITY

SOURCE: ESE, 1981.

CAES

SITE SELECTION **STUDY**

5.8 REGIONAL ENVIRONMENTAL SCREENING RESULTS

5.8.1 COMPOSITE REGIONAL SCREENING MAP

The five environmental regional screening maps developed during the preliminary phases of Stage 11 were composited into one regional screening map (Figure 5-6). The net result was a final map indicating areas environmentally favorable for siting a CAES plant. A conservative approach was employed for this integration process in which the five environmental categories examined were combined into one single map indicating site favorability. Any area of Illinois examined in this stage was classified according to the most restrictive rating given that area by any environmental category. Using the system, an area rated as favorable by four environmental categories and restricted by one category was classified as restricted for the composite map.

Only a small area of the Illinois study was rated as environmentally favorable as a result of the regional screening analysis. Much of the remainder of the study area was rated as potentially favorable. The potentially favorable designations were the result of many factors, but most commonly were associated with percentage occurrence of prime farmland. Areas classified as potentially favorable with conditions were the result of two major factors: high percentage of prime farmland or poor water quantity favorability. The latter was generally associated with the smaller rivers and tributaries of the region in which ground water or supplemental water storage would be necessary. Restricted areas were usually areas in which either air quality or ecological conditions would not allow CAES siting. Restrictive air quality areas were near St. Louis, Peoria, Chicago, and in the vicinity of major pollutant-emitting sources, commonly fossil-fueled power plants. Ecologically restrictive areas included state parks, conservation areas, wildlife areas, and other ecologically sensitive areas. These were typically small areas scattered throughout the state, but slightly more common in the southern sections.

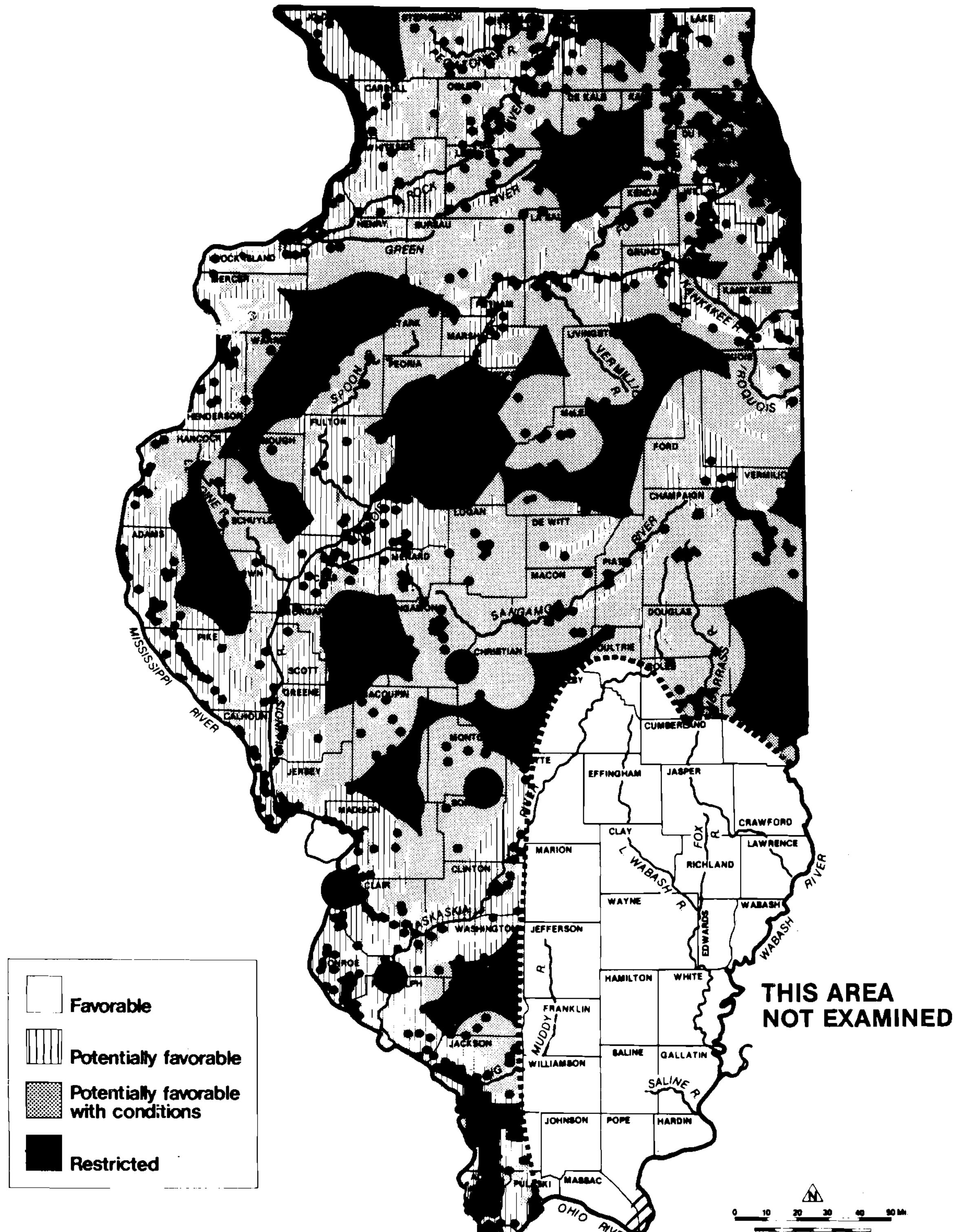


Figure 5-6

COMPOSITE CAES REGIONAL SCREENING MAP: ALL ENVIRONMENTAL CATEGORIES

SOURCE: ESE, 1981.

CAES

SITE SELECTION STUDY

The restricted areas were excluded from further evaluation in the siting process.

5.8.2 POTENTIAL SITING AREAS

The composite regional environmental screening map yielded only a small area of the state as being rated favorable for CAES siting (Figure 5-6). This was probably a reflection of the conservative criteria applied in this stage.

The final objective of this step was to identify 25 to 30 geographical areas that were manageable from an information gathering and analysis viewpoint, and yet allowed flexibility in CAES siting within any individual area. This approach dictated selecting areas ranging from 15 to approximately 25 square miles in size. Using this criterion it was possible to identify seven candidate siting areas within the environmentally favorable areas. As this did not yield the desired number of candidate sites for evaluation in the next stage, it was decided that sites would be selected from areas having one of the following attributes:

1. Areas rated environmentally favorable in Stage II;
2. Areas rated environmentally potentially favorable in Stage II and geologically favorable in Stage I; and
3. Areas rated environmentally potentially favorable in Stage 11, geologically favorable in Stage I, and previously identified as suitable for major power generating facilities.

The first category yielded the seven sites indicated above. The remaining two categories increased the area available for candidate site selection. Because of the conservative approach, it was reasonable to assume that a CAES plant could be licensed in an area rated as environmentally potentially favorable. The selection of candidate sites in areas rated geologically favorable, however, was a conservative approach which maximized the potential for locating sites in areas having suitable geologic conditions. Thus, the three categories previously listed assured selection of the maximum environmental or geological suitable sites, or both. The last category included the selection of sites previously identified as being suitable for the placement of energy production facilities (ESE et al., 1980).

In selecting the candidate sites, attention was given to specific locally identifiable conditions that either favored or ruled against specific candidate site boundaries. Included in these factors were proximity to water sources, existing railroads or highways, and urban areas. Site boundaries which avoided potential conflict and maximized engineering characteristics were selected.

Rather uniform geographic distribution was one of the goals in selecting candidate sites. This was generally possible, with sites selected in all available areas within the three categories above. However, the combination of both environmental and geologic factors predicated the selection of most sites near the western side of Illinois.

Figure 5-7 shows the 28 sites resulting from the Stage II analysis. Seven of the sites were from regions rated in Stage II as environmentally favorable. The remaining sites were selected from areas rated environmentally potentially favorable (Stage II) and geologically favorable (Stage I).

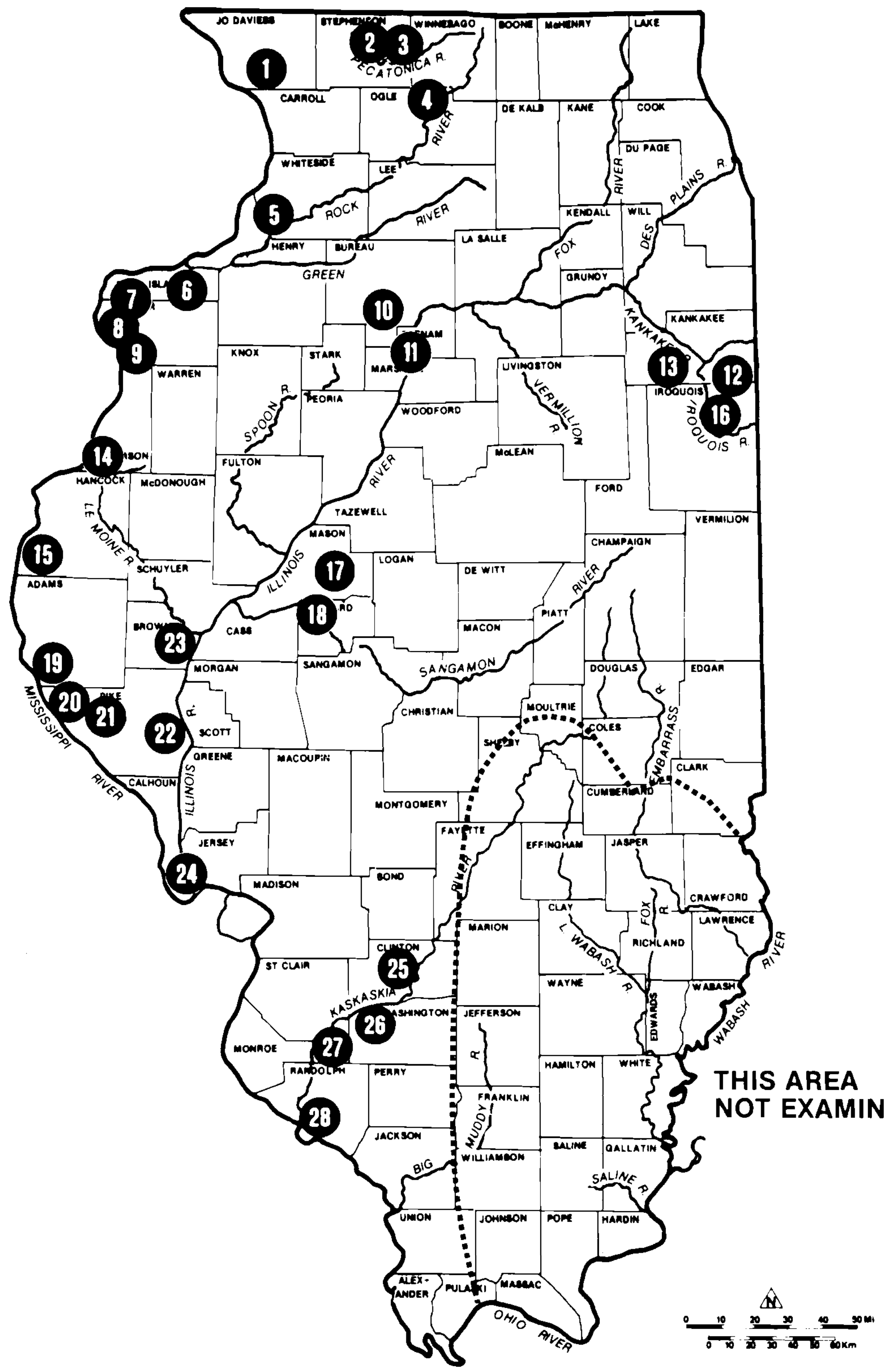


Figure 5-7

POTENTIAL SITING AREAS

SOURCE: ESE, 1981.

CAES

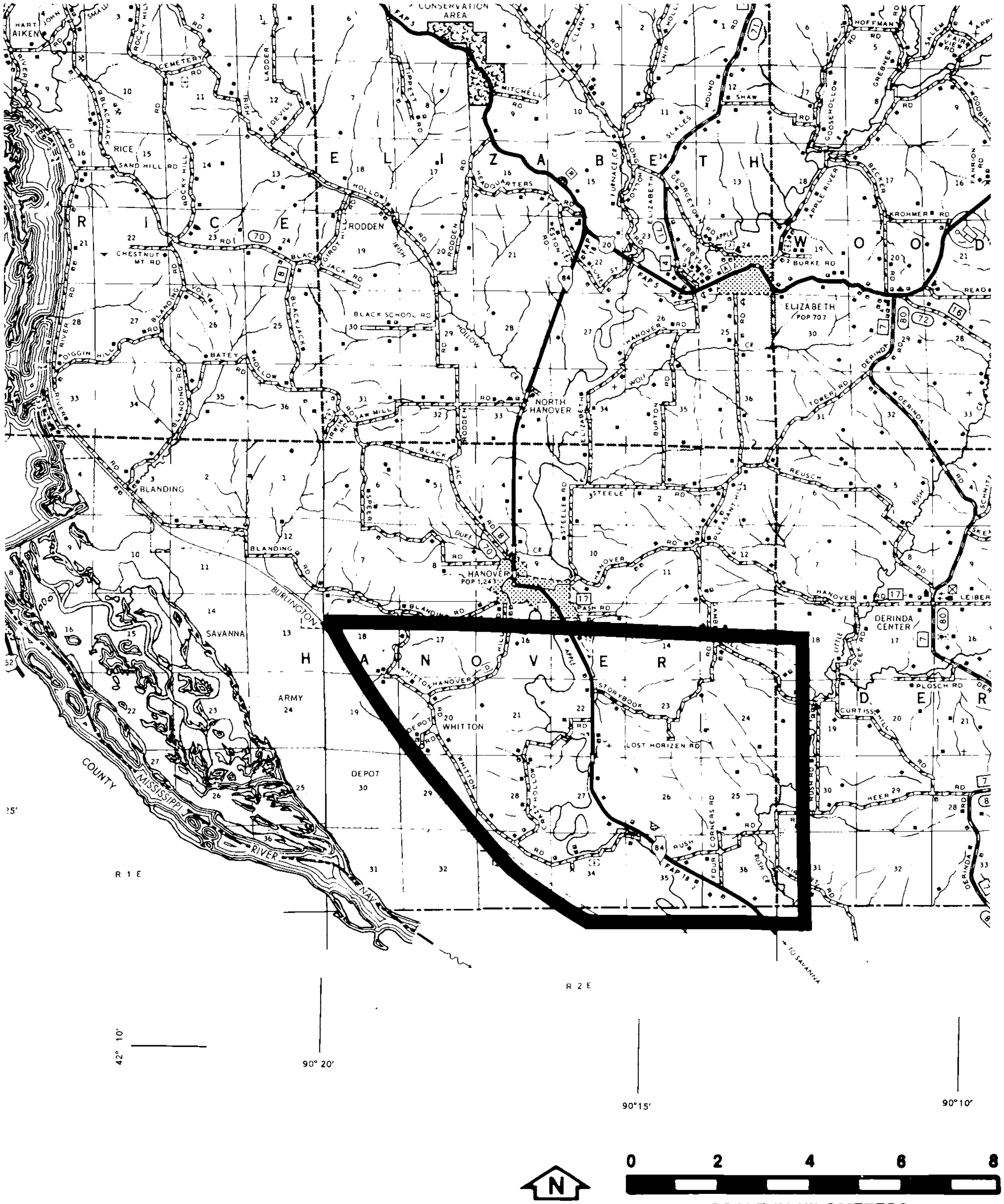
SITE SELECTION STUDY

6.0 STAGE 111--INTERMEDIATE ENVIRONMENTAL ANALYSIS

6.1 INTRODUCTION

The objective of the Intermediate Analysis was to evaluate and rank the 28 sites selected as a result of the Stage II Regional Environmental Screening. The sites indicated in Figure 5-7 and Figures 6-1 through 6-28 are distributed throughout northern and western Illinois. These areas were approximately 15 to 25 square miles in size and rated favorable or potentially favorable environmentally. The Intermediate Analysis was a two-fold study applying both environmental and geotechnical criteria concurrently. All criteria were based on the potential requirements or impact of Soyland's proposed 220-MW CAES facility.

The result of the Intermediate Analysis was a reduced number of candidate sites ranked the most favorable by environmental and geological criteria. These sites would then be more closely examined in later stages.



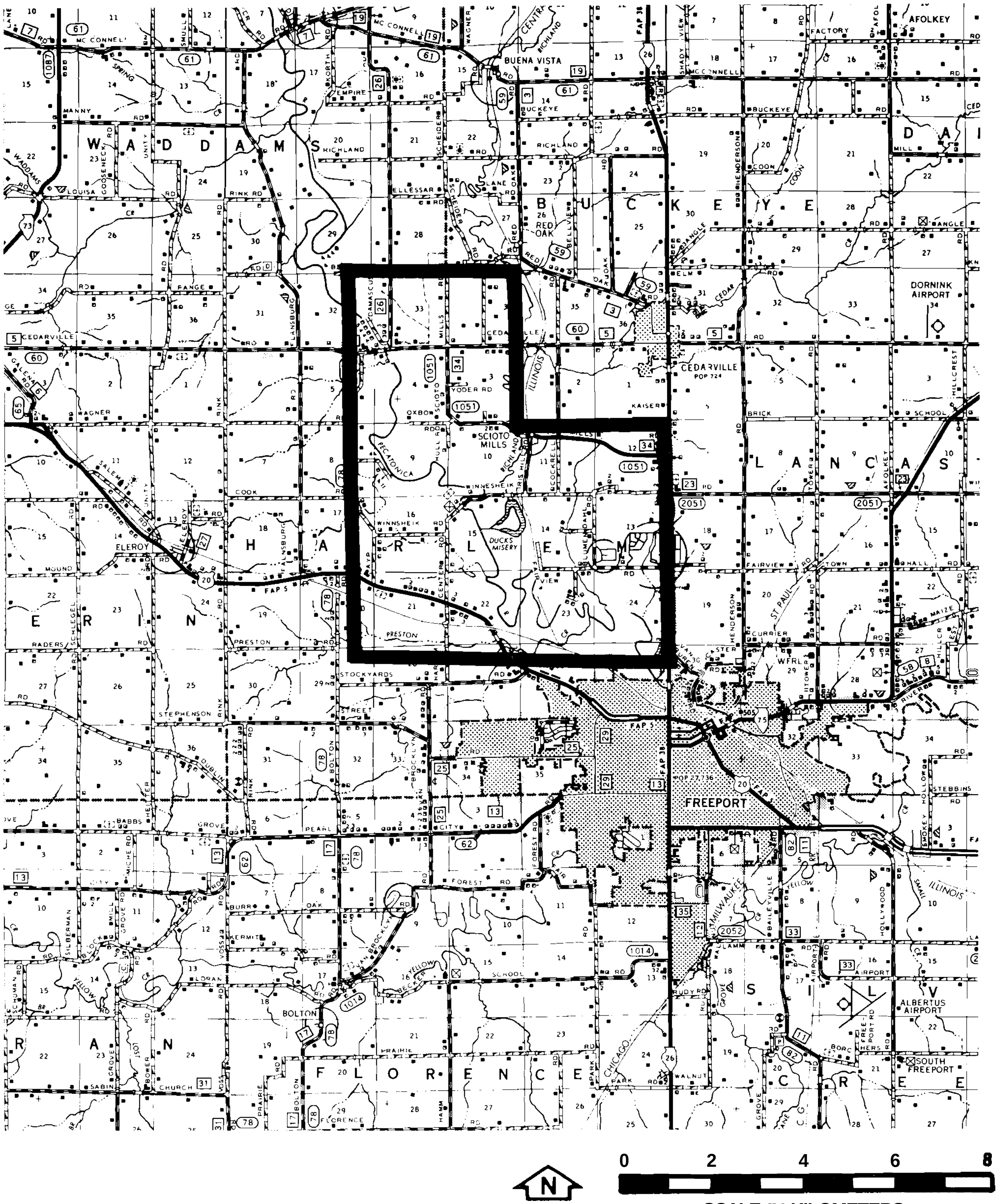
Adapted from Department of Transportation Maps

Figure 6-1

SITING AREA 1: JO DAVIESS COUNTY

CAES

SITE SELECTION STUDY



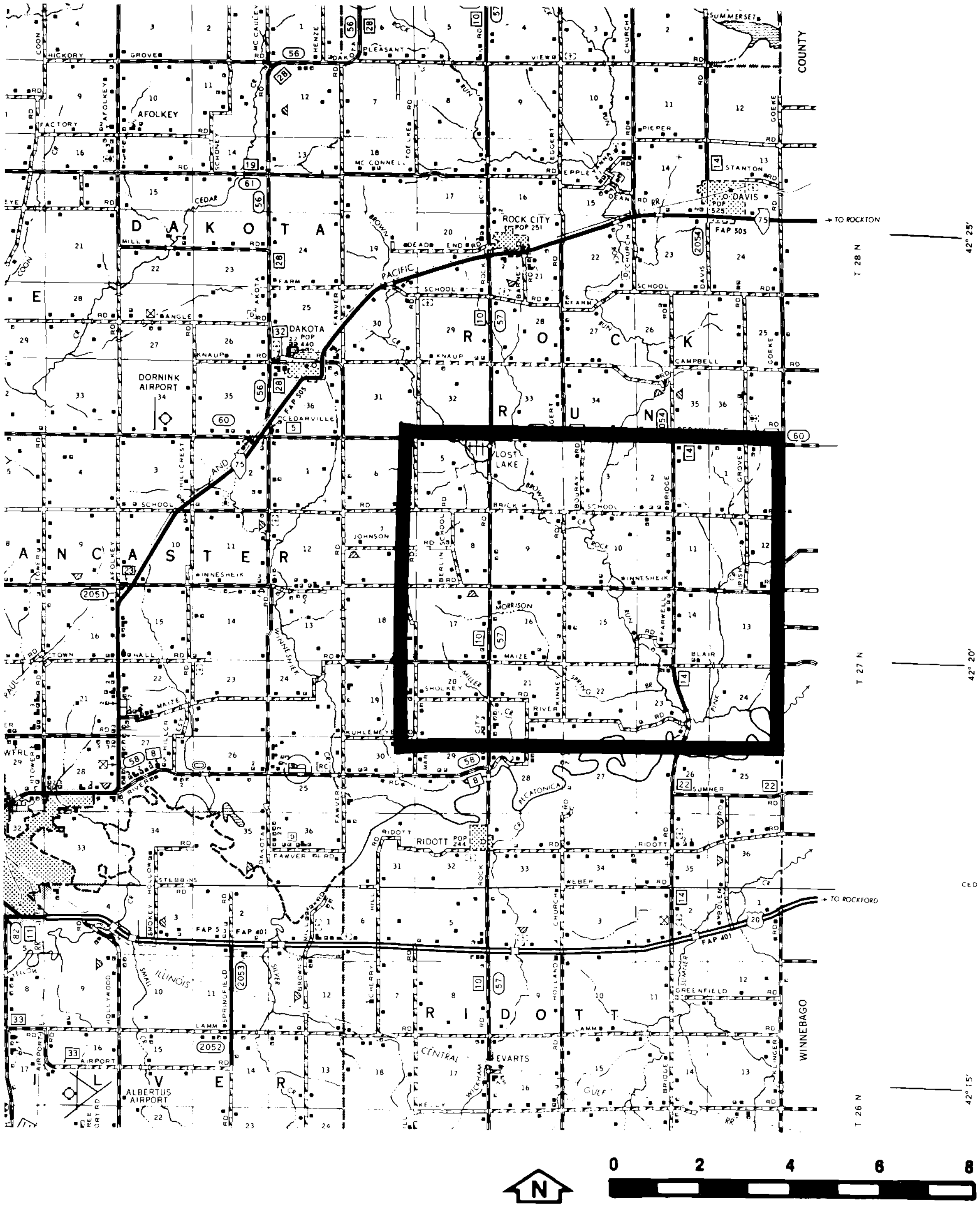
Adapted from Department of Transportation Maps

Figure 6-2

SITING AREA 2: STEPHENSON COUNTY - A

CAES

SITE SELECTION STUDY



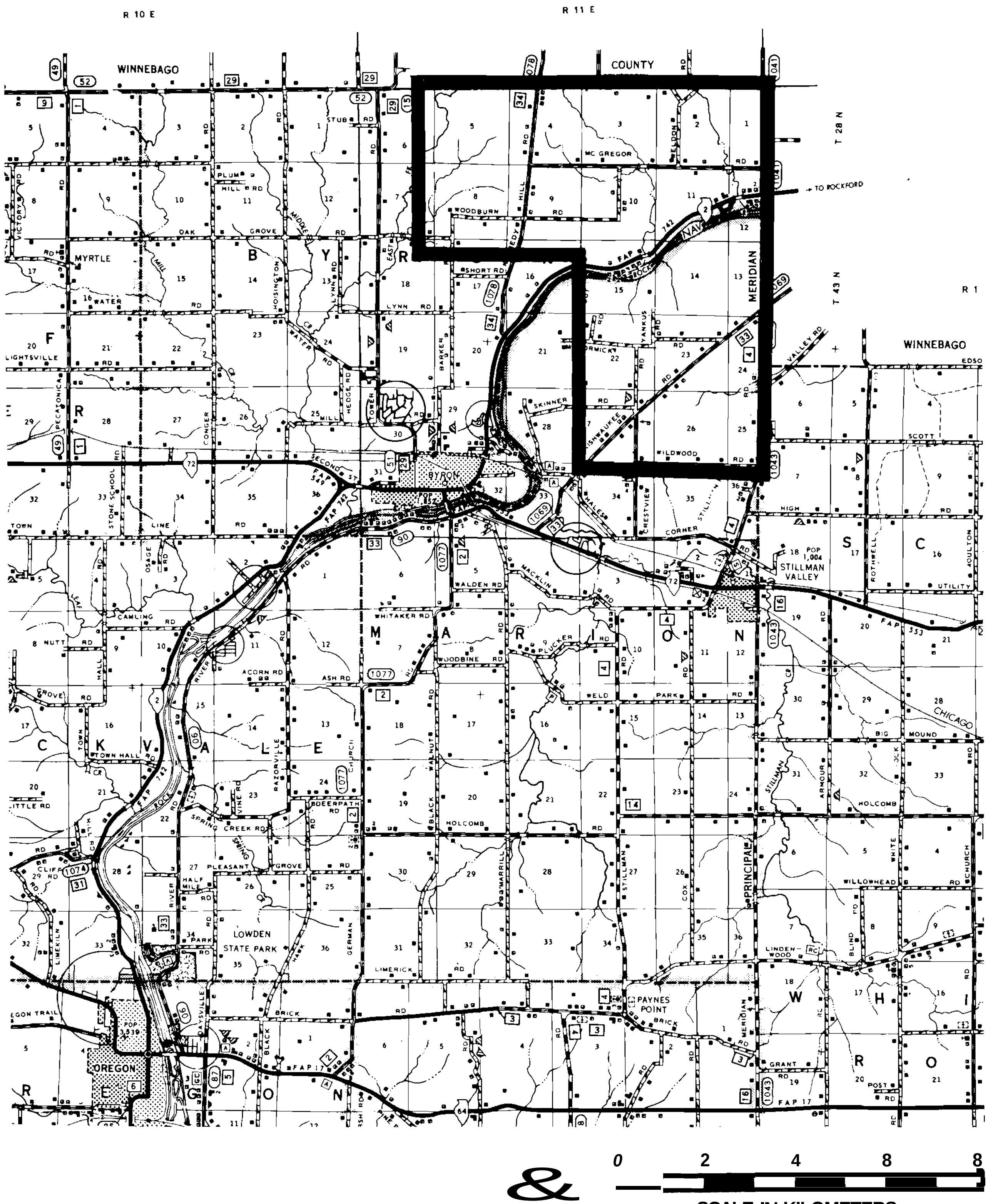
Adapted from Department of Transportation Maps

Figure 6-3

SITING AREA 3: STEPHENSON COUNTY - B

CAES

SITE SELECTION STUDY



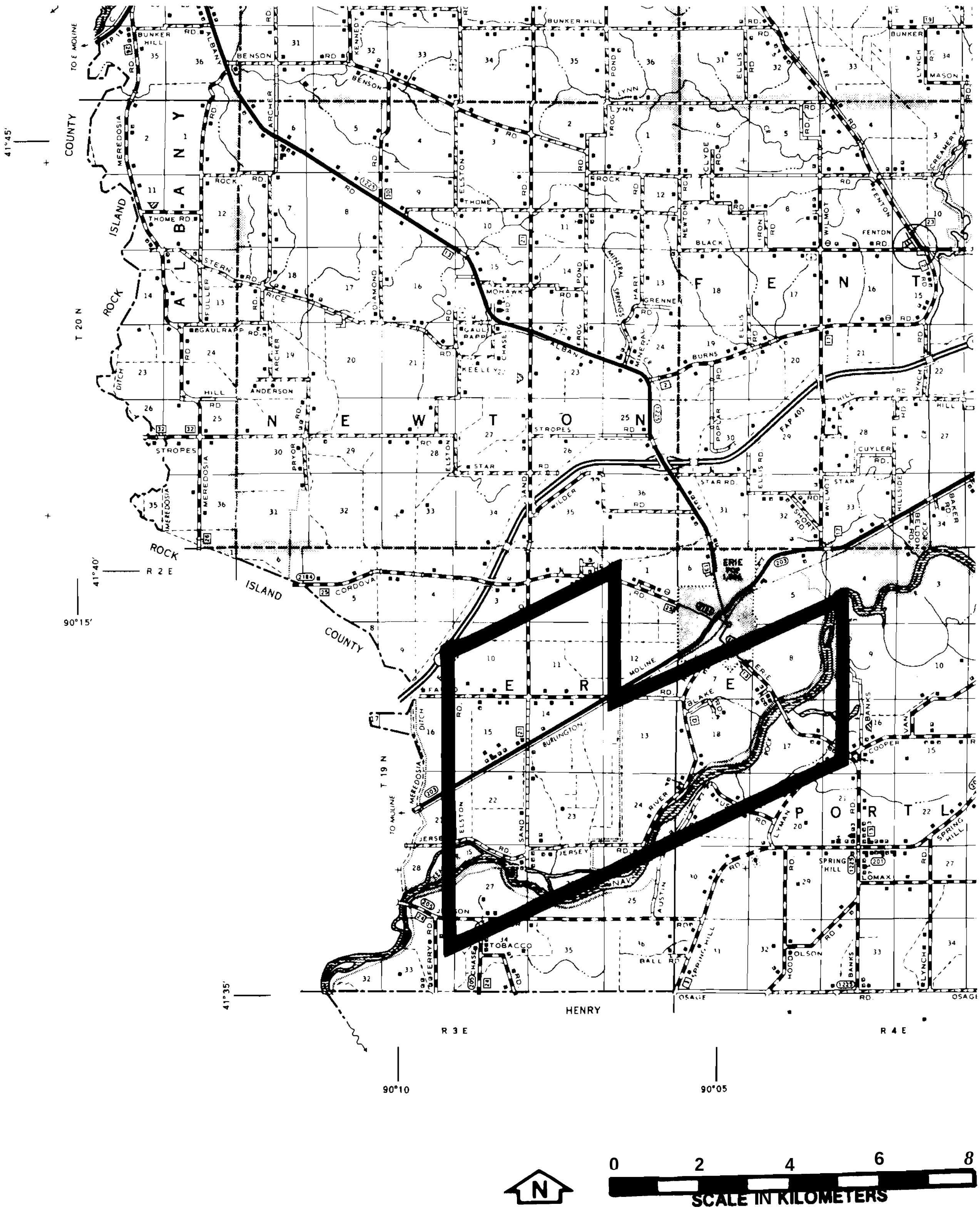
Adapted from Department of Transportation Maps

Figure 6-4

SITING AREA 4: OGLE COUNTY

CAES

SITE SELECTION STUDY



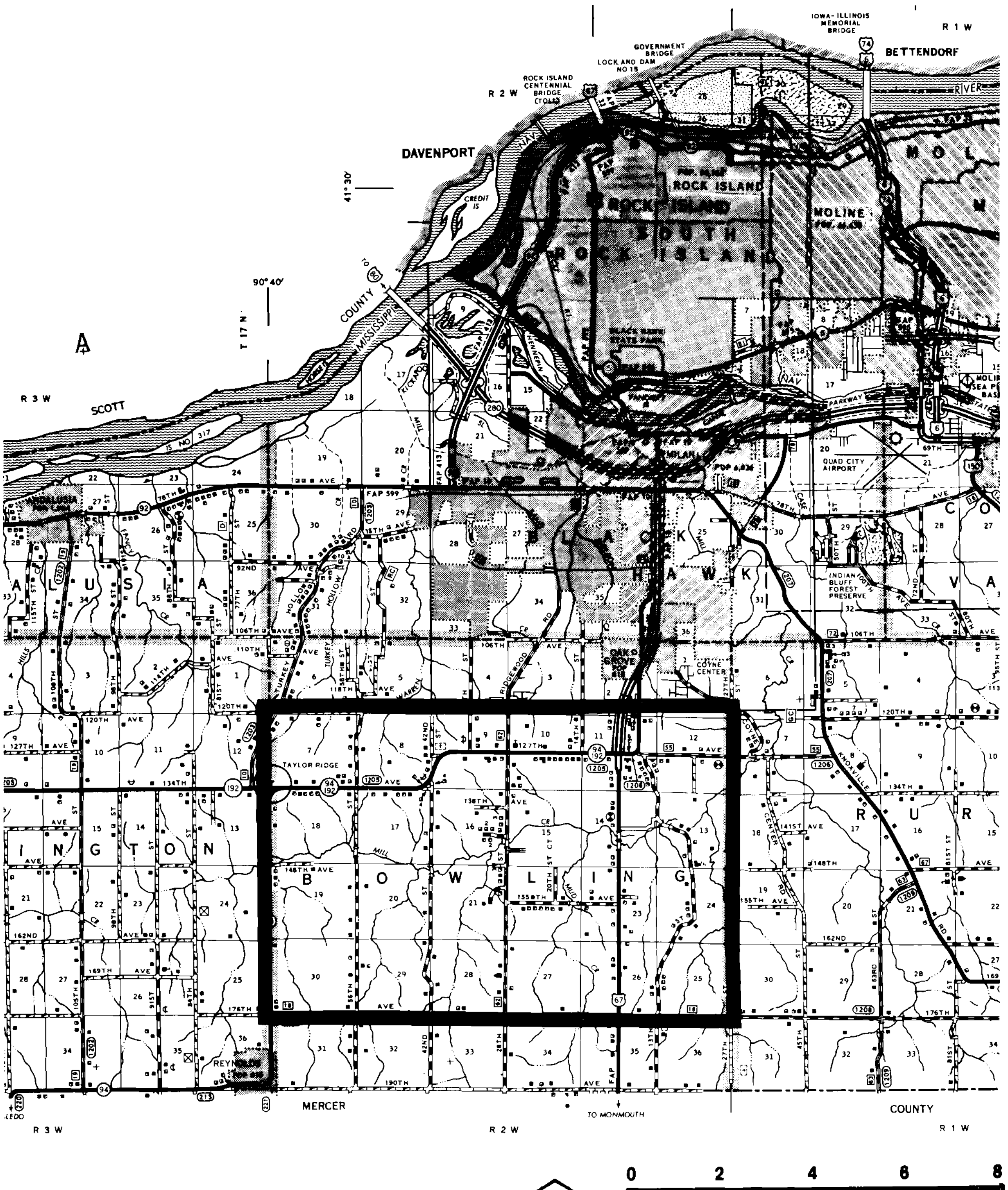
Adapted from Department of Transportation Maps

Figure 6-5

SITING AREA 5: WHITESIDE COUNTY

CAES

SITE SELECTION STUDY

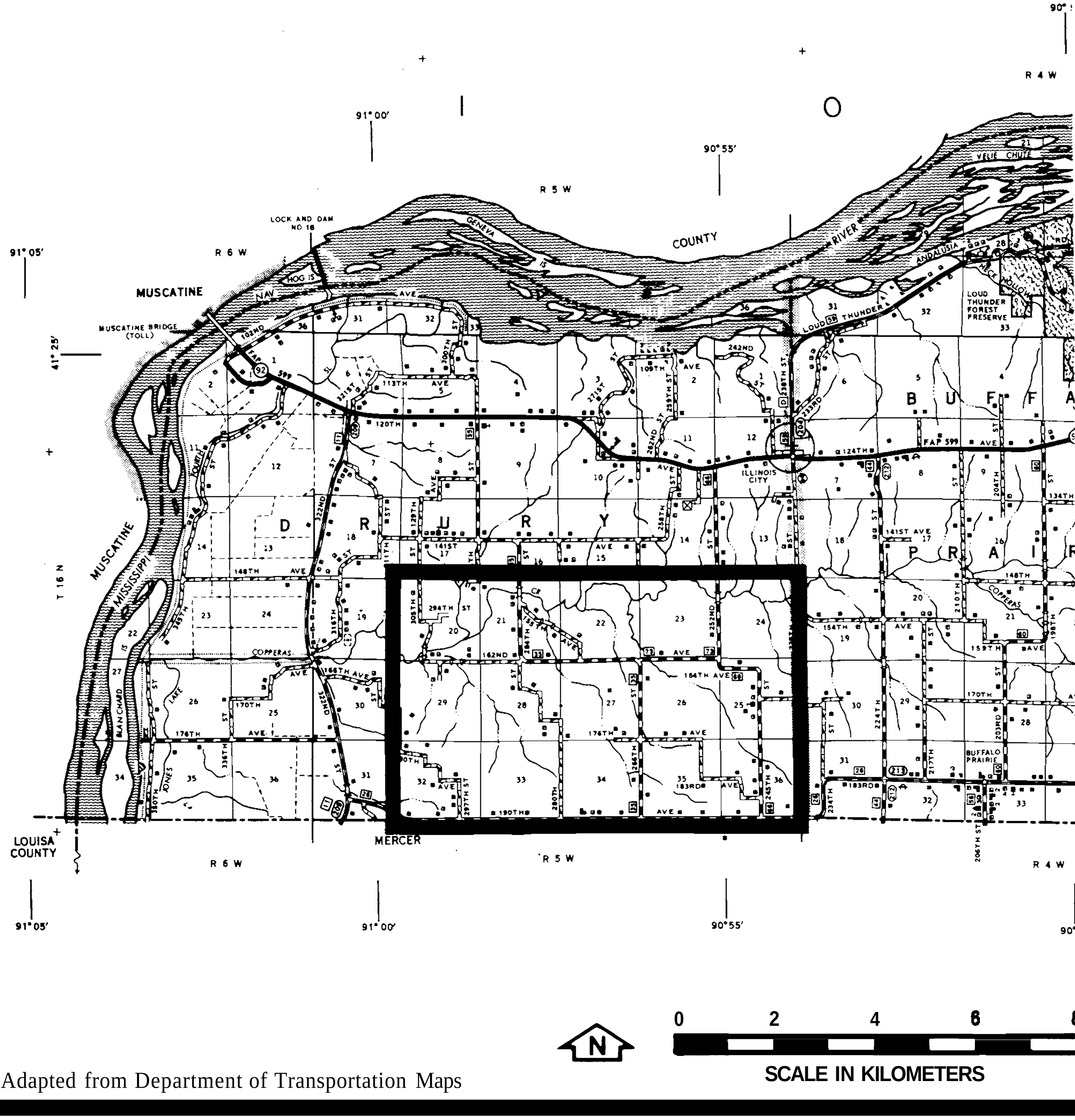


Adapted from Department of Transportation Maps

Figure 6-6

SITING AREA 6: ROCK ISLAND COUNTY - A

CAES
SITE SELECTION STUDY



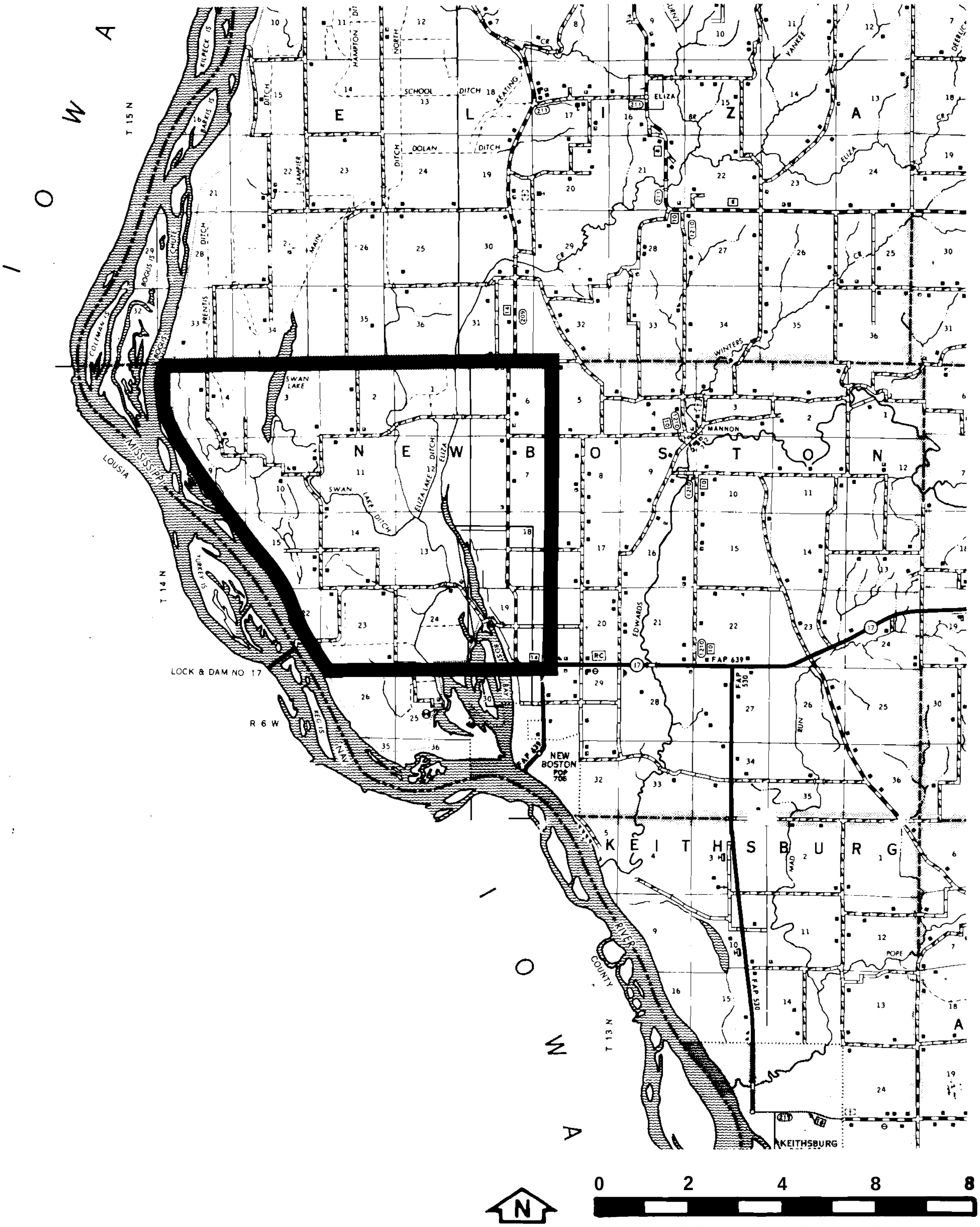
Adapted from Department of Transportation Maps

