

WATER RESOURCES INVESTIGATION
St. Louis Metropolitan Area
Missouri and Illinois

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RECONNAISSANCE REPORT

AMERICAN BOTTOMS GROUNDWATER STUDY

AUGUST 1979

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SYLLABUS

The purpose of this study is to investigate groundwater flooding and associated water problems in the American Bottoms area to determine the need for, and the feasibility of, providing improvements.

The study area is located on the Illinois side of the Mississippi River floodplain between Alton and Dupo, Illinois. The area comprises about 175 square miles, is approximately 30 miles long, and has a maximum width of 11 miles. Federally constructed levees protect the area from direct Mississippi River flooding.

Problem areas identified during Stage I of this study include damage caused by high groundwater levels, water supply, environmental quality and water related recreation opportunities. Stage II, Development of Intermediate Plans, will address the problems. The estimated study cost for Stage II is \$730,000. Stage II will be complete in October 1981.

The inter-disciplinary team conducting this study consists of the study manager, a hydrologic engineer, an environmental specialist, an economist, a recreation resources manager, a geologist, a design engineer, and a real estate specialist. The team will address the following functional areas: study management, public involvement, institutional analysis, social and economic, cultural resources, environmental, fish and wildlife, hydrology and hydraulics, foundations and materials, design and cost estimates, real estate, recreation and plan formulation.

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DESCRIPTION**PAGE NO.****INTRODUCTION**

STUDY AUTHORITY	2
SCOPE OF THE STUDY	9
STUDY PARTICIPANTS AND COORDINATION	10
STUDIES OF OTHERS	15
OTHER CORPS STUDIES	15
THE REPORT AND STUDY PROCESS	17
THE REPORT	17
STUDY PROCESS	17

PROBLEM IDENTIFICATION

NATIONAL OBJECTIVES	20
EXISTING CONDITION (PROFILE) AND CONDITIONS	
IF NO FEDERAL ACTION WERE TAKEN	21
NATURAL RESOURCES	21
HUMAN RESOURCES	32
DEVELOPMENT AND ECONOMY	33
DESCRIPTIVE PUBLICATIONS	36
PROBLEMS, NEEDS AND OPPORTUNITIES	41
WATER LEVELS, PUMPAGE, AND RAIN -	
A DYNAMIC SYSTEM	41
HIGH GROUNDWATER LEVELS CAUSE	
PROBLEMS	45
DAMAGED AREAS AND MAGNITUDE OF	
DAMAGE	45
PUBLIC PERCEPTION OF PROBLEMS AND NEEDS	48
PLANNING CONSTRAINTS	50
PLANNING OBJECTIVES	51

DESCRIPTION

PAGE NO.

FORMULATION OF PRELIMINARY PLANS

MANAGEMENT MEASURES	52
MEASURES	52
A GROUNDWATER PLANNING MAP	55
PLAN FORMULATION RATIONALE	59
PLANS OF OTHERS	60
ANALYSIS OF PLANS CONSIDERED IN PRELIMINARY	
PLANNING (STAGE I)	61
COMPARATIVE ASSESSMENT AND EVALUATION OF PLANS	65
THE PROS AND CONS	65
MORE COMMENTS ABOUT DISADVANTAGES	67
CONCLUSIONS (SCREENING)	68

PROCEDURES AND REQUIREMENTS FOR FURTHER STUDY

ECONOMIC STUDIES	69
ENVIRONMENTAL STUDIES	72
ENGINEERING STUDIES	72
DESIGN AND COST ESTIMATES	73
GEOLOGY AND SOILS	73
GROUNDWATER LEVEL ANALYSIS	74
GROUNDWATER QUALITY ANALYSIS	74
HYDROLOGY AND HYDRAULICS	75
RECREATION STUDIES	76
CONSTRAINTS AND CONTROLS	76
PUBLIC INVOLVEMENT	76
STUDY SCHEDULE	79
STUDY COST	80

RECOMMENDATIONS

APPENDIX - PUBLIC VIEWS AND RESPONSES

LIST OF FIGURES

<u>NO.</u>	<u>TITLE</u>
1	Regional Study Area
2	Vicinity Map - American Bottoms
3	Map of the American Bottoms
4	Overlap of Two Studies
5	General Soil Groups
6	Landform Regions of the American Bottoms
7	Lakes and Former Lakes
8	Normal Groundwater Flow in American Bottoms
9	Groundwater Flow to a Pumped Well
10	Induced Infiltration
11	Perched Water Table and Pumping
12	Flood Conditions
13	Shallow Groundwater Area, 1956
14	Shallow Groundwater Areas, 1973
15	Groundwater Change Map
16	Sewer Damage
17	Groundwater Planning Map
18	Pumping Alternative (1 year)
19	Pumping Alternative (5 year)
20	Line Collector Alternative (1 year)
21	Line Collector Alternative (5 year)
22	Reduced Infiltration Alternative (1 year)
23	Reduced Infiltration Alternative (5 year)
24	Study Activities

INTRODUCTION

The American Bottoms Groundwater Study is an outgrowth of the St. Louis Metropolitan Area, Missouri and Illinois, Study (Metro Study). The Metro Study provided a comprehensive overview of water resources for four counties plus the city of St. Louis in Missouri and three counties in Illinois (FIGURE 1). The American Bottoms Area (FIGURE 2) with its groundwater problem was identified as one of the significant areas for detailed study.

The American Bottoms Groundwater Study will be conducted in three stages: reconnaissance, development of intermediate plans, and development of detailed plans. Within each stage, four planning tasks will be accomplished: problem identification, formulation of alternative, impact assessment and evaluation. During Stage I, the emphasis is on problem identification. This Reconnaissance Report is the Stage I planning document. It presents the study objectives, addresses the methods of public participation in the planning process, identifies the study area, and describes available data. Estimates of the time and cost required to complete the study and a schedule of major milestones are also provided.

This first major segment of the Reconnaissance Report presents information on the study authority, the scope of the study, study participants and coordination, the studies of others and finally the process to be used in completing this study.

STUDY AUTHORITY

The primary purpose of the Corps of Engineers' American Bottoms water resources planning is to develop, in conjunction with the public, practical action plans which offer realistic prospects for solving specific water resources problems with emphasis upon groundwater flooding. A secondary purpose is to develop plans which have the potential to serve as a catalyst for solving other related urban and suburban water resource related problems.

This Reconnaissance Report is the first of a number of reports that will result from the American Bottoms water resources management authorization study stemming from the St. Louis Metropolitan Area, Missouri and Illinois, Study authority. The goals of the overall study are: (1) to identify present and future water and related land resource problems and opportunities in the city of East St. Louis and surrounding Mississippi River floodplain area, Illinois; (2) to formulate alternative comprehensive plans that will solve the problems and capitalize on the opportunities; (3) to select and provide for the implementation of sound water and related land resources plan that is consistent with local, state, and Federal objectives and authorities; and (4) to focus primary attention upon solving the flood related problems identified by the parent St. Louis Metro Area Study as being high priority. The final recommended plan should be the one that the public agrees is best for the area.

As this study stems from the St. Louis District, Corps of Engineers' more comprehensive water resources regional report entitled the "St. Louis Metropolitan Area, Missouri and Illinois, Study" (Metro Study), it represents only a partial response to the following resolutions:

COPY

**89th Congress
2nd Session**

**United States Senate
Committee on Public Works**

COMMITTEE RESOLUTION

RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE UNITED STATES SENATE, That the Board of Engineers of Rivers and Harbors, created under Section 3 of the River and Harbor Act approved June 13, 1902, be, and is hereby requested to review the report of the Chief of Engineers on the Mississippi River at St. Louis, Missouri, published as Senate Document Numbered 57, Eighty-fourth Congress, and other pertinent reports, with a view to determining whether any modifications of the recommendations contained therein are desirable at this time, with particular reference to providing improvements in the interest of flood control on tributary streams within the Metropolitan St. Louis Sewer District, St. Louis and vicinity, Missouri.

Adopted: October 4, 1966.

/S/

JENNINGS RANDOLPH

Chairman

(At the request of Senators Stuart Symington and Edward V. Long of Missouri.)

Copy

91st Congress
2nd Session

United States Senate
Committee on Public Works

COMMITTEE RESOLUTION

RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE UNITED STATES SENATE, That the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act approved June 13, 1902, be, and is hereby requested to review the report of the Chief of Engineers on the Mississippi River at St. Louis, Missouri, published as Senate Document Numbered 57, Eighty-fourth Congress, and other pertinent reports, with a view to determining whether any modifications of the recommendations contained therein are desirable at this time, with particular reference to providing improvements in the interest of flood control and other water and related land resource purposes, on tributary streams within the Metropolitan St. Louis Sewer District, St. Louis and vicinity, Missouri.

Adopted: July 15, 1970

/S/

JENNINGS RANDOLPH

Chairman

(At the request of Senators Stuart Symington and Thomas F. Eagleton of Missouri)

Copy

Committee on Public Works
U. S. HOUSE OF REPRESENTATIVES
Washington, D. C. 20515

Resolved by the Committee on Public Works of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act approved June 13, 1902, be, and is hereby requested to review the report of the Chief of Engineers on the Mississippi River at St. Louis, Missouri, published as Senate Document Numbered 57, Eighty-fourth Congress, and other pertinent reports, with a view to determining whether any modification of the recommendations contained therein are desirable at this time, with particular reference to providing a plan for the development, utilization and conservation of water and related land resources of St. Louis County and the City of St. Louis, Missouri including, but not limited to, consideration of the needs for flood control, wise use of flood plains lands, waste water management facilities regional water supply, water quality control, recreation fish and wildlife conservation, and other measures for enhancement and protection of the environment on streams tributary to the Meramec, Missouri, and Mississippi Rivers.

Adopted July 29, 1971

Attest: /S/ John A. Blatnik

Requested by: Hon. Ichord, Hon. Symington, Hon. Hungate

Copy

92nd Congress
2nd Session

United States Senate
Committee on Public Works

COMMITTEE RESOLUTION

RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE UNITED STATES SENATE, That the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act approved June 13, 1902, be, and is hereby requested to review the report of the Chief of Engineers on the Mississippi River between Coon Rapids Dam and the mouth of the Ohio River, published as House Document Numbered 669, Seventy-sixth Congress, third session, and other pertinent reports, with a view to determining whether any modification of the recommendations contained therein are desirable at this time, with particular reference to providing a plan for the development, utilization and conservation of water and related land resources of the metropolitan area of St. Louis, Missouri, with due consideration for the metropolitan planning activities in the area consisting of Franklin, Jefferson, St. Charles, and St. Louis Counties and the City of St. Louis in Missouri, and Madison, Monroe, and St. Clair Counties in Illinois. Such study to include, but not be limited to, consideration of the needs for flood control, wise use of flood plain lands, waste water management facilities, including storm water runoff, regional water supply, water quality control, recreation, fish and wildlife conservation, protection and enhancement of aesthetic qualities, and other measures for enhancement and protection of the environment on streams in the metropolitan area. Investigation to be conducted in cooperation with the East-West Gateway Coordinating Council, the States of Missouri and Illinois, local governmental entities, and other interested Federal, State and local agencies as appropriate.

Adopted: October 2, 1972 /S/

Jennings Randolph Chairman

(At the request of Senators Symington and Eagleton of Missouri and Senators Percy and Stevenson of Illinois)

Copy

Committee on Public Works
U. S. HOUSE OF REPRESENTATIVES
Washington, D. C. 20515

Resolved by the Committee on Public Works of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors is hereby requested to review the reports of the Chief of Engineers on the Mississippi River between Coon Rapids Dam and the mouth of the Ohio River, published as House Document Numbered 669, 76th Congress, 3rd Session, and other pertinent reports, with a view to determining whether any modifications to the recommendations contained therein are desirable at this time, with particular reference to providing a plan for the development, utilization, and conservation of water and related land resources of the metropolitan area of Saint Louis, Missouri, with due consideration for the metropolitan planning activities in the area consistig of Franklin, Jefferson, St. Charles, and St. Louis Counties and the City of Saint Louis in Missouri, and Madison, Monroe, and St. Clair Counties in Illinois. Such a study to include, but not be limited to, consideration of the needs for flood control, wise use of flood plain lands, wastewater management facilities, including storm water runoff, regional water supply, water quality control, recreation, fish and wildlife conservation, protection and enhancement of aesthetic qualities, and other measures for the enhancement and protection of the environment on streams in the metropolitan area. Investigation to be conducted in cooperation with the East-West Gateway Coordinating Council, the States of Missouri and Illinois, local governmental entities, and other interested Federal, State, and local agencies as appropriate.

Adopted October 12, 1972

Attest:

/S/

John A. Blatnik, M.C.
Chairman

Requested by: Hon. Melvin Price

Copy

89th Congress
2nd Session

United States Senate
Committee on Public Works

COMMITTEE RESOLUTION

RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE UNITED STATES SENATE, That the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act approved June 13, 1902, be, and is hereby requested to review the report of the Chief of Engineers on the Mississippi River at St. Louis, Missouri, published as Senate Document Numbered 57, Eighty-fourth Congress, and other pertinent reports, with a view to determining whether any modifications of the recommendations contained therein are advisable at this time, with particular reference to providing improvements in the interest of flood control, and other allied purposes, in the Columbia Bottoms area at the confluence of the Missouri-Mississippi Rivers.

Adopted: April 7, 1966

/S/ _____
PAT. McNAMARA, U.S.S., Chairman

(At the request of Senators Stuart Symington and Edward V. Long of Missouri.

SCOPE OF THE STUDY

This report addresses the entire area within the boundaries of the American Bottoms. The name "American Bottoms," as used herein, refers to the Illinois side of the Mississippi River floodplain between Alton and Dupo, Illinois. A map of the area is shown in FIGURE 3. The area comprises about 175 square miles, is approximately 30 miles long, and has a maximum width of 11 miles. Portions of Madison and St. Clair Counties and a small corner of Monroe County are included in the Bottoms. The principal cities are East St. Louis, Granite City, Wood River, and Alton.

STUDY PARTICIPANTS AND COORDINATION

The overall responsibility for this study belongs to the Corps of Engineers. However, to insure full participation and coordination during the course of this study, many other agencies and interest groups will be participating.

The Federal agencies most actively participating in the American Bottoms planning process include the Fish and Wildlife Service, the Corps of Engineers and the Environmental Protection Agency. The Illinois Department of Transportation, Division of Water Resources, the Illinois Water Survey and the Illinois Department of Conservation have taken an active role in this study. On the local level, the principal contributors to the study are the East-West Gateway Coordinating Council, the Southwestern Illinois Metropolitan and Regional Planning Commission, the Metro-East Sanitary District, the city of Granite City, and the city of East St. Louis.

Coordination will continue in general with a substantial list of additional Federal, state, county, local and individual citizens for this study. They will be informed of all major developments through public information fact sheets and through notices of all public meetings and workshops. Over one thousand agencies and citizens are included on the general mailing list.

In addition to general coordination, the following list of agencies and citizens will be asked to review all planning documents, including this draft Reconnaissance Report.

**Division Engineer
Engineering Division
Lower Mississippi Valley
Corps of Engineers**

**Chairman
Council on Environmental Quality**

**Chief, River Basin Planning Branch
USDA Soil Conservation Service**

**State Conservationist
Soil Conservation Service
U. S. Department of Agriculture**

**Department of Health, Education and Welfare
Office of the Chief Engineer, DHS**

**Regional Administrator
U. S. Department of Housing and Urban Development
Region V**

**Secretary of the Interior
Department of Interior**

**Regional Director (LWR)
U. S. Fish and Wildlife Service**

**Regional Hydrologist, WRD, NR
U. S. Geological Survey**

**District Chief, WRD
U. S. Geological Survey**

**Administrator
Environmental Protection Agency**

U. S. Fish and Wildlife Service

Chairman, Upper Mississippi Basin Commission

Director, Water Resource Council

**Illinois Department of Transportation
Division of Water Resources
Southern Projects Manager**

**Illinois Department of Transportation
District 8**

**Horseshoe Lake Conservation Committee
Illinois Department of Conservation**

Illinois State Clearinghouse

Director, Illinois Department of Transportation

**Illinois Department of Transportation
Division of Water Resources**

Director, Illinois Environmental Protection Agency

Director, Illinois Department of Agriculture

Director, Illinois Department of Conservation

**Southwest Chapter
Illinois Audubon Society**

**Illinois Audubon Society
Chairman, Southern Regional Conservation Commission**

Director, Illinois Wildlife Federation

President Illinois Division Izaak Walton

Secretary, Tri-Cities Area Chamber of Commerce

Mayor of Alorton

Mayor of Alton

Mayor of Belleville

Mayor of Caseyville

Mayor of Centerville

Mayor of Collinsville

Mayor of Dupon

Mayor of East Carondelet

Mayor of East St. Louis
Mayor of East Alton
Mayor of Granite City
Mayor of Hartford
Mayor of Pontoon Beach
Mayor of Roxana
Mayor of Sauget
Mayor of Venice
Mayor of Washington Park
Mayor of Wood River
County Administrator, Madison County
Supervisor, Collinsville Township
Supervisor, Edwardsville Township
Supervisor, Nameoki Township
Supervisor, Chouteau Township
Supervisor, Venice Township
County Clerk, Monroe County Courthouse
City Engineer, Granite City, Illinois
Executive Director
E.W.G.C.C.
Director, Madison County Planning
Executive Director, SIMPAC
Director, St. Clair County Planning Commission
President, Board of Commissioners
Canteen Creek Drainage District

Chairperson

Board of Commissioners

Chouteau, Nameoki and Venice Drainage and Levee District

Clerk, Metro-East Sanitary District

STUDIES OF OTHERS

NON-CORPS STUDIES

The Illinois Water Survey has been actively studying groundwater problems in the American Bottoms area for longer than 50 years. Initially, their studies revolved around the problem of insuring sufficient groundwater supplies to meet increasing demand and usage. Recently, their studies have considered the problems of high groundwater levels and groundwater quality. However, it should be noted that the area of emphasis of their studies is on data collection, not analysis. They collect information on the groundwater levels and on groundwater quality, but they have not specifically developed plans of improvement to resolve the groundwater problems.

A listing of reports prepared by the Illinois Water Survey is contained in the section DESCRIPTIVE PUBLICATIONS which is located at the end of the section titled EXISTING CONDITION (PROFILE).

OTHER CORPS STUDIES

The East St. Louis and Vicinity, Illinois Interior Flood Control (IFC) Project significantly overlaps the geographic of this study (FIGURE 4). This reformulated post-authorization study is currently addressing surface water alternative solutions (Stage II). A substantial amount of data developed for the surface water project, such as two-foot contour maps and environmental inventory, will be used by this groundwater study. To insure duplication does not occur between these studies, the study manager and several members of the interdisciplinary planning team are the same for both studies.

The Wood River Drainage and Levee District letter report, a negative report, will provide useful data for that portion of the study area. Also, the Looks and Dam No. 26 Replacement Studies will have an effect, but only in the Alton area.

THE REPORT AND STUDY PROCESS

THE REPORT

This Stage I document, Reconnaissance Report, identifies the results of the first major phase of the multi-objective planning process. This report serves as the primary management tool and an informational aid for the conduct of the study, and indicates the need for further study. With the completion of the next stage, Development of Intermediate Plans, the Stage II document will be prepared. Again, a decision will be made to stop or continue and complete the study. If the recommendation is to complete the study, then at the end of Stage III, the Development of Detailed Plans, the Stage III report will be prepared.

STUDY PROCESS

The multi-objective planning framework as described in the ER 1105-2-200 series provides guidance for conducting feasibility studies for water and related land resources consistent with the planning requirements of the WRC Principles and Standards (P&S), the National Environmental Policy Act of the 1969 (NEPA) and related policies. The process establishes a methodology under which alternative plans are formulated and the resulting economic, social, and environmental impacts are assessed and evaluated. The American Bottoms Groundwater Study is being conducted under this guidance.

P&S requires that Federal water and related land planning be directed to achieve National Economic Development (NED) and Environmental Quality (EQ) as equal national objectives. NED is to be achieved by increasing the value of the nation's output of goods and services and improving national economic efficiency; EQ is to be

achieved by the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems. P&S also requires that the impact of a proposed action be displayed and accounted for in terms of contributions to four accounts. The four accounts are: National Economic Development, Environmental Quality, Regional Development, and Social Well Being.

To accomplish the goals and objectives of the multi-objective planning framework, the study process is divided into three sequential stages. The three stages are: Reconnaissance, Development of Intermediate Plans, and Development of Detailed Plans. Within each of these three stages, four planning tasks will be carried out. The four planning tasks that will be performed are: Problem Identification, Formulation of Alternatives, Impact Assessment, and Evaluation. It should be noted that while each of the four tasks is carried out in each stage, there is different emphasis placed on each task in each stage. For instance, during Stage I the major emphasis is on Problem Identification (Task 1). There is effort on formulation of alternatives and impact assessment and evaluation, but the major effort is on Task 1. During Stage II the emphasis changes such that there is less emphasis on problem identification, but major emphasis on formulation of alternatives and associated impact assessment and evaluation. During Stage III the Development of Detailed Plans, the alternatives carried forward from Stage II are refined and detailed but the major emphasis is on impact assessment and evaluation leading toward plan selection and recommendation.

PROBLEM IDENTIFICATION

This second major section of the American Bottoms Groundwater Study Reconnaissance Report presents information on problem identification in the study area. An existing condition profile, discussion of conditions if no Federal action were taken (without condition profile), and a discussion of problems and needs and opportunities follow.

The culmination of this section is the development of the planning objectives. These objectives are developed based on information obtained from technical analyses and from public involvement activities.

NATIONAL OBJECTIVES

As discussed in the previous section titled THE REPORT AND STUDY PROCESS, this study is accomplished following the guidance of the Water Resource Council's Principles and Standards (P&S). This guidance is presented as the ER 1105-2-200 series titled PLANNING PROCESS: MULTI-OBJECTIVE PLANNING FRAMEWORK.

The P&S require that Federal water and related land planning be directed to achieve National Economic Development (NED) and Environmental Quality (EQ) as equal national objectives. NED is to be achieved by increasing the value of the nation's output of goods and services and improving national economic efficiency. EQ is to be achieved by the management, conservation, preservation, creation, restoration or improvement of the quality of certain natural and cultural resources and ecological systems. Specifically, NED is evaluated using the benefit-cost analysis and EQ is evaluated using the System of Accounts.

In addition to the two national objectives stated, P&S require that all impacts of proposed action be measured and the results displayed in terms of contributions to four accounts: National Economic Development, Environmental Quality, Regional Development (RD) and Social Well-Being (SWB). The NED and EQ accounts have already been discussed. Contributions to the RD accounts are determined by establishing a proposal's effects on the region's income, employment, population, economic base, environment and social development. Contributions to the SWB account are determined by establishing a proposal's effects on the real income, security of life, health and safety, education, cultural and recreational opportunities, emergency preparedness and other factors.

EXISTING CONDITION (PROFILE) AND CONDITIONS
IF NO FEDERAL ACTION WERE TAKEN

NATURAL RESOURCES

The American Bottoms refers to the Illinois side of the Mississippi River floodplain between Alton and Dupon, Illinois. The area comprises about 175 square miles, is approximately 30 miles long, with a maximum width of 11 miles. Portions of Madison and St. Clair Counties and a small corner of Monroe County are included in the American Bottoms. The principal cities are East St. Louis, Granite City, Wood River, and Alton.

Climate- The St. Louis region's climate is temperate and humid. The mean annual temperature is 56 degrees Fahrenheit, and the average annual amount of precipitation is 35.4 inches. Snowfall accumulation is usually 16 to 17 inches per year. The mid-day relative humidity is between 50 and 60 percent in the summer and about 55 to 65 percent in the winter.

Because of the region's geographic location, rapid weather changes are common due to the interaction of continental polar and maritime tropical air masses. The prevailing winds for most of the year are southerly. The major exception is during the winter when northwesterly winds prevail.

The metropolitan area is located in what is commonly referred to as "tornado alley." Consequently, wind velocities have reached 80 to 90 miles per hour. Generally, the winds range from 10 to 15 miles per hour. Besides tornadoes, other major weather disturbances are thunderstorms and hailstorms.

During any given year, the region can expect to have clear to partly cloudy days over 66 percent of the time. In the winter, skies are overcast about 40 percent of the time.

TABLE 1 presents a summary of climatic data for the St. Louis Metropolitan area.

Geology- A detailed study of the geology of the American Bottoms, with considerable emphasis on the materials above bedrock, was done by Bergstrom and Walker (1956). The American Bottoms is situated over a bedrock valley averaging about 120 feet below ground level. This valley has been filled by sands, gravels, silts, and clays. Because of variations in the bedrock surface and ground elevations, the thickness of the valley fill ranges from a featheredge near the bluffs and the Chain of Rocks area of the Mississippi River to more than 170 feet near Wood River. The valley fill is composed both of glacial materials deposited by melt waters from the Ice Ages, and recent alluvium deposited by the Mississippi River during floods in post-glacial times. Generally, the glacial materials consist of sand and gravel, and are found near the bottom of the valley fill; whereas the alluvium may be gravel, sand, silt, and/or clay and is in the upper part of the fill. This discussion is general, and the actual composition of the deposits is very complex and erratic. Glacial and alluvial materials cannot always be distinguished with certainty. Although levees now protect the area from Mississippi River flooding, interior watersheds continue to erode and redeposit materials, changing the surficial soils. Actions of man, such as artificial drainage changes, likewise alter surface materials. Some of the areas having the poorest foundation conditions were in fact lake bottoms less than 100 years ago.

CLIMATIC DATA FOR ST. LOUIS AREA

	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Annual Total or Average</u>
Clear Days*	11	9	10	11	11	12	13	14	15	15	12	10	143
Partly Cloudy Days*	9	7	10	10	12	12	13	12	9	9	8	9	120
Cloudy Days*	11	12	11	9	8	6	5	5	6	7	10	12	102
Mean Max. Temperatures	40	43	53	65	75	83	88	96	78	68	54	43-	65
Mean Min. Temperatures	24	26	36	47	57	66	71	69	62	50	38	28-	48
Mean Temperatures	32	35	45	56	66	75	80	78	70	59	46	36-	56
Days Over 90 Degrees*	0	0	0	0	1	6	12	10	4	0	0	0	33
Days Under 32 Degrees*	26	23	16	3	0	0	0	0	0	2	13	23	106
Mean Precipitation	2.0	2.0	3.1	3.7	3.7	4.3	3.3	3.0	2.8	2.9	2.6	2.0-	35.4
Snowfall in Inches*	4.2	3.9	4.6	.3	T**	.0	.0	.0	.0	T**	1.1	3.0	17.1
Mean Wind Speed	13	13	14	13	12	11	9	9	10	11	13	12	12
Mean Wind Direction	NW	NW	WNW	WNW	S	S	S	S	S	S	S	WNW	S

* Average Number

** Trace

The highly variable soils have been discussed to some extent in the preceeding paragraphs. Much general soils information is already available. Surficial soil mapping is performed by the United States Department of Agriculture, Soil Conservation Service (SCS) in cooperation with a local sponsor, in this case, the Madison County Board. General soil maps have been published for Madison County, while detailed soils mapping has been completed and has been partially published for St. Clair County. Soils of similar profile composition are assigned a soil series name, and series that tend to occur in definite groups are termed soil associations. Detailed soil surveys involve large scale mapping at the series level.

FIGURE 5 illustrates the distribution of three very general soil groups that have been differentiated for this study. The first group, shown in blue, consists of soil associations in which most of the soils series have seasonally high water tables. This is due to clay layers near the surface that restrict downward movement of water to a rate less than that at which it accumulates from rainfall. This condition causes a perched water table which is discussed in more detail in subsequent paragraphs. Much of the soils in the Lake Region and nearly all in the Aggraded Cut and Fill Region fall into this category. The second group, shown in brown, consists of soil associations in which some, but less than half, of the land consists of soil series having seasonally high water tables. The Ridge and Swale Region and the East St. Louis Rise typify these conditions. The third group, shown in yellow, has very sandy, well drained soils and is found only in the Terrace Region.

Topography- As a typical floodplain, the American Bottoms is nearly flat. Overall relief is in the range of 40 to 50 feet. Maximum elevations are about 445 feet above mean sea level (msl) near the riverbank, creek banks, and low swales in the southern part

of the area. An early report by Bowman and Reeds (1907) stated that only 10 percent of the area was more than 5 feet above flood stage. The area is protected from Mississippi River flooding by federally constructed levees. Although the American Bottoms has previously been described as a nearly flat floodplain, significant variations in topography, related to the varying depositional history, occur. Yarbrough and Chiste (1972) categorized the area into seven landform regions. These regions are shown in FIGURE 6.

(1) The Terrace Region- The Terrace Section lies in the northern section of the floodplain above the confluence of the Missouri River. It is the only area where the original glacial sand deposits (Henry Formation) extend to the surface. It is 10 to 15 feet higher than the immediately adjacent bottomlands and has very sandy, permeable soils. Portions of East Alton, Wood River, and Roxana occupy the Terrace Region.

(2) The Ridge and Swale Region- This region lies adjacent to the river, and is associated with the most recent out and fill action by the river. In the past, this was a region of swampy, partially filled watercourses, active sloughs, natural levees, and sand bars. Today, the old chutes have been filled and the islands are part of the mainland. Soils in this region are typically variable; usually sandy soils occur in the ridges, and soft, weak clay occur in the swales. Major development in this region includes portions of Cahokia, Madison, and Granite City.

(3) The East St. Louis Rise- This region is a topographic high, although not as high as the Terrace Region, consisting in part of an old alluvial fan, or soil deposits washed onto the floodplain from the bluffs. East St. Louis occupies this region which has the largest population of any physical region in the American Bottoms.

(4) The Lake Region- This is an area of recent oxbow, old river bends subsequently cut off by natural river changes, and dried up by drainage projects, filling, and groundwater pumping, leaving Horseshore Lake as the only major remaining water body. Soils in these dried-up lake areas are frequently soft, weak, poorly drained clays, although some sandy ridges occur. These ridges in turn may be underlain by the clays. No major cities are located in the lake region and poor soil conditions were apparently an important factor. As areas with better soils become fully developed, new development is beginning to encroach on the Lake Region.

(5) The Tributary Meander- This region consists of the areas in which Wood River and Cahokia Creeks cut through and meandered about the floodplain enroute to the Mississippi River. During man's development of the American Bottoms, these streams were rerouted into dug channels to reduce flooding, leaving a topographic low area that has surface ponding problems.

(6) The Alluvial Fan Region- This area paralleling the bluff consists of relatively high deposits of reworked loess carried down from the hills by small creeks. The town of Caseyville is situated in this region.

(7) The Aggraded Cut and Fill Region- This region is the most level in the American Bottoms because it has been covered by clay sediments during flooding of Long Lake and Cahokia Creek. The area suffers from internal ponding, a high water table, and clay soils that shrink and swell. The area is primarily agricultural.

Drainage- At the present time, water which enters the area is removed by gravity flow except when the outlets are blocked. The East Side Levee and Sanitary District maintains approximately 52-1/2

miles of drainage ditches and channels. In addition, there are approximately 14 miles of storm sewer systems serving the various cities and industrial plane areas. The project area may be divided into six principal drainage systems, each of which has one or more pumping stations at the gravity outlets which operate during periods of blocked drainage. The flow in Prairie du Pont Creek, which is confined between flank levees, has high hydraulic gradient which has a direct effect upon the operation of adjacent gravity and pumping facilities.

