SECTION 4

CARBONDALE, IL

The estimates of vulnerability and availability presented in this report represent statistical averages and overall assessments resulting from the application of a new, preliminary methodology. They are intended for emergency management and planning purposes only.

4.1 Location and Characteristics

The City of Carbondale, located in extreme southern Illinois, is the fifth-most populous of the six project cities. The population of Carbondale in 1980 was approximately 26,000 persons. Carbondale is a major factor in the economy of southern Illinois, contributing in the areas of coal, agriculture, commerce and education, being the site of Southern Illinois University.

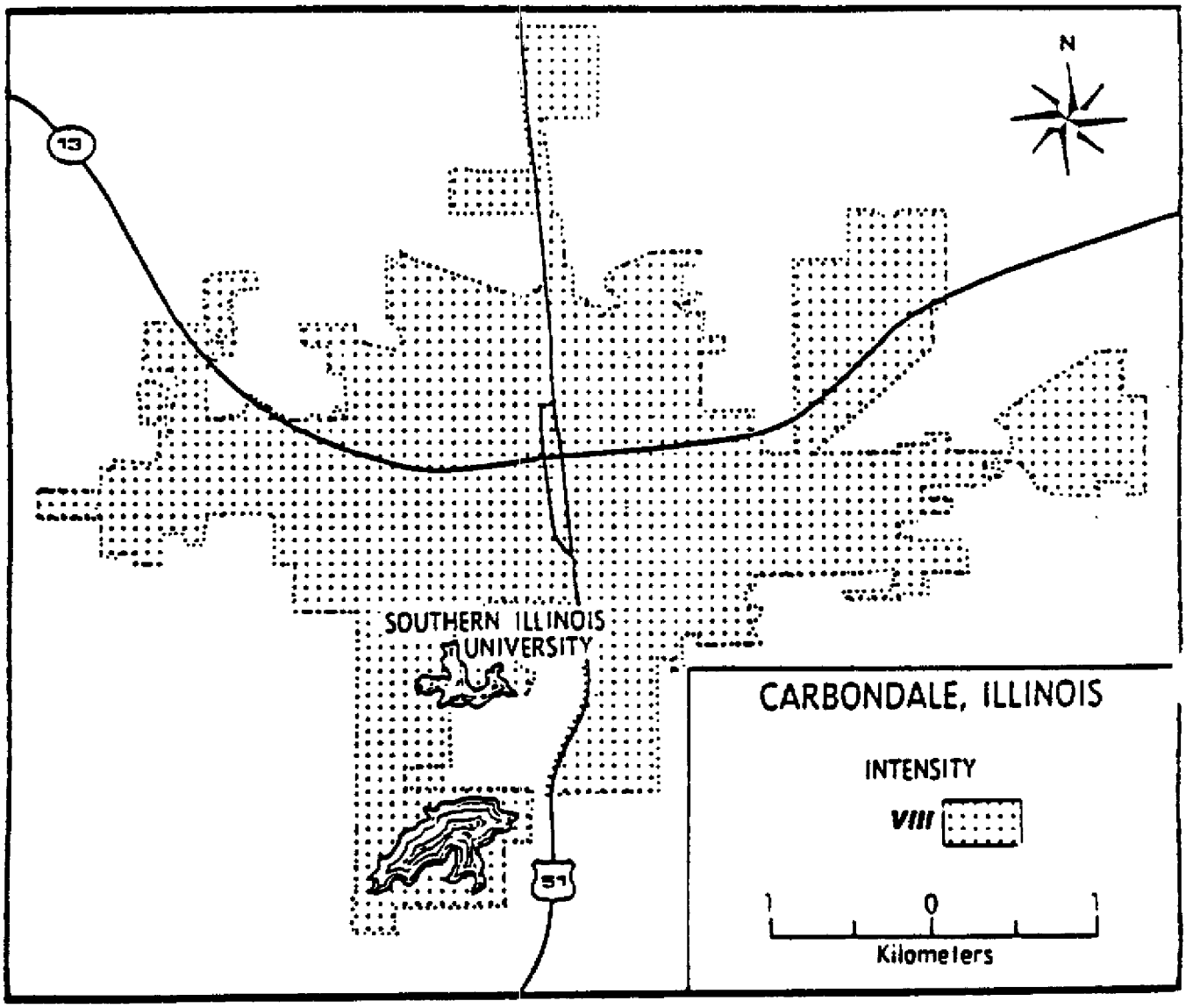
Physiographic Description (from Reference 16):

Carbondale is situated in the till plains of the Central Lowland province (Fenneman, 1938) in an area of very low topographic relief.

Figures 4-1 and 4-2 show the hypothetical ground shaking intensities in Carbondale following an occurrence of the Ms=7.6 and Ms=8.6 scenario earthquakes. These intensities would cause significant disruption in this city. The estimates resulting from the vulnerability analyses are presented in this section of the report.

4.2 Medical Resources and Facilities

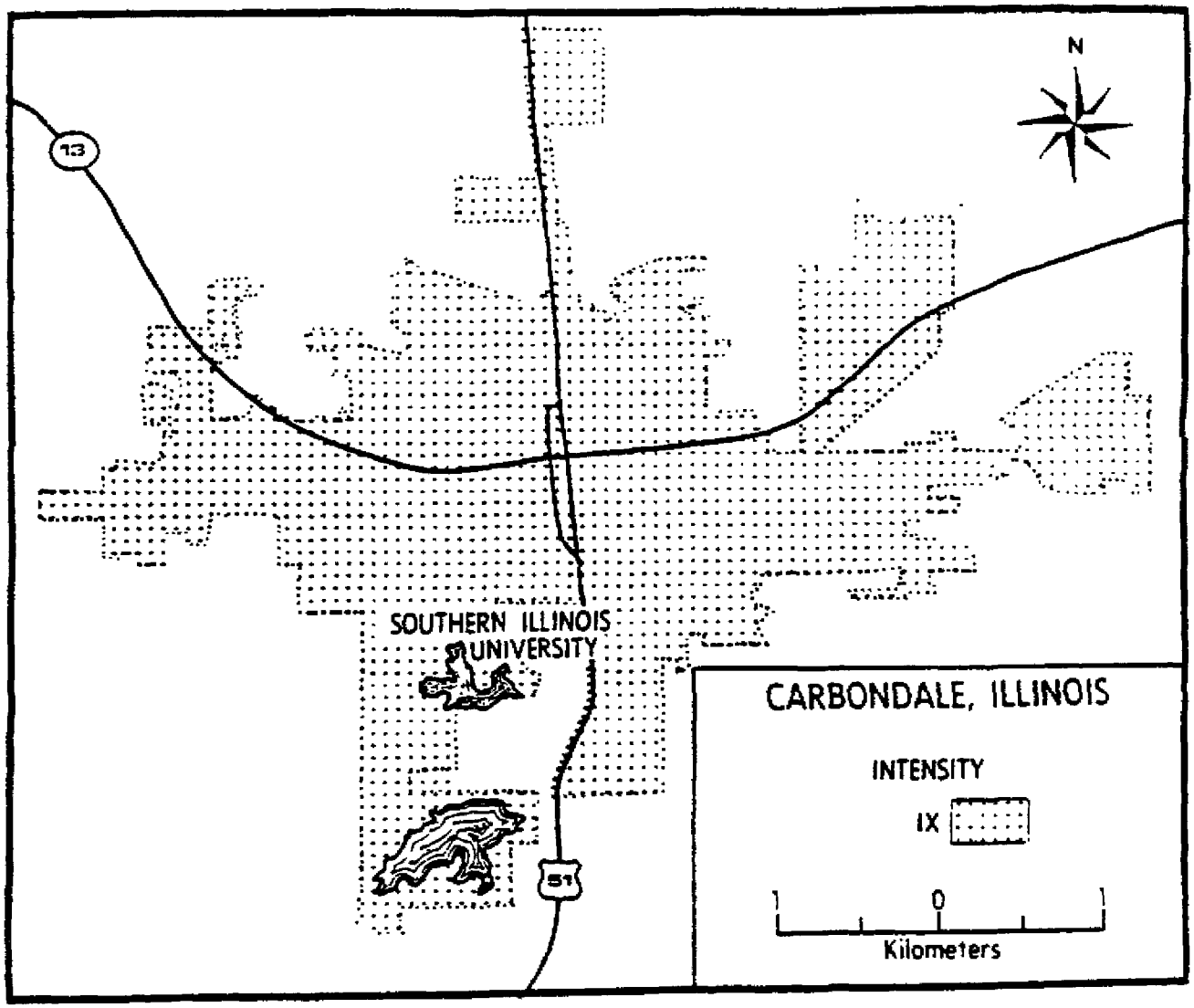
Carbondale possesses a full spectrum of medical services and facilities. They provide medical support to the city, surrounding communities and general region. Medical services surveyed during