Figure 6-7

SITING AREA 7: ROCK ISLAND COUNTY - B

CAES

SITE SELECTION STUDY



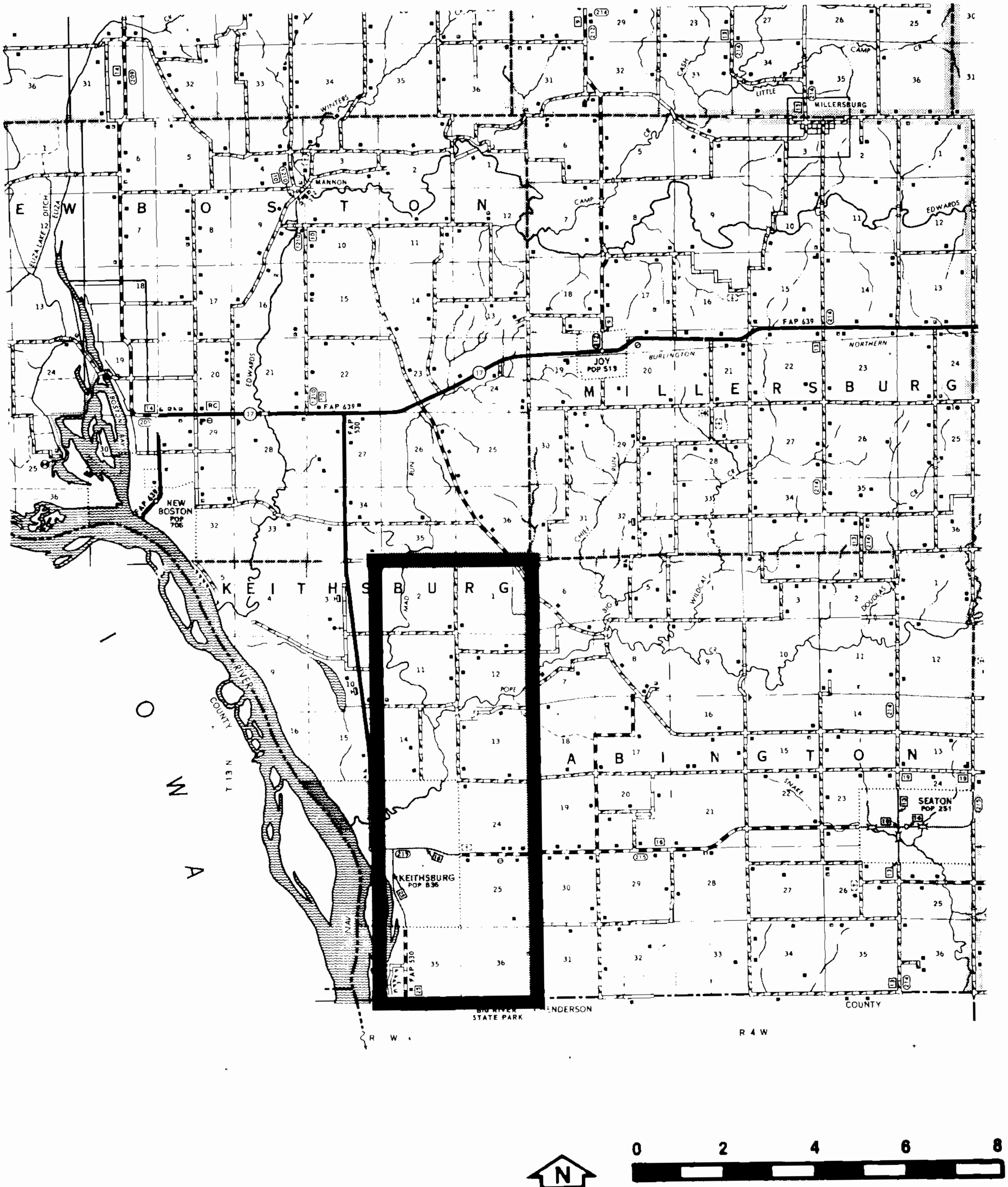
Adapted from Department of Transportation Maps

Figure 6-8

SITING AREA 8: MERCER COUNTY - A

CAES

SITE SELECTION STUDY

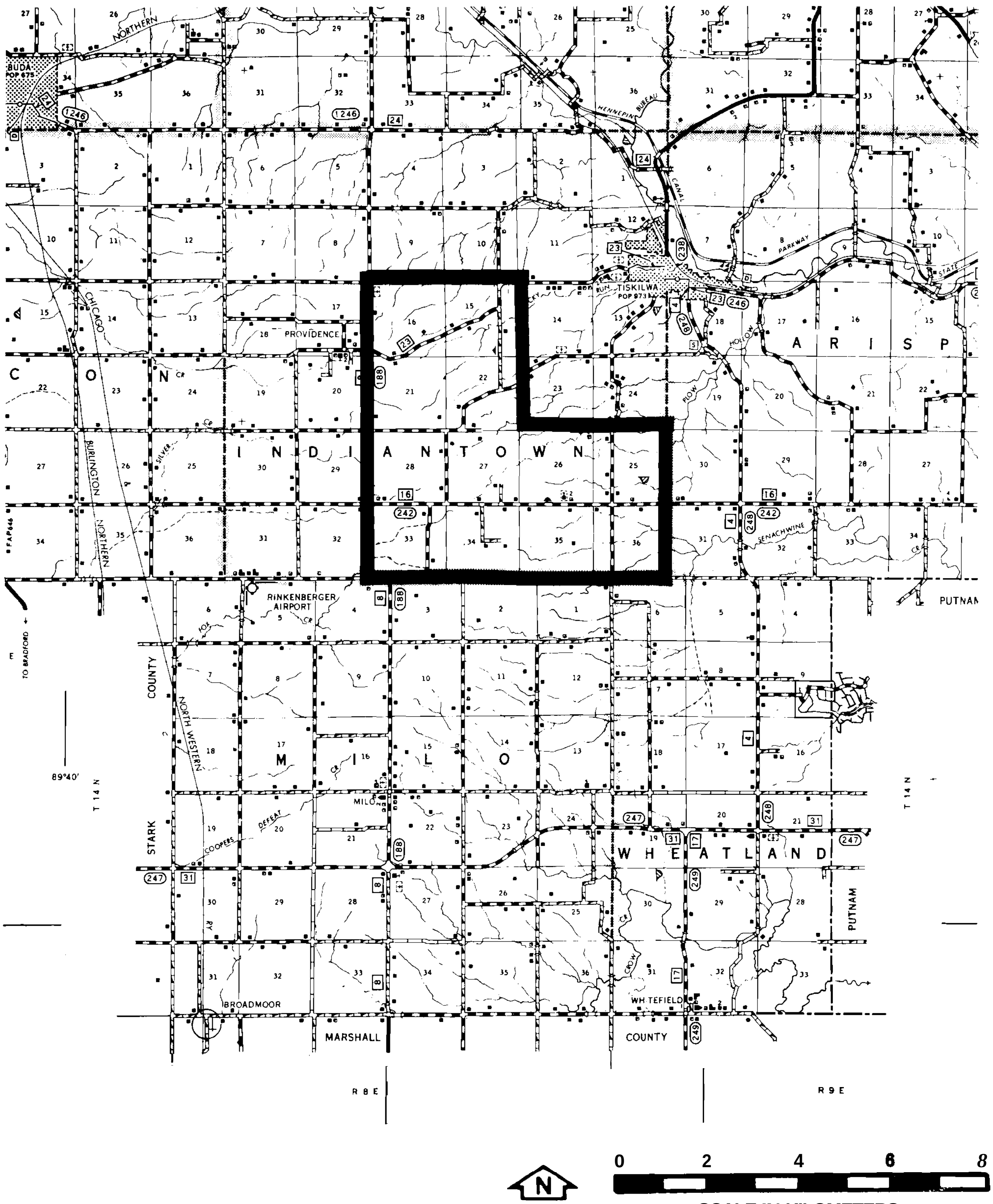


Adapted from Department of Transportation Maps

Figure 6-9

SITING AREA 9: MERCER COUNTY - B

CAES
SITE SELECTION STUDY



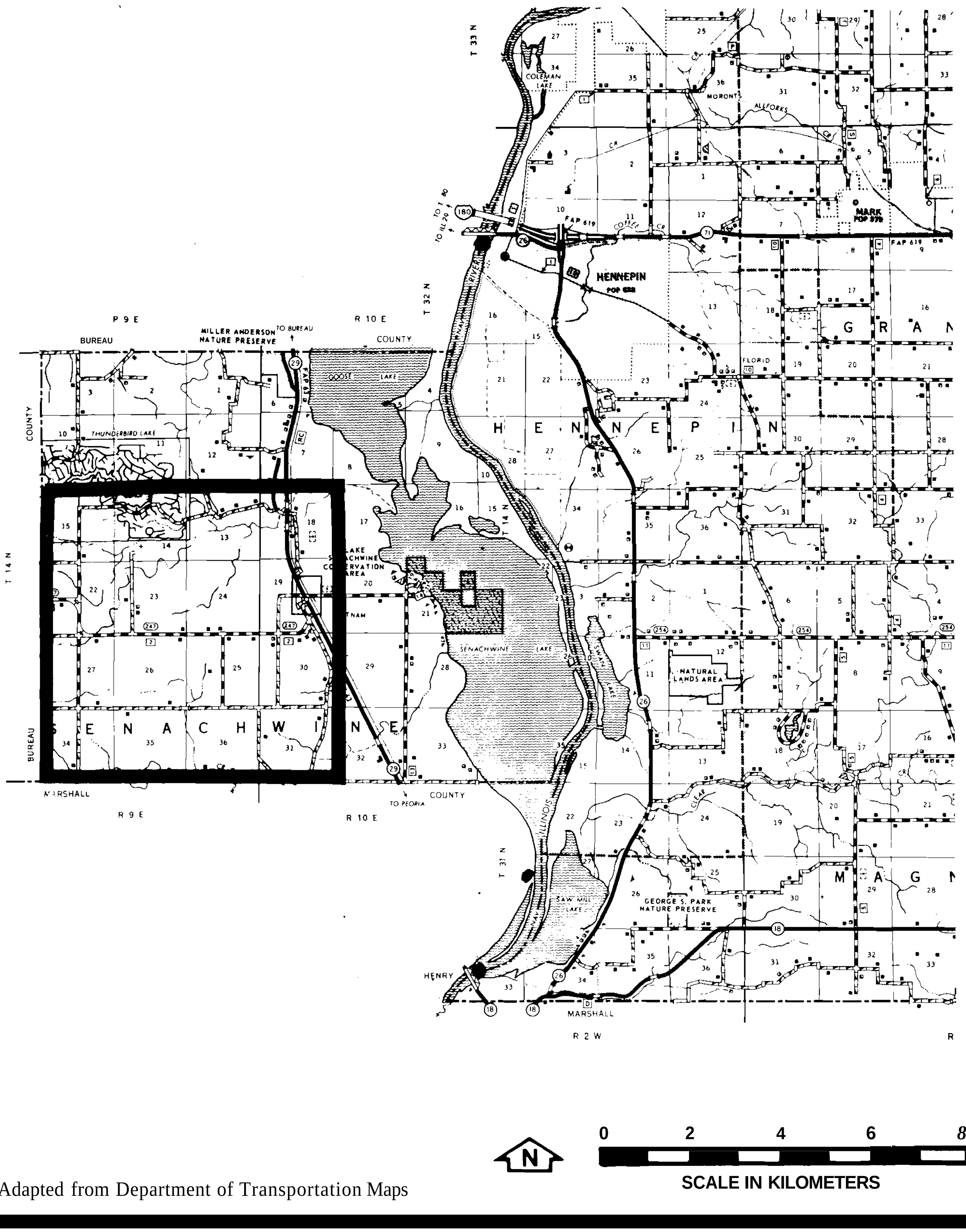
Adapted from Department of Transportation Maps

Figure 6-10

SITING AREA 10: BUREAU COUNTY

CAES

SITE SELECTION STUDY



Adapted from Department of Transportation Maps

Figure 6-11

SITING AREA 11: PUTNAM COUNTY

CAES
SITE SELECTION STUDY

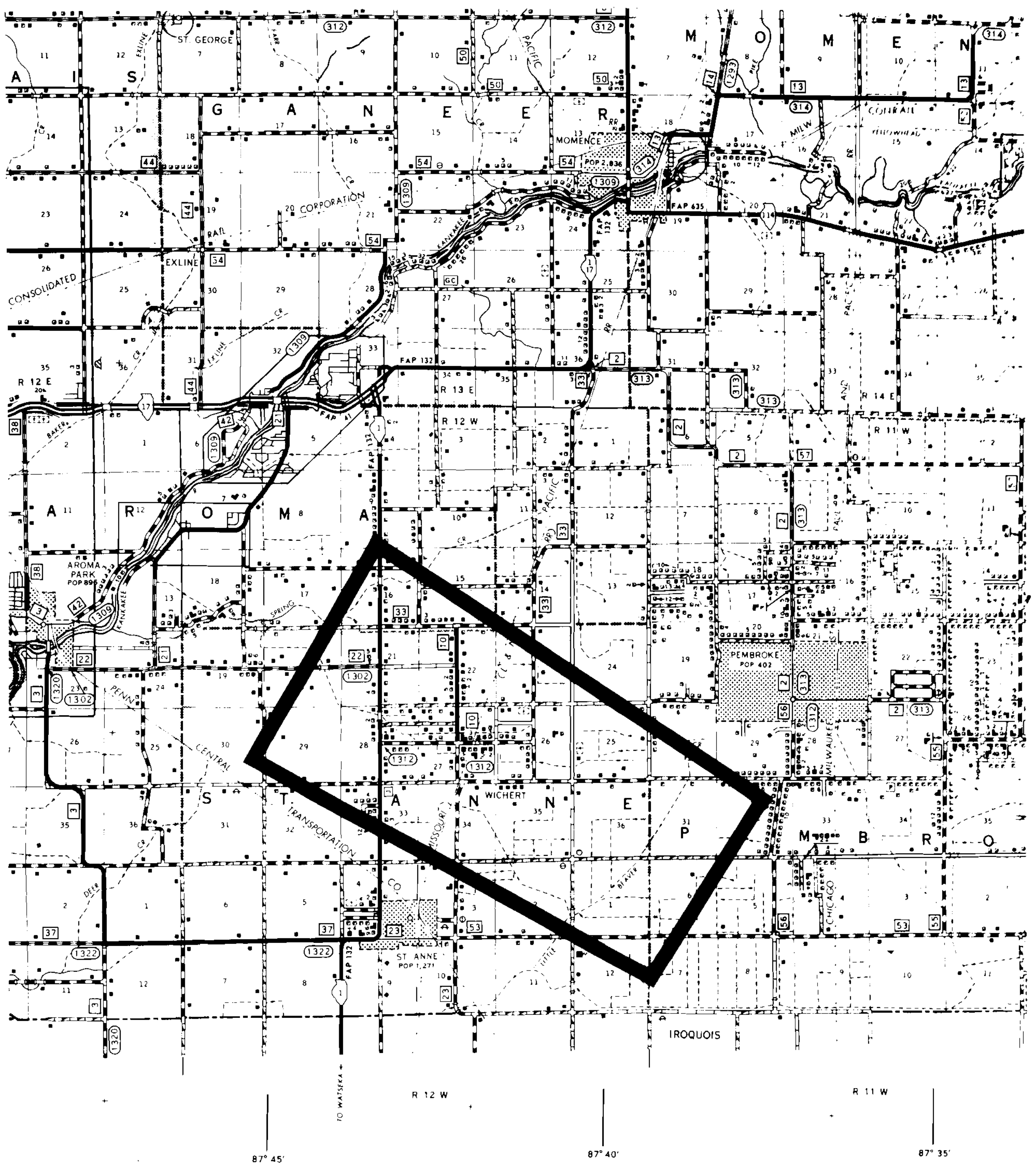
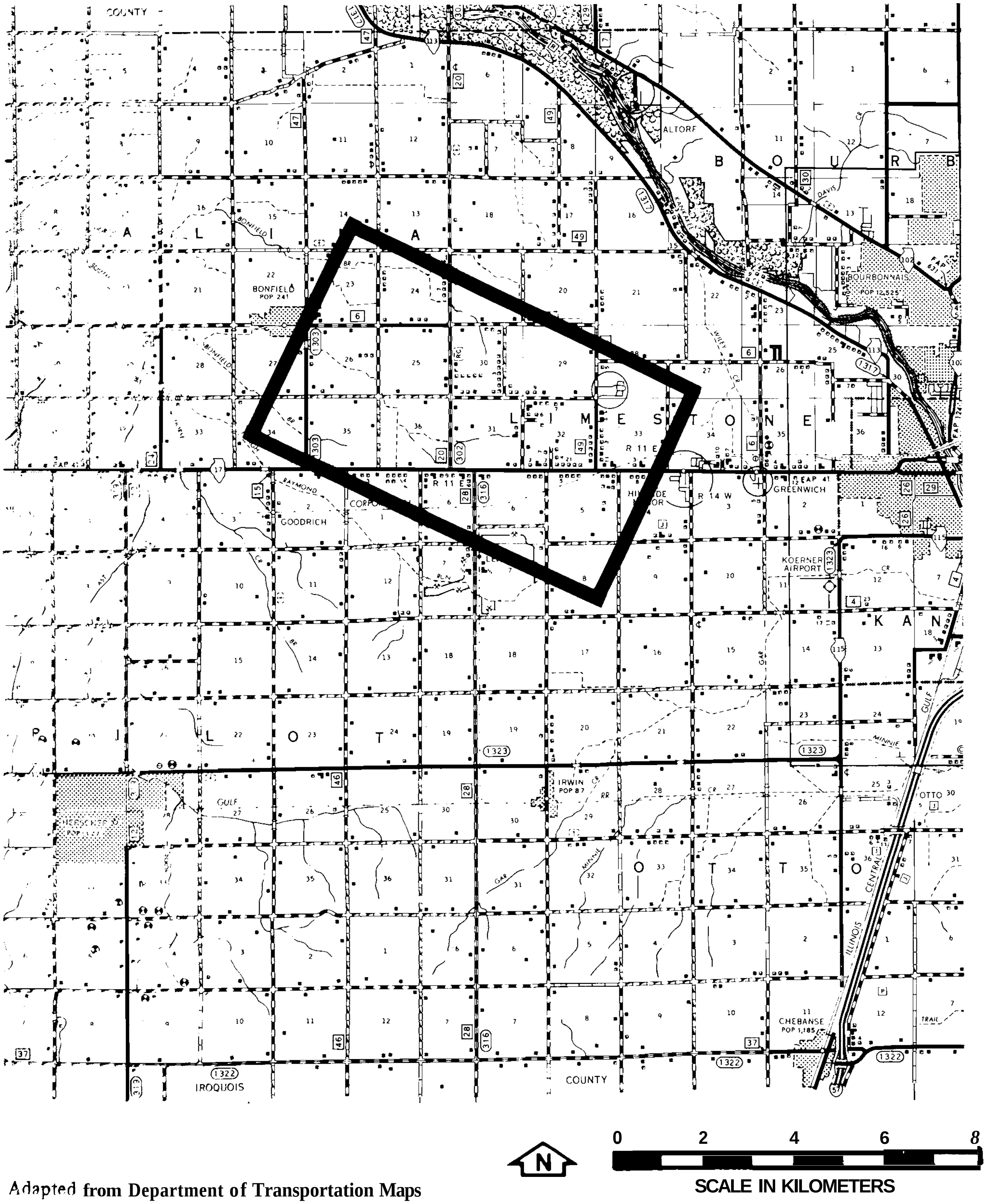


Figure 6-12

SITING AREA 12: KANKAKEE COUNTY - A

CAES
SITE SELECTION STUDY



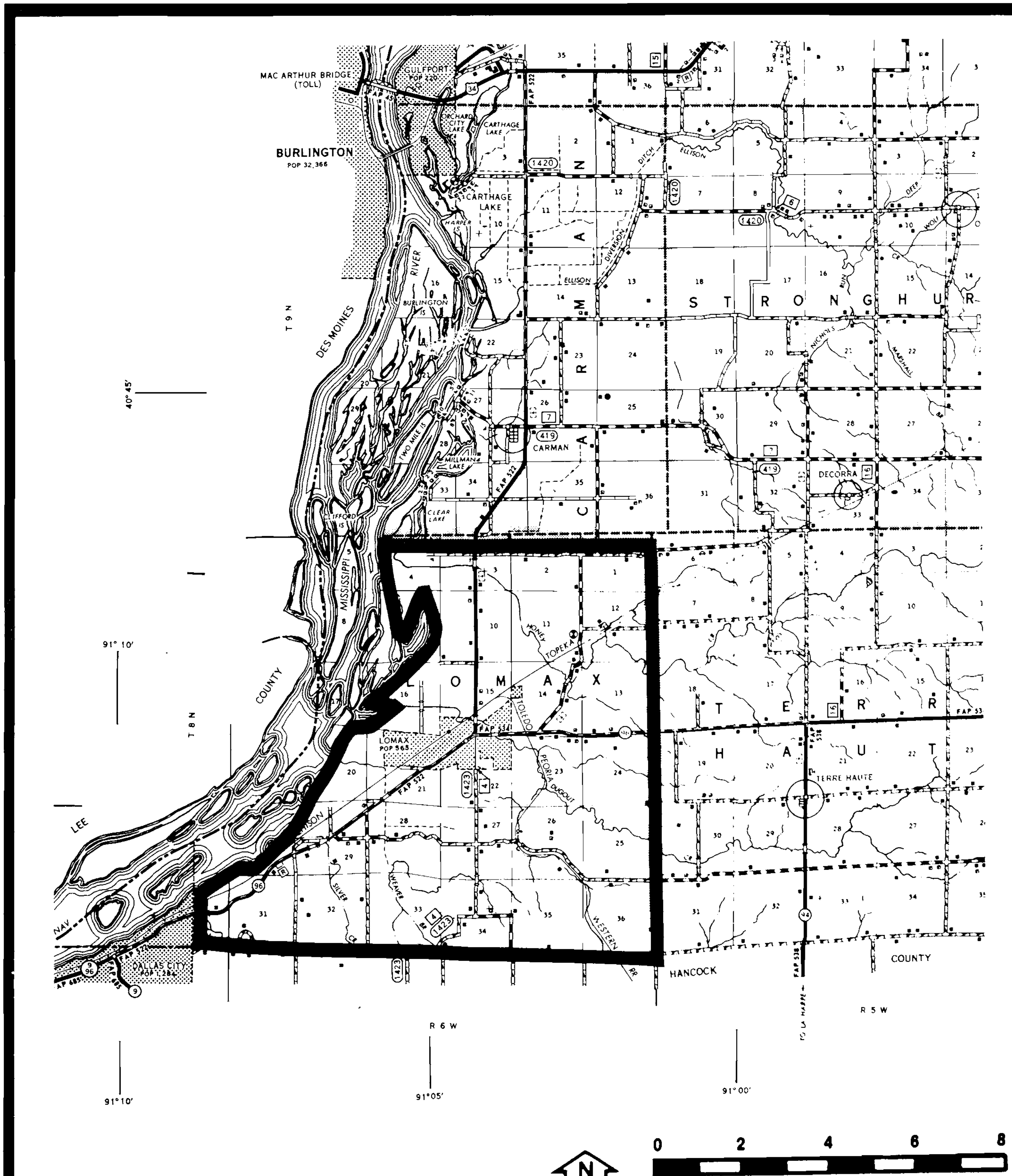
Adapted from Department of Transportation Maps

Figure 6-13

SITING AREA 13: KANKAKEE COUNTY - B

CAES

SITE SELECTION STUDY



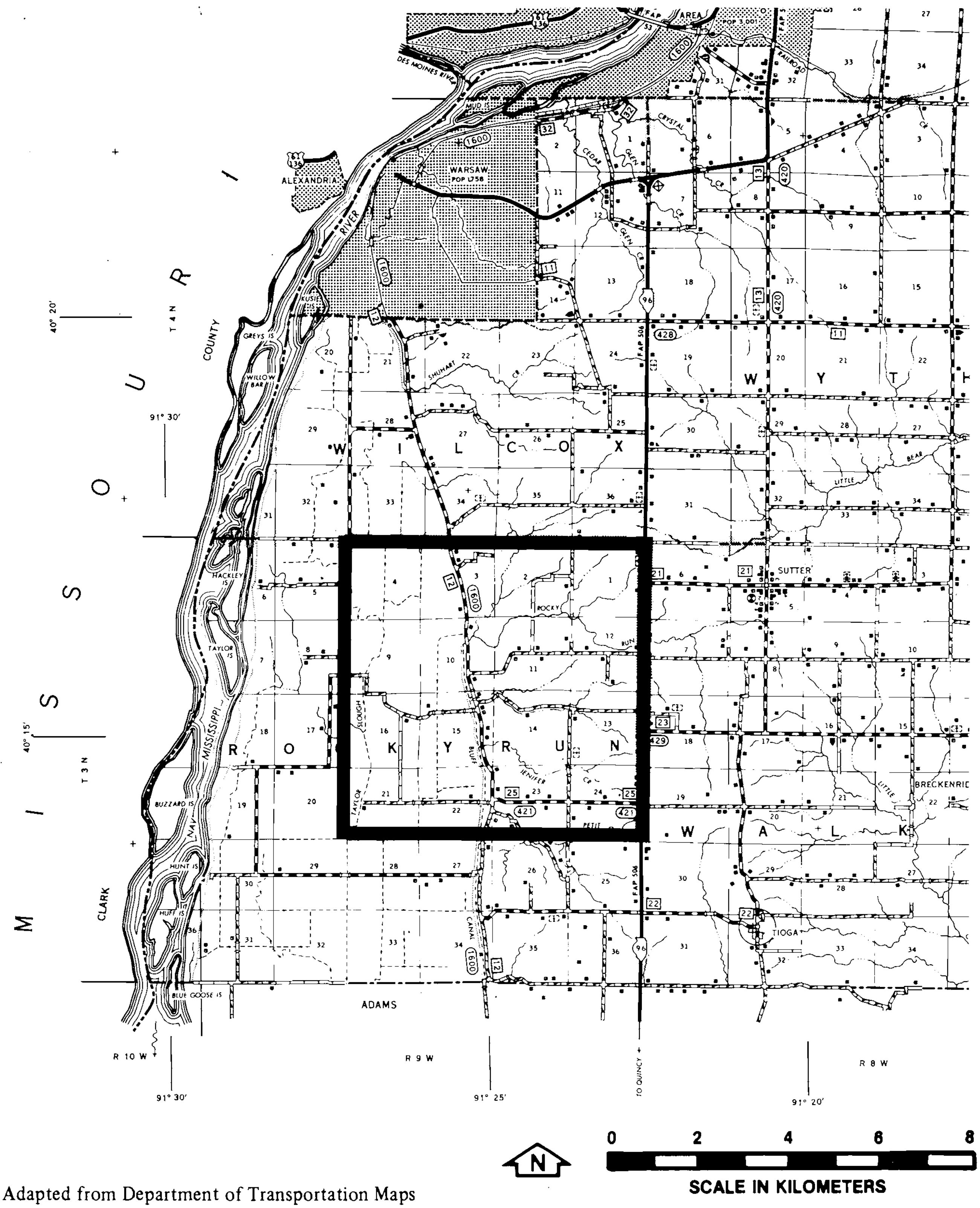
Adapted from Department of Transportation Maps

Figure 6-14

SITING AREA 14: HENDERSON COUNTY

CAES

SITE SELECTION STUDY



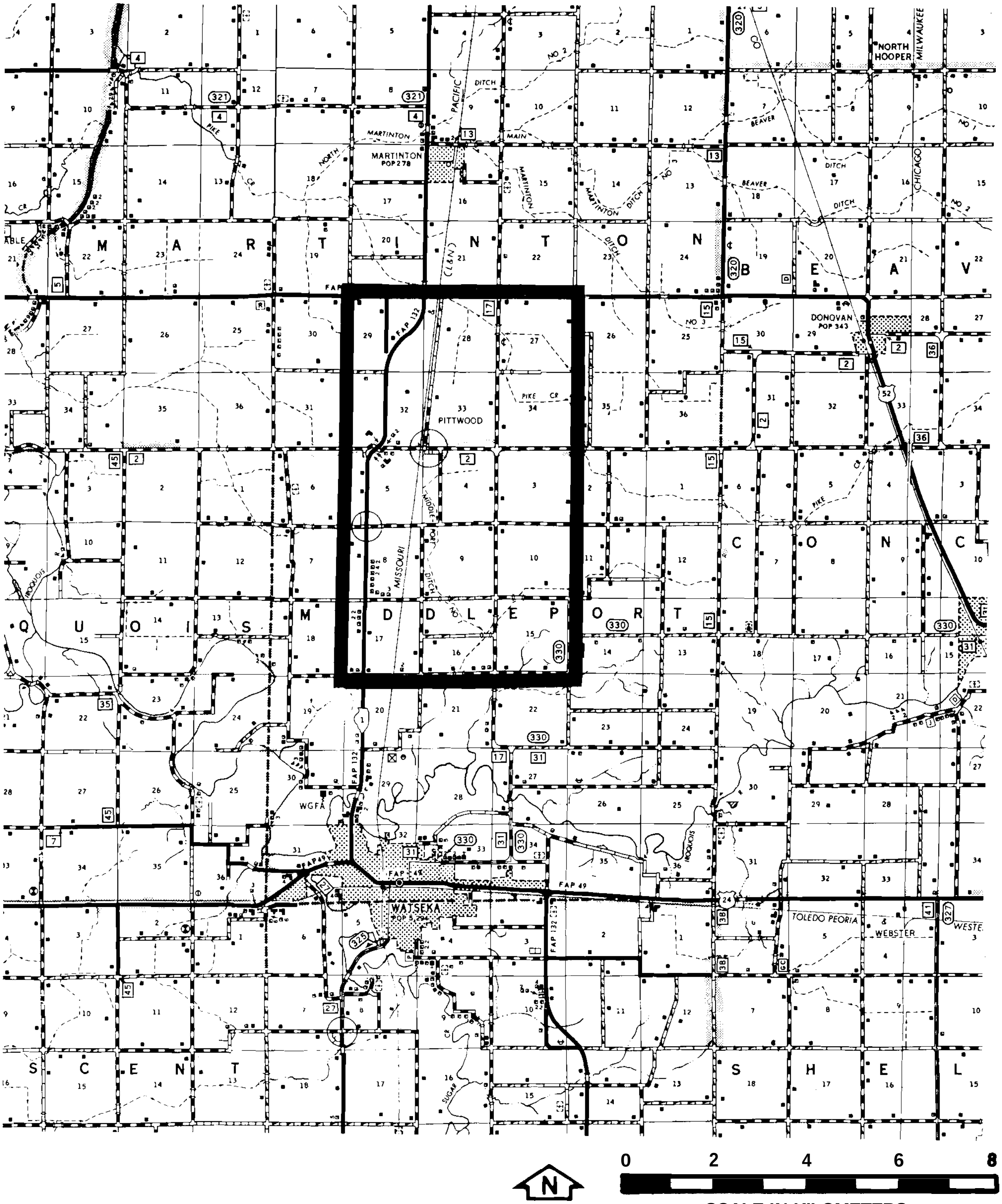
Adapted from Department of Transportation Maps

Figure 6-15

SITING AREA 15: HANCOCK COUNTY

CAES

SITE SELECTION STUDY



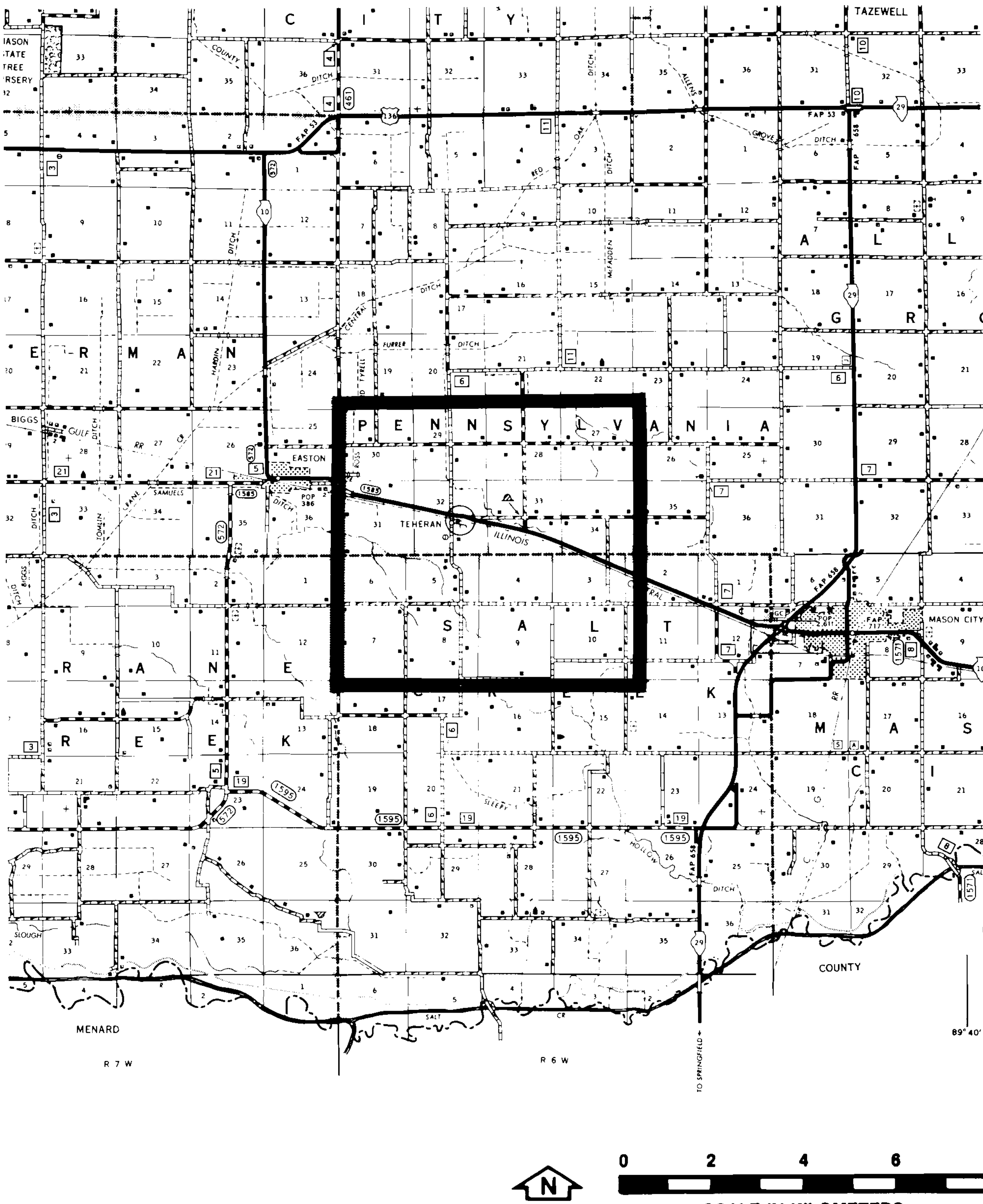
Adapted from Department of Transportation Maps

Figure 6-16

SITING AREA 16: IROQUOIS COUNTY

CAES

SITE SELECTION STUDY



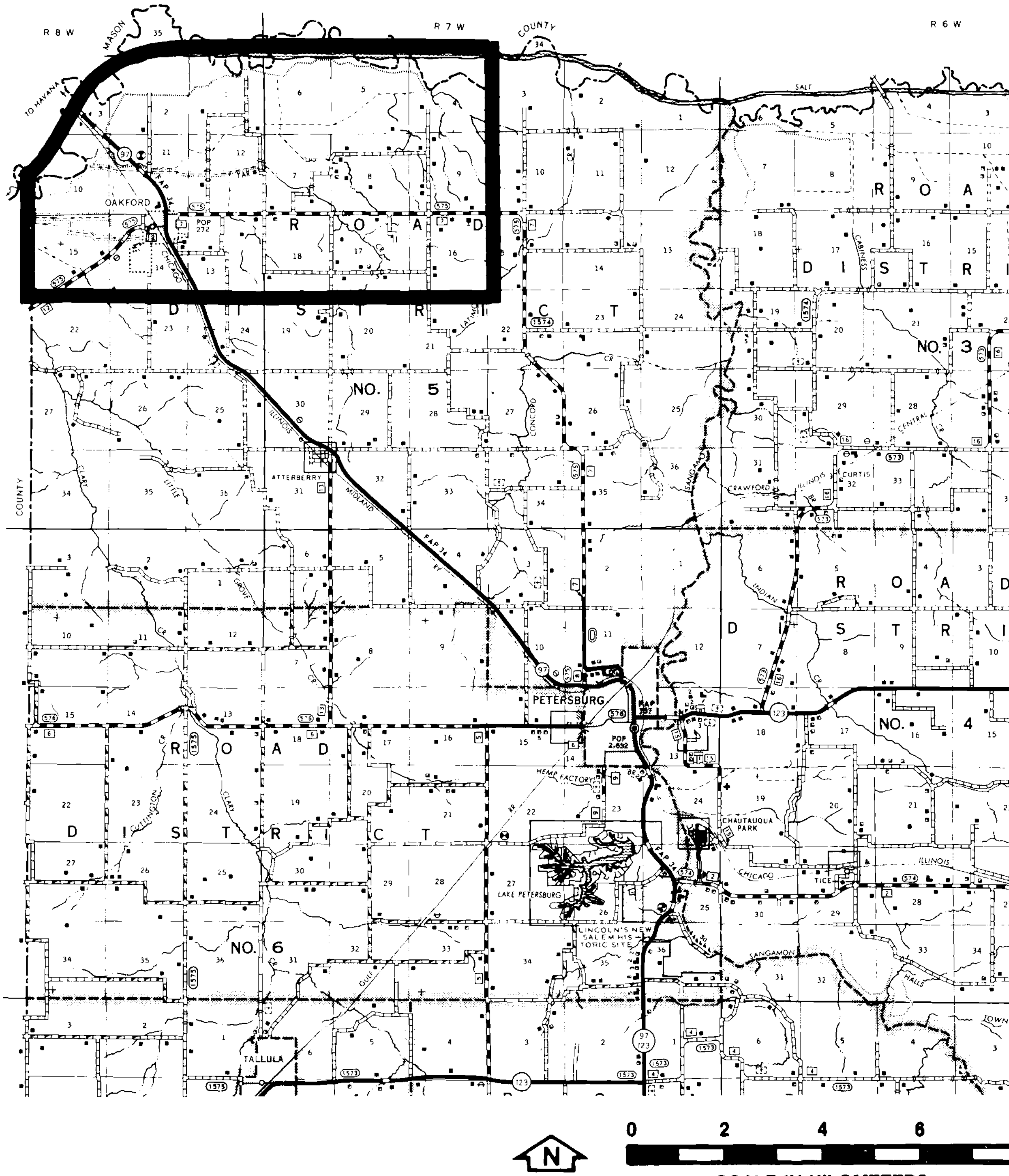
Adapted from Department of Transportation Maps