Cahokia Canal- The principal channel originates in the northwestern part of the area as County Ditch and continues in a southerly direction to the New York Central Railroad. From this point, the creek channel has been improved and enlarged, and is designated as Cahokia Canal. It flows in a southwesterly direction, continuing through the city of East St. Louis, and enters the Mississippi River at the North Pumping Station. The principal tributary streams from the hillside areas, listed from north to south, are Judys Branch, Burdick Branch, School House Branch, and Canteen Creek. Surface runoff from the bottom lands also enters Horseshoe, McDonough, and Long Lakes, as well as several sloughs and other low areas. These provide detention which decreases the requirements of the principal channels and the pumping station. The total tributary areas includes 43,841 acres of bottom land and 31,492 acres of hill land.

Harding Ditch- Harding Ditch, which drains the eastern part of the project area, originates in the vicinity of the village of Caseyville where Little Canteen Creek emerges from the hill land. This ditch extends in a southerly direction to Prairie du Pont Creek which it enters about 25,000 feet east of the Mississippi River where the South Pumping Station is located. Principal tributaries

include Schoenberger Creek, Goose Lake Ditch, and Blue Waters Ditch. The area includes 20,192 acres of bottom land and 15,403 acres of hill land.

Canal No. 1- A large drainage channel, designated as Canal No. 1, has been constructed in the southern part of the project area. It lies east of and parallel to Harding Ditch from its confluence with Prairie du Pont Creek to the New York Central Railroad. Plans were prepared for extending this canal northeast to intercept additional hillside runoff, but this construction has not been accomplished. The principal channel from the hillside is Powdermill Creek. This canal provides drainage for 826 acres of bottom land and 3,220 acres of hill land. Canal No. 1 Pumping Station is located at Prairie du Pont Creek.

Chouteau Slough- Facilities for drainage include a number of ditches and improved channels with two gravity outlets into the Chain of Rocks Canal below the locks. One of these is the 108-inch outlet operated in connection with the Granite City Pumping Station. Water ponds in Chouteau Slough, Long Lake, and several other small low-lying areas. Runoff and seepage are removed during periods of blocked drainage by the Chouteau, Nameoki, and Venice Pumping Station located along the Chain of Rocks levee. The drainage area contains 7,181 acres of bottom land. This area is so far removed from the bluffs that it is not affected by hill runoff.

Upper urban area- This area lies east of the riverfront levee and includes portions of Granite City, Madison, Venice, and East St. Louis. Drainage facilities include a number of open ditches and channels and storm sewers in the various municipalities and industrial areas. Gravity outlets provide drainage during low water

periods. The Venice, Madison, Granite City, and Granite City Engineer Depot Pumping stations remove runoff and seepage when the outlets are blocked. This area lies such a distance from the bluffs that it is not affected by hillside runoff.

Lower urban area- This area lies below the Cahokia Canal outlet and includes the major portion of the cities of East St. Louis and Monsanto and a portion of the village of Cahokia. Drainage facilities include open channels, as well as storm sewers in the various municipalities and industrial areas. Drainage is provided by a number of gravity outlets during low river stages. The East St. Louis, Monsanto, and Cahokia Pumping Stations take care of runoff during high river stages. The area is so located that it is not affected by hillside runoff.

Hillside runoff- Water from the various hill creeks and ditches enters the bottom lands at high velocity and flows into the drainage systems served by Cahokia Canal, Harding Ditch, and Canal No. 1. Tributary channels are not adequate to carry the runoff after it enters the bottom lands and the levees and/or spoil banks are overtopped. The overflow then floods adjacent low areas.

Lakes- The American Bottoms contained a number of natural lakes well into the first part of this century. As previously mentioned, Horseshoe Lake is the only major lake remaining. The other lakes have been artificially drained, ditched, etc., or dried out by groundwater pumping. Since clays deposited in these lake bottoms in modern geologic times would increase the likelihood of perched water tables, their locations were investigated. FIGURE 7 shows the location of these old lakebeds. The most prominent were Pittsburg Lake, of which remnants are located in Frank Holten State Park, and Goose Lake, now an agricultural area near the Bi-States-Parks Airport.

Groundwater- Groundwater is water in the ground and below its surface. While the foregoing definition may appear oversimplified, it serves to emphasize that groundwater, contrary to some popular beliefs, is not similar to surface water. Precipitation, oceans, water vapor in the air, and groundwater, however, are all a part of the hydrologic cycle. Precipitation either runs off the surface into streams and lakes or soaks into the ground by percolating or infiltrating, becoming groundwater. It eventually will return to some surface body of water or is evaporated into the atmosphere. Evaporated ocean water eventually becomes precipitation, starting the process over. Groundwater occupies the voids or pore spaces in permeable soils or rocks; and since most soils and rocks have some permeability and porosity, groundwater is found at some depth and quantity at most locations. The top surface of the groundwater is the water table, which is frequently found near or slightly above the level of adjacent streams or lakes. Groundwater should be viewed as a more or less continuous system and not occurring in veins or underground rivers. Aquifers exist in those geologic formations that contain water in quantities.

The alluvial and glacial valley fills of sand and gravels described earlier contain the American Bottoms aquifer. The levels, quantities of water, and direction of movement have been studied in detail over a long period of time by the Illinois State Water Survey. The results have been published in a number of reports. Most of the water naturally flowing into the aquifer comes from precipitation falling directly on the American Bottoms. About one-fifth of the water comes from groundwater and runoff flowing from the bluffs. The groundwater then flows slowly west and percolates downward, exiting to the Mississippi River under normal circumstances. A generalized cross section view of groundwater flow in the American Bottoms is shown in FIGURE 8. This does not

represent any particular location, but is typical of most of the American Bottoms. In this figure, the vertical scale has been exaggerated to better show the prevailing conditions. The vertical dimensions represent about 120 feet, while the horizontal dimensions are about 10 miles. The water table rises during long periods of above average rainfall and/or river stages, and falls during long term dry spells.

When pumped wells are installed in the aquifer, groundwater is drawn down and toward the well forming a cone of depression which is an artificially lowered groundwater surface. The depth and extent of the cone of depression varies depending upon the quantity and duration of the pumping. A typical cross section of the American Bottoms has been redrawn in FIGURE 9 to illustrate the groundwater surface as affected by pumping. Where groundwater facilities are constructed "in the dry" over pumping cones, there is the possibility of these facilities being below the groundwater table if pumping is subsequently reduced. Where pumped wells are located sufficiently close to the river and pump a sufficient quantity of water, aquifer flow may be reversed and water pulled from the river. This is induced infiltration and occurs frequently in the American Bottoms. It is illustrated in FIGURE 10. This increases the total recharge, water flow to the aquifer, but adjacent water table levels are lowered because groundwater will flow down to the wells.

Clay layers near but below the surface may restrict downward percolation of the groundwater and result in locally high water tables even though water levels in the sand and gravel aquifer are lower. This condition produces perched water tables, as shown in FIGURE 11. In the American Bottoms, these conditions are frequently associated with old sloughs, lake bottoms, swales, marsh areas, etc.

Prior to construction of levees, major floods covered most of the American Bottoms, periodically bringing the groundwater table to the surface. While levees now prevent such landside flooding, high Mississippi river stages prevent flow of groundwater to the river, causing a water table rise until the river returns to a normal stage. Flood conditions are illustrated in FIGURE 12.

HUMAN RESOURCES

Those portions of Madison, St. Clair, and Monroe Counties which make up the American Bottoms study area had a population in 1970 of approximately 208,000. This number represents a one percent decrease over the estimated population of 210,299 derived from the 1960 census. This pattern of decrease, however, is not consistent over the entire study area as some communities have shown marked population decreases which were partially offset by increases elsewhere.

In the study area, the white population accounted for about 68.3 percent of total population. Blacks comprised 31.4 percent of total population, while the remainder (.3 percent) was made up of other races. The state of Illinois, in comparison, has a white population which was 86 percent of total population and a black population of 13 percent with the rest being made up of other races.

The table below compares social indicators of the study area with those for the state of Illinois. In general, residents of the American Bottoms study area had a standard of living roughly comparable to that for Illinois. The study area figure for level unemployment, however, deviates substantially from that for the state. Fewer employment opportunities cause job seekers to go to other areas to find employment, while at the same time discouraging people from moving into the area. This factor may explain why the study area population has grown so slowly.

Social Indicators

	American Bottoms Study Area	Illinois
Median Family Income	\$ 10,310	\$ 10,959
Percent of Families Below Poverty Level	8.27%	7.7%
Percent of Population Below Poverty Level	9.80%	10.20%
Unemployment Rate	5.45%	3.70%

According to the Office of Business Economics - Economic Research Service (OBERS) series "E" projections, the study area should have a population of approximately 271,170 in the year 2020. This population increase represents a compounded growth rate of only .53 percent over the 1970 - 2020 time period.

DEVELOPMENT AND ECONOMY

General Economy. The study area is a major contributor to the economies of Missouri, Illinois and the United States. Much trade, commerce, and industry is conducted here due largely to the central location of the area in regard to the nation as a whole and also to the transportation network found here. Because of the many railroads in the area and because of the availability of large shipping on the Mississippi River system, the study area possesses advantages in transporting products rarely found elsewhere.

The study area is characterized by a diversity of industry with manufacturing being the single most important industry in the area. Agriculture, though still the predominant land use, has declined due to increased urbanization.

Land Use. The American Bottoms study area has a total area of approximately 112,000 acres, much of which is highly urbanized. The predominant land use is cropland and accounts for 53 percent of total acreage. Residential development is the second largest land use with 19 percent of the total. Approximately 11 percent of the land is in natural vegetation. Developed open spaces make up 6.7 percent of the study area. Industrial areas are 3.75 percent of total acreage with the remaining land space being made up of schools, churches, public buildings, commercial areas, railroads, highways, water bodies, mines and quarries.

The most probable future land use shows increasing industrialization, especially in the western portion of the study area along the Mississippi River. The percentage of residential area is also expected to increase, for the most part, in the eastern part of the area. This increased industrial and residential land use is expected to displace agricultural and undeveloped land.

Transportation. The American Bottoms study area is served by an extensive transportation network which includes navigation and ports, railroads, pipelines, highways and airports. The St. Louis Harbor is the site of the nation's largest inland port, thus making the St. Louis Metropolitan Area a center of commerce and transportation.

Although the study area has no commercial airport contained within its boundaries, the metropolitan area is served by Lambert

International Airport across the Mississippi River in St. Louis County. Numerous railroad lines also pass through the study area as East St. Louis is the focal point of an extensive railroad network that links that community and the rest of the American Bottoms region with the rest of the country. Completing the transportation picture are the roads and highways. Principal vehicular routes passing through the study area are Interstates 55/70, 64 and 270; Federal highways 40/66, 50 and 460; and state highways 3, 15, 111, 157 and 230.

Manufacturing. In the American Bottoms study area the most important single form of employment is in manufacturing. Approximately 35 percent of the labor force is involved in a manufacturing occupation compared to 25 percent for the nation as a whole. This points out the importance of manufacturing to the region. It also points out a problem in that manufacturing is very susceptible to fluctuations in the business cycle.

The most significant manufacturing activity in the area is in the primary metals industry. This is followed in descending order of importance by fabricated metal products, food and kindred products, chemicals, petroleum refining and numerous other types of manufacturing.

Agriculture. Less than one percent of the people employed in the area are involved in agriculture. This compares to 3.6 percent of the United States labor force involved in farming. This, of course, is due to the highly urbanized nature of the study area. Urban sprawl has taken up cropland and decreased the importance of agriculture for the area.

Decreased crop acreage is not the only change that has come to area agriculture. Economic necessity has forced the adoption of

new crop types and thus the conversion to more grain farming. In the past there was much truck farming in order to supply the metropolitan area with crops such as sweet corn, cabbage, tomatoes, horseradish, etc. Today, it is often cheaper to grow produce in other areas and ship it by fast moving means of transportation. This, together with higher rates of return on grain crops has caused farming in the area to shift to more grain production. Soybean - wheat double cropping has also increased the profitability of growing these grains.

Other Economic Indicators. The ability of local governments to raise revenue for projects and programs has an important effect on local economies. St. Clair and Madison Counties, in which most of the study area is contained, have demonstrated strong revenue raising capabilities. Revenues have increased substantially owing in large part to increased property taxes. Per capita property tax in Madison County increased from \$108 in 1962 to \$132 in 1967. In the same time period, per capita property tax for St. Clair County increased from \$91 to \$108.

Bank deposits give another indication of economic health. The ability of the local economy to make loans upon which investment decisions are made is largely dependent upon the amount in bank deposits. In Madison County, bank deposits increased from 254.7 million dollars in 1964 to 376.3 million in 1970. St. Clair County bank deposits increased from 346.4 million to 508.5 million for the same period.

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PROBLEMS, NEEDS AND OPPORTUNITIES

The American Bottoms Groundwater Study as indicated in the section titled STUDY AUTHORITY is an outgrowth of the St. Louis Metropolitan Area, Missouri and Illinois, Study. That study addressed all water resources problems in the St. Louis Metropolitan area. The results of the Metro Study, an overall water resources planning document, indicated several problem areas which required specific survey level detailed studies. The American Bottoms Groundwater area is one of these.

WATER LEVELS, PUMPAGE, AND RAIN - A DYNAMIC SYSTEM

General

Groundwater in the American Bottoms is a dynamic system, constantly changing in response to variations in rainfall, river levels, and pumpage. While small streams react quickly to individual rainstorms, the relatively slow process of water percolation down to the aquifer causes a much slower or sluggish groundwater response. Thus, groundwater levels vary primarily with seasonal and long-term variations in precipitation, pumpage, and river stages. Equilibrium - aquifer inflow equaling outflow and groundwater levels being stationary - is probably never reached. Where above average precipitation occurs for an extended period, groundwater levels rise. If pumpage exceeds average infiltration, groundwater levels will decline. The following sections summarize the major trends that have occurred since the turn of the century. Most of this information has been summarized from the several reports of the Illinois State Water Survey listed in the section DESCRIPTIVE PUBLICATIONS.

1900-1956

"Shallow wells indicate that the water level occurs normally from a few inches to a few feet below the surface . . ." (Bowman and Reeds, 1907).

The above quotation is taken from the comprehensive report on the water resources of the American Bottoms written shortly after the turn of the century. It is seen that the "high" groundwater levels of 1973 and 1974 are not new to the area but represent a returning to a condition existing prior to major development. Development of the East St. Louis area led to the construction of levees and drainage ditches. Bruin and Smith (1953) estimated the natural lake area had been reduced by more than 40 percent between 1907 and 1950 and that probably 40 miles of improved drainage ditches had been constructed during this period. They further estimated that these developments caused lowering of the groundwater levels by 2 to 12 feet. During the period, 1900 to 1956, groundwater pumpage, mostly industrial, increased steadily from 2.1 million gallons per day (mgd) to 111.0 mgd (Schicht and Jones, 1962). As a result of this pumping, water levels declined about 50 feet in the Monsanto area, 40 feet in the Wood River area, and 60 feet in the Granite City area. Because of alarming water level recessions and concern with depleted water supply, the Illinois State Water Survey accelerated its program of groundwater investigation in 1941. A prolonged drought occurred from 1952 to 1956 when rainfall at Edwardsville averaged about 34.3 inches per year, about 6.5 inches per year below normal. This drought further contributed to low groundwater levels, and the lowest groundwater levels on record occurred in 1956. Areas having shallow groundwater levels even during the drought are shown in FIGURE 13. These areas are generally low-lying, remote from pumping centers, and have

poor surface drainage. While groundwater levels were very low in the bottoms, underground construction was fairly simple and could be done "in the dry". Where such construction was not watertight and not designed and constructed for submerged conditions, it was susceptible to damage when groundwater levels rose.

1957 to 1961

Groundwater levels were so low in 1956 that the Granite City Steel Company abandoned its wells in 1957 and began obtaining its water from the Mississippi River (Schicht and Jones, 1962). As a result of this and other pumpage reductions, withdrawal (in the Granite City area) of groundwater dropped sharply from the peak of 31.6 mgd in 1954 to 7.6 mgd in 1958. From 1957 to 1961, groundwater levels in this area rose 50 feet. Overall pumpage in the American Bottoms declined from 111.0 mgd in 1956 to 93.0 mgd in 1960. Aside from the major rise in Granite City, the groundwater rise in the American Bottoms from 1956 to 1961 varied from 0 to 10 feet.

1962 to 1966

During this period, pumpage increased erratically from 99.4 to 108.1 mgd (Reitz, 1968). Pumpage was greatest in 1964 when 110.2 mgd was withdrawn. Pumpage in all major pumping centers except the Monsanto area showed an increase. Over most of the American Bottoms, groundwater levels declined from 0 to 5 feet.

During this period, the Illinois State Water Survey published a significant report, "Groundwater Development in the East St. Louis Area, Illinois" (Schicht, 1965), presenting the results of extensive mathematical and analog computer model investigations. This report includes extensive quantitative data. Recharge to the aquifer was computed for 1962 conditions:

	Total Flow
Recharge from precipitation	65 mgd
Subsurface flow from bluffs	12.8 mgd
Induced infiltration	48.2 mgd
TOTAL RECHARGE	126.0 mgd

The difference between the 126.0 mgd recharge and the estimated pumpage of 96.8 mgd represents the groundwater flow to the river.

1967 to 1971

Pumpage during this period steadily declined from 108.1 mgd in 1966 to 79.5 mgd in 1971 (Baker, 1972). The decrease in pumpage was attributed in the report to closing down of two large groundwater-using industries and to conservation measures being introduced by almost all industries. Pumpage in four or five major pumping centers declined, with the Monsanto area showing the largest decline. Pumpage in the Alton area remained nearly stable. High Mississippi River stages also occurred during this 5-year span; precipitation was near normal. The rise in groundwater levels over the period was 25 feet in the Monsanto area, 5 feet in the National City area, and 10 feet in the Granite City area. Remote from pumping centers, groundwater levels rose from 0 to 5 feet. Localized declines took place in the Alton and Wood River areas due to continuation of pumping and shifts in pumping centers.

1972 to 1976

Above-average precipitation and record long-duration high river stages (including the 1973 flood) and continued low pumping rates resulted in record high groundwater levels in the summer of 1973. A map of shallow groundwater areas in September 1973 was prepared and

is shown in FIGURE 14. While levels were even somewhat higher in June of 1973, the intent of this map is to show areas where shallow groundwater levels persisted for a considerable time. Pumping continued to decrease during this period. Based on preliminary data from selected wells, groundwater levels have declined somewhat in the past 2 years (1975-1976) but are still generally above 1971 levels. FIGURE 15 displays the change in water level between 1956 and 1973.

HIGH GROUNDWATER LEVELS CAUSE PROBLEMS

As early as 1961, rising groundwater levels reached some sewers built "in the dry" and some failure occurred. A number of failures occurred in 1969 as groundwater levels continued to rise and the Mississippi River exceeded flood stage. A major highway interchange requires a permanent pumping system, as groundwater levels exceed the road level in the underpass. Following the heavy rains and flooding of 1973, sewer failures were a major economic concern, inconvenience, and health danger in the American Bottoms. Flooding of basements and structural damage to homes are also discussed in news accounts of the high groundwater problem.

DAMAGED AREAS AND MAGNITUDE OF DAMAGE

Numerous cases of subsurface damage occurred to both public (sewers) and private (basements, etc.) subsurface facilities as groundwater levels rose, particularly in 1973. Sewer breaks were found to be good indicators of overall damage and damage susceptibility because (1) they are usually lower than basements and are damaged first, and (2) they are well documented. Sewer break locations were obtained from the files of several American Bottoms communities; a report by Bovay Engineers, Inc., for the Federal Disaster Assistance Administration; and records of sewer repairs by

the Corps of Engineers (acting as agent for the FDAA). The location of these sewer breaks is shown in FIGURE 16. It is recognized that other breaks may have occurred that were not found in the sources listed, but the breaks shown are considered representative of the overall distribution of damage. It should be noted in particular that many of the breaks occurred in a few concentrated locations.

The table below is a list of known repairs to structures damaged in increased groundwater levels in American Bottoms. These repairs were authorized under Public Law No. 99.

1973

<u>Project</u>	<u>Cost of Repair</u>
East Side Levee and Sanitary District - 84-inch storm sewer repairs	\$ 130,070
Sanitary Sewer Repairs - Centerville Township, St. Clair County, Illinois	200,244
East Side Levee and Sanitary District - sanitary and storm sewer repairs	19,300
City of East St. Louis - sanitary and storm sewer repairs	1,727,542
Centerville Township - sanitary sewer repairs	215,221
Wood River Drainage and Levee District, Madison County, Illinois - removal of twin 60's	126,510

Wood River Drainage and Levee District,
Madison County, Illinois

31,568

TOTAL 1973

\$ 2,450,455

1974

Project

Cost of Repair

East St. Louis and Vicinity -
repairs to pumping stations, floodwalls,
and closure structures

\$ 111,000

East Side Sanitary and Levee District -
sanitary and storm sewer repairs

51,081

East St. Louis Vicinity, East Side Levee
and Sanitary District, Madison and St. Clair
Counties, Illinois - repairs to Cahokia, East
St. Louis, N and S pump stations

145,019

TOTAL 1974

\$ 307,100

1975

Project

Cost of Repair

East Side Levee and Sanitary District -
84-inch and 78-inch storm sewer damage

\$ 77,000

Repairs to Monsanto and East St. Louis
Pumping Stations, St. Clair County, Illinois

168,900

East Side Levee and Sanitary District, Madison
and St. Clair Counties, Illinois - sanitary and
storm sewer repairs 487,600

East Side Levee and Sanitary District, Madison
and St. Clair Counties, Illinois - 84-inch and
78-inch storm sewer damage 84,000

TOTAL 1975 \$ 817,500

TOTAL 1973 - 1975 \$ 3,575,055

PUBLIC PERCEPTION OF PROBLEMS AND NEEDS

The preceding is a technical analyses looking at the history of groundwater levels in the American Bottoms area. This section discusses public input and their perception of problems, needs and concerns in the American Bottoms area specifically relating to groundwater levels. Specifically, public input came in two major forms: a Delphi panel questionnaire and a public meeting.

A questionnaire concerning water resources problems was administered to 33 panelists, the Delphi panel, who had knowledge and interest in water related problems in the American Bottoms area. The panel included residents, public officials, state and local agency representatives, business owners, farmers and various interest groups. This group, in comparing all water resource problems, indicated that groundwater problems were the number two problem as far as they were concerned. On a scale of 0, being "no problem" to 4 of "severe problem," the panel rated groundwater an average of 2.81. Only one problem, sedimentation, was rated higher at 2.85. In particular they rated groundwater flooding of

residential areas, agricultural areas, commercial areas and city property, in order of importance. They indicated that some of the effects of the high groundwater levels were basement flooding, severe backup, sewer line damage, structure or foundation damage and crop damage. Also, they rated the need for protection of groundwater quality an average of 2.69.

The second major aspect of public input occurred at the public meeting held on 27 February 1979 in Granite City, Illinois. Two different major areas of input were obtained from the public. First, as they entered the meeting they were asked to note two of their most important water related problems and needs. The results of this is that the most frequently mentioned topic was flooding. The second most frequently mentioned topic was groundwater, showing significant importance to the public. Also, later in the meeting small group sessions were held where problems were mentioned and rated and ranked by the public. From the small group session, there are two indicators of the magnitude of the problem. These are the frequency of mention within the small groups and the weighted mean that the small group members gave to the groundwater problem. Here again, according to frequency of mention groundwater was mentioned second most often. Concerning the mean, the average value was 3.31. In other words a high average rating. It should be mentioned that two problems related specifically to groundwater were brought out at the public meeting. Those being that there is a concern that in the future quantity of water available for water supply be maintained and secondly that the quality of that water supply be maintained for water supply purposes.

PLANNING CONSTRAINTS

The American Bottoms Groundwater Study will be conducted using the Corps of Engineers planning process which implements the WRC Principles and Standards. Specifically, this guidance provides that the planning will be done by an interdisciplinary planning team, that the process will be flexible and will include institutional analyses and public involvement. The planning process includes three stages, namely: Reconnaissance Report, Development of Intermediate Plans, and Development of Detailed Plans. For each of the three stages, four tasks will be carried out. The four tasks to be completed in each stage are: problem identification, formulation of alternatives, impact assessment, and evaluation. All alternative plans developed must be implementable plans. In the formulation of alternatives, one alternative must be designated as the National Economic Development (NED) plan and one plan must be designated as the Environmental Quality (EQ) plan. Besides these two accounts, the plans must be evaluated against the Regional Development (RD) and Social Well-Being (SWB) accounts. Finally, the recommended plan must pass the net benefits rule. This means that when considered individually, on the basis of "with" versus "without" comparison, the plan must be justified in the sense that total beneficial contributions (monetary and non-monetary) exceed total adverse contributions (monetary and non-monetary). The recommended plan must have net NED benefits unless the deficiency is the result of NED benefits foregone or costs incurred to obtain positive EQ contributions.

PLANNING OBJECTIVES

Based on technical studies and public input the following planning objectives have been developed for this study.

1. Reduce damages caused by the high groundwater level to residential, commercial and agricultural areas, and utilities in the American Bottoms area.
2. Maintain an adequate supply of groundwater for water supply uses in the study area.
3. Enhance the environmental and aesthetic quality of the American Bottoms area.
4. Increase water related recreation opportunities in the study area.

Even though assuring good water quality of the groundwater was identified by the public as a real problem or need in the American Bottoms area, it is not specifically addressed by a planning objective in this study. This is because the local 208 wastewater planning agency, the Southwestern Illinois Metropolitan and Regional Planning Commission jointly with the Illinois State Water Survey, is going to study maintaining the quality of the American Bottoms groundwater as a part of the 208 continuing planning program. Therefore, Corps efforts in this area would be duplicating these 208 efforts. However, it should be noted that their major purpose is to try to maintain the existing quality or improve it by restricting possible sources of contamination. The Corps study will gather information on existing groundwater quality which will be used to attempt to identify potential uses for the groundwater.

FORMULATION OF PRELIMINARY PLANS

This section of the Reconnaissance Report presents information on the initial formulation of alternative plans considered to solve the high groundwater level problem. Plans have not been developed which address all of the planning objectives identified in the previous section. However, since the groundwater level problem is the major problem for the study area, management measures, and an initial analysis of the plans considered is presented to address this problem.

MANAGEMENT MEASURES

The management measures considered include those which will act upon high groundwater levels. In other words, the measures will either reduce the amount of water entering and becoming a part of the groundwater or else they will decrease the amount of water which is already part of the groundwater. Additionally, a groundwater planning map is presented to assist state and local officials in limiting future damages due to high groundwater levels.

MEASURES

There are four potential sources of groundwater recharge. These include inflow from the Mississippi River directly to the groundwater table, direct groundwater inflow from the adjacent hillside areas, rainfall which falls directly on the study area and then infiltrates to the groundwater table and lastly, surface water runoff from the tributary areas which enters the bottoms area as surface water and then infiltrates to the groundwater table.

The four sources of water and possible methods to reduce the inflow are:

- | | |
|-----------------------------------|--|
| From the Mississippi River | - maintain a low river stage
- provide an impermeable barrier |
| From rainfall on the Bottoms area | - eliminate/reduce infiltration
- weather modification, reduce rainfall |
| From hillside groundwater | - intercept/divert
- impermeable barrier |
| From hillside surface water | - diversion before it enters the bottoms
- eliminate/reduce infiltration
- weather modification, reduce rainfall |

In a similar manner, other measures will address removing the groundwater from the American Bottoms groundwater table. Potential measures include increasing flow to the river, increasing evaporation from the groundwater table, pumping the groundwater or forcing it to flow into deeper geologic formations. These are the types of groundwater management measures being considered. In addition, there are the non-structural types which include relocation, flood proofing, and zoning. Potential measures and alternatives to lower the groundwater level include:

Pumpage

- horizontal collector wells
- vertical wells
- combination of above
- increase pumpage for municipal and industrial usage

Syphoning system

Gravity collector

- surface
- subsurface (such as the Chicago tunnel or fracture geologic formation)

Increase Evaporation

- artificially (lake or mechanical spray, for example)
- naturally (such as deep rooted plants)

Non-structural methods to be considered to reduce the high groundwater table damage include:

- Relocate damagable structures, utilities and activities
- Floodproof
- Raise damagable structures, etc., (by use of fill or stilts, for example)
- Zoning, building codes, etc.
- Temporary evacuation

A GROUNDWATER PLANNING MAP

Discussion with state and local officials identified the need for a document defining groundwater conditions in a form usable to local planners, decision makers, and developers. The map divides the American Bottoms into various zones in which differing groundwater conditions should be considered in the planning and development process.

Developing the Map

Conditions affecting groundwater levels and/or suitability of various approaches to dealing with high groundwater levels have been described and mapped in previous sections. These conditions include soil characteristics, landforms, land use, past and present groundwater levels, and pumping. Using an approach similar to that of McHarg (1969), the combinations of these factors were studied to determine where the least and most adverse conditions occurred. Intermediate conditions were also identified. This information was then developed into a 5-category groundwater planning map to be discussed in the next paragraph. These categories were further subdivided into developed and undeveloped portions. This procedure allows separation of areas where good future planning and construction practices can prevent a problem (undeveloped areas) from areas where development has already taken place.

Using the Map

The groundwater planning map prepared for the American Bottoms is shown in FIGURE 17. Five categories, or zones, are shown in various colors. These zones are discussed below.

The Red Zone - Damage Expected

The red zone has the greatest likelihood of groundwater damage to underground facilities. In the red areas, significant groundwater rise occurred between 1956 and 1973. Because of this fluctuation, underground facilities improperly constructed during "dry" periods can later become "wet". In addition to changing groundwater levels, the red areas also are situated on the poorest soils, those with seasonal high water tables and/or those on old lake bottoms. Soils near the surface can become waterlogged during wet spring seasons; perched water tables are possible. The combination of these two conditions - high aquifer levels and poorly drained surficial soils - places these areas in the red zone.

Great care should be exercised when development locates in these areas, to insure that proper professional engineering and construction practices are required. The shaded portion of the red zone is developed, and the largest number of sewer breaks occurred in this zone. A strong likelihood of damage to existing facilities exists in the shaded red area. Structural methods to provide positive control of groundwater levels would be most cost-beneficial in these areas. The unshaded portion of the red zone is generally undeveloped. Future underground facilities in this zone should be carefully designed and constructed for high groundwater conditions. Each local community has the capability to require that the developers follow proper engineering and construction practices. Building codes provide an excellent vehicle for implementing these practices.

The Orange Zone - Damage Likely

Groundwater levels in this zone showed a rise from 1956 to 1973 similar to the red zone; however, soils fall into the intermediate

(brown) category in FIGURE 5. Poorly drained soils and/or perched water tables may occur but are not as prevalent as in the red zone. Most of the remaining sewer breaks (after considering the red zone) occurred in the orange zone. Again, the shaded portion represents development and the unshaded portion is undeveloped. The same need for careful design and construction for high groundwater conditions occurs in this area as for the red zone. Much or all of the East St. Louis, Granite City, Alorton, Centreville, and Washington Park is located in the red or orange zones.

The Yellow Zone - Damage Possible

Groundwater levels in the yellow zone were generally deeper than 15 feet in 1973 but are situated over pumping cones. Future reduction in pumpage could allow these artificially depressed groundwater levels to rise. Some of the areas in the yellow zone also have soils with seasonal high water tables. Again, developed areas have been shaded and undeveloped areas are shown unshaded. Proposed underground facilities may be "in the dry" during the planning process, but specific studies of the need for high groundwater design and construction considerations are recommended due to the possibility for change. Parts of Alton and Wood River are included in the yellow zone.