Hypothetical intensity map for Carbondale, Illinois, for a magnitude M(S)=7.6 earthquake. For an earthquake near the north end of the New Madrid seismic zone, the intensity for Carbondale is VIII for the entire city. For an earthquake near the south end of the New Madrid seismic zone, the intensity at Carbondale would be lower.

Reference 16

FIGURE 4-1



Hypothetical intensity map for Carbondale, Illinois. For an Ms=8.6 earthquake near the north end of the New Madrid seismic zone, the intensity for Carbondale is IX for the entire city. For an earthquake near the south end of the New Madrid seismic zone, the intensity at Carbondale would be lower.

Reference 16

FIGURE 4-2

this project were: Major Hospitals, Blood Banks, Clinical Laboratories, Ambulance Services and Personnel.

4.2.1 Major Hospitals

Carbondale is served by one major hospital with six major structures. This full service general health care facility includes a diesel powered electric generator which supplies emergency power to a large number of functional areas essential to hospital operation.

A probability of moderate disruption of this facility is indicated following occurrence of the earthquake scenarios. Five of six major structures (83%) would be available, which corresponds to 187 (94%) available hospital beds. The emergency power system is also likely to be available. Table 4-1 presents these findings.

TABLE 4-1
Availability of Major Hospital Facilities
Carbondale, IL

Base Information		
Major Hospitals Surveyed	Hospital Structures Surveyed	Beds in Surveyed Structures
1	6	199

Availability Analysis

Earthquake	Hospital Structures Estimated to be Available/Percent	Beds Estimated to be Available/Percent	Emergency Power Unit Available
Ms=7.6	5/83%	187/94%	Yes
Ms=8.6	4/67%	160/80%	Yes

4.2.2 Blood Banks

Probable availability of blood storage facilities in Carbondale following the Ms=7.6 and Ms=8.6 scenario earthquakes is shown in the

following tables. These structures normally have emergency power units and should be available for service.

BLOOD STORAGE FACILITIES
(Blood Banks)
Carbondale, IL

	Number of Facilities Surveyed	Number Estimated to be Available Ms=7.6	Ms=8.6
Major Hospital:	1	1/100%	1/100%
Non-Hospital:	None Surveyed		-
Total	1	1/100%	1/100%

4.2.3 Clinical Laboratories

The probable availability of clinical laboratory facilities in Carbondale following an occurrence of the Ms=7.6 and the Ms=8.6 scenario earthquakes is depicted in the following table. Those facilities associated with major hospitals can utilize the hospitals' emergency power systems. The availability of emergency power to non-hospital laboratories was not inventoried or analyzed.

AVAILABILITY OF CLINICAL LABORATORIES
CARBONDALE, IL

	Total Number Surveyed	Number Estimated To Be Available/Percent Ms=7.6	Ms=8.6
Major Hospitals	1	1/100%	1/100%
Others	0	0	0
Totals	1	1/100%	1/100%

4.2.4 Ambulance Services

The probable availability of ambulance service structures in Carbondale following an occurrence of the Ms=7.6 and the Ms=8.6

scenario earthquakes is depicted in the following table. As ambulances are frequently parked outdoors, the survival of vehicles is likely to be good, but difficult to quantify. Structures contain supplies, communications equipment and personnel, and thus contribute significantly to the provision of this service.

AVAILABILITY OF AMBULANCE SERVICE STRUCTURES
CARBONDALE, IL

Number of Structures Surveyed	Number Estimated to be Available	
	Ms=7.6	Ms=8.6
11	7/64%	4/36%

4.2.5 Personnel

Casualty estimates among medical personnel are presented collectively in Tables 3-2 and 3-3, Section 3.

4.3 Public Services

This part presents the probable availability of selected vital services, facilities and systems in Carbondale, following the occurrence of the Ms=7.6 and the Ms=8.6 scenario earthquakes. These services include fire fighting and police.

4.3.1 Fire Services

The following table shows the estimated availability of fire fighting structures. Since fire fighting vehicles and other equipment are typically located inside a structure, the loss of a structure contributes to the non-availability of needed equipment.

AVAILABILITY OF FIRE SERVICE STRUCTURES
CARBONDALE, IL

Total Structures Surveyed	Structures Estimated To Be Available	
	Ms=7.6	Ms=8.6
11	7/64%	4/36%

4.3.2 Police Services

The following table shows the estimated availability of police service structures in Carbondale.

AVAILABILITY OF POLICE SERVICES STRUCTURES
CARBONDALE, IL

Total Structures Surveyed	Structures Estimated To Be Available	
	Ms=7.6	Ms=8.6
2	1/50%	1/50%

4.4 Communications

The following table shows the estimated availability of radio, television, and telephone structures in Carbondale following the occurrence of the Ms=7.6 and the Ms=8.6 earthquakes.

AVAILABILITY OF COMMUNICATIONS STRUCTURES
CARBONDALE, IL

	Total Structures Surveyed	Structures Estimated To Be Available	
		Ms=7.6	Ms=8.6
Radio	7	5/71%	3/43%
Television	-	-	-
Telephone	3	2/67%	2/67%
Total	10	7/70%	5/50%

4.5 Transportation Systems

4.5.1 Highways

The probable effects of the two earthquake scenarios on major highways in Carbondale and Jackson County are summarized in the following distribution of section survival probabilities:

Probability of Survival	Number of Sections (City Only)		Number of Sections (City + County)	
	M= 7.6	M= 8.6	M= 7.6	M= 8.6
0.00 - 0.25	-	-	-	3
0.26 - 0.50	-	-	-	1
0.51 - 0.75	-	1	1	6
0.76 - 1.00	4	3	15	6
Total	4	4	16	16

The probabilities of survival calculated for the individual are shown on Table 4-2. Figures 4-3 and 4-4 indicate graphically the sections most likely to remain passable after the stronger of the two earthquakes.

Within the city limits, few of the structures on the major highways would suffer severe structural damage or collapse. In the Ms = 7.6 scenario, all highway sections would be estimated to survive with a probability of 0.95 or greater. In the event of an Ms = 8.6 earthquake scenario the lowest probability of survival would drop to 0.69.