Figure 6-17

SITING AREA 17: MASON COUNTY

CAES

SITE SELECTION STUDY



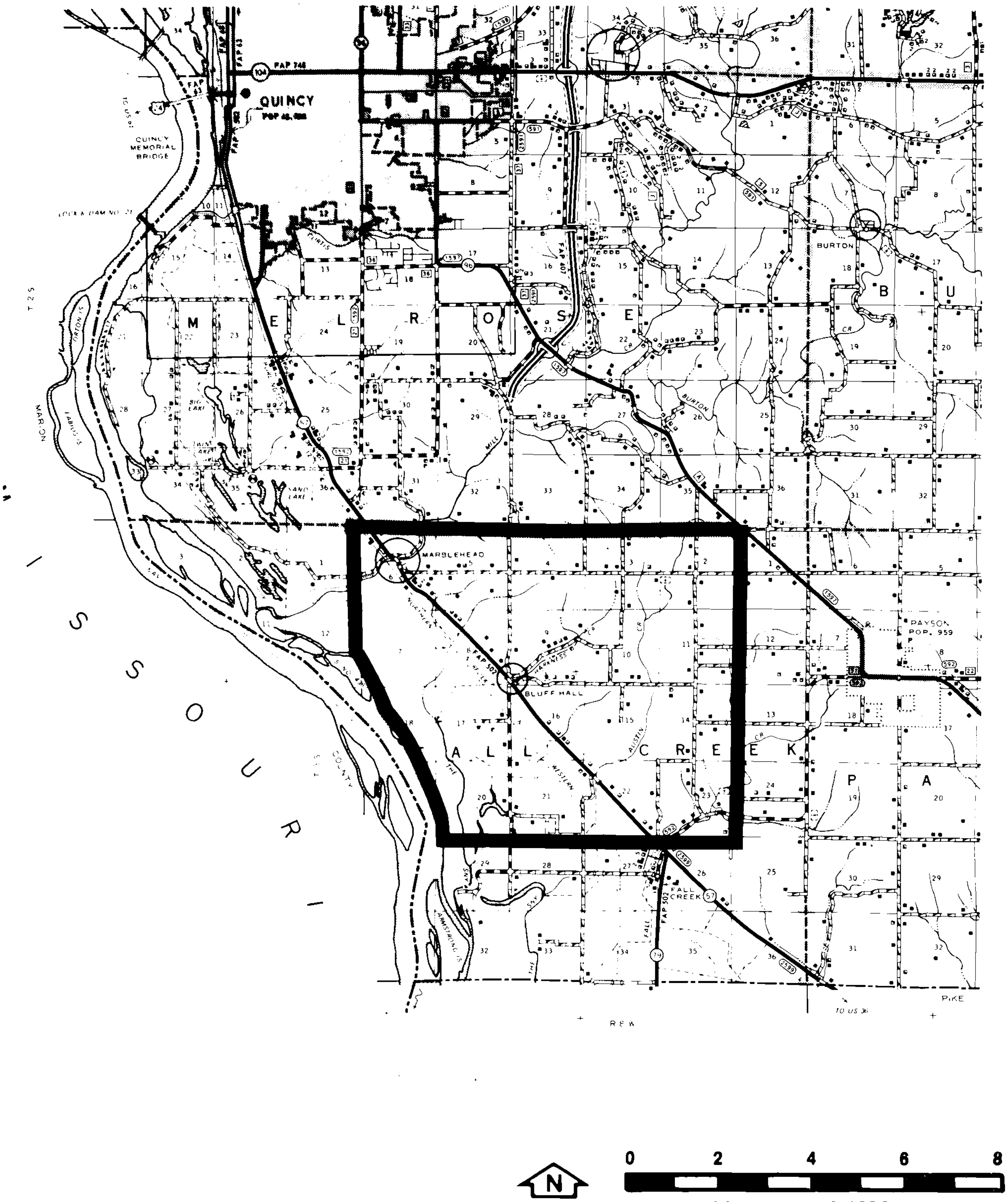
Adapted from Department of Transportation Maps

Figure 6-18

SITING AREA 18: MENARD COUNTY

CAES

SITE SELECTION STUDY



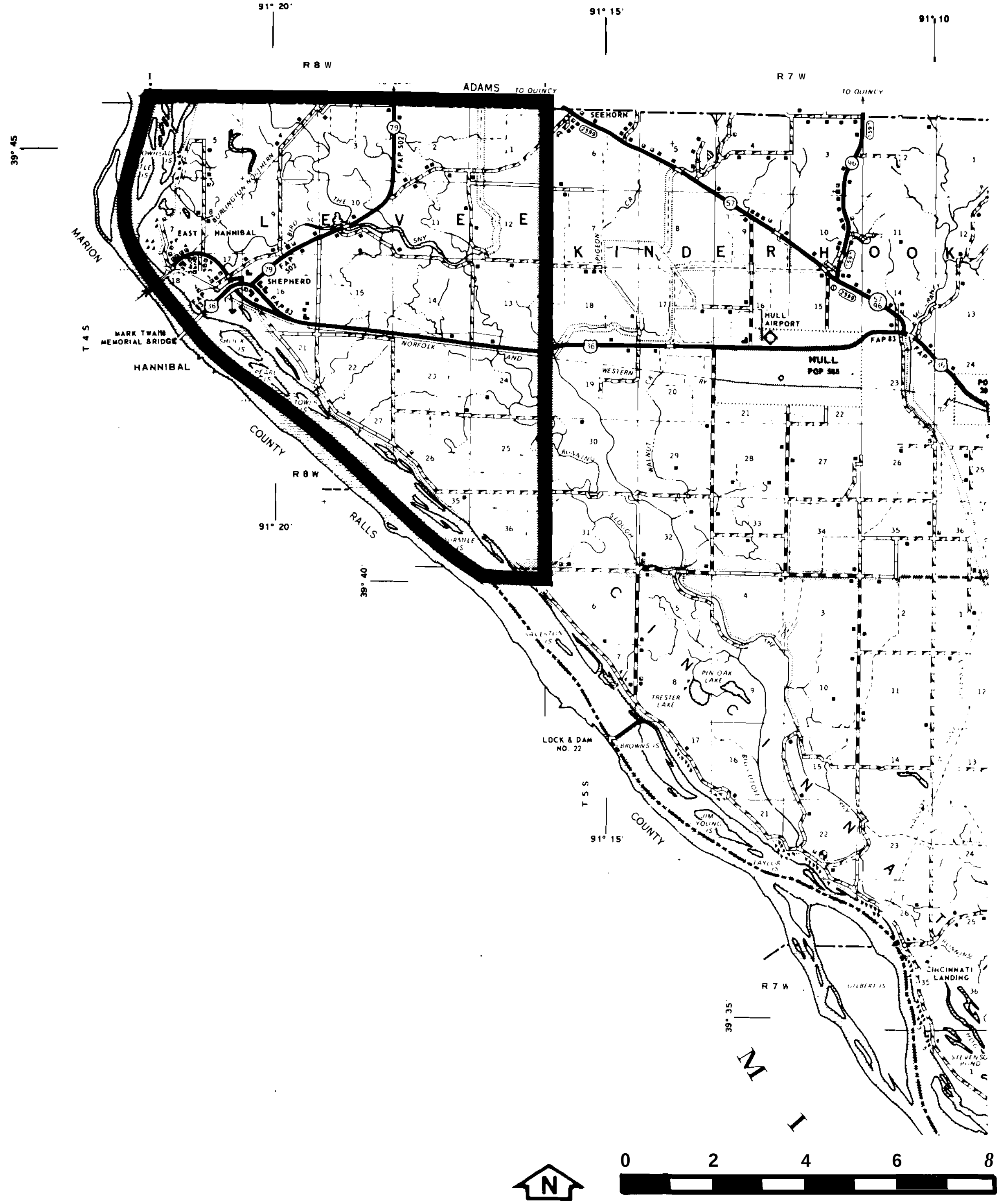
Adapted from Department of Transportation Maps

Figure 6-19

SITING AREA 19: ADAMS COUNTY

CAES

SITE SELECTION STUDY

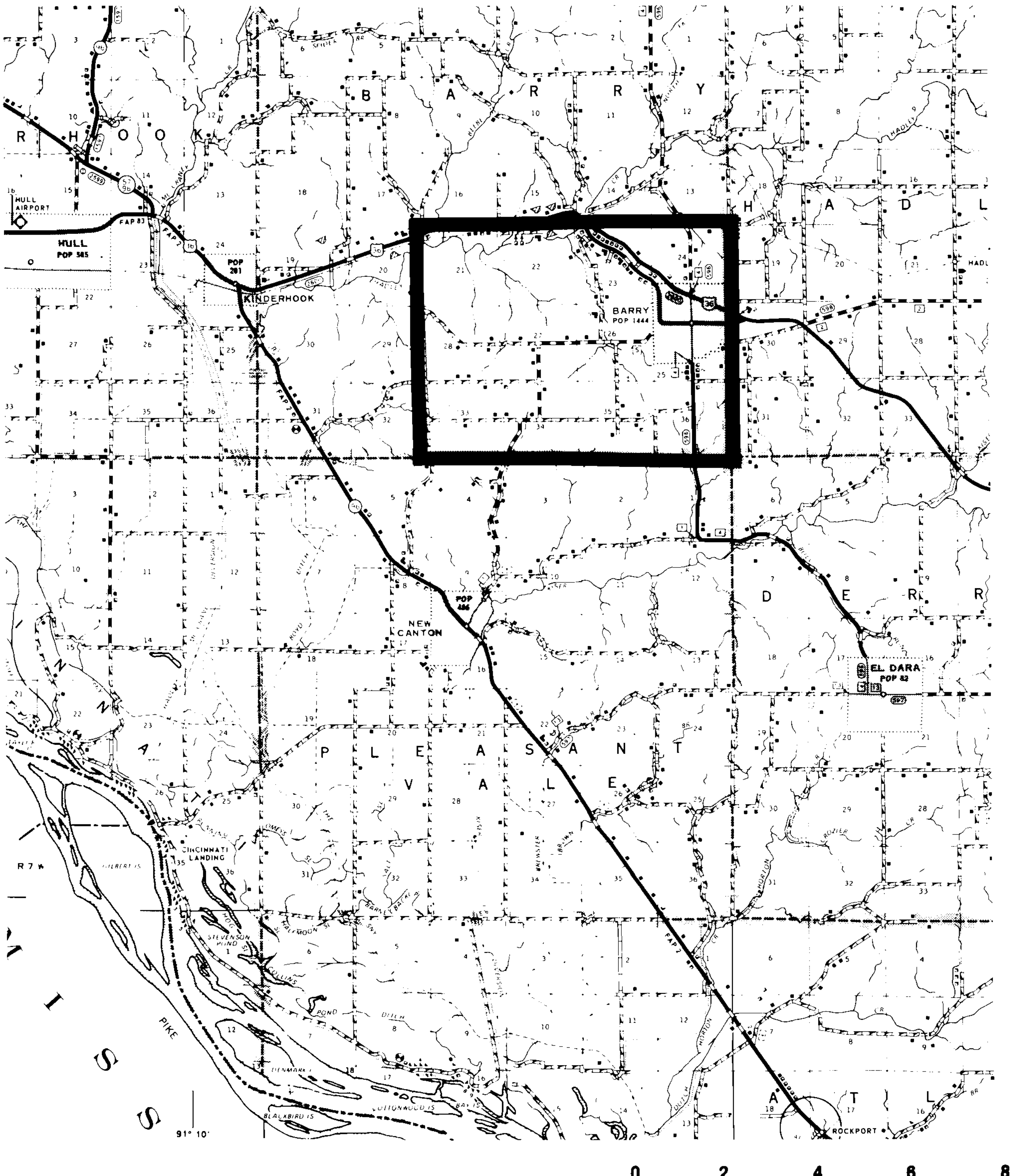


Adapted from Department of Transportation Maps

Figure 6-20

SITING AREA 20: PIKE COUNTY - A

CAES
SITE SELECTION STUDY



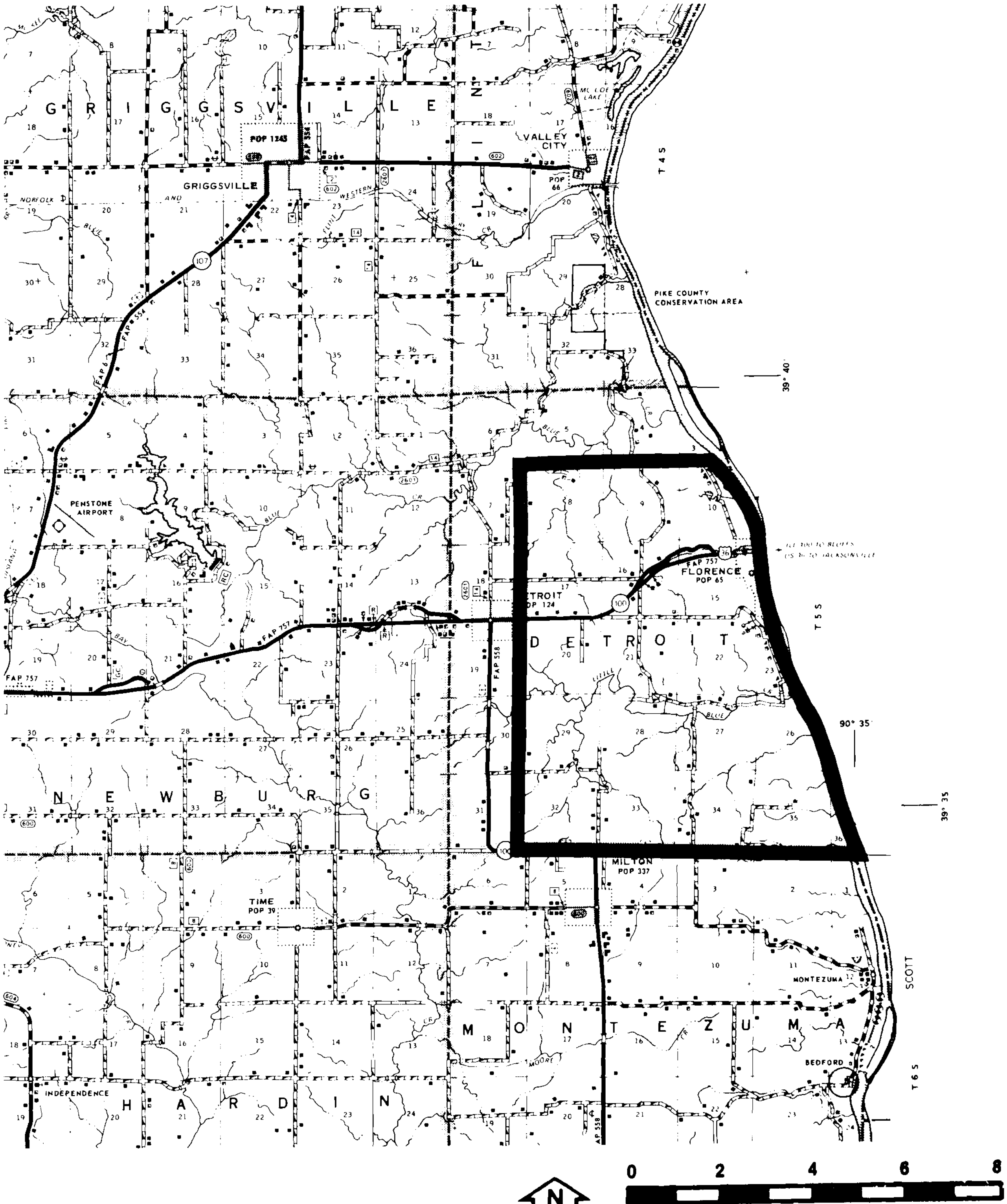
Adapted from Department of Transportation Maps

Figure 6-21

SITING AREA 21: PIKE COUNTY - B

CAES

SITE SELECTION STUDY



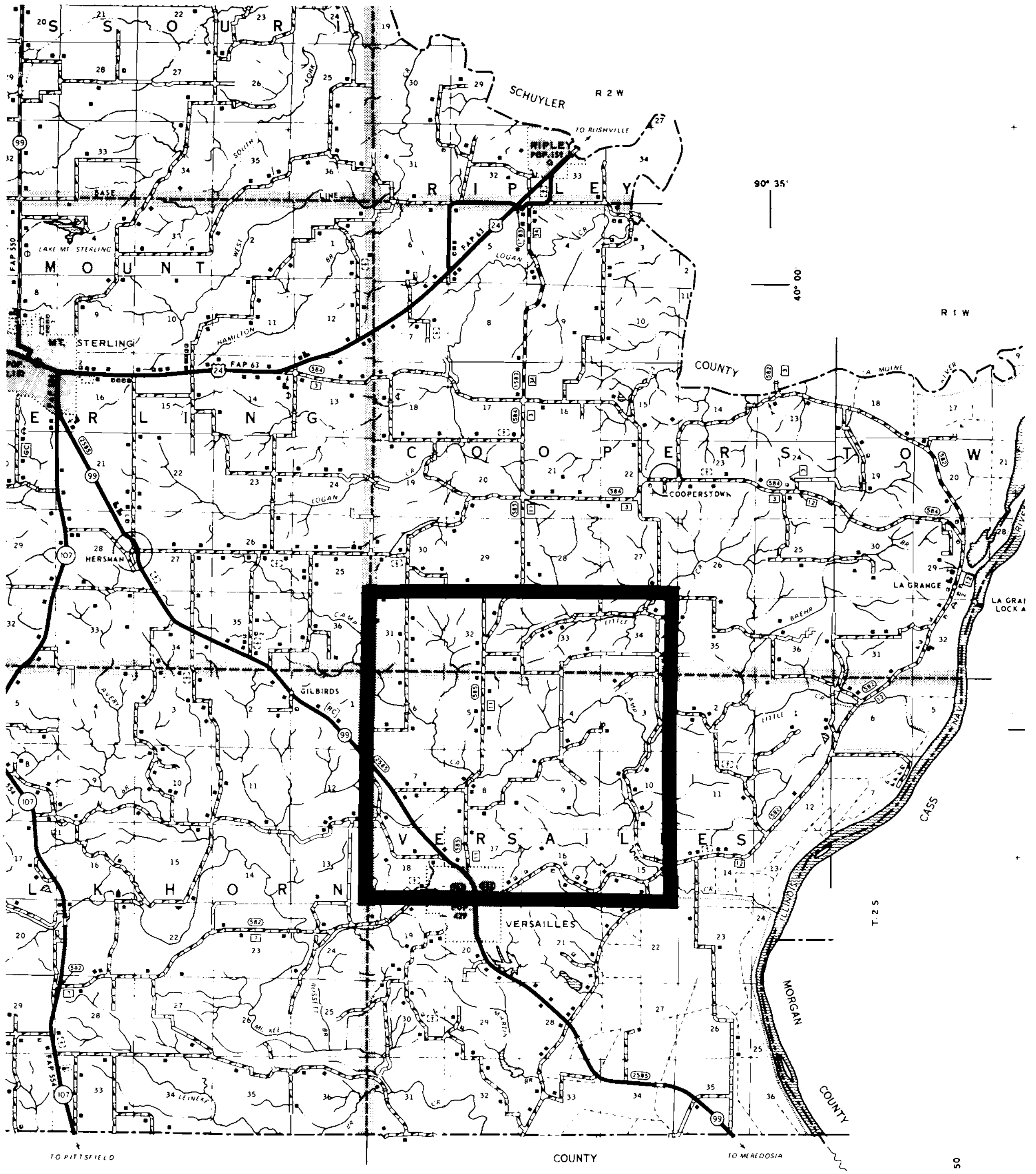
Adapted from Department of Transportation Maps

Figure 6-22

SITING AREA 22: PIKE COUNTY - C

CAES

SITE SELECTION STUDY



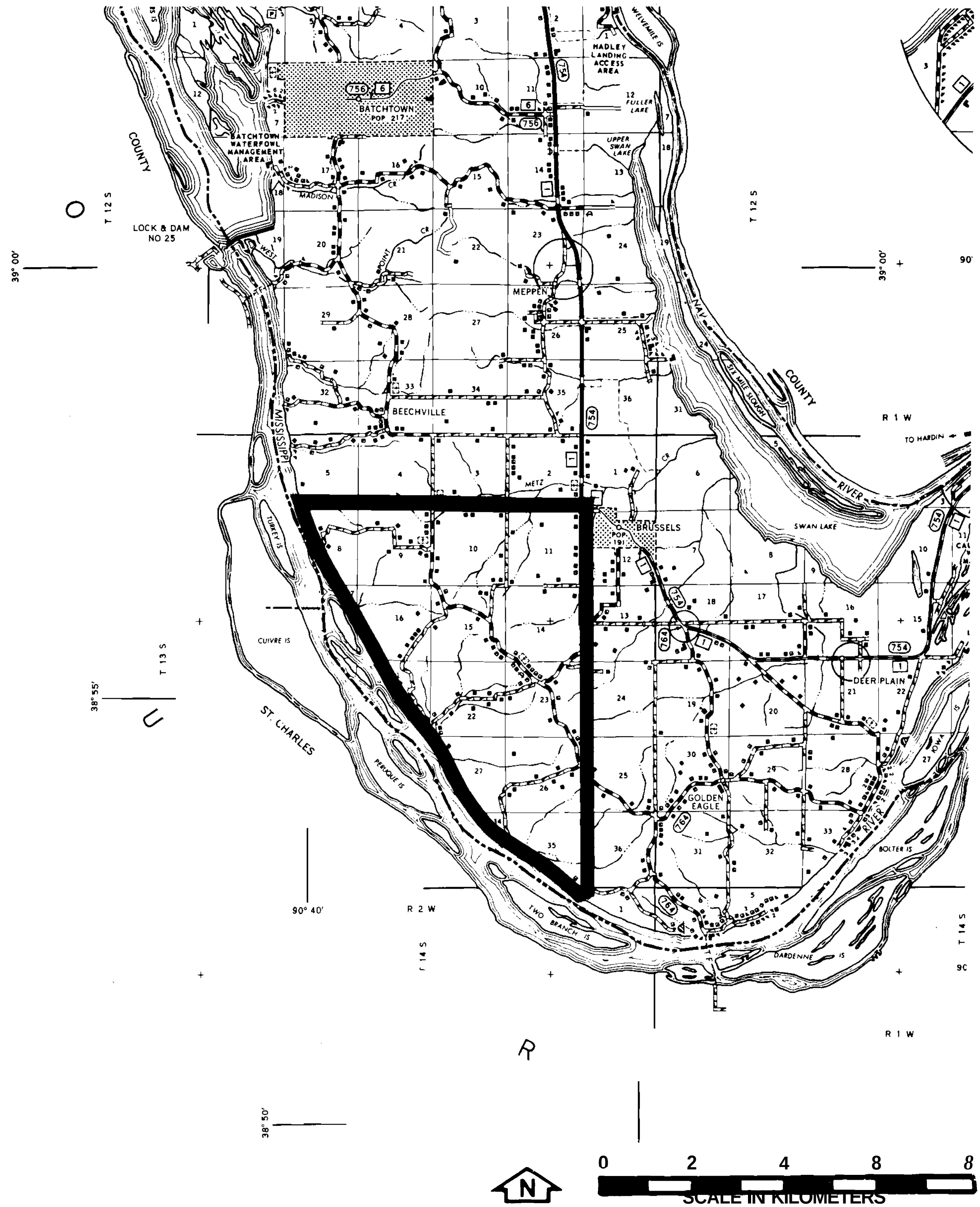
Adapted from Department of Transportation Maps

Figure 6-23

SITING AREA 23: BROWN COUNTY

CAES

SITE SELECTION STUDY

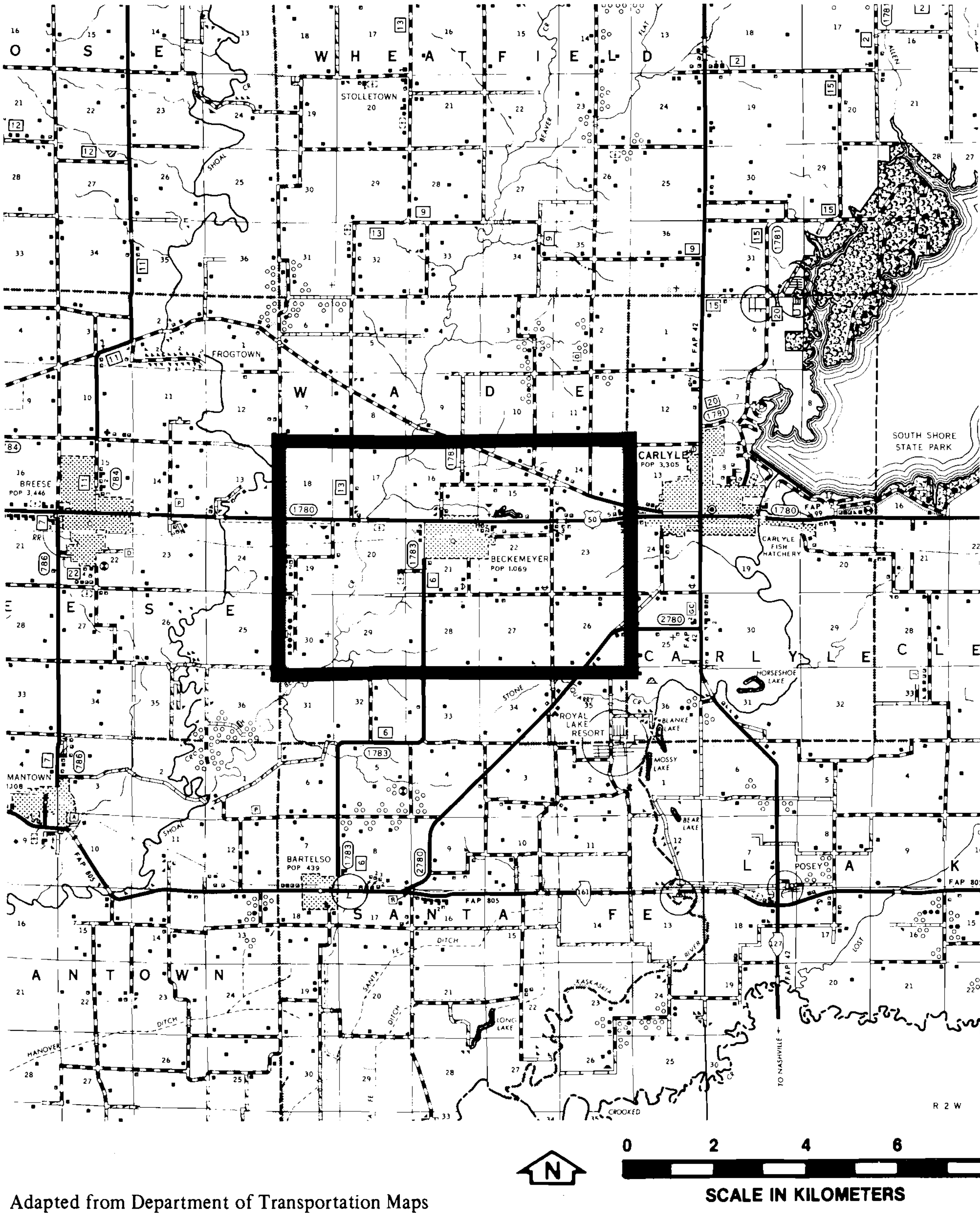


Adapted from Department of Transportation Maps

Figure 6-24

SITING AREA 24: CALHOUN COUNTY

CAES
SITE SELECTION STUDY



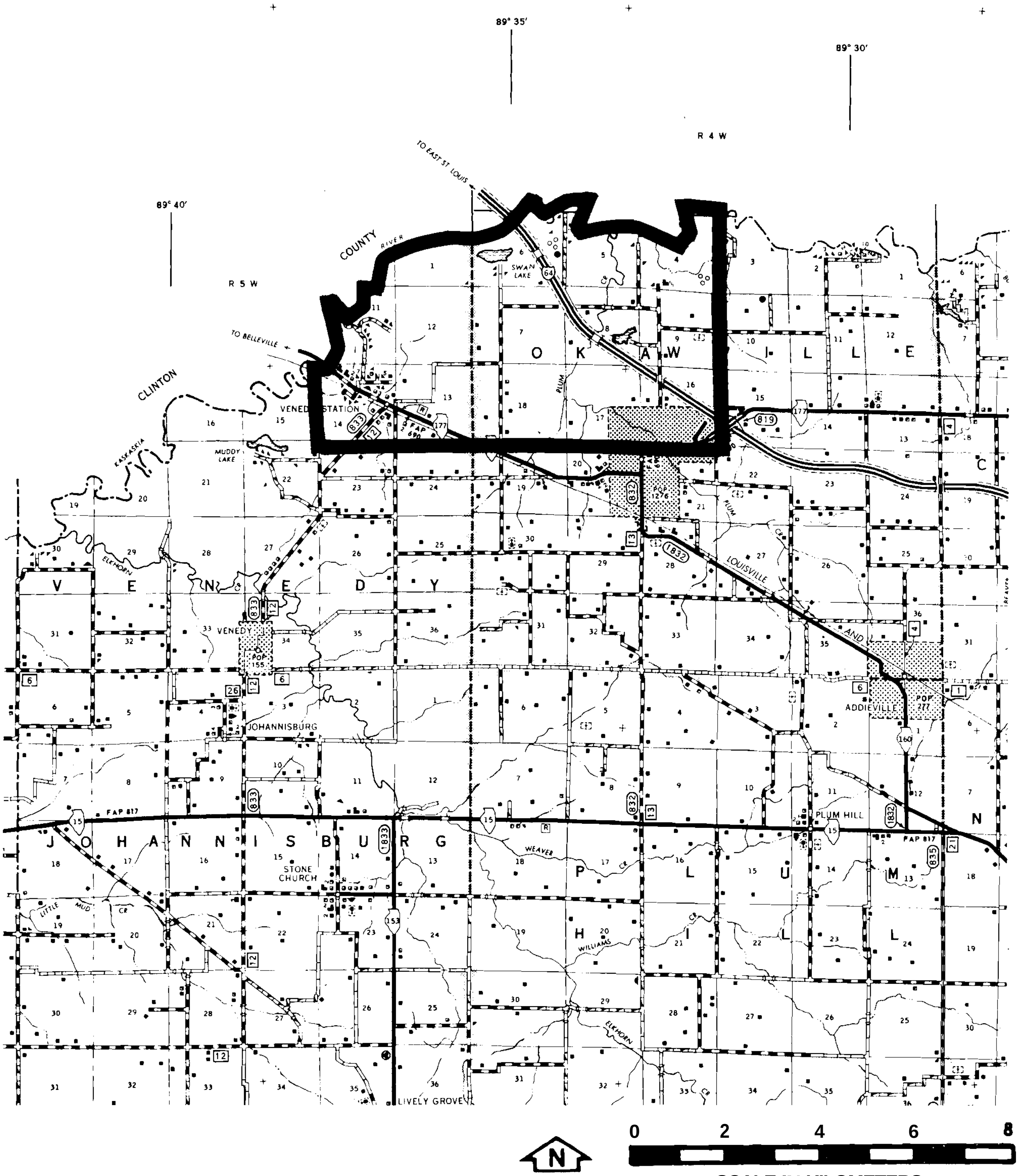
Adapted from Department of Transportation Maps

Figure 6-25

SITING AREA 25: CLINTON COUNTY

CAES

SITE SELECTION STUDY

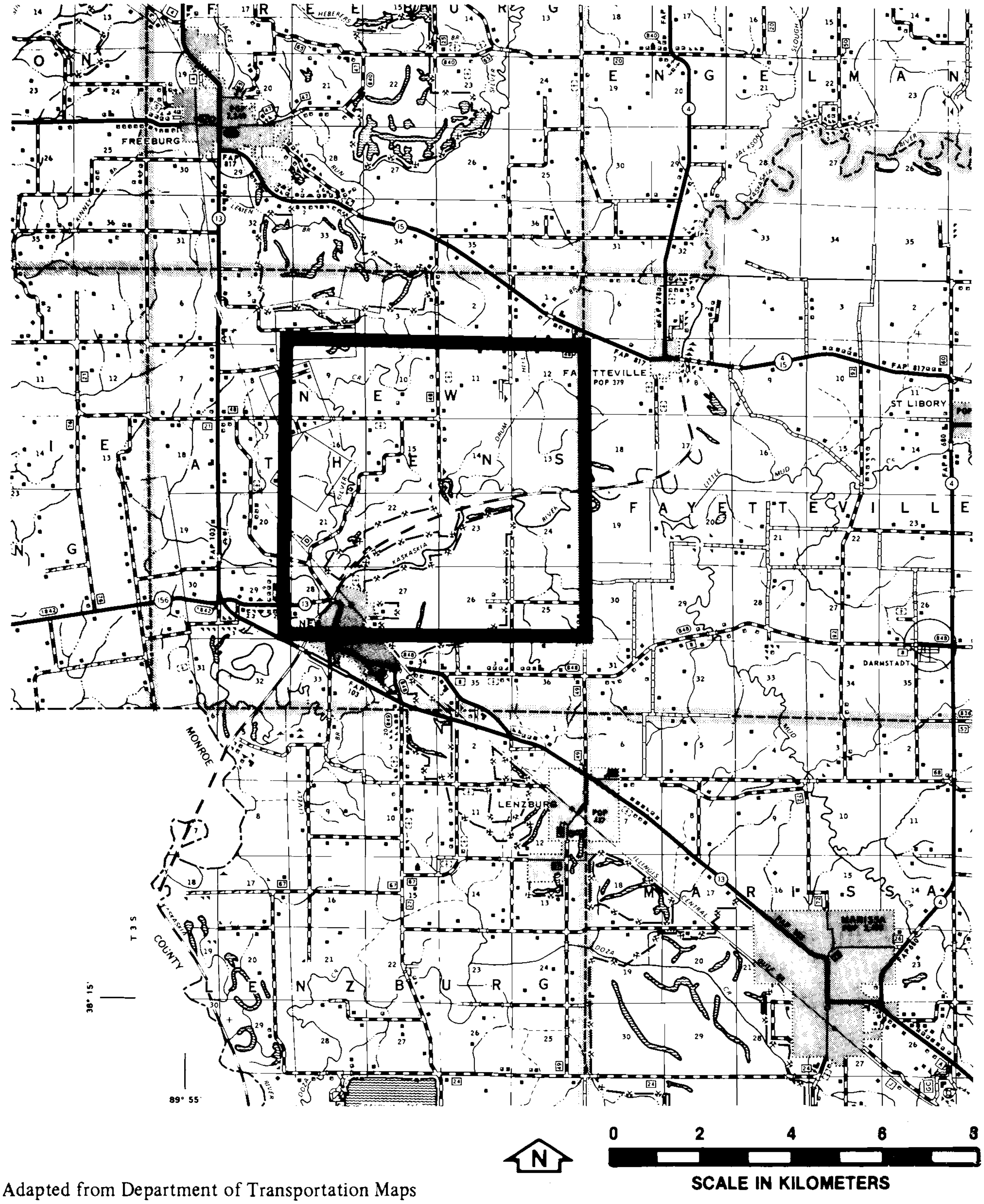


Adapted from Department of Transportation Maps

Figure 6-26

SITING AREA 26: WASHINGTON COUNTY

CAES
SITE SELECTION STUDY



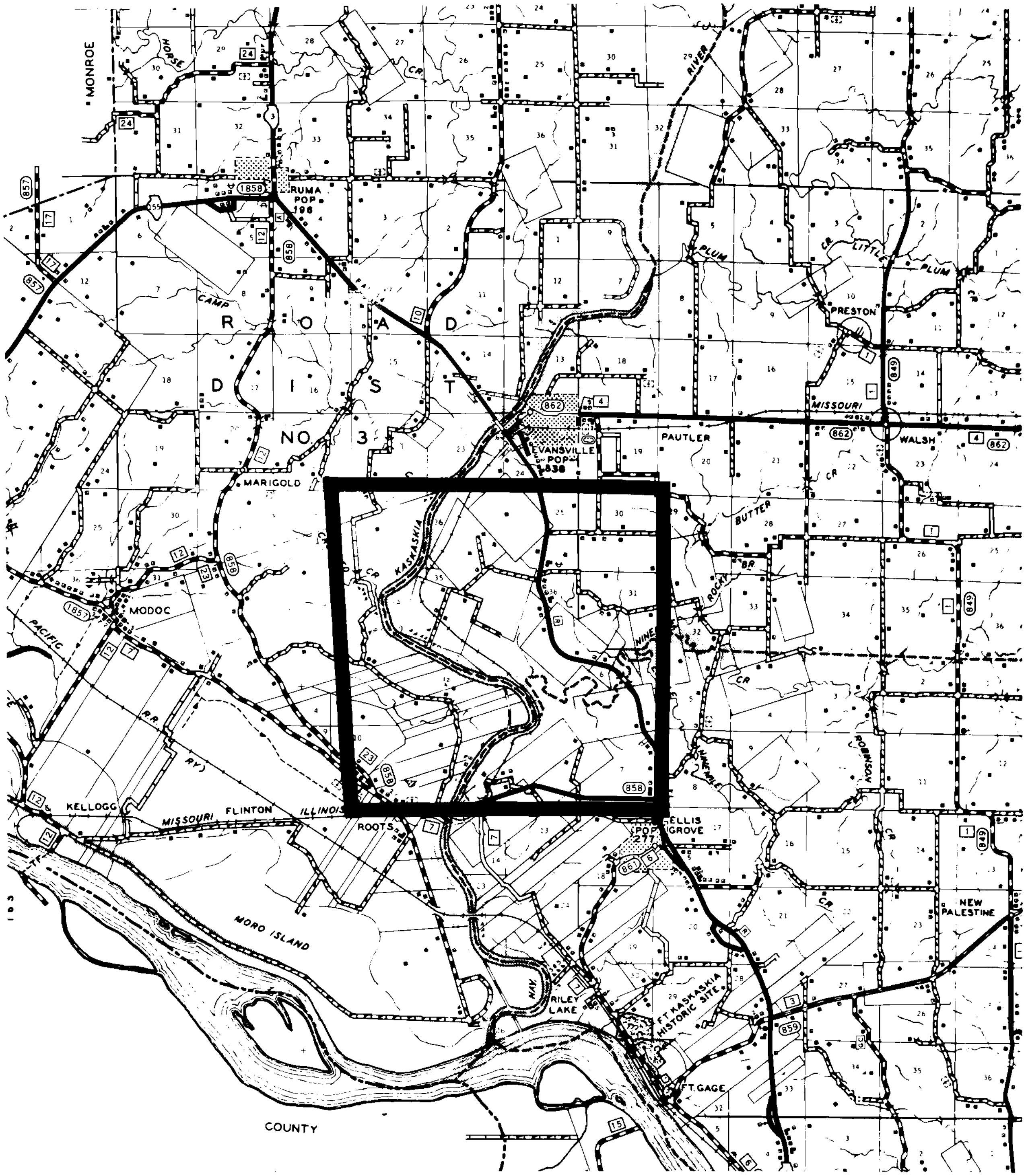
Adapted from Department of Transportation Maps

Figure 6-27

SITING AREA 27: ST. CLAIR COUNTY

CAES

SITE SELECTION STUDY



Adapted from Department of Transportation Maps

Figure 6-28

SITING AREA 28: RANDOLPH COUNTY

CAES
SITE SELECTION STUDY

6.2 APPROACH AND METHODOLOGY

6.2.1 ENVIRONMENTAL IMPACT RATING AND WEIGHTING SYSTEM

Four major environmental disciplines were selected for comparison of siting considerations, including air quality, water resources, ecology and socioeconomics. In order to rank the relative environmental suitability of the 28 candidate sites, 14 environmental siting considerations were identified to provide a basis for comparison of the sites. These criteria, listed in Table 6-1, were developed by an interdisciplinary team of scientists and engineers as the essential environmental siting characteristics for a CAES plant site.

Geotechnical favorability of the 28 candidate sites was evaluated separately. This process is addressed in Section 6.2.2. By treating geotechnical favorability separately, the process increased the potential for geological suitability at any site. A conservative approach allowed the removal of any site at any time due to geologic unfavorability.

Environmental rankings of candidate siting areas were based on a weighted impact rating of each siting area for each of the four environmental considerations. The impact rating indicated the magnitude of the effect of CAES plant development on a particular environmental consideration for a given area. The weighting indicated the relative importance of the particular impact rating.

Two types of weighting were used--an internal weighting and a discipline weighting. The internal weighting indicated the relative importance of the impact rating to the discipline. The discipline weighting indicated the relative importance of each discipline in relation to the other disciplines. Internal weightings ranged from 5 to 1, with 5 indicating the highest level of importance. The discipline weightings had the

Table 6-1. Environmental Siting Considerations and Weighting System for CAES Intermediate Analysis

Criteria	Internal Weightings	Discipline Weightings
Air Quality		1
Ambient Air Quality	3	
Density of Sources	2	
PSD Increments	3	
Nonattainment Areas	1	
Water Resources		8
Water Quality	3	
Water Supply	5	
Ecology		
Terrestrial Ecology	3	
Aquatic Ecology	3	
Threatened and Endangered Species	5	
Socioeconomics		10
Archaeology	5	
Land Use	5	
Community Impact	1	
Accessibility	1	
Transmission	2	

Source: ESE, 1981.

potential of ranging from 10 to 1, with 10 indicating the most important discipline. Table 6-1 presents the internal and discipline weightings.