The Blue Zone - The Riverbank Area

A narrow strip paralleling the river is shown in blue. In this area, groundwater levels are influenced almost exclusively by the river. Groundwater levels change rapidly with river stage changes. Underground facilities should be designed considering the likelihood of large, rapid variations in groundwater levels. When river stages exceed the ground level (but river water is kept out by levees),

groundwater may reach the surface. Despite frequent high groundwater levels, subsurface damage is not a common problem because the groundwater levels are commonly considered in design and construction in this area.

The Green Zone - High Groundwater Unlikely

This zone includes areas on ground situated somewhat higher than the rest of the American Bottoms that pose the least limitation to subsurface construction. This in no way negates the need for good design and construction. The planning map is necessarily general in nature and local variations can and do occur. The major units in this zone are the Roxanna Terrace and some of the alluvial fan units near the bluffs. Caseyville is located on one of these alluvial fans. The town of Dupou is situated on a slight rise and was also placed in the green zone.

PLAN FORMULATION RATIONALE

As identified in the section entitled PLANNING OBJECTIVE this study will address the groundwater level, potential problems with water supply, environmental quality and water related recreation. The study will concentrate on eliminating the problems caused by the high groundwater level. If solutions are found to lower the groundwater level, then the resulting reduction in using the groundwater as a source of water supply will be investigated to insure a future water supply source so that water supply does not become a problem in the area. The environmental quality aspect will be fully addressed for all alternatives. Water related recreation will not be initially addressed in this study. Recreation is being addressed in the on-going East St. Louis and Vicinity, Illinois Interior Flood Control Study.

PLANS OF OTHERS

No comprehensive plans of improvements have been developed which address the high groundwater level by other Federal, state, local agencies or public citizens.

ANALYSIS OF PLANS CONSIDERED IN STAGE I

For initial analysis of Stage I, three plans were considered and an initial analysis completed. These three plans and alternatives are pumped wells, gravity surface collectors and reduced infiltration in the study area. The plans and the initial analysis of the reduction of groundwater levels are described following:

Alternative 1 - Pumped Wells

This is usually the first method that comes to mind when lowering the groundwater is discussed. Alternative 1 consists of constructing a network of wells in critical areas. Pumping will lower the groundwater in the surrounding area to an extent dependent on pumping rate, well spacing, time, and subsurface conditions. Effectiveness will diminish with increasing distance from the wells. For a preliminary look at the relationship between groundwater levels and pumpage, a network of wells was assumed to be located on a 1-mile grid spacing within the groundwater change areas shown in FIGURE 15. The wells were assumed to continuously pump 900 gallons per minute (gpm) each. The resulting lowering of the groundwater, or drawdown, was computed by the Illinois State Water Survey using a digital computer model. The location of the assumed wells and drawdown after 1 year and after 5 years of pumping is shown in FIGURES 18 and 19, respectively. Further consideration of this alternative will require studying varying well configurations, pumping rates, etc., to find an optimum scheme. The quantity of water required to be pumped is technically feasible; economic feasibility remains to be determined. Drawdowns after 5 years are probably in excess of what is required, suggesting wells could be operated intermittently or at a reduced rate as time progresses.

To indicate the magnitude of this potential solution, a preliminary cost estimate was developed for the 31 wells displayed on FIGURES 18 and 19. The first cost includes the necessary wells, pumps and motors. Annual costs include the electricity cost to operate the pumps plus the required maintenance costs. Electrical and mechanical components make up the replacement cost. It must be noted that the cost estimate presented below does not include land costs or any costs for dealing with the water after it leaves the ground. No provision is included to transport the water to the Mississippi River, either by open channels or sewers. No provision, if required, is included to treat the groundwater before spilling it in the river. Though not complete, this estimate does provide an initial indication of the magnitude of the cost of pumped wells to solve the high groundwater level problem.

TOTAL FIRST COST

Includes Contingencies, E&D, S&A \$1,033,000

OPERATION AND MAINTENANCE

Includes electricity and maintenance \$ 17,500/year

REPLACEMENT

Includes electrical and mechanical \$ 1,950/year

TOTAL ANNUAL COST @ 7-1/8% = \$ 34,350

Alternative 2 - Gravity Collectors

This alternative consists of constructing a system of linear collectors below the desired water table to intercept the groundwater and convey it to a discharge structure. Such a collector might conceivably consist of a large perforated conduit or a ditch/conduit with a line of gravity wells on either side. Outlets for the wells would be constructed lower than the desired groundwater level, and groundwater rising above this level would flow from the wells into the ditch. Effectiveness would diminish with increasing distance from the collectors. A preliminary study of this alternative was also made using the Illinois State Water Survey's digital computer model. FIGURE 20 shows the drawdown predicted 1 year after the collector system is put into effect; total system flow at that time would be 62 cubic feet per second (cfs). FIGURE 21 shows the drawdown predicted 5 years after the collector system is put into effect; total system flow at that time would be 32.6 cfs. Further consideration of this alternative will require studying various collector locations and elevations to find an optimum scheme. Conveying this quantity of water is technically feasible; economic feasibility remains to be determined. From initial study of the drawdown contours in FIGURE 21, it appears that the southern collectors in this assumed scheme are slightly deeper and/or more closely spaced than required.

Alternative 3 - Reduced Infiltration

The more efficiently stormwater is removed from an area, the less water will infiltrate to the aquifer. This upsetting of the balance between water flow in and out of the aquifer will tend to make the groundwater surface seek equilibrium at a lower level.

Bruire and Smith (1953) estimate groundwater levels have already dropped 1 to 12 feet since the turn of the century due to construction of improved drainage facilities. This improved drainage refers mostly to regional systems, such as Harding Ditch, Cahokia Canal, etc. Comprehensive local storm sewers are non-existent in most of the American Bottoms. It was recognized that storm sewers alone would not reduce infiltration enough to significantly lower groundwater levels; but since some storm sewer construction will probably occur, it was desirable to estimate the effects thereof. This effect would somewhat reduce the requirements of the two previously mentioned alternatives.

To estimate the effects of reduced infiltration, this alternative was also modeled by the Illinois State Water Survey. In the areas outlined in FIGURES 22 and 23, all normal infiltration was reduced to zero. This area consists of the major urban centers. Eliminating all infiltration is possible theoretically, but not practically, since this would require intercepting all stormwater (i.e., paving everything) and collecting all flow. However, groundwater level reductions are approximately proportional to the percentage reduction in infiltration. For instance, if all infiltration in the selected area is eliminated, the drawdown in groundwater levels after 1 to 5 years is shown in FIGURES 22 and 23; if only one-third of the infiltration were actually eliminated, drawdowns would be only about one-third of those shown. From a practical standpoint, reducing infiltration one-third to one-half is probably a maximum attainable reduction; thus, 1 to 3 feet is probably the greatest drawdown that can be achieved by improved storm sewers alone.

COMPARATIVE ASSESSMENT AND EVALUATION OF PLANS

An initial assessment (non quantitative) was made comparing the three alternatives discussed above. This analysis briefly lists some of the pros and cons of each alternative.

THE PROS AND CONS

Alternative 1 - Pumped Wells

ADVANTAGES

1. Flexibility in operation.
2. "Positive" means of control (water is removed from aquifer).
3. Possibility for new industry if use for water could be found.
4. Less loss of land than some other alternatives.
5. Some possibility to use existing wells.

DISADVANTAGES

1. Large initial investment, continued maintenance.
2. Energy costs.
3. Discharge water may require treatment to meet water quality standards.
4. Flexibility of system allows variation of "opinion" on how to operate system.
5. May encourage uncontrolled floodplain development.
6. Lower groundwater levels reduce available groundwater resource.
7. Possibility of localized land subsidence.
8. May have adverse effect on Horseshoe Lake.
9. Possible community disruption.

Alternative 2 - Gravity Collectors

ADVANTAGES

1. Lesser continuing energy requirement than pumped wells.
2. Less maintenance expected than pumped wells.

DISADVANTAGES

1. Large initial investment, continued maintenance.
2. Discharge water may require treatment to meet standards.
3. May encourage uncontrolled floodplain development.
4. Lower groundwater levels reduce available groundwater resource.
5. Possibility of localized land subsidence.
6. More disturbance, disruption of area during construction than pumped wells.
7. Possible community disruption and environmental problems if open ditches are involved.
8. Less flexibility of operation, less adaptability to isolated areas.
9. May have adverse effect on Horseshoe Lake.

Alternative 3 - Reduced Infiltration

ADVANTAGES

1. Less continuing energy requirement than previous alternatives.
2. Implementation (storm sewers) is likely to occur to some extent regardless of groundwater considerations.

DISADVANTAGES

1. Very large initial investment.
2. May encourage uncontrolled floodplain development.
3. Some disruption/disturbance to community.
4. Increased storm sewage flow.
5. May reduce opportunity for ecological enhancement.
6. May require treatment prior to discharge to Mississippi River.
7. May have adverse effect on Horseshoe Lake.

MORE COMMENTS ABOUT DISADVANTAGES

Water Treatment

It is uncertain at this time whether groundwater can be pumped to the Mississippi River without some treatment to improve its quality in order to meet governmental regulations. The level of quality that will be required for discharges in the future is uncertain. Groundwater in the American Bottoms is known to be high

in hardness and dissolved minerals, especially iron. The relationship between groundwater quality and required discharge quality will have to be considered in evaluating the alternatives during Stage II.

Subsidence

In some cases, land subsidence has accompanied large withdrawals of groundwater. Significant subsidence due to water level decline has occurred in Louisiana, Texas, Arizona, Nevada, and California (Poland, 1974). In simplified terms, removal of water in the soil pores increases the stress between the soil particles, causing them to compress. This process is only partially reversible; that is, the soil will not expand back to its original volume if water is returned to the pores. Pumping or draining groundwater in the American Bottoms is not expected to cause any significant subsidence because (1) groundwater levels have already been drawn down in the 1950's, and (2) the significant subsidence in the states listed above are related to groundwater level declines of 100 to 600 feet. However, localized subsidence due to lowering groundwater levels should be considered a possibility in localized areas with wet, marshy soils.

CONCLUSIONS (SCREENING)

Presented earlier are the management measures being considered to eliminate the groundwater level plus an initial analysis of three alternatives considered in Stage I. It is fairly obvious that several of the measures are beyond the capability of this study to address. Specifically, these are the alternatives which are unrealistic which include weather modification and maintaining a low

Mississippi level. Therefore, these alternatives will not be considered further. Several other alternatives which may be questionable will be given an initial look in Stage II to get an indication of the magnitude of the cost and the amount of reduction groundwater level that may occur if that alternative was accomplished. If then determined to be unrealistic, they will not be considered further.

As discussed in the previous sections THE REPORT AND STUDY PROCESS and PLANNING CONSTRAINTS, this study will be completed under the guidance of Principles and Standards as described in ER 1105-2-200. This means that the study will be conducted in three stages: 1) Reconnaissance Report; 2) Development of Intermediate Plans; and 3) Development of Detailed Plans. Within each stage, the four planning tasks of: 1) Problem Identification; 2) Formulation of Alternatives; 3) Evaluation; and 4) Impact Assessment will be accomplished.

To accomplish the three stages and the four planning tasks within each stage, a variety of input is required for many technical areas. These include economic, environmental and engineering studies; other significant inputs are required from public involvement and institutional analysis studies. The following paragraphs describe these technical studies.

ECONOMICS STUDIES

The traditional Corps of Engineer economic study will be accomplished for the American Bottoms Groundwater Study. This means that both tangible and intangible damages will be identified and evaluated which are caused by the flood problem, the high groundwater table. There are three basic components in analyzing groundwater damages. One is the direct damages to a structure from being exposed to a groundwater flood event. Secondly, direct damages due to the duration of exposure to a given event. It is hypothesized that the longer a structure is exposed to inundation,

the greater will be accumulated damages. The third component of groundwater damages involves the number of times in any given year a structure will experience a specific duration. For example, how many times in a period of record will a tiled flood (ground level or lower) be subject to a flood exposure of fifteen hours? Benefits are defined as the amount of damages relieved by the various alternative plans that would solve all or part of the problem. It is anticipated that several specific variations to normal flood damage studies will be necessary to accurately portray the damages as described below.

The first major economic category deals with residential, commercial and industrial damage. In many Corps studies the first floor elevation of the structure is selected as the appropriate critical level from which to evaluate flood damages. However, when considering groundwater flooding, the basement elevation (if present) is the appropriate critical elevation. Substantial damage can occur before flooding reaches the first floor. Additionally, groundwater flooding may cause the total loss of use of the basement. This loss of basement use occurred after the 1973 high water levels in the study area. Due to the recurrent flooding, some basements had to be filled with dirt or sand to maintain the integrity of the structure. Therefore the total loss of basement use can occur causing a reduction of the total value of the structure. Additionally, the total structure could be lost as the structure attempts to "float" during rising water table periods. The structure literally cracks apart and may sustain irreparable damage prior to the flood waters reaching the first floor elevation. Thus, the economic analysis must properly account for the significant losses that can, and do, occur when groundwater elevations may not have even reached the ground surface.

The second category of economic damage is agricultural flooding. Much of the undeveloped portion of the study area is used for agricultural pursuits as described in EXISTING CONDITIONS. Crops are destroyed if the groundwater level rises above the surface, flooding the crops. With the groundwater level very close to the surface, some crops may drown due to the root systems encountering fully saturated ground conditions. On the other hand, some plants may be enhanced by having such an abundant supply of water. In other words the high groundwater table could actually be a benefit. Special studies will be accomplished to investigate the positive and negative aspects of having the groundwater table very close to the ground surface as far as the agricultural economy is concerned.

Another significant area of economic analysis is sanitary and storm sewer problems. As described under PROBLEMS, NEEDS AND OPPORTUNITIES, substantial damages (over \$3.5 million in 1973-1975) have occurred to sewers in the study area. Thus an inventory of the location and elevation of sewers is needed within the study area to estimate the potential damage caused by high groundwater levels. Sanitary and storm sewers attempt to float and break up as they cannot stand the pressure caused by the high groundwater levels. Thus, one problem is the cost to repair or replace storm and sanitary sewers. Extra considerations in this area include the reduced capacity of storm sewers as groundwater seeps into them and the extra sewage treatment capacity required because of the inflow of groundwater into sanitary sewers. Reduced capacity means extra cost for new sewers, both sanitary and storm, because they must be larger and must be constructed using special techniques to prevent future damage. Relieving the high groundwater table could reduce damage or repair to existing sewers, increase their capacity, and reduce future construction costs to place sewers under water.

ENVIRONMENTAL STUDIES

Initial environmental studies involve the wide range of information on natural and human resources of the study area. As discussed previously, the American Bottoms area significantly overlaps the East St. Louis and Vicinity, Illinois IFC Project area. As a detailed environmental inventory is complete for that area, no new general environmental inventory will be accomplished for this study. As alternatives are formulated, evaluated, and impacts determined, site specific environmental studies will play a key role in an attempt to indicate environmental problems and opportunities. For example, storm and sanitary sewer breaks cause environmental and health hazards not easily or directly evaluated in the economic analysis. These intangible environmental impacts will be identified and evaluated for each of the alternative solutions considered.

The impacts of each component of every alternative plan as well as the "without" condition will be compared to the base condition identified by the environmental inventory. Every effort will be made to eliminate, minimize, and/or mitigate all adverse environmental impacts of any proposed plan of improvements. This task will be reiterated for each of the final two stages of this study as the physical attributes of the alternative plans are more specifically identified. Significant effort will be devoted to being alert to all opportunities to enhance the environmental quality of the area.

ENGINEERING STUDIES

A number of engineering studies are required to fully determine the technical implementability of the alternative plans formulated during Stage II. The following paragraphs describe briefly these studies.

DESIGN AND COST ESTIMATES

Engineering design studies are made to insure the technical feasibility and constructibility of the alternative plans being considered. Each plan is also studied to insure compliance with engineering regulations and directives. Initial cost studies, based on preliminary information, are made to determine the most cost effective technical solution to solve the problems. These cost studies are made by quantifying and costing definable components of the solution under consideration. In subsequent design and cost estimates, efforts will be made to further refine the designs and costs. Design and cost estimates will insure the technical feasibility, cost effectiveness and the compatibility of the alternative solution. Cost and design aspects will include real estate acquisitions, relocations, ditch or channel improvements, and all other possible components. Costs will include the first construction costs, operation and maintenance costs, and replacement costs.

GEOLOGY AND SOILS

The studies in the area of geology and soils fall under three broad categories. First, determining the general soils and geology information that affects groundwater. This category includes information about the combination of soil properties which determine the amount and the rate of water movement into and out of the groundwater aquifer. The second area of special studies are those which relate to alternative improvements which require specific soils and geology input. These would include the alternatives that address the possible deep tunnel method to remove groundwater, fracturing the geologic structure to lower the groundwater level and alternatives which include an impermeable barrier to reduce inflow.

Lastly, a soils analysis is required for all potential structural solutions to insure integrity for adequate bearing capacity and slope stability.

GROUNDWATER LEVEL ANALYSIS

The procedure to properly analyze groundwater levels in the American Bottoms area will require the use of a digital computer model capable of simulating existing and modified groundwater levels. This model would have to be capable of handling varied aquifer properties present in the study area. Input variables to the model will be changing Mississippi River stages, rainfall infiltration and variable pumping. The model will be calibrated to reflect existing and past groundwater trends and then will be used to predict future groundwater levels. This information will be used to provide frequency elevation data which can be combined with the damage elevation data to provide damage exceedence frequency data.

The second use of the model will be to evaluate the various alternative plans under consideration to reduce the groundwater levels. The various alternatives act upon the model and the resulting lowering of groundwater levels determined. This is similar to the work performed in the previous section FORMULATION OF ALTERNATIVES for the three alternatives considered. This aspect of the work will be accomplished by a contract.

GROUNDWATER QUALITY ANALYSIS

There are two main purposes to the groundwater quality analysis. As SIMPAC will accomplish a study to insure that the groundwater quality is not degraded in the future, the first purpose of the groundwater quality analysis is to determine if the

groundwater can be spilled into the surface waters of the area without treatment. This activity will be coordinated with U.S.E.P.A. The second purpose of the groundwater quality analysis is to determine potential users and evaluate what are the opportunities for use of the groundwater if it is removed from the ground. This work will be accomplished by taking groundwater samples at approximately 100 wells and piezometers and testing for numerous water quality parameters. The water quality sampling data will be analyzed to determine if the groundwater would meet discharge water quality standards or have potential uses. This work activity will be accomplished by contract.

HYDROLOGY AND HYDRAULICS

Hydrology studies will provide basic input data to the groundwater level computer modeling. The groundwater levels are impacted upon by the Mississippi River, by rainfall falling on the area and surface water entering the American Bottoms area. The hydrology studies will provide this necessary data from long-term Mississippi River stage and duration data, from rainfall data in the study area and from surface water runoff computed for the East St. Louis and Vicinity Project. The hydrology studies will provide this input for existing conditions to calibrate the model and then for future projected conditions so that groundwater levels may be determined in the future.

Additionally, certain alternative plans require hydraulic design to insure they will function in a technically feasible manner. This could include design of well depth and diameter, well spacing and design capacity. This might include pipes or channels to get the water from the wells as it is pumped out of the water table to a non-damaging surface water source.

RECREATION STUDIES

As existing conditions and facilities will be inventoried and evaluated, and demand and activity analysis accomplished for the East St. Louis and Vicinity, Illinois IFC Project, these tasks will not be duplicated by this study. Formulation of recreation resource development plans will give consideration to alternative scales of development ranging from minimum facilities to optimum development. During these processes of analysis, opportunities to enhance the project requirements to further accommodate provisions for outdoor recreation will be studied. Features such as land forms, aesthetics, and environmental buffers could be considered in the various design and engineering solutions developed for the several alternatives.

CONSTRAINTS AND CONTROLS

The main purpose of the iteration study process as guided by P&S is to look at all alternatives initially, evaluate and determine the impacts of the alternatives, then to narrow the alternatives considered as the iterations progress. Early in Stage II a wide range of alternatives as discussed above will be considered to solve the high groundwater level problem. As early as possible, the alternatives which are infeasible due to economic, environmental or other reasons will be eliminated from further study. The remainder of the study will be focused on those remaining measures and alternatives.

PUBLIC INVOLVEMENT

The objective of the public involvement program is to actively involve the public in the study to insure that the study responds to

the public needs and preferences to the maximum extent possible, within the bounds of Federal, state and local authorities. The public involvement program is designed to:

1. Open and maintain channels of communication with the public;
2. Encourage public understanding of Federal, state, regional and local responsibilities, authorities and procedures in conducting water resources planning studies and implementing water resources programs;
3. Present information which will assist the public in defining its water resources problems, needs, and objectives;
4. Solicit the public's comments, views and perceptions of problems, needs, alternative solutions and related impacts, and any recommendation for Federal action; and
5. Give full consideration to public needs and preferences in the planning process.

The public involvement program will include, as necessary, the use of:

1. public meeting/workshop announcements
2. public information fact sheets/brochures
3. questionnaires
4. public meetings/workshops

5. coordination with other agencies
6. personal contacts/interviews
7. guest speaker engagements at interest group activities
8. public service announcements
9. newspaper announcement ads
10. press releases
11. media interviews as requested, and
12. any other approved technique of actively involving interested publics which helps accomplish program objectives.

Prior to the Stage I public meeting, a public information fact sheet/announcement introduced the study, presented the study's background, and announced when and where the public meeting was to be held. This technique (fact sheet) will continue to be used to inform the interested publics of study progress, significant study events, and scheduled public contacts (i.e., public meetings, interviews, workshops, etc.). Following each meeting or workshop, the program will close the informational loop by explaining the results of the meeting or workshop in a fact sheet/brochure. At this time, over one thousand organizations and individuals are on the study's mailing list.

As an example of coordination, this Reconnaissance Report has been sent to the list of Federal, state, and local agencies and individuals presented at the end of the Study Participants and Coordination, for their review and comments.

Meetings and workshops are designed to accomplish the purpose of that stage of the planning process germane to the study. For example, the purpose of the Stage I public meeting was to inform the public about the study, and, more importantly, afford the public the opportunity to express, as input, their perceptions of the problems, needs, and concerns within the study area. The meeting agenda called for a general opening session to explain the study, a session of small work groups to allow each individual to have his or her input recorded and rated, and a general closing session to summarize each small work group's ideas to the other work groups' participants.

Meetings and workshops held toward the end of Stage II will explain the alternatives considered and the evaluation and impact assessment of the alternatives. The public will be asked to review the alternatives, suggest modifications, provide their evaluation of the various plans, and indicate their preference among the alternatives. This input will then be considered in selecting the plans to be further developed in Stage III.

STUDY SCHEDULE

The various study activities described above have been used to develop a bar graph (FIGURE 24) showing principal study activities through the completion of Stage II. Following is a milestone schedule for report submissions by this District and assistance and review by higher level Corps offices.

TENTATIVE MILESTONE SCHEDULE

2	LMVD/MRC approval of Reconnaissance Report	Sep 1979
3	Submit Stage II Report	Aug 1981
4	Stage II Checkpoint Conference	Sep 1981
5	Complete action on MFR	Oct 1981
6	Submit Draft Feasibility Report and DEIS	Oct 1982
7	Stage III Checkpoint Conference	Nov 1982
8	Complete Action on MFR	Dec 1982
9	Coordinate Draft Report and DEIS	Feb 1983
10	Submit Final Report and Revised DEIS	Apr 1983
11	Notice of Report	May 1983

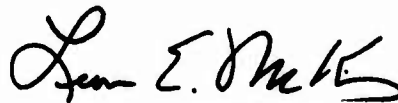
STUDY COST

The total estimated study cost is \$1,100,000, of which \$40,000 was expended to complete the Stage I studies and this Reconnaissance Report. It is estimated that Stage II will cost \$730,000 to complete. The remainder \$330,000 will be required if Stage III is executed.

RECOMMENDATIONS

I recommend that this Reconnaissance Report be approved.

I further recommend that Option B, Section 404 (b)(1) evaluation, included in the Survey Report and EIS, be followed to meet the requirements of Section 404 of the Clean Water Act (EC 1105-2-90).



LEON E. MCKINNEY

Colonel, CE

District Engineer

APPENDIX

PUBLIC VIEWS AND COMMENTS

As stated in the cover letter transmitting the Draft Reconnaissance Report for review and comment, no response assumes concurrence with the report.

Comments and responses concerning the Draft Reconnaissance Report are attached. Specific word corrections and changes are reflected in the final Reconnaissance Report. Other concerns and suggestions will be fully considered during Stage II. Responses from the following agencies were received:

U.S. Department of Agriculture
Soil Conservation Service

Department of Health, Education and Welfare
Public Health Service

U.S. Department of the Interior
Fish and Wildlife Service

Illinois Department of Transportation
Division of Water Resources

Illinois Department of Conservation (2)

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

P.O. Box 678, Champaign, Illinois 61820

July 10, 1979

Re: LMSD-BU - Review of Draft Reconnaissance Report, American Bottoms
Ground Water Study

Jack R. Niemi, Chief
Engineering Division
Department of the Army
St. Louis District
Corps of Engineers
210 North 12th Street
St. Louis, MO 63101

Dear Mr. Niemi:

I have reviewed the above mentioned report and have the following comments:

Page 22: Third to last sentence states, "Although levees now protect the area from Mississippi River flooding, interior streams continue to erode and redeposit materials." The implication is that interior streams is the sole or dominant source of erosion and deposition. With 53% of the total acreage in cropland, it would be more accurate to state that "interior watersheds continue to erode, etc.". This would take into account sheet and rill erosion (as well as stream erosion and deposition) which is a significant factor in recent surface changes of the landscape.

Page 24: First paragraph: The local sponsor for the Madison County Soil Survey is the Madison County Board, not the Southwestern Illinois Metropolitan and Regional Planning Commission.

Page 34: First paragraph states that agriculture has declined in importance due to increased urbanization. Nevertheless, in the following paragraph it states that 53% of the land use of American Bottoms is in cropland while residential, developed open spaces, industrial areas and other cultural uses account for only 36%. In spite of the decline, agriculture is obviously still playing a very viable role in the Bottoms with much of the land being prime or important farmlands.

Pages 35-36: Section on Agriculture: There are no references listed in pp. 37-40 which would substantiate the agricultural condition of the area as described in this section.

Page 52: Management Measures: The term "ground water table" is used incorrectly six times on this page. First paragraph should read "..... a part of the ground water or else they already in the ground water." Third paragraph, first sentence should read: "There are four potential sources of ground water recharge." Same paragraph, next three references stating "into the ground water table" should read "to the ground water table."

Paragraph 53: Fifth line of text: change the phrase "pumping water from the ground water table" to "pumping the ground water."



Mr. Niemi, Page 2, July 11, 1979

Pages 61-64: Analysis of Plans Considered in Stage I: Four methods were recognized in the formulation of preliminary plans on p. 54, yet only three of the four alternatives are addressed here. On page 54, it states that nonstructural methods would be considered to reduce the high ground water table damages. An analysis of the nonstructural methods, including zoning, building codes, relocating damageable structures, flood proofing, and raising damageable structures should be presented. A comparison with no project action is also needed.

Pages 65-68: The first three methods (pumped wells, gravity collectors, and reduced infiltration) would possibly have adverse effects upon Horseshoe Lake which is an important recreation and wildlife area in the American Bottoms. This possibility should be listed as a Disadvantage in each of the three comparative assessments of the plans.

Page 65: In the Advantages column, no. 6, it states that there would be little disruption of community using Alternative 1, Pumped Wells. This is true only insofar as the pumped wells themselves are concerned. The analysis on p. 62 does not include provisions for the transport of the pumped water. These transport systems, be they open channels or sewers, would, of necessity, be an integral part of a pumped well alternative. These systems would therefore cause disruption of community. The omission of transport systems is misleading and "disruption of community" should be listed as a Disadvantage.

Another unmentioned Disadvantage would be the possibility for the need for additional land for disposing of pumped water.

Alternative no. 2, Gravity Collectors, would also cause disruption of community because additional land would be needed for ditch construction to make disposal of excess water possible.

This reconnaissance report does not indicate whether there is local interest, willingness, or financial abilities for the local people to accept this project and maintain it after it is installed. It is essential that this area be investigated.

In addition, it is essential that much greater consideration be given to land use planning and zoning of the American Bottoms to avoid costly problems where high ground water tables occur.

Sincerely,

Warren J. Fitzgerald

Warren J. Fitzgerald
State Conservationist

cc: Bridgman, AC, A-6
Kohnke, Washington



DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
CENTER FOR DISEASE CONTROL
ATLANTA, GEORGIA 30333

TELEPHONE (404) 633-3111

July 10, 1979

Mr. Jack R. Niemi
Chief, Engineering Division
U.S. Army Engineer District, St. Louis
210 North 12th Street
St. Louis, Missouri 63101

Dear Mr. Niemi:

We have reviewed the Reconnaissance Report for the American Bottoms Groundwater Study, Illinois, and are submitting our comments on vector mosquito problems and mosquito-borne diseases of the general area. The City of St. Louis experiences some of the same groundwater conditions as described in the report, specifically the continued seepage into storm and sanitary sewers. Many of the storm sewers maintain a constant level of water during the summer and become breeding sites for the vector of St. Louis encephalitis, Culex pipiens pipiens or the northern house mosquito. The reduction of the standing water in the storm sewers and the improved drainage of the outfall would benefit local mosquito control by eliminating such breeding places. If such a situation exists in the American Bottoms area, the effects of improved storm sewer drainage on mosquito production would be a positive impact.

Sincerely yours,

James M. Stewart, Acting Chief
Water Resources Activity
Medical Entomology Branch
Vector Biology & Control Division
Bureau of Tropical Diseases



United States Department of the Interior

FISH AND WILDLIFE SERVICE

IN REPLY REFER TO:

ROCK ISLAND FIELD OFFICE (ES)

1830 SECOND AVENUE

ROCK ISLAND, ILLINOIS 61201

Com: 309-788-3991/3925

FTS: 360-9217/9274

July 31, 1979

Mr. Jack R. Niemi
Chief, Engineering Division
U. S. Army Engineer District
St. Louis
210 North 12th Street
St. Louis, Missouri 63101

Dear Mr. Niemi:

Thank you for providing us with a copy of the American Bottoms, Groundwater Study Reconnaissance Report. In reply to your request, our staff will participate to the extent of our areas of expertise and within the limits that other commitments permit. As the study advances into the development of alternatives phase, we anticipate more complete and comprehensive involvement. Our intent during this early stage, however, is to point out the fish and wildlife features on the study area which should be considered during planning efforts, and to identify study needs which we feel should be satisfied to insure that these resources are adequately protected.

The American Bottoms at one time supported one of the most diverse and productive wetland ecosystems in the midwest. Remnants of these formally expansive habitats are still found in scattered locations throughout the area. Many still support extant communities of the once abundant flora and fauna endemic to the region. Among these are little blue heron, snowy egret, Mississippi kite, great plains rat snake, ring-billed gull and heart leaf plantain.

These wetlands have been extensively abused over time as a result of municipal and industrial development. Many of the few remaining remnants which do exist are subject to toxic and caustic discharges; others are illegally used as landfills. However, the presence of the only known nesting population of little blue heron and snowy egret in the state of Illinois in the eastern portion of the bottoms (Comment Rookery) provides evidence of the resiliency of some wildlife species if given half a chance. Proper planning can minimize future impacts to such resources.