Outside the city limits, the access routes into Carbondale most likely to remain passable would be U.S. 51 from the south and State Route 13 from the east. The highways most vulnerable to damage, especially in the event of an Ms = 8.6 earthquake scenario include State Route 3, in the western end of the county, and sections of State Route 13/127 and U.S. 51 to the north of Carbondale.

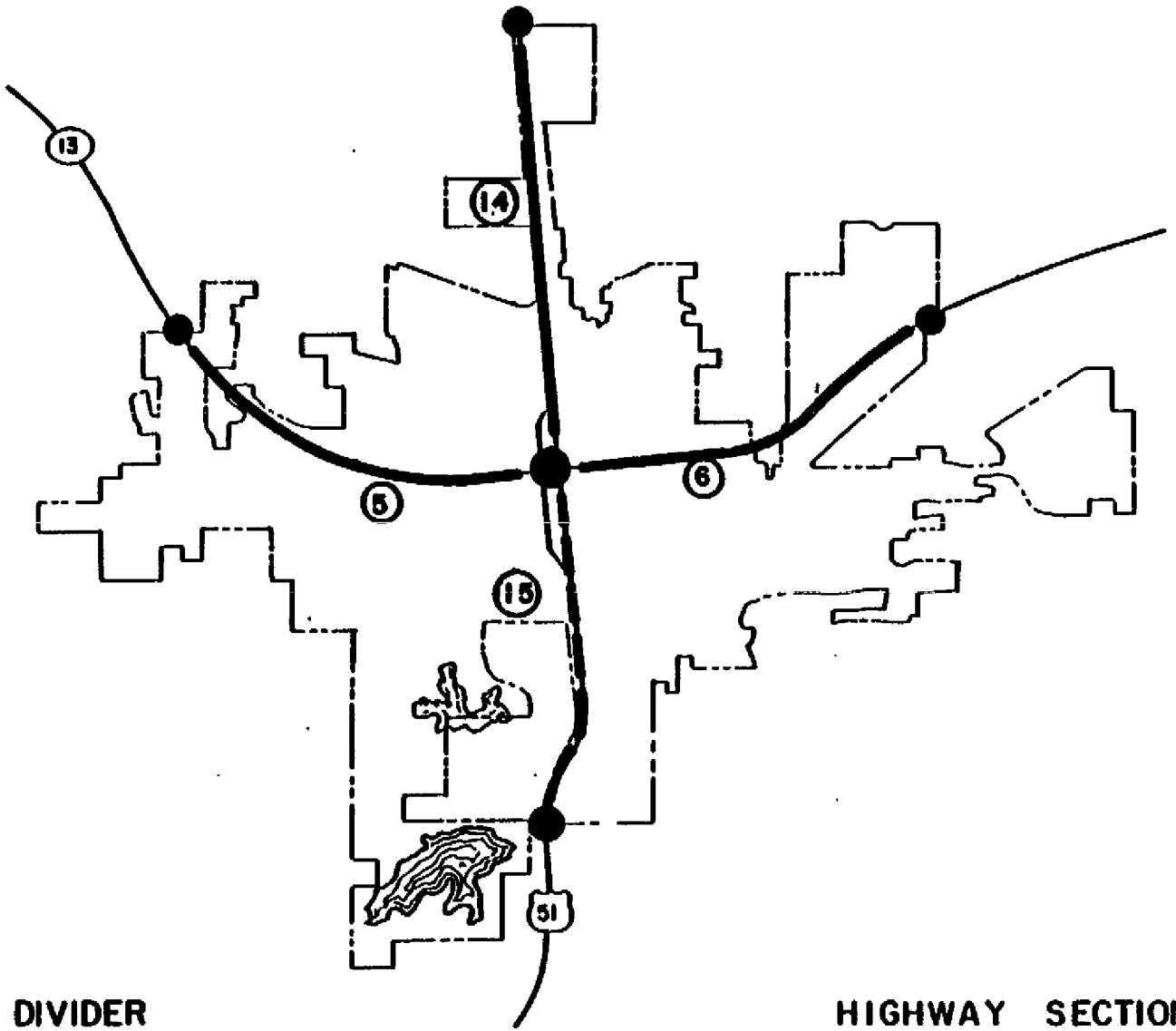
TABLE 4-2

PROBABILITY THAT ALL BRIDGES ON AND OVER HIGHWAY SECTIONS WOULD SURVIVE NEW MADRID EARTHQUAKE

CARBONDALE/JACKSON COUNTY

Highway Section No.	Route No.	No. of Support Structures		No. of Over-passing Struct.	Earthquake Intensity (MMI)		Probability of Survival	
		Single Struct.	Parall. Pairs		Ms=7.6	Ms=8.6	Ms=7.6	Ms=8.6
1*	SR3	5			VIII	IX	.80	.19
2*	SR3	1			VIII	IX	.95	.69
3*	SR3	4			VIII	IX	.81	.23
4*	SR13		4		VIII	IX	1.00	.87
5	SR13		1		VIII	IX	1.00	.98
6	SR13		2		VIII	IX	1.00	.89
7*	SR13		1		VIII	IX	1.00	.95
8*	SR13	2			VIII	IX	.93	.59
9*	SR13	3		2	VIII	IX	.67	.19
10*	SR127	2		1	VIII	IX	.92	.56
11*	SR149	2		1	VIII	IX	.92	.56
12*	US51	3		1	VIII	IX	.87	.35
13*	US51	2			VIII	IX	.92	.54
14	US51				VIII	IX	1.00	1.00
15	US51	1			VIII	IX	.95	.69
16*	US51				VIII	IX	1.00	1.00

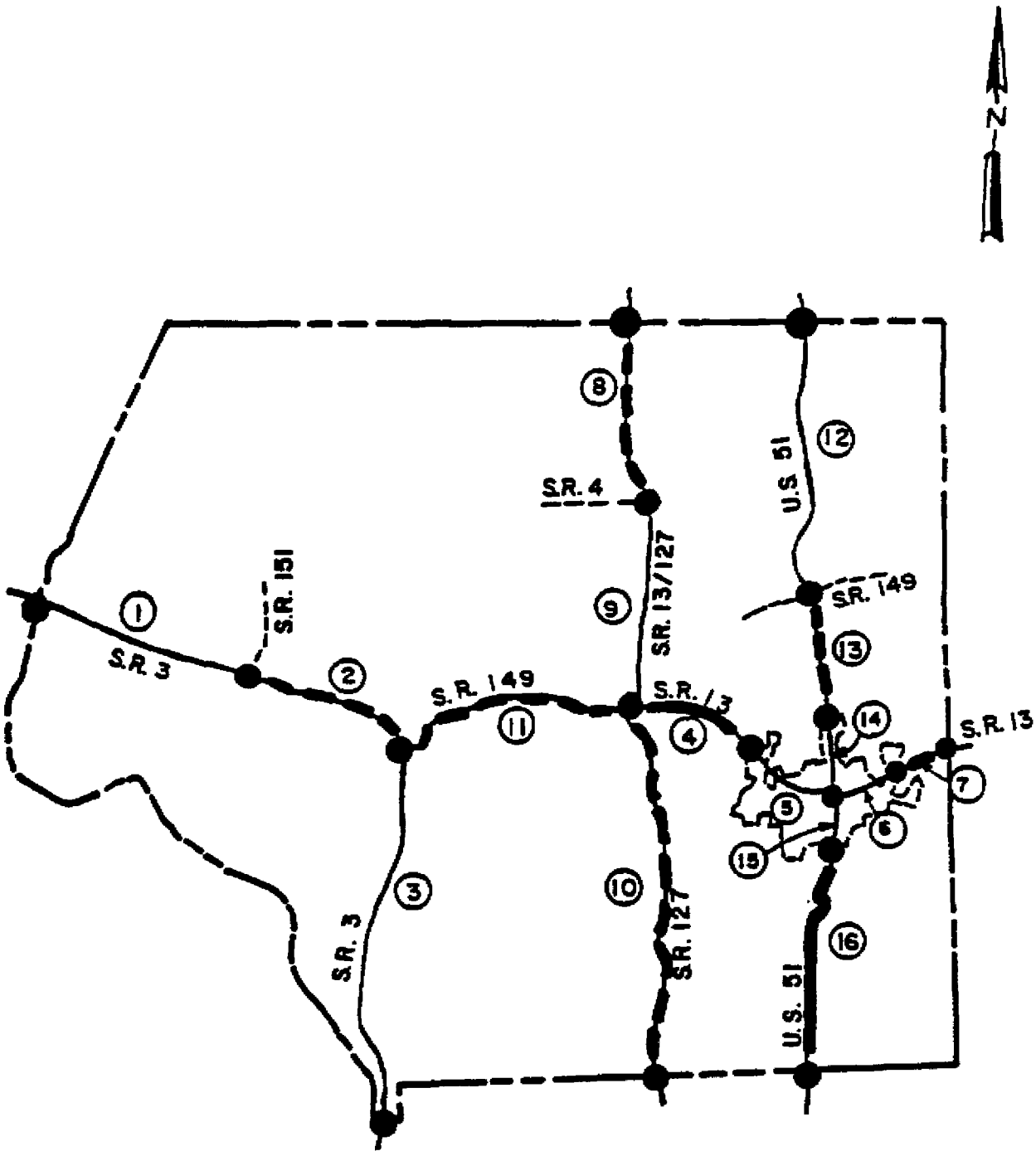
* Located in Jackson County outside the city limits of Carbondale.