Initially, each siting area was given an impact rating for each of the 14 siting considerations. This analysis was based on secondary data sources, including available literature, aerial photos, USGS maps, Soil Conservation Survey (SCS) maps, and Illinois Department of Transportation (DOT) highway maps. The impact ratings ranged from 5 to 1, with 5 indicating the least impact or the most suitable choice for CAES development.

The second step determined a discipline ranking for each siting area. Internal weightings were assigned to the impact ratings to reflect the relative importance of a siting consideration within a discipline in the licensing, construction, and operation of a CAES plant. Thus, an internally weighted impact rating was developed, and an average internally weighted impact rating was calculated for each discipline (Table 6-2). A discipline ranking for each siting area was determined by comparing the average internally weighted impact rating for the siting areas.

The final step was to calculate an overall environmental ranking for each siting area based on the discipline rankings. An average environmental ranking score for each siting area was determined by weighting the discipline rankings, summing these weighted rankings, and dividing by the sum of discipline weightings. This calculation gave an average environmental ranking score for each siting area (Table 6-3). The average environmental ranking scores for each siting area were compared to give an overall environmental ranking for each siting area.

The objective of this numerical analysis was to assign an overall environmental ranking to each siting area to reflect the siting area's relative environmental suitability for CAES development. The resulting

Table 6-2. Example of Calculation for Average Internally-Weighted Impact Ratings for a CAES Plant Siting Area

Discipline/Environmental Considerations	Impact Rating (A)	Internal Weightings (B)	Internally-Weighted Impact Rating (C)	Average Internally Weighted Impact Rating (D)*
Air Quality				
Ambient Air Quality	2	3	6	
Density of Sources	4	2	8	3.55
PSD Increments	5	3	15	
Nonattainment Areas	3	1	3	
TOTAL		9	32	

* D = Total of C ÷ Total of B

Source: ESE, 1981.

Table 6-3. Example of Calculation of Average Environmental Ranking Scores for a CAES Plant Siting Area

Disciplines	Discipline Ranking (A)	Discipline Weighting (B)	Discipline-Weighted Ranking (C)*	Overall Environmental Ranking Score (D)†
Air Quality	16	1	16	
Water Resources	18	8	144	11.24
Ecology	3	2	6	
Socioeconomics	7	10	70	
TOTAL		21	236	

* C = A x B.
† Total of C ÷ Total of B

Source: ESE, 1981.

overall environmental ranking formed the basis for determining a siting area's relative environmental suitability compared to the other siting areas. Nonparametric statistical tests were applied to determine if any significant differences existed between the siting areas based on the environmental rankings.

The internal criteria weightings are summarized in Table 6-1. Specific discussions of these internal weightings and the rationale for these weightings are found in Sections 6.3 through 6.6.

The overall discipline weightings were developed by a consensus or Delberg approach (Runyan, 1977) involving the judgments of several scientists and engineers, including biologists, geologists, socioeconomists, hydrologists, and air resource engineers. The discipline weightings assigned were based on several considerations, including:

1. The importance of the discipline to licensing of a CAES plant varies, with some discipline considerations being more important than others.
2. All siting areas identified in Stage II had acceptable sites, but some siting areas have sites which are more favorable.
3. Areas with the most severe environmental constraints in siting, such as areas restricted because of air quality conditions or lack of water, were previously eliminated in the Stage II analysis.

The overall discipline weightings are presented in Table 6-1. Socioeconomic characteristics of a siting area were considered to be the most important of the environmental aspects of licensing a CAES plant. Within this discipline archaeological and land use considerations were weighted most heavily. This is a reflection of those existing environmental regulations or reviews controlling use of land resources (i.e. prime farmland, zoning) and the preservation or mitigation of historical or archaeological resources. The relatively high weighting for water resources is the result of a combination of both environmental and engineering factors. Lack of adequate water for cooling, or lack of relatively close water, places some constraints on the design and operation of a CAES plant. This could necessitate the use of long pipelines, reservoir construction, or well-fields. Associated with these activities would be specific additional environmental regulatory requirements relating to water withdrawal, consumption, and transfer.

Because of the relatively benign potential impacts on air quality and natural biological systems, the air quality and ecology disciplines were weighted less than socioeconomics and water resources. Air pollutant emissions from the 220-MW CAES facility are expected to be low due to the fuel used and frequency of operation. Sulfur and particulate emissions will be significantly below federal and state standards. Due to the small land area (less than 100 acres) and low levels of gaseous or effluent discharges, the plant's impacts on fish and wildlife resources should be minimal.

6.2.2 GEOTECHNICAL REVIEW AND RATING

Concurrent with the environmental criteria weighting and ranking as described in Section 6.2.1, a separate geotechnical review of the sites was conducted. Because of the need for geotechnical suitability of a site, each candidate siting area was evaluated, utilizing more regional or site-specific information, if available. The main criteria for this evaluation were:

1. Existence of a suitable rock type in the target depth rank (1,700 to 2,500 feet), and
2. Structural integrity as a result of site proximity to known structural features.

Unfavorable sites identified during this stage of the evaluation would be eliminated from further consideration in the intermediate environmental analysis.

6.3 AIR QUALITY

6.3.1 AIR QUALITY EVALUATION CRITERIA

The Stage II analysis identified and described the rationale for choosing six major air quality criteria related to siting a CAES gas turbine plant:

1. Existing ambient air quality,
2. Density of air pollution sources,
3. Class II Prevention of Significant Deterioration (PSD) increments,
4. Impacts on designated nonattainment areas,
5. Class I PSD increments, and
6. Restrictive air quality regulations or stack height limitations.

The relationship of these criteria and the applicable federal, state, and local air quality regulations were also considered in the Stage II analysis.

The Stage III analysis involved a further evaluation of the 28 siting areas identified in Stage II as containing potential sites for a CAES gas turbine power plant. These potential siting areas were not located in any restrictive areas identified by the composite environmental siting criteria. Thus, a CAES gas turbine power plant could be located in any of these potential siting areas. The Stage III analysis ranked these siting areas from most favorable to least favorable with ratings ranging from 5 to 1.

Since the six air quality criteria used in the Stage II analysis continue to be major factors in siting a CAES gas turbine power plant, these criteria were further evaluated in Stage III. From these basic criteria, siting area rating specifications were developed as guidelines to evaluate each of the 28 candidate siting areas. The rating methodology for each of the six air quality considerations is discussed in the following sections.

6.3.1.1 EXISTING AMBIENT AIR QUALITY LEVELS AND DENSITY OF AIR POLLUTION SOURCES

The rating guidelines for these criteria were developed to reflect the portion of the AAQS consumed by existing emission sources at each potential site. The applicable AAQS in this candidate site analysis are those of the Illinois Environmental Protection Agency (EPA) and the U.S. EPA. These AAQS are identical.

To quantify the favorability of the candidate sites, a 5-level siting criteria scheme for existing ambient air quality was established. The 5-level criteria utilized the amount of the AAQS (above the background level) which was consumed in an area prior to site selection, as demonstrated through available monitoring data and source information for major air pollution sources. The rating scheme reflects progressively higher air quality levels existing at candidate sites, ranging from less than 25 percent up to 100 percent of the AAQS consumed:

Rating	Amount of the AAQS Above the Background Level Consumed in the Area Prior to Site Selection (percent)
5	Less than 25
4	Between 25 and 50
3	Between 50 and 75
2	Between 75 and 90
1	Between 90 and 100

Since background total suspended particulate matter (TSP) levels can consume a major portion of the AAQS, such levels were considered in applying the ratings. For this analysis, a typical background TSP level of 35 ug/m^3, annual geometric mean, was utilized for all candidate sites. This assumed background concentration is within the range recommended by EPA in Ambient Monitoring Guidelines for Prevention of Significant Deterioration (May 1978).

Evaluation of each candidate siting area required review of the available monitoring data applicable to that area, as well as consideration of nearby major emitting sources. The monitoring data for the county in which a particular siting area is located were first reviewed. Both location of the monitors (urban and rural) and the distance to the site from the monitors were considered. Evaluation was also made of neighboring counties having monitoring stations in proximity to the siting area. The primary source utilized to obtain available air quality data was the Illinois EPA Annual Air Quality Report for 1980.

The objective of the major source evaluation criteria was to qualitatively evaluate the effects of sulfur dioxide, particulate matter, and nitrogen oxide emissions from these sources upon the 28 candidate sites. Essential to this effort was an extensive sulfur dioxide and particulate matter emission inventory update for all counties including the 28 candidate siting areas. Source data on emission rates and locations were obtained through the Illinois EPA state emissions inventory data bank and through discussions with agency personnel. Siting areas were categorized based upon the proximity and magnitude of emission sources to these areas. Although this criterion is closely related to the ambient air quality criterion, a separate rating was applied to each criterion as each criterion aided in providing a more definitive assessment of the true air quality of the specific siting area than combining the two criteria and applying a single rating would have been able to produce.

6.3.1.2 CLASS 11 PREVENTION OF SIGNIFICANT DETERIORATION INCREMENTS

In siting a CAES gas turbine power plant which could consume a portion of the allowable Class II PSD increments, that portion of the increments which has already been consumed is a major concern. If a large portion has already been consumed in an area, a CAES power plant may not be able to locate in the same area except under certain restrictive conditions. The siting area rating specifications for the Class II PSD criterion reflect this consideration. This criterion applies only to sulfur dioxide and particulate matter. Although the Clean Air Act Amendments (CAAA) of 1977 require that PSD regulations for the other criteria pollutants (nitrogen dioxide, hydrocarbons, carbon monoxide, and ozone) be promulgated by U.S. EPA by August 7, 1979, and be enacted by August 7, 1980, no PSD increments have been established at this time; therefore, they were not considered in the Stage III analysis.

The following siting area rating specifications for the Class II PSD criterion were used:

Rating	Amount of Class II PSD Increment Consumed in the Area Prior to Site Selection (percent)
5	No increment consumed
4	Between 0 and 25
3	Between 25 and 50
2	Between 50 and 75
1	Between 75 and 90

As shown, none of the classifications would preclude locating a CAES gas turbine power plant in an area, but a rating of 1 would indicate potentially restrictive conditions for approval. The maximum increment consumption value of 90 percent is based upon the Stage II analysis, which categorized this level as "Restricted" for power plant siting. The most favorable potential site is one where no PSD increments have been consumed, and the rating specifications show a nearly steady gradation between 0- and 90-percent increment consumption.

Both U.S. EPA Region V and Illinois EPA were contacted to identify major sources which are located in the candidate siting areas and which have consumed or will consume PSD increments. Increment consumption for identified sources was obtained from available impact analysis studies, by qualitatively evaluating emission types and magnitudes (for minor sources only), and from a direct inventory of such sources as obtained from the Illinois EPA, Missouri DNR, and Iowa DEQ. Maximum increment consumption in the vicinity of each siting area was utilized to rate the site.

6.3.1.3 IMPACTS ON DESIGNATED NONATTAINMENT AREAS

On March 3, 1978, U.S. EPA published a list of the state's attainment status for National Ambient Air Quality Standards (Federal Register, Vol. 43, No. 43). This list included all areas in Illinois and adjacent states designated as nonattainment for any criteria pollutant (see Stage 11 analysis). The designations determined by U.S. EPA were based upon information submitted by the states.

The site impact-rating guidelines for nonattainment areas are based on the minimum distances which a 220-MW CAES gas turbine power plant could locate from a nonattainment area without exceeding certain "significance of impact levels" (see Stage II analysis). The required distance is a function of emission and stack parameters, and meteorology of the siting area. If the significance-of-impact levels are exceeded at or within a nonattainment area because of a proposed major new source located outside of the nonattainment area, then the new source would be subject to stringent permitting conditions. A potential CAES plant site becomes less suitable as more stringent emission conditions are imposed on its operation.

In order to determine emission-distance-direction relationships for the proposed plant, atmospheric dispersion modeling was utilized with the typical emission parameters developed for the 220-MW capacity CAES gas turbine plant (see Stage II analysis). The EPA-developed Industrial Source Complex model was utilized to estimate short-term (24-hour and 3-hour) sulfur dioxide concentrations for various distances from the plant.

Other criteria pollutants (i.e., particulates, carbon monoxide, hydrocarbons and ozone) are either emitted in insignificant quantities (compared to resulting ground-level impacts and respective significance of impact levels and AAQS) by a 220-MW CAES gas turbine power plant or cannot be accurately modeled for ground-level concentrations. Therefore, only nitrogen dioxide impacts were considered in the siting analysis within this criterion besides sulfur dioxide.

The rating guidelines for evaluating impacts on the nonattainment areas follow. In developing these guidelines, the amount of emission limitation placed upon the proposed plant to meet the significance of impact levels was considered. The most favorable potential site would be allowed maximum NSPS emissions for sulfur dioxide of 0.113 $lb/10^6$ Btu. Since modeling the emissions from a 220-MW CAES gas turbine plant showed low ambient air quality impact levels, only two rating values were found to be necessary in order to site the plant in the proximity of a nonattainment area. Further, since the particulate emission rate for a 220-MW CAES gas turbine power plant was determined to be only about 5 percent of the sulfur dioxide emission rate, it was determined that ambient particulate concentrations from the plant would be far below significance-of-impact levels established for nonattainment areas. Therefore, this parameter would not affect the siting effort with respect to proximity to nonattainment areas.

Sulfur Dioxide

5 - Sulfur dioxide emission rate of 0.113 $lb/10^6$ Btu meets significance-of-impact levels.

4 - Sulfur dioxide emission rate of 0.1 to 0.113 $lb/10^6$ Btu meets significance-of-impact levels.

6.3.1.4 CLASS I PREVENTION OF SIGNIFICANT DETERIORATION INCREMENTS

The Stage II analysis did not identify any Class I PSD areas within Illinois or in any surrounding states which would affect power plant siting; therefore, Class I PSD was not considered in the rating/ranking process.

6.3.1.5 RESTRICTIVE AIR QUALITY REGULATIONS/STACK HEIGHT LIMITATIONS

The Stage II analysis did not identify any restrictive air quality regulations in Illinois that could affect the siting of a CAES gas turbine power plant. Also, careful examination of FAA guidelines governing minimum approach distances as a function of approach height for all airports having instrument approach capabilities (see Stage II analysis) showed that the minimum distance allowable for location of the CAES gas turbine plant from such an approach path was about 1.5 km. Since this distance is only limited to runway glide path, this criterion was determined to have an insignificant impact on the siting of the CAES gas turbine power plant and was therefore not considered in the Stage II ranking process.

6.3.2 SITE RATING SPECIFICATIONS, COMPOSITE SITE RATINGS, AND WEIGHTINGS

As mentioned in Section 6.3.1, the siting areas were rated on the basis of the following six air quality criteria site rating specifications:

1. Existing ambient air quality,
2. Density of air pollution sources,
3. Class II PSD increments,
4. Impacts on nonattainment areas,
5. Impacts on Class I areas, and
6. Restrictive air quality regulations/stack height limitations.

The individual criteria were rated for each of the siting areas and then these ratings were weighted based on their relative importance to the siting process.

6.3.2.1 RATIONALE FOR RATINGS

Sulfur dioxide impacts on ambient air quality and Class II PSD increments were judged to be the most important and given the most weight in the rating process since, as discussed in Section 6.3.1.3, none of the other criteria pollutants are emitted in significant quantities to cause ambient air quality impacts to exceed PSD significance levels. Therefore, these other pollutants were not considered in the rating evaluation. Although nitrogen oxide emissions are considerably higher than the other criteria pollutants (except sulfur dioxide which was determined to be emitted in the greatest quantities), upon evaluation of its impact on ambient air quality levels, it was determined that none of the predicted concentrations would exceed the significance level of 1 ug/m^3 on an annual basis. Since no short-term AAQS or PSD increment or significance levels currently exist, no assessment of any impacts of nitrogen oxide emissions for such averaging periods could be made.

The weightings for sulfur dioxide were developed on the basis of a 3-to-1 scale according to importance, with 3 indicating the most important for siting. The weightings for each criterion are shown below.

Criterion	Internal Weighting Sulfur Dioxide
Existing Ambient Air Quality	3
Density of Air Pollution Sources	2
Class 11 PSD Increments	3
Restrictive Regulations/Stack Height Restrictions	-
Impacts on Nonattainment Areas	1
Class I PSD Increments	-
Total	9

Although dispersion modeling results predicted that air quality impacts for all of the criteria pollutants except sulfur dioxide would be below PSD significance levels and that sulfur dioxide impacts would be just above the significance level for the 24-hour averaging period, an assessment of these impacts must be considered in the siting process. Certain restrictions may be imposed by the fact that proximity to large major sources where AAQS are being exceeded or are close to being exceeded is of critical concern in the siting process.

Existing air quality and PSD increments were given equal weighting and were assigned the highest weighting value.

Although impacts on nonattainment areas would normally be considered of primary concern because these areas are well defined by U.S. EPA and Illinois EPA, and because of the short radial distance required to bring the ambient impacts from the CAES gas turbine power plant below significance levels for nonattainment areas, siting the CAES facility outside the area of influence of such nonattainment areas can be easily accomplished. This evaluation criterion was therefore assigned the lowest weighting.

Proximity to areas of high air pollution source density was assigned a middle weighting of 2, which is usually indicative of areas where ambient air quality is poor (close to or exceeding AAQS, or where PSD increments are the most likely to be least available). Rural areas experience problems with available PSD increments or meeting AAQS due to the location of a single large major source.

6.3.2.2 RESULTS

Table 6-4 presents the internal weighted ratings and siting area rankings for air quality considerations for each siting area.

Siting Areas 2, 3, 4, 8, 9, 12, 13, 15, 16, 17, 18, 22, 23, 25, and 26 are ranked highest. The lowest-ranked areas were Siting Areas 27 and 10, which are near existing air pollution sources which have consumed most of the sulfur dioxide and particulate AAQS in the area.

Table 6-4. Impact for Air Quality Considerations

	Impact Ratings					
Siting Area	Existing Ambient Air Quality (3)*	Class II PSD Increments (3)*	Density of Air Pollution Sources (2)*	Impact on Nonattainment Areas (1)*	Average Weighted Impact Rating†	Discipline Ranking*
1	4	5	5	5	4.67	10
2	5	5	5	5	5.0	18
3	5	5	5	5	5.0	18
5	5	5	4	5	4.78	12
6	4	5	5	4	4.56	7
7	4	5	5	4	4.56	7
8	5	5	5	5	5.0	18
9	5	5	5	5	5.0	18
10	3	5	3	4	3.78	2
11	4	4	4	4	4.0	3
14	4	5	5	5	4.67	10
15	5	5	5	5	5.0	18
16	5	5	5	5	5.0	18
17	5	5	5	5	5.0	18
18	5	5	5	5	5.0	18
19	5	4	4	5	4.44	4.5
20	5	4	4	5	4.44	4.5
21	4	5	5	5	4.67	10
22	5	5	5	5	5.0	18
25	5	5	5	5	5.0	18
26	5	5	5	5	5.0	18
27	3	5	2	3	3.44	1
28	5	5	3	5	4.56	7

* Internal weighting for each consideration.

† Average weighted impact rating = impact ratings x internal weightings; product is then summed and divided by total internal weightings (ratings rounded off for presentation).

** For tied average impact ratings, half rankings were assigned for siting areas tied 2 or 4 times; siting areas tied 3 or 5 times were assigned the same ranking.

Source: ESE, 1981.

6.4 WATER RESOURCES

6.4.1 WATER AVAILABILITY

Water for cooling, plant service (including potable water), and water compensation for compressed air are the three water needs for the CAES facility. Potential siting areas were examined for capability and reliability in providing these water needs.

Cooling towers were the only cooling system considered (see Stage II analysis). Plant service water requirements include any water used at the proposed facility except for cooling and water compensation of the compressed air. Drinking water and demineralizer wastes are plant service water uses of particular concern. Make-up water for the water compensation reservoir will normally not be required. During extended periods of drought, water may have to be made up to the reservoir. This can be accomplished during the generation cycle when water needs for cooling are substantially less than during the compression cycle. For purposes of this phase of the site selection study, it was assumed that water brought in for cooling purposes would be adequate to serve as plant service water and make-up for the water compensation reservoir.

The possible water sources considered during the Stage II analysis include: (1) fresh water from rivers, (2) fresh water from lakes, (3) fresh water from groundwater wells, and (4) treated wastewater from municipal and industrial plants. Nonpotable water from groundwater wells were not considered (see Stage II analysis). The only area where wastewater supplies are sufficient to provide a reliable source of water for the CAES facility is in the Chicago area. None of the siting areas were within 10 miles of the Chicago area; therefore this source is not applicable to the Stage II analysis.

Based on the considerations mentioned previously, the following water requirements are identified:

1. Areas with a dependable supply of 2.7 cfs (1,200 gpm) or greater available from surface water sources are candidate sites for the cooling tower option. On-site water storage facilities are not needed during most drought periods.
2. Areas with a dependable supply of ground water at 1,200 gpm (2.7 cfs) are also suitable candidate sites for the cooling tower option without the need for storage facilities.
3. Areas with an excess flow equal to or greater than 2.7 cfs but minimum daily streamflow of record less than 2.7 cfs are suitable for a CAES plant water supply; however, major on-site water storage facilities (i.e., lakes or ponds) are required to assure a dependable water supply. Only closed-cycle cooling systems with storage are feasible. Water sources in this category are less dependable than the previous categories.

Groundwater availability analysis was based on aquifer yields obtained from the State of Illinois report entitled, "Coal and Water Resources for Coal Conversion in Illinois" (Smith and Stall, 1975). This analysis included consideration of potable ground waters only. Sand and gravel aquifer yield maps were used to delineate areas where water well systems could be constructed to yield an estimated 14 mgd.

The Stage II water availability map was the basis for water availability. The minimum daily flow of record (USGS gaging station records through water year 1979), aquifer yields (Smith and Stall, 1975), and annual average excess available water were the measures used to estimate long-term water availability. Annual average excess available water was defined as the long-term (5 years or more) average flow minus the minimum daily flow for the period of record.

6.4.1.1 RATING SPECIFICATIONS--WATER SUPPLY

5--Minimum daily streamflow of record equal to or greater than 2.7 cfs; site is totally within 10 miles of such a water source.

4--Minimum daily streamflow of record equal to or greater than 2.7 cfs; although only a portion of site is within 10 miles of such a water source, the rest of the site is within 10 miles of a region with fresh groundwater yields of at least 1,200 gpm.

3--Fresh groundwater yield equal to at least 1,200 gpm (2.7 cfs).

2--Excess available water equal to or greater than 2.7 cfs, but minimum daily flow of record less than 2.7 cfs.

In addition to total water supply available, it is useful to look at the ratio of the water needed by the CAES system to the water available during drought periods. Given two sites, one where the CAES facility will use a significant portion of the water available during a period of drought and one where the CAES facility will use a relatively small amount of water, it may be more difficult to license the plant at the first site than at the second site. To evaluate the water need/supply ratio, the water needs for the CAES facility (2.7 cfs) were divided by the 7-day, 10-year low flow, and multiplied by 100 percent. The 7-day, 10-year low flow was obtained from the Illinois Water Survey Bulletin 57, "The 7-Day, 10-Year Low Flows of Illinois Streams" (Singh and Stall, 1973)

6.4.1.2 RATING SPECIFICATIONS--WATER NEED/SUPPLY RATIO

5--Water need/supply ratio is 0.03 percent or less.

4--Water need/supply ratio is less than or equal to 0.3 percent, but greater than 0.03 percent.

3--Water need/supply ratio is less than or equal to 0.7 percent, but greater than 0.3 percent.

2--Water need/supply ratio is less than or equal to 2.7 percent, but greater than 0.7 percent.

1--Water need/supply ratio is greater than 2.7 percent.

The water need/supply ratio varied from the Mississippi River sites (with a ratio of 0.02 percent) to the Iroquois River site (with a ratio of 18.5 percent).

The overall water availability ratings were computed by giving the water supply rating twice the weight of the water need/supply ratio and dividing the sum by three.

6.4.2 WATER QUALITY

In this analysis the water quality needed for the major systems of the proposed CAES facility, and the relation of discharge of wastewater to water quality standards, were compared with the existing water quality characteristics of the environment. Major plant systems pertaining to water quality considerations include: (1) cooling water, (2) water pollution control, (3) water treatment, and (4) other miscellaneous systems.

In general, process water treatment is divided into two levels of sophistication. The first level involves treating the raw water by precipitation, coagulation/settling, pH adjustment, and rapid sand filtration, which are standard unit processes that may be applied to the incoming make-up water, regardless of source. The second level of treatment may be applied to water that is not adequately treatable by conventional technology. Nearly any water source could be handled by a combination of the two treatment levels, but costs would be much higher. The advanced treatment technologies include: (1) reverse osmosis, (2) ion exchange, (3) activated carbon, and (4) special flocculation techniques requiring polymers.

For purposes of this phase of the site selection study, it was assumed that fresh water brought in for cooling purposes would be adequate to serve as plant service water.

For the siting study, pollutants of primary concern were water temperature (cooling water system), chloride, sulfate and total dissolved solids (cycles of concentrations within the cooling towers), and toxic pollutants (wastewater streams).

A site's suitability for discharge of blowdown generally is directly proportional to the 7-day, 10-year low flow. Blowdown is water discharged from the cooling tower system after several cycles of reuse. The 7-day, 10-year low flow value represents a long-term estimate of low-flow conditions. The state water quality standards (Chapter 3, Illinois Pollution Control Board Rules and Regulations, 1979) use this flow as design stream conditions for wastewater pollution control systems. The dilution ratio (which is the ratio of the 7-day, 10-year low flow to the average dry weather flow of the treatment works for the design year) is critical in the Illinois EPA review of wastewater discharges.

Existing thermal standards for Illinois are specific in relation to heat discharges (chapter 3, Illinois Pollution Control Board Rules and Regulations, 1979). Maximum water temperature, change in water temperature from normal conditions, and mixing zones are critical environmental factors to be evaluated.

State regulations (Chapter 3, Illinois Pollution Control Board Rules and Regulations, 1979) specify that total dissolved solids (TDS) in surface waters at the point of discharge must not exceed 3,500 milligrams per liter (mg/l). TDS in the water body after mixing must not exceed 1,000 mg/l, or 750 mg/l above background. Therefore, a stream with low TDS values generally is preferable to a stream with high TDS values because cycles of concentrations can be greater when the source of surface water has a low TDS value.

6.4.2.1 SURFACE WATER QUALITY RATING SPECIFICATIONS

The three factors used in the ratings were: (1) specific conductivity, (2) temperature, and (3) 7-day, 10-year low flow. The USGS report, "Chemical Analyses of Surface Water in Illinois, 1975-1977" (U.S. Geological Survey, 1979), was the data base for the specific conductivity factor. Qualitative judgments relative to temperature factors were based on state thermal regulations (Chapter 3, Illinois Pollution Control Board Rules and Regulations, 1979), and existing surface-water temperatures according to The Illinois Water Survey, Report of Investigation 49, "Temperatures of Surface Waters in Illinois" (Harmeson and Schnepper, 1965). If temperature data for a specific river were not available in "Temperatures of Surface Waters in Illinois," the minimum temperature of record was taken from the U.S. Geological Survey, "Water Resources Data for Illinois," water years 1975-1979. The 7-day, 10-year low flows were obtained from the Illinois Water Survey Bulletin 57, "The 7-Day, 10-Year Low Flows of Illinois Streams" (Singh and Stall, 1973).

Each site was rated for the three factors and the rating composite for surface water was the arithmetic average. The three factors were given the following weights: specific conductance = 1, 7-day, 10-year low flow = 2, and temperature = 1.

Specific Conductivity

5--Specific conductivity value did not exceed 517 umhos per cm^2.

4--Specific conductivity value did not exceed 683 umhos per cm^2, but exceeded 517 umhos per cm at least once.

3--Specific conductivity value did not exceed 783 umhos per cm^2, but exceeded 683 umhos per cm at least once.

2--Specific conductivity value did not exceed 917 umhos per cm^2, but exceeded 783 umhos per cm at least once.

1--Specific conductivity value exceeded 917 umhos per cm^2 at least once.

7-Day, 10-Year Low Flow

5--Value equals or exceeds 10,000 cfs.

4--Value equals or exceeds 1,000 cfs but less than 10,000 cfs.

3--Value equals or exceeds 400 cfs but less than 1,000 cfs.

2--Value equals or exceeds 100 cfs but less than 400 cfs.

1--Value less than 100 cfs.

Although these absolute values used in the specifications have no environmental licensing significance, they are logical dividing points to provide a wide distribution of ratings between siting areas.

ATD (ambient temperature differential) is defined as the water quality standard of a given month minus the maximum existing ambient temperature for that month. Negative values of ATD (rated 1 and 2 above) occur when the existing water temperature is already above the water quality standard.

Temperature

5--ATD >10 degrees F all months.

4--ATD > 5 degrees F and ATD 10 degrees F at least 1 month.

3--ATD > 0 degrees F and ATD 5 degrees F at least 1 month.

2--ATD >-3 degrees F and ATD 0 degrees F at least 1 month.

1--ATD <-3 degrees F at least 1 month.

Further quantitative analysis (including discussion of mixing zones and changes in normal water temperature) is impossible at this level of investigation.

6.4.3 INTERNAL WEIGHTINGS

Because water quantity is one of the primary requirements in siting, it was given a weighting of "5"; water quality was given a weighting of "3".

6.4.4 RESULTS

Table 6-5 presents the results of the internally weighted ratings and site area **rankings** for water resource considerations for each siting area. Siting areas along the Mississippi River which had the same rating were ranked highest in relation to water resources. The Mississippi River provides an abundant water supply and good navigation routes at each of these sites. The lowest **rankings** were assigned to Sites 17, 25, and 27 because of water quality and periodically low streamflows.

Table 6-5. Impact Ratings for Water Resources Considerations

Siting Area	Impact Ratings: Water Quality (3)*	Water Supply (5)*	Average Weighted Impact Rating†	Discipline Ranking**
1	4.0	5.0	4.63	19
2	3.0	4.0	3.63	9
3	3.0	4.0	3.63	9
5	3.0	5.0	4.25	13
6	4.0	5.0	4.63	19
7	4.0	5.0	4.63	19
8	4.0	5.0	4.63	19
9	4.0	5.0	4.63	19
10	3.0	4.0	3.63	9
11	3.0	5.0	4.25	13
14	4.0	5.0	4.63	19
15	4.0	5.0	4.63	19
16	2.0	4.0	3.25	5.5
17	1.0	4.0	2.88	2
18	2.0	4.0	3.25	5.5
19	4.0	5.0	4.63	19
20	4.0	5.0	4.63	19
21	4.0	4.0	4.00	11
22	3.0	5.0	4.25	13
25	1.0	4.0	2.88	2
26	2.0	4.0	3.25	5.5
26	1.0	4.0	2.88	2
28	2.0	4.0	3.25	5.5

* Internal weighting for each consideration.

† Average weighted impact rating = impact ratings x internal weightings, product then summed and divided by total internal weightings (ratings rounded off for presentation).

** For tied average impact ratings, half rankings were assigned for siting areas tied 2 or 4 times; siting areas tied 3 or 5 times were assigned the same ranking; for tied rankings, an equivalent number of the next highest rankings were omitted.

Source: ESE, 1981.

6.5 ECOLOGICAL SYSTEMS

The evaluation of the 27 candidate siting areas in the Stage III analysis focused on three ecological considerations: (1) terrestrial systems, (2) aquatic systems, and (3) significant natural areas and threatened and endangered flora and fauna. For each candidate site, specific characteristics relating to these three ecological considerations were identified and analyzed. Sites were then rated according to the vulnerability of their ecological systems to potential impacts from construstion and operation of the CAES facility.

The major sources of information for the evaluation were: (1) Agricultural Stabilization and Conservation Service (ASCS) aerial photographs (black and white photographs of a scale 1:40,000 used at the USDA ASCS offices in Springfield, Illinois); (2) site-specific data collected by the Natural Areas Section of the Illinois Department of Conservation, on unique natural areas; and (3) the scientific and conservation literature describing known ranges and locations of rare plant and animal species in Illinois.

The specifications for each of the three ecological siting criteria were incorporated into a worksheet used in evaluating each of the Stage III sites (see Table 6-6). This worksheet allowed the entry and compilation of site-specific quantitative data as they were collected from aerial photos and other sources. The use of this worksheet also assured an objective evaluation of each site and thus maintained the integrity of the comparative analysis.

6.5.1 TERRESTRIAL SYSTEMS

6.5.1.1 CRITERION DEFINITION

Terrestrial ecosystems on the candidate sites were evaluated as to their suitability for the CAES facility based upon two related criteria: (1) diversity of habitat types, and (2) habitat edge. Because different

Table 6-6. Worksheet for Evaluation of Siting Areas Based on Ecological Criteria

SITE INFORMATION

Site Description: ____________________

____

____

____

		%	Area	No.	Ave. Size	Prime Areas
Terrestrial Habitats:	Bottomland	___	___	___	___	______
	Upland	___	___	___	___	______
	Old field	___	___	___	___	______
	Grassland	___	___	___	___	______
	Cultivated	___	___	___	___	______
	Other	___	___	___	___	______

Habitat Interspersion Index ____________________

Fencerows/Hedgerows ____________________

Notable Habitat Gradients and Associations ____________________

____

____

Table 6-6. Worksheet for Evaluation of Siting Areas Based on Ecological Criteria (Continued, Page 2 of 3)

Aquatic Systems

Streams:

No. & Miles ______

Valley length ______

Average Size ______

Bottomland ______

Habitat Diversity and Types ______

Fishery Rating ______

Alterations and Meanders ______

Standing Water:

Number & Area (by type) ______

______

______

Drainage Patterns ______

Identified Natural Areas on or Adjacent to Site ______

______

______

Threatened and Endangered Species Occurrence or Potential Occurrence:

Based on Natural Area Inventory ______

______

Based on Known Range ______

______

Notes:

Table 6-6. Worksheet for Evaluation of Siting Areas Based on Ecological Criteria (continued, Page 3 of 3)

SITE RATING

Criteria	Rating	Rationale
Terrestrial System:		
Habitat Diversity	______	____________________
Habitat Edge	______	____________________
Overall Rating	______	____________________
Aquatic System:		
Habitat Diversity	______	____________________
Distance to Wetlands	______	____________________
Fishery Rating	______	____________________
Overall Rating	______	____________________
Significant Natural Areas and Endangered and Threatened Species:		
Known or Potential Existence	______	____________________
Significant Natural Areas	______	____________________
Overall Rating	______	____________________

habitats support different organisms, an area with many different habitats will typically support more species than the same size area of less diverse habitats. Habitat diversity, therefore, reflects the ecological importance of an area.

Many animals use several habitat types but the habitats must be interspersed with each other to be most useful to the animals. The habitat edge criterion is a measure of the interspersion of habitats. This criterion also considers the availability of marginal habitat edge (fencerows and hedgerows) within areas of low habitat diversity.

6.5.1.2 RATING SPECIFICATIONS

The predicted sensitivity of a candidate site to construction and operation of the CAES facility was based on the ecological characteristics of the area. The terrestrial systems of each siting area were ranked on a scale of 5 to 1, with a rating of 5 as the most favorable for placement of a facility. The rating specifications were as follows:

5--(a) The site has a low diversity of terrestrial habitats, with minimal acreages of upland or bottomland forest, and a large percentage of cultivated cropland; or

(b) The site has a low habitat edge value.

4--(a) The site has a moderate diversity of terrestrial habitats, with limited acreages of upland or bottomland forest, and a significant percentage of the site is cultivated cropland; or

(b) The site has a moderate habitat edge value due primarily to fencerows and hedgerows.

3--(a) The site has a moderate diversity of terrestrial habitats, with moderately-sized stands of both upland and bottomland forests, and a moderate percentage of the site is cultivated cropland; or

(b) The site has a moderate habitat edge value due primarily to the high interspersion of habitat types.

2--(a) The site has a moderate-high diversity of terrestrial habitats, with some large stands of upland and bottomland forests, and a moderate percentage of the site is comprised of cultivated cropland; or

(b) The site has a high habitat edge value due to common hedgerows and fencerows and moderate interspersion of habitats.

1--(a) The site has a high diversity of terrestrial habitats, with some large stands of upland and bottomland forests, and a moderate percentage of the site is cultivated cropland; or

(b) The site has a high habitat edge value due to numerous hedgerows and fencerows and the high interspersion of habitats.

6.5.1.3 RATING METHODOLOGY

Diversity of terrestrial habitats was calculated by using a standard diversity index (Shannon) and calculating acreages of each type of terrestrial habitat. The resulting value indicates the number of habitats represented and how equally they are represented at the site The diversity levels and their associated ratings are:

Rating	Diversity Value
5	0.00-0.29
4	0.30-0.58
3	0.59-0.88
2	0.89-1.21
1	>l.21

'The diversity rating is largely determined by acreages and types of habitat represented on the siting area. A rating of 1 indicates good or high diversity; 2 to 4 indicates moderate diversity; and 5 indicates low diversity.

Interspersion of habitat types was measured by counting the number of habitat changes along two perpendicular lines set over a 1-square-mile section on aerial photographs of the site (after Baxter and Wolfe, 1972). As many complete square-mile sections as could be fit into the site were measured, and the value reported is the average of the individual section values. Interspersion indices for the 28 sites ranged from 0.45 to 10.5. Values below 15 percent of the range were assigned a rating of 5, values in percentiles 16 through 41 were rated 4, percentiles 41 through 59 were rated 3, percentiles 60 through 80 rated 2, and above 80 percent were rated 1.

Fencerows or hedgerows provide travel lanes for wildlife between separate habitats and, in intensively cultivated areas, provide major sources of cover for wildlife. An index of hedgerow abundance was obtained by counting the number of square-mile sections which contained a total of more than 0.5 mile of hedgerow within the site. For this purpose, a hedgerow was defined as woody vegetation greater than 0.25 mm and less than 2.5 mm wide on 1:40,000-scale aerial photographs. The hedgerow index is reported as the number of sections with a 0.5 mile of hedgerow over the total number of complete sections within the siting area. Values ranged from 0.27 to 1.0. Ratings were assigned to values within percentiles as follows: below 15 percent rated 5, 16 to 36 percent rated 4, 37 to 63 percent rated 3, 64 to 85 percent rated 2, and 85 to 100 percent rated 1.

Final edge habitat ratings for each study siting area are an average of the site's interspersion rating and its hedgerow rating. In general, sites rated as 5 are described as having a small amount or low percentage of habitat edge. Sites with a 4, 3, or 2 rating have moderate amounts of habitat edge, and a rating of 1 represents a high percentage of habitat edge. Intermediate descriptions (such as moderate-high) indicate that one of the ratings, either interspersion or hedgerows, was different from the average rating. Interspersion was favored when ratings did not average to a whole number. For example, if interspersion was rated 3 and hedgerows 4, the final rating would be 3. This reflects the biological importance of interspersed habitats over hedgerows.

Overall ratings for each site are composites (or averages) of the two criteria. Where an average value was not a whole number, the value was rounded to the nearest whole number.

6.5.2 AQUATIC SYSTEMS

6.5.2.1 CRITERION DEFINITION

The aquatic systems analysis considered both the presence and diversity of aquatic habitats and the relative proximity of aquatic and wetland systems to the sites. The aquatic systems considered in the analysis included major rivers, perennial streams, intermittent streams, bottomland hardwood swamps, permanent marshes, seasonally flooded depressions, farm ponds, and large reservoirs.

The primary concern of the analysis was to determine the potential loss of aquatic systems due to construction of the CAES facility. All aquatic habitat types and their areal distribution at each site were identified, and the diversity of aquatic habitats and the integrity of the systems were evaluated. The potential impacts resulting from direct loss or alteration of aquatic habitats on site were considered. Also noted were surrounding systems and existing linkages which may transfer aquatic impacts to systems off site.

The secondary evaluation involved operational impacts. Two potential problems relating aquatic habitats to the plant were considered:
(1) the possible change in surface and groundwater levels due to water withdrawals or discharges from the facility, and (2) chemical alteration of surface and ground water due to cooling or boiler water discharges. Water withdrawals may affect aquatic systems by changing water levels,

and thereby reduce diversity and productivity of aquatic flora and fauna. Likewise, excessive water discharge or the creation of impoundments with different downstream flow regimes can also alter aquatic systems. At each candidate siting area, major aquatic systems were reviewed, and particularly sensitive wetlands were located and evaluated for potential impacts from the CAES plant.

6.5.2.2 RATING SPECIFICATIONS

The aquatic system characteristics which determine the sensitivity of a site include the extent and diversity of such systems and their proximity to the site and individual habitat sensitivities to water level or chemical changes. The individual rating specifications are:

5--(a) The site has a low diversity of aquatic habitats with minimal acreage of wetlands or miles of perennial streams;

(b) Major aquatic habitats are off site; or

(c) Streams in the basin are rated poor based on fish populations, and many habitats have been altered by channelization or siltation.

4--(a) The site has a moderately low diversity of aquatic habitats with limited acreages of small disturbed wetlands or some perennial streams;

(b) Major aquatic habitats are restricted to small portions of the site; or

(c) Streams are rated poor to fair based on fish populations and habitats.

3--(a) The site has an average diversity of aquatic habitats with significant wetland acreage or perennial streams;

(b) A major stream passes through a site of wetlands; or

(c) Streams are rated fair to good based on fish populations and habitats.