Many of the flooding problems in the American Bottoms area are attributable to the fact that development proceeded in an unwise manner and on areas which prudent men would have avoided. Many of these problems could have been avoided by merely enforcing existing zoning requirements. Future problems can be prevented, in addition, by proper planning. This is the most practical and economical method of avoiding damage to human properties from groundwater flooding.

Unwise developments of the past are history. We generally agree that some efforts should be made to reduce human property damage. However, because they represent scientific and aesthetic values beyond the scope of economics, the relict wetlands of the study area should be preserved. We would oppose any action which would result in the further destruction (directly or indirectly) of the wetlands in the American Bottoms and will provide whatever assistance necessary to prevent such loss.

For conducting your groundwater studies, the effects of various alternatives which could be developed (i.e. pumping, ditching, tiling, ect.) on surface water and moist soil conditions should be explicitly defined, in order for our staff to evaluate impacts on wetland ecosystems and assist you in preventing their loss. The information provided in your Reconnaissance Report does not lend itself to such interpretation. We suggest that additional studies be conducted to answer these needs with special emphasis placed on the areas where wetland habitats could be affected. Please let us know if we can assist you in identifying these habitats.

Sincerely yours,

Thomas M. Groutage

Thomas M. Groutage
Field Supervisor



Illinois Department of Transportation

Division of Water Resources
2300 South Dirksen Parkway/Springfield, Illinois/62764

July 20, 1979

Colonel Leon E. McKimney
District Engineer
U. S. Army Corps of Engineers
210 N. 12th Street
St. Louis, Missouri 63101

Dear Colonel McKimney:

Thank you for the opportunity to respond to the American
Bottoms Groundwater Study Reconnaissance Report.

The reconnaissance report is acceptable to the Illinois
Division of Water Resources. We look forward to the contin-
uation of the study in Stage II.

Sincerely,

Frank Kudrna
Director

Illinois



Department of Conservation

life and land together

FILE A1-3-330

605 WM. G. STRATTON BUILDING • 400 SOUTH SPRING STREET • SPRINGFIELD 62706

CHICAGO OFFICE - ROOM 100, 180 NO. LASALLE 60601

David Kenney, Director • James C. Helfrich, Assistant Director

August 1, 1979

Mr. Jack R. Niemi
Chief, Engineering Division
Department of the Army
210 North 12th Street
St. Louis, MO 63101

RE: LMSD-BU

Dear Mr. Niemi:

We have completed our review of the Draft Reconnaissance Report for the American Bottoms Groundwater Study.

The document well serves the purpose for which it is intended: to identify the existing problem, determine whether further study is warranted, and develop a work plan for further action. It also provides a good deal of useful information concerning the local groundwater system, historical fluctuations in the water table, and possible solutions to the existing problem.

We note that the draft report gives very little consideration to fish, wildlife, and recreational concerns in the project area. While this is to be expected at this stage of the planning process, we would hope that future studies would thoroughly investigate the relationship of the groundwater system to existing lakes and marshes in the American bottoms and evaluate the possible impacts to these areas that could be brought on by a lowering of the groundwater table. As you know, two of our properties, Frank Holten and Horseshoe Lake State Parks, include aquatic resources that could be affected. In addition, the Illinois Natural Areas Inventory recognized two sites in the project area that could be impacted by lowering of the groundwater table. These are Levee Lake, the last remaining relatively undisturbed shrub swamp/pond in the American bottoms, and the Comment Rookery, which is a marsh area supporting several Illinois threatened and endangered avian species. Maps of these two sites are attached for your information.

We appreciate the opportunity to comment on this draft report, and we look forward to further interaction as the study progresses.

Sincerely,

Robert W. Schanzle
Resources Planner
Division of Planning

RWS:th



County MADISON No. 1

Name of Area LEEVE LAKE

Quadrangle MONKS MOUND 7.5'

Location SEC 25 AND 36, T3N, R9W

ILLINOIS NATURAL AREAS INVENTORY





County ST. CLAIR

No. 229

Name of Area COMMENT ROOKERY

Quadrangle FRENCH VILLAGE 7.5'

Location SEC. 15, T2N, R9W

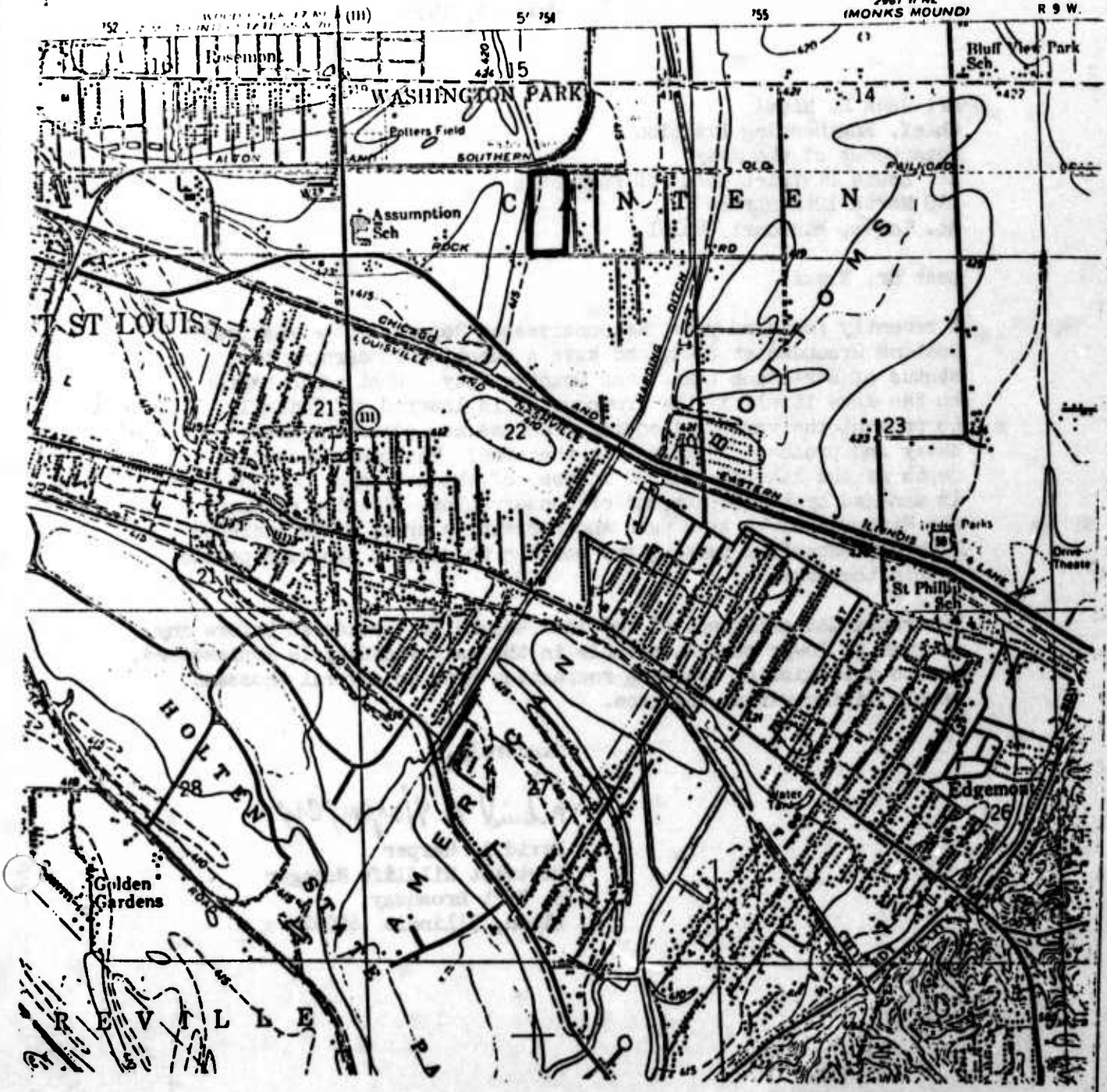
ILLINOIS NATURAL AREAS INVENTORY

TERIOR
Y

GEOLOGICAL SURVEY DIVISION

2961 H NE
(MONKS MOUND)

R 9 W.



Illinois



Department of Conservation

life and land together

REGION IV
34 W. Broadway
Alton, Illinois 62002
Phone 618/462-1181

605 STATE OFFICE BUILDING - 100 SOUTH SPRING STREET - SPRINGFIELD 62706
CHICAGO OFFICE - ROOM 1001 150 N. LASALLE 60601
David Kennedy, Director • James C. Helfrich, Assistant Director

July 25, 1979

Mr. Jack R. Niemi
Chief, Engineering Division
Department of the Army
St. Louis District Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Dear Mr. Niemi:

I recently reviewed your Reconnaissance Report of the American Bottoms Groundwater Study and have a question concerning the status of Horseshoe Lake, near Granite City. What would happen to the lake itself if the groundwater is lowered sufficiently to prevent the various flooding problems now occurring after heavy and prolonged rainfall in the area? The overall average depth of the lake is only 30 inches, of which a major portion is managed by the Department of Conservation, Division of Lands and Historic Sites as a park and recreation area. This includes fishing, waterfowl hunting and boating to several thousand people within the area.

The continued existence of the lake should be considered before any program to lower the water table in the lake vicinity is implemented, due to its existing use as a recreation area to several thousand people living within the area.

Sincerely,

David A. Harper/erg

David A. Harper
District Wildlife Manager
34 West Broadway
Alton, Illinois 62002

DH/erg

REGIONAL STUDY AREA

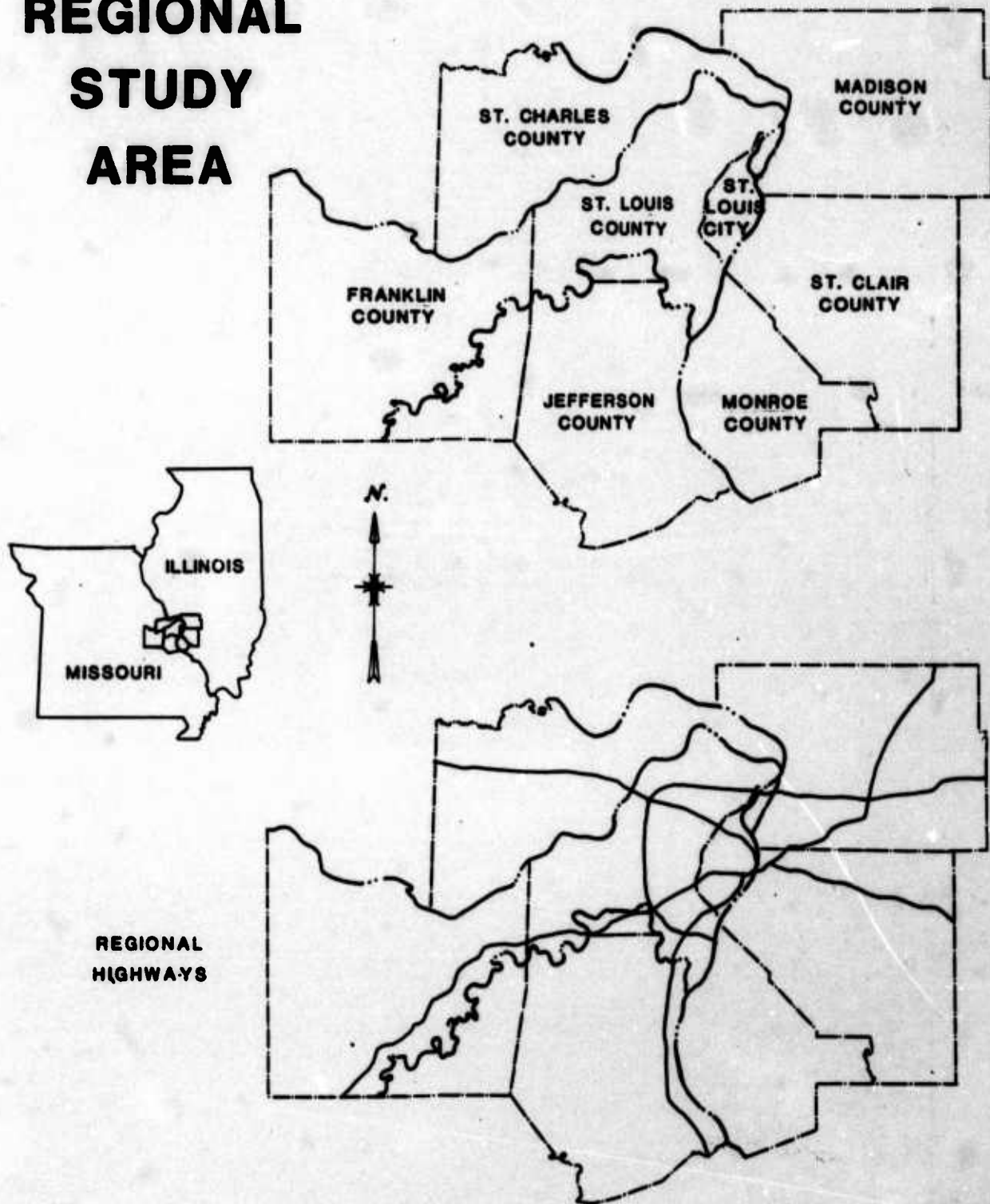


FIGURE 1

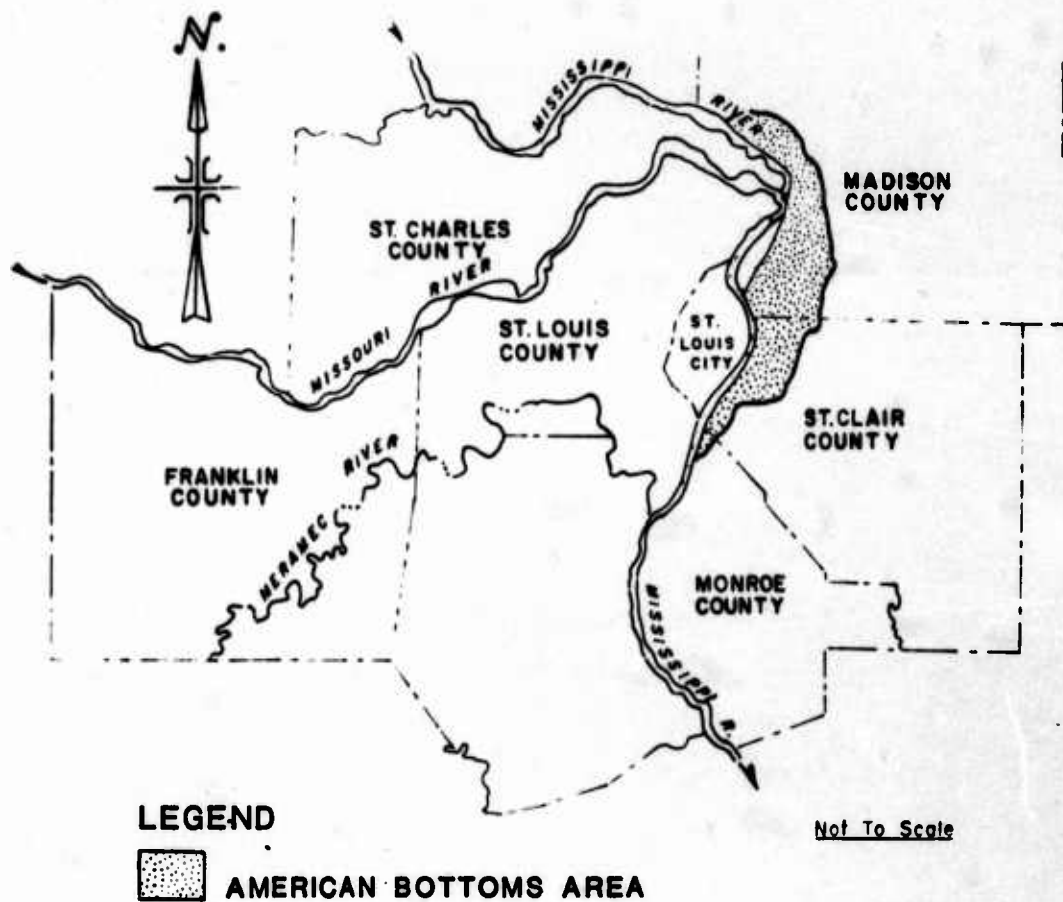
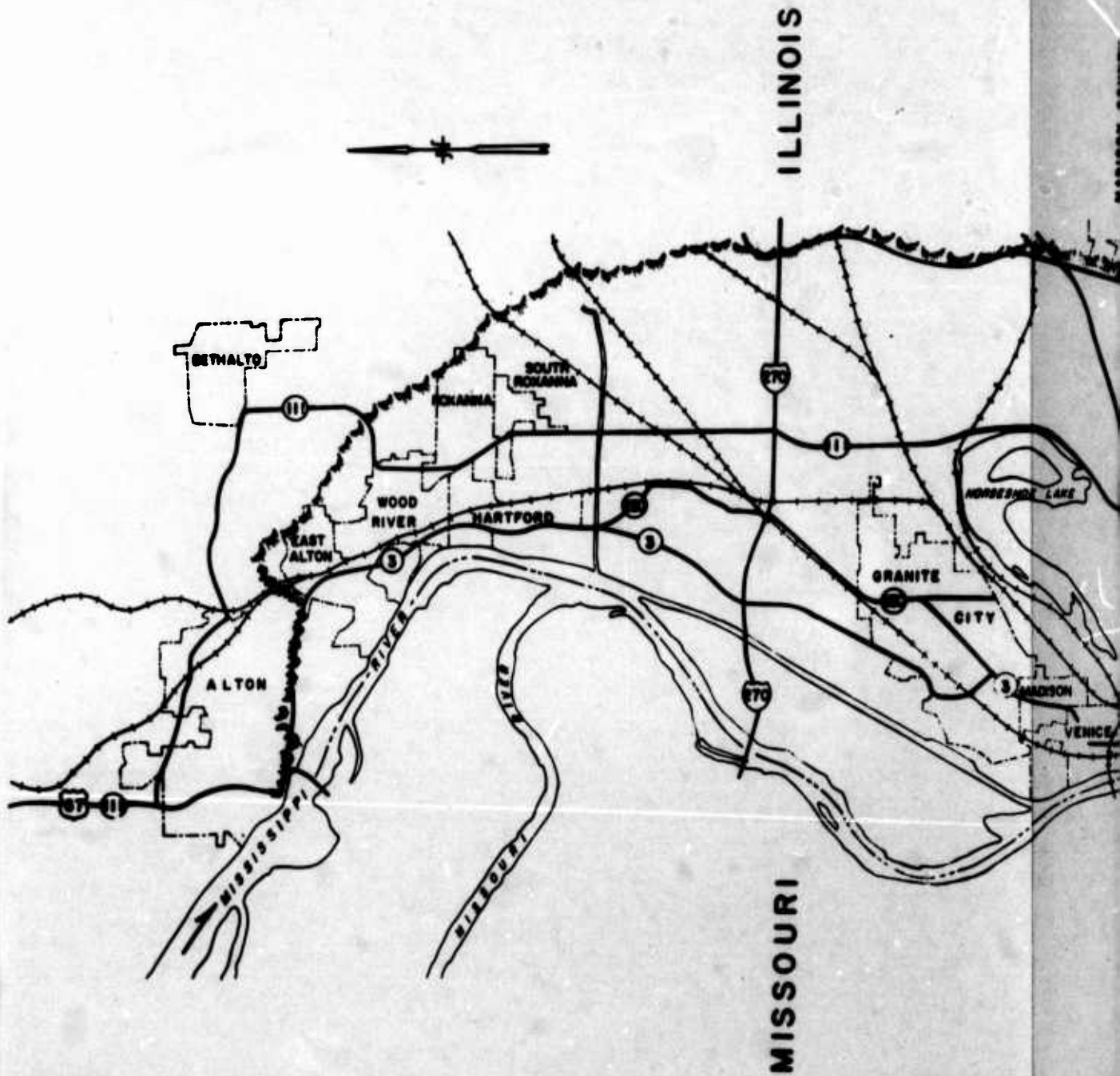


FIGURE 2 VICINITY MAP - AMERICAN BOTTOMS



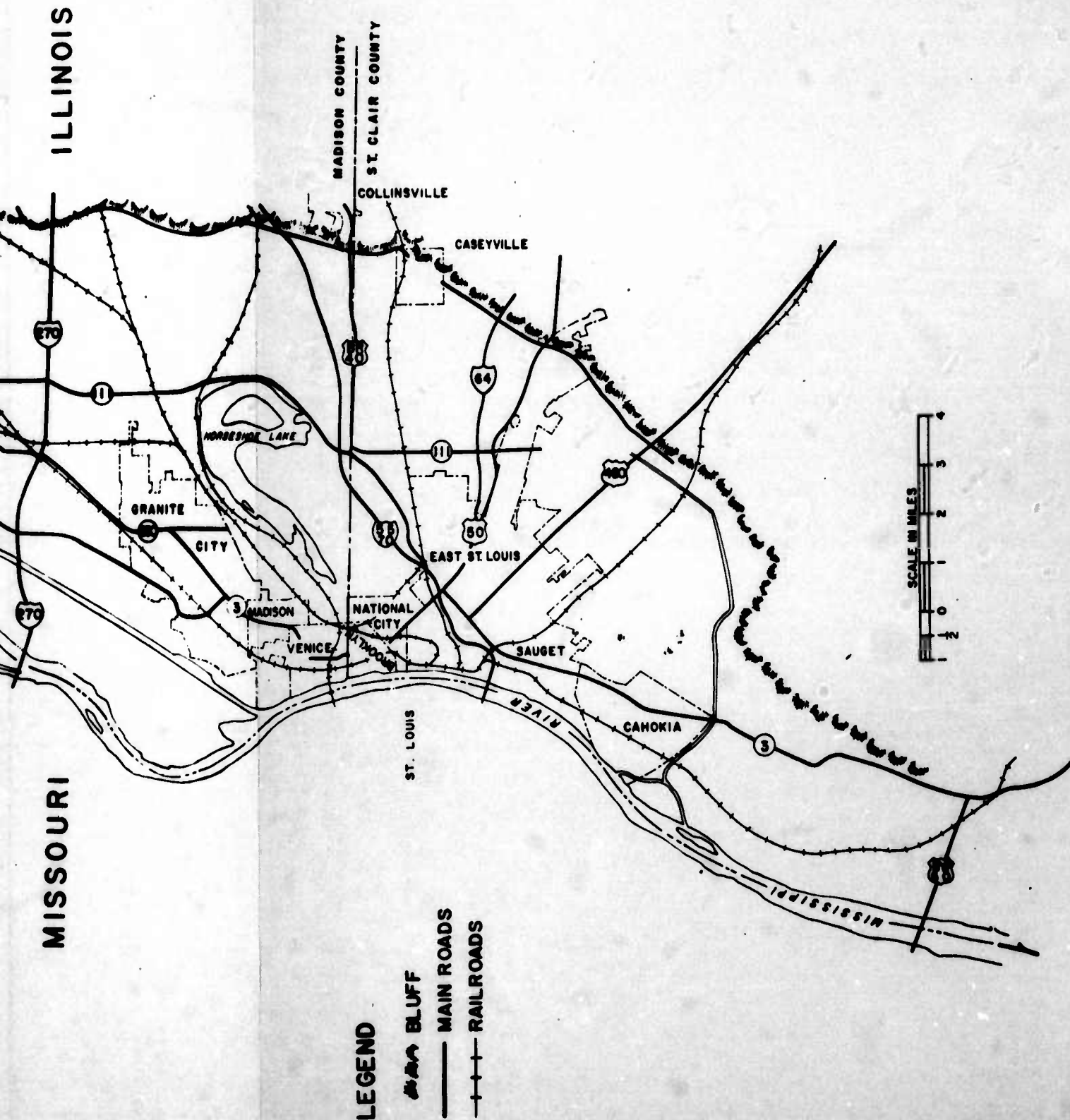


FIGURE 3 MAP OF THE AMERICAN BOTTOMS

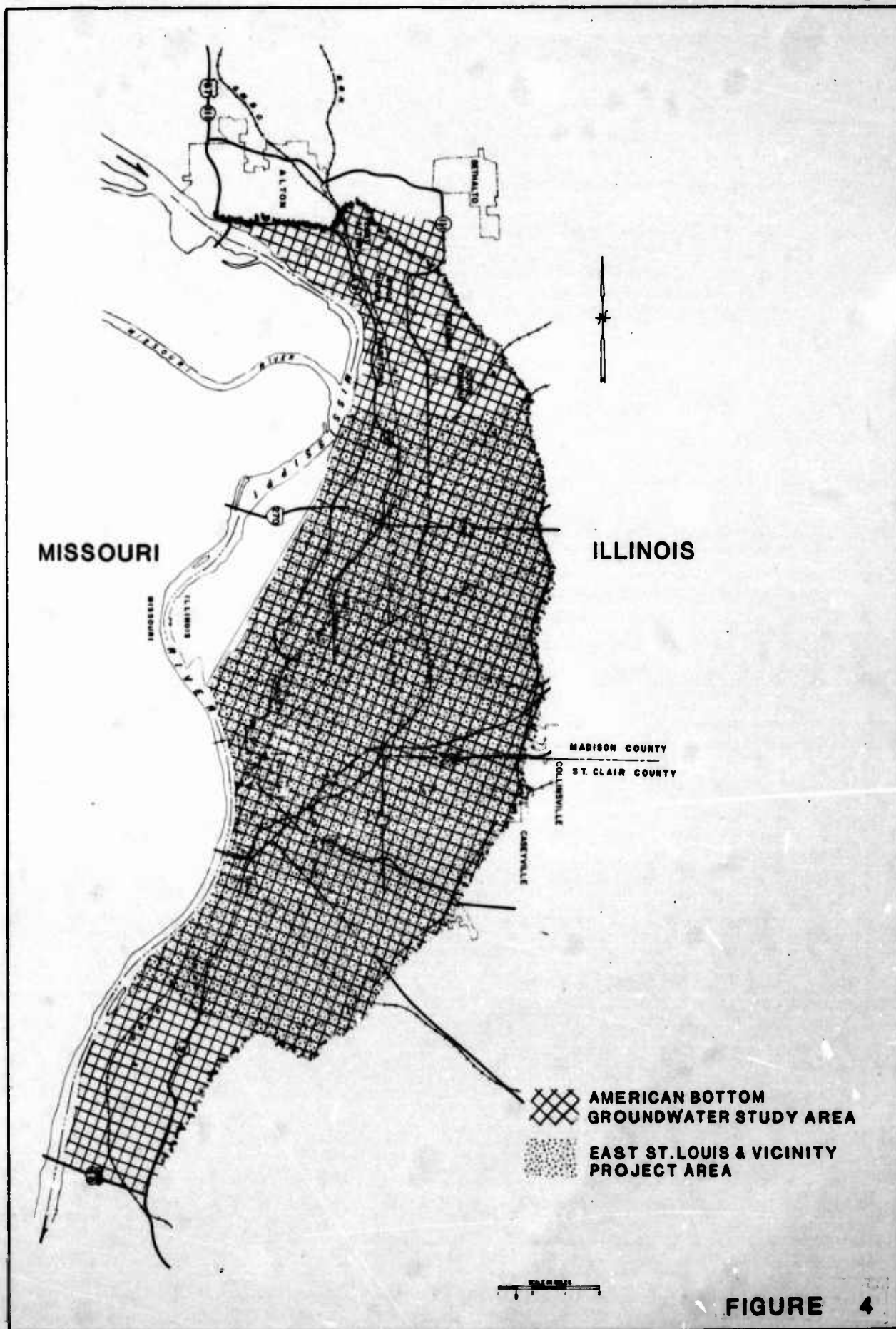
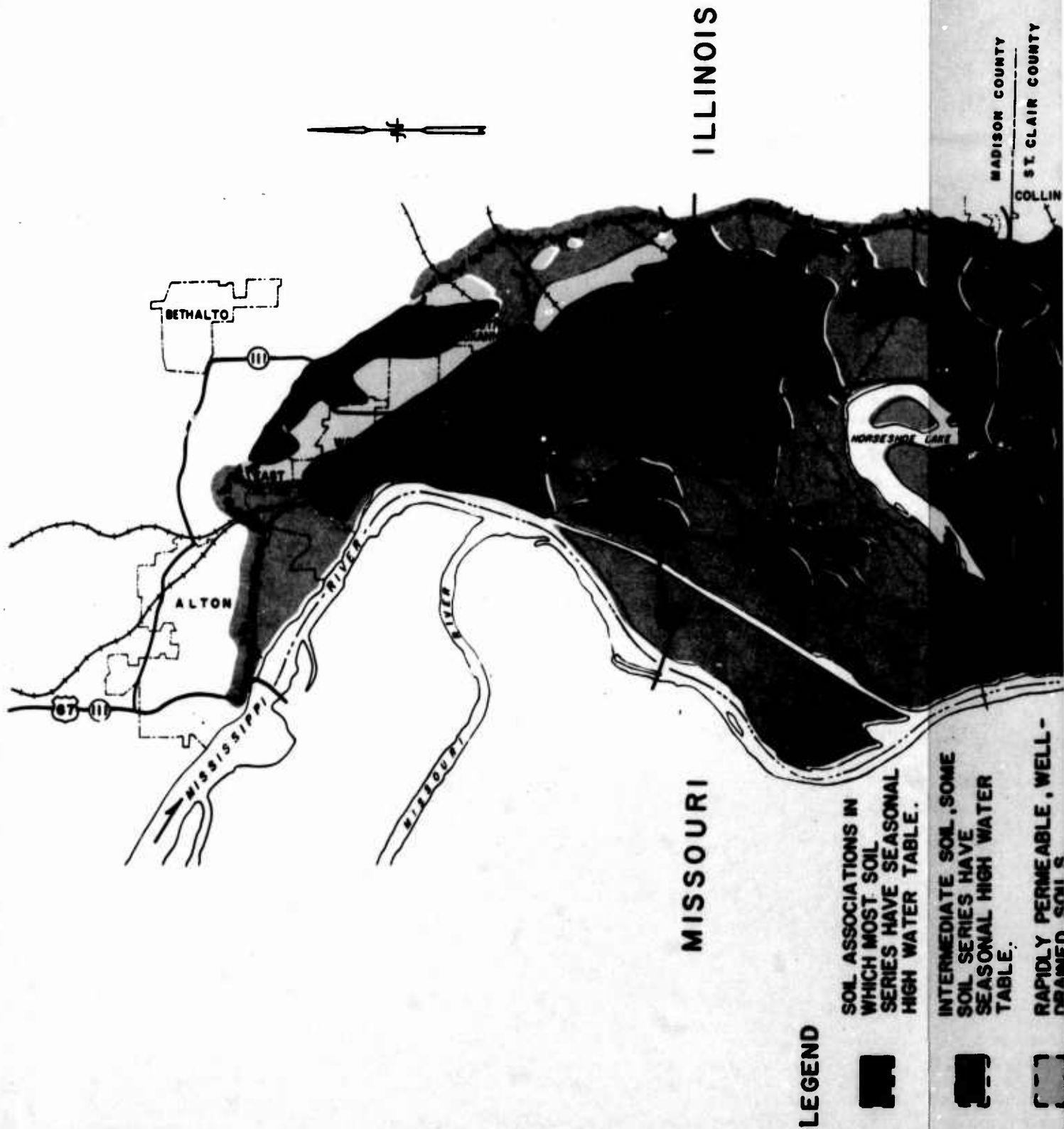


FIGURE 4



MISSOURI

ILLINOIS

LEGEND

 SOIL ASSOCIATIONS IN WHICH MOST SOIL SERIES HAVE SEASONAL HIGH WATER TABLE.

 INTERMEDIATE SOIL, SOME SOIL SERIES HAVE SEASONAL HIGH WATER TABLE.