● SECTION DIVIDER

○ SECTION NUMBER

HIGHWAY SECTIONS IN CARBONDALE CITY LIMITS



● SECTION DIVIDER

○ SECTION NUMBER

HIGHWAY SECTIONS IN CARBONDALE AREA

FIGURE 4-4

4.5.2 Railways

The probable effects of the two earthquakes on major railway lines in Carbondale and Jackson county are summarized in the following distribution of section survival probabilities:

Probability of Survival	Number of Sections (City Only)		Number of Sections (City + County	
	M = 7.6	M= 8.6	M= 7.6	M= 8.6
0.00 - 0.25	-	-	-	4
0.26 - 0.50	-	-	-	5
0.51 - 0.75	-	1	1	2
0.76 - 1.00	3	2	12	2
Total	3	3	13	13

The probabilities of survival calculated for the individual sections are shown in Table 4-3. Figures 4-5 and 4-6 indicate graphically the sections most likely to remain passable after the stronger of the two earthquakes.

Within the city limits, the north-south Illinois-Central-Gulf (ICG) line has no bridges or underpasses and would therefore suffer no structural damage. The east-west ICG line which crosses the city at its northern limits would survive the Ms = 8.6 scenario with a probability of 0.54.

Outside the city limits, two or three of the ten railway sections would probably be impassable after the Ms = 7.6 scenario earthquake. One of the sections would have a survival probability of 0.62; all others would survive with a probability of 0.80 or greater. In the postulated Ms = 8.6 earthquake scenario several more sections would be removed from service; nine of the ten sections would have survival probabilities of less than 0.5. The line least likely to be interrupted would be the ICG line to the south of the city.