2--(a) The siting area has a good diversity of aquatic habitats, with significant wetland acreages in fresh marsh or bottomland forest and several miles of perennial streams;

(b) A major stream with perennial tributaries passes through site; or

(c) Streams are rated good based on fish populations and habitats.

1--(a) The siting area has a high diversity of aquatic habitats, with significant acreages of freshwater marsh, bottomland forest, and several miles of high quality perennial streams;

(b) A major stream with perennial tributaries and associated wetlands passes through the site; or

(c) Streams are rated excellent or unique based on fauna and available habitat.

6.5.2.3 RATING METHODOLOGY

Similar to the terrestrial systems rating, individual components of the aquatic rating were evaluated quantitatively.

The rating for diversity of aquatic habitats was an average of three separate sub-criteria including: (1) miles of perennial streams on site, (2) sinuosity of streams, and (3) acreages of standing water on site.

The perennial stream mileage rating was calculated based on the following ranking:

Miles of Stream On Site	Sub-Rating
none	5
<5 miles	4
5-10 miles	3
10-15 miles	2
>15 miles	1

6.5.2.4 SINUOSITY

The sinuosity values of the streams on site were used to quantify the habitat diversity associated with the natural meanderings of flowing water. In general, the greater the number of meanders, the higher the diversity of habitats and organisms found in that stream. As streams lose their meanders due to natural alterations or artificial channelization, the diversity of habitats decreases.

Sinuosity was calculated as a ratio of the length of the stream valley to the total length of the stream as it cuts through the valley. A sinuosity rating for each site was based on the following range of sinuosity values:

Sinuosity Value	Sub-Rating
0.01-0.45	1
0.46-0.69	2
0.70-0.86	3
0.87-0.99	4
>0.99	5

6.5.2.5 STANDING WATER

A measure of the acreage of standing water on each site included both natural and artificial water impoundments (e.g., farm ponds, reservoirs, lakes, depressions, oxbows, sloughs, and floodplain lakes and associated wetlands).

The types, sizes, and kinds of habitats adjacent to the standing water were included in this evaluation in order to assess the potential diversity provided by these aquatic habitats.

The sites were rated for standing water as follows:

5--(a) No standing water on site; or
(b) No individual farm ponds or depressions more 2 acres on site.

4--(a) Individual farm ponds or reservoirs on site more than 2 acres, with adjacent habitat mainly cropland.

3--(a) Farm ponds and/or reservoirs more than 2 acres on site, with adjacent (vegetation) habitat mainly wooded.

2--(a) Wetlands and sloughs on site; or

(b) Oxbow lakes and floodplain lakes on site.

1--(a) Wetlands or sloughs on site and oxbows on floodplain lakes present.

The three sub-ratings (perennial streams, sinuosity value, and standing water) were averaged to obtain the diversity rating for aquatic habitat. Where an average value was not a whole number, the value was rounded to the nearest whole number.

Distance-to-aquatic habitat ratings were based on positions of the major stream and associated wetlands on the site. Sites were rated according to the following definitions:

Rating	
5	Stream and wetlands off site with no perennial streams or wetlands on the site.
4	Major stream restricted to one side or corner of the site with no wetlands or perennial streams draining off the site.
3	Major river passes through the center of the site, with no perennial streams draining the site into the river; streams are intermittent.
2	Major stream passes through center of the site and has entering perennial streams which drain the site.
1	Major stream passes through the site, possibly meandering, with oxbows and/or backwaters, and perennial streams, which drain the site, enter.

Streams were rated for potential fishery populations according to the evaluation of Smith (Illinois Streams: A Classification Based on Their

Fishes, 1971). In this evaluation Smith used the terms excellent, good, fair, and poor. These terms are quantified in the following rating system:

Smith's Term	Fishery Rating
Excellent	1
Good	2
Fair	3
Poor	4

6.5.3 SIGNIFICANT NATURAL AREAS AND THREATENED AND ENDANGERED SPECIES

6.5.3.1 CRITERION DEFINITION

Certain flora and fauna species have been identified by the U.S. Department of Interior as having relatively few remaining individuals. These species have been designated as threatened or endangered and accorded special protection. In some instances, not only the species but also areas of critical habitat have come under protection.

The definitions for threatened and endangered species are:

Endangered--Species in danger of extinction if the deleterious factors affecting their populations continue to operate. These are forms whose numbers have already declined to such a critically low level or whose habitats have been so seriously reduced or degraded that without active assistance their survival is questionable.

Threatened--Species that are likely to become endangered within the foreseeable future if current trends continue. This category includes: (1) species of which most or all populations are decreasing because of over-exploitation, habitat loss, or other factors; (2) species whose populations have already been heavily depleted by deleterious conditions and which, while not actually endangered, are nevertheless in a critical state; and (3) species which may still be relatively abundant but are being subjected to serious adverse pressers throughout their range.

Each of the candidate siting areas was evaluated for the known or potential presence of threatened or endangered species. Potential impacts during both construction and operation were evaluated for each species having the potential to frequent an area.

The existence of an operational CAES plant near unique natural or scientific areas may lessen the integrity of such areas. These lands, which may be incorpoated into preserves, refuges, state or federal parks, or set aside by themselves, deserve consideration during siting because they often contain rare or unique habitats or natural systems worthy of preserving. Many are protected by law from further degradation. Evaluation of the candidate sites included review for the presence of such areas, their proximity to the site, and their sensitivity to the construction and operation of the CAES facility.

6.5.3.2 SIGNIFICANT NATURAL AREAS AND THREATENED AND ENDANGERED SPECIES RATING SPECIFICATIONS

Each site was rated with regard to the existence of, or potential for supporting, plants and animals designated by the U.S. Department of the Interior as threatened or endangered species. The presence of significant natural areas was also used in evaluating each site. Significant Natural Areas included: (1) natural areas identified by the Illinois Natural Areas Inventory, and (2) state or national parks, forests, refuges, recreational areas, and nature preserves.

Using the rating criteria below, a site with a rating of 5 would be favorable for plant operation. The criteria were defined as:

5--(a) The site has no known threatened or endangered species and the potential for their existence is low; or

(b) No significant natural areas are located on site or within 2 miles of site boundaries.

4--(a) The siting area has known threatened or endangered species but the potential for their existence is moderate; or

(b) Significant natural areas are located within 2 miles of the site but the potential for impact is low.

3--(a) The site has no known threatened or endangered species but the potential for their existence is high; or

(b) Significant Natural Areas are located within 2 miles of the site and the potential for impact is moderate.

2--(a) The site has known threatened or endangered species, but with mitigation potential impacts can be reduced; or

(b) Significant Natural Areas are located within site boundaries, but with mitigation potential impacts can be reduced.

1--(a) Threatened or endangered species are known to inhabit the site and impacts will likely be severe even with mitigation; or

(b) Significant Natural Areas are located within site boundaries and severe impact is likely. Construction on the site should be avoided.

6.5.3.3 RATING METHODOLOGY

It is difficult at the level of effort involved in the Stage III analysis to quantify information regarding the existence (or potential existence) of threatened or endangered species or possible impacts resulting from plant siting. However, the following definitions and techniques should clarify the evaluation of threatened and endangered species and natural areas in the Stage III analysis.

The presence of threatened and endangered species in a siting area was classified as being low, moderate, or high. Low potential indicates that no species are known to frequent an area because it is out of their normal range or that the necessary habitat is not available on the site. Moderate potential indicates that the siting area is within the normal range of the species and/or the proper habitat is present for the species' normal range, the proper habitat is present, and the species has been located in the vicinity of the siting area.

In rating the closeness of threatened and endangered species, refuges, natural or scientific areas, the term "near" indicates that the area is within approximately 2 miles of the site boundary. All such specific areas within this range were included in the analysis of the sites, because it is possible that impacts from the operation of the CAES facility may extend several miles and impact these nearby sensitive areas.

In addressing possible impacts, the terms "moderate" and "severe" are used. "Moderate" impacts are generally those of a chronic nature that over a long period may decrease the productivity, diversity, or integrity of an area. Impacts such as increased road or rail traffic with resulting noise or dust may decrease the use of an area by some animal species or decrease the productivity of specific sensitive plants. These changes may decrease the natural character of unique ecological area, and may reduce its attractiveness for threatened or endangered species. Moderate impacts generally were associated with special natural areas at the fringe of the siting area or off site, and with threatened and endangered species that only migrate through the siting area or do not utilize the siting area for nesting or breeding activity.

"Severe" impacts relate to actions that will abruptly and directly affect threatened and endangered species or lessen the productivity or diversity of special use areas. If threatened and endangered species are known to exist on the siting area and are sensitive to environmental disturbance, it is probable that construction and operation of the CAES facility may have severe impacts on the species. Likewise, unique habitats may have a high risk of being impacted by the plant.

6.5.4 INTERNAL WEIGHTINGS

Because of the more severe licensing difficulties that would result if endangered or threatened species were affected by a project, an importance weighting of 5 was assigned to the endangered and threatened species criterion. A weighting of 3 was assigned to both the terrestrial and aquatic systems criteria.

6.5.5 RESULTS

Table 6–7 presents the results of the internal weighted ratings and site area rankings for ecological considerations at each site. During the Stage III analysis, Sites 4, 12, 13, 23, and 24 were dropped as potential siting areas due to overriding geological considerations. For this reason no rating or rankings are given for these sites. The geological factors were reviewed concurrently with this ecological review and are described in Chapter 6.7 in this document.

Table 6-7. Impact Ratings for Ecological Considerations

Site	Impact Ratings: Terrestrial (3)*	Aquatic (3)*	Threatened and Endangered (5)*	Average Weighted Impact Rating†	Discipline Rankings**
1	3.0	6.0	15.0	2.2	2
2	9.0	6.0	25.0	3.6	16.5
3	12.0	6.0	20.0	3.5	13
5	12.0	9.0	15.0	3.3	10
6	6.0	9.0	25.0	3.6	17
7	9.0	12.0	25.0	4.2	20.5
8	9.0	6.0	5.0	1.8	1
9	12.0	9.0	20.0	3.7	10
10	9.0	9.0	25.0	3.9	19
11	9.0	9.0	15.0	3.0	7
14	9.0	9.0	20.0	3.5	13
15	9.0	9.0	15.0	3.0	7
16	12.0	15.0	25.0	4.7	22.5
17	15.0	12.0	25.0	4.7	22.5
18	12.0	9.0	25.0	4.2	20.5
19	6.0	6.0	15.0	2.5	3
20	12.0	6.0	20.0	3.5	13
21	6.0	12.0	20.0	3.5	13
22	9.0	9.0	15.0	3.0	7
25	9.0	9.0	20.0	3.5	13
26	9.0	9.0	10.0	2.6	4
27	9.0	6.0	15.0	2.7	5
28	6.9	9.0	20.0	3.2	9

* Internal weighting for each consideration.

† Average weighted impact rating = impact ratings x internal weightings, product then summed and divided by total internal weightings (ratings rounded off for presentation).

** For tied average impact ratings, half rankings were assigned for siting areas tied 2 or 4 times; siting areas tied 3 or 5 times were assigned the same ranking.

Source: ESE, 1981.

6.6 SOCIOECONOMIC SYSTEMS

The socioeconomic site-specific criteria used to evaluate the potential plant site areas are basic characteristics of the siting area which might be impacted. The site rankings (5 to 1) are based on the relative significance of impacts among the sites.

6.6.1 ARCHAEOLOGICAL/HISTORICAL RESOURCES

6.6.1.1 CRITERION DEFINITION

Historical sites are a vital cultural resource, and their preservation has long been an important endeavor of government in Illinois. It may be desirable, or in some cases mandatory, to protect a significant archaeological/historical find. Section 1 (3) of Executive Order 111593, May 13, 1979, "Protection and Enhancement of the Cultural Environment," requires that the federal agencies, in consultation with the Advisory Council on Historical Preservation, establish procedures for the preservation and enhancement of nonfederally-owned historic and cultural properties in the execution of their plans and programs. The Code of Federal Regulations (36 CFR 800) delineates the circumstances and regulations regarding the protection of historical and cultural properties.

Upon identification of a cultural resource on a tract of land, the impact of site development must be determined. In some cases, the development might be beneficial for the resource by either providing public access or recording and preserving the find. However, even if the resource would be adversely affected by the construction of the proposed CAES power plant, planned mitigation of these effects would not be required unless the resource were eligible for listing on, or nomination to, the National Register of Historic Places or the Illinois Register of Historic Places.

The National Register is the official list of the nation's cultural resources worthy of protection. Sites included on the list are protected by the National Advisory Council on Historic Sites, which reviews and comments on the impact that projects receiving federal funds have on historic sites and is authorized to stop projects which would endanger historic sites.

The Illinois Register carries protective measures more stringent than those contained in the National Register program. Sites listed on the Illinois Register have deed restrictions which require prior approval from the State Historic Preservation Officer for any modification of the sites.

Mitigative options available include: project abandonment; cultural resources abandonment (no protective action); modification of the project's design (in this case, rearrangement of the CAES power plant's location on the site); salvage of data; testing of structures, objects, and artifacts; and physical protection of the cultural resources. Since salvage excavations are not only destructive to the resource, but also costly and time consuming, they are undertaken only as a last resort and then only by professionally qualified investigators.

This analysis involves identifying known prehistoric and historic resources of significance and estimating, to some extent, the possibility of other resources occurring on each site. The location of an archaeological/historical resource on a tract of land does not necessarily disqualify a site. The information obtained from a resource is often of primary value, not the artifacts themselves. Therefore, the effect on the suitability of a site depends on the significance of the find and the project impact.

The following three factors are important at this stage of analysis:

1. Recorded archaeological or historical resources included in the National Register of Historic Places,

2. Recorded archaeological or historic resources included in the Illinois Register, and
3. Potential for prehistoric or historic resource occurrence on the tract based on analysis of the distribution of Register sites in the area.

6.6.1.2 RATING SPECIFICATIONS

It is recognized that unknown and unpredicted archaeological or historical resources of significance may be discovered on any site during later intensive surveys; however, the most reliable data currently available were used for this analysis.

The rating specifications employed were:

5--No National or State Register archaeological or historical resources recorded after records check; such resources are unlikely.

4--(a) No National or State Register resources recorded and low predicted potential of resources occurring;
(b) Cultural resources identified, but project impact judged to be minimal or beneficial; or
(c) Resources identified, but project impact mitigated by avoidance.

3--(a) No National or State Register cultural resources recorded and moderate predicted potential of resources occurring;
(b) Resources identified, but project impact mitigated only by difficult avoidance; or
(c) Resources identified, adverse impact anticipated, but easily mitigated.

2--(a) No Register cultural resources recorded, but high predicted potential of resources occurring; or
(b) Resources identified, adverse impact anticipated, and mitigation difficult.

1--Register cultural resources identified, adverse impact anticipated, and mitigation undesirable or not feasible.

6.6.2 LAND USE COMPATIBILITY

6.6.2.1 CRITERION DEFINITION

In the site-specific analysis, the land use of each candidate site and its immediate surroundings was examined. Each site was ranked according to the degree of compatibility of a CAES power plant with the various land uses.

The term "land use" is difficult to distinguish from other social, economic, or environmental variables. This land use compatibility analysis focuses on the regulatory controls that govern the type and intensity of human activities permitted on a particular parcel of land.

County and regional planning commissions, along with other appropriate agencies, were contacted to obtain currently available data regarding the following aspects of land use compatibility:

1. Existing land use patterns,
2. Planned land use patterns, and
3. Regulatory constraints.

Existing land use was the first consideration, and prime farmland was minimized as potential site areas. Any planned or potential land uses were also be taken into account. For example, the area may be assessed for recreation potential. The regulatory aspects of land use, such as the land use plans adopted, are more subject to change than are the actual land use patterns. State regulatory constraints, other than adopted land use plans, are generally incorporated into local programs.

6.6.2.2 RATING SPECIFICATIONS

In evaluating a candidate site for land use compatibility, existing and future land use patterns, both regulated (e.g., zoned areas) and unregulated (e.g., recreational uses), were considered. Since regulations concerning land use are subject to change, the probability of changing conditions(toward more regulation or toward relaxation of existing regulations) also needs to be considered.

The seriousness of a conflict or restriction was also evaluated. It is rare to find a tract of land large enough for CAES plant siting and devoid of any important natural or cultural feature. If the important features within a site could be preserved through mitigative design measures, then such restrictions will not be deemed serious and will not greatly affect the overall rating of a site. Wetland areas, for instance, could be preserved by proper positioning of the plant on the site to avoid them. Similarly, regulations or restrictions in conflict with the development of a site which could be easily changed or relaxed within a reasonably short time, either by variance or reclassification of zoning, should not be deemed serious obstacles. The resolution of a regulatory conflict in this manner is termed "relaxation of restriction."

The rating specifications are:

5--Usage of the site for a CAES system would generally be compatible with both existing and proposed land use patterns of the area, there are no significant conflicts with regulatory constraints, and any proposed changes in regulations probably would not change the rating of the site.

4--Usage of the site for a CAES system would generally be compatible with both existing and proposed land use patterns, except that minor mitigative design measures or a relaxation of regulatory restrictions, which are considered feasible, would be required.

3--Usage of the site for a CAES system would conflict with some existing or planned land uses; however, conflict could be mitigated by design changes or by relaxation of the regulatory restrictions involved.

2--Usage of the site for a CAES system would be incompatible or in conflict with important land use patterns, although they may not be regulated, and mitigative design measures would generally not be feasible.

1--Usage of the site for a CAES system would conflict with existing land use regulations that are not likely to change within an acceptable time, and mitigative design measures would generally not be feasible.

6.6.3 COMMUNITY IMPACT

6.6.3.1 CRITERION DEFINITION

Many community elements are a direct function of the proximity of population concentrations. Thus, in determining the level of community impact that might be associated with each candidate site, two elements are considered:

1. The population levels of incorporated communities within a 50-mile radius of each site, and
2. The presence of existing communities in the proximity of each site (10 miles).

It was assumed that the presence of larger, established communities within reasonable daily commuting distances would minimize the community impact of a CAES plant. The work force associated with the project would then account for only a small share of each community's population. In addition, a large portion of the work force could be drawn from local communities without adversely impacting the local labor market or necessitating in-migration of workers. When communities within reasonable commuting distance are small, the incoming- worker households would lead to a relatively major increase in community residents which would in turn increase the demand for local goods and services.

Locating a power plant close to existing communities would impact these communities. Not only would some workers want to live there, but congestion, commercial activity, and the demand for public services would accelerate. The greater the number of communities surrounding the site, the more the impact would be dispersed, without adversely affecting one or two population centers.

6.6.3.2 RATING SPECIFICATIONS

Rating specifications established on the basis of the previously-mentioned fundamental assumptions are:

5--(a) Site is within a 1-hour trip to many existing communities with populations totaling more than 250,000, or

(b) There are a number of communities (10+) within 10 miles of the site.

4--(a) Site is within a 1-hour trip of communities with total populations exceeding 250,000, or

(b) There are several communities (6 to 9) within 10 miles of the site.

3--(a) Site is within a 1-hour trip of communities with total populations exceeding 125,000, or

(b) There are only a few (3 to 5) communities within 10 miles of the site.

2--(a) Site is within a 1-hour trip of communities with populations totaling 50,000 to 125,000, or

(b) There are very few (0 to 2) communities closer than 10 miles to the site.

1 - Site is within a 1-hour trip of communities with populations totaling less than 50,000, or

(b) There are very few (0 to 2) communities closer than 10 miles to the site.

6.6.4 RAIL ACCESSIBILITY

6.6.4.1 CRITERION DEFINITION

The extent of new rail lines required to service each of the proposed sites was considered. It is assumed that rail will be used to deliver oil to the proposed CAES plant. The suitability of the candidate sites was evaluated primarily on the basis of the relative length of new rail line required to connect each of these sites to the nearest existing rail line. The costs of constructing additional rail line were considered: (1) the operating characteristics of the different railroads (i.e., their availability for client usage and ability to'transport oil), and (2) any physical barriers that might hinder locating the proposed rail line spurs.

For each site, the required length of new rail line was the distance from the closest edge of the site to the nearest existing rail line.

6.6.4.2 RATING SPECIFICATIONS

The rating specifications used to establish the suitability of each site in terms of rail accessibility were:

5--A Class I rail line currently runs to the site.

4--A Class I rail line runs close (0 to 2 miles) to the site and a relatively insignificant length of new line would be required; physical terrain would pose no problem; or, a Class I rail line currently runs to the site, but is subject to pending or potential abandonment.

3--The nearest Class I rail line is located a short or intermediate distance (2+ to 6 miles) from the site and a short or intermediate length of new line would be required; physical terrain would pose no problem.

2--The nearest Class I rail line is located a short or intermediate distance (2+ to 6 miles) from the site and a short or intermediate length of new line would be required; definite physical barriers are present.

1--The nearest Class I rail line is located a relatively long distance (6+ miles) from the site and a long length of new line would be required; or, major physical barriers are present.

Following is a list of the railroad companies involved and their abbreviations:

Illinois Central Gulf	ICG
Burlington Northern	BN
Norfolk and Western	NW

Missouri Pacific	MP
Milwaukee Road	MILW
Rock Island	RI
Atchison, Topeka and Santa Fe	ATSF
Louisville & Nashville	LN
Toledo, Peoria and Western	TPW
Chicago & Illinois Midland	CIM
Missouri Illinois	MI
Kankakee & Beaverville	KBSR
Chicago, Rock Island & Pacific	CRI & P
Chicago & North Western	CNW
Chicago, Milwaukee, St. Paul & Pacific	CMSPP
Central & Eastern Illinois	CEI
Baltimore & Ohio	B & O

6.6.5 HIGHWAY ACCESSIBILITY

6.6.5.1 CRITERION DEFINITION

Analysis of site suitability with respect to highway accessibility involves two considerations. The primary consideration is proximity to an existing state or federal highway. No distinction is made between state and federal highways since both are capable of handling the traffic predicted to be generated by the development.

The secondary consideration is the extent of new highways and/or service roads that would be required to support proposed facilities at each site. Both the existence and condition of secondary roads from the site to a state/federal highway were considered in determining new highway/service roads requirements. A hard-surfaced roadway is more desirable than an unimproved or graded roadway. It was assumed that anything other than a hard-surfaced roadway from a site to a state/federal highway would require improvement. Economic or environmental factors that may require relocating secondary access roads (i.e., service roads) were not considered in this analysis.

6.6.5.2 RATING SPECIFICATIONS

The rating specifications employed to establish the suitability of each of the sites in terms of highway accessibility are:

5--The site is adjacent to existing state or federal highways.

4--The site is relatively close (0.5 to 2 miles) to a state or federal highway and is serviced by an existing hard-surfaced road.

3--The site is relatively close (0.5 to 2 miles) to a state or federal highway and is not serviced by a hard-surfaced road.

2--The site is not close (2+ miles) to a state or federal highway but is serviced by a hard-surfaced road.

1--The site is not close (2+ miles) to a state or federal highway and is not serviced by a hard-surfaced road.

The overall accessibility ratings for each site are a composite (average) of the two criteria, rail accessibility and highway accessibility. Where an average value was not a whole number, the value was rounded to the nearest whole number.

6.6.6 ELECTRICAL TRANSMISSION ACCESSIBILITY

6.6.6.1 CRITERION DEFINITION

The extent of transmission lines required to service each of the sites is based on the routine of two 345-kV single circuit transmission lines from the center of each specific site to the nearest 345-kV substation. Both lines were terminated at the same substation when the substation had two outgoing lines. Only straight transmission line distances between the site and substation were considered.

It was assumed, for reliability and efficiency, that the electric power output of the 220-MW CAES plant integrates into the system by means of two 345-kV single circuit transmission lines. These lines may consist of lattice steel towers, suspension insulators, and a bundle of two conductors per phase. The right-of-way width for each line was assumed to be 150 feet.

6.6.6.2 RATING SPECIFICATIONS

The rating specifications employed to establish the suitability of each site in terms of transmission lines are defined as follows:

5--The nearest substation is located relatively close to the site, with transmission line lengths of 0 to 75 miles required.

4--The nearest substation is located a short distance from the site, with transmission line lengths of 76 to 150 miles required.

3--The nearest substation is located an intermediate distance from the site, with transmission line lengths of 151 to 225 miles required.

2--The nearest substation is located a relatively long distance from the site, with transmission line lengths of 226 to 300 miles required.

1--The nearest substation is located a long distance from the site, with transmission line lengths of over 300 miles required.

6.6.7 INTERNAL WEIGHTINGS

Specific federal and state acts, and executive orders mandate the protection of cultural and historic resources in Illinois. The presence of such significant resources could restrict siting and licensing of a facility. Therefore, an importance weighting of 5 was assigned to the archaeological criterion. Likewise, land use is controlled by state, county and local zoning, thus this category was also assigned a weighting of 5. No specific laws or regulations govern accessibility, community impact and transmission; therefore, weights of 1, 1, and 2 were assigned respectively.

6.6.8 RESULTS

The results of the Stage III socioeconomics and land use analysis are presented in Table 6.8. Sites 11 and 3 were the two top ranked sites within this environmental discipline. Site 27 was the lowest ranked site.

Table 6-8. Impact Ratings for Socioeconomic/Land Use

Site	Archeology (5)*	Impact Ratings: Land Use (5)*	Community Impact (1)*	Accessibility (1)*	Transmission (2)*	Average Weighted Impact Rating†	Discipline Rankings**
1	3	4	4	5	2	3.43	10
2	4	3	5	5	1	3.36	8.5
3	5	1	5	4	1	2.93	2
5	3	4	4	5	3	3.57	12.5
6	3	3	5	3	4	3.29	6
7	3	3	4	3	4	3.21	4
8	3	4	3	3	3	3.36	8.5
9	3	4	4	4	4	3.64	15.5
10	3	3	5	3	4	3.29	6
11	3	1	4	5	4	2.64	1
14	3	3	3	5	4	3.29	6
15	3	3	3	3	4	3.14	3
16	4	3	5	5	4	3.79	17
17	3	3	5	5	5	3.57	12.5
18	4	3	4	5	5	3.86	18
19	3	4	2	5	4	3.57	12.5
20	3	4	2	5	4	3.57	12.5
21	4	4	3	5	4	4.0	20
22	3	4	3	5	4	3.64	15.5
25	4	4	5	5	5	4.29	21.5
26	3	4	5	5	5	3.93	19
27	4	5	4	5	5	4.57	23
28	3	5	5	5	5	4.29	21.5

* Internal weighting for each consideration.

† Average weighted impact rating = impact ratings x internal weightings, product then summed and divided by total internal weightings (ratings rounded off for presentation).

** For tied average impact ratings, half rankings were assigned for siting areas tied 2 or 4 times; siting areas tied 3 or 5 times were assigned the same ranking.

Source: ESE, 1981.

6.7 GEOTECHNICAL SUITABILITY RESULTS

Examination of the canditate siting areas utilizing more site-specific geological information yielded 23 acceptable sites. These sites and the anticipated target formation suitable for CAES cavern development are listed in Table 6-9.

Five of the 28 candidate sites were considered to be unacceptable for CAES development according to the criteria defined in Section 6.2.2. These sites and the reasons for elimination follow.

Site 4, Ogle County. It is unlikely that qualified rock formations could be located at the prescribed depth in this area. The Cambrian-Precambrian contact is at a depth of about 2,700 feet. Adding to this consideration that a significant portion of the Precambrian surface may be weathered (weakened), the target horizon is probably too deep to qualify as a prime site. Rock formations that would probably be encountered in the 1,700- to 2,500-foot depth range are Cambrian sandstones of the Cambrian System. While it is possible that a sufficient thickness of acceptable Cambrian strata could be located in this area, it is unlikely.

There also exists the possibility that the geology in this area is affected by local structural features. The site is located close to and approximately on strike from the Plum River Fault Zone. The area is also about 15 miles north of the Sandwich Fault Zone. Small extensions of either of these fault zones could be present in the site area.

Site 12, Kankakee County-A. A nearby drill hole, which appears to be approximately along a formation strike from this site, encountered the top of the Lombard member at a depth of 2,800 feet. This is deeper than the projected depth for the CAES cavern. It is

Table 6-9. Target Rock Formations of Potentially Favorable Sites Examined in Stage III Intermediate Analysis

Site	County	Target Formations
1	Jo Daviess	Precambrian Granite
2	Stephenson-A	Precambrian Granite
3	Stephenson-B	Precambrian Granite
5	Whiteside	Lombard Member of Eau Claire Formation
6	Rock Island-A	Lombard Member of Eau Claire Formation
7	Rock Island-B	Lombard Member of Eau Claire Formation
8	Mercer-A	Lombard Member of Eau Claire Formation
9	Mercer-B	Lombard Member of Eau Claire Formation
10	Bureau	Lombard Member of Eau Claire Formation
11	Putnam	Lombard Member of Eau Claire Formation
14	Henderson	Lombard Member of Eau Claire Formation
15	Hancock	Lombard Member of Eau Claire Formation
16	Iroquois	Lombard Member of Eau Claire Formation
17	Mason	Knox Dolomite Megagroup
18	Menard	Knox Dolomite Megagroup
19	Adams	Lombard Member of Eau Claire Formation
20	Pike-A	Lombard Member of Eau Claire Formation
21	Pike-B	Lombard Member of Eau Claire Formation
22	Pike-C	Lombard Member of Eau Claire Formation or Precambrian Granite
25	Clinton	Hunton Limestone Megagroup
26	Washington	Ottawa Limestone Megagroup (possible Hunton Limestone Megagroup)
27	St. Clair	Ottawa Limestone Megagroup
28	Randolph	Knox Dolomite Megagroup (possible Ottawa Limestone Megagroup)

Source: Fenix and Scisson, 1981.

likely that some minor structural disturbances have occurred in this area. Small extensions of the Sandwich Fault Zone and minor slump faults associated with the Kankakee Arch are possible.

Site 13, Kankakee–B. This site was eliminated for the same reasons as Site 12. Although the depth to the top of the target formation should be slightly less here than at Site 12, it should still be close to or deeper than the established maximum cavern depth of 2,500 feet.

Site 23, Brown County. Two potential acceptable cavern formations exist in the area: the Lombard Member of the Eau Claire Formation and the Knox Dolomite Megagroup. However, the Lombard Member at this site probably occurs below a depth of 2,500 feet and the Knox Dolomite about 1,700 feet.

Site 24, Calhoun County. This site is located just to the south, on the down–dip side, of a structural feature called the Cap au Gres Faulted Flexure. This is a southerly dipping monocline which is faulted, possibly as a result of slumping or wrenching. It is likely that structural disturbances exist in the area of this candidate site.

The five candidate sites not found to be acceptable were not considered further in the siting analysis, including the weighting and ranking described in Sections 6.3 through 6.6.

6.8. SITING AREA ENVIRONMENTAL SUITABILITY RANKING RESULTS

The results of the discipline rankings and overall environmental rankings for each of the 23 siting areas (28 less 5 judged geotechnically unfavorable) are presented in Table 6-10. The maximum attainable ranking value was 23, the total number of sites. To attain a maximum ranking of 23, a candidate siting area would have to be ranked the highest for all disciplines examined.

The overall environmental rankings for the siting areas, ordered from the highest to the lowest, are shown in Table 6-11. No siting area was scored the highest possible ranking (23) for all disciplines. The range of suitability for the sites ranged from Site 9 with an overall ranking of 17.19 to Site 10 with a ranking of 5.62. Site 9 thus had the highest environmental suitability for CAES, and Site 10 had the lowest.

A statistical analysis was applied to the numerical rankings to provide a level of confidence in interpreting the rankings. To determine if there were significant differences between siting areas based on their overall environmental rankings, nonparametric statistical tests of the ranked siting areas were conducted. The analysis indicated that no one group of sites was significantly different from any other group of siting areas. For significance to occur, ranking of the sites would have to have been consistent between the disciplines.

The lack of significance for any group indicated that there was no strong preference by the interdisciplinary siting team for any one site or sites. The tests did indicate that the best site, Site 9 in Mercer County, was significantly different ($P > 90$ percent) from the lowest site, Site 10. The range of suitability rather than a clumping of similarly suitable siting areas is not completely unexpected. One of the goals of the Stage II regional screening was to eliminate any areas

Table 6-10. Discipline Rankings and Overall Discipline Rankings for Stage III Siting Areas*

SITE	DISCIPLINE (Discipline Weight): Air Quality (1)	Water Resources (8)	Ecology (2)	Socio-Economics (10)	OVERALL? RANKINGS
1	10	19	2	10	12.67
2	18	9	16.5	8.5	9.9
3	18	9	13	2	6.48
5	12	13	10	12.5	12.43
6	7	19	16.5	6	12.0
7	7	19	20.5	4	11.43
8	18	19	1	8.5	12.24
9	18	19	18	15.5	17.19
10	2	9	19	6	5.62
11	3	13	7	1	6.24
14	10	19	13	6	11.81
15	18	19	7	3	10.19
16	18	5.5	22.5	17	13.19
17	18	2	22.5	12.5	9.71
18	18	5.5	20.5	18	13.48
19	4.5	19	3	12.5	13.69
20	4.5	19	13	12.5	14.64
21	10	11	13	20	15.43
22	18	13	7	15.5	13.86
25	18	2	13	21.5	13.10
26	18	5.5	4	19	12.38
27	1	2	5	23	12.24
28	7	5.5	9	21.5	13.52

* The higher the ranking, the greater the environmental suitability for CAES.

† Overall ranking = discipline rankings for each siting area times overall discipline weightings, summed and divided by total discipline weighting.

Source: ESE, 1981.

Table 6-11. Overall Environmental Ranking of the Siting Areas in Descending Order of Environmental Suitability

Environmental Suitability	Siting Area	Overall Ranking
Highest	9*†	17.19
	21†	15.43
	20†	14.64
	22†	13.86
	19†	13.69
	28†	13.52
	18†	13.48
	16	13.19
	25	13.10
	1	12.67
	5	12.43
	26	12.38
	27	12.24
	8	12.24
	6	12.0
	14	11.81
	7	11.43
	6	10.19
	2	9.90
	17	9.71
	3	6.48
	11	6.24
Lowest	10	5.62

* Statistical significance ($P > 90$ percent) of the difference of this siting area from Site 10.

† Statistical significance ($P > 75$ percent) of the difference of these siting areas from Site 10.

Overall Ranking = Discipline ranking for each candidate siting area times overall discipline weightings, summed and divided by total discipline weightings.

Source: ESE, 1981.

of gross environmental deficiencies from further evaluation. The favorable and potentially favorable categories should all contain sites which can be licensed.

As originally stated, the goal of this stage of siting was to evaluate and reduce the total number of sites under consideration for siting Soyland's CAES plant. Of the 28 original sites, 5 were eliminated due to geotechnical unfavorability. The remaining sites spanned a continuum of environmental favorability, with no one site or group clearly identifiable as being more favorable. In order to reduce the number of sites to a more manageable group, a level of statistical confidence ($P > 75$ percent) was chosen, splitting the top environmentally-ranked sites from the lowest-ranked site (Table 6-11). This resulted in seven sites (Sites 9, 21, 20, 22, 19, 28, and 18) being identified. While this was more than the desired number of three sites (one preferred and two alternatives), it did allow greater flexibility in conducting the fatal flaw analysis in the next stage.

6.9 SUMMARY

In summary, the intermediate analysis accomplished the following:

1. Evaluated 28 sites based on geotechnical considerations, eliminating 5 sites;
2. Environmentally weighed and ranked the 23 remaining sites according to air quality, water resources, ecology, and socioeconomics; and
3. Identified statistical differences in the ranked sites and selected seven sites for the next siting step.

Seven candidate siting areas (Sites 9, 21, 20, 22, 19, 28, and 18) were carried into the next siting stage, the fatal flaw analysis. Siting areas are shown in Figure 6-29.

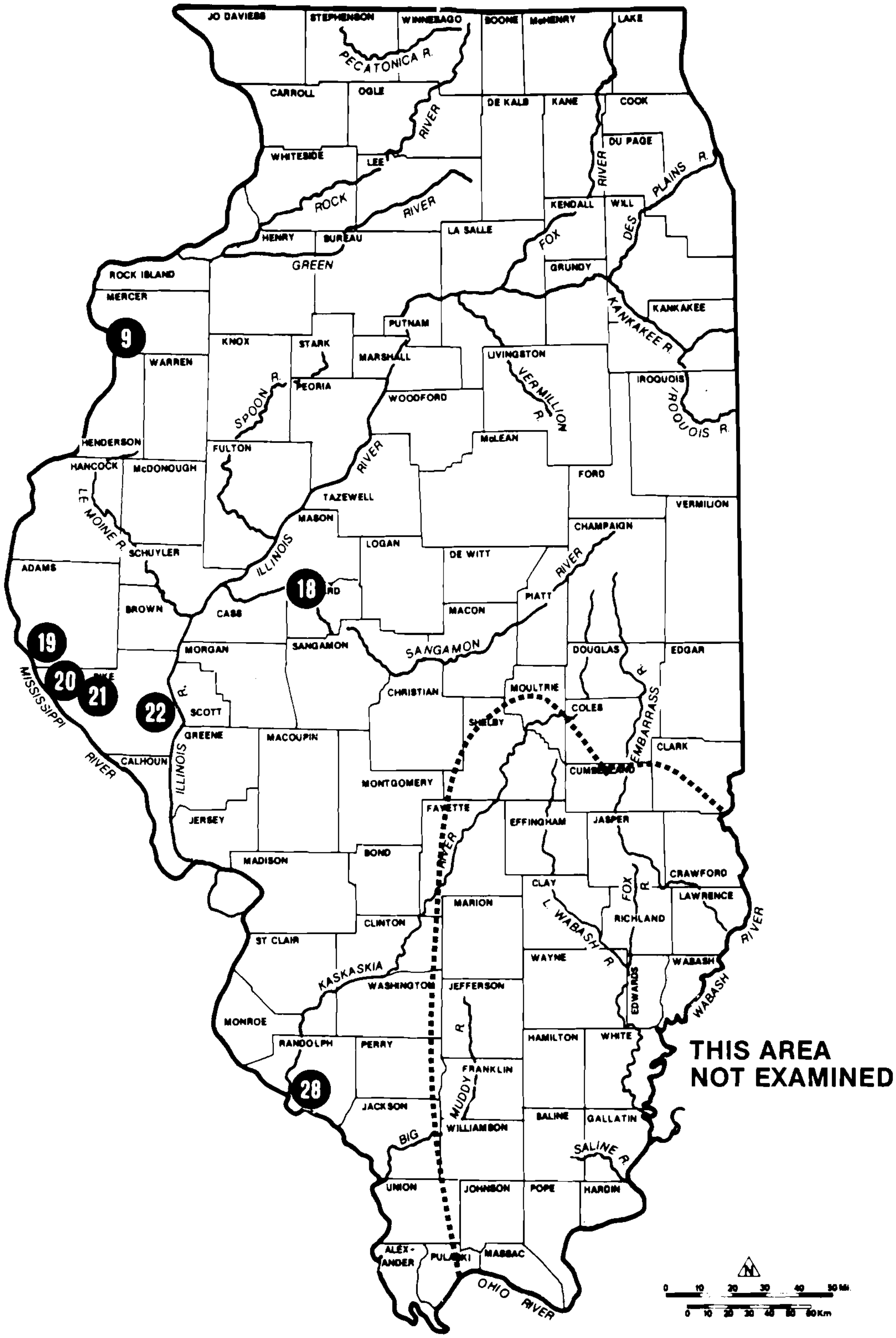


Figure 6-29

PRIME SITING AREAS

SOURCE: ESE, 1981.

CAES

SITE SELECTION STUDY

7.0 STAGE IV--FATAL FLAW ANALYSIS

7.1 OBJECTIVE

The objective of the Stage IV fatal flaw analysis was to examine the seven remaining candidate sites in terms of their ultimate licensability for a 220-MW CAES plant. This was done by comparing the existing physical, natural, and human environments on the site to significant site-specific environmental issues or regulations which could delay or prevent CAES licensing and construction. The identification of such fatal flaws (if they exist) and their importance relative to other sites would also provide a means of further reducing the number of sites under consideration.

The final goal was to identify one preferred and two alternative sites suitable for more detailed geotechnical analysis.

7.2 APPROACH AND METHODOLOGY

The licensing and construction of Soyland's proposed 220-MW CAES plant will result in both positive and negative environmental effects. Regulatory guidelines at the federal, state, and local level will presumably require studies, permits, reviews and hearings (public and agency), or other processes relating to environmental impact issues. This is all part of routine licensing activities for major energy projects.

If the design or operation of the CAES facility cannot be altered such that mitigation of significant impacts is possible, then long delays, costly studies, or even permit denial can occur. Additionally, delay of construction past a particular date may also decrease the viability of the project to Soyland.

Agencies may either temporarily or permanently deny a permit application if there is a reasonable probability that such a facility cannot be operated in compliance with pollution control or other regulations. Alteration of the design or operation of the plant necessary to assure permit approval may be too costly, making alternative generation facilities more viable. Public issues can also flaw licensing of a proposed facility regardless of regulatory mandate. Additionally, a fatal flaw for a site could consist of several issues which cumulatively could effect a significant licensing delay.

In summary, four types of actions that could be regarded as fatal flaws for the Soyland CAES were considered:

1. Long delays in licensing permit approval;
2. Lengthy and costly studies;
3. Extensive need for mitigation, design, or operational changes; and
4. Permit denial.