 RAPIDLY PERMEABLE, WELL-DRAINED SOILS.

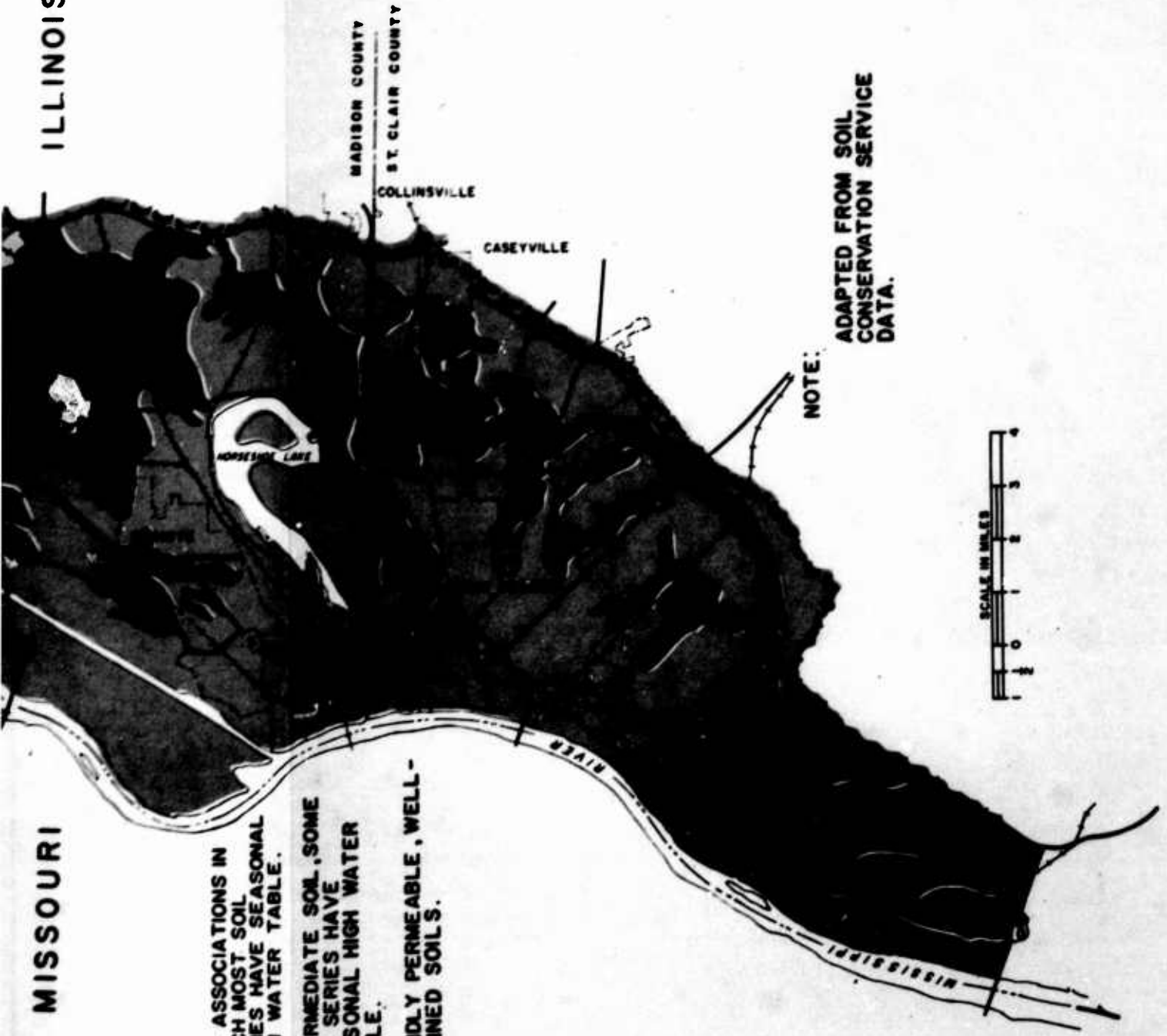
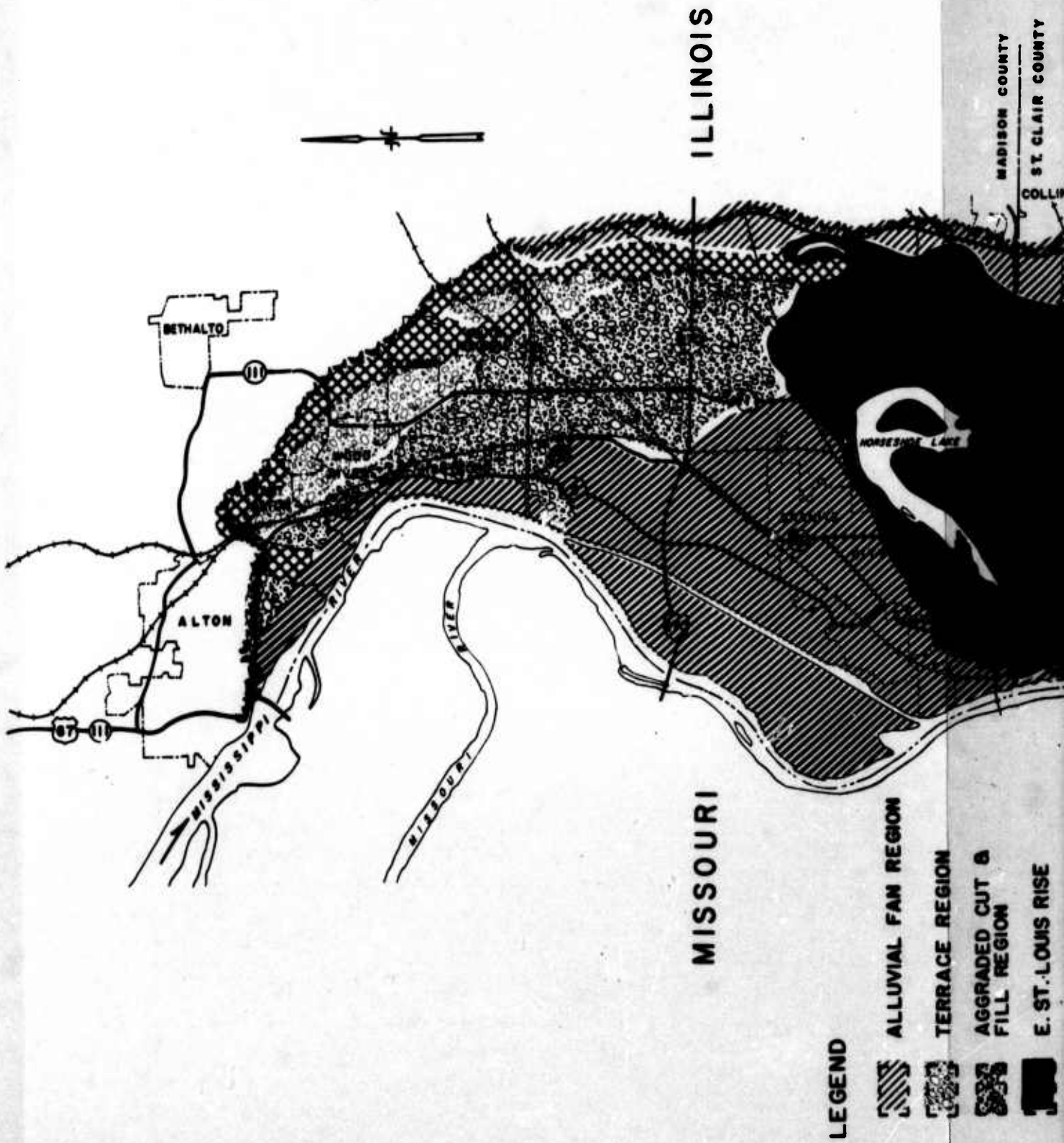


FIGURE 5 - GENERAL SOIL GROUPS.

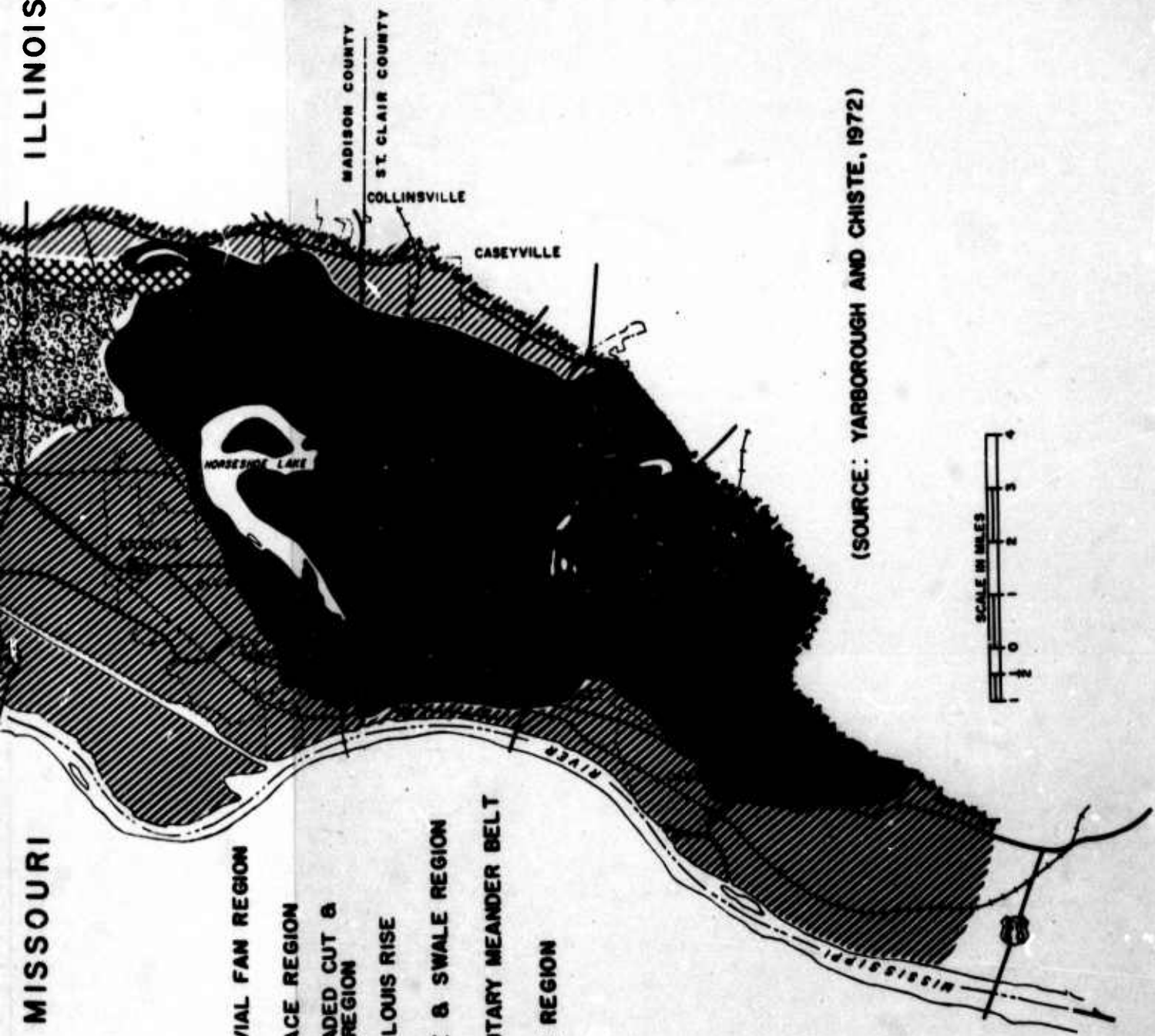


ILLINOIS

MISSOURI

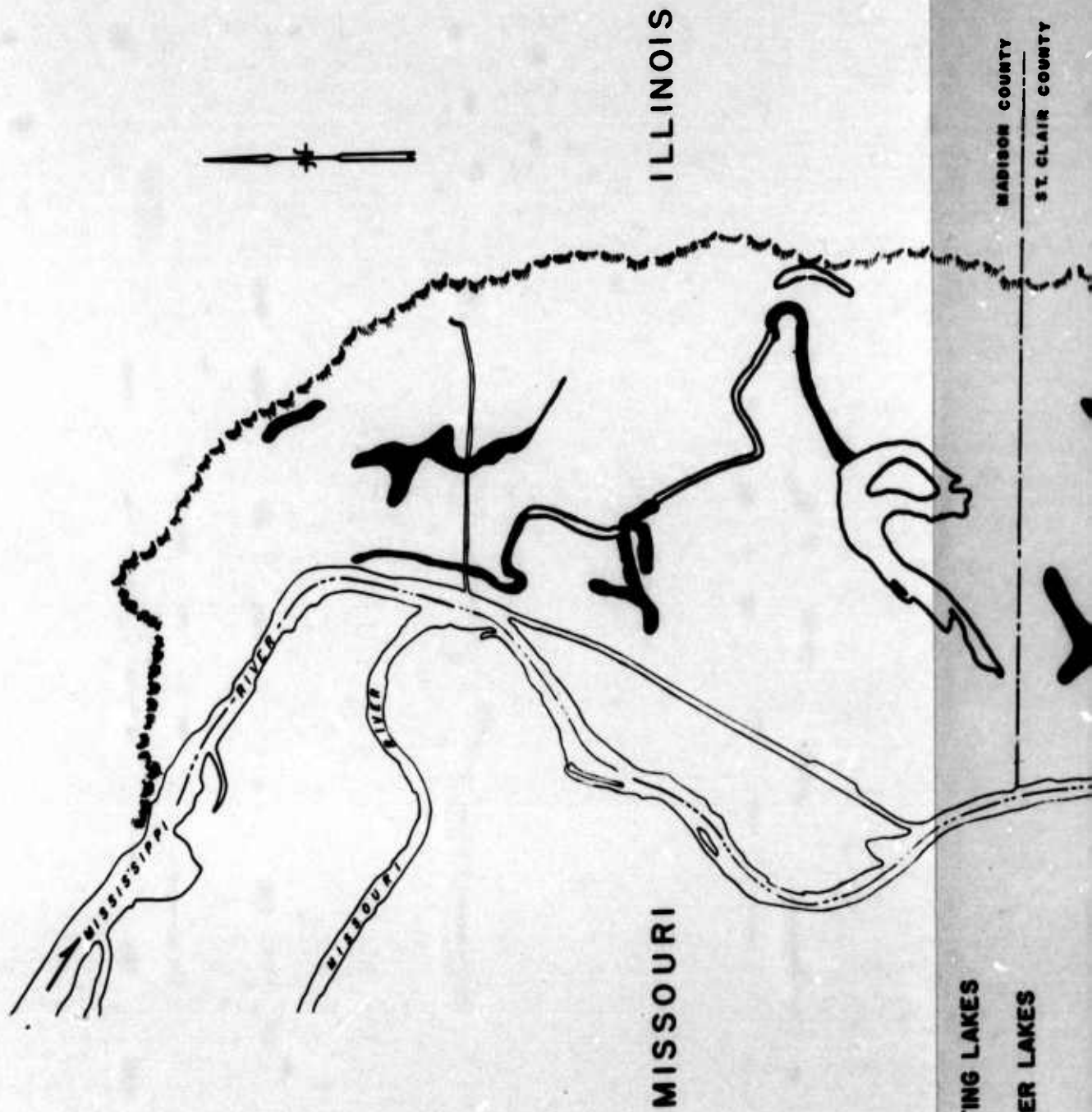
LEGEND

- ALLUVIAL FAN REGION
- TERRACE REGION
- AGGRADED CUT & FILL REGION
- E. ST. LOUIS RISE
- RIDGE & SWALE REGION
- TRIBUTARY MEANDER BELT
- LAKE REGION



(SOURCE: YARBOROUGH AND CHISTE, 1972)

FIGURE 6 - LANDFORM REGIONS OF THE AMERICAN BOTTOMS



LEGEND

EXISTING LAKES



FORMER LAKES



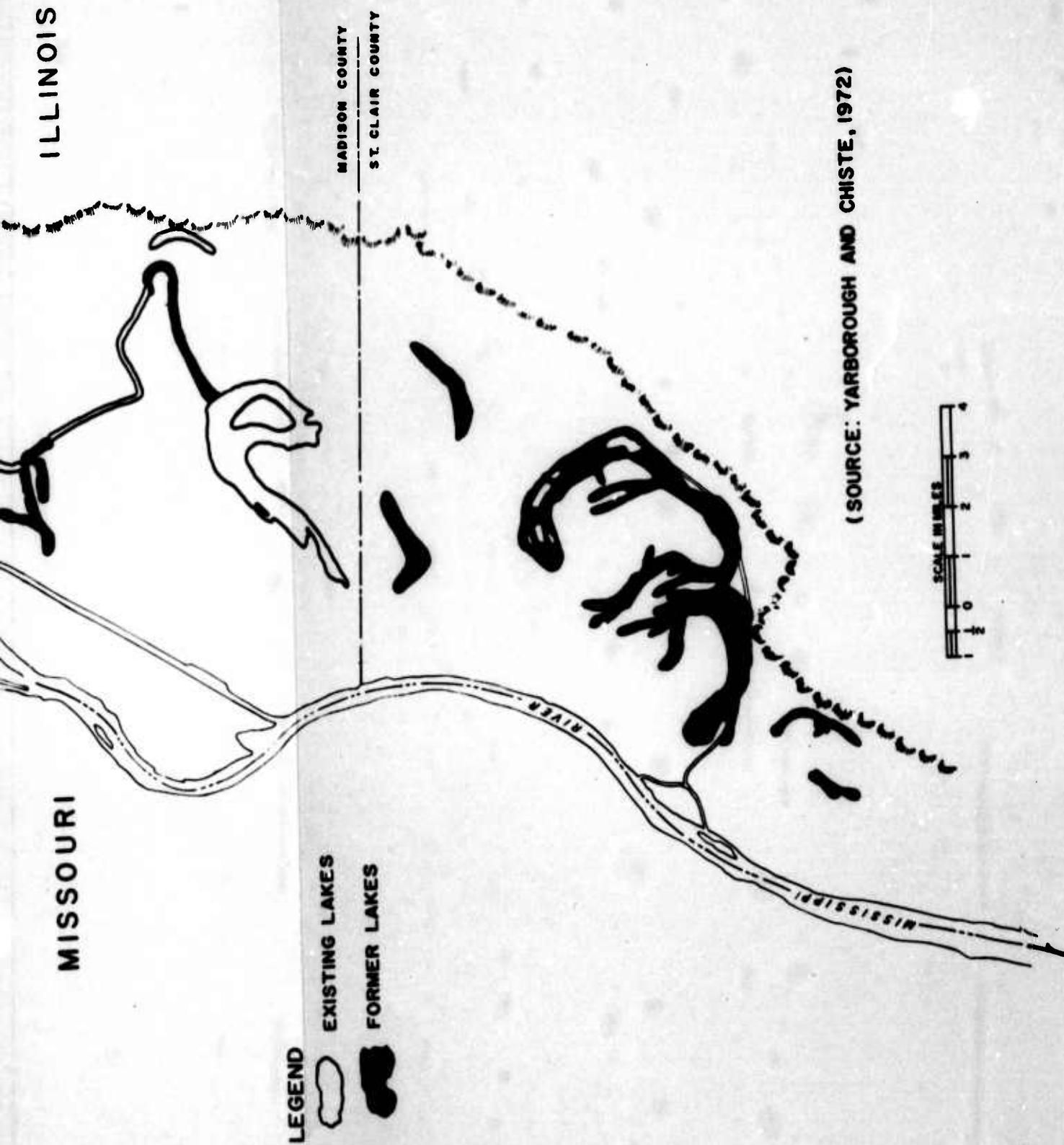


FIGURE 7 - LAKES AND FORMER LAKES.

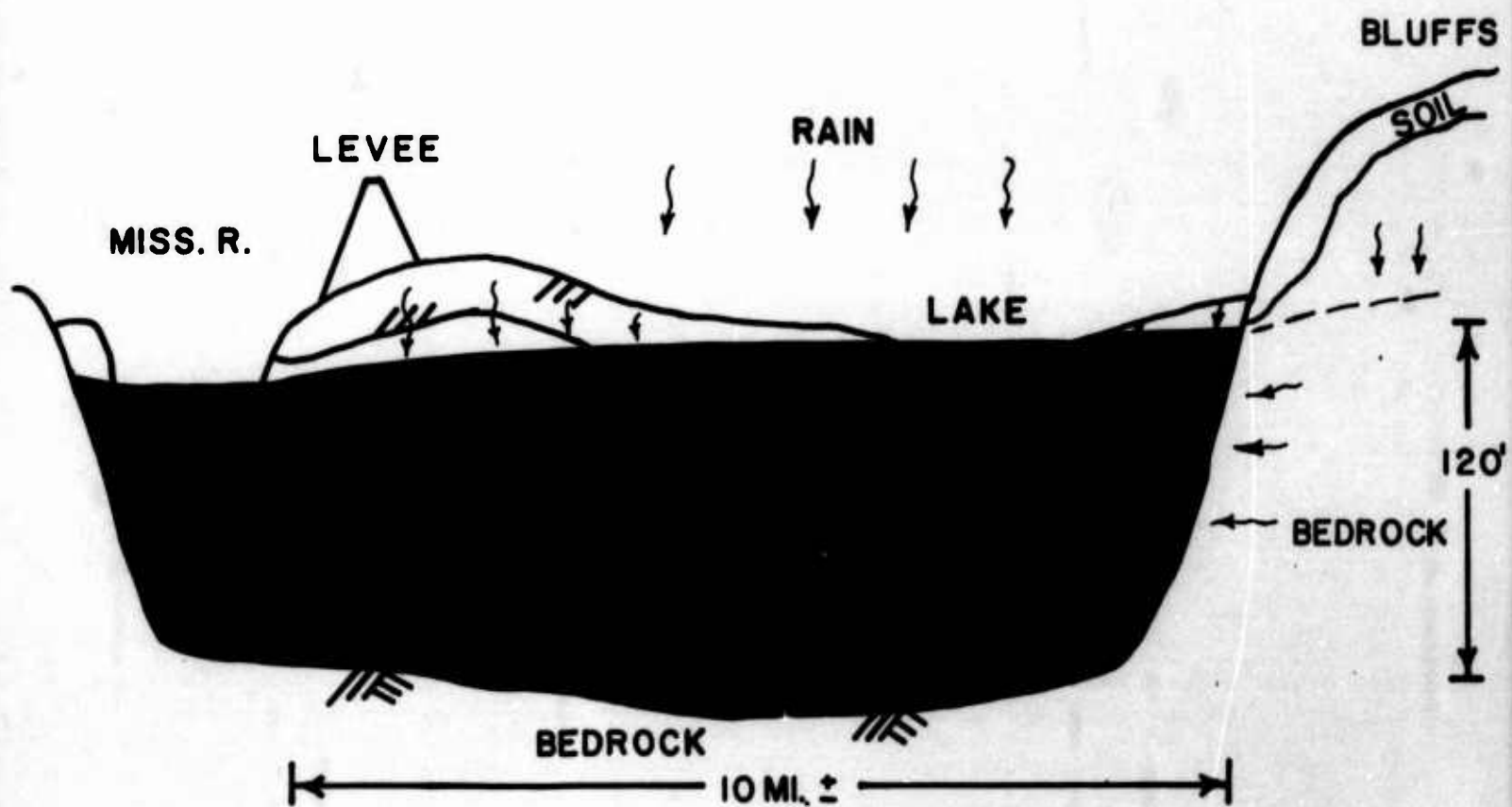


FIGURE 8 - NORMAL GROUNDWATER FLOW IN AMERICAN BOTTOMS.

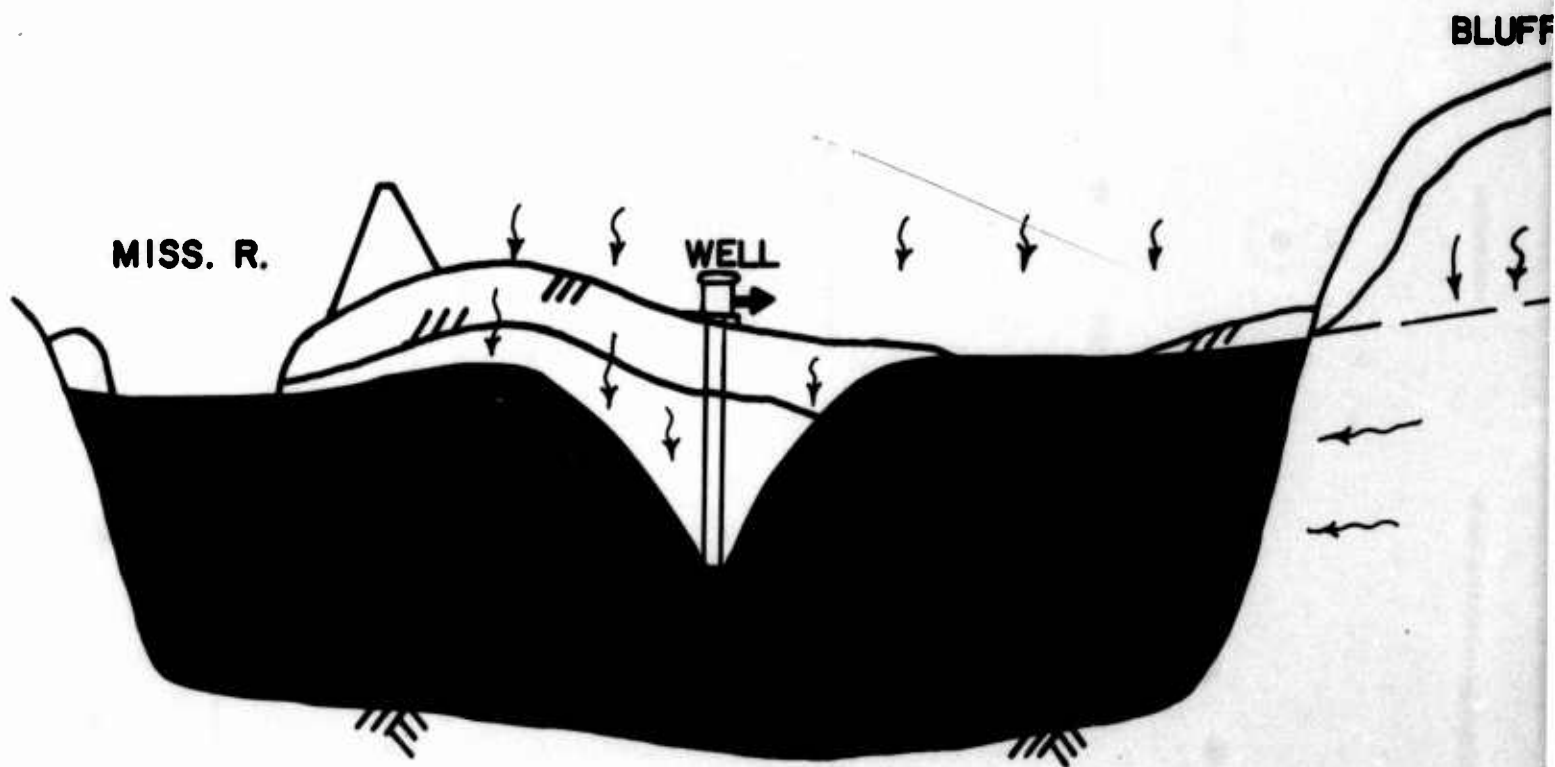


FIGURE 9 - GROUNDWATER FLOW TO A PUMPED WELL.

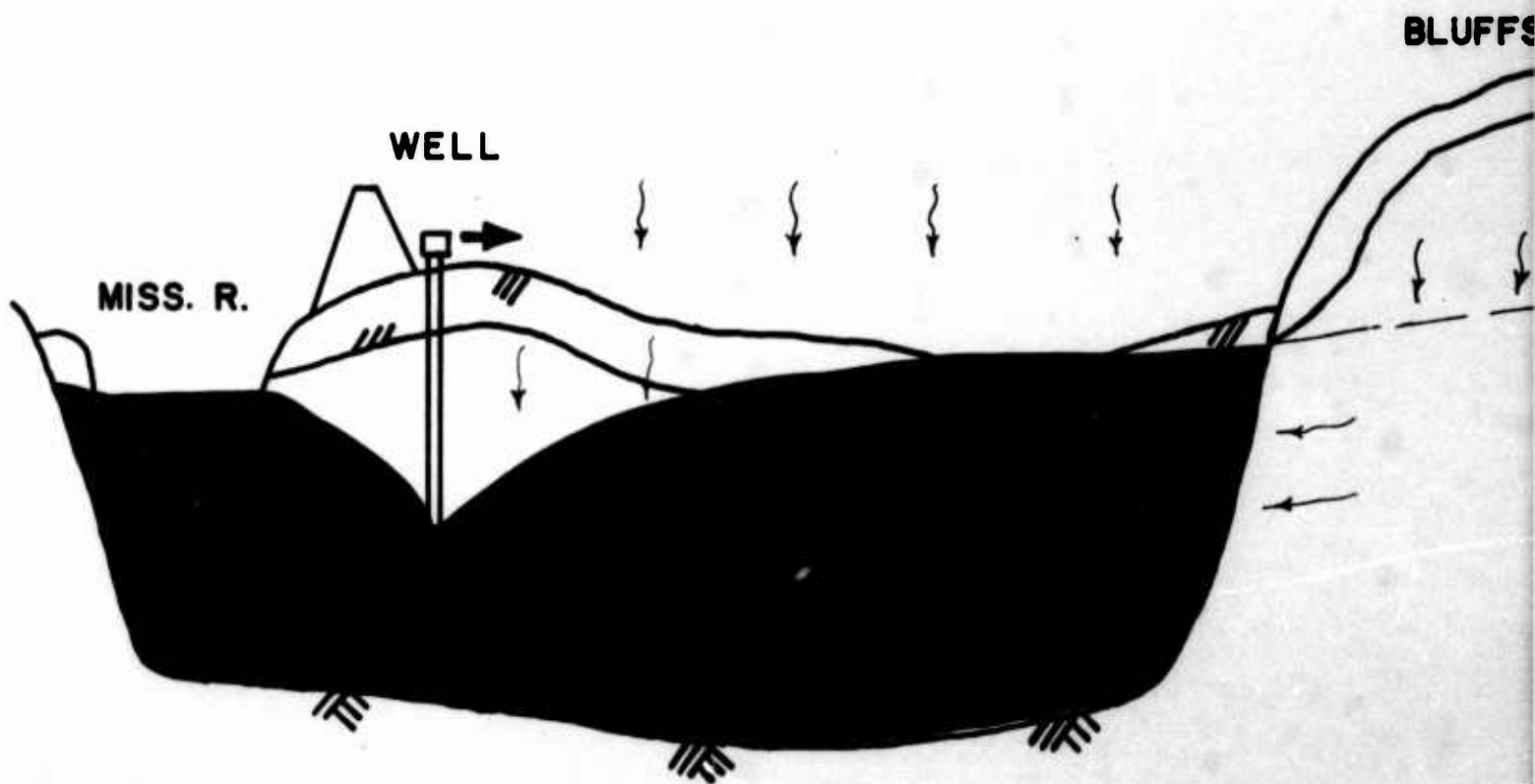


FIGURE 10 - INDUCED INFILTRATION.