TABLE 4-3

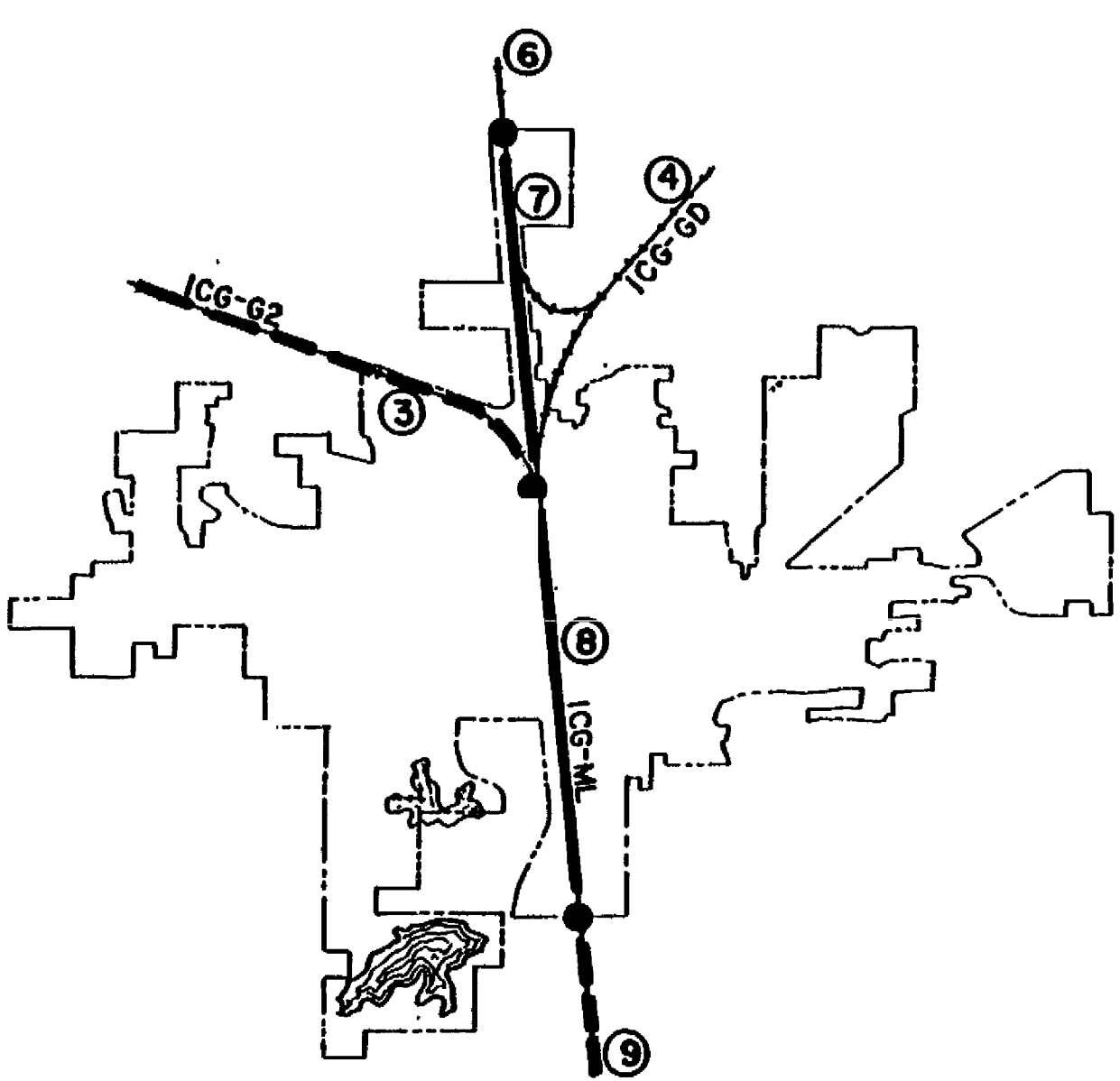
PROBABILITY THAT ALL BRIDGES ON AND OVER RAILWAY SECTIONS

WOULD SURVIVE NEW MADRID EARTHQUAKE

CARBONDALE/JACKSON COUNTY

Railway Section No.	Route No.	No. of Support Structures		No. of Over-passing Struct.	Earthquake Intensity (MMI)		Probability of Survival	
		Single Struct.	Parall. Pairs		Ms=7.6	Ms=8.6	Ms=7.6	Ms=8.6
1*	ICG-G1	5			VIII	IX	.80	.19
2*	ICG-G2	4		2	VIII	IX	.83	.26
3	ICG-G2	3		1	VIII	IX	.92	.54
4*	ICG-GD	3			VIII	IX	.91	.47
5*	ICG-GM	6			VIII	IX	.84	.25
6*	ICG-ML	4	1	2	VIII	IX	.90	.46
7	ICG-ML				VIII	IX	1.00	1.00
8	ICG-ML				VIII	IX	1.00	1.00
9*	ICG-ML	2			VIII	IX	.96	.74
10*	ICG-MN	7		1	VIII	IX	.82	.20
11*	UPAC-EW	16			VIII	IX	.62	.02
12*	UPAC-NS	3	11		VIII	IX	.92	.35
13*	UPAC-NS	3	1	1	VIII	IX	.89	.40

* Located in Jackson County outside the city limits of Carbondale.



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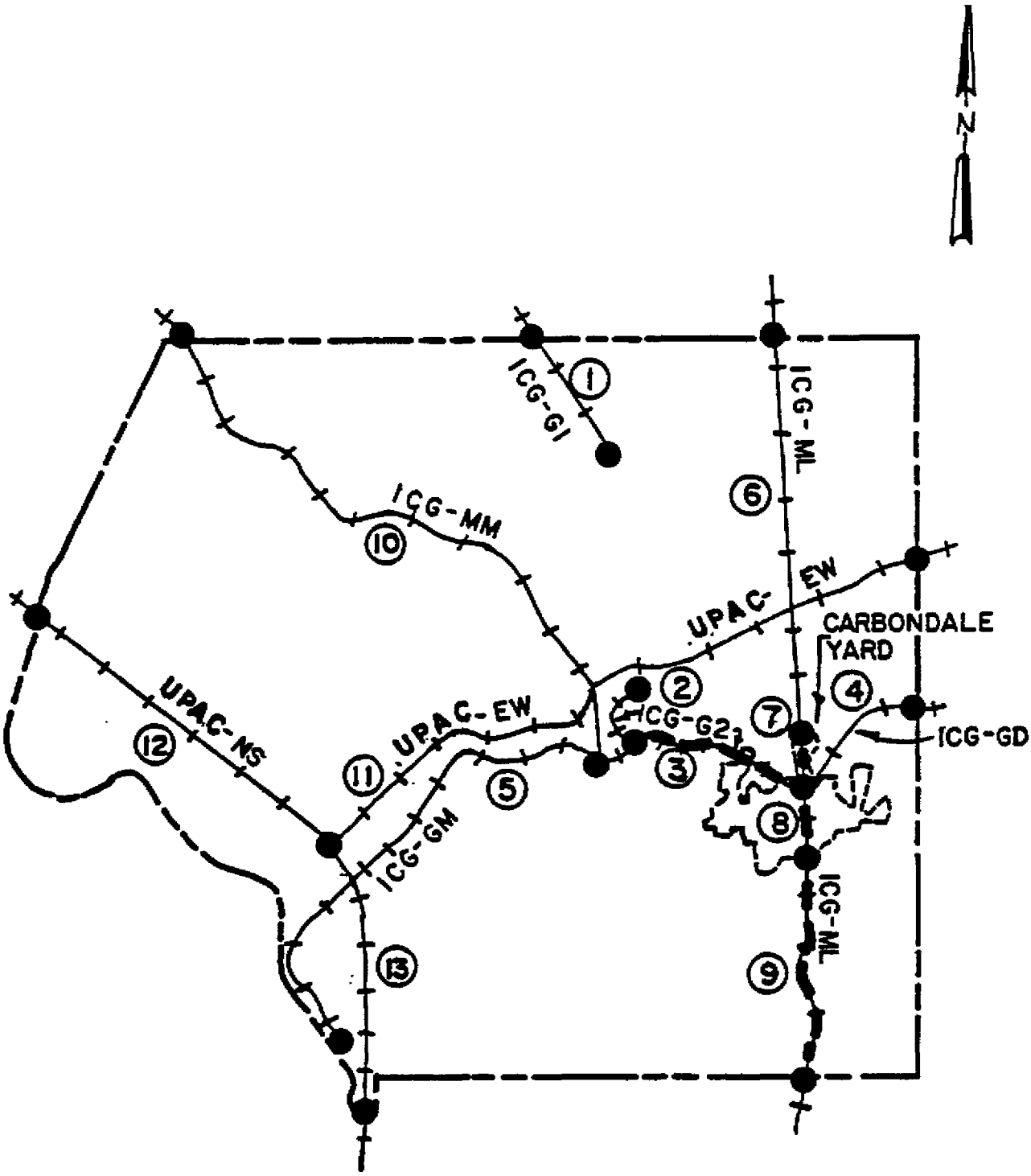
① SECTION NUMBER

RAIL SECTIONS IN CARBONDALE
CITY LIMITS



● SECTION DIVIDER
① SECTION NUMBER

RAIL SECTIONS IN
CARBONDALE AREA

FIGURE 4-6

4.5.3 River Ports

Carbondale does not possess dock or river port facilities.

4.5.4 Airports

As discussed in the general section on airports (Section 3.5.4) airport runways will probably be at least partially available for use in Carbondale following the scenario earthquakes. Delicate and complex landing-aid instruments and devices, as well as general lighting, are not estimated to be available. Airport buildings have probabilities of damage typical for others in the area of similar structural type.