The Stage IV fatal flaw analysis attempted to identify such potential events at each of the sites. As such, it was the final environmental evaluation in the siting process.

The fatal flaw analysis was conducted for each of the four environmental disciplines: air quality, water resources, ecology, and socioeconomics. The analysis consisted of four steps:

1. Identification of site-specific environmental features relevant to siting and licensing a 220-MW CAES plant;
2. Listing of pertinent regulatory requirements;
3. Listing anticipated environmental issues which may be potential fatal flaws; and
4. Evaluating possible mitigating measures.

The fatal flaw analysis was based on knowledge of existing and anticipated federal and state laws, discussions with appropriate agency representatives, and site visits. Additionally, REA's Methodology for Identifying Environmental Constraints in Power Plant Siting (November 1979) and EPA's Implementation of Procedures on the National Environmental Policy Act (December 1979) were also incorporated into the analysis.

The following chapters outline the critical features of the fatal flaw analysis at each site.

7.3 FATAL FLAW ANALYSIS

7.3.1 MERCER COUNTY

7.3.1.1 AIR QUALITY

Important Environmental Features

Site 9 is located along the east side of the Mississippi River adjoining Keithsburg, Illinois. The site starts at the Mercer-Henderson County line and extends north about 3 km past Pope Creek.

No sources that emit more than 100 tons per year of any of the criteria pollutants are located in Mercer County, Illinois. Only minor particulate sources may be found in Henderson County, Illinois, and in adjoining portions of Louisa and Des Moines Counties, Iowa.

Significant Environmental Regulations, Permits, and Reviews

EPA--PSD permit, Compliance with AAQS

Environmental Issues Evaluated for Potential Fatal Flaws

Since no major influencing sources exist within the impact area of the CAES plant at Site 9 and the contribution of air pollutant concentrations to existing ambient levels is predicted to be at or below significant impact levels, impact on AAQS and PSD increment consumption will be minimal.

Possible Mitigating Measures

Measures to mitigate the impact of the CAES plant, if required, would consist of increasing stack height. This measure alone should provide adequate protection of AAQS and PSD increments.

7.3.1.2 WATER RESOURCES

Important Environmental Features

The site is located along the Mississippi River at Keithsburg. The 7-day, 10-year low flow on the Mississippi River is 15,725 cfs. The specific conductivity ranges from 350 to 500 umhos. The temperature ranges from 33°F to 87°F. Pope Creek and Mad Run also cross the site. The Mark Twain National Wildlife Refuge borders the site.

Significant Environmental Regulations, Permits, and Reviews

Federal Permits/Studies:

EIS Review (National Environmental Polivy Act)
NPDES Permit; 316 Studies (Federal Water Pollution Control Act)
Section 404 Permit (Federal Water Pollution Control Act)
Section 10 Permit (Rivers and Harbors Act)
EIS/Review (Flood Disaster Protection Act)
EIS/Review (Executive Order 11988)
EIS/Review (Safe Drinking Water Act)

State Permits/Studies:

Water Supply
Water Pollution
Solid Waste
Administrative Procedures
Canals and Waterways
Drainage
Roads and Bridges
Wells

Environmental Issues Evaluated for Potential Fatal Flaws

The presence of the nearby Mark Twain National Wildlife Refuge places restrictions on the siting of the CAES facility. Care must be taken with intake structures and outflow location to minimize impacts.

Possible Mitigating Measures

Siting the CAES facility away from the wildlife refuge would be advisable. The inflow and outflow structures should be located to minimize the impact on the wildlife refuge.

7.3.1.3 ECOLOGY

Environmental Features

Over 90 percent of the site is cultivated cropland. Some scattered woods are present, partcularly along the Mississippi River and Pope Creek. Hedgerows provide much of the available wildlife habitat. The river is just off the site and the other streams (Pope Creek, Mad Run Creek, and others) are small in size. Some floodplain lakes are present. The heavily-wooded Mark Twain National Wildlife Refuge, which is adjacent to the site, supports wintering bald eagles and migrating peregrine falcons.

Significant Environmental Regulations, Permits, and Reviews

Federal Permits/Studies:

- Section 404 Permit (Federal Water Pollution Control Act, Executive Order 11990)
- 316b Study (Federal Water Pollution Act) may be required for water intake structure
- Section 7 Consultation-Biological Assessment (Endangered Species Act)

State Permits/Studies:

- Environmental review by state agencies, especially the Illinois Department of Conservation

Potential Fatal Flaws and Possible Mitigation

Bald eagles (U.S. Endangered) winter on the Mark Twain National Wildlife Refuge, and peregrine falcons (U.S. Endangered) have been known to occur there during migration. Most real biological impacts could probably be mitigated by siting the CAES plant as far as possible from the refuge. Public reaction to siting in the area may be more critical than biological impacts. A study of movements and habitat use by bald eagles would likely be required prior to construction of the plant.

7.3.1.4 SOCIOECONOMICS

Important Environmental Features

Except for the City of Keithsburg (which is zoned for residential and business use) the site is zoned Agricultural, AG-1.

The Keithsburg Division of the Mark Twain National Wildlife Refuge (Louisa Wildlife Refuge) lies 500 feet west of the site, and the U.S. Fish and Wildlife Service intends to expand the boundaries southward. No state nature preserves, areas of concern, or inventoried natural areas are within the siting area. The New Boston Rookery lies north of New Boston, 3 to 4 miles northwest of the site. Big River State Park lies just south of the site in Henderson County. Three archaeological resource areas have been identified within the siting area, and the Illinois Department of Conservation estimates that the area has a high potential for archaeological resources.

Although no recent soil survey has been completed for Mercer County, the U.S. Soil Conservation Service (SCS) District Conservationist has identified the siting area as having a low percentage of prime farmland.

Significant Environmental Regulations, Permits, and Reviews

Federal Permits/Studies:

- EIS/Review (National Historic Preservation Act)
- EIS/Review (Archaeological and Historic Preservation Act)
- EIS/Review (Executive Order 11593, Protection and Enhancement of the Cultural Environment)
- EIS/Review (USDA Secretary's Memorandum 1827 and CEQ's Memorandum for Heads of Agencies)

State Permits/Studies:

- Environmental review based on Illinois State Park and Nature Preserves Act

County Permits/Studies:

- County zoning ordinances

Environmental Issues Evaluated for Potential Fatal Flaws

Possible impact to archaeological resources and the site's proximity to a national wildlife refuge, an Illinois state park, and a heron rookery are likely to be of concern.

Possible Mitigating Measures

Engineering design and site facility location will be used to minimize the loss of prime farmland and archaeological resources and maximize the distance of the facility from the wildlife refuge.

7.3.2 PIKE COUNTY NEAR BARRY

7.3.2.1 AIR QUALITY

Important Environmental Features

The American Cyanamid Agricultural Products plant (a fertilizer and pesticide plant is located more than 30 km northwest of Site 21 near Palmyra, Missouri. At the same approximate distance, only south of Site 21, is the Hercules Chemical Plant near Louisiana, Missouri. The site is approximately 25 km from Hannibal, Missouri, and about 40 km from Quincy, Illinois. Although both cities have some industrial activity, most emission sources are relatively small particulate sources--the largest at 1,176 tons/year is in Quincy, Illinois. Few major SO_2 sources exist--the largest at 4,800 tons/year is also located in Quincy, Illinois.

Significant Environmental Regulations, Permits, and Reviews

Federal Permits/Studies

EPA-PSD permit; Compliance with AAQS

Environmental Issues Evaluated for Potential Fatal Flaws

No large major sources are located close enough to Site 21 to have warranted any detailed analysis. The on-site air quality impacts from the sources identified will be relatively insignificant since the relatively low emissions generated by these facilities and/or the long distances observed from Site 21 govern the dispersion of emitted pollutants resulting in low ambient concentrations.

Possible Mitigating Measures

The low level of emissions and corresponding insignificant ambient impact levels resulting from operation of a 220-MW CAES facility makes the employment of any mitigating measures unnecessary. For similar facilities of larger capacity, the only mitigating measure that may be necessary in order to maintain the same level air quality impact (insignificant) would be to increase stack height.

7.3.2.2 WATER RESOURCES

Important Environmental Features

The site is located in north-central Pike County at Barry. The Mississippi River lies 10 to 12 miles southwest of the site. Water would either have to be piped from the river or pumped from alluvial groundwater sources along the river. Wastewater would have to be returned to the Mississippi River or disposed of by underground injection. The ground water available is in sand and gravel aquifers with probable yields of 500 gpm or more.

Significant Environmental Regulations, Permits, and Reviews

Federal Permits/Studies:

- EIS Review (National Environmental Policy Act)
- NPDES Permit; 316 Studies (Federal Water Pollution Control Act)
- Section 404 Permit (Federal Water Pollution Control Act)
- Section 10 Permit (Rivers and Harbors Act)
- EIS/Review (Flood Disaster Protection Act)
- EIS/Review (Executive Order 11988)
- EIS/Review (Safe Drinking Water Act)

State Permits/Studies:

- Water Supply
- Water Pollution
- Solid Waste
- Administrative Procedures
- Canals and Waterways
- Drainage
- Roads and Bridges
- Wells

Environmental Issues Evaluated for Potential Fatal Flaws

The major drawback to this site is related to the economics of pumping water a long distance from the river. The alternative, using ground water, would involve drilling a well field system. Treated wastewater would still need to be pumped to the river for disposal or disposed of by underground injection.

Possible Mitigating Measures

Further study would be needed to determine the best alternative, both from environmental and economic standpoints.

7.3.2.3 ECOLOGY

Environmental Features

About 80 percent of the site is cultivated cropland and most of the remainder is forest or pasture. Hadley Creek is the only major aquatic habitat on site, although much of the site is dissected by numerous small intermittent streams. The Mississippi River is about 8 miles off site, and no designated natural areas or refuges are located on site. A more intensive investigation of the site may determine that Indiana or gray bats occur along Hadley Creek.

Significant Environmental Regulations, Permits, and Reviews

Federal Permits/Studies:

- Section 404 Permit (Federal Water Pollution Control Act, Executive Order 11990)
- 316b Study (Federal Water Pollution Act) may be required for water intake structure
- Section 7 Consultation-Biological Assessment (Endangered Species Act)

State Permits/Studies:

- Environmental review by state agencies, especially the Illinois Department of Conservation

Potential Fatal Flaws and Possible Mitigation

Indiana and gray bats (U.S. Endangered) could potentially occur along portions of Hadley Creek in summer. Siting away from the creek would avoid any potential impacts to the bats. If construction is planned for the creek and a field visit indicates suitable habitat is present, a study of bat use of the creek might be required.

7.3.2.4 SOCIOECONOMICS

Important Environmental Features

The site is zoned as Agricultural District with some Industrial District along the north site border. The existing land use is mainly agricultural.

No nature preserves, inventoried natural areas, or areas of concern are located within the site. Several archaeological sites have been identified within the siting area, and the Illinois Department of Conservation estimates that the area has a high potential for archaeological resources.

Although no recent soil survey has been completed for Pike County, the U.S. SCS State Soil Scientist has identified the siting area as having a low percentage of prime farmland.

Significant Environmental Regulations, Permits, and Reviews

Federal Permits/Studies:

EIS/Review (National Historic Preservation Act)
EIS/Review (Archaeological and Historic Preservation Act)
EIS/Review (Executive Order 11593, Protection and Enhancement of the Cultural Environment)
EIS/Review (USDA Secretary's Memorandum 1827 and CEQ's Memorandum for Heads of Agencies)

State Permits/Studies:

Environmental review based on Illinois State Park and Nature Preserves Act

County Permits/Studies:

County Zoning Ordinances

Environmental Issues Evaluated for Potential Fatal Flaws

Possible impacts to archaeological resources are likely to be of concern.

Possible Mitigating Measures

Engineering design and site facility location will be used to minimize the loss of prime farmland and archaeological resources.

7.3.3 PIKE COUNTY NEAR EAST HANNIBAL

7.3.3.1 AIR QUALITY

Important Environmental Features

American Cyanamid's Agricultural Products plant is located approximately 8 to 10 km northwest of Site 20. Lehigh Portland Cement Company is located approximately 8 to 10 km south of Site 20. Several small sources are located in Hannibal, Missouri, 3 km west of the site.

Significant Environmental Regulations, Permits, and Reviews

Federal Permits/Studies

EPA-PSD permit; Compliance with AAQS

Environmental Issues Evaluated for Potential Fatal Flaws

Emission inventories of both the American Cyanamid plant and the Lehigh Portland Cement plant were reviewed and compared to other similar-size sources for which dispersion modeling had been performed in order to assess ambient air quality impact potential. Predicted sulfur dioxide impacts from these sources indicate relatively high concentration levels occurring within 2 km of each plant that would, however, be below AAQS and drop off rapidly by the time they would reach within 2 km of Site 20. Since dispersion modeling of the 220-MW CAES facility predicts ambient sulfur dioxide concentrations to be at or below significant impact levels, AAQS will, therefore, be met. Also, since emissions from both the American Cyanamid and Lehigh Portland Cement plants are included in the baseline air quality, increment consumption due to the 220-MW CAES facility will be minimal.

Possible Mitigating Measures

Measures to mitigate the impact of the proposed CAES plant, if required, would include increasing stack height and siting the plant farther from the two major influencing sources, but still within the siting area.

7.3.3.2 WATER RESOURCES

Important Environmental Features

The site is located along the Mississippi River near East Hannibal. Bird Slough, Running Slough, and the Sny all cross the site. The 7-day, 10-year low flow on the Mississippi is 16,170 cfs. The site is entirely within the 100-year floodplain.

Significant Environmental Regulations, Permits, and Reviews

Federal Permits/Studies:

- EIS Review (National Environmental Policy Act)
- NPDES Permit; 316 Studies (Federal Water Pollution Control Act)
- Section 404 Permit (Federal Water Pollution Control Act)
- Section 10 Permit (Rivers and Harbors Act)
- EIS/Review (Flood Disaster Protection Act)
- EIS/Review (Executive Order 11988)
- EIS/Review (Safe Drinking Water Act)

State Permits/Studies:

- Water Supply
- Water Pollution
- Solid Waste
- Administrative Procedures
- Canals and Waterways
- Drainage
- Roads and Bridges
- Wells

Environmental Issues Evaluated for Potential Fatal Flaws

The only water resources issue on this site is the 100-year floodplain. The CAES facility would be inside the 100-year floodplain level if it were sited anywhere within this siting area. This issue is a potential fatal flaw.

Possible Mitigating Measures

Engineering design and site location would need to minimize flood hazards to the facility and adjacent areas.

7.3.3.3 ECOLOGY

Environmental Features

Over 90 percent of the area is cultivated cropland. Some bottomland forests occur along the Mississippi River, which borders the west side of the site, and Sny Creek, which occurs within the site.

The Mississippi River and Sny Creek provide a small amount of bottomland forest, which is potential habitat for wintering bald eagles. The floodplains also provide extensive oxbow sloughs and temporary wetlands, which provide diverse habitat for terrestrial as well as aquatic organisms. No natural areas occur on the site; however, Fall Creek Gorge, a limestone cliff area, is located about 1 mile north of the site. This area provides potential habitat for the Indiana and gray bats.

Significant Environmental Regulations, Permits, and Reviews

Federal Permits/Studies:

- Section 404 Permit (Federal Water Pollution Control Act, Executive Order 11990)
- 316b Study (Federal Water Pollution Act) may be required for water intake structure
- Section 7 Consultation-Biological Assessment (Endangered Species Act)

State Permits/Studies:

- Environmental review by state agencies, especially the Illinois Department of Conservation

Potential Fatal Flaws and Possible Mitigation

No federally threatened or endangered species are known to occur on the site. However, the site contains potential habitat for the bald eagle (U.S. Endangered). These potential areas should be avoided by the CAES plant.

Fall Creek Gorge should not be affected by the CAES plant, since it is located off site. There is a low potential for the endangered mussel *Lampsilis higginsi* in the Mississippi River. Any possible impacts can be reduced by avoiding disturbance of the sediments in the Mississippi River.

7.3.3.4 SOCIOECONOMICS

Important Environmental Features

This site is zoned Agricultural, A-1; Highway Business, B-2 at Sheppard; and F-1, Flood Plain District. The entire site is designated as "Flood Prone if Levee Breached." The existing land use is agriculture.

No nature preserves, inventoried natural areas, or areas of concern are located within the site. Several archaeological sites have been identified within the siting area, and the Illinois Department of Conservation estimates that the area has a high potential for archaeological resources.

Although no recent soil survey has been completed for Pike County, the U.S. SCS Area Conservationist has identified the siting area as having a high percentage of prime farmland.

Significant Environmental Regulations, Permits, and Reviews

Federal Permits/Studies:

EIS/Review (National Historic Preservation Act)
EIS/Review (Archaeological and Historic Preservation Act)
EIS/Review (Executive Order 11593, Protection and Enhancement of the Cultural Environment)
EIS/Review (USDA secretary's Memorandum 1827 and CEQ's Memorandum for Heads of Agencies)

State Permits/Studies:

Environmental review based on Illinois State Park and Nature Preserve Act

County Permits/Studies:

County Zoning Ordinance

Environmental Issues Evaluated for Potential Fatal Flaws

Possible impacts to floodprone areas, prime farmlands, and archaeological resources are likely to be of concern.

Possible Mitigating Measures

Engineering design and site facility location will be used to minimize the flood hazards, and loss of prime farmland and archaeological resources. Since the siting area has such a high percentage of prime farmland, complete mitigation of impact to farmland through site facility location may be difficult. Opposition to the selection of this site may arise if other alternative sites are shown to have less of an impact on prime farmland.

7.3.4 PIKE COUNTY NEAR FLORENCE

7.3.4.1 AIR QUALITY

Important Environmental Features

Meredosia Power Plant (CIPS) is located about 25 km north of the site, and the Pearl Power Plant (WIPCO) is located about 20 km south of the site. Small particulate sources are located 15 km to the north and west of the site. The Peoria nonattainment area is northeast of the site, but the site is well outside of the impact area.

Significant Environmental Regulations, Permits, and Reviews

EPA--PSD; Nonattainment Review, compliance with AAQS

Environmental Issues Evaluated for Potential Fatal Flaws

Dispersion modeling of the Meredosia and Pearl plant emissions show their impact to be insignificant with respect to effects on AAQS. Also, PSD increments are not affected by either of these sources since their emissions are included in the baseline air quality.

Possible Mitigating Measures

The insignificant level of emissions and corresponding impact on ambient air quality resulting from the operation of the 220-MW CAES facility should require no mitigating measures to meet permitting requirements.

7.3.4.2 WATER RESOURCES

tant ironmental eatures

The site lies between Mile 53 and Mile 59 on the Illinois River at Florence. Little Blue Creek crosses the site. The Illinois River is a U.S. Army Corps of Engineers-maintained navigation channel. The minimum flow of record at the site is estimated at 1,740 cfs, while the 7-day, 10-year low flow is 3,541 cfs. The specific conductance values of the river water during 1975-1977 ranged between 483 and 860 umhos per cm^2, The temperature of the river ranges from 32°F to 89°F.

Significant Environmental Regulations, Permits, and Reviews

Federal Permits/Studies:

- EIS Review (National Environmental Policy Act)
- NPDES Permit; 316 Studies (Federal Water Pollution Control Act)
- Section 404 Permit (Federal Water Pollution Control Act)
- Section 10 Permit (Rivers and Harbors Act)
- EIS/Review (Flood Disaster Protection Act)
- EIS/Review (Executive Order 11988)
- EIS/Review (Safe Drinking Water Act)

State Permits/Studies:

- Water Supply
- Water Pollution
- Solid Waste
- Administrative Procedures
- Canals and Waterways
- Drainage
- Roads and Bridges
- Wells

Environmental Issues Evaluated for Potential Fatal Flaws

There are no potential significant environmental issues beyond general siting considerations.

Possible Mitigating Measures

No special mitigation would be required.

7.3.4.3 ECOLOGY

Environmental Features

Over 80 percent of the site is cultivated and most of the remainder is maintained as forest or pasture. Little Blue Creek, a springfed stream, flows along the southern edge of the site to the Illinois River, which forms the site's eastern boundary. The majority of the site is out of the river floodplain. No designated natural areas or refuges are on site; however, the Pike County Conservation Area is north of the site.

Bald eagles are known to winter near the site and within the conservation area.

Significant Environmental Regulations, Permits, and **Reviews**

Federal **Permits/Studies:**

- Section 404 Permit (Federal Water Pollution Control Act, Executive Order 11990)
- 316b Study **(Federal** Water Pollution Act) may be required for water intake structure
- Section *7* Consultation-Biological Assessment **(Endangered** Species Act)

State **Permits/Studies:**

- Environmental review by state agencies, especially the Illinois Department of Conservation

Potential Fatal Flaws and Possible Mitigation

Indiana and gray bats may feed along Little Blue Creek in summer, and a study of bats along the creek would be required if plant construction will affect the creek. Eagles are known to winter along the Illinois River at the site, and an assessment of the impacts (particularly noise) from the CAES plant would have to be assessed.

Because the region has recently become well-known as a wintering area for bald eagles, public resistance to construction of the CAES plant may override real biological concerns. The effect of the new highway at Valley City on the eagles may be great enough to convince private environmental groups and, perhaps, governmental agencies that added impacts from the CAES facility would create impacts to the wintering eagles.

7.3.4.4 SOCIOECONOMICS

Important Environmental Features

The site is zoned Agricultural District, A; and Highway Business District, B-2; by Florence. Existing land use is primarily agricultural.

No nature preserves, inventoried natural areas, or areas of concern are located within the site. An archaeological walkover survey has been completed on approximately 1,200 acres of Site 22.

Although no recent soil survey has been completed for Pike County, the U.S. SCS State Soil Scientist has identified the siting area as having a low percentage of prime farmland.

Significant Environmental Regulations, Permits, and Reviews

Federal Permits/Studies:

- EIS/Review (National Historic Preservation Act)
- EIS/Review (Archaeological and Historic Preservation Act)
- EIS/Review (Executive Order 11593, Protection and Enhancement of the Cultural Environment)
- EIS/Review (USDA Secretary's Memorandum 1827 and CEQ's Memorandum for Heads of Agencies)

State Permits/Studies:

- Environmental review based on Illinois State Park and Nature Preserves Act

County Permits/Studies:

- County zoning ordinance

Environmental Issues Evaluated for Potential Fatal Flaws

Possible impact to archaeological resources are likely to be of concern.

Possible Mitigating Measures

Engineering design and site facility location will need to minimize the loss of prime farmland and archaeological resources.

7.3.5 ADAMS COUNTY

7.3.5.1 AIR QUALITY

Important Environmental Features

Site 19 is located along the east bank of the Mississippi River near Marblehead, Illinois. The site is dissected diagonally by Illinois State Route 57.

The American Cyanamid plant is located across the river (Mississippi) from the western border of the site (approximately 2 to 3 km). The Lehigh Portland Cement Company is located approximately 18 km south of the site. Other smaller sources are located in Quincy, Illnois, about 22 km north of the site, and in Hannibal, Missouri, about 10 km south of the site.

Significant Environmental Regulations, Permits, and Reviews

EPA--PSD permit; Compliance with AAQS

Environmental Issues Evaluated for Potential Fatal Flaws

Review of the emissions inventory of the two major influencing sources (American Cyanamid and Lehigh Portland Cement) revealed high annual sulfur dioxide emissions. However, comparison of these emissions with plants of similar emission potential for which dispersion modeling has been performed shows that although high ground-level concentrations may occur periodically, these concentrations will be within AAQS and the maximum impact zone will occur within 2 km of the source. Since contribution of sulfur dioxide concentrations to ambient levels from the CAES facility is predicted to be at or below significant impact levels, AAQS at Site 19 will be met. Also, since the emissions from all of the sources in the impact area of Site 19 are included in the baseline air quality, PSD increment consumption will be minimal.

Possible Mitigating Measures

Measures to mitigate the impact of the CAES plant, if required, would include increasing stack height and siting the plant farther (east) from the Cyanamid plant, but still within the siting area (east of State Route 57).

7.3.5.2 WATER RESOURCES

Important Environmental Features

The site is located on the Mississippi River at Marblehead. The Sny, Mill Creek, Harness Creek, Austin Creek, and Fall Creek all cross the site. The Mississippi River has a minimum flow at record of 5,000 cfs at Keokuk, Iowa. The 7-day, 10-year low flow is 16,170 cfs. The Mississippi River is controlled by locks and dams for navigational purposes. The site is between Lock and Dam 21 at Quincy and Lock and Dam 22 south of Hannibal. The specific conductance of the river ranges from 283 to 600 umhos.

Significant Environmental Regulations, Permits, and Reviews

Federal Permits/Studies:

EIS Review (National Environmental Policy Act)
NPDES Permit; 316 Studies (Federal Water Pollution Control Act)
Section 404 Permit (Federal Water Pollution Control Act)
Section 10 Permit (Rivers and Harbors Act)
EIS/Review (Flood Disaster Protection Act)
EIS/Review (Executive Order 11988)
EIS/Review (Safe Drinking Water Act)

State Permits/Studies:

Water Supply
Water Pollution
Solid Waste
Administrative Procedures
Canals and Waterways
Drainage
Roads and Bridges
Wells

Environmental Issues Evaluated for Potential Fatal Flaws

Part of the siting area lies within the 100-year floodplain. There are wetlands on the site which could be affected by the barge unloading facility.

Possible Mitigating Measures

Engineering design and facility location should be used to mitigate any impacts of the barge facility on wetlands. The facility should be located away from the floodplain.

7.3.5.3 ECOLOGY

The site is divided between the floodplain of the Illinois River and upland areas. Approximately 80 percent of the site is cultivated, and there are equal areas of bottomland and upland forest. The Mississippi River flows along the western border of the site. Much of the floodplain area is drained by the Sny drainage system. Relatively deep canyons have been created by creeks draining from the uplands to the river in the southwest corner of the site.

Extensive woods along the river create a high potential for occurrence of bald eagles (U.S. Endangered) on site. Nearby Fall Creek Gorge Natural Area has recently been purchased by the State of Illinois.

Significant Environmental Regulations, Permits, and Reviews

Federal Permits/Studies:

- Section 404 Permit (Federal Water Pollution Control Act, Executive Order 11990)
- 316b Study (Federal Water Pollution Act) may be required for water intake structure
- Section 7 Consultation-Biological Assessment (Endangered Species Act)

State Permits/Studies:

- Environmental review by state agencies, especially the Illinois Department of Conservation

Potential Fatal Flaws and Possible Mitigation

If bald eagles or Indiana or gray bats are found on the site, the CAES plant will have to be sited away from their known habitat. The plant will also need to be sited away from the geological area and the Fall Creek Gorge Nature Preserve.

7.3.5.4 SOCIOECONOMICS

Important Environmental Features

This site is not zoned, and the county does not have a zoning ordinance. The far west portion of the site is designated "Flood Prone" with the remaining west half "Flood Prone if Levee Breached."

Two inventoried natural areas are within the siting area. No nature preserves or areas of concern are within the site. There are identified archaeological resource areas within the siting area, and the Illinois Department of Conservation estimates that the area has a potential for archaeological resources.

The Important Farmlands map for Adams County, published by the U.S. SCS, shows a high percentage of the land in Site 19 as either prime farmland or designated farmland of state-wide importance.

Significant Environmental Regulations, Permits, and Reviews

Federal Permits/Studies:

- EIS/Review (National Historic Preservation Act)
- EIS/Review (Archaeological and Historic Preservation Act)
- EIS/Review (Executive Order 11593, Protection and Enhancement of the Cultural Environment)
- EIS/Review (USDA Secretary's Memorandum 1827 and CEQ's Memorandum for Heads of Agencies)

State Permits/Studies:

- Environmental review based on Illinois State Park and Nature Preserves Act

Environmental Issues Evaluated for Potential Fatal Flaws

Possible impacts to floodprone and natural areas, prime farmlands, farmlands of state-wide importance, and archaeological resources are likely to be of concern.

Possible Mitigating Measures

Engineering design and site facility location will be used to avoid natural and floodprone areas, and loss of prime farmland, designated farmland of state-wide importance, and archaeological resources. Since the only areas in the site which do not qualify as important farmlands are forested areas along steep bluffs, complete mitigation of impacts to farmland through site facility location may be difficult.

7.3.6 RANDOLPH COUNTY

7.3.6.1 AIR QUALITY

Important Environmental Features

Illinois Power Baldwin Power Plant is located about 15 km north of Site 28, and Rush Island Power Plant (Union Electirc) is located about 25 km northwest. A large particulate source (Mississippi Lime Company) is located approximately 10 km southwest of the site. Several small sources are located in Chester, 15 km southeast of the site.

Significant Environmental Regulations, Permits, and Reviews

EPA--PSD permit, Compliance with AAQS

Environmental Issues Evaluated for Potential Fatal Flaws

Of the major air pollution sources described above, Illinois Power Company's Baldwin Station is the largest, single, most significant source of impact on the air quality of Site 28. However, dispersion modeling of the emissions from the Baldwin facility shows that ambient air quality standards will not be exceeded at Site 28 by a considerable margin. Also, since the emissions from the Baldwin plant are included in the baseline air quality, PSD increments are not affected by these emissions. The predicted emissions from the 220-MW CAES facility are at or below the significance levels; therefore a minimal impact will be observed relative to consumption of PSD increments.

Possible Mitigating Measures

Due to the insignificant nature of the CAES emissions, no mitigating measures will be required.

7.3.6.2 WATER RESOURCES

Important Environmental Features

The site is located on the Kaskaskia River, with the southern boundary 3 miles north of the Mississippi River. Nine Mile Creek crosses the site. The flow on the Kaskaskia River is controlled by the Shelbyville and Carlyle reservoirs. The 100-year flood level is 394 feet above MSL, while the 500-year flood level is approximately 2 to 3 feet higher than the 100-year flood level. The 7-day, 10-year low flow is estimated at 139 cfs just below Nine Mile Creek. The river was recently channelized for navigation by the U.S. Corps of Engineers, and has a lock at the mouth of the Kaskaskia River.

Significant Environmental Regulations, Permits, and Reviews

Federal Permits/Studies:

- EIS Review (National Environmental Policy Act)
- NPDES Permit; 316 Studies (Federal Water Pollution Control Act)
- Section 404 Permit (Federal Water Pollution Control Act)
- Section 10 Permit (Rivers and Harbors Act)
- EIS/Review (Flood Disaster Protection Act)
- EIS/Review (Executive Order 11988)
- EIS/Review (Safe Drinking Water Act)

State Permits/Studies:

- Water Supply
- Water Pollution
- Solid Waste
- Administrative Procedures
- Canals and Waterways
- Drainage
- Roads and Bridges
- Wells

Environmental Issues Evaluated for Potential Fatal Flaws

A barge unloading facility on the river and its possible impacts on river traffic and wetlands may be an area of concern. Stipulations in the contract may limit withdrawals during drought conditions. The design water-level conditions in the navigation channel at the lock need to be maintained at all times. Water users who obtain contracts first will have priority in receiving shares. All potential water users may not be able to satisfy future water needs from the river. In addition, groundwater supplies in the area are minimal.

Possible Mitigating Measures

No fatal flaws are expected; however, mitigation of environmental concerns mentioned previously could include the following programs:

1. Engineer the unloading facility to minimize impact to navigation, wetlands, and need for maintenance dredging.
2. Obtain water supply from below the lock on the Kaskaskia River or in the Mississippi River instead of the Kaskaskia River. No water supply contract is needed for this design concept.
3. Decrease the water requirements from the Kaskaskia River during limited withdrawal periods by providing surface water storage areas on site.
4. Have discussions with the Illinois DOT, Division of Water Resources, to define contract details; and attempt to obtain water supply contract for the life of the project.

7.3.6.3 ECOLOGY

Most of the site consists of cultivated cropland on the rolling hills along the Kaskaskia River. About 15 percent of the site is wooded. Nine Mile Creek, a meandering, wooded tributary to the Kaskaskia, is also located on site. No designated natural areas or refuges are on site. Bald eagles are known to occur sporadically along the river during winter, and Nine Mile Creek has suitable feeding habitat for Indiana bats.

Significant Environmental Regulations, Permits, and Reviews

Federal **Permits/Studies:**

- Section 404 Permit (Federal Water Pollution Control Act, Executive Order 11990)
- 316b Study (Federal Water Pollution Act) may be required for water intake structure
- Section 7 Consultation-Biological Assessment (**Endangered** Species Act)

State **Permits/Studies:**

- Environmental review by state agencies, especially the Illinois Department of Conservation

Potential Fatal Flaws and Possible Mitigation

Much of the land along the river is state-owned property which has been designated for use as wildlife management lands. Although present policy does not inhibit adjacent land use, future land-use plans along the river may be more restrictive. If the CAES plant impacts Nine Mile Creek, a survey of bats along the creek would be required. Siting away from the river and creek would reduce the potential for impacts.

7.3.6.4 SOCIOECONOMICS

Important Environmental Features

This site is not zoned and the county does not have a zoning ordinance, comprehensive plan, or land use plan.

No nature preserves, inventoried natural areas, or areas of concern are located within the siting area. Several archaeological sites have been identified within the siting area, and the Illinois Department of Conservation estimates that the area has a high potential for archaeological resources.

The U.S. SCS District Conservationist has identified the siting area as having a low percentage of prime farmland.

Significant Environmental Regulations, Permits, and Reviews

Federal Permits/Studies:

- EIS/Review (National Historic Preservation Act)
- EIS/Review (Archaeological and Historic Preservation Act)
- EIS/Review (Executive Order 11593, Protection and Enhancement of the Cultural Environment)
- EIS/Review (USDA Secretary's Memorandum 1827 and CEQ's Memorandum for Heads of Agencies)

State Permits/Studies:

- Environmental review based on Illinois State Park and Nature Preserves Act

Environmental Issues Evaluated for Potential Fatal Flaws

Possible impacts to archaeological resources are likely to be of concern.

Possible Mitigating Measures

Engineering design and site facility location will be used to minimize the loss of prime farmland and archaeological resources.

Major new legislation related to prime farmlands and archaeological resources is not foreseen. However, greater enforcement and use of policies and laws to protect prime farmlands and other unique lands is expected.

7.3.7 MENARD COUNTY

7.3.7.1 AIR QUALITY

Important Environmental Features

Site 18 is located south of Salt Creek along the Cass-Menard County line near Oakford, Illinois, and is dissected diagonally along the western third of the site by State Route 97.

Illinois Power Company's Havana Station is located about 20 km northwest of the site. Small particulate sources are located in Oakford and other small communities surrounding the site at a distance of 5 to 10 km. An area extending 10 to 15 km surrounding Petersburg, Illinois, is designated as secondary nonattainment for total suspended particulates.

Significant Environmental Regulations, Permits, and Reviews

EPA--PSD permit; Compliance with AAQS

Environmental Issues Evaluated for Potential Fatal Flaws

The secondary nonattainment designation given the area around Petersburg, Illinois, is simply a result of the occurrence of several total suspended particulates readings above the secondary standard that were influenced by agricultural activities. No major particulate sources exist in that area. The Illinois Power Havana plant, although a large major source of sulfur dioxide and nitrogen oxides emissions, due to its distance from Site 18, will not result in any violations of AAQS at the site. Since the contribution of sulfur dioxide concentrations to ambient levels is predicted to be at or below significant impact levels, impacts on AAQS will be minimal. Because, the emissions from the Illinois Power Havana plant are included in the baseline air quality, PSD increment consumption will be minimal.

Possible Mitigating Measures

Measures to mitigate the impact of the CAES plant, if required, would consist of increasing stack height. This measure alone should be adequate to protect AAQS and to minimize PSD increment consumption.

7.3.7.2 WATER RESOURCES

Important Environmental Features

The site is located on the Sangamon River near Oakford. The Sangamon River is channelized, but a few oxbows remain along the former river meanders. The Sangamon River has a 7-day, 10-year low flow of 206 cfs. There are also sand and gravel aquifers along the river yielding 100 to 500 or more gpm which could be used to supply the water for the CAES facility. The specific conductance on the Sangamon River ranges from 433 to 883 umhos downstream of the site (Chandlerville), and from 400 to 1,333 umhos upstream (Greenview) on Salt Creek. These values are high, since the water quality standard for total dissolved solids is 1,000 mg/l.

Significant Environmental Regulations, Permits, and Reviews

Federal Permits/Studies:

EIS Review (National Environmental Policy Act)
NPDES Permit; 316 Studies (Federal Water Pollution Control Act)
Section 404 Permit (Federal Water Pollution Control Act)
Section 10 Permit (Rivers and Harbors Act)
EIS/Review (Flood Disaster Protection Act)
EIS/Review (Executive Order 11988)
EIS/Review (Safe Drinking Water Act)

State Permits/Studies:

Water Supply
Water Pollution
Solid Waste
Administrative Procedures
Canals and Waterways
Drainage
Roads and Bridges
Wells

Environmental Issues Evaluated for Potential Fatal Flaws

Since the Sangamon River is much smaller than the Illinois or Mississippi River, meeting the water quality standards may require more mitigating design measures. However, this should not be considered a fatal flaw.

Possible Mitigating Measures

Engineering design to minimize impacts of the wastewater stream in the Kaskaskia River will be used.

7.3.7.3 ECOLOGY

Environmental Features

Only about 6 percent of the site is maintained as forest or grassland; the rest is cultivated cropland. The site extends from the floodplain of the Sangamon River to gently rolling land to the south. The river has been channelized and, consequently, several large sloughs and oxbow lakes are present along the river channel. Most of the timber is in scattered woodlots, and no designated natural areas or refuges occur on site. No federal threatened or endangered species are known on site.

Significant Environmental Regulations, Permits, and Reviews

Federal Permits/Studies:

- Section 404 Permit (Federal Water Pollution Control Act, Executive Order 11990)
- 316b Study (Federal Water Pollution Act) may be required for water intake structure
- Section 7 Consultation-Biological Assessment (Endangered Species Act)

State Permits/Studies:

- Environmental review by state agencies, especially the Illinois Department of Conservation

Potential Fatal Flaws and Possible Mitigation

No potential fatal flaws have been identified. Potential environmental problems would most likely be associated with the river and associated areas; therefore, location of the facility away from that area would avoid most potential ecological impacts.

7.3.7.4 SOCIOECONOMICS

Important Environmental Features

The site is zoned Agricultural, A-1. The City of Oakford which is found within the site boundaries is zoned for business, B-2. Power plants and similar utilities are designated as suitable land uses anywhere in

Menard County. Existing land use within the site is agricultural, except for the City of Oakford.

No nature preserves, inventoried natural areas, or areas of concern are located within the site. Two archaeological sites have been identified within the siting area, and the Illinois Department of Conservation estimates that the area has a high potential for archaeological resources.

The Important Farmlands map for Menard County, published by the U.S. SCS, shows a high percentage of the land in Site 18 as either prime farmland or designated farmland of state-wide importance.

Significant Environmental Regulations, Permits, and Reviews

Federal Permits/Studies:

- EIS/Reivew (National Historic Preservation Act)
- EIS/Review (Archaeological and Historic Preservation Act)
- EIS/Review (Executive Order 11593, Protection and Enhancement of the Cultural Environment)
- EIS/Review (USDA Secretary's Memorandum 1827 and CEQ's Memorandum for Heads of Agencies)

State Permits/Studies:

- Environmental review based on Illinois State Park and Nature Preserves Act

Environmental Issues Evaluated for Potential Fatal Flaws

Possible impacts to prime farmland, farmland of state-wide importance, and archaeological resources are likely to be of concern.

Possible Mitigating Measures

Engineering design and site facility location will be used to minimize the loss of prime farmland, designated farmland of state-wide importance, and archaeological resources. Only a few scattered areas not designated as important farmland are found within the site, and probably none are sufficiently large to permit complete mitigation of impact to prime farmland through site facility location.

7.4 FATAL FLAW ANALYSIS RESULTS

The interdisciplinary siting team evaluated each of the seven siting areas based on the information summarized previously. Each was evaluated for potential fatal flaws, as identified in Section 7.2. Consequently, four of the sites were dropped from further consideration. The following rationale was used for site elimination:

Site 9, Mercer County. A number of factors combined to decrease the overall favorability of this site, and therefore could flaw any licensing attempt by Soyland. The most critical feature was the proximity of the Mark Twain National Wildlife Refuge, an area frequented by both bald eagles and peregrine falcons. Less than 4 miles northwest of the site is the New Boston Rookery. Operational impacts, whether of real or perceived biological consequence, could be a local issue requiring modification of CAES design or operation, or lengthy ecological studies. Additionally, while the total percent of prime farmland is relatively low, much of the site is cultivated agricultural land.

Site 21, Pike County Near Barry. The major critical feature of this site was the distance from the Mississippi River. Cooling makeup water and cooling tower blowdown would have to be withdrawn from and discharged to the Mississippi River, respectively. While the engineering and economic requirements are greater than a CAES system closer to water, other environmental impacts associated with such a corridor may be more critical to licensing. Such a corridor would require gaining easement and crossing prime agricultural land along the Mississippi River and traversing an area with a high potential for archaeological resources. Additionally, Indiana or gray bats may occur along Hadley Creek. Therefore, development of the site may require extended studies or mitigation associated with those agencies overseeing prime farmland, and ecological and archaeological resources.