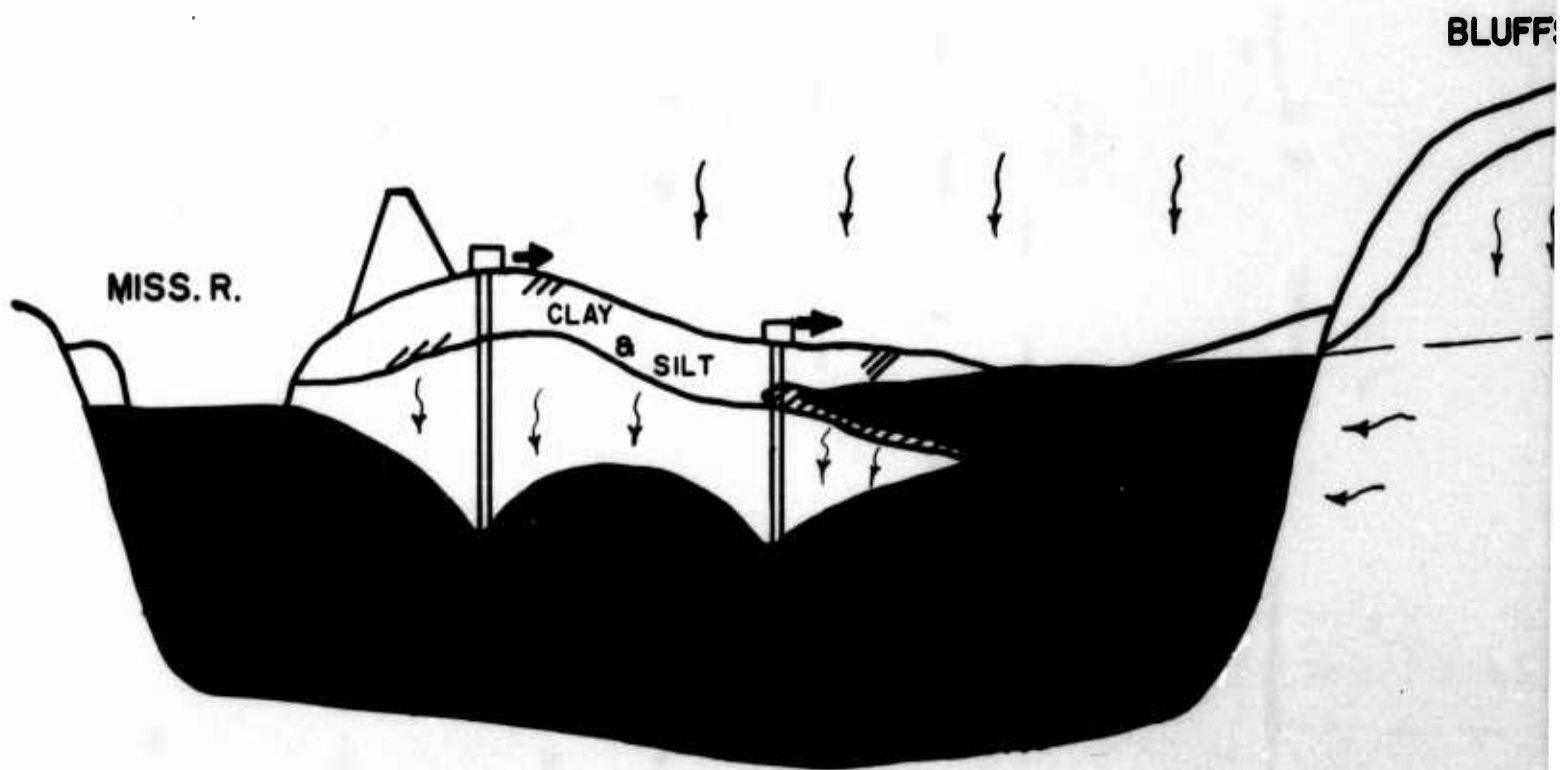


FIGURE 11 - PERCHED WATER TABLE AND PUMPING.

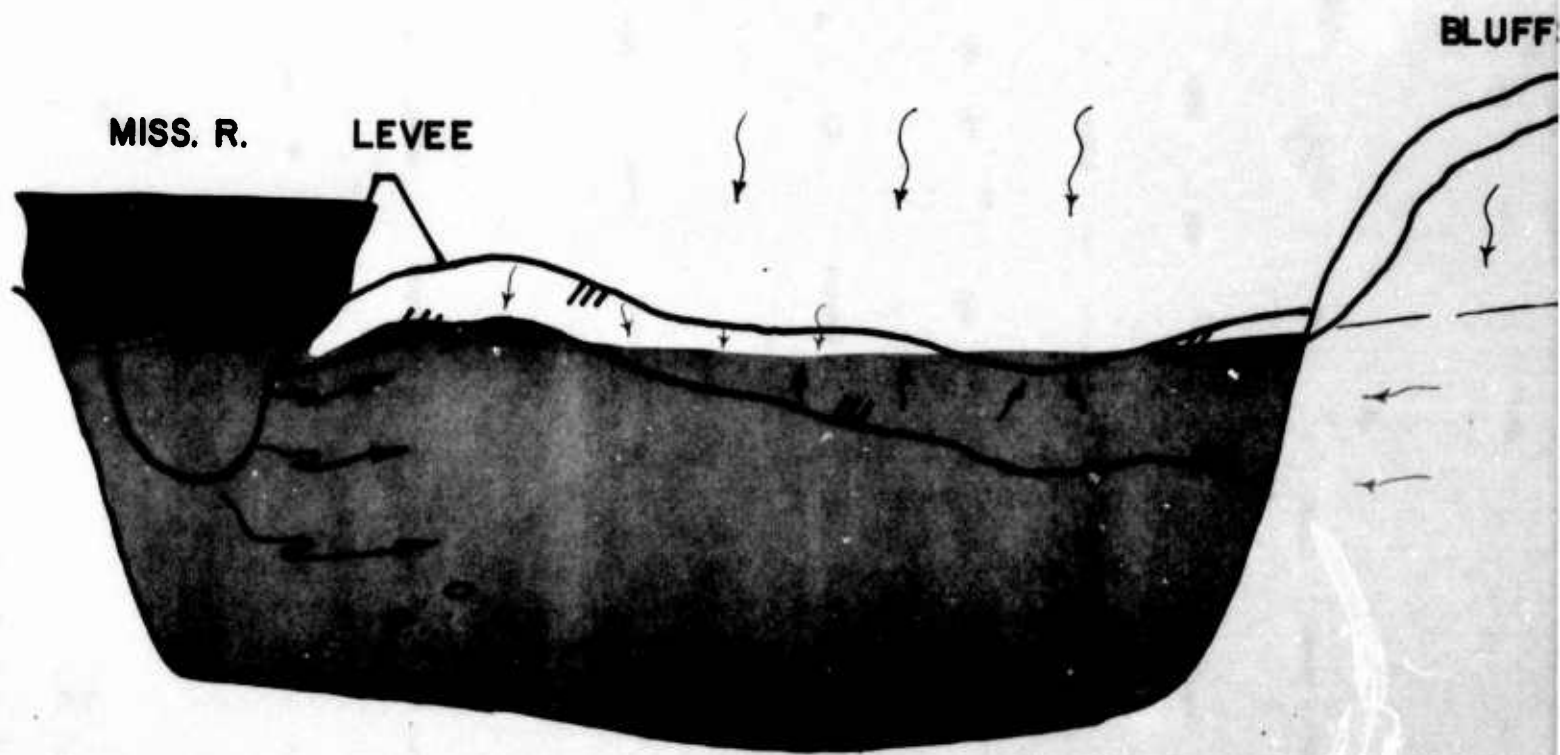


FIGURE 12 - FLOOD CONDITIONS.

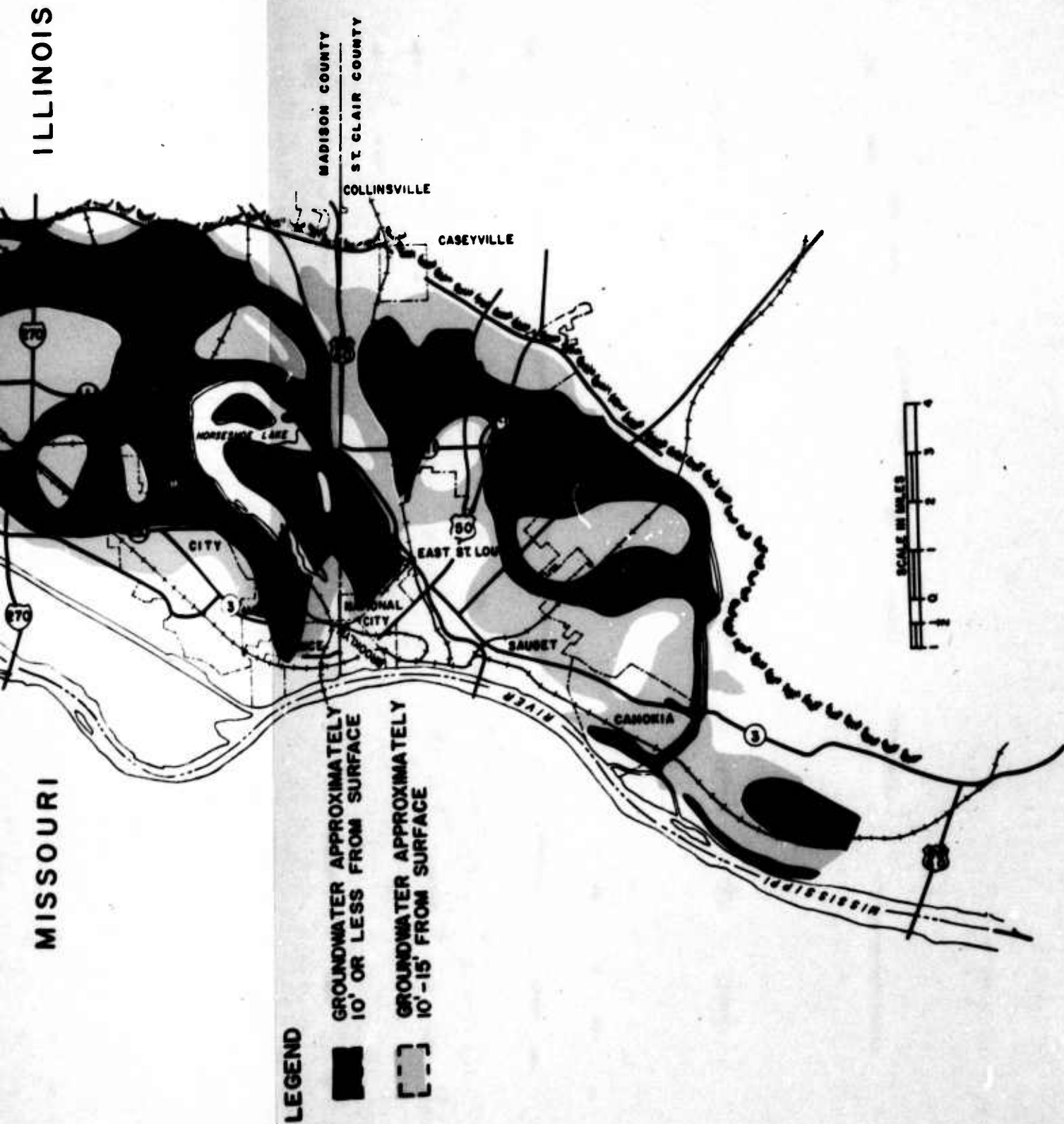
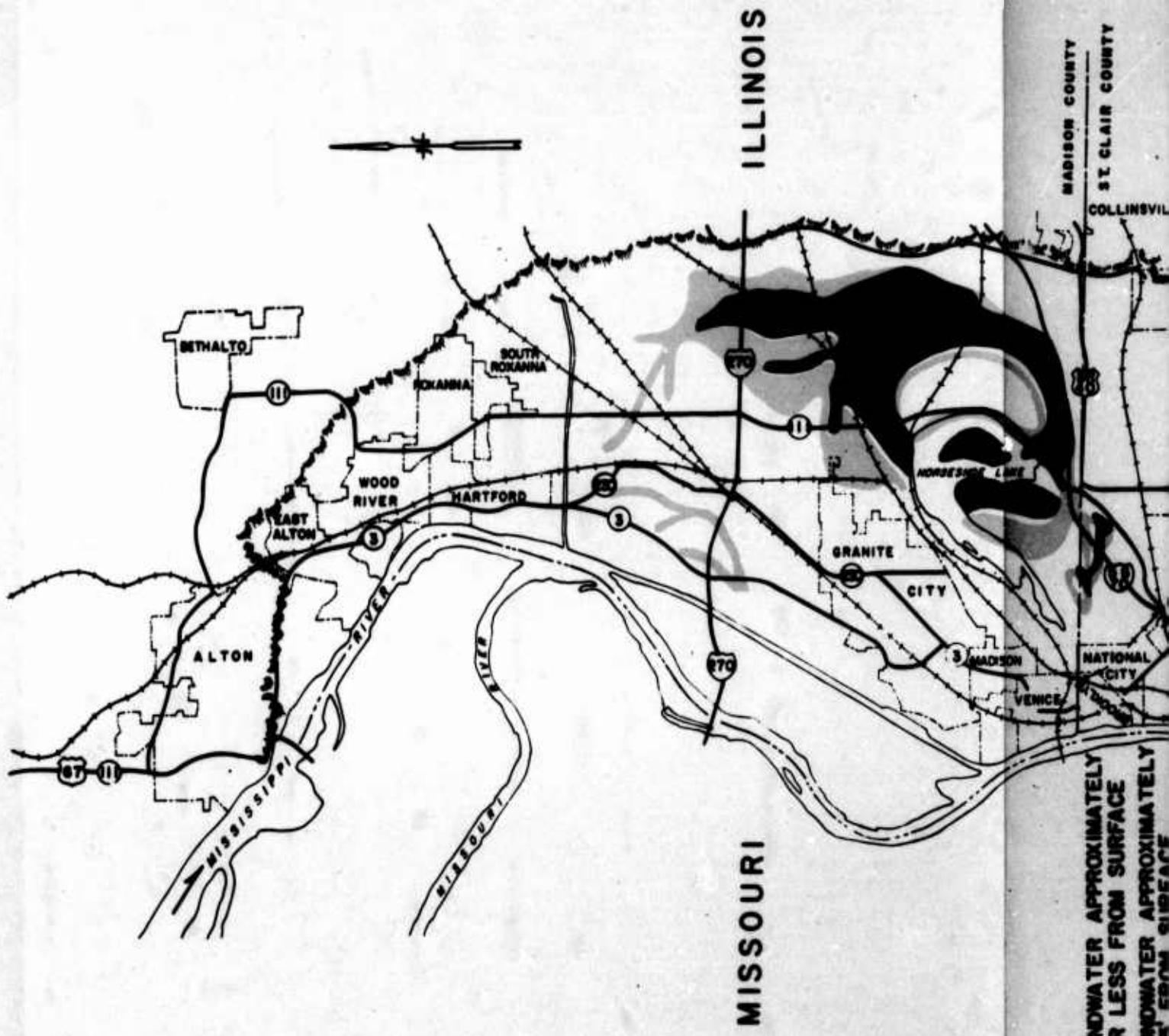


FIGURE 13 - SHALLOW GROUNDWATER AREAS, 1956.



LEGEND

-  GROUNDWATER APPROXIMATELY 10' OR LESS FROM SURFACE
-  GROUNDWATER APPROXIMATELY 10' TO 15' FROM SURFACE

MADISON COUNTY
ST. CLAIR COUNTY

COLLINSVILLE

ILLINOIS

MISSOURI

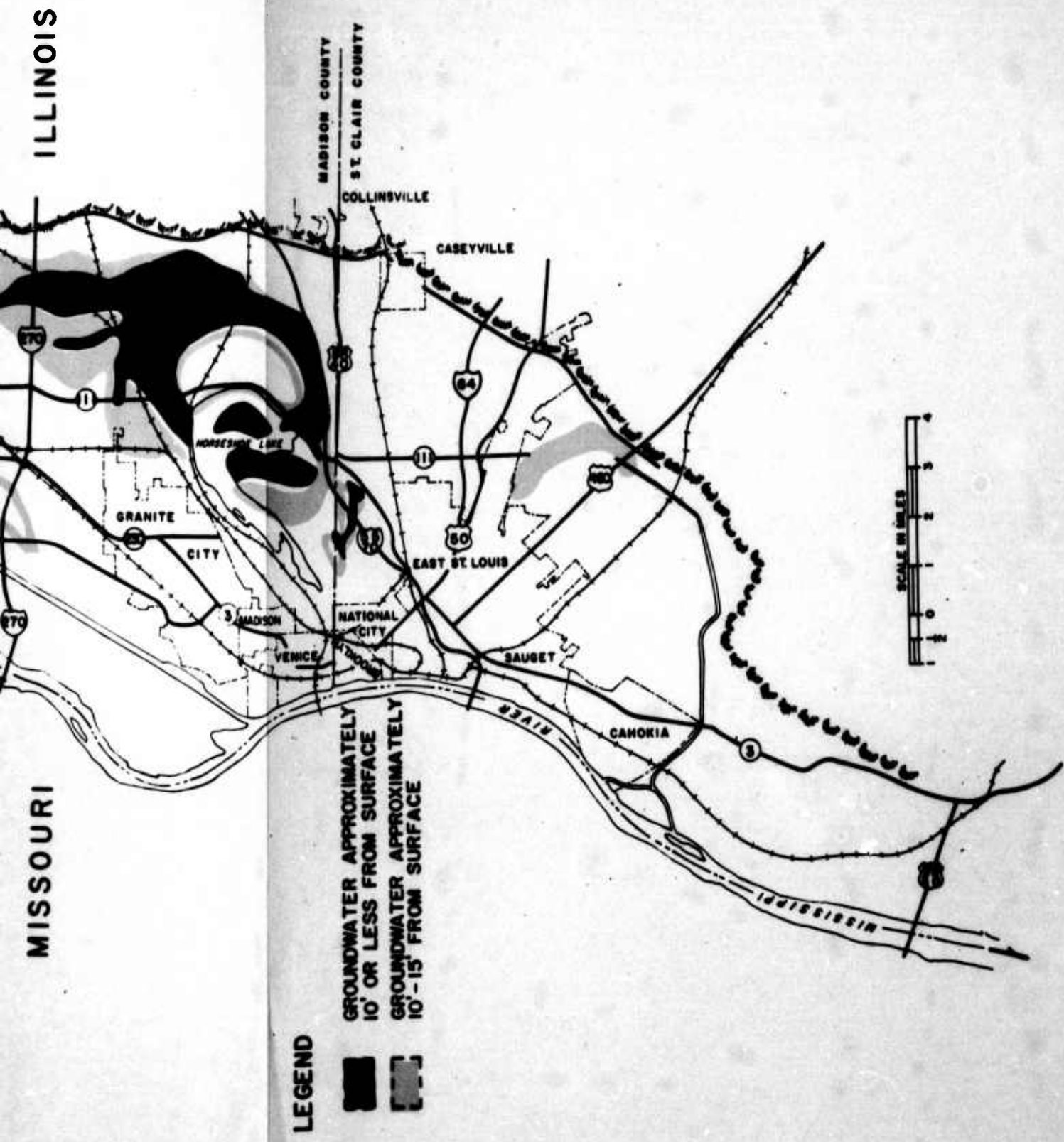
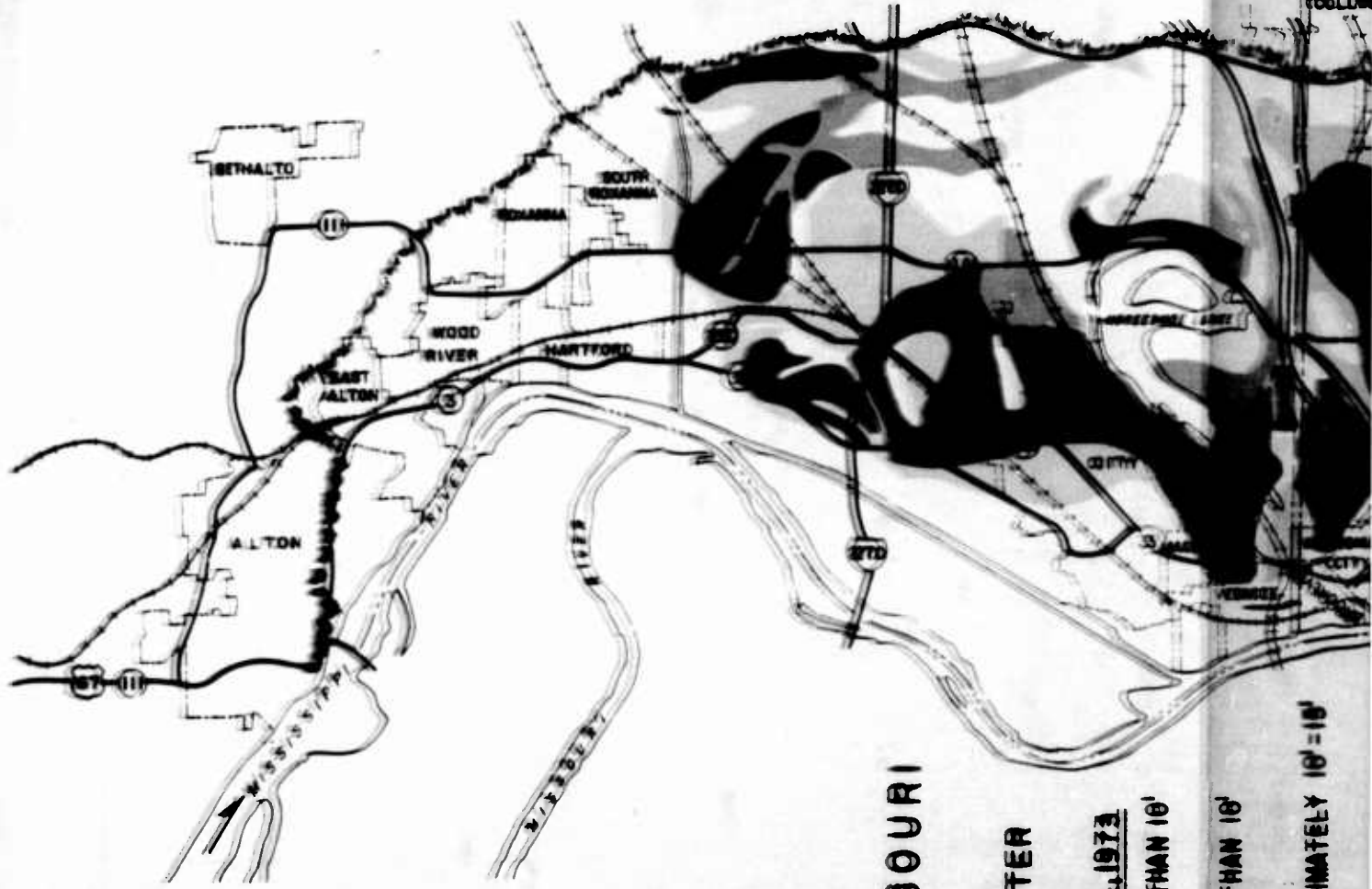


FIGURE 14 - SHALLOW GROUNDWATER AREAS, 1973.



MISSOURI

ILLINOIS

DEPTH TO GROUNDWATER

LEGEND

DEC., 1956

SEPT., 1973

GREATER THAN 15'

LESS THAN 10'

APPROXIMATELY 10'-15'

LESS THAN 10'

GREATER THAN 15'

APPROXIMATELY 10'-15'



MADISON COUNTY
COLLIER COUNTY

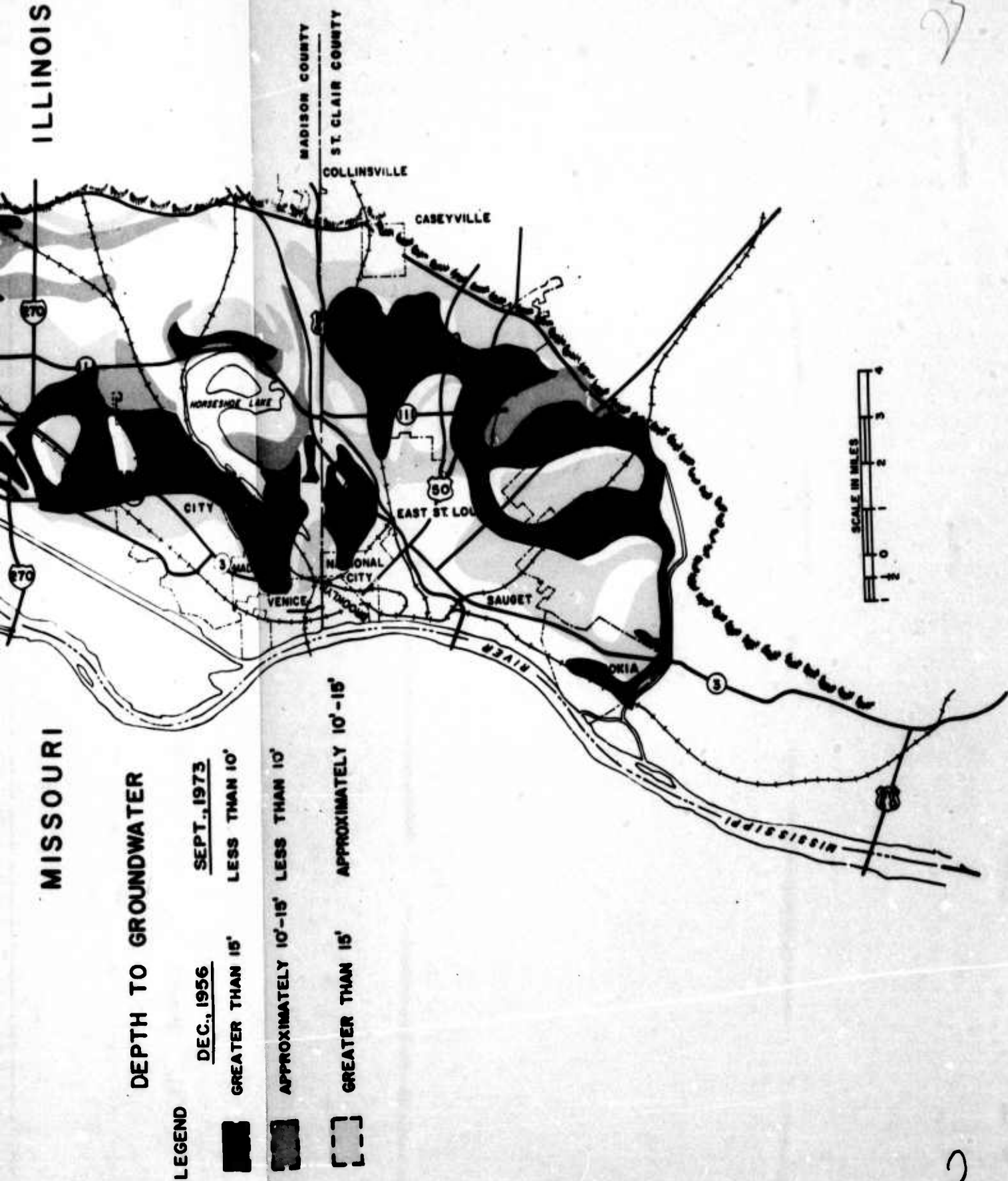
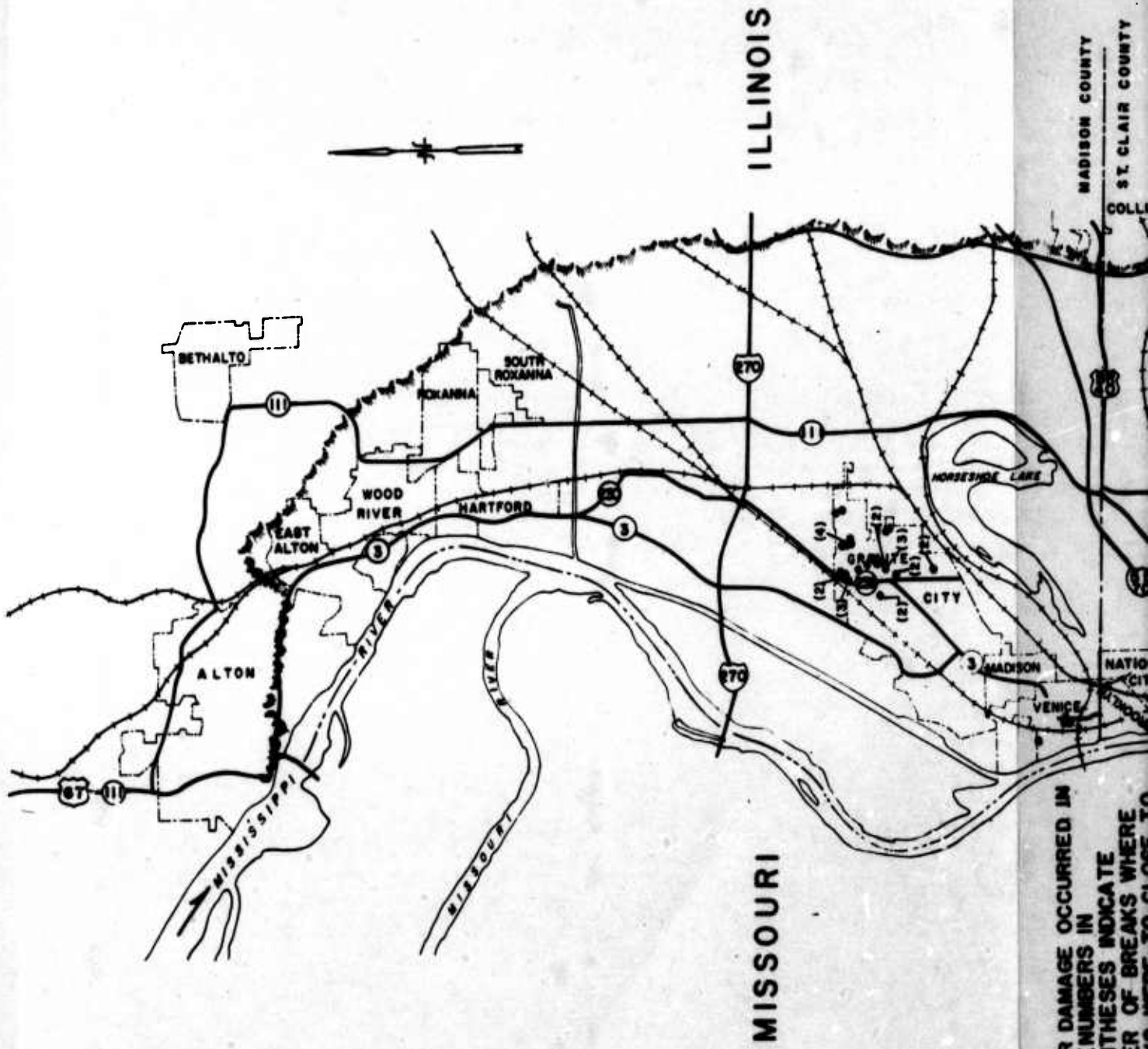


FIGURE 15 - GROUNDWATER CHANGE MAP.