4.6 Public Utilities

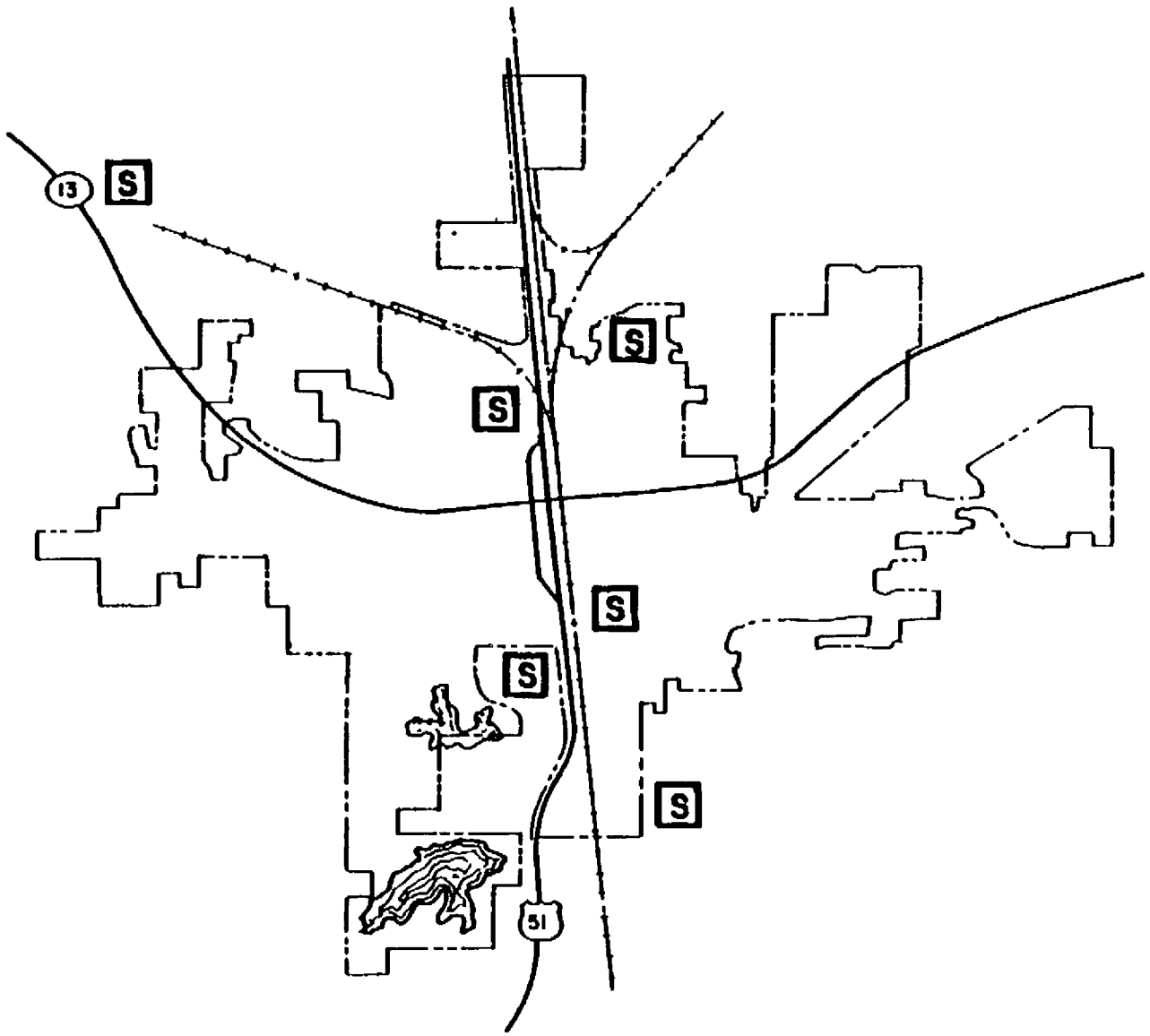
4.6.1 Electric Utilities

Carbondale is served by Central Illinois Public Service (CIPS). Three major transmission interconnects serve Carbondale's three bulk power substations which feed five distribution substations. CIPS has 2,600 employees, five generating stations, two mobile spares, other spare substation transformers located throughout system and approximately 600 radio equipped vehicles.

CIPS's Grand Tower generating plant is located near Carbondale. Grand Tower has a total plant capacity of 195 MW. Figure 4-7 shows major elements of the Carbondale system.

Availability Analysis

The following table presents the results of the availability analysis for this utility. Disruption to the system will be significant; the system is not estimated to be available following either of the Ms=7.6 or the Ms=8.6 scenario earthquakes.



S SUBSTATION

ELECTRIC UTILITIES
CARBONDALE, ILLINOIS

AVAILABILITY OF ELECTRIC UTILITIES
CARBONDALE, IL

Total Number Of Structures Surveyed		Structures Estimated To Be Available/Percent		Overall System Availability(Yes/No)	
		Ms=7.6	Ms=8.6	Ms=7.6	Ms=8.6
Substations	6	2/33%	0/0%	No	No
Power Plants	1	0/0%	0/0%		
Total	7	2/29%	0/0%		

4.6.2 Water Utility

The Carbondale Water and Sewer Services Department serves the Carbondale Township, the South Highway Water District and the Crab Orchard Water District. The Department also has an agreement with the Kinkaid Water Conservancy District to supply water to Desoto and Elkville during an emergency. The raw water source is Cedar Lake which is located four or five miles from the water treatment plant. Water is pumped directly to the water treatment plant or is stored in the Carbondale Reservoir located in the southern portion of the town.

The water plant capacity is 8.0 million gallons per day (MGD). The treatment operations include coagulation, flocculation, filtration, and chlorination. There are three clearwells at the water treatment plant which have a total capacity of 3.45 million gallons. In addition, there are three storage locations in outlying parts of town. The Helen Street tank is elevated and has a 250,000 gallon capacity. A 750,000 gallon elevated storage tank is located on Chautaqua Street and the Bicentennial Industrial Park has a 500,000 gallon ground storage tank. Total storage capacity is 4.95 MG. The water distribution system consists of 4-inch through 14-inch ductile iron pipe. The system has one booster pumping station which is located at the Bicentennial Industrial Park for use in fire

protection. The locations of the water treatment plant, storage facilities and booster pumping station are indicated in Figure 4-8.

Availability Analysis

The following table presents the results of the damage probability analysis for availability for Carbondale's water system. The analysis indicates that serious damage to system elements is likely. This, combined with the estimated loss of electricity, indicates that this system will not be available following the Ms=7.6 or the Ms=8.6 scenario earthquakes.

AVAILABILITY ANALYSIS WATER UTILITY
CARBONDALE, IL

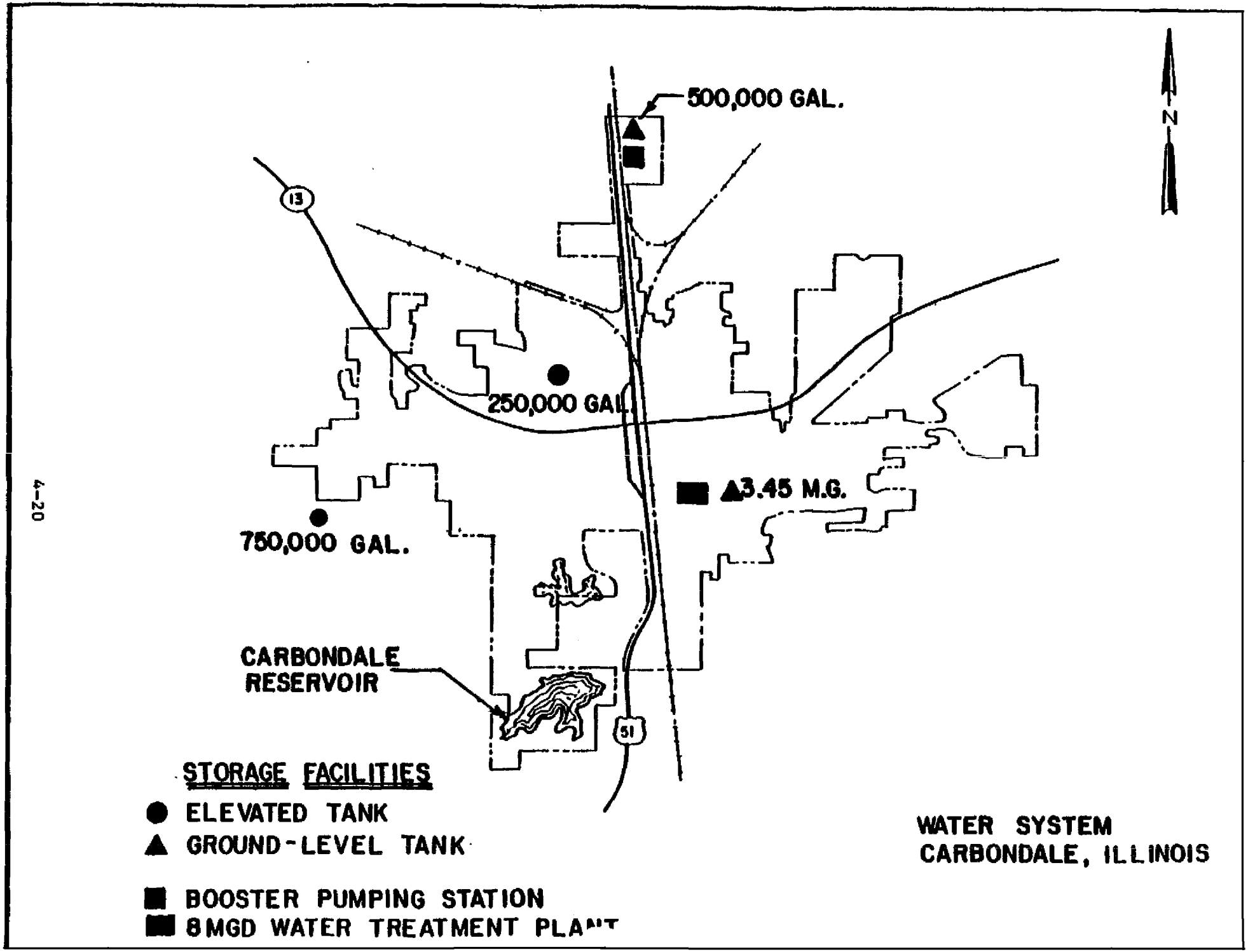
	Total Number of Structures Surveyed	Structures Estimated To Be Available/Percent Ms=7.6	Ms=8.6
Treatment Plants	1	0/0%	0/0%
Storage Tanks:			
Elevated	2	1/50%	0/0%
Non-elevated	4	3/75%	2/50%
Pump Station	1	0/0%	0/0%
Total	8	4/50%	2/25%