Site 20, Pike County near East Hannibal. The entire site is designated as being flood prone if the levees are breached; therefore the site is within the 100-year floodplain. This would prohibit any federal loan guarantees if the Soyland CAES unit were within the floodplain. Additionally, approximately 90 percent of the site is cultivated prime farmland.

Site 28, Randolph County. Several factors, mitigatable individually, combined to reduce the viability of this site. The most important features are minimal flow requirements on the Kaskaskia River and potential water user charges. An alternative water source is the Mississippi River; however, such a system would require a pipeline corridor, crossing both Mississippi River bottomlands and habitat frequented by bald eagles. Any development along or near Nine Mile Creek would probably also require studies investigating the presence and importance of Indiana bats. The Fort Kaskaskia historical district is also located near the mouth of the Kaskaskia River, and several archaeological sites have been identified within the siting area.

The remaining three sites [Adams County near Quincy (Site 19), Menard County near Oakford (Site 18), and Pike County near Florence (Site 22)] were all judged to be qualified for CAES licensing. While there are features at each site which may require some study, mitigation, or minor design changes, these factors (or a combination of factors) were not viewed by the siting team with the same level of concern.

Therefore, the three sites in Adams, Menard, and Pike Counties (see Figure 7-1) were recommended for more detailed geological investigation in the last part of the siting study.

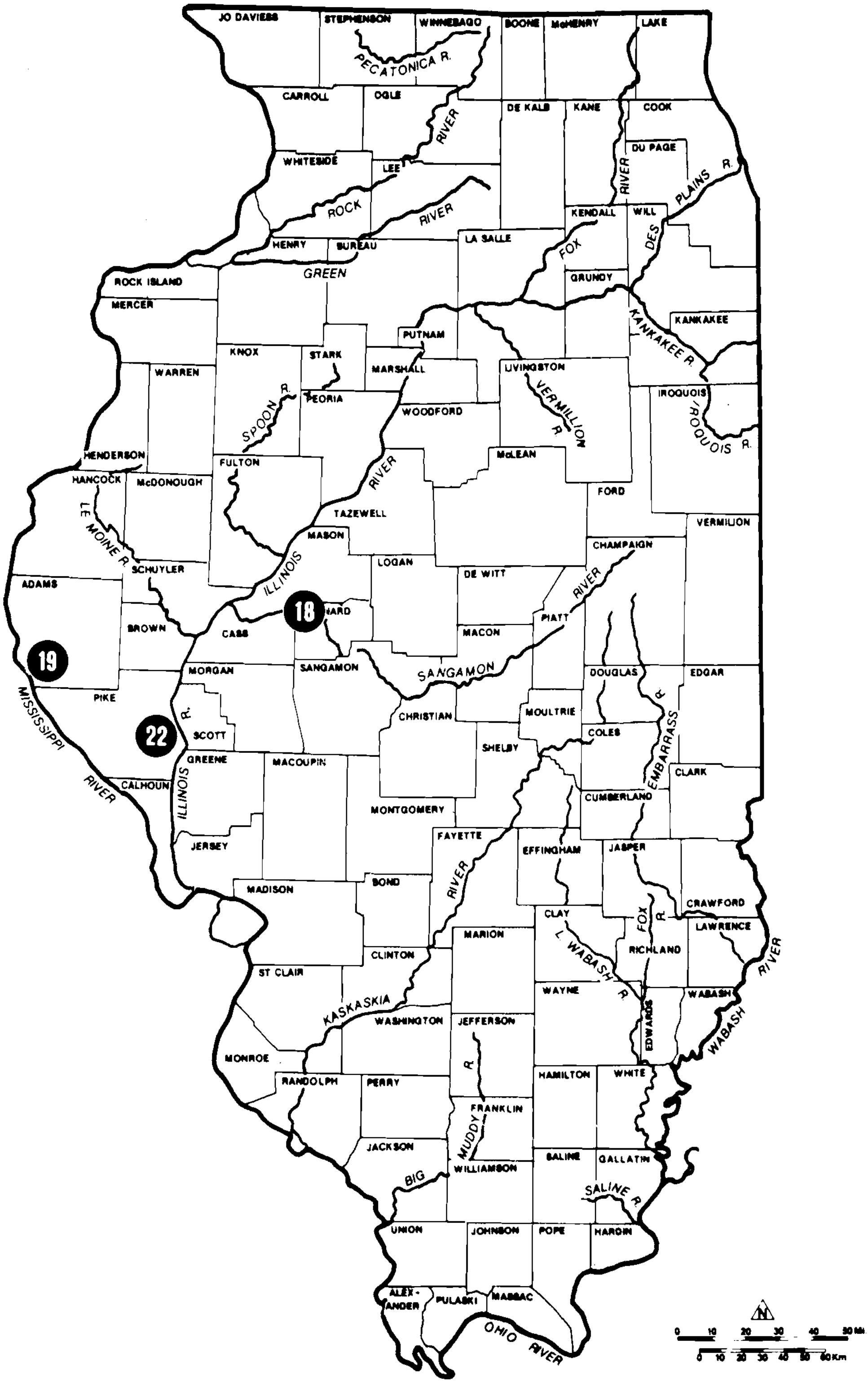


Figure 7-1

LOCATION OF THREE PREFERRED SITING AREAS

SOURCE: ESE, 1981.

CAES

SITE SELECTION STUDY

8.0 SITE SPECIFIC GEOLOGIC INVESTIGATIONS

8.1 INTRODUCTION

Fenix & Scisson, Inc. was requested by ESE to perform a geologic investigation to evaluate the potential subsurface conditions at three sites in central and west-central Illinois (Figures 8-1 and 8-2) in southwestern Adams, eastern Pike, and northwestern Menard Counties. The investigation was to determine the potential suitability of the underlying rock formations at each site for possible construction of a 213,500-m^3 Mined Compressed Air Energy Storage Cavern and to rank the three sites in order of potential favorability.

Data obtained in this geotechnical data search were used to estimate the stratigraphic section present at each site. The individual stratigraphic columns were developed largely from structural contour and isopach maps of individual rock formations developed by the Illinois and Missouri Geological Surveys. These results were modified to include the results of previously drilled wells near each area, where applicable. The resulting stratigraphic columns represent the best estimates of the stratigraphy at each site, given the current state of knowledge and based largely on regional data. However, it should be kept in mind that specific information below about 1,000 feet deep is scarce and the actual elevations at which the specific formations are found, as well as their thicknesses, could vary significantly from what is presented. A detailed subsurface investigation program, including core drilling, would be required to provide more exact information.

For this report, a tentative cavern search horizon of 1,700- to 2,500-foot depths was used. Drill cuttings samples of rock formations believed to be within that horizon at each site were examined in an effort to form opinions as to the potential suitability to mining of each formation.

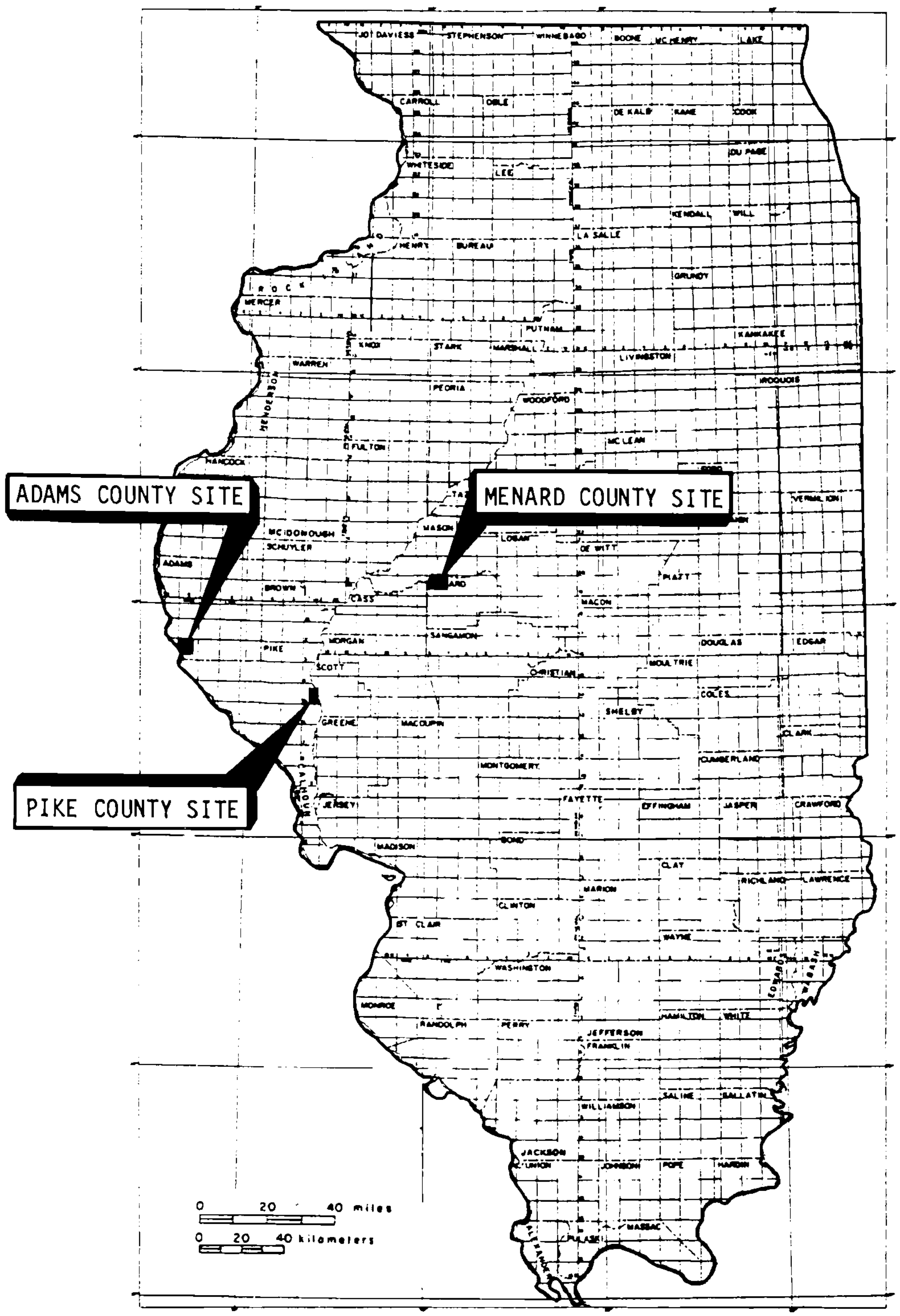


Figure 8-1

LOCATION MAP

SOURCE: FENIX & SCISSON, INC., 1981.

CAES

SITE SELECTION STUDY

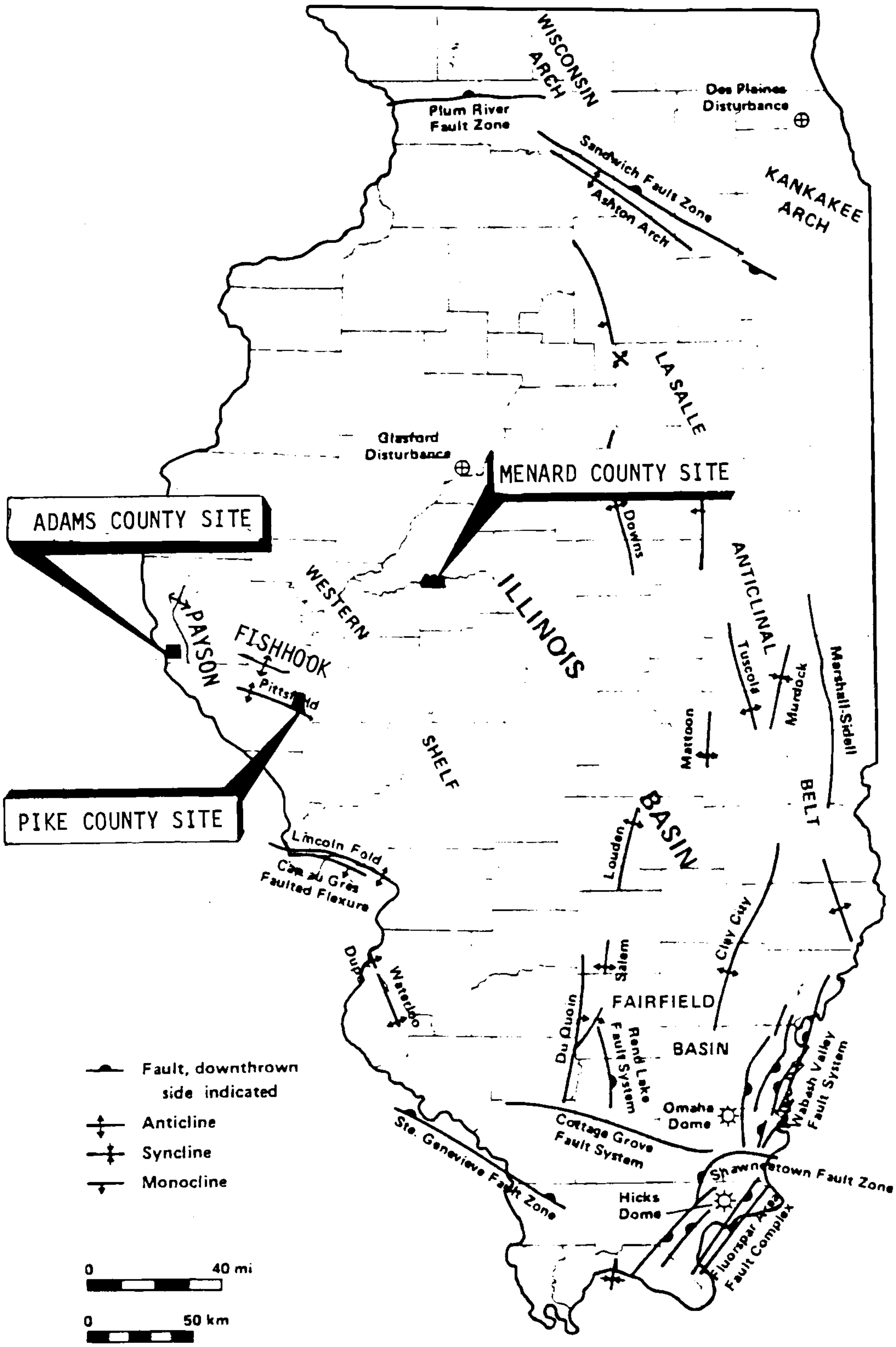


Figure 8-2

GEOLOGIC STRUCTURES OF ILLINOIS

SOURCE: FENIX & SCISSON, INC., 1981.

CAES

SITE SELECTION STUDY

The hydrology of each site was examined based on water well completion reports.

Each site was visited in the field and any exposed geology was observed.

8.2 GEOLOGY

The rocks of Illinois above the basement complex (the Precambrian rocks) are dominantly marine or transitional marine sedimentary rocks. These rocks, in cross-section, form a basin, with the deepest portion of that basin being located in the southeast portion of Illinois (see Figure 8-2). In general, all sedimentary rocks dip into the basin. The three study sites, located in Adams, Pike, and Menard Counties, are all located on the west-northwest side of the basin and therefore should dip towards the east-southeast. All three sites are far from the deep basin, in an area where this dip should be mild, on the order of 25 to 50 feet per mile.

Tectonic movements occurred in Illinois throughout the entire Paleozoic Era, creating both folds and faults. All three study sites appear to be free from the influence of any known faults, but some of the folding (and small unknown faults associated with it) could have an influence and will be considered individually.

The stratigraphy of each site was determined as closely as possible from available structure and isopach maps of the formations involved, as well as from information available on previously drilled test holes and wells. They will also be discussed individually.

8.2.1 ADAMS COUNTY SITE

8.2.1.1 GENERAL

The Adams County site is located in west-central Illinois (see Figure 8-1) in the "Dissected Till Plains" physiographic province of Illinois and Missouri. The site is in T.3S., R.8W. in the southwestern part of Adams County (Figure 8-3).

Topographically, the surface elevations vary from a low of about 460 feet in the southwest where the site borders the Mississippi River, to a

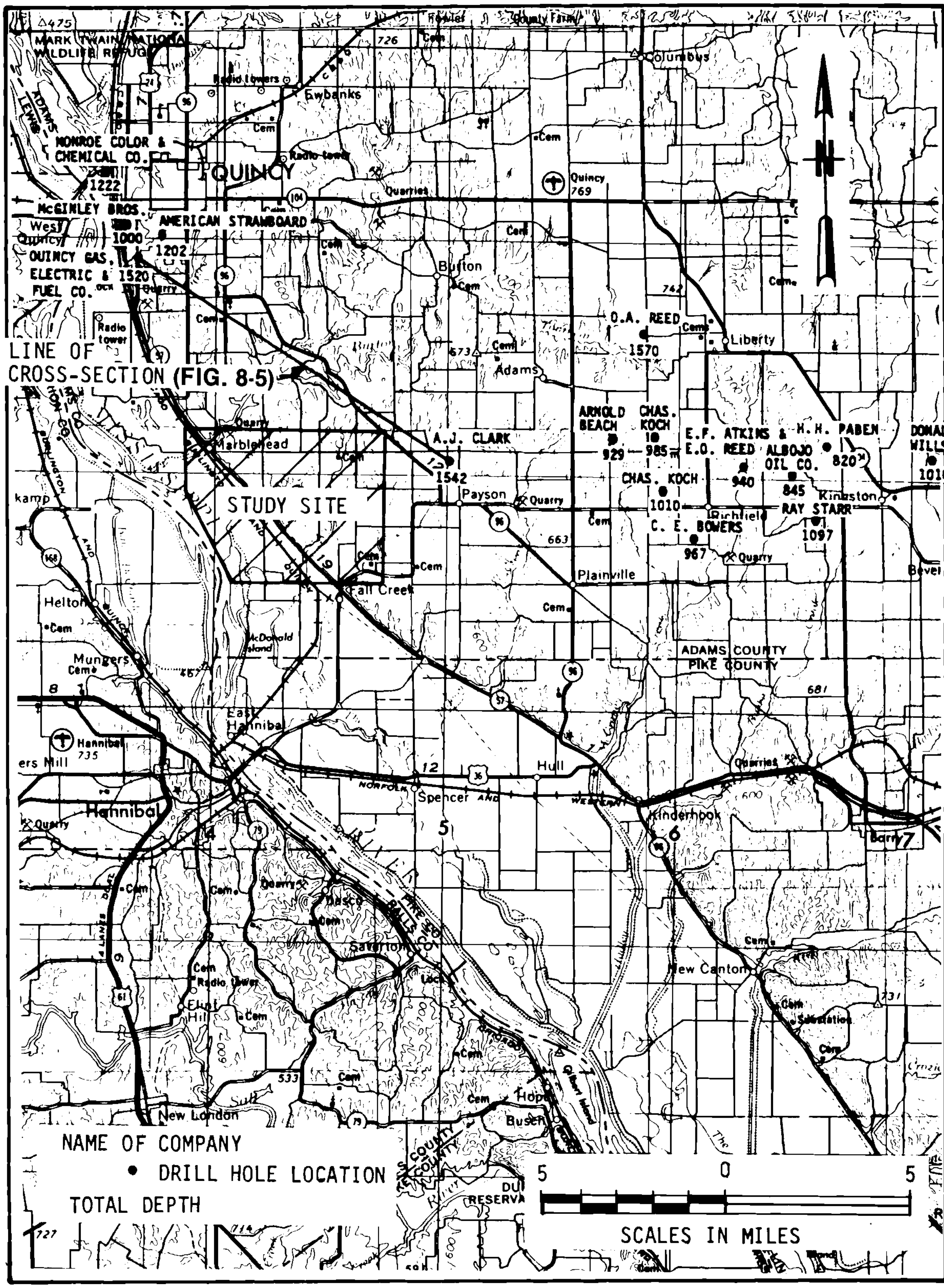


Figure 8-3

PLAN MAP OF ADAMS COUNTY SME, SHOWING DRILL HOLE LOCATIONS AND LINE CROSS-SECTIONS

SOURCE: FENIX & SCISSON, INC., 1981.

CAES

SITE SELECTION STUDY

high of about 720 feet on the eastern site border. The relief is distinctly more mild in the southwest portion (southwest of Illinois Highway 57). This is probably due to the fact that Kinderhookian shales and siltstones are the shallowest bedrock in the southwest, while the more resistant limestones of the Lower Valmeyeran series are the shallowest bedrock formation in the northeastern area of the study site.

Some of the Valmeyeran rocks are exposed in road cuts and quarries, but in general, all bedrock units are covered with from 20 to 200 feet of Cahokia alluvium and Kansan glacial till. This overburden should be thickest in the southwest protion of the study site.

The area receives about 35 inches of rainfall per year, which should be sufficient amount to maintain a stable groundwater level. Based on water well completion reports, the static water level should be from 20 to 90 feet below surface. This would imply that a minimum theoretical hydrostatic pressure of 698 psig would exist at the 1,700-foot depth level [(1,700 ft. - 90 ft.) 0.4335 psi/ft. = 697.9 psig].

8.2.1.2 STRATIGRAPHY

Based on generalized geologic data and records of nearby drill holes supplied by the Illinois Geological Survey, the shallowest bedrock formations present are those of the Mississippian System. There are two major series of Mississippian rock present in the area. As previously mentioned, the shales of the Kinderhookian Series are the shallowest bedrock present in the southwest portion of the study site, and these are overlain by a varying thickness of limestone of the Valmeyeran Series in the northeast portion of the study site. Illinois Highway 57 marks the approximate geologic contact in plain view. The total Mississippian section should attain an average thickness of approximately 170 feet in this area (see Figure 8-41, and it will be thickest in the northeast.

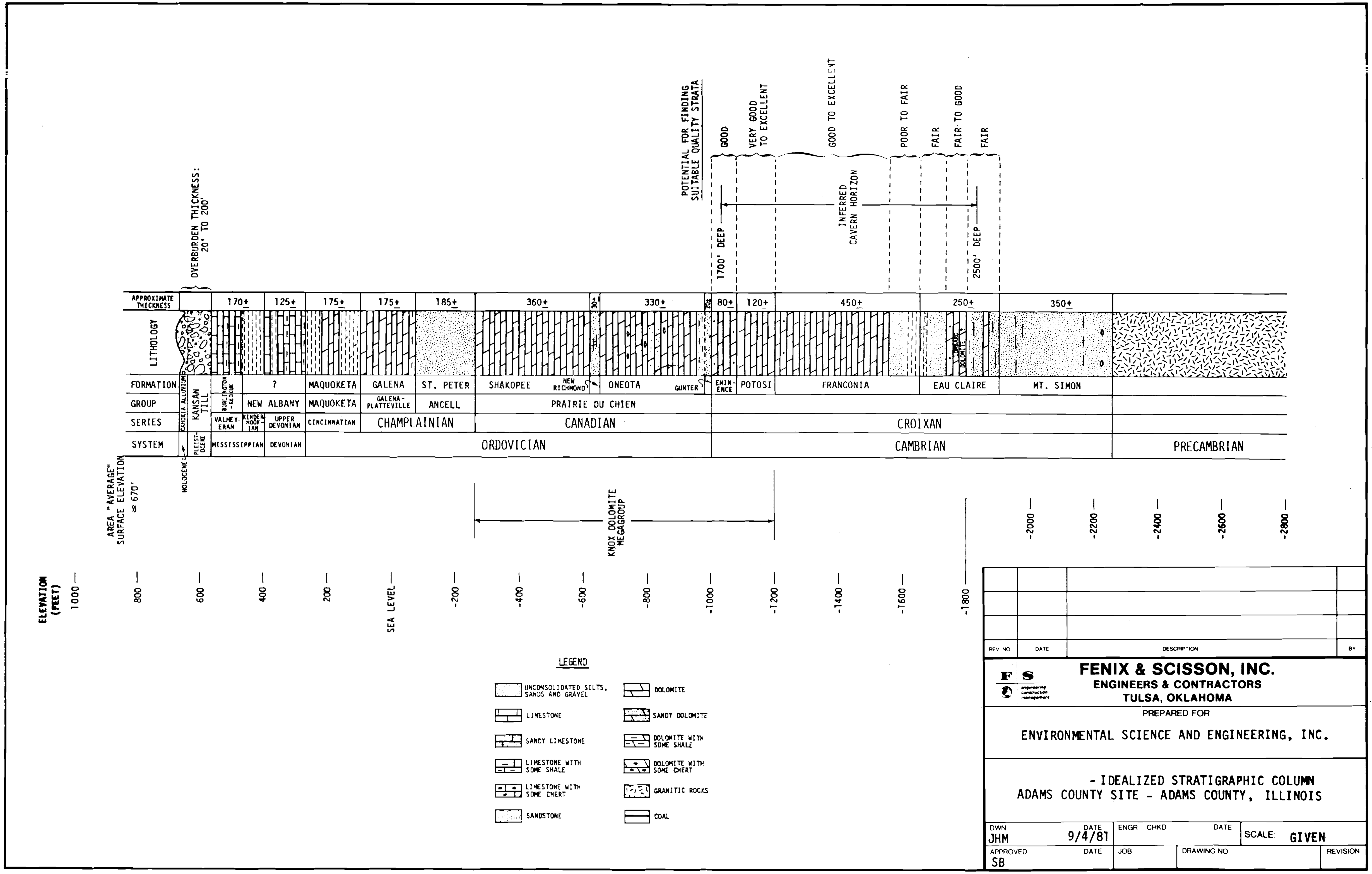


Figure 8-4

IDEALIZED STRATIGRAPHIC COLUMN—ADAMS COUNTY SITE

SOURCE: FENIX & SCISSON, INC., 1981.

CAES

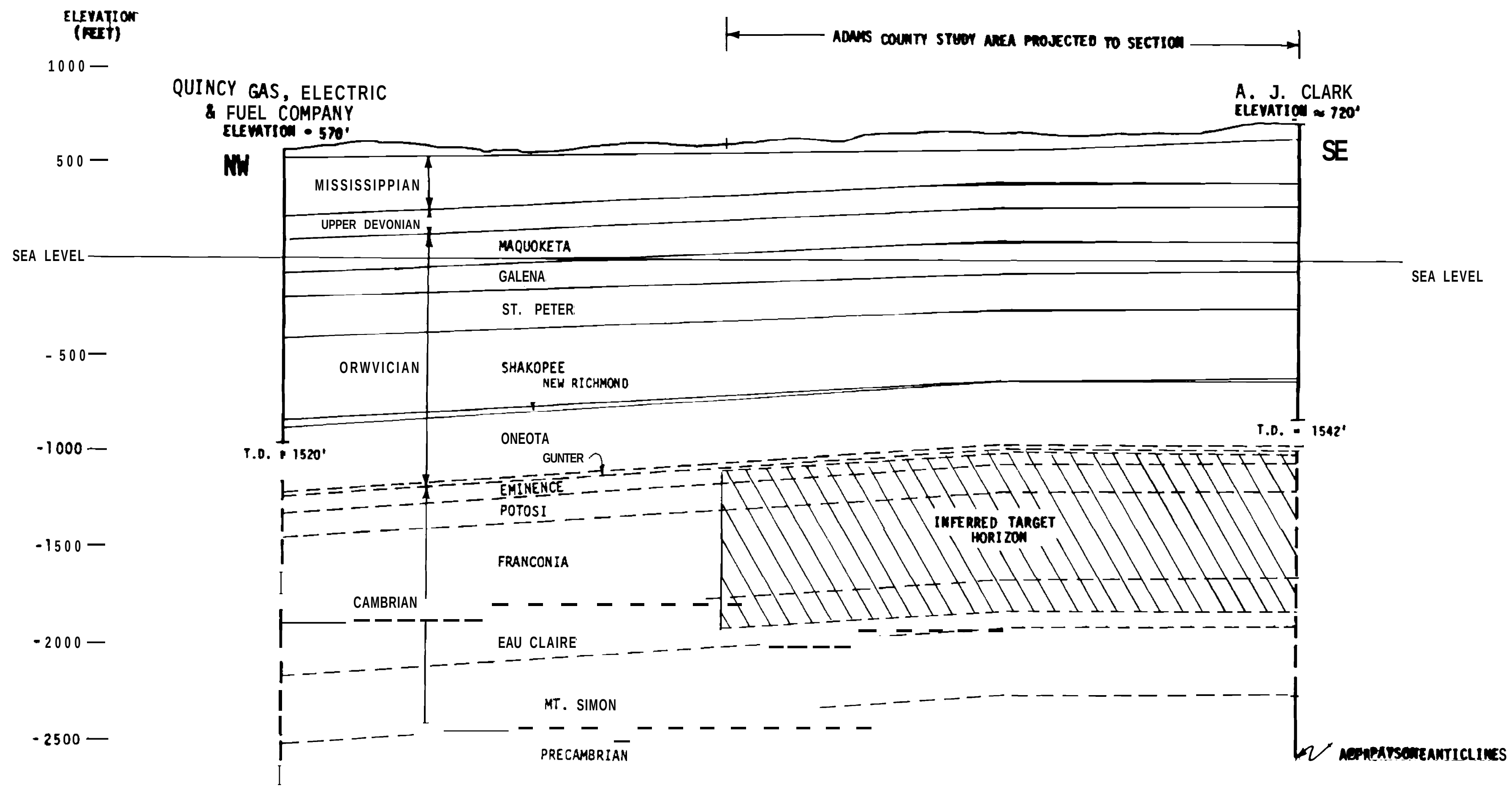
SITE SELECTION STUDY

Below the Mississippian strata, rocks belonging to the Devonian System should be encountered. Only the shales and limestones of the Upper Devonian Series should be present, as the Middle and Lower Series have been eroded away. The Devonian should attain a thickness of about 125 feet (Figure 8-41. Since the Silurian System has probably also been eroded away in this area, Upper Devonian rocks unconformably overlie the Ordovician System.

The marine sandstones, shales, and dolomites of the Ordovician System should attain a total thickness of approximately 1,275 feet (Figure 8-41. The depth to the base of the Ordovician should be about 1,700 feet, which would be the approximate top of the cavern search horizon (see Figures 8-4 and 8-5).

Below the Ordovician System, there should be about 1,250 feet of marine and transitional marine strata belonging to the Cambrian System. These strata are dominantly massive or relatively thick-bedded dolomites at the top, becoming more clastic at depth (Figure 8-4).

Beneath the Cambrian System lie the Precambrian basement rocks. The top of the Precambrian rocks should exist at an elevation of about -2,250 feet or at a depth of approximately 2,820 feet (assuming an "average'' surface elevation of 570 feet--see Figure 8-41. This is probably too deep to be a candidate for cavern construction, which is unfortunate, since observed samples of this igneous-textured rock appear to have excellent engineering characteristics. It is possible that local topographic high points or hills exist on the Precambrian surface in this area; however, this is not indicated on available information, and the state geological surveys of both Missouri and Illinois are in agreement with the results presented in Figure 8-4. The configuration of the Precambrian surface is relatively unknown.



NOTE: SEE FIGURE 8-3 FOR LOCATION OF CROSS-SECTION

1 ½ 0 1 2

HORIZONTAL SCALE IN MILES

REV NO	DATE	DESCRIPTION	BY

FENIX & SCISSON, INC.
ENGINEERS & CONTRACTORS
TULSA, OKLAHOMA

PREPARED FOR

ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

- IDEALIZED GEOLOGIC CROSS-SECTION
ADAMS COUNTY SITE

DWN	DATE	ENGR	CHKD	DATE		
JHH	9/4/81					
APPROVED SB	DATE	JOB	DRAWING NO		SCALE GIVEN	REVISION

Figure 8-5

IDEALIZED GEOLOGICAL CROSS-SECTION— ADAMS COUNTY SITE

SOURCE: **FENIX & SCISSON, INC., 1981.**

CAES
SITE SELECTION STUDY

8.2.1.3 ESTIMATION OF ROCK SUITABILITY AT REQUIRED DEPTH

Based on the current state of knowledge, the following Cambrian formations are believed to be within the 1,700- t~ 2,500-foot deep target horizon: Eminence, Potosi, Franconia, and Eau Claire. As mentioned in the introduction, the actual depths at which these formations will be found could vary significantly from what is presented here, but only a detailed feasibility study could provide exact information. Drill cuttings samples of these formations from a well in Section 15, T.4S., R.5W. in Pike County (about 16 miles east-southeast of the site) were examined and, along with some petrographic information from the Illinois Geological Survey, were used to formulate the following opinions on the potential suitability of each formation for mined storage.

Eminence Formation

This formation seems to hold good potential for finding good quality mining rock. It should be a thick to medium bedded dolomite, with variable amounts of sand. On the negative side, some of the samples examined showed evidence of alteration in the form of chert and iron oxides.

Potosi Formation

This formation seems to hold very good to excellent potential. Samples examined appeared to be from a pure to slightly argillaceous (like or containing clay), massive, dense dolomite. On the negative side, there was some chert present, but not nearly as much as the Eminence Formation above.

Franconia Formation

This formation should hold good to excellent potential in its upper ±300 feet. In this part of the formation, the samples examined appeared very similar to the Potosi Formation above. The bottom 150 feet probably have poor to fair potential. Here the formation should be thin bedded, poorly sorted sandstones and shales; abundant alteration materials were present.

Eau Claire Formation

The potential in this formation is only fair. A sandy facies of the Eau Claire Formation is present in this part of Illinois. It has undergone some alteration and may have a high primary permeability. The Lombard Dolomite Member, identified as a favorable unit in previous regional evaluations, may hold good potential, but its position within the formation could not be determined and it may exist below the 2,500-foot depth level.

8.2.1.4 STRUCTURAL CONSIDERATIONS

Sinkholes and other solutioning features would have to be a major consideration in a detailed feasibility study conducted in this area. There are a few large (about 20-foot diameter) sinkholes present in the northeastern part of the area. These may have a major influence in the siting of the surface facilities and it may be desirable to locate the plant in the southwestern portion of the study site. Solution features at depth may also be encountered, as the record of a drill hole about 18 miles to the west reported a 5-foot "gap" at the base of the Cambrian System and a 10-foot "gap" in the Shakopee Formation. It could not be definitely determined whether these gaps are solution features or merely lapses in the drill cuttings sample record.

The area is located on the western flank of the Paysan Anticline (Figures 8-2 and 8-51, but the effects of this feature should be very small, if any. Outcrops observed near the study site were nearly flat, but seemed to have a very mild dip toward the east (probably less than 50 feet per mile), which conforms to the overall regional geology.

8.2.2 PIKE COUNTY SITE

8.2.2.1 GENERAL

The Pike County site is located in the west-central portion of Illinois (Figure 8-1) in the "Galesburg Plain" physiographic province. The site is in T.5S., R.2W. in the east-central part of Pike County (see Figure 8-6).

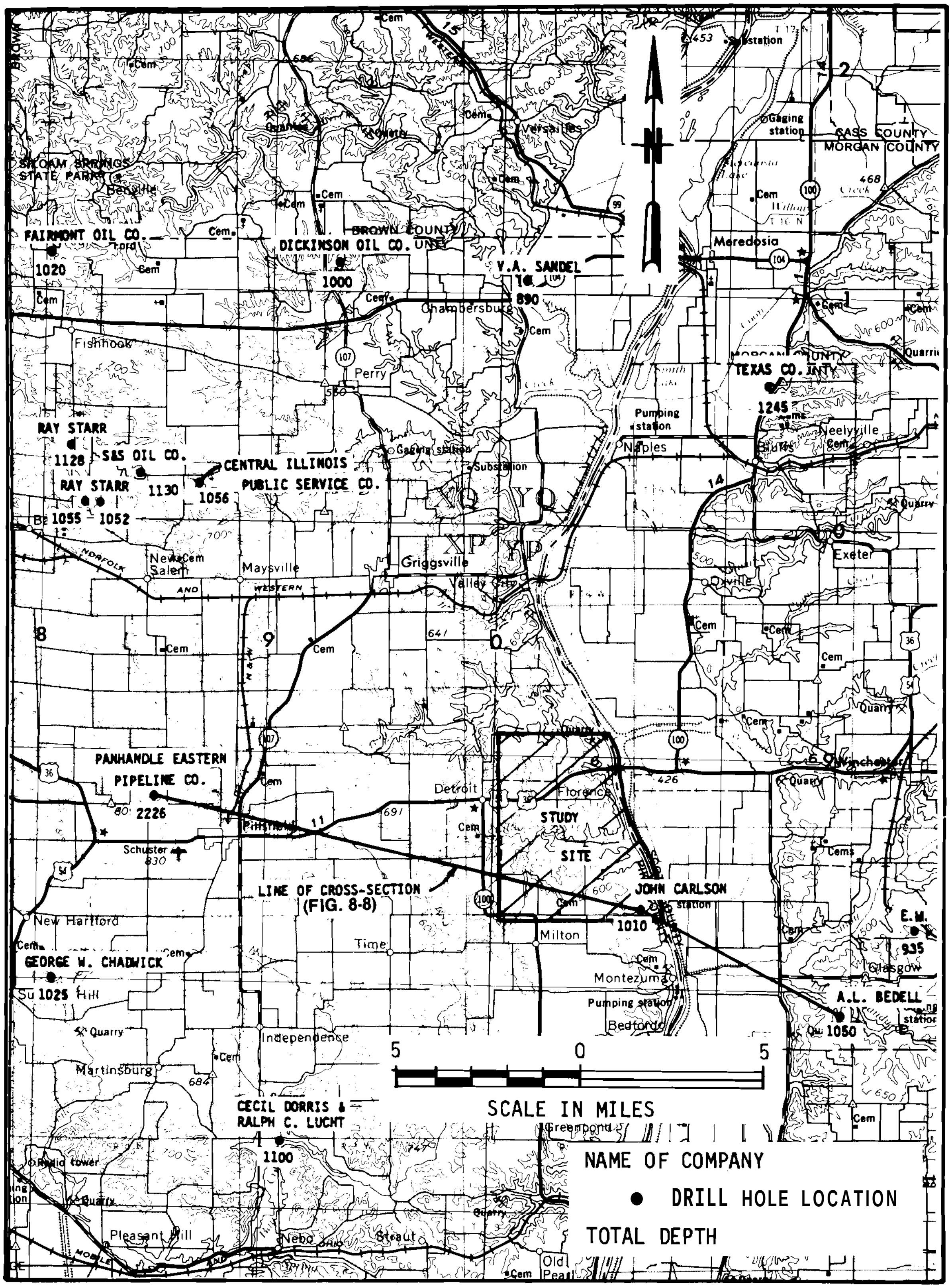


Figure 8-6

PLAN MAP OF PIKE COUNTY SITE, SHOWING DRILL LOCATIONS AND LINE OF CROSS-SECTIONS

SOURCE: FENIX & SCISSON, INC., 1981.

CAES

SITE SELECTION STUDY

Topographically, the surface elevations vary from a low of about 440 feet in the east where the site borders the Illinois River, to a high of about 675 feet near the southwestern site border. The weathering patterns of small streams draining into the Illinois River are the dominant feature of the surface topography.

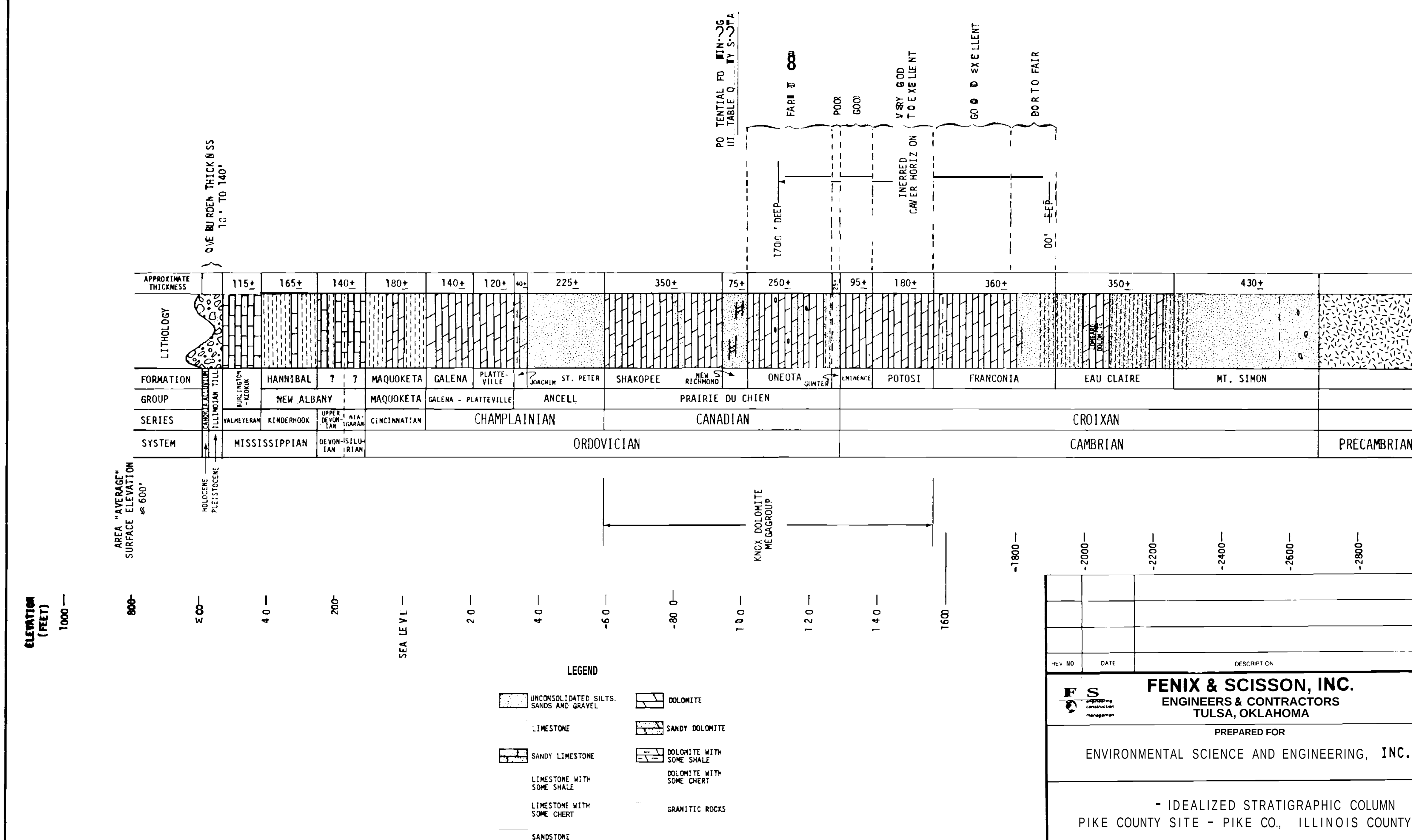
Some rocks of the Lower Valmeyeran Series are exposed in road cuts, but in general, all bedrock units are covered with from 10 to 140 feet of Cahokia alluvium and Illinoian glacial till.