LEGEND

- SEWER DAMAGE OCCURRED IN 1973 (NUMBERS IN PARENTHESES INDICATE NUMBER OF BREAKS WHERE DAMAGE OCCURRED)

MADISON COUNTY
ST. CLAIR COUNTY

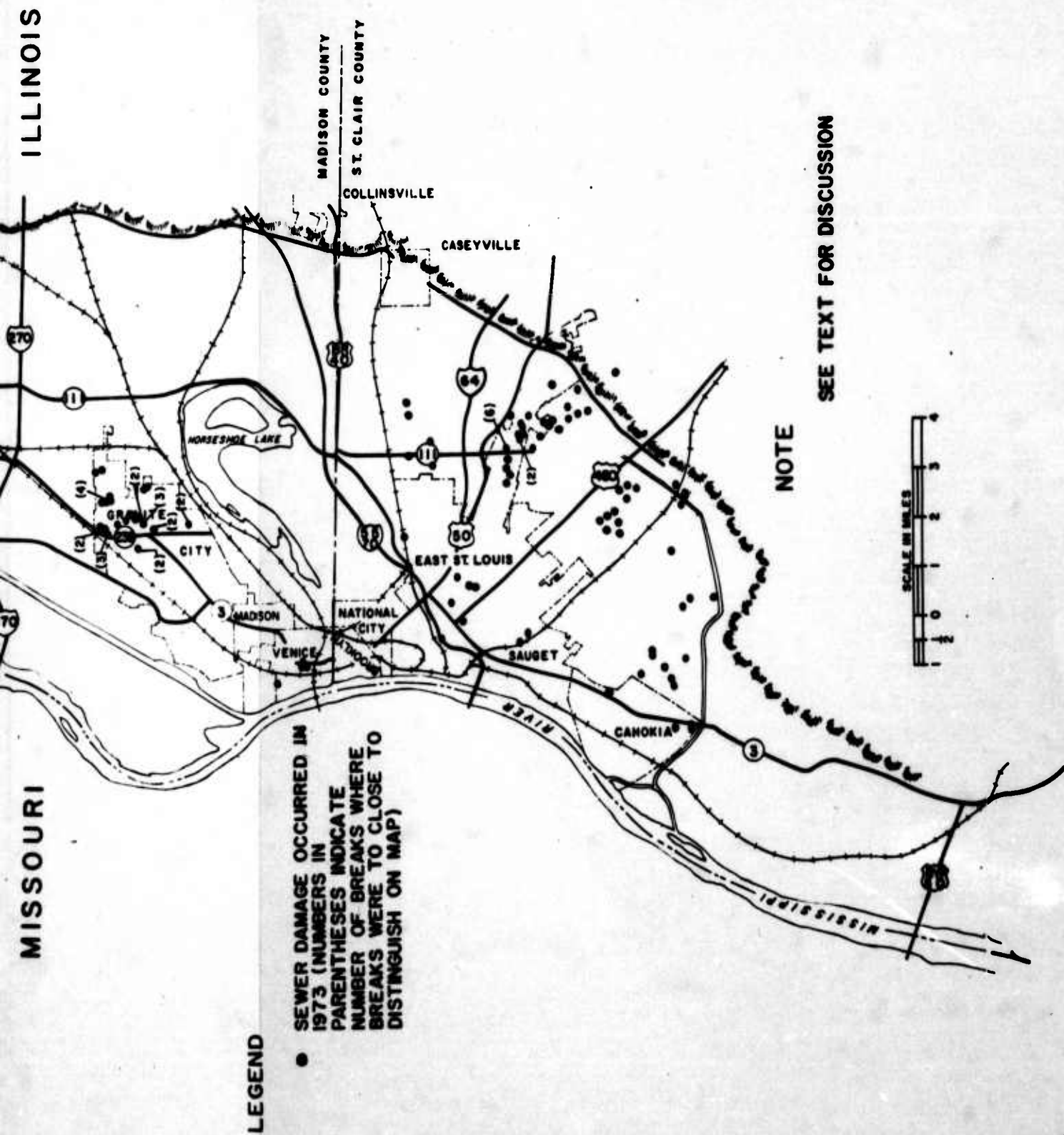
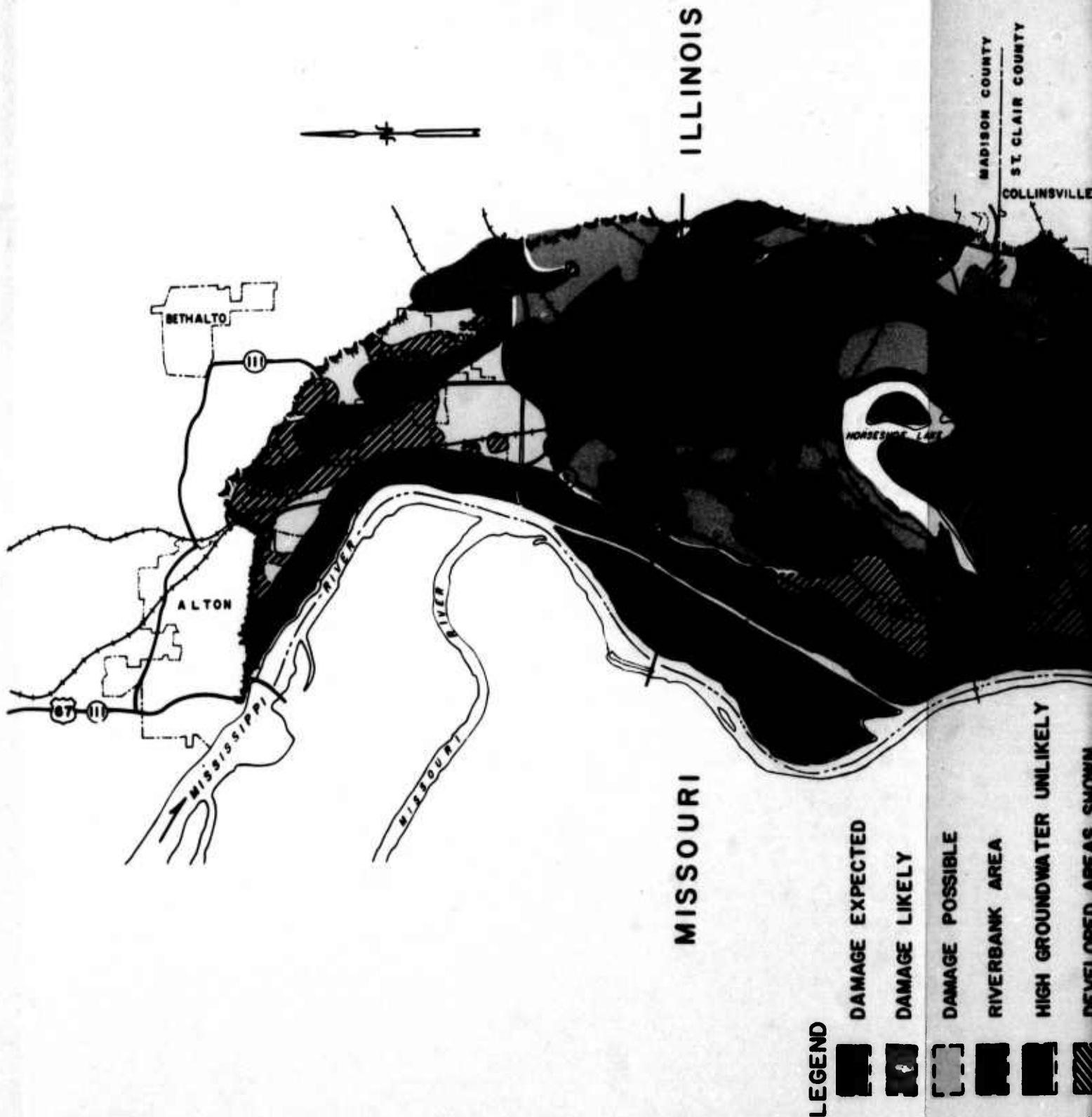


FIGURE 16 - SEWER DAMAGE.



ILLINOIS

MISSOURI

MADISON COUNTY
ST. CLAIR COUNTY

COLLINSVILLE

BETHALTO

ALTON

HORSESHOE LAKE

MISSISSIPPI

MISSOURI

87 11

11

ILLINOIS

MISSOURI

LEGEND

 DAMAGE EXPECTED

 DAMAGE LIKELY

 DAMAGE POSSIBLE

 RIVERBANK AREA

 HIGH GROUNDWATER UNLIKELY

 DEVELOPED AREAS SHOWN

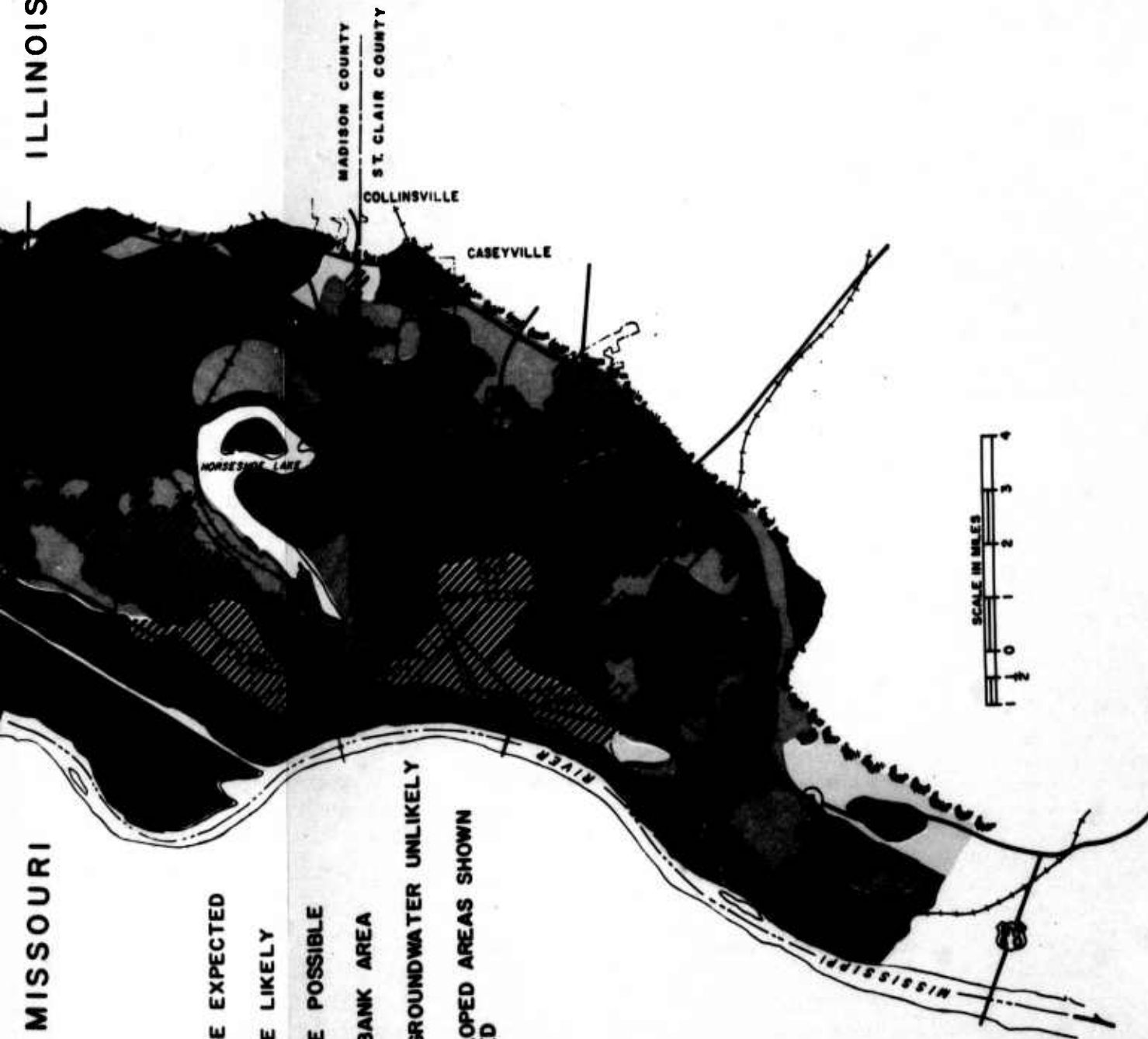
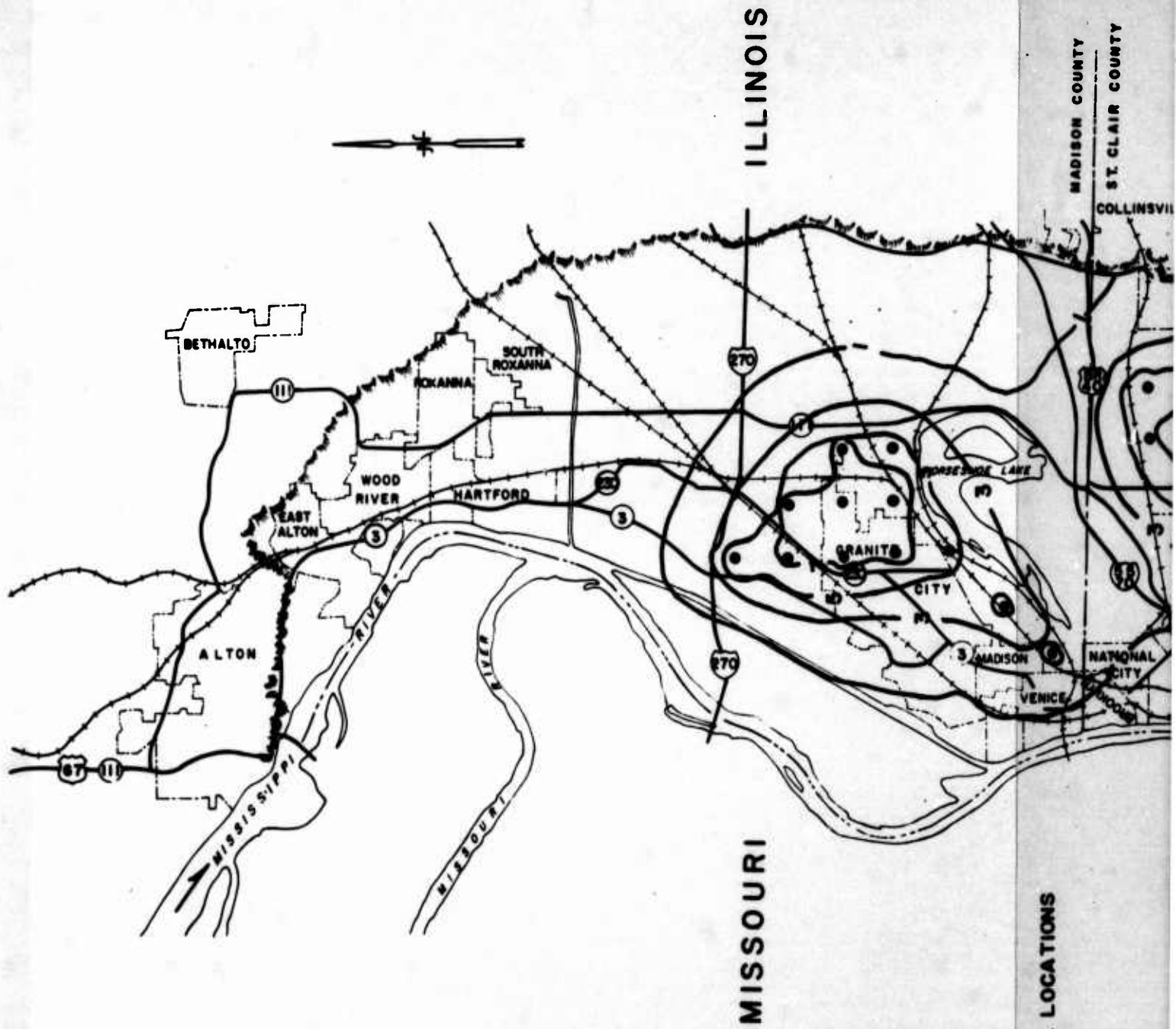
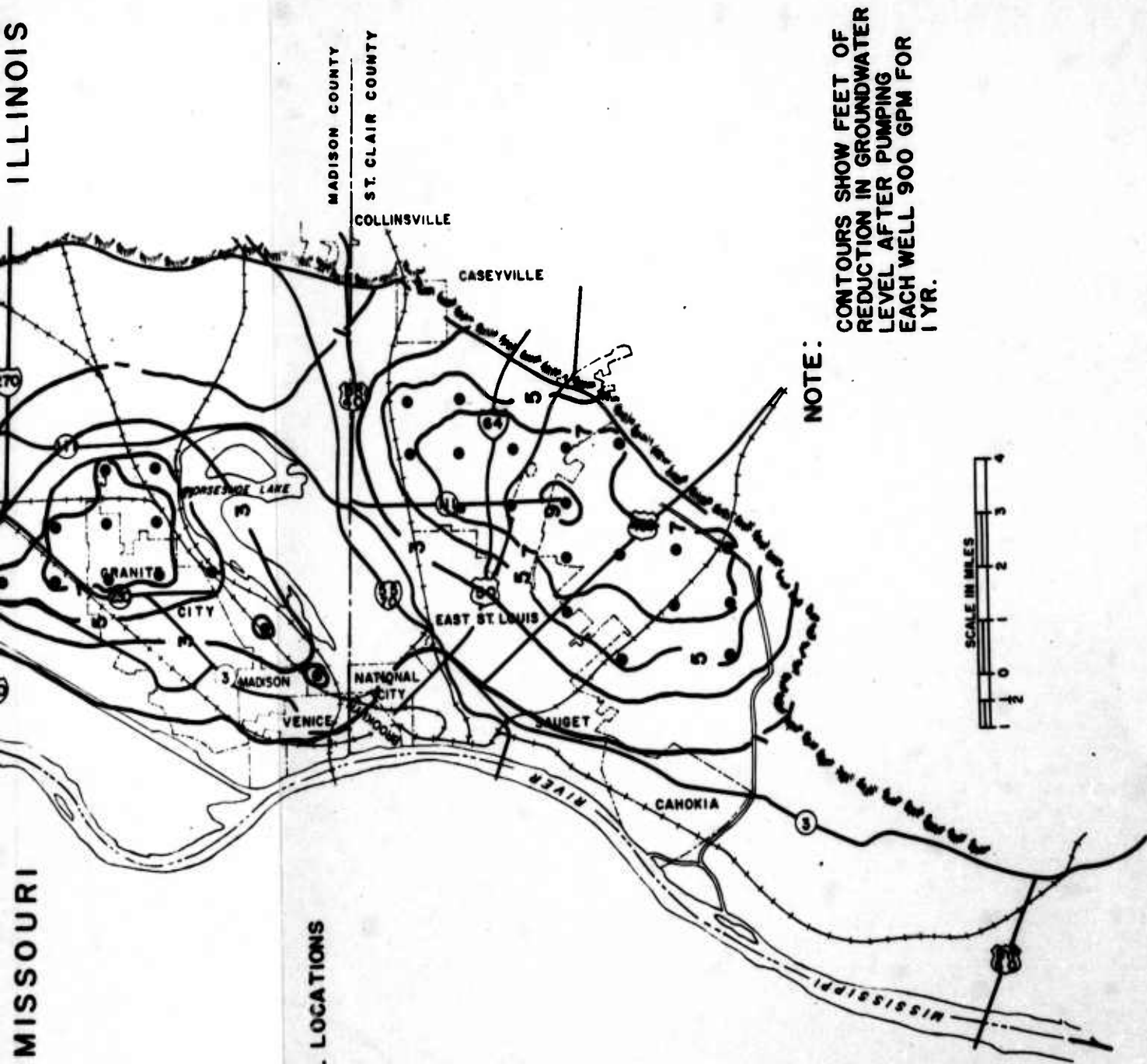


FIGURE 17 - GROUNDWATER PLANNING MAP.



ILLINOIS

MISSOURI



LEGEND

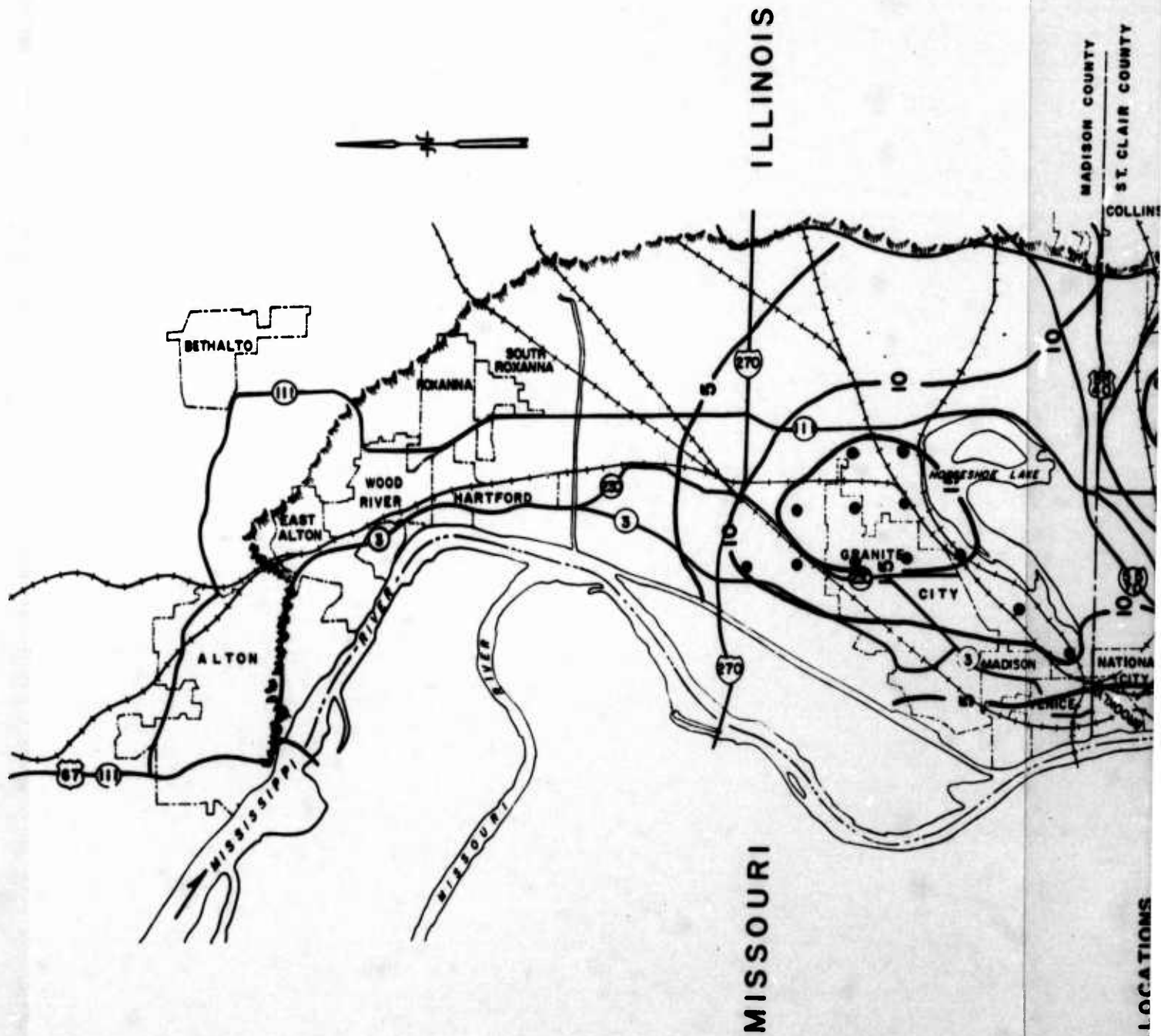
● WELL LOCATIONS

NOTE:

CONTOURS SHOW FEET OF
REDUCTION IN GROUNDWATER
LEVEL AFTER PUMPING
EACH WELL 900 GPM FOR
1 YR.

FIGURE 18 - PUMPING ALTERNATIVE (1 YR.).

2



LEGEND

WELL LOCATIONS

MADISON COUNTY
ST. CLAIR COUNTY

COLLINS

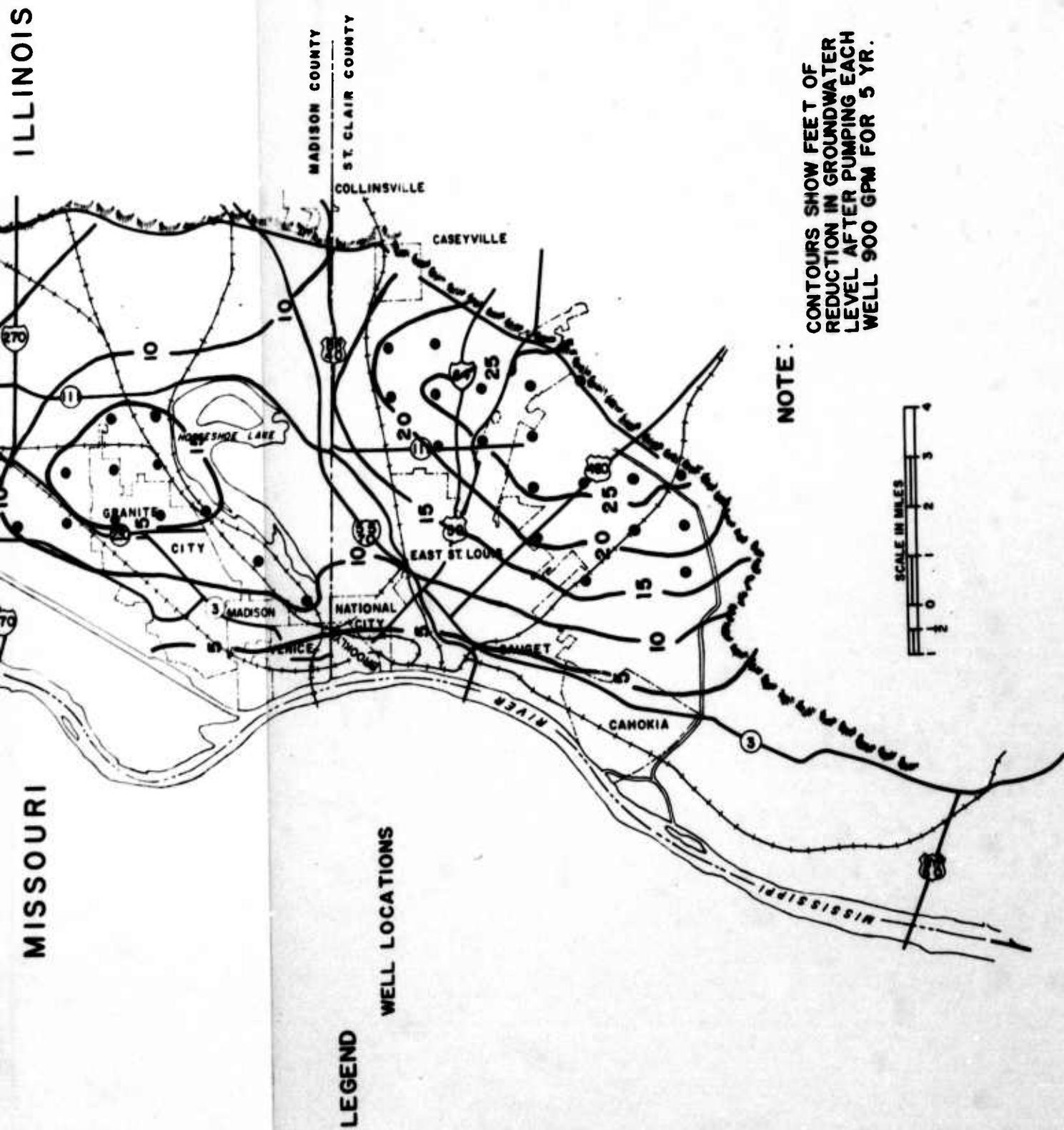
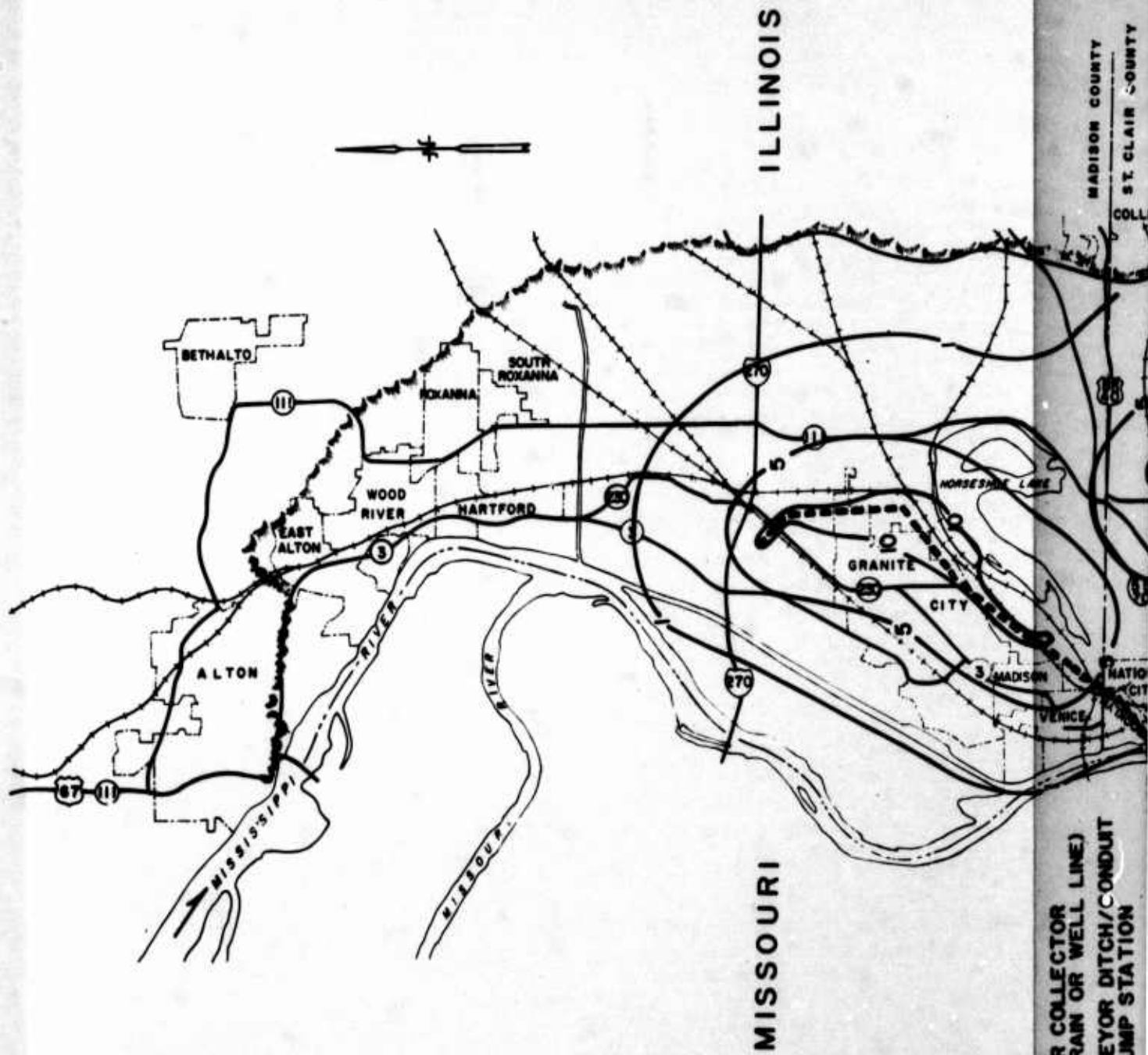


FIGURE 19 - PUMPING ALTERNATIVE (5 YR.).