PROBABLE SYSTEM AVAILABILITY
(Yes/No)

Ms=7.6	Ms=8.6
No	No

4.6.3 Natural Gas Utility

The natural gas system of Carbondale, Illinois is also owned by Central Illinois Public Service Company. The system has one purchase point and buys gas from Texas Eastern Transmission Company. There are no propane-air or Liquid Natural Gas plants in the system. One hundred three (103) miles of piping make up the system, of which


500,000 GAL.
N
13
250,000 GAL.
3.45 M.G.
750,000 GAL.
CARBONDALE
RESERVOIR
51
STORAGE FACILITIES
ELEVATED TANK
GROUND-LEVEL TANK
BOOSTER PUMPING STATION
8 MGD WATER TREATMENT PLANT
WATER SYSTEM
CARBONDALE, ILLINOIS

ninety-three (93) miles are steel and the remaining ten (10) miles plastic.

The steel and plastic piping making up the natural gas system serving Carbondale would fare well in either of the earthquake scenarios. Isolated piping ruptures might occur with either scenario, being more frequent with the Ms=8.6 postulated event. However, damage to service piping and meter sets would require that the system be shut-off immediately following either postulated event.

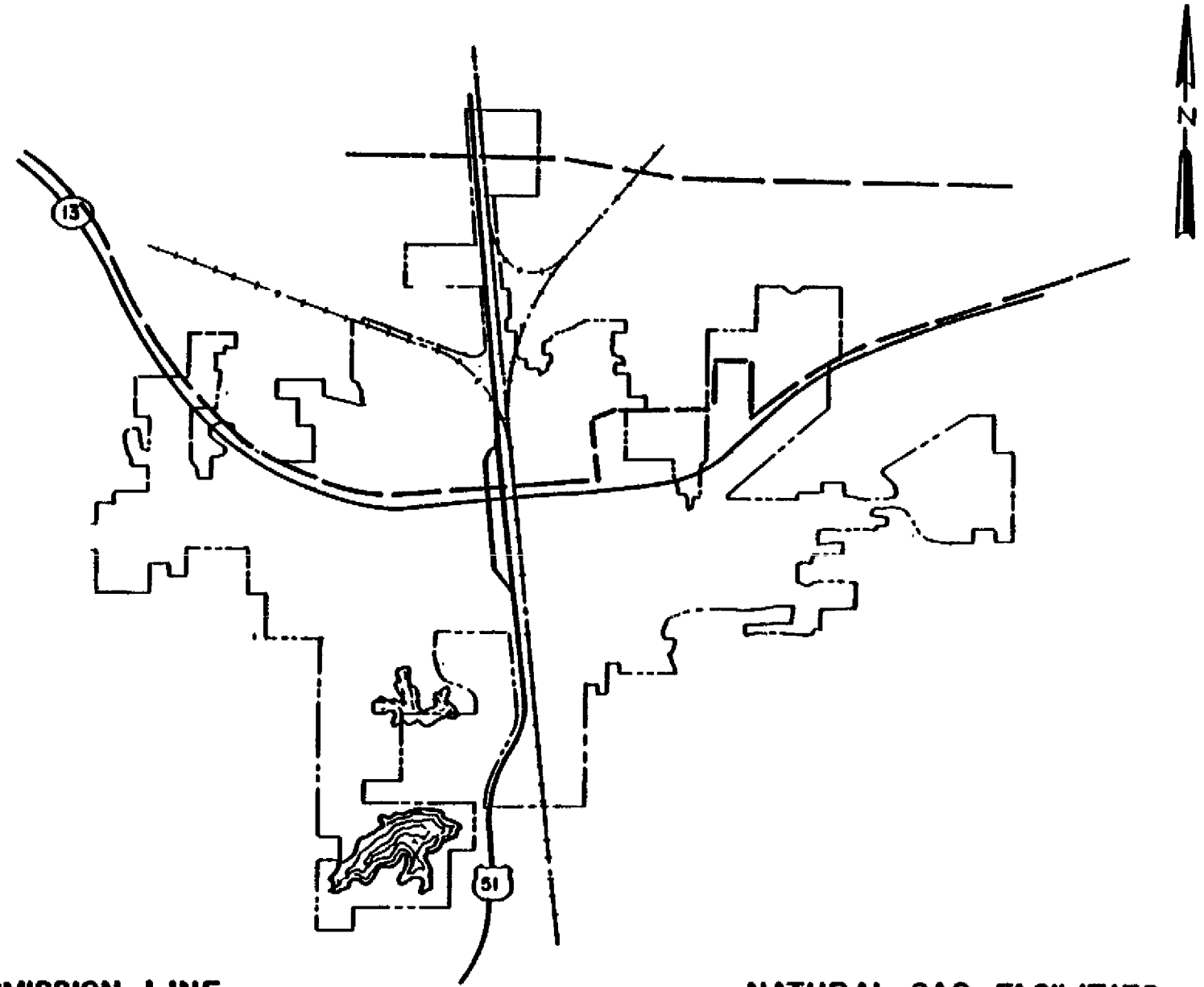
Some areas of the system could probably be restored to service within 24 hours to provide heat to a few selected areas near the system's single purchase point. The full system could be restored in one to two weeks. Major elements of this system are shown in Figure 4-9.

Availability Analysis

As discussed above, this system is estimated to be unavailable immediately following either the Ms=7.6 or the Ms=8.6 scenario earthquakes.

4.6.4 Sewage System

The Carbondale Public Works Department operates two wastewater treatment facilities which serve the Carbondale Township. The Northwest wastewater treatment plant (WWTP) has a design capacity of 2.64 MGD. The activated sludge treatment operations include influent pumping, grit removal, clarification, aeration, and sludge digestion. The Northwest WWTP also has a nearby pretreatment facility on-site through which industrial wastewater is routed prior to treatment in the activated sludge plant. Treated wastwater is discharged into the



——— TRANSMISSION LINE

NATURAL GAS FACILITIES
CARBONDALE, ILLINOIS

Big Muddy River. The Northwest plant receives electrical power from two separate sources. No other auxiliary power source is available. The Southeast wastewater treatment plant is an activated sludge facility with a capacity of 3.9 MGD. The unit processes include an influent pumping station, a grit chamber, clarifiers, aeration basins, chlorine contact basin and sludge treatment facilities. The Southeast WWTP discharges the treated wastewater into Little Crab Orchard Creek. The plant is served by one electrical feed line. A gasoline operated generator provides auxiliary power to a portion of the plant. The locations of the wastewater treatment plants are shown in Figure 4-10 .