The area receives about 35 inches of rainfall per year, which should be a sufficient amount to maintain a stable groundwater level. Based on water well completion reports, the static water level should be from 5 to 100 feet below surface. This would imply that a minimum theoretical hydrostatic pressure of 694 psig would exist at the 1,700-foot depth level [(1,700 ft.-100 ft.) 0.4335 psi/ft. = 693.6 psig].

8.2.2.2 STRATIGRAPHY

Based on generalized geologic data and records of nearby drill holes supplied by the Illinois Geological Survey, the shallowest bedrock formations present are those of the Mississippian System. The Keokuk and Burlington limestone formations of the Lower Valmeyeran Series should be the shallowest bedrock units present in the area, and they should attain a thickness of about 115 feet. Below this are Kinderhookian shales which should have a thickness of about 165 feet. This makes the total anticipated thickness of Mississippian strata approximately 280 feet (Figure 8-7).

Below the Mississippian strata, rocks belonging to the Devonian System should be encountered. Only the shale and limestones of the Upper Devonian Series should be present, as the Middle and Lower Series have been eroded away. Below this, rocks of the Silurian System are probably present; however, it was difficult to determine where the



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ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

- IDEALIZED STRATIGRAPHIC COLUMN
PIKE COUNTY SITE - PIKE CO., ILLINOIS COUNTY

DWN	DATE	ENGR	CHKD	DATE	SCALE
JHM	9/4/81				GIVEN
APPROVED SB	DATE	JOB	DRAWING NO		REVISION

Figure 8-7

IDEALIZED STRATIGRAPHIC COLUMN— PIKE COUNTY SITE

SOURCE: **FENIX & SCISSON, INC., 1981.**

contact should be located from available drill hole records. The total thickness of Devonian and Silurian strata should be about 140 feet, with the bottom 50 to 70 feet being Silurian aged and unconformably overlying the Ordovician System.

The marine shales, dolomites, and sandstones of the Ordovician System should attain a total thickness of approximately 1,405 feet. The 1,700-foot depth level should be about 180 feet above the base of the Ordovician System in the Oneota Formation, which would be the approximate top of the cavern search horizon (Figures 8-7 and 8-8).

Below the Ordovician System, there should be about 1,415 feet of marine and transitional marine strata belonging to the Cambrian System. These strata are dominantly massive or relatively thick-bedded dolomites at the top of the Cambrian, becoming more clastic (containing fragments of older rocks) at depth.

Beneath the Cambrian System lie the Precambrian basement rocks. The top of the Precambrian rocks should exist at an elevation of about -2,700 feet or at a depth of about 3,300 feet (assuming an "average" surface elevation of 600 feet). As in Adams County, this is probably too deep to be considered a candidate for cavern construction at this time. While there is a slightly higher possibility of finding local topographic high points or hills on the Precambrian surface in this area than there is in Adams County, the chances are probably low. There are no indications found in available literature that Precambrian hills exist in this area. The configuration of the Precambrian surface is relatively unknown.

8.2.2.3 ESTIMATION OF ROCK SUITABILITY AT REQUIRED DEPTH

Based on the current state of knowledge, the following formations are believed to be within the 1,700- to 2,500-foot deep target horizon: Oneota, Gunter, Eminence, Potosi, and Franconia. The Oneota and Gunter are formations of the Ordovician System, while the Eminence, Potosi and Franconia are formations of the Cambrian System.

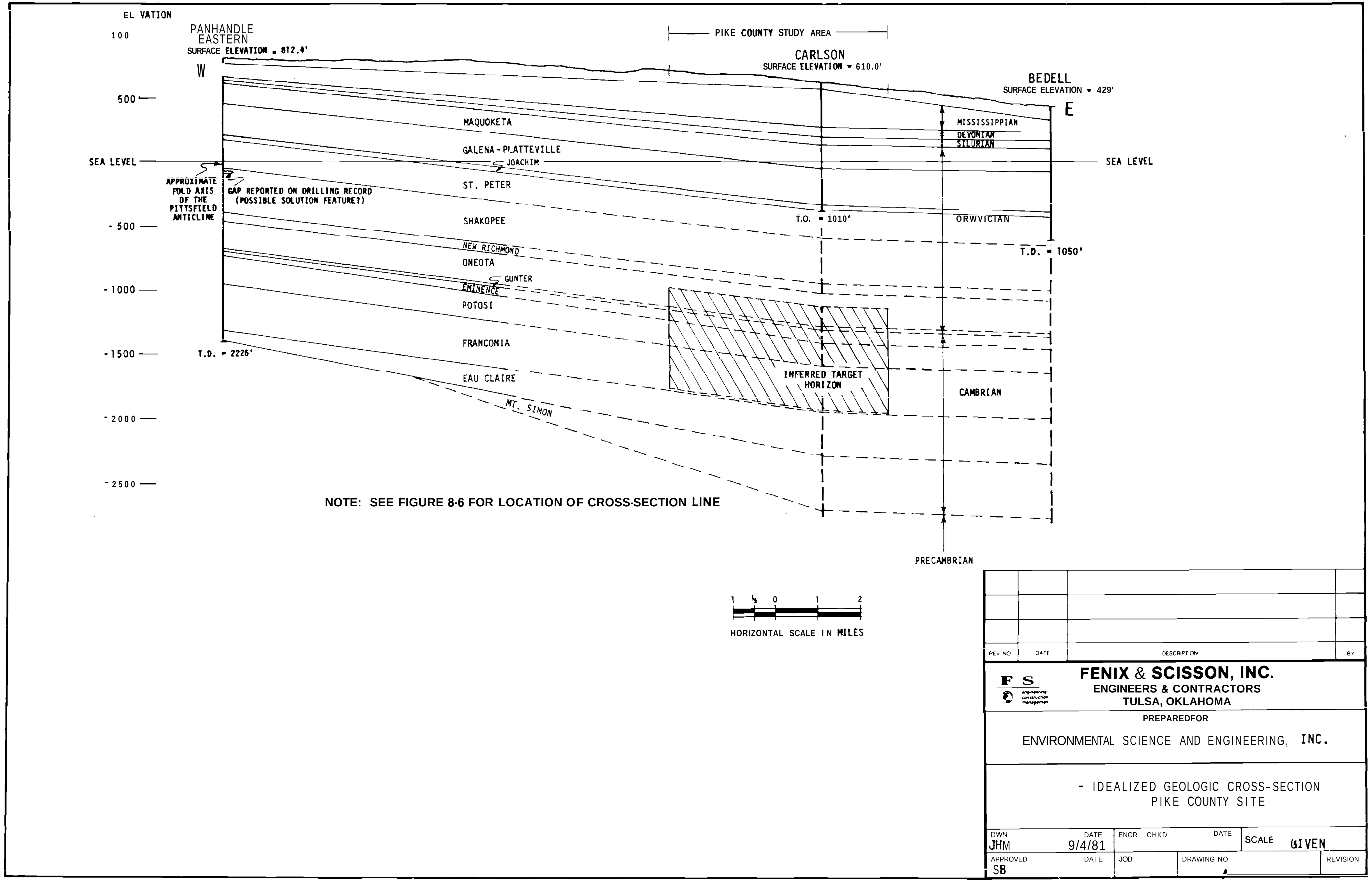


Figure 8-8

IDEALIZED GEOLOGIC CROSS-SECTION— PIKE COUNTY SITE

SOURCE: **FENIX & SCISSON, INC., 1981.**

CAES

SITE SELECTION STUDY

Again, the actual depths at which these formations will be found could vary significantly from what is presented here, but a detailed feasibility study would be necessary to provide more exact stratigraphic information. Drill cuttings samples of these formations from a well in Sections 21, T.5S., R.4W. in Pike County (about 11 miles west of the site) were examined, and along with some petrographic information from the Illinois Geological Survey, were used to formulate the following opinions on the potential suitability of each formation for mined storage.

Oneota Formation

The potential for finding suitable mining quality rock is considered fair to good in this formation. The formation appears to be a coarsely crystalline, massive dolomite and for this reason potential is considered good. Many of the samples had up to 10 percent iron oxide stained fragments, which could indicate extensive alteration. This could be a localized feature from another part of Pike County and may not occur at the study site.

Gunter Formation

This formation is considered to hold poor potential for mining. It is a thinly bedded, poorly sorted sandstone with a high clay content.

Eminence Formation

As was the case for Adams County, this formation seems to hold good potential for finding good quality mining rock. It should be a thick to medium bedded dolomite, with variable amounts of sand. Samples showed evidence of alteration in the form of chert and some iron oxides.

Potosi Formation

This formation seems to hold very good to excellent potential. Samples examined appeared to be from a pure to slightly argillaceous, finely crystalline, massive, dense dolomite. There was some chert present.

Franconia Formation

This formation should hold good to excellent potential in its upper ±230 feet. In this part of the formation, the samples examined appeared similar to the Potosi Formation. The bottom 130 or so feet probably have poor to fair potential. Here the formation should be thin bedded, poorly sorted sandstones and shales; abundant alteration materials were present.

8.2.2.4 STRUCTURAL CONSIDERATIONS

While no sinkholes were observed, it would be necessary to fully evaluate the possibility in a detailed feasibility study. Again, solution features at depth may be encountered. The drill record mentioned in the Adams County section, where a 5-foot "gap" at the base of the Cambrian and a 10-foot "gap" in the Shakopee Formation were reported, was drilled about 11 miles west of the site. Again, these "gaps" may simply be intervals for which samples were not taken.

The study area lies between the extended axes of the Fishhook and Pittsfield Anticlines. The effects of these features within the study area are unknown. Outcrops in the area are almost flat, but the dip seems to fluctuate from very slightly east to very slightly west. The possibility of effects due to local structure is considered higher here than in the Adams County site.

8.2.3 MENARD COUNTY SITE

8.2.3.1 GENERAL

The Menard County Site is located in the central portion of Illinois in the "Springfield Plain" physiographic province. The site is in T.19N., R.7&8W. in the northwestern corner of Menard County (Figure 8-9).

Topographically, the surface elevations vary from a low of about 460 feet in the west, where the site borders the Sangamon River, to a high of about 600 feet near the eastern site border. Throughout most of the area the relief is very mild.

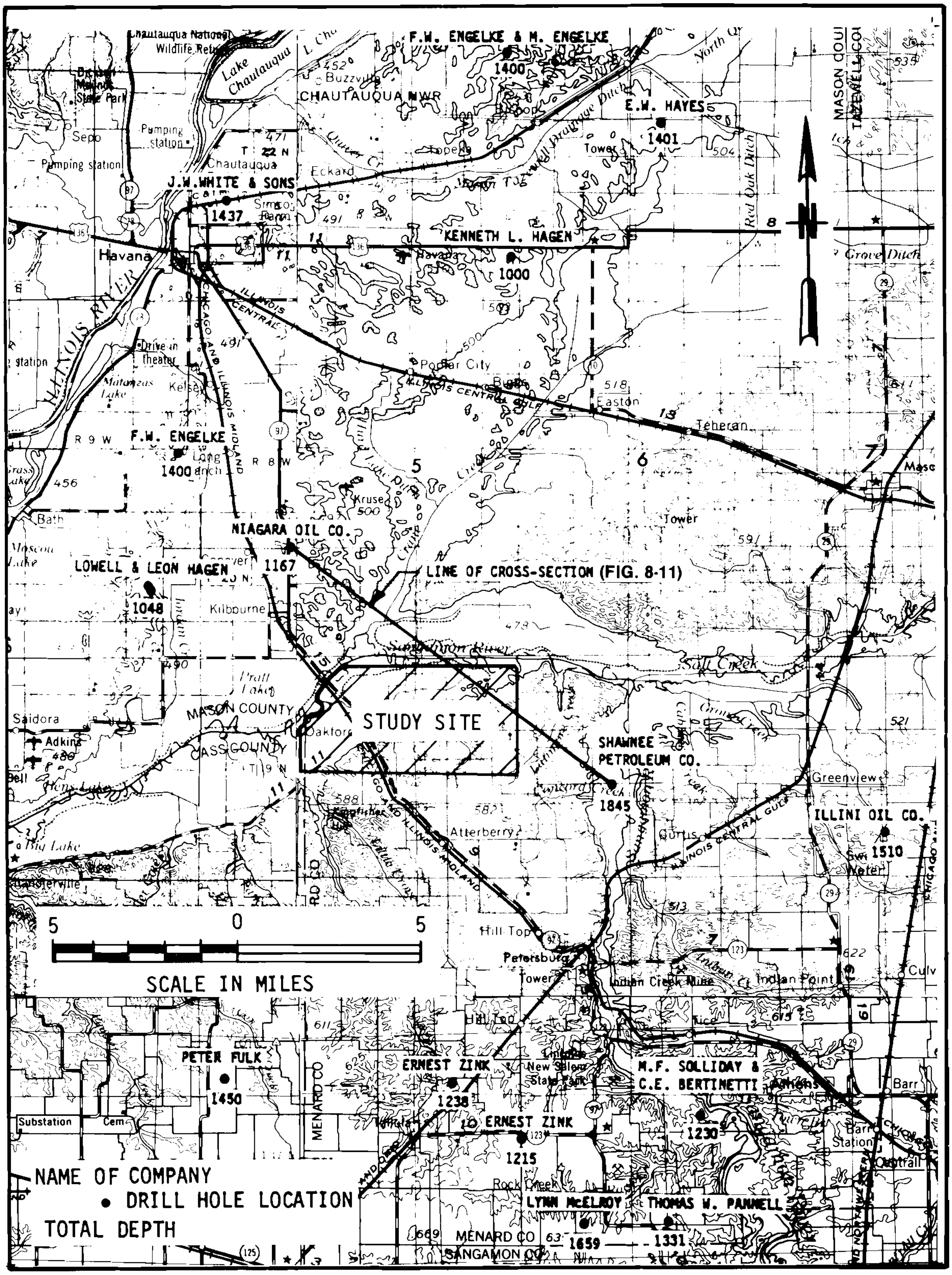


Figure 8-9

PLAN MAP OF MENARD COUNTY SITE, SHOWING DRILL HOLE LOCATIONS AND LINE OF CROSS-SECTION
SOURCE: FENIX & SCISSON, INC., 1981.

CAES
SITE SELECTION STUDY

No bedrock exposures were found, and based on old drilling records, bedrock is,covered with from 65 to 200 feet of Cahokia alluvium and Illinoian glacial till.

The area receives about 35 inches of rainfall per year, which should be a sufficient amount to maintain a stable groundwater level. Many portions within the study site appear to be very damp and almost swampy, and water well completion reports confirm that the static water level should be within 60 feet of the surface. This would imply that a minimum theoretical hydrostatic pressure of 711 psig would exist at the 1,700-foot depth level [(1,700 ft.-60 ft.) 0.4335 psi/ft. = 710.9 psig].

8.2.3.2 STRATIGRAPHY

Based on generalized geologic data and records of nearby drill holes supplied by the Illinois Geological Survey, the shallowest bedrock formations present are those of the Pennsylvanian System. The coal-bearing calcareous sandstones and sandy limestones of the Kewanee Group, which includes the Carbondale and Spoon Formations, will be the shallowest bedrock and attain a thickness of approximately 160 feet. Below this there should be about 60 feet of sandstones (possibly with some coal) belonging to the Abbott Formation of the McCormick Group. The total thickness of Pennsylvanian strata should be approximately 220 feet (Figure 8-10).

Below this, rocks belonging to the Mississippian System will be encountered. There should be about 460 feet of Valmeyeran strata underlain by about 140 feet of Kinderhookian shales giving the Mississippian System a total thickness of approximately 600 feet.

Below the Mississippian strata, rocks of the Devonian System should be encountered. Only the shales of the Upper Devonian Series should be present, as the Middle and Lower Series have been eroded away. Below this, rocks of the Silurian System are probably present; however, it was difficult to determine where the contact should be located from

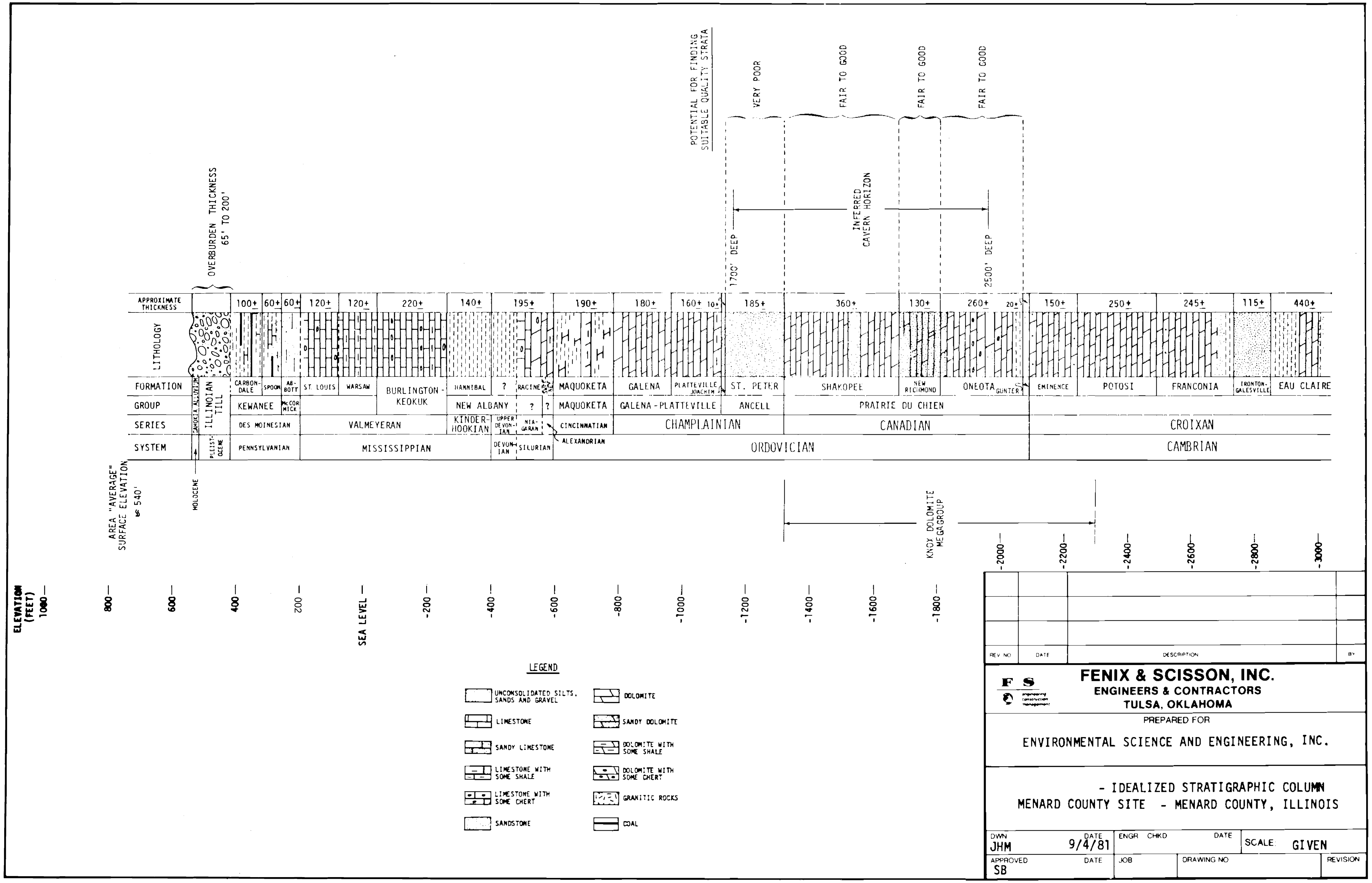


Figure 8-10

IDEALIZED STRATIGRAPHIC COLUMN— MENARD COUNTY SITE

SOURCE: FENIX & SCISSON, INC., 1981.

CAES

SITE SELECTION STUDY

available drill hole records. The total combined thickness of Devonian and Silurian strata should be about 195 feet, with the bottom 100 to 125 feet being Silurian aged and unconformably overlying the Ordovician System.

The marine shales, dolomites, and sandstones of the Ordovician System should attain a total thickness of approximately 1,495 feet. The 1,700-foot depth level should be about 565 feet below the top of the Ordovician System in the St. Peter Formation, which would be the approximate top of the cavern search horizon (Figures 8-10 and 8-11). The 2,500-foot depth level should be encountered about 130 feet above the base of the Ordovician System.

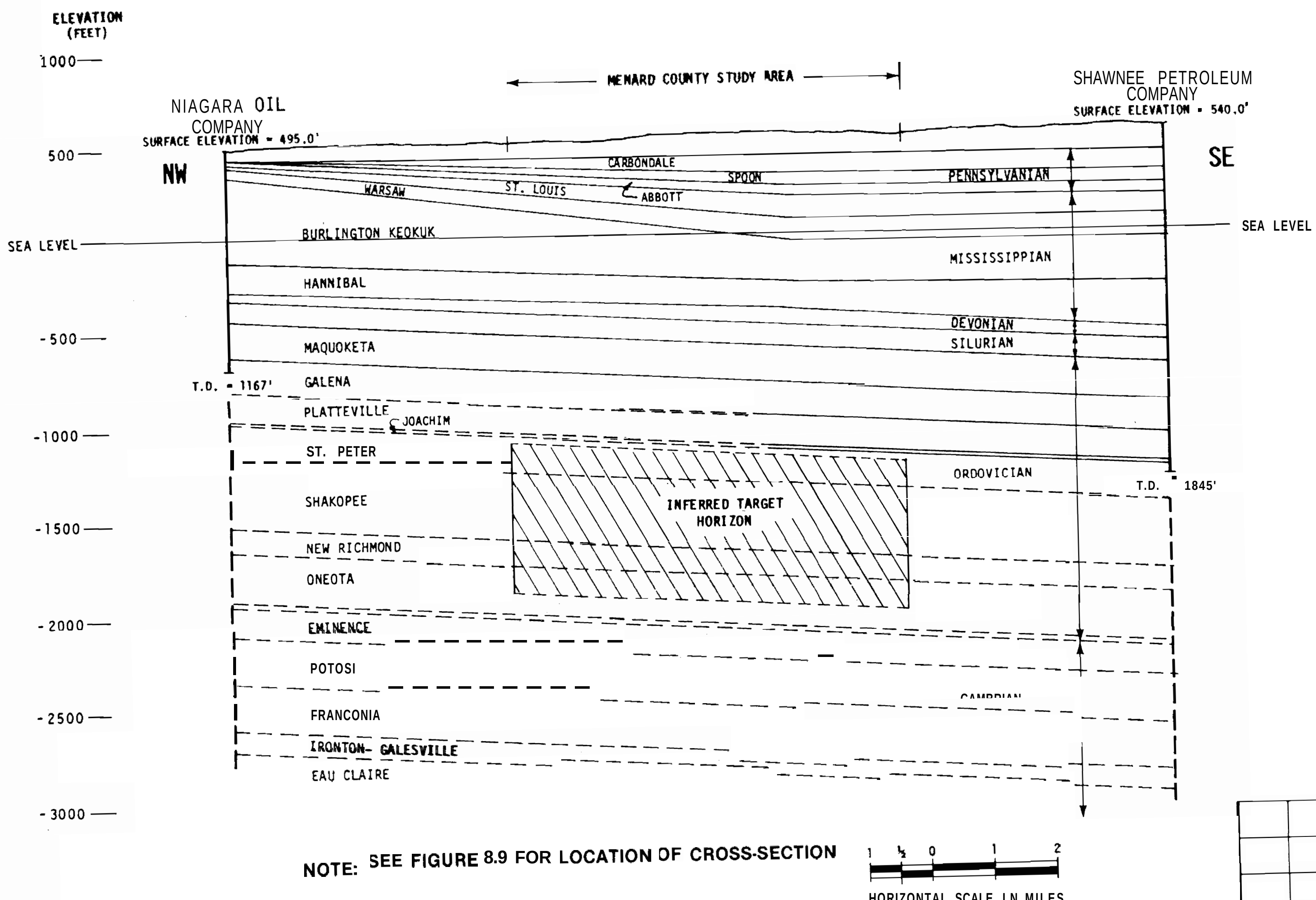
Below the Ordovician, there should be about 2,300 or more feet of marine and transitional marine strata of the Cambrian System on top of the Precambrian basement rocks.

8.2.3.3 ESTIMATION OF ROCK SUITABILITY AT REQUIRED DEPTH

Based on regional estimates, the following Ordovician formations are believed to be within the 1,700- to 2,500-foot deep target horizon: St. Peter, Shakopee, New Richmond, and Oneota. As mentioned previously, the actual depths at which these formations will be found could vary significantly from what is presented here, but only a detailed feasibility study could provide exact information. Drill cuttings samples from a well in Section 21, T.5S., R.4W. in Pike County (about 55 miles southwest of the site) were examined and along with some petrographic information form the Illinois Geological survey, were used to formulate the following opinions on the potential suitability of each formation for mined storage.

St. Peter Formation

Based on past experience, this formation has no potential to be a cavern host rock. The St. Peter is a friable or weakly cemented quartz sandstone, normally with a high permeability. No samples were examined.



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IDEALIZED GEOLOGIC CROSS-SECTION
MENARD COUNTY SITE

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Figure 8-11

IDEALIZED GEOLOGIC CROSS-SECTION—MENARD COUNTY SITE

SOURCE: FENIX & SCISSON, INC., 1981.

CAES

SITE SELECTION STUDY

Shakopee Formation

Most samples appeared to be from a relatively dense dolomite; however, other samples showed a high sand and/or shale content indicating the formation may be thin bedded. There was also a high amount (about 10 percent) of alteration material in the form of clay, iron oxides, and secondary quartz present in some samples. The cuttings sample record of the hole examined included a 10-foot interval within the Shakopee labled "gap" where no samples were found. The meaning of this is unknown, but it could be a solution feature. The potential for finding a thick interval of relatively pure dolomite where a cavern could be sited is considered fair to good.

New Richmond Formation

The potential for finding strata suitable for mining is also fair to good here. It is similar to the Shakopee, but may be slightly less favorable due to an increased sand content.

Oneota Formation

This formation also appears to hold fair to good potential. This formation appears to be a coarsely crystalline, massive dolomite and for this reason potential is considered good. Many of the samples had up to 10 percent iron oxide stained fragments, which could indicate extensive alteration. This could be a localized feature in the area the samples were obtained (Pike County) and may not occur at the Menard County study site.

8.2.3.4 STRUCTURAL CONSIDERATIONS

Again, it would be necessary to evaluate the possibility of sinkhole occurrences in the area as part of a detailed feasibility study. No sinkholes were identified in the field; however, there are several circular-shaped depressions on the topographic maps of the area. This may be due to the poorly developed drainage system, which is natural to this relatively flat area. Solution features at depth would also need to be a consideration in a detailed feasibility report. One of the "gaps" reported in the drilling record of a Pike County well occurred in the Shakopee Formation, which is believed to be within the cavern target horizon at this site.

This area appears to be void of any known structural features.

Based on Figure 8-11, the idealized geologic cross-section of the Menard County site, the dip should be very mild (probably about 35 feet per mile) toward the southeast into the deepest part of the Illinois Basin.

8.3 CONCLUSIONS

The ranking of the three sites in decreasing order of inferred favorability for mined storage construction in the 1,700- to 2,500-foot depth range is:

1. Adams County Site
2. Pike County Site
3. Menard County Site

8.3.1 RESULTS

While the Adams and Pike County sites are considered very close in potential, the Adams County site is considered slightly more favorable because:

1. The depth to rock with good potential should be about 200 feet shallower in Adams County.
2. There appears to be a greater chance for structural irregularities being encountered at the Pike County site.

The Menard County site is considered last because it is least likely to have suitable rock at the required depth.

8.4 RECOMMENDATIONS

It is recommended that a detailed feasibility study be performed on an area of adequate size within the selected site, providing it is also deemed acceptable with respect to environmental and other non-geologic considerations. The feasibility study program for the site should include the following elements:

1. Initially drill one continuously cored test hole to an approximate depth of 2,500 feet. Results of the first hole will determine whether the site should be retained for additional study, or abandoned.
2. If results of the first test hole are favorable, drill as many additional test holes as necessary to prove or disprove the site For proving a site large enough for the desired 213,500-M^3 cavern, a minimum of six total holes would be required. All holes after the first hole should be non-core drilled in the upper parts and cored in the lower parts to reduce cost.
3. Log all drill core in detail in accordance with good engineering geologic practice.
4. Run drill hole geophysical logs and tests as required:
   a. Self Potential--Resistivity,
   b. Gamma Ray--Neutron,
   c. Deviation Survey, and
   d. Hole-to-hole seismic tests.
5. Perform open-hole hydrologic testing:
   a. Static-water level determination, and
   b. Injection pressure testing with straddle packer assembly.
6. Perform laboratory testing of representative drill core samples to determine pertinent engineering properties:
   a. Vertical unconfined compressive strength,
   b. Permeability to air,

c. Effective Porosity,
d. Specific Gravity, and
e. Deterioration in Water.

7. Evaluate test results and prepare final report.

8.4.1 DETAILED FEASIBILITY STUDY

The principal items of a detailed subsurface investigation program designed to determine the feasibility of constructing a mined compressed air energy storage cavern at the selected site were summarized earlier in Section 8.4. Further discussion of the various tasks of the suggested study are presented in the following subsections. The same basic investigation program would apply, with minor changes, in the event that either of the other two sites were chosen for follow-up study.

8.4.1.1 FIRST TEST HOLE

The first hole should be drilled, depending on available land, in a position where it could provide both the greatest flexibility for siting the next hole and help define a cavern horizon. As mentioned in Section 8.4, the first hole should be continuously cored from the top of bedrock to a total depth of about 2,500 feet. Drilling such a hole would be carried out using a core rig with a depth capacity of ±3,000 feet, and if possible, using water as a lubricating and circulating medium (drilling muds could close some of the rock's natural permeability and give unreliable pressure test results). The hole diameter should decrease with depth and the hole should be about 3 inches in diameter, recovering an N.Q. or N.X. size (1 7/8-inch or 2 1/8-inch core diameter) core within the zone of interest for testing purposes. A possible drilling procedure would be:

- Drill a 5 1/2-inch diameter hole through the overburden and a few feet into bedrock using a tri-cane bit. Set casing to this point.
- H.Q. core drill (3.762-inch hole diameter and 2.5-inch core diameter) to equal 100 feet. Set casing to this point.

- N.Q. core drill to the 2,500-foot total depth.
- Perform drill hole hydrologic testing.
- Perform geophysical logging and surveying of the hole.
- Attempt to remove casing strings and plug hole with neat cement grout.

8.4.1.2 ADDITIONAL TEST HOLES

After the first hole is completed it may be determined that it is not necessary to core the shallower portions. It may be a significant savings to drill the upper ±1,500 feet with an air hammer or some other type of non-coring drill rig and set casing. The core rig could then be set up over the hole and the zone of interest cored. The geophysical logs could assist in correlation of the shallower formations.

8.4.1.3 CORE LOGGING

All drill cores should be described in detail in accordance with good engineering geologic practice. Items to be measured, observed, and recorded on the log include the following:

- Percentage core recovery,
- Rock Quality Designation (RQD),
- Description and graphic plot of lithology, and
- Description of structural features including all discontinuities such as bedding, rock unit contacts, faults, joints, fractures, veins and cavities.

8.4.1.4 GEOPHYSICAL LOGGING AND TESTING

- Geophysical logs, such as a resistivity-spontaneous potential or a gamma ray-neutron log would be helpful in evaluating stratigraphy, especially if the entire hole were not cored.
- Some hole-to-hole seismic tests may be desirable and would be helpful in evaluating the hazards of hidden solution features and fault zones.
- A directional survey of the hole may be desirable to determine hole deviation.

8.4.1.5 HYDROLOGIC TESTING

Each hole should be water injection pressure tested within the N.Q. size interval of the hole. This could be accomplished by using a straddle packer assembly which is a standard Fenix & Scisson procedure on all mined storage feasibility studies. Pressure testing is one of the most useful and important procedures which can be used to evaluate rock suitability for cavern construction since it identifies the magnitude of total rock permeability, zone by zone. Total rock permeability includes both primary and secondary (fracture) permeability. Impermeable or low permeability rocks are desirable for compressed air energy storage cavern construction.

8.4.1.6 LABORATORY TESTING

Selected core samples should be tested in a reputable laboratory to determine the engineering properties of the rock, such as:

- Vertical unconfined compressive strength--This is one of the most important engineering properties to be determined. The rock strength is one major factor governing the cross-sectional dimensions at which stable underground workings can be mined. High strength is desirable.
- Permeability to air--This lab test, while useful, generally determines only primary permeability. Drill hole injection pressure testing, on the other hand, identifies total permeability.
- Effective Porosity--In many sedimentary rocks an increase in porosity is accompanied by an increase in primary permeability.
- Specific Gravity
- Deterioration in water--Obviously, rocks which are subject to deterioration from contact with water would be unsuitable for mines of compressed air storage caverns.

Inventories of drill hole records examined for the Pike County and Menard County sites are given in Tables 8-2 and 8-3, respectively.

Table 8-1. Inventory of Drill Hole Records Examined for Adams County Site

Company Name & Date Drilled	Location (Section, Township, Range) & County (If other than Adams)	Total Depth (T.D.) & Formation at T.D.
Quincy Gas, Electric and Fuel Co. June 1912	2, 2S., 9W.	1,520' Oneota
A.J. Clark August 1904	7, 3S., 7W.	1,542' Oneota
American Strawboard Co. November 1890	11, 2S., 9W.	1,202' Shakopee
Monroe Color & Chem. Co. June 1919	27, 1S., 9W.	1,222' New Richmond?
O.A. Reed October 1941	19, 2S., 6W.	1,570' Oneota
Charles J. Koch, Jr. August 1964	7, 3S., 6W.	1,010' St. Peter
Ray F. Starr May 1962	24, 3S., 5W.	905' St. Peter
C.E. Bowers Date Not Recorded	17, 3S., 6W.	967' Platteville?
Ray F. Starr April 1962	15, 3S., 6W.	1,097' Platteville?
Arnold Beach 1956	7, 3S., 6W.	929' Platteville
Charles Koch, Jr. March 1963	5, 3S., 6W.	985' Galena
Pea Ridge Oil & Gas Co. Date Not Recorded	22, 1N., 5W.	1,129' St. Peter

Table 8-1. Inventory Of Drill Hole Records Examined for Adams County Site (continued, Page 2 of 2)

Company Name & Date Drilled	Location (Section, Township, Range) & County (If other than Adams)	Total Depth (T.D.) & Formation at T.D.
H.H Paben September 1961	1, 3S., 6W.	820' Galena
Albojo Oil Company October 1962	3, 3S., 6W.	845' Galena
E.F. Atkins & E.O. Hale April 1960	4, 3S., 6W.	940' Platteville
Ray F. Starr March 1962	24, 3S., 5W.	972' St. Peter
Ohio Oil Company September 1916	23, 3S., 5W.	860' St. Peter
Donald W. Woltz April 1964	10, 3S., 5W.	982' St. Peter
Donald L. Wills September 1957	5, 3S., 5W.	1,010' St. Peter
Ray F. Starr February 1963	3, 3S., 5W.	841' St. Peter
McGinley Brothers Date Not Recorded	2, 2S., 9W.	1,000' St. Peter?
Ray F. Starr August 1961	2, 2S., 5W.	1,072' St. Peter

The records for the drill holes were obtained from the Illinois Geological Survey, located in Urbana, Illinois. The drill holes are listed under the site for which they were utilized.

Table 8-2. Inventory of Drill Hole Records Examined for Pike County Site

Company Name & Date Drilled	Location (Section, Township, Range) & County (If other than Pike)	Total Depth (T.D.) & Formation at T.D.
Herndon Drilling Co. April 1944	15, 4S., 5W.	3,207' Precambrian
Panhandle Eastern Pipeline Co. January 1948	21, 5S., 4W.	2,226' Precambrian
John E. Carlson August 1973	35, 5S., 2W.	1,010' St. Peter
George W. Chadwick Date Not Recorded	7, 6S., 4W.	1,025' St. Peter
Cecil Dorris & Ralph C. Lucht January 1958	31, 6S., 3W.	1,100' Platteville?
Ray F. Starr November 1958	1, 4S., 5W.	1,018' Platteville
Ray F. Starr April 1959	8, 4S., 4W.	1,052' St. Peter
Ray F. Starr June 1958	7, 4S., 4W.	1,055' St. Peter
The Dickinson Oil Company, Inc. December 1959	4, 3S., 3W.	1,000' Platteville
Fairmount Oil Co. 1938	5, 3S., 4W.	1,020' St. Peter
V.A. Sandel June 1957	8, 3S., 2W.	890' Galena?
Ray F. Starr May 1958	32, 3S., 4W.	1,128' St. Peter

Table 8-2. Inventory of Drill Hole Records Examined for Pike County Site (Continued, Page 2 of 2)

Company Name & Date Drilled	Location (section, Township, Range) & County (If other than Pike)	Total Depth (T.D.) & Formation at T.D.
Central Illinois Public Service Co. June 1968	2, 4S., 4W.	1,056' St. Peter
S&S Oil Company July 1956	3, 4S., 4W.	1,130' St. Peter
Pike County Gas Assoc. May 1957	4, 4S., 4W.	1,212' St. Peter?
A.L. Bedell March 1941	27, 13N., 13W. Scott County	1,050' St. Peter
Texas Company March 1930	2, 15N., 13W. Scott County	1,245' St. Peter
Edgar White August 1940	17, 13N., 2W. Scott County	935' Galena?

Table 8-3. Inventory of Drill Hole Records Examined for Menard County Site

Company Name & Date Drilled	Location (Section, Township, Range) & County (If other than Menard)	Total Depth (T.D.) & Formation at T.D.
Shawnee Petroleum Company February 1959	23, 19N., 7W.	1,845' St. Peter
Cantine & Haley November 1950	24, 19N., 5W.	1,560' Silurian
E.V. Richardson November 1965	23, 19N., 5W.	1,500' Silurian
Ed Duvall et al. 1938	24, 19N., 5W.	2,156' St. Peter
M.F. Solliday & C.F. Bertinetti September 1959	4, 17N., 6W.	1,230' Silurian
Ernest Zink October 1952	8, 17N., 7W.	1,215' Devonian
Lynn McElroy September 1960	22, 17N., 7W.	1,659' Galena
Thomas W. Pannell September 1962	19, 17N., 6W.	1,331' Silurian
Ernest Zink November 1952	32, 18N., 7W.	1,238' Silurian
Dwight Beckham December 1957	13, 19N., 5W.	1,597' Silurian
Illini Oil Company February 1963	30, 19N., 5W.	1,510' Maquoketa
Marvin T. Pritchett November 1956	25, 19N., 5W.	1,880' Galena
Lowell & Leon Hagen February 1966	26, 20N., 9W. Mason County	1,048' Galena

Table 8-3. Inventory of Drill Hole Records Examined for Menard County Site. (Continued, Page 2 of 2)

Company Name & Date Drilled	Location (section, Township, Range) & County (If other then Menard)	Total Depth (T.D.) & Formation at T.D.
Jacob L. Pinkston June 1950	3, 19N., 10W. Mason County	1,051' Galena
Jacob L. Pinkston June 1950	15, 19N., 10W. Mason County	1,685' Shakopee?
F.W. Engelke June 1959	1, 20N., 9W. Mason County	1,400' Platteville?
Kenneth L. Hagen August 1966	9, 21N., 7W. Mason County	1,000' Devonian
E.W. Hayes May 1943	19, 22N., 6W. Mason County	1,401' Galena
J.H. White & Sons Date Not Recorded	31, 22N., 8W. Mason County	1,437' St. Peter
Niagara Oil Comapny August 1959	21, 20N., 8W. Mason County	1,167' Galena
F.W. Engelke & M. Engelke June 1958	9, 22N., 7W. Mason County	1,400' Platteville?
Perry Fulk August 1960	30, 18N., 8W. Cass County	1,450' Maquoketa

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