LEGEND

- LINEAR COLLECTOR (SUBRAIN OR WELL LINE)
- > CONVEYOR DITCH/CONDUIT TO PUMP STATION

MADISON COUNTY
ST. CLAIR COUNTY

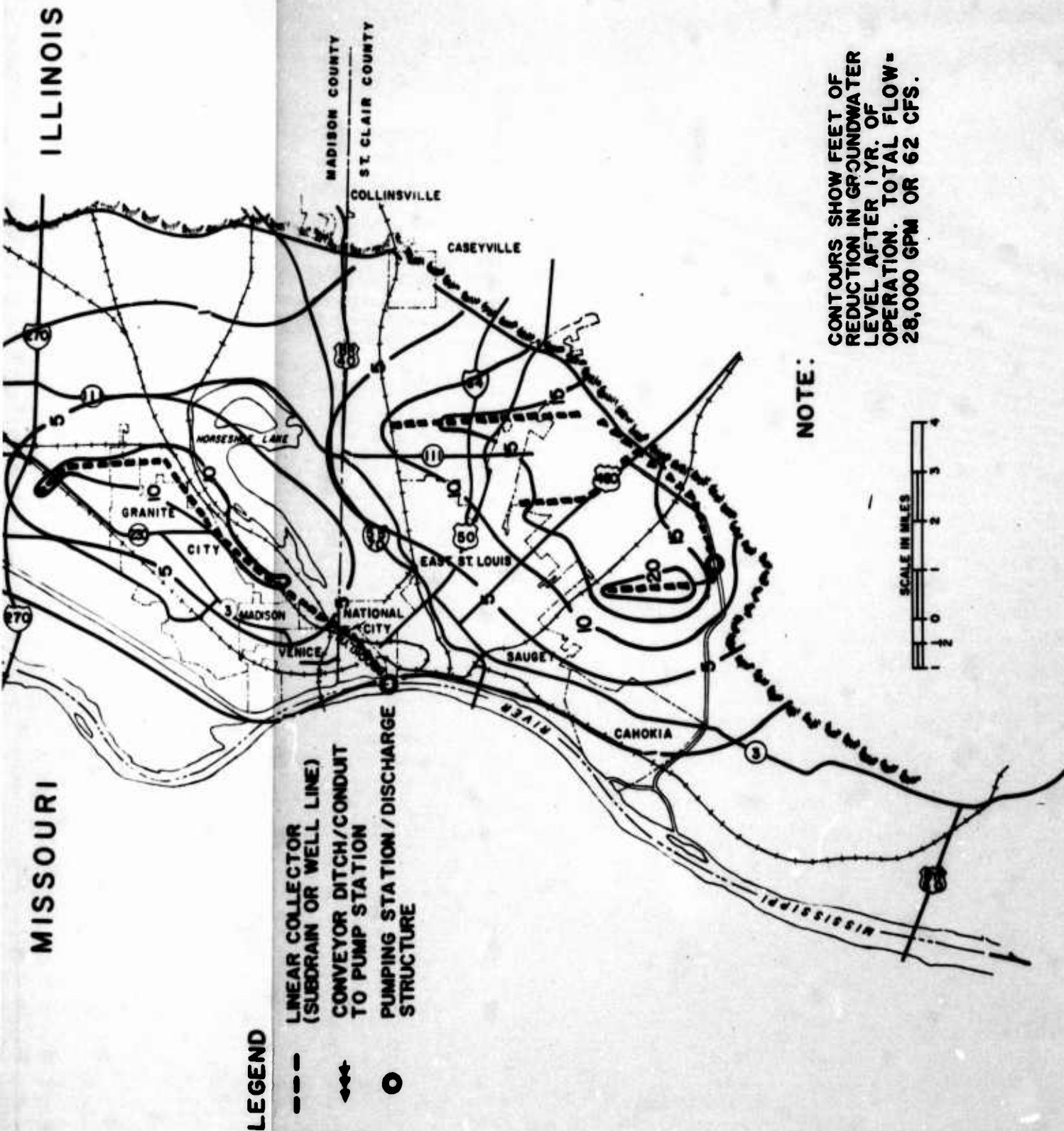
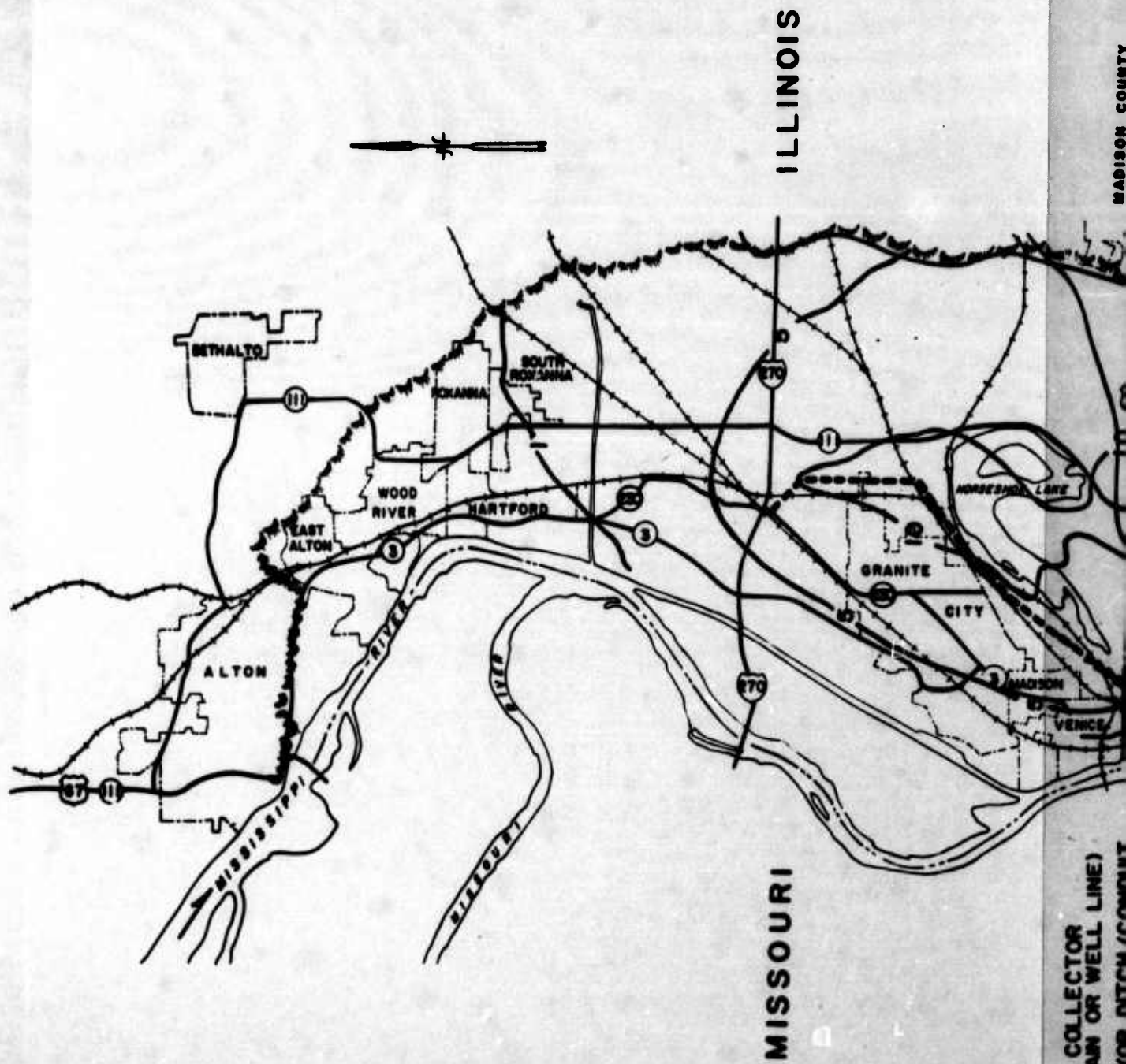


FIGURE 20 - LINE COLLECTOR ALTERNATIVE (1 YR.).



LEGEND

- LINEAR COLLECTOR (SUBDRAIN OR WELL LINE)
- CONVEYOR DITCH / CONVEYOR

MADISON COUNTY

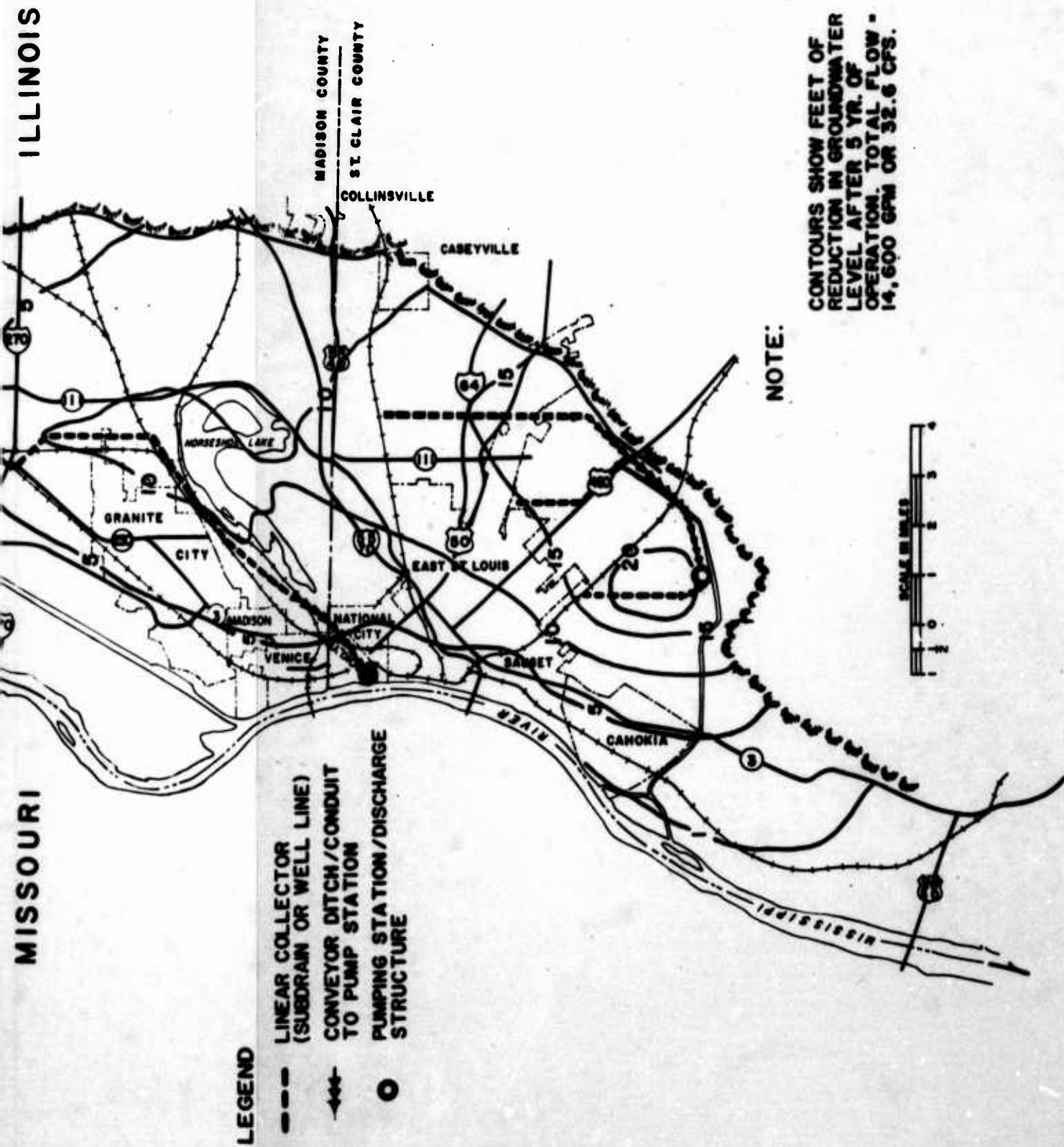
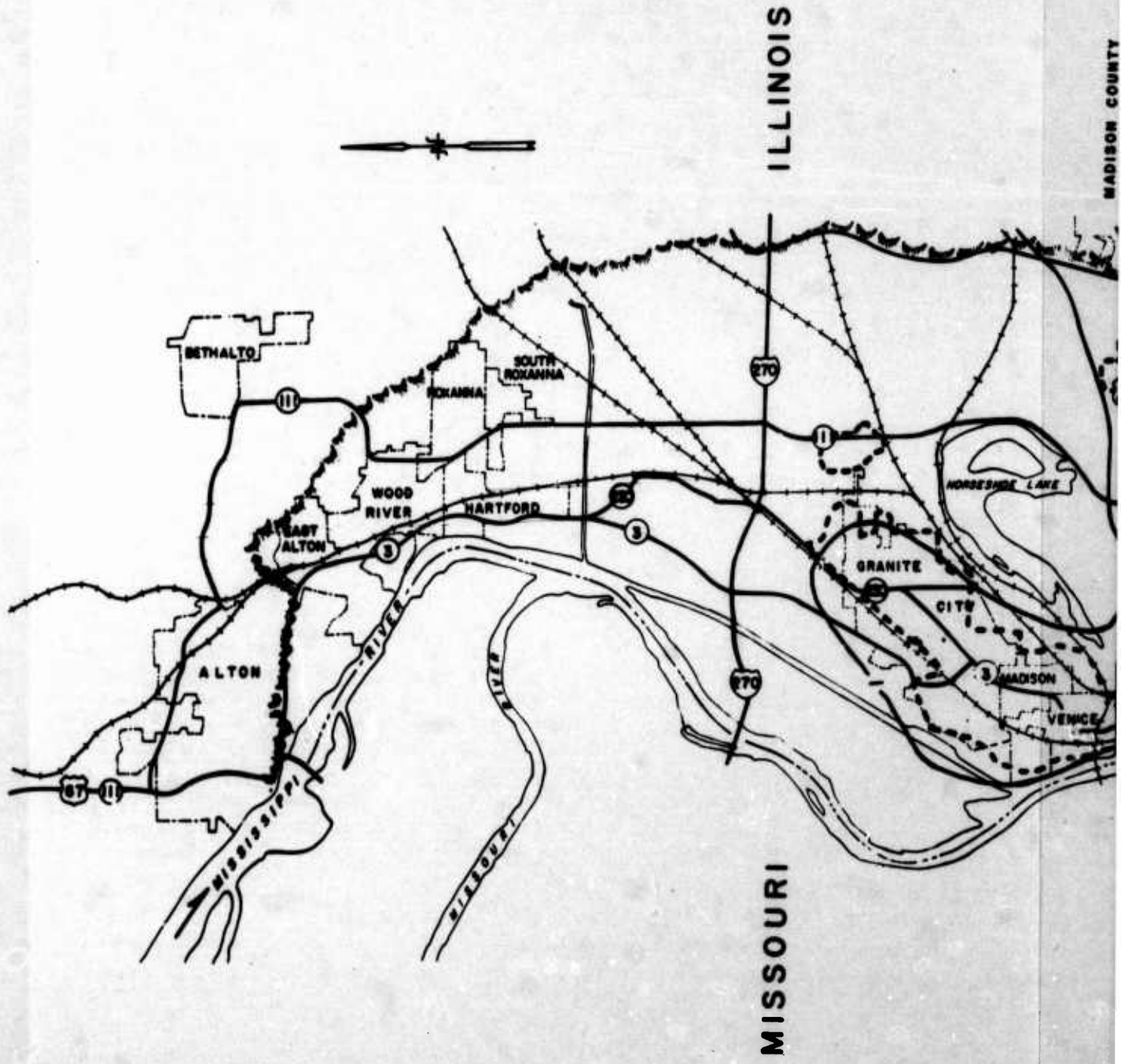


FIGURE 21 - LINE COLLECTOR ALTERNATIVE (5 YR.).



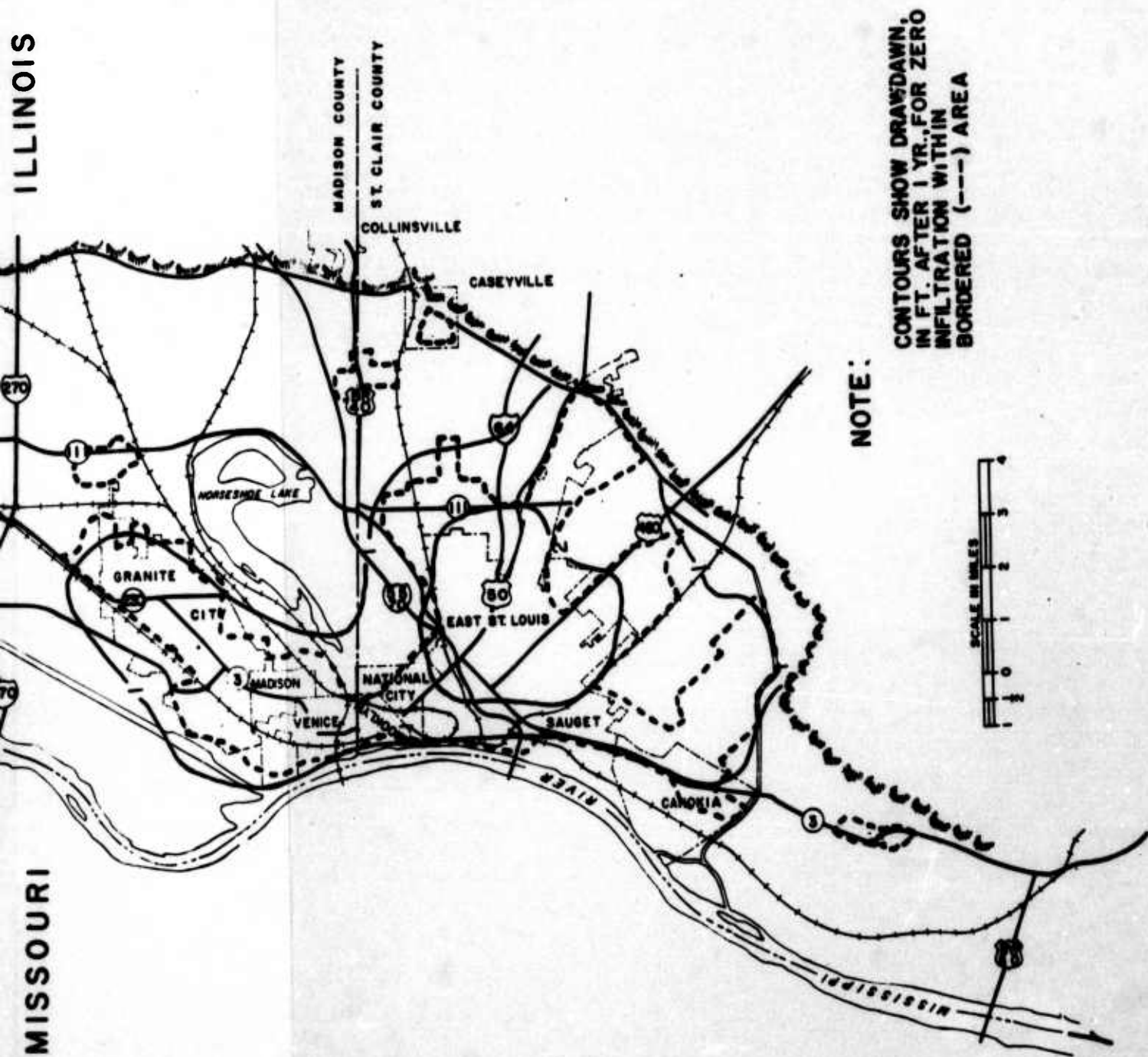
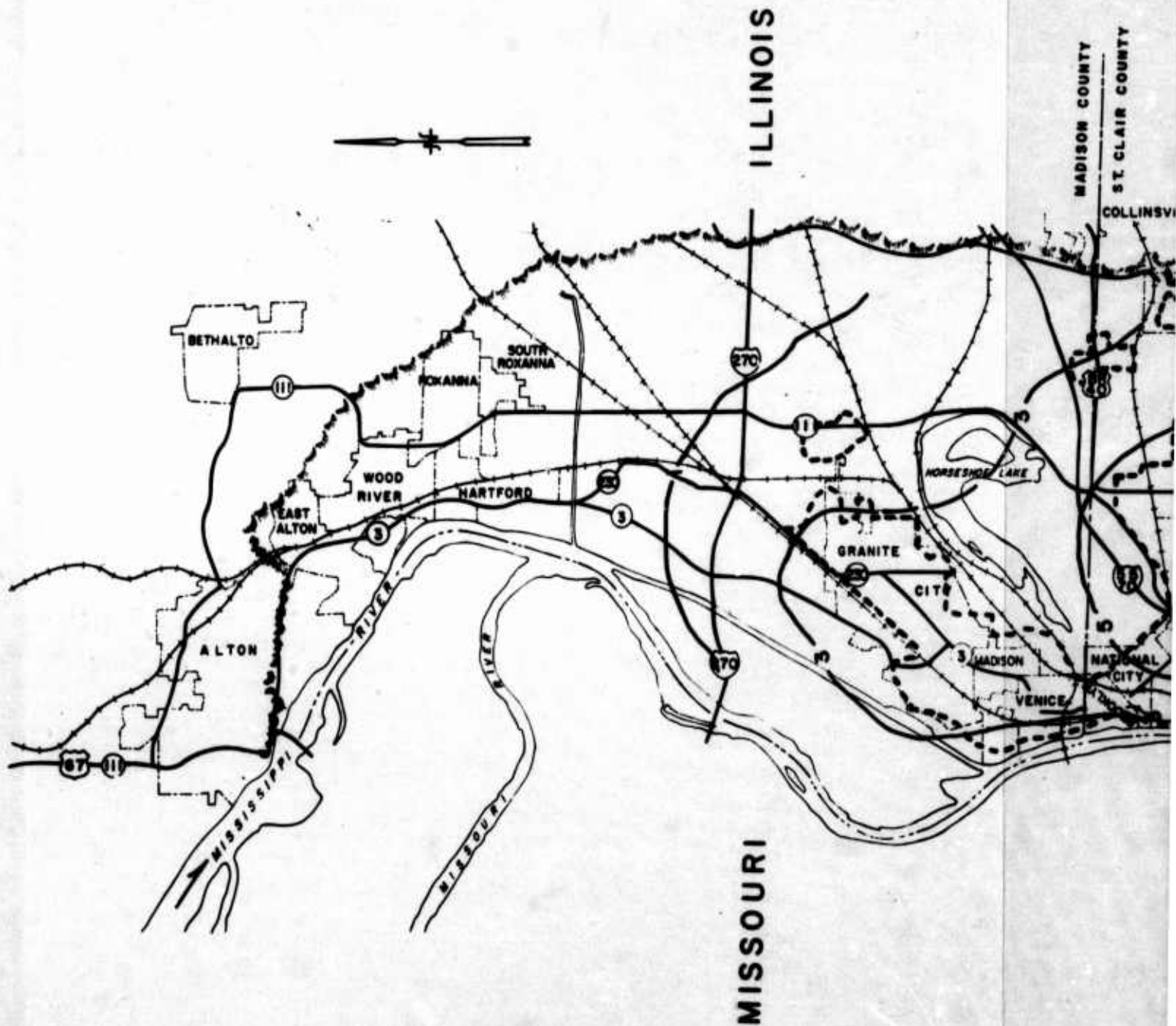


FIGURE 22 - REDUCED INFILTRATION ALTERNATIVE (1 YR.).



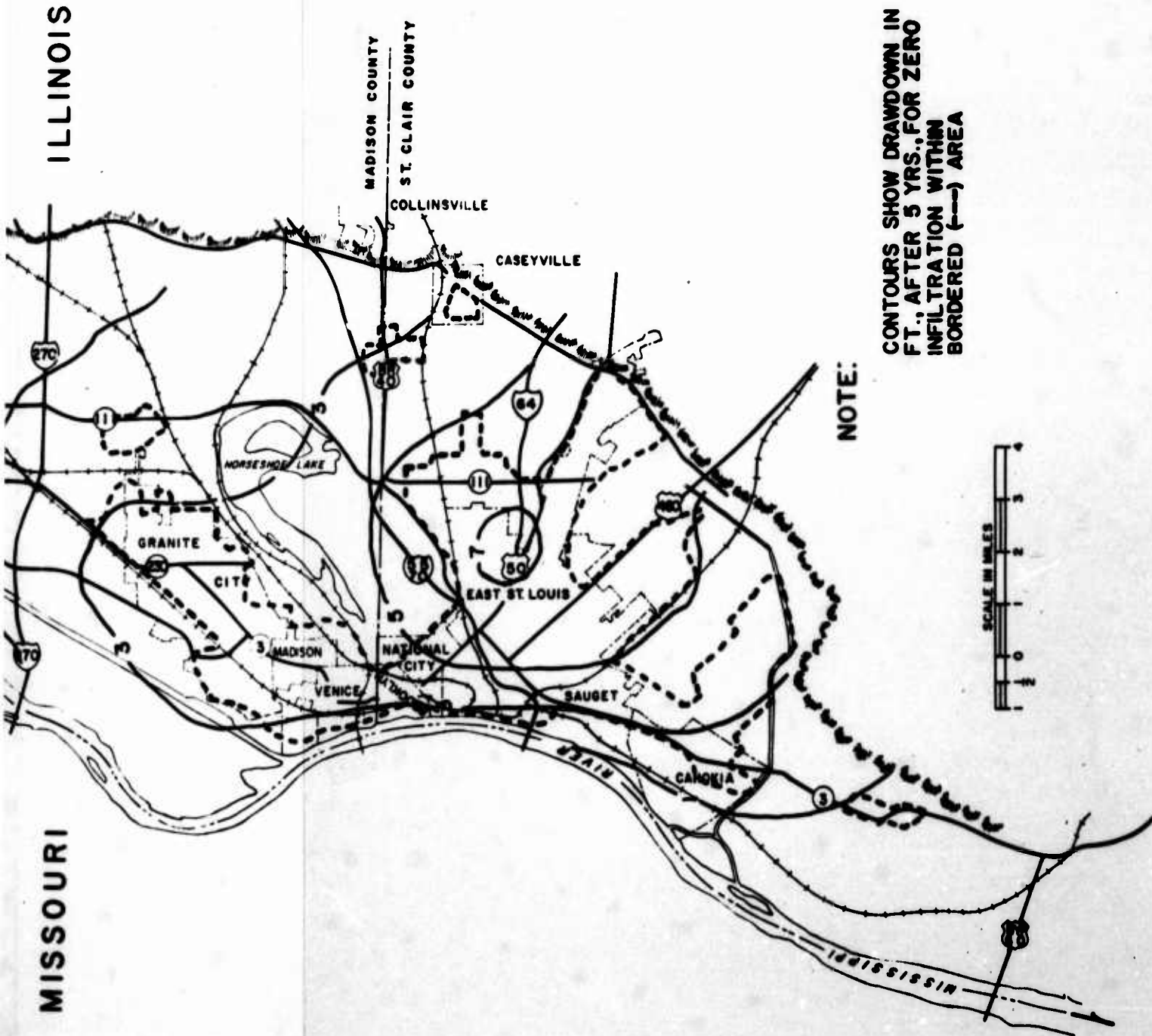


FIGURE 23 - REDUCED INFILTRATION ALTERNATIVE (5 YR.).

STUDY ACTIVITY

FISCAL YEAR 1980

DISTRICT ELEMENT

PLAN FORMATION

ECONOMICS

GROUNDWATER LEVEL ANALYSIS
SOILS & FOUNDATIONS

HYDROLOGIC ENGINEERING

DESIGN & COST ESTIMATES

WATER QUALITY ANALYSIS

ENVIRONMENTAL

REAL ESTATE

PUBLIC INVOLVEMENT

O | N | D | J | F | M | A | M | J | J

IDENTIFY MEASURES

FORMULATE AL
SINGLE & MUL

QUANTIFY DAMAGES

PREPARE CONTRACT EXISTING & FUTURE W/O
IMPROVEMENT GW LEVELS

PREPARE HYDROLOGIC DATA
FOR GW LEVEL ANALYSIS

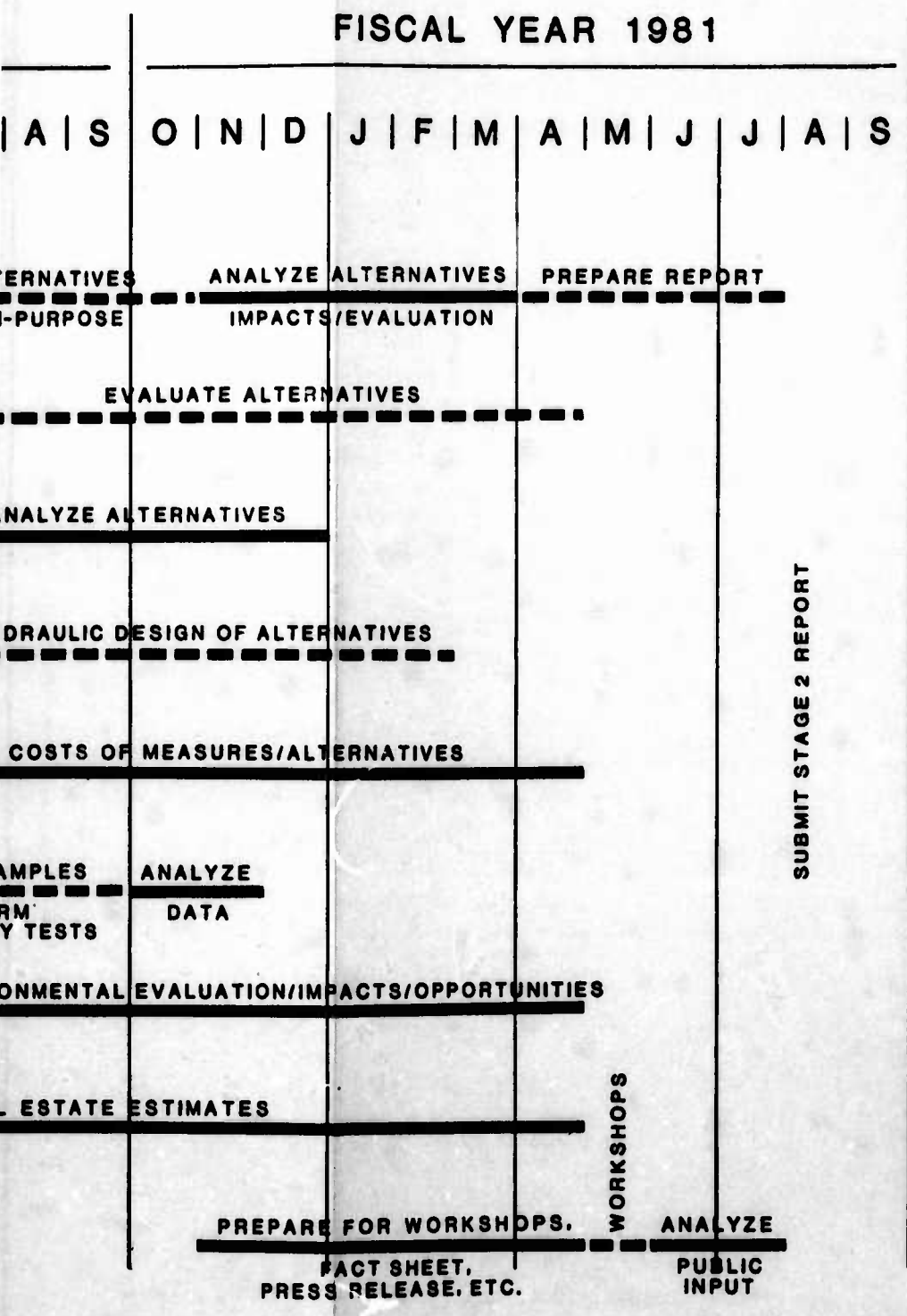
DETERMINE DESIGN

PREPARE CONTRACT COLLECT
PERF
LABORATO

ENV

RE

ACTIVITIES IN STAGE 2



SUBMIT STAGE 2 REPORT

AMERICAN BOTTOMS
GROUNDWATER STUDY

FIGURE 24 2