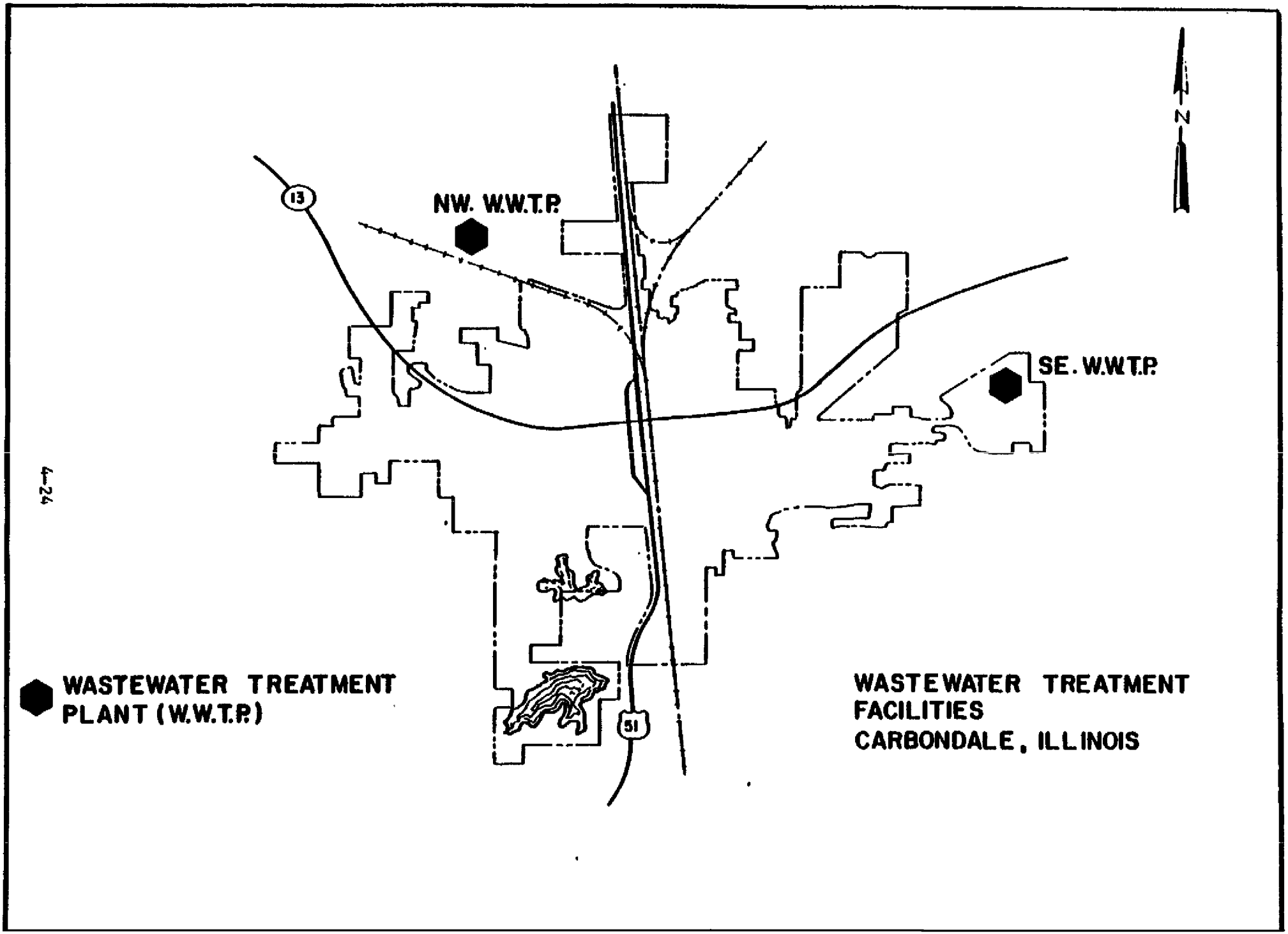
There are five wastewater pumping stations dispersed throughout the city. The sanitary and storm sewer systems are separate in Carbondale. The sanitary sewers are primarily clay pipe, ranging in diameter from 6 inches to 48 inches.

Availability Analysis

This sewage system has a low probability of availability following either postulated earthquake scenario. This is due to the materials of the pipe in the collection system, the probable loss of electric power and structural damage to treatment facilities.

AVAILABILITY ANALYSIS SEWAGE SYSTEMS
CARBONDALE, IL

Number of Structures Surveyed (Treatment Plants: 3)		Structures Estimated To Be Available/Percent	
		Ms=7.6	Ms=8.6
Structures	24	20/83%	12/50%


N
13
NW. W.W.T.P.
SE. W.W.T.P.
51
WASTEWATER TREATMENT PLANT (W.W.T.P.)
WASTEWATER TREATMENT FACILITIES
CARBONDALE, ILLINOIS

SYSTEM AVAILABILITY (Yes/No)	
Ms=7.6	Ms=8.6
No	No

4.7 Dams and Levees

The general circumstances involved with the failure of dams and levees was discussed in Section 3.7. There are no dams in Carbondale's vicinity which would subject this city to significant risk of flooding.

4.8 Residential, Commercial and Industrial Buildings

Section 3.8, Tables 3-6 and 3-7, contains tabulations of damage to these structures for Carbondale. This information was used to compute casualties and building availability.

4.9 Casualties, Displaced Persons and Shelter

4.9.1 Deaths, Injuries and Displaced Persons

The estimated deaths and injuries which would occur in Carbondale as a consequence of the two earthquake scenarios are summarized in the following table:

Source of Casualties	Ms = 7.6				Ms = 8.6			
	Deaths		Injuries		Deaths		Injuries	
	Night	Day	Night	Day	Night	Day	Night	Day
Residential struct.	8	3	30	11	14	5	57	24
Commercial/industrial	1	21	4	83	2	38	8	151
Hospitals							1	1
Schools		22		87		40		160
Universities	20	28	79	110	53	77	211	307
Total casualties	29	74	113	291	69	160	277	643
Per 100,000 population*	92	234	357	919	218	505	875	2,030

* Based upon U.S. Bureau of Census Figure

A higher probable incidence of casualties exists in the primary and secondary schools and at Southern Illinois University.

Relatively few would be experienced in residential structures. No casualties would be estimated to be caused by flooding.

The probability of damage to residences, particularly damage which would cause residences to no longer be habitable, could displace the following numbers of persons:

	Number of Displaced Persons	
	Ms = 7.6	Ms = 8.6
From single family residences	3,000	6,575
From multi-family structures	2,730	4,500
Total	5,730	11,075
Percentage of population	18%	43%

4.9.2 Shelter

The following table shows the number of school structures (non-university) with a probability of surviving, and capable of functioning as shelters, following the postulated earthquake scenarios.

AVAILABILITY OF SCHOOL STRUCTURES FOR SHELTERS

Total Structures Surveyed	Structures Estimated To Be Available/Percent	
	Ms=7.6	Ms=8.6
96	17/18%	6/